To the Graduate Council:

I am submitting herewith a thesis written by Paula Teresa DePriest entitled "The Macrolichen Flora of Unaka Mountain, Unicoi County, Tennessee-Yancey County, North Carolina." I have examined the final copy of this thesis for form and content and recommend that it be accepted in partial fulfillment of the requirements for the degree of Master of Science, with a major in Botany.

David K. Smith

David K. Smith, Major Professor

We have read this thesis
and recommend its acceptance:

Edward Shiels

B. Eugene Wofford

Accepted for the Council:

Lew Minkel

The Graduate School

# THE MACROLICHEN FLORA OF UNAKA MOUNTAIN, UNICOI COUNTY, TENNESSEE-YANCEY COUNTY, NORTH CAROLINA

A Thesis

Presented for the

Master of Science

Degree

The University of Tennessee, Knoxville

Paula Teresa DePriest

August 1983

## ACKNOWLEDGMENTS

With deep gratitude I acknowledge the influence of two lichenologists on my studies. Dr. Herbert A. Sierk first introduced me to lichenology when I was an undergraduate at Union University and patiently guided my progress during those early years. First at the University of Montana Field Station and later through correspondence and visits, Dr. Mason E. Hale, Jr. of the Smithsonian Institution has provided expertise in chemotaxonomic methods. In addition his advice in the Parmeliaceous genera of the southern Appalachians has been invaluable in this study.

I wish to express my appreciation to several members of The University of Tennessee, Knoxville, Botany Department. Dr. David K. Smith, serving as my major professor, initiated and guided this lengthy project. My committee members, Drs. Edward Schilling and B. Eugene Wofford, reviewed the manuscript and provided helpful comments in its revision. Additionally, Professors Aaron J. Sharp and Hal DeSelm have provided much information from their extensive personal libraries.

The Cherokee Division of the National Forest Service proved cooperative and helpful in this study, first in permitting collection of the lichen specimens, and secondly in providing detailed information of the study area. Special thanks go to Dr. Levester Pendergrass whose interest made this project possible and to the staff of the Erwin District Office who provided more information on Unaka Mountain than I could use.

Climatic data was supplied generously and freely by the Hydraulic Data Branch of the Tennessee Valley Authority, Knoxville, and the National Weather Bureau, Knoxville Municipal Airport.

I gratefully acknowledge financial support of this study by a Sigma Xi Grant in Aid of Research, the Sharp Fund, and the Botany Department of The University of Tennessee, Knoxville. This funding allowed field studies and travel to the Smithsonian Institution, both crucial to the quality of this study.

I thank my fellow graduate students, especially Frank, Laurina, Debbie, and Adam, for their intellectual and social companionship. To Mrs. Marilyn Caponetti goes my deepest appreciation and thanks for the typing of this lengthy document. Her expertise and insight have been indispensable.

To my parents I am deeply indebted--to my father for his continuing support, concern, and encouragement and to my mother for her invaluable aid in the field portion of this study.

## ABSTRACT

The purpose of this study was to examine the macrolichen flora of Unaka Mountain. The study site, located centrally in the southern Appalachians, and the elevational zone, 3000 to 5238 ft., had not been studied previously. Results of this study expand and complement previous lichenological studies of high elevational areas in the southern Appalachians.

Macrolichens were collected from available substrates in 14 sites representing the vascular plant communities and unique habitats present in this elevational zone. After morphological examination many specimens were examined for chemical composition using spot tests and, when important, thin layer chromatography. Lichen substances determined by these techniques formed the basis of identification of chemical species in many genera.

A total of 142 species in 40 genera were collected in the study area. Specimens were used to prepare descriptions expressing the range of variability within the species on Unaka Mountain. Keys were prepared to families, genera, and species, including taxa not collected in the study site but known from the southern Appalachians. Information for each species within the study area included substrate, community, and elevational preferences, and an estimate of abundance.

Distributional patterns of the species are compiled into 10 world and 11 North American patterns, and general preferences on

Unaka Mountain. The report of Parmelina spathulata (Kurok.) Hale, the first for North America, represents a significant range extension from its African distribution.

A number of nomenclatural changes have been recognized at both the generic and species level. The segregate genera Bryoria, Cladina, Evernastrum, Hypotrachyna, Melanelia, Parmelina, Parmotrema, Phaeophyscia, Physconia, and Pseudoparmelia are used in this study. New specific epithets due to nomenclatural and taxonomic changes include Cladonia rei Schaer., Collema subflaccidum Degel., Phaeophyscia rubropulchra (Degel.) Moberg, Physconia detersa (Nyl.) Poelt, and Ramalina americana Hale.

TABLE OF CONTENTS


| CHAPTER | | PAGE |
|---|---|---|
| INTRODUCTION | | 1 |
| I. | DESCRIPTION OF THE STUDY SITE | 5 |
| | Location | 5 |
| | History | 8 |
| | Physiography | 11 |
| | Geology | 12 |
| | Climate | 15 |
| | Vegetation and Community Types | 17 |
| II. | MATERIALS AND METHODS | 21 |
| III. | TAXONOMIC AND FLORISTIC ANALYSIS | 25 |
| | Verrucariaceae | 33 |
| | 1. *Normandina* | 34 |
| | Collemataceae | 35 |
| | 2. *Collema* | 36 |
| | 3. *Leptogium* | 40 |
| | 4. *Polychidium* | 45 |
| | Peltigeraceae | 47 |
| | 5. *Peltigera* | 47 |
| | Stictaceae | 54 |
| | 6. *Lobaria* | 55 |
| | 7. *Sticta* | 59 |
| | Stereocaulaceae | 61 |
| | 8. *Stereocaulon* | 61 |
| | Baeomycetaceae | 65 |
| | 9. *Baeomyces* | 65 |
| | Cladoniaceae | 67 |
| | 10. *Cladina* | 68 |
| | 11. *Cladonia* | 73 |
| | 12. *Pycnothelia* | 115 |
| | Umbilicariaceae | 116 |
| | 13. *Lasallia* | 117 |
| | 14. *Umbilicaria* | 118 |
| | Hypogymniaceae | 121 |
| | 15. *Hypogymnia* | 122 |
| | 16. *Menegazzia* | 127 |
| | 17. *Pseudevernia* | 129 |
| | Parmeliaceae | 132 |
| | 18. *Cetraria* | 134 |
| | 19. *Cetrelia* | 140 |
| | 20. *Everniastrum* | 145 |

CHAPTER PAGE

III. (Continued)
21. Hypotrachyna . . . . . 147
22. Melanelia. . . . . 167
23. Parmelia . . . . . 171
24. Parmelina. . . . . 188
25. Parmeliopsis . . . . . 197
26. Parmotrema . . . . . 200
27. Platismatia. . . . . 215
28. Pseudoparmelia . . . . . 217
29. Xanthoparmelia . . . . . 221
Anziaceae. . . . . 228
30. Anzia. . . . . 228
Usneaceae. . . . . 230
31. Bryoria. . . . . 230
32. Usnea. . . . . 232
Ramalinaceae . . . . . 244
33. Ramalina . . . . . 244
Candelariaceae . . . . . 246
34. Candelaria . . . . . 247
Physciaceae. . . . . 248
35. Anaptychia . . . . . 250
36. Heterodermia . . . . . 251
37. Phaeophyscia . . . . . 264
38. Physcia. . . . . 270
39. Physconia. . . . . 274
40. Pyxine . . . . . 275

IV. DISTRIBUTION . . . . . 279
Unaka Mountain Distributions . . . . . 279
North American and World Distributions . . . . . 289

V. SUMMARY. . . . . 297

LITERATURE CITED . . . . . 305

APPENDIX . . . . . 314

VITA . . . . . 321

# INTRODUCTION

Lichenological investigations in the southern Appalachians have centered on collections and field observations around the easily accessible, scenic areas of the National Parks, or highest elevational zones along the Appalachian Trail. These studies have produced a strong body of knowledge concerning these areas. Lower elevational and often less accessible sites remain largely unstudied, accounting for a large gap in our understanding of the lichen flora.

The first floristic study of lichens in the southern Appalachians was conducted by Degelius (1941). In a two-week visit to the Great Smoky Mountains National Park, the European lichenologist collected 206 species of crustose, foliose, and fruticose lichens, 15 of which were new to science. Included in this study were observations on altitudinal and geographical distributions. A total of 96 species (47%) were found exclusively in the coniferous forest, 66 (32%) in the deciduous forest, and the remaining 43 (27%) in both zones.

Moore (1963) examined herbarium and field collections to prepare a preliminary checklist of foliose and fruticose lichens of the Great Smoky Mountains National Park. The study documented the presence of 131 species in 30 genera and produced keys to the species, descriptions, and ecological notes. One Tennessee state checklist has been prepared in which 427 lichen species in 94 genera

were reported (Skorepa, 1972). Of these 375 (65%) were fruticose or foliose. Recent changes in nomenclatural and taxonomic concepts, largely due to the development of chemical taxonomic techniques, have made these treatments incomplete and ineffective.

Recent studies (Dey, 1975, 1977, 1978, 1979) have examined the fruticose and foliose lichen flora of the high elevational areas above 5500 ft. elevation in the southern Appalachians. Dey emphasized species restricted to fraser fir, a species now threatened by the balsam woolly aphid. Based on herbarium collections and specimens from collecting sites in Virginia, North Carolina, and Tennessee, 178 species were documented, with 250 species proposed as present throughout the range. Descriptions were prepared which included morphological characteristics, chemical constituents, substrate preferences, and estimates of abundance. Distributions within communities supplemented more general patterns along the Appalachian chain, within North America, and throughout the world.

Studies of lichens in the southern Appalachians have focused on the richness of the flora which has been enhanced by elements of boreal, montane, and southern floras. Skorepa (1972) examined this feature and defined 13 general distributional patterns for North America represented in the Tennessee lichen flora. In the high elevational flora, Dey (1979) found representatives of 10 of these distributions ranging from widespread in the North American continent to narrowly endemic to the southern Appalachians. Occurrences of representatives of these floristic units have variously been

ascribed to distributional history, climatic conditions, elevation, and substrate availability.

Unaka Mountain represents a suitable and favorable study area because of its central position in the southern Appalachians and close proximity to high elevational areas already intensely studied. It offers typical mid-elevation communities, a number of unique areas, and an interesting and well-documented natural history. Reaching a maximum elevation of 5238 ft., Unaka Mountain falls just short of the lowest elevation in Dey's (1975) survey.

The principal goal of this study is to document the macrolichen flora of Unaka Mountain. The study has produced a taxonomic list of macrolichens and descriptions of each species with keys to the families, genera, and species. The keys include extralimited taxa known elsewhere in the southern Appalachians.

The descriptions are supplemented with information important in identification of the taxa. The chemical composition, crucial in many genera for species delineation, has been determined by thin layer chromatography (TLC) or derived from literature sources and listed along with chemical spot test reactions. Diagnostic characteristics of each species are discussed and compared with similar species present in the southern Appalachians. Taxonomic and nomenclatural problems are noted where appropriate.

Distributional information accompanies each description and is compiled in Chapter IV. This includes an estimate of abundance in the study area and the substrates, community types, and

elevational zone in which specimens were collected. These distributional patterns are compared to distributions of the species in the southern Appalachians (Dey, 1975, 1981; Esslinger, 1981). North American and world-wide ranges, derived from monographs and floras, are listed and compiled into 11 North American and 10 world-wide patterns.

# CHAPTER I

## DESCRIPTION OF THE STUDY SITE

### I. LOCATION

Unaka Mountain is an isolated ridge of the Unaka Range of the southern Appalachians (see Figure 1). A major portion of the mountain is contained within the Cherokee National Forest of Unicoi Co., Tennessee, and the Pisgah National Forest of Yancey Co., North Carolina. The northeast-southwest crest of this mountain ridge forms the boundary between these two states and is followed by the Appalachian Trail.

The southern boundary of the mountain is formed by the Nolichucky River which carves through the Unaka Range draining the intermountain basins, western slopes of the Blue Ridge and the eastern slopes of the Unakas. To the west, the mountain dips to a broad valley where the towns of Erwin and Unicoi, Tennessee are located. The northern boundary is Limestone Cove, followed by US 107 connecting Unicoi and Buladeen, North Carolina. To the north Unaka Mountain joins Iron Mountain at Iron Mountain Gap. On the east, the slopes are dissected into smaller southeast-northwest ridges which grade into the intermountain basin of the southern Appalachians. For the purposes of this study, Poplar Creek in North Carolina forms the eastern boundary of the mountain.

Figure 1. Location of the study site.

A. Location of study sites on Unaka Mountain:

(1) Beauty Spot

(2) Beauty Spot Forest

(3) Beauty Spot Gap

(4) Cherry Gap Trail

(5) Chestnut Knob

(6) Horseback Ridge

(7) North Beauty Spot

(8) Rattlesnake Ridge

(9) Roadcut

(10) Rock Creek Headwaters

(11) Rockslide Area

(12) Stamping Ground Ridge

(13) Summit

(14) White Pine Plantation

B. Location of Unaka Mountain within the southern Appalachians.

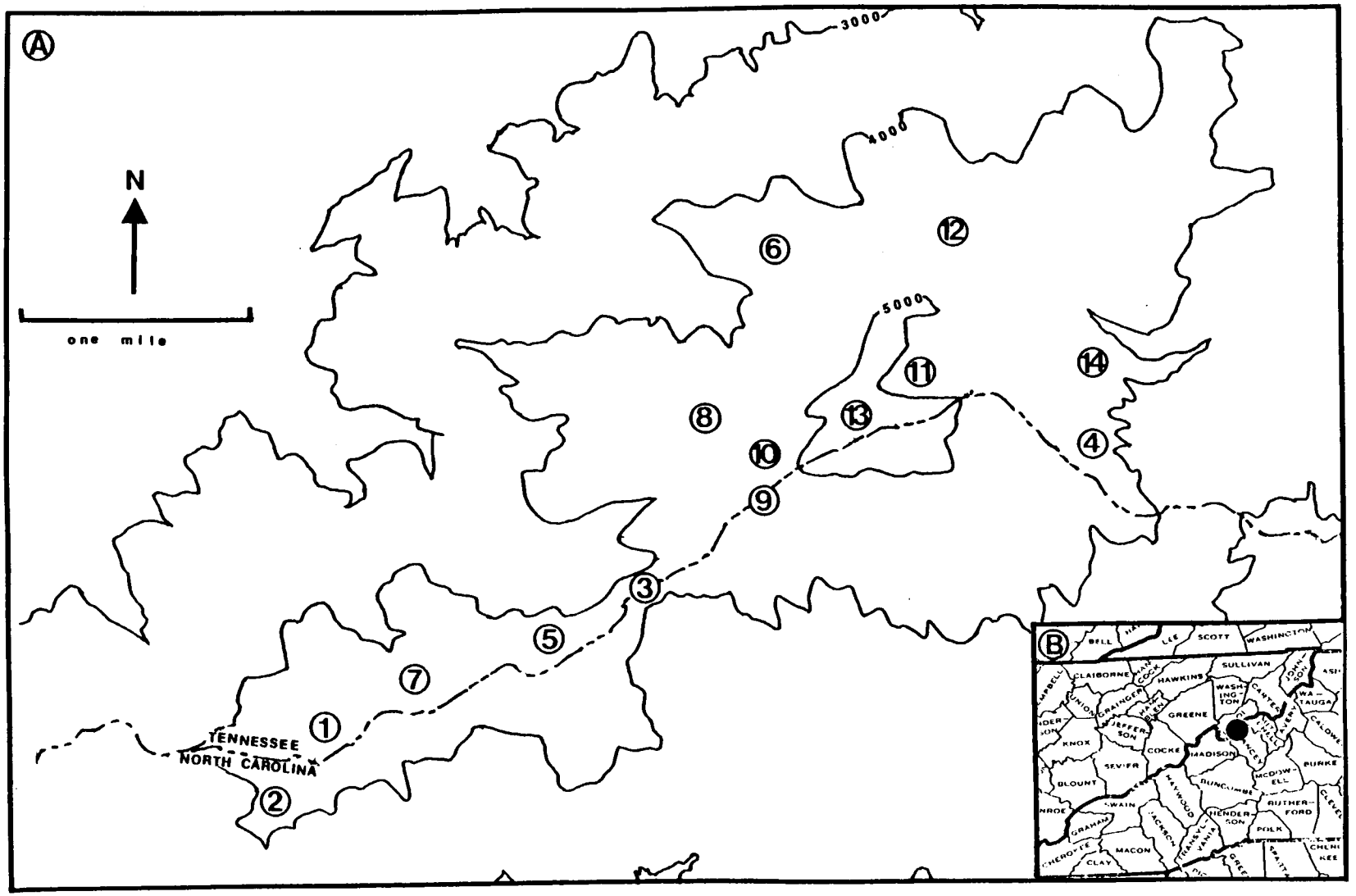

A
N
one mile
3000
4000
5000
TENNESSEE
NORTH CAROLINA
1
2
3
4
5
6
7
8
9
10
11
12
13
14
B
BELL
LEE
SCOTT
WASHINGTON
SULLIVAN
CLAIBORNE
HAWKINS
GREENE
KNOX
COCKE
MADISON
SEVIER
BLOUNT
BUNCOMBE
MACON
CLAY
GRAHAM
SWAIN
POLK
RUTHERFORD

Figure 1

Unaka Mountain lies approximately 60 miles south to Mt. Rogers, Virginia where the Blue Ridge and Unaka Ranges of the southern Appalachians diverge. These ranges, the Blue Ridge to the south and east, and the Unaka Range, to the north and west, are separated by a series of interior basins extending from southwestern Virginia to northern Georgia. Many cross ranges, expressions of structural irregularities in the underlying rock formations (Burchfield, 1941), extend southward from the Unaka Range to the Blue Ridge. The highest of the cross ranges, Roan Mountain (elevation 6285 ft.) is approximately 10 miles to the northeast of Unaka Mountain.

The Continental Divide follows the crest of the Blue Ridge, although the western Unaka Range is higher and more rugged. This younger western system is deeply cut by a westerly drainage of the interior slopes and intermountain basin. The highest peak in the Blue Ridge is Mt. Mitchell (elevation 6684 ft.) which lies 20 miles to the east of Unaka Mountain. A number of prominent peaks are contained in the Great Smoky Mountains National Park, located 60 miles to the southwest and in the same mountain range as the study area.

## II. HISTORY

Unaka Mountain became a part of the Unaka National Forest in 1914. It was later incorporated into the Cherokee and Pisgah National Forests. Prior to this time the area was in private ownership with a number of homesites and pastures throughout the region. The economic

value of the mountain lay in its timber production. Cutting-over was extensive and the timber was removed by short-gauge railroad to Limestone Cove (Payne, 1966). A number of cleared areas were maintained for pasture, the most important of which was Beauty Spot. This site remained in private ownership until 1965 and Lefler (1978) estimated that grazing continued through that time. Other private inholdings are presently in similar use. Cut-over areas near the summit (i.e., on Stamping Ground Ridge) were burned as late as 1915 to increase blueberry production (Payne, 1966).

The most severe fire season in Southeastern Forest Service history was in 1925. In that summer Unaka Mountain recorded five fires. The first four occurred in August burning less than 318 acres (Kelly, 1926). The fifth fire was first spotted on August 27 in the Red Fork Drainage at an elevation of 3500 ft. (Dahl and Stoneburner, 1925). A Board of Review Report (Kelly, 1926) listed the cause of the fire as incendiary, starting in leaf, brush, and litter accumulation. Initially 148 acres burned within maintained fire lines. Break-overs on August 31 and September 4 swept the fire over Stamping Ground Ridge, Rattlesnake Ridge, Horseback Ridge, and the mountain summit (Board of Review, 1925). Showers in September 10, 11, 12, and 13 halted the fire as it reached Beauty Spot Gap and the Forest Service was able to control the burn.

On September 22, 1925 a letter from the Forest Supervisor to the Erwin Forest Ranger noted that there was "still some fire on Rocky Brand burning in the tuff." Fire crews continued working in the Dicks Creek Area to put out ground fires. By October 1, the fire

was completely out (Kelly, 1926), with a total of 5379 acres burned. In the National Forest holdings, 200 acres of mature forest and 4779 acres of second growth were completely destroyed. Sixty-five percent (400 acres) of private inholdings were destroyed.

Photographs of high elevational slopes taken one year after the fire showed 75% exposed rock, bare tree roots, and severely eroded soil. Six years later, typical vegetation was blackberry, hay-scented fern, and bracken fern, with a moderate overstory of fire cherry (Forest Service Photographs). Approximately 1000 acres were replanted with white pine, tulip poplar, red spruce, northern red oak, and chestnut between 1930 and 1935 (Woods, 1953). In 1943, red spruce was planted in the Pleasant Gardens area at a density of 1000 trees per acre (Payne, 1966). Many areas were not available for restocking because of the rock debris and taluslike slides.

After 45 years many fire scars still exist. Large boulder fields and slides are exposed on the steeper slopes. Vegetation in these areas consists largely of ferns and shrubs with widely spaced trees along the edges of the slides where soil has accumulated. Ericaceous shrubs are dominant on the edges of the boulder fields of Stamping Ground, Horseback, and Rattlesnake Ridges.

In recent years timber harvesting by clear-cutting has continued in the low elevations on the mountain (aerial photograph, Lefler, 1978; Forest Service Timber Management Reports, unpublished). The large grassy bald at Beauty Spot has been maintained since 1975 through annual mowing. This management practice has retarded white pine encroachment (Lefler, 1978).

# III. PHYSIOGRAPHY

Unaka Mountain comprises a long crest with three peaks and a rich system of ridges extending in all directions. The summit reaches a maximum elevation of 5238 ft. in the westernmost peak, 5037 ft. in the northeastern peak, and 4957 ft. in the southeastern peak (Payne, 1966). The ridge extends northeast through Cherry Gap and Low Gap to Iron Mountain Gap where it joins the Iron Mountain Ridge. The steep western slopes drain into the Red Fork River and are littered with long boulder slides. Broader boulder fields occur on the southwestern slopes of the summit.

South of the summit the ridge dips to a narrow saddle, Beauty Spot Gap. On the east, the slopes plummet to Poplar Creek, and on the west to the headwaters of Rock Creek. From Beauty Spot Gap the ridge ascends to Beauty Spot (4200 ft.), a rounded grassy bald. The elevation drops to 3000 ft. at Indian Grave Gap, and to the south increases to 3700 ft. At Ephram's Place, the ridge drops to the Nolichucky River exposing sedimentary cliffs.

Rattlesnake Ridge extends in a southwesterly direction from the summit. At Pleasant Gardens it reaches a maximum elevation of 4800 ft. Horseback Ridge forms a narrow spur northwest of the peak. A backbone of granite bedrock is exposed along the ridge between 4900 and 4600 ft. elevations. Extending north into Limestone Cove, Stamping Ground Ridge is an undulating ridge line with large block fields and slides.

Red Fork and Falls Branch Creek drain the eastern slopes of Stamping Ground Ridge and the northwestern mountain ridge. Below the convergence of these streams a high falls is preceded by a series of cascades. The western bank of the falls is a sheer rock wall and to the east the gorge opens into a sheltered cove. The eastern slopes of Stamping Ground Ridge, Horseback Ridge, and the northern portion of Rattlesnake Ridge form the Lick's Creek Watershed. Rock Creek drains the southern slopes of Rattlesnake Ridge and the western mountain ridge, with a falls at 2500 ft. elevation. On the eastern side of the ridge numerous small ridges extend into the intermountain basin and are drained by Poplar Creek.

## IV. GEOLOGY

The geological formation of Unaka Mountain is a result of complex thrusting and overthrusting of the Bald Mountain, Iron Mountain, Shady Valley, and Limestone Cove sheets. At the summit of the mountain the Limestone Cove Overthrust has been eroded forming the Limestone Cove Window and exposing pre-Cambrian crystalline complexes which are mostly granite (King et al., 1941). On the western slopes at 4600 ft. elevation the first bands of quartzites and slates in the Unicoi formation are seen. This formation, the oldest of the Lower Cambrian basal clastic group, surrounds the pre-Cambrian granite on three sides and forms much of the crest of the mountain.

In the Limestone Window as elevation decreases, the Unicoi formation is replaced by the Hampton and Erwin formations.

The Hampton formation, the second basal clastic group deposited, often forms mountain ridges with sags or strike valleys. The Erwin formation, the most recent basal clastic deposit, often produces ledges of vitreous quartzite which show little weathering.

Deposits of granite have been mapped where the edge of the Limestone Cove overthrust contacts the Mountain City Window. The Mountain City Window is a product of the erosion of the Bald Mountains and Shady Valley Thrust Sheets covering the area where the Iron Mountain and Stone Mountain Sheets join. In this window, the Unicoi formation reappears as a broad band extending from the Dicks Creek Area on the northwest face to the Nolichucky River on the southwest face, and then is replaced by narrow bands of the Hampton and Erwin formations. The presence of two slip lines in the window accounts for the two repetitions of the Unicoi, Hampton, and Erwin series. Inside the second repetition, the Shady Dolomite Formation of more recent origin, occurs for the first time between the Erwin formation and the edge of the window.

The Iron Mountain Overthrust replaces the Mountain City Window. Because of its location in the valley relatively little erosion has occurred. The oldest layer exposed is the Erwin Formation which only appears in the Grassy Cove area near Unaka Springs. In this area the Shady Dolomite Formation forms the second band, whereas to the north it forms the first band.

The Rome Formation appears in a narrow band between the cities of Erwin and Unicoi. Named for Rome, Georgia, it is characterized by

red shale and siltstone, some green shale, and some dolomite. Alluvial deposits are found along the major creeks such as Rock Creek, North Indian Creek, and South Indian Creek.

Many high elevational slopes on Unaka Mountain are covered by granitic rock rubble. Boulder size varies from ca. 6 in. to 4 ft. as measured along the longest face. The most extensive rubble areas spill-down the slopes just north of the summit into the drainage area between the main ridge and Stamping Ground Ridge at elevations of between 5000 and 4300 ft. This linear array is joined by a broader rock exposure on the southwest slope of Stamping Ground Ridge. Similar areas occur on the western slope of the summit. Rubble slides are classified as boulder fields, blockfields, and blockstreams (Michalek, 1968), scree (Hack, 1965), talus (King and Ferguson, 1969), and colluvial debris slides (Sharp, et al., 1975). Similar slides have been studied in the Southern Blue Ridge (Michalek, 1968), Balsam Mountains (Weaver, 1972), Great Smoky Mountains (King, 1964), northeastern Tennessee (King and Ferguson, 1969), Shenandoah Valley (Hack, 1965), and Cumberland Escarpment (Sharp, et al., 1975).

Frost action and solifluction during the waning stages of glaciation have been proposed as a mechanism for breaking-up the bedrock and heaving boulders through the colluvial mantle to the surface (Weaver, 1972). Before the fire of 1925 existing scree on Unaka Mountain may have been covered by spruce forest and a mantle of soil largely organic in nature as Weaver (1972) described for the Balsam Mountains. In the intense fire, the organic soil

burned, and the vegetation was completely destroyed. Rapid run-off would have removed the remaining mineral soils and exposed the bedrock or scree. Exposed scree may have moved down the slope or new scree may have been formed by frost action and solifluction due to exposure of the bedrock at high elevations to extreme climate as has been proposed for scree formation in the Shanendoah Valley (Hack, 1965).

## V. CLIMATE

The southern Appalachians are under the influence of two storm centers; one bringing moisture from the Gulf of Mexico along the Atlantic Coast to the northeast, and the second moving from Oklahoma to the coast of Maine (U.S. Dept. Agric., 1941). In general, a decrease in precipitation is measured from south to north (U.S. Dept. Com., 1960); however, local topography may obscure this climatic pattern. Uplifting of the air masses due to interception by the complex ridges of the southern Appalachians cools the air and condenses-out precipitation. As elevation increases, precipitation increases (Smallshaw, 1953; Tennessee Valley Authority, 1955) while temperature and growing season decrease (Tanner, 1963). Upper East Tennessee is shielded on the east by the high elevational ridges of the Unaka and Blue Ridge Ranges, and to the west by the Cumberland Plateau. Air masses entering the area are warmer and drier due to this blocking effect (Nat. Oc. Atmosph. Admin., 1980).

Eastern Tennessee has an annual mean temperature of 57° F, with the lowest annual mean 53° F reported by Mountain City (2371 ft.),

and the highest, 60° F, by Chattanooga (808 ft.). Highest monthly averages occur in July and lowest in January. Average length of the growing season varies from 130 on the highest mountains (U.S. Dept. Com., 1960) to 207 days at Lookout Mountain (U.S. Dept. Com., 1957). On the average the first killing frost of autumn occurs on October 21 and the last killing frost on April 15, a growing season of 189 days (U.S. Dept. Com., 1957).

Average annual precipitation is 50 in. for East Tennessee (U.S. Dept. Com., 1930) with 55 in. in the Appalachian Mountain area (Smallshaw, 1953). A state low of 39 in. is recorded in the Great Valley of northeastern Tennessee, and a state high of 93 in. on high elevation ridges of the Great Smoky Mountains National Park (Smallshaw, 1953). Highest monthly averages occur in July due to shower and thunderstorm activity (U.S. Dept. Com., 1960). Lowest monthly averages are measured in October. Average snowfall for Tennessee is 9 in., ranging from 6 in. in Memphis to 22 in. in Mountain City (U.S. Dept. Com., 1941). Higher snowfall averages occur in the mountainous regions.

Air masses reaching Unaka Mountain are blocked to the west by the Cumberland Plateau and to the east by higher ridges of the Blue Ridge and Unaka Ranges, leaving dry and somewhat warm conditions (Nat. Oc. Atmos. Admin., 1980). The elevational gain of 3000 ft. from the valley floor to the mountain ridge indicates an increase in precipitation and a decrease in both temperature and growing season length. At Beauty Spot, precipitation gauges maintained between

1924 and 1969 by the Tennessee Valley Authority recorded a yearly average of 50.07 in. with the highest monthly average, 5.7 in. in July, and the lowest monthly average, 3.01 in. in October. Nearby sites record yearly averages of 47.57 in. at Erwin, 47.92 in. at Poplar, North Carolina, and 50.81 in. at Sams Gap. The Beauty Spot gauge may not express the expected increase in precipitation resulting from increase in elevation because of its ridge crest position (Smallshaw, 1953; Tennessee Valley Authority, 1955).

Monthly average temperatures at the Erwin reporting station range from 33.8° F in January to 73.0° F in July, with a yearly average of 54.2° F. A 5-10° F decrease in temperature is expected for the mountain peak because of the elevational increase (Tanner, 1963).

More complete climatic data for the Unaka Mountain area are presented in Table 1.

## VI. VEGETATION AND COMMUNITY TYPES

The Cherokee National Forest is classified into forest types based on plurality of species in stock overstory (U.S. Forest Service, 1971). These divisions are used to identify compartments uniform in composition, stand age, and slope (Forest Service Timber Management Reports, unpublished). Unforested areas are classified as grass communities, shrub communities, and cleared areas. On Unaka Mountain five major forest types are present: spruce, maple-beech-birch, oak-hickory, oak-pine, and white pine. Additionally, all divisions of unforested areas are represented.

Table 1. Climatic Data from Stations Reporting in the Unaka Mountain Area.

| Station | Source | Normal Temp. °F | | | Precipitation in Inches | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Jan. | July | Yr. | J | F | M | A | M | J | J | A | S | O | N | D | Total |
| Beauty Spot, NC | Precip. 35 yrs.[1] | | | | 4.3 | 4.3 | 4.8 | 4.1 | 4.1 | 4.3 | 6.0 | 4.6 | 3.5 | 3.0 | 3.6 | 3.3 | 50.1 |
| Erwin, TN | Precip. 46 yrs.[2]<br>Temp. 2 yrs.[3] | 33.5 | 73.0 | | 3.7 | 3.7 | 4.6 | 3.7 | 4.7 | 4.2 | 5.8 | 4.4 | 3.6 | 2.7 | 3.1 | 3.3 | 47.6 |
| Unicoi, TN | Temp. 3 yrs.[4] | 29.5 | 73.6 | | | | | | | | | | | | | | |
| Johnson City, TN | Precip. 33 yrs.[5]<br>Temp. 20 yrs. | 38.5 | 75.6 | | 3.2 | 3.8 | 4.4 | 3.6 | 4.0 | 4.4 | 4.5 | 4.6 | 2.8 | 2.6 | 2.4 | 3.5 | 43.5 |
| Poplar, NC | Precip. 35 yrs.[6] | | | | 3.1 | 3.5 | 4.7 | 3.9 | 4.2 | 4.5 | 5.2 | 4.5 | 3.7 | 3.0 | 3.5 | 3.4 | 48.0 |
| Bristol, TN | Precip. 40 yrs.[7]<br>Temp. 40 yrs. | 36.0 | 74.8 | 56.0 | 3.6 | 3.4 | 4.1 | 3.2 | 3.6 | 3.5 | 4.8 | 3.5 | 3.0 | 2.3 | 2.8 | 3.4 | 41.1 |
| Sam's Gap, NC | Precip. 27 yrs.[8] | | | | 4.4 | 4.2 | 5.5 | 4.3 | 4.3 | 4.3 | 5.0 | 4.0 | 3.7 | 3.2 | 3.9 | 3.8 | 50.8 |

[1]Tennessee Valley Authority, 1934-1969.

[2]Tennessee Valley Authority, 1926-1980.

[3]United States Department of Commerce, Weather Bureau 1976-1978.

[4]United States Department of Commerce, Weather Bureau 1980-1981.

[5]National Oceanic and Atmospheric Administration, 1980.

[6]Tennessee Valley Authority, 1945-1980.

[7]National Oceanic and Atmospheric Administration, 1980.

[8]Tennessee Valley Authority, 1953-1980.

The summit of the mountain is a spruce forest interspersed with northern hardwoods. The canopy is closed and the forest floor relatively clear. Second growth northern hardwoods replace the spruce as elevation decreases north of the summit. In many stands tulip poplar is dominant. White pine plantations occur at intermediate elevations around 4000 ft.

South of the summit are large shrub-dominated stands of blueberry, rhododendron, and blackberry interspersed with fire cherry. The broad boulder fields in this area, as well as other areas, are bordered by fire cherry and other northern hardwoods. These hardwoods replace the shrub communities as elevation decreases to Beauty Spot Gap. This saddle gap was only partially damaged in the 1925 fire and now has a grove of honey locust trees as well as mature oaks, mountain ash, and maples. The protected coves on either side of this gap have well-developed cove hardwood forest.

Beauty Spot is a maintained grassy bald ringed by white pine and hawthorns. The gentle, rounded slopes have large mats of lycopods, polytrichaceous moss, and strawberry. On all sides the pasture is surrounded by northern red oak-dominated forest.

A spruce plantation, dating from the 1930's is located at Pleasant Garden on Rattlesnake Ridge. The closed spruce forest is situated on the crest and colder north slope. On the southwest slopes a large heath slick replaces this plantation. At lower elevations northern hardwoods, oak, and eventually cove hardwood communities are dominant.

The narrow rock backbone of Horseback Ridge is edged with ericaceous shrubs, serviceberry, pines, and stunted spruce trees. A dense heath slick occurs on the southwest slope until replaced by hardwood communities. Stamping Ground Ridge differs in having boulder fields and slides with heath gardens. The well-spaced blueberry shrubs are a favorite for berry pickers. These ericaceous communities follow the ridge crest and are replaced in sheltered gaps by spruce plantations and mesic forest. Such forest quickly grades into northern hardwoods and red oak forest.

The cove areas along Red Fork and Falls Branch Creeks display cove hardwoods and other secondary successional forests.

# CHAPTER II

## MATERIALS AND METHODS

This study was based on approximately 2000 collections made in the fall of 1979 and spring and summer of 1980. Collecting sites representative of each major community were identified from Forest Service Timber Management Reports (unpublished) and selected by accessibility and topography. Unique habitats were also selected for collecting. For descriptions of the sites, see Appendix. Within each site collections of representative lichens were made from all available substrates.

Following morphological sorting, specimens were screened for chemical composition using standard spot test reagents: potassium hydroxide (K); calcium hypochlorite (C); and paraphenylenediamine (PD). Small amounts of reagent were applied to the cortex and medulla using a capillary tube. A positive reaction was indicated by a visual color shift due to compounds present in the thallus.

The K test reacts to a diverse group of compounds with at least one acidic functional group (Santesson, 1973). A positive reaction results in formation of salts with a red, yellow, or dark red to violet color. The color response may be immediate, as in the K+ deep yellow thamnolic acid, or gradual, requiring a few minutes, K+ yellow turning red, norstictic acid. A dingy color response is not considered a positive reaction.

Since 1866 when Nylander first used calcium hypochlorite as a taxonomic tool the C test has been a standard spot test. Today sodium hypochlorite, easily obtained as commercial liquid bleach, is frequently substituted. A positive reaction, a pink to red color, indicates the presence of aromatic compounds with "two free hydroxyl groups meta to each other" (Santesson, 1973). Strepsilin, present in Cladonia strepsilis, has a blue-green color. Excess calcium hypochlorite destroys the color change and this test should be observed carefully. Often scratching the exposed medulla will start the reaction. The mechanism of this reaction is not known, but may involve chlorination and oxidation with formation of a quinonoid structure.

K and C reagents are often combined in the KC test where application of KOH is followed immediately by $CA(OCl)_2$. The K is thought to hydrolyze ester bonds to prepare depsides and depsidones for the C test. The reaction gives a rose or red color change which may be fleeting or persistent (Santesson, 1973).

The PD test was developed by Asahina in 1934. It is prepared by dissolving crystals of paraphenylenediamine in ethanol and must be prepared the day of use. Yellow, orange, orange-red, or red Schiff bases are produced in reaction to aromatic aldehydes.

Over 500 specimens were analyzed using standard thin layer chromatographic methods developed by Culberson and Kristinsson (1970), and improved by Culberson (1972, 1974) and Culberson et al. (1981). Acetone extracts of the specimens were spotted on

precoated Merek silica gel 60 $F_{254}$ Plates (thickness 0.2 mm). Plates were developed in three solvent systems (Culberson, 1972; Culberson et al., 1981): toluene, 1,4-dioxane, and acetic acid in the following proportion (180, 45, 5; 230 ml); hexane, diethyl ether, and formic acid (120, 90, 20; 230 ml); and toluene, ethyl acetate, and formic acid (139, 83, 8; 230 ml). The first and third systems are modified from those proposed by Culberson in 1972. In system one, toluene replaces the potentially carcinogenic benzene. The third system was developed specifically for use in the genera Hypotrachyna and Parmelina and improves separation of compounds and resists shifts in concentration for up to two weeks.

Spotted plates were developed in standard chromatography tanks which were at constant temperature and had reached saturation equilibria. The solvent front was allowed to advance to a height of 10 cm above the base line. After removal from the solvent the plates were air dried completely.

All plates were scanned with long- and short-UV light. All spots visualized were circled and those fluorescing labeled and their color recorded. This step was essential for identification of alectoronic and squamatic acids.

For permanent visualization a 10% solution of sulfuric acid was used to oxidize chemical compounds. The acid developer was sprayed with an atomizer until the surface was evenly covered and damp. Overspraying causes soaking and results in streaking and shifting of the spots or uneven development.

Culberson (1972) suggested that sprayed plates develop for 10 minutes in a 110° C oven. However, such an oven was not available and a cooler oven (between 70° and 100° C) proved satisfactory. The developing time was increased to between 20 and 40 minutes which actually allowed better control of development. The plates were removed before their maximum color was obtained and allowed to completely oxidize at ambient temperature. After a few days the optimum color was obtained and the binder showed less destruction than with standard oxidation techniques.

Color of the spots and their $R_f$ values in the three systems were used to identify the compounds. More important than the absolute $R_f$ value is its position relative to standard compounds. Extract from Parmotrema hypotropum was run on each plate with the positions of atranorin and norstictic acid used to divide the plate into $R_f$ classes. The approximate $R_f$ classes in the three solvent systems for each compound were compared to a table of values (Culberson, 1972) to determine possible identities. Consideration of spot size, shape, color and co-chromatography was used to confirm identities.

Determination of the chemical constituents has proven essential in many groups for correct identification of species. Chemical compounds present in specific taxa are listed in monographic and floristic treatments and have been cataloged (Culberson, 1969, 1970; Culberson, et al., 1977). Comparison of the chemical composition determined by standard TLC methods to that published in other studies was used to confirm or reject taxonomic identities.

# CHAPTER III

## TAXONOMIC AND FLORISTIC ANALYSIS

Descriptions of the species of macrolichens from Unaka Mountain have been prepared from material collected during this study. The descriptions include citations following presently accepted nomenclature from monographic or floristic treatments (Dey, 1975, 1978; Hale, 1979; and Esslinger, 1978), and morphological observations with comments on the variability within each species. Information on chemical spot test reactions are listed along with chemical composition derived either from thin layer chromatographic analysis or literature citations. Diagnostic characteristics are discussed and compared to other species found in the region.

Distributional information includes an estimate of abundance of each species in the Unaka Mountain area with substrate, community type, and elevational preferences. These observations are compared to distributional information reported by Dey (1975) for the high elevational areas of the southern Appalachians. North American and world-wide distributions are collected from monographic and floristic studies to propose general distributional patterns.

Voucher specimens of each species have been deposited in the Cryptogamic Herbarium of The University of Tennessee, Knoxville [TENN]. These specimens are identified by an asterisk (*) in the list of specimens examined.

For completeness and usability, the keys to families, genera, and species include additional macrolichen taxa which are represented in the southern Appalachians. Those species not documented for the study area appear in brackets in the keys.

Key to the Families of Macrolichens in the southern Appalachians

1. Thallus peritheciate when fertile. . . . . .I. Verrucariaceae

1. Thallus apotheciate when fertile . . . . . .2

2. Thallus gelatinous and unstratified. . . . . .3

2. Thallus stratified and not gelatinous. . . . . .4

3. Cortex not differentiated; thallus fruticose . . .[Lichinaceae]

3. Cortex differentiated; thallus fruticulose or foliose . . . . . .II. Collemataceae

4. Thallus fruticose. . . . . .5

4. Thallus foliose. . . . . .9

5. Primary thallus crustose or squamulose, persistent or not. . .6

5. Primary thallus not produced . . . . . .8

6. Thallus podetiate and hollow . . . . . .VII. Cladoniaceae

6. Thallus pseudopodetiate or podetiate and solid . . . . . .7

7. Pseudopodetia bearing algae in phyllocladia. V. Stereocaulaceae

7. Podetia lacking algae and phyllocladia . . . VI. Baeomycetaceae

8. Branches round in cross section; medulla lax and hollow or surrounding a central cord. . . . . XII. Usneaceae

8. Branches flattened; medulla consistent and compressed . . . . . XIII. Ramalinaceae

9. Lower surface with veins . . . . . III. Peltigeraceae

9. Lower surface lacking veins; terricolous, corticolous or saxicolous . . . . . 10

10. Lower surface tomentose; phycobiont blue-green or green. . . . . .11

10. Lower surface rhizinate, bare, or ecorticate, not tomentose; phycobiont green. . . . . .15

11. Tomentum long and spongy, over 2 mm, forming a dense mat. . .12

11. Tomentum short and felty, less than 1 mm long, dense but not mat forming . . . . . .14

12. Phycobiont blue-green. . . . . .13

12. Phycobiont green . . . . . XI. Anziaceae

13. Upper and lower surfaces corticate; thallus with concentric zones . . . . . [Coccocarpiaceae]

13. Upper surface corticate, lower surface ecorticate; thallus lacking concentric zones. . . . . .[Pannariaceae]

14. Apothecia on lower surface; lower surface smooth, never pored. . . . . .[Nephromaceae]

14. Apothecia on upper surface; lower surface cyphellate, pseudocyphellate, or lenticellular-like. . .IV. Stictaceae

15. Thallus umbilicate. . . . . VIII. Umbilicariaceae

15. Thallus not umbilicate. . . . . .16

16. Lower surface corticate, rhizinate; lobes inflated and hollow or strongly canaliculate. . . . .IX. Hypogymniaceae

16. Lower surface corticate or ecorticate, rhizinate; lobes not inflated and hollow, occasionally canaliculate . . .17

17. Thallus yellow or orange; lobes minutely divided. . . . . .18

17. Thallus yellow-green, mineral gray, green, or brown, lobes finely divided, lobed, or entire. . . . . .19

18. Thallus yellow or yellow-orange; pigment K- . . . . . XIV. Candelariaceae

18. Thallus orange; pigment K+ red to purple . . . . . [Teloschistaceae]

19. Lobes narrow to broad; lower surface always corticate; spores colorless and simple . . . . . X. Parmeliaceae

19. Lobes narrow; lower surface corticate or ecorticate; spores brown and two-celled or polarilocular . . . . . XV. Physciaceae

Key to the Genera of Macrolichens in the southern Appalachians

1. Thallus gelatinous, not stratified. . . . . 2

1. Thallus not gelatinous, stratified. . . . . 6

2. Thallus fruticose . . . . . 3

2. Thallus foliose . . . . . 4

3. Thallus with a differentiated cortex, usually corticolous . . . . . .4. Polychidium

3. Thallus lacking a differentiated cortex, saxicolous . .[Ephebe]

4. Lower surface with raised veins . . . . . [Hydrotheria]

4. Lower surface lacking raised veins. . . . . 5

5. Lower surface with a true cortex, occasionally tomentose; upper surface slate gray, or rarely greenish black, lower surface lighter . . . . . .3. Leptogium

5. Lower surface with a pseudocortex, not tomentose; upper surface greenish black, lower surface not lighter . .2. Collema

6. Thallus fruticose . . . . . 7

6. Thallus foliose or squamulose . . . . . .20

7. Thallus of two phases; primary thallus squamulose or crustose; secondary thallus podetiate or pseudopodetiate. . . 8

7. Thallus only one phase, pendulous or caespitose . . . . . .15

8. Podetia or pseudopodetia solid. . . . . 9

8. Podetia hollow. . . . . .13

9. Pseudopodetia containing algae in phyllocladia and cephalodia. . . . . .10

9. Podetia or pseudopodetia lacking algae. . . . . .11

10. Apothecia apical; podetia simple or sparsely branched. . . . . .[Pilophoron]

10. Apothecia lateral; podetia usually richly branched . . . . . 8. Stereocaulon

11. Apothecia tan, flesh colored, or pink; primary thallus squamules not strap-shaped. . . . . .12

11. Apothecia black; primary thallus squamules strap-shaped . . . . . .[Gymnoderma]

12. Primary thallus crustose; apothecia tan or pink . . . . . .9. Baeomyces

12. Primary thallus squamulose; apothecia flesh colored. . . . . [Icmadophila]

13. Primary thallus crustose and persistent . . . . 12. Pycnothelia

13. Primary thallus squamulose or absent at maturity. . . . . .14

14. Podetia corticate, at least initially. . . . .11. Cladonia

14. Podetia ecorticate . . . . . 10. Cladina

15. Branches round in cross section . . . . . .16

15. Branches flattened and compressed . . . . . .18

16. Branches solid; central cord present . . . . . 32. Usnea

16. Branches hollow; central cord absent . . . . . .17

17. Thallus green . . . . . [Alectoria]

17. Thallus brown . . . . . 31. Bryoria

18. Upper and lower surface defined; thallus canaliculate . . . . . .19

18. Upper and lower surface not defined. . . . . .33. Ramalina

19. Lobes narrow, mineral gray. . . . . .17. Pseudevernia

19. Lobes wider, brown. . . . . .18. Cetraria

20. Thallus umbilicate . . . . . .21

20. Thallus not umbilicate . . . . . .23

21. Upper surface with black dots, perithecia . . . [Dermatocarpon]

21. Upper surface lacking perithecia. . . . . .22

22. Thallus pustulate and pitted . . . . . .13. *Lasallia*

22. Thallus smooth or wrinkled, not pustulate or pitted . . . . . 14. *Umbilicaria*

23. Thallus foliose . . . . . .24

23. Thallus squamulose. . . . . .58

24. Lower surface tomentose. . . . . .25

24. Lower surface rhizinate, bare, or ecorticate, not tomentose. . . . . .31

25. Tomentum thick and spongy . . . . . .26

25. Tomentum short and felty. . . . . .28

26. Phycobiont green . . . . . 30. *Anzia*

26. Phycobiont blue-green. . . . . .27

27. Thallus with concentric zones . . . . . .[*Coccocarpia*]

27. Thallus lacking concentric zones. . . . . .[*Pannaria*]

28. Lower surface cyphellate or pseudocyphellate . . . . . .29

28. Lower surface not cyphellate or pseudocyphellate . . . .30

29. Lower surface cyphellate; medulla white . . . . . 7. *Sticta*

29. Lower surface and upper surface pseudocyphellate; medulla yellow. . . . . [*Pseudocyphellaria*]

30. Apothecia produced on the lower surface. . . . .[*Nephroma*]

30. Apothecia produced on the upper surface. . . . .6. *Lobaria*

31. Lower surface with raised veins and tufted rhizines . . . . . .5. *Peltigera*

31. Lower surface lacking raised veins; rhizines tufted or scattered when present. . . . . .32

32. Lobes inflated and hollow. . . . . .33

32. Lobes not inflated, solid. . . . . .34

33. Upper surface with regular perforations into the medullary cavity. . . . . .16. Menegazzia

33. Upper surface lacking perforations, occasionally perforate at the lobe tips. . . . . .15. Hypogymnia

34. Thallus yellow or orange . . . . . .35

34. Thallus not yellow or orange, either mineral green, yellow-green, oliveaceous or brown . . . . . .36

35. Thallus orange, K+ red-purple . . . . . [Xanthoria]

35. Thallus yellow or yellow-orange, K- . . . . . .34. Candelaria

36. Upper surface pseudocyphellate or angularly maculate . .37

36. Upper surface lacking pseudocyphellae and angular maculae. . . . . .39

37. Thallus sorediate; soralia marginal and linear; lower surface black . . . . . .19. Cetrelia

37. Thallus sorediate, isidiate, lobulate, or apotheciate; soralia when marginal and laminal, often orbicular; lower surface usually tan, rarely black . . . . . .38

38. Thallus yellow-green or mineral green; either usnic acid or atranorin present. . . . . .23. Parmelia

38. Thallus greenish brown or brown; lacking usnic acid and atranorin. . . . . 22. Melanelia

39. Apothecia and pycnidia marginal; pycnidia abundant, exserted, produced in soralia and with isidia . . . . . .40

39. Apothecia and pycnidia laminal; pycnidia rare to moderately abundant, immersed, usually not produced on sorediate and isidiate thalli . . . . . .41

40. Lower surface mottled and exfoliating. . . 27. Platismatia

40. Lower surface tan to brown, uniform, not exfoliating. . . . . .18. Cetraria

41. Thallus yellow-green, usnic acid present. . . . . .42

41. Thallus mineral green, greenish brown, or brown . . . . . .43

42. Lobes narrow and linear, less than 2 mm wide, saxicolous . . . . . .29. Xanthoparmelia

42. Lobes irregular to rotund, more than 3 mm wide, saxicolous and corticolous . . . . . .28. Pseudoparmelia

43. Thallus greenish brown or brown, little or no atranorin present . . . . . .44

43. Thallus mineral gray or green, atranorin present. . . . . .48

44. Lobes linear or irregular, 2 mm or wide. . . 22. Melanelia

44. Lobes narrow, less than 2 mm wide. . . . . .45

45. Lower surface pale, white to tan, occasionally ecorticate. . . . . .35. Anaptychia

45. Lower surface brown or black. . . . . .46

46. Thallus tightly appressed, rhizines indistinct . . . . . [Physciopsis]

46. Thallus adnate to loosely attached, rhizines distinct, often forming a mat. . . . . .47

47. Lobes pruinose, rhizines occasionally squarrosely branched. . . . . 39. Physconia

47. Lobes not pruinose, but shiny . . . . . .37. Phaeophyscia

48. Lower surface pale or white. . . . . .49

48. Lower surface dark brown or black. . . . . .51

49. Thallus tightly appressed . . . . . .25. Parmeliopsis

49. Thallus adnate. . . . . .50

50. Lower surface frequently ecorticate; rhizines marginal; upper cortex with longitudinal hyphae, cartilaginous. . . . . .36. Heterodermia

50. Lower surface always prosoplectenchymatous corticate; rhizines laminal; upper cortex paraplectenchymatous, not cartilaginous. . . . . 38. Physcia

51. Medulla yellow or yellow-orange . . . . . .52

51. Medulla white . . . . . .53

52. Medulla faint yellow; cortex continuous. . . 24. Parmelina

52. Medulla yellow-orange; cortex splitting along the margins. . . . . .40. Pyxine

53. Lobes narrow and linear, less than 4 mm wide. . . . . .54

53. Lobes broad and rounded, more than 4 mm wide. . .26. Parmotrema

54. Lobes canaliculate; rhizines ciliate and marginal . . . . . 20. Evernastrum

54. Lobes not canaliculate; rhizines laminal and occasionally ciliate and marginal. . . . . .55

55. Marginal cilia present. . . . . .56

55. Marginal cilia absent . . . . . .57

56. Cilia bulbate and inflated . . . . . .[Bulbothrix]

56. Cilia cylindrical, not inflated. . . . . 24. Parmelina

57. Rhizines dichotomously branched . . . . . .21. Hypotrachyna

57. Rhizines simple . . . . . .28. Pseudoparmelia

58. Squamules orbicular, with raised margins; lower surface finely pruinose . . . . . 1. Normandina

58. Squamules linear or strap-shaped; occasionally producing podetia or apothecia. . . . . 59

59. Squamules strap-shaped, with a black base, saxicolous. . . . . .[Gymnoderma]

59. Squamules linear to finely divided, lacking a black base, corticolous or terricolous. . . . . .11. Cladonia

## I. VERRUCARIACEAE

The Verrucariaceae can be recognized by the presence of perithecia on the umbilicate, squamulose, or crustose thalli. Two genera in this family occur in the southern Appalachians,

Dermatocarpon and Normandina. Only Normandina pulchella was collected in the study area. Its pale green, platelike squamules with raised rims are very distinctive. In contrast Dermatocarpon, collected at lower elevations, has rigid, gray or brown thalli which are umbilicate or squamulose.

## 1. Normandina Nyl.

### 1. Normandina pulchella (Borr.) Nyl.

Normandina pulchella (Borr.) Nyl., Ann. Sci. Nat. Bot. IV. 15: 382. 1861.

Verrucaria pulchella Borr. in Hook. & Sowerby, Suppl. Engl. Bot. 1: pl. 2602, f. 1. 1831.

Thallus squamulose, colony to 1 cm in diameter, adnate, mineral to ashy green; unbranched. Squamules orbicular, 0.2-2 mm in diameter, concave; margins inflated and raised. Lower surface white or pale green; tomentum abundant, short and felty. Upper surface smooth and concave, pruina occasional; soredia reported by Dey (1975) as granular in marginal soralia. Apothecia not seen. Thallus K-, C-, KC-, PD-.

Chemical composition, one unidentified terpene reported by Dey (1975).

Widespread, infrequently collected with other lichens on hardwood trees. Dey (1975) reported this species as widespread at all elevations. It occurs in North, Central, and South America, Europe, and Asia.

Normandina pulchella is occasionally found during examination of other corticolous lichens. The distinctive platelike squamules

are pale green in color with raised marginal rims. Because of the small size it is inconspicuous in the field.

Specimens examined. Tennessee. Unicoi Co.: Cherry Gap Trail 3451, 3452*.

## II. COLLEMATACEAE

Members of the Collemataceae have a gelatinous thallus with a differentiated cortex or pseudocortex. The lower surface lacks rhizines but may produce tufted, scattered hairs. Three genera were collected on Unaka Mountain. Collema is foliose and produces only a pseudocortex on the lower surface. Leptogium differs in producing a true lower cortex and occasionally tomentum. Usually, these genera can be distinguished by their thallus color. Collema has a blackish green color with a lower surface not significantly different in color. Leptogium is slate gray, or rarely blackish green, but with a distinctly lighter lower surface.

Polychidium, a fruticulose genus in the Collemataceae, is represented on Unaka Mountain by Polychidium umhausenses. This minute, shrubby thallus is only rarely collected with other lichens.

The Collemataceae of Tennessee was studied by Sierk (1958) and the North American species of Leptogium have been monographed (Sierk, 1964). The genus Collema is difficult and not well understood in North America. A valuable aid is the European monograph by Degelius (1954, 1974).

## 2. *Collema* Web. in Wigg.

Key to the Species of *Collema* in the southern Appalachians

1. Thallus plicate and pustulate. . . . . 2
1. Thallus not plicate or pustulate . . . . . 3
   2. Isidia cylindrical . . . . .2. *C. furfuracum* (Arn.) Du Rietz
   2. Isidia globular or lacking . . .3. *C. nigrescens* (Huds.) DC.
3. Isidia globular, lobulate, and squamiform . . . . . 1. *C. flaccidum* (Ach.) Ach.
3. Isidia globular or, infrequently, cylindrical . . . . . 4. *C. subflaccidum* Degel.

1. *Collema flaccidum* (Ach.) Ach.

*Collema flaccidum* (Ach.) Ach., Lich. Univ. 647. 1810.

*Lichen flaccidus* Ach., Kongl. Vetensk. Acad. Handl. 16: 14. 1795.

Thallus foliose, 1-1.5(-6) cm in diameter, loosely adnate, greenish black; branching irregular. Lobes 2-5(-8) mm across, rounded, membranaceous; margins entire to dentate or lobulate. Lower surface lighter greenish, finely wrinkled; cortical hairs occasional, in tufts. Upper cortex, weakly pustulate to nearly smooth, faintly ridged, very sparsely innate or bare; isidia numerous, occasionally globular, but usually lobulate, laminal and marginal; apothecia reported by Dey (1975) as not common, to 1 mm broad; disc pale brown. Thallus K-, C-, KC-, PD-.

Chemical composition, no lichen substances detected.

Not common, collected on maple in the high elevational deciduous forest at the headwaters of Rock Creek, ca. 4600 ft. elevation.

Dey (1975) reported this species as widespread but not common at all elevations in the southern Appalachians. It occurs throughout the eastern United States, excluding the Coastal Plain, and in southeasternmost Canada. It is widely distributed in the Northern Hemisphere, and very common in Europe (Degelius, 1954).

Collema flaccidum has isidia which are globular, lobulate, or squamiform. C. subflaccidum differs by having only globular isidia.

Specimens examined. Tennessee. Unicoi Co.: Rock Creek Headwaters 3074, 3075*.

2. Collema furfuraceum (Arn.) Du Rietz

Collema furfuraceum (Arn.) Du Rietz, Ark. Bot. 22A(13): 3. 1929.

Synechoblastus nigrescens a. furfuraceum Arn., Flora 64: 115. 1881.

Thallus foliose, to 8 cm in diameter, adnate to appressed, olive to greenish black; branching irregular to radiating. Lobes 1-4 mm wide, rounded to irregular; margins entire or occasionally isidiate. Lower surface lighter olive to yellowish gray, pitted and wrinkled; cortical hairs occasional, in tufts. Upper surface shiny, puckered, ridged, and pustulate; isidia abundant, darker than the thallus, globose, cylindrical, or coralloid, laminal and densest on the ridges, occasionally marginal; apothecia reported by Sierk (1958) as rare, small to medium-sized, 0.15-1.15 mm in diameter; disc, brown; rim isidioid. Thallus K-, C-, KC-, PD-.

Chemical composition, no lichen substances detected.

Not common, collected on bark and moss over bark of hardwoods in deciduous communities between 3500 and 3700 ft. elevations. Dey (1975) reported this species as rare at all elevations in the southern Appalachians. In North America it is found throughout the eastern United States, and the Southwest, Pacific Coast, and the northern Rockies. Widely distributed in the Northern Hemisphere, it occurs in Europe, North Africa, and Asia (Degelius, 1954).

Collema furfuraceum is recognized by its radiant ridges and pustules, and cylindrical isidia. A similar species C. nigrescens differs in having only globular isidia or lacking isidia entirely.

Specimens examined. Tennessee. Unicoi Co.: Cherry Gap Trail 1408, 1409*, 1410; North Beauty Spot 1187.

3. Collema nigrescens (Huds.) DC.

Collema nigrescens (Huds.) DC. in Lam. & DC., Flora Franc., ed. 3. 2: 384. 1805.

Lichen nigrescens Huds., Flora Angl. 450. 1762.

Thallus foliose, to 5(-10) cm in diameter, adnate to appressed, greenish black; branching irregular-radiating. Lobes 3-5 mm wide; margins entire, slightly ascending. Lower surface green- to charcoal gray, ridged and pitted; cortical hairs usually lacking, or rare, in tufts. Upper surface radially ridged and pustulate, minutely wrinkled and pitted; isidia dense, globular and occasionally procumbent and club-shaped; apothecia reported by Sierk (1958) as small to medium-sized, 0.4-1.25 mm in diameter, sessile; disc

reddish brown, plane to convex; rim concolorous with the thallus, thin and often disappearing. Thallus K-, C-, KC-, PD-.

Chemical composition, no lichen substances detected.

Not common, collected only on maple bark in a secondary successional hardwood forest at ca. 3500 ft. elevation. Dey (1975) reported this species as rare at all elevations in the southern Appalachians. In North America it is widely distributed in the eastern United States, southeasternmost Canada, the Pacific Coast, northern Rockies, and the Southwest. Also, this corticolous species, rarely found on rock, is known from oceanic Europe (Degelius, 1954), North Africa, Asia, Australia, and Central America (Dey, 1975).

Collema nigrescens is distinguished from C. furfuraceum only by its globular to procumbent isidia. The delineation of these two species in the southern Appalachians needs re-evaluation.

Specimen examined. Tennessee. Unicoi Co.: Cherry Gap Trail 1411*.

4. Collema subflaccidum Degel.

Collema subflaccidum Degel., Sym. Bot. Ups. 20: 200. 1974.

Thallus foliose, up to 5(-8) cm in diameter, adnate, olive green to greenish black; branching irregular. Lobes 3-5(-10) mm across, rounded, ascending; margins entire. Lower surface lighter gray-green; cortical hairs occasional, in tufts. Upper surface glaucous, minutely puckered, occasionally somewhat wrinkled and pustulate; isidia dense, granular and globose, occasionally cylindrical or coralloid, but never lobulate; apothecia frequent,

0.5-1 mm in diameter, sessile; disc dark brown, deeply concave; rim pseudocorticate, lacking a proper exciple. Thallus K-, C-, KC-, PD-.

Chemical composition, no lichen substances detected.

Not common, collected on buckeye and maple in oak and tulip poplar dominated forest between 3000 and 4200 ft. elevations. Dey (1975) under the name C. subfurvum (Mull. Arg.) Degel., reported this taxon as widespread but not common in the southern Appalachians. It occurs throughout the eastern United States and southeasternmost Canada. Widely distributed in the Northern Hemisphere it is known from Asia, Africa, Europe, and Hawaii.

Collema subflaccidum is very similar to C. flaccidum (Ach.) Ach. It differs in bearing globular or infrequently cylindrical isidia while C. flaccidum produces globular and lobulate isidia. Formerly (Sierk, 1958; Dey, 1975) this taxon was called C. subfurvum.

Specimens examined. Tennessee. Unicoi Co.: Indian Grave Gap 3076; North Beauty Spot 1014*.

### 3. Leptogium (Ach.) S. Gray

Key to the Species of Leptogium in the southern Appalachians

1. Lower surface tomentose. . . . . 2
1. Lower surface not tomentose. . . . . 4
    2. Tomentum short, composed of one to six spherical cells. . . . . .2. L. laceroides B. de Lesd.
    2. Tomentum longer, composed of elongate cells. . . . . 3
3. Thallus charcoal to olive black; isidia granular . . . . . 3. L. saturninum (Dicks.) Nyl.

3. Thallus light gray; isidia cylindrical and branching . . . . . .[L. burnatiae Dodge]

4. Thallus isidiate . . . . . 5

4. Thallus not isidiate . . . . . 7

5. Lobes narrow, 1-2 mm wide; margins finely dissected. . . . . [L. lichenoides (L.) Zahlbr.]

5. Lobes broad, 2.5-11 mm wide; margins entire. . . . . 6

6. Lobes wrinkled; isidia coarse to lobulate . . . . . .[L. austroamericanum (Malme.) Dodge]

6. Lobes smooth; isidia fine and cylindrical . . . . . 1. L. cyanescens (Ach.) Korb.

7. Thallus dark gray; lobes radiating and continuous . . . . . [L. chloromelum (Ach.) Nyl.]

7. Thallus light gray; lobes irregular and distinct . . . . . .[L. corticola Tayl.]

1. Leptogium cyanescens (Ach.) Korb.

Leptogium cyanescens (Ach.) Korb., Syst. Lich. 420. 1855.

Collema tremelloides v. cyanescens Ach., Syn. Meth. Lich. 326. 1814.

Thallus foliose, 2.5(-11) cm in diameter, adnate or loosely attached, slate gray to lead color; branching irregular. Lobes 2-5(-7) mm wide, rounded; margins entire to lacerate and isidiate. Lower surface lighter gray, shiny, etomentose and erhizinate; cortical hairs in scattered tufts. Upper surface shiny, plane, undulate, or slightly roughened; isidia dense, concolorous with the surface, cylindrical to coralloid or lobulate, laminal and marginal. Apothecia reported by Sierk (1964) as not common, 0.5-2 mm wide,

sessile to short stipitate; disc light brown to reddish brown, slightly concave to plane or convex; rim entire to isidiate, light gray to cream colored. Cortex K-; medulla K-, C-, KC-, PD-.

Chemical composition, no lichen substances detected.

Not common, one collection on hickory in the secondary successional forest near Low Gap, ca. 3500 ft. elevation. This species was reported by Dey (1975) as common at all elevations in the southern Appalachians. In North America it ranges throughout the eastern United States, southeasternmost Canada, and the southern Rockies and the Southwest. It has been reported in the Black Hills of South Dakota and in British Columbia and southern Alaska (Sierk, 1964). It also occurs in Central and South America, Europe, Asia, Australia, and New Zealand.

Leptogium cyanescens has a shiny smooth upper surface which is lead gray and bears isidia. The lower surface lacking tomentum and rhizines, has cortical hairs in tufts which anchor the thallus to its substrate. L. austroamericanum common in the southeastern United States has a thicker, wrinkled thallus. Known from the Gulf Coast and tropical regions, L. azureum (Sw.) Mont. lacks isidia.

Specimen examined. Tennessee. Unicoi Co.: Cherry Gap Trail 1334*.

2. Leptogium laceroides B. de Lesd.

Leptogium laceroides B. de Lesd., Ann. Crypt. Exot. 2: 217-254. 1933.

Thallus foliose, 2-5(-7) cm in diameter, adnate or loosely adnate, slate gray to dark charcoal; branching irregular. Lobes 2-3(-5) mm wide, sublinear to elongate; margins entire to lacerate and isidiate, appearing fringed. Lower surface gray-white; tomentum dense, white, composed of one to six spherical cells up to 5 µm in diameter, covering the entire surface. Upper surface shiny, plane to roughened; isidia dense, granular or lobulate to squamiform, marginal and laminal; apothecia reported by Sierk (1964) as not common, 3-4 mm in diameter, sessile; disc light brown to dark red-brown, slightly convex; rim isidioid, concolorous with the thallus. Cortex K-; medulla K-, C-, KC-, PD-.

Chemical composition, no lichen substances detected.

Not common, collected on maple and hickory bark in high elevation deciduous forest, ca. 4700 ft. elevation, and secondary growth forest, ca. 3500 ft. elevation. Dey (1975) reported this species as infrequent but widespread in deciduous forest above 5500 ft. elevation, while rare at lower elevations in the southern Appalachians. In North America it occurs in southern Canada, New England, and the southern Appalachians (Sierk, 1964, as L. americanum Degel.) as well as South America, Europe, Africa, and New Zealand (Dey, 1975).

Leptogium laceroides is distinguished by its dense, short tomentum consisting of chains of spherical cells. The lighter color of the lower surface is a key to field identification of this taxon, but microscopic examination of thin sections is required for positive identification of the tomentum. The darker blackish

brown color may initially cause some confusion with Collema. Previously North American collections were called L. americanum Degel.

Specimens examined. Tennessee. Unicoi Co.: Cherry Gap Trail 1333; Rock Creek Headwaters 3171, 3172*, 3173, 3174, 3175.

3. Leptogium saturninum (Dicks.) Nyl.

Leptogium saturninum (Dicks.) Nyl., Act. Soc. Linn. Bord, 21: 272. 1856.

Lichen saturninus Dicks., Fasc. Pl. Crypt. Brit. 2: 21. 1790.

Thallus foliose, 2(-6) cm in diameter, loosely attached to adnate, dark olive to greenish black; branching irregular. Lobes 2-5(-10) mm wide, rounded and spreading; margins entire to dissected and lobulate, occasionally reflexed. Lower surface concolorous with the thallus; tomentum dense, light brown, completely covering the surface except for occasional bare spots. Upper surface plane, sparsely tomentose, yellow-brown in a narrow marginal zone; isidia sparse, granular to occasionally lobulate, produced marginally and laminally, usually along wounds and tears; apothecia reported by Sierk (1964) as rare, 0.5-2.5 mm in diameter, sessile; disc brown to red-brown, plane to convex; rim entire to occasionally granulose, concolorous with the thallus to cream colored. Cortex K-; medulla K-, C-, KC-, PD-.

Chemical composition, no lichen substances detected.

Rare, one collection on maple bark in the high elevational deciduous forest at the headwaters of Rock Creek, ca. 4700 ft.

elevation. This species was not reported by Dey (1975) for the high elevational areas of the southern Appalachians. In North America it occurs in the New England, Great Lakes and Appalachian regions, northward into the Arctic, the Rocky Mountains and Pacific coast. This circumboreal species also is known from Asia and Europe (Sierk, 1958, 1964).

Leptogium saturninum is closely related to the species L. burnetiae which also occurs in the southern Appalachian. It differs in having a darker color and granular isidia, while L. burnetiae is gray with cylindrical, often branching isidia. L. saturninum has a thicker, more gelatinous thallus when moist which appears thinner when dry (Sierk, 1964).

Specimens examined. Tennessee. Unicoi Co.: Rock Creek Headwaters 3176*.

## 4. Polychidium (Ach.) S. Gray

### 1. Polychidium umhausense (Auerse.) Hennsen

Polychidium umhausense (Auerse.) Hennsen, Sym. Bot. Ups. 18: 103. 1963.

Cornicularia (?) umhausensis Auerse., Hedwigia 8: 113. 1869.

Thallus fruticulose, minute, 1-5 mm in diameter, caespitose, lead gray to black; branching subdichotomous. Lobes narrow-elongate, less than 0.5 mm in diameter, to 5 mm long, somewhat flattened, freely branching; lobe tips digitate and terete, with apical pores which may be pycnidiate, darker in color. Apothecia not seen or reported. Thallus K-, C-, KC-, PD-.

Chemical composition, no lichen substances detected.

Possibly widespread but not common, collected on maple bark in the high elevational forest at the headwaters of Rock Creek at ca. 4700 ft. elevation and on hickory in an oak dominated forest at ca. 3700 ft. elevation along the trail to Cherry Gap. Sierk (1958) reported its distribution as Massachusetts, New Jersey, Illinois, South Carolina, and Tennessee in eastern North America as well as in Europe.

Polychidium umhausense is easily recognized by its minute, shrubby habit and narrow, branching lobes with terete tips. Because of its small size it is frequently overlooked and rarely collected. It was first collected in the southern Appalachians by Degelius (1941).

In Europe (Nylander, 1888) and New Zealand (James and Hennsen, 1976) this lichen is reported to occur as "glomerules" on Lobaria amplissima (Scop.) Forss. Also, in New Zealand it occasionally produces dorsiventrally flattened, rounded lobes with a green phycobiont, leading to the conclusion that it may be a propagule of the Lobaria species. On Unaka Mountain one specimen with such a lobe was collected on a hickory bole at ca. 4700 ft. elevation. It was mixed with Phaeophyscia pusilloides, Lobaria pulmonaris, L. quercizans, Parmelia aurulenta, and Parmotrema reticulatum.

Specimens examined. Tennessee. Unicoi Co.: Cherry Gap Trail 3361; Rock Creek headwaters 3362, 3363*.

## III. PELTIGERACEAE

The family Peltigeraceae has a poorly defined lower cortex with distinct veins and tufted rhizines. The phycobiont is typically blue-green, or when green, cephalodia with blue-green algae are present. Apothecia are marginal, or rarely laminal, on the upper surface.

Species of Peltigera are distinctly stratified and terricolous. One other genus Hydrotheria, not collected on Unaka Mountain, is represented in the southern Appalachians by H. venosa Russell (Dennis, et al., 1981). This aquatic species is weakly gelatinous and filmy but has yellowish veins on its lower surface.

Peltigera has been monographed by Thomson (1950) for North America.

### 5. Peltigera Willd.

Key to the Species of Peltigera in the southern Appalachians

1. Phycobiont green; cephalodia present and conspicuous . . . . . .[P. apthosa (L.) Willd.]
1. Phycobiont blue-green; cephalodia lacking. . . . . 2
    2. Thallus isidiate . . . . . 2. P. evansiana Gyel.
    2. Thallus not isidiate, infrequently lobulate. . . . . 3
3. Lower surface with narrow veins becoming pale near the margin. 4
3. Lower surface with dark, flattened veins . . . . . 5
    4. Upper surface tomentose at least near the margin . . . . . .1. P. canina (L.) Willd.
    4. Upper surface not tomentose. . . . . .[P. degenii Gyel.]

5. Apothecia horizontal . . . . . 3. P. horizontalis (Huds.) Baumg.

5. Apothecia vertical and erect . .4. P. polydactyla (Neck.) Hoffm.

1. Peltigera canina (L.) Willd.

Peltigera canina (L.) Willd., Flora Berol. Prodr. 347. 1787.

Lichen caninus L., Sp. Pl. 2: 1149. 1753.

Thallus foliose, 4-20 cm in diameter, frequently in large mats, loosely attached, greenish brown, light brown, or slate gray when dry, bright green when wet; branching irregular. Lobes 5-20 mm wide, variable in shape, long and broad to short and narrow, flat or curled; margins prostrate or ascending and inrolled, crenate; apex prostrate and rounded or ascending and somewhat pointed. Lower surface buff; veins reticulate, pale to darkening, narrow and strongly raised; rhizines brown, furcate, in tufts arising from the veins. Upper surface waxy and plicate or brittle and cracking, dull or shiny in the center, usually pruinose-tomentose at the lobe tips, cortex splitting and cracking along the margins, smooth to undulate and wrinkled; soredia occasional, granular, in laminal soralia or marginal; isidia and lobules sparse along wounds and tears in the cortex; apothecia common, up to 1 cm wide on the lobe tips, reflexed and erect; disc pinkish to reddish brown; rim light brown, arachnoid; immature apothecia covered by light brown tissue with a dense tomentum. Medulla white with spots of orange pigment. Cortex K-; medulla K-, C-, KC-, PD-.

Chemical composition, no lichen substances detected.

Common and locally abundant, collected on disturbed soil along roadbanks, in the grassy bald, and in various deciduous communities between 4200 and 4900 ft. elevations. Dey (1975) reported this species as widespread but infrequent at high elevations while common at lower elevations in the southern Appalachians. It occurs throughout North America. The distribution of this species includes Europe, Asia, and Australia (Dey, 1975).

Peltigera canina is quite variable because of its large number of growth stages and responses to environmental conditions. It can be recognized by its vertical apothecia, fine tomentum on the upper surface, and pale, narrow veins. A large number of varieties are recognized and often elevated to specific rank. In this study P. canina is used in the broad sense.

Three species of Peltigera found in the southern Appalachians are similar to P. canina.

Peltigera polydactyla also with vertical apothecia has a shiny upper cortex which lacks tomentum and broad, slightly raised veins on the lower surface. Horizontal apothecia characterize P. horizontalis; however, when sterile the broad flat veins which are charcoal to black in color sufficiently distinguish this species. Known from lower elevations in the southern Appalachians, but lacking at high elevations, P. degenii has the distinct raised veins of P. canina but the upper surface is shiny, etomentose, and esorediate.

Two other southern Appalachian species in this genus are quite distinct. P. evansiana, collected in the study area but

absent at higher elevations, produces globular isidia and narrow, strongly raised veins. Peltigera apthosa common in the boreal areas and the western mountain ranges has infrequently been collected as far south as Tennessee and North Carolina in the Appalachians and occurs in the Doe River Gorge of Carter County in upper east Tennessee near Unaka Mountain. The primary phycobiont is a green algae with cephalodia containing Nostoc on the upper surface. Specimens with dark, distinct veins in eastern North America have been called P. leucophlebia (Nyl.) Gyel.

Specimens examined. Tennessee. Unicoi Co.: Beauty Spot 3321, 3322; Rattlesnake Ridge 3320; Rock Creek Headwaters 3323*.

2. Peltigera evansiana Gyel.

Peltigera evansiana Gyel., Bryologist 34: 16. 1931.

Thallus foliose, 8-10 cm in diameter, loosely adnate, charcoal color when dry, greenish black when wet; branching irregular. Lobes 7-15 mm wide, rounded; margins prostrate and entire. Lower cortex light brown to buff; veins brown to dark brown, narrow, raised and distinct, reticulate; rhizines occasional, to 3 mm long, simple, tufted on veins. Upper surface undulate, somewhat scabrid but lacking pruina, frequently cracked and splitting; isidia darker greenish brown, granular to globular, scattered on the laminal surface. Cortex K-; medulla K-, C-, KC-, PD-.

Chemical composition, no lichen substances detected.

Rare, collected only on a decorticated log in the high elevation deciduous forest at the headwaters of Rock Creek. This species

was not present at high elevations in the southern Appalachians in Dey's study (1975), but occurs throughout the eastern United States excluding the Coastal Plain and in southeasternmost Canada. This species is a North American endemic (Thomson, 1950).

Peltigera evansiana is the only southern Appalachian species which produces isidia. The greenish black color of the Unaka material differs from the reported thallus color of pale gray to brown (Thomson, 1950; Dey, 1975; Hale, 1979). However, this population corresponds in all other aspects to these earlier descriptions.

Specimens examined. Tennessee. Unicoi Co.: Rock Creek 3324*.

3. Peltigera horizontalis (Huds.) Baumg.

Peltigera horizontalis (Huds.) Baumg., Flora Lips. 562. 1790.

Lichen horizontalis Huds., Flora Angl. 452. 1762.

Thallus foliose, up to 14 cm in diameter, frequently occurring in extensive mats, loosely attached to suberect, brownish or greenish gray when dry, bluish gray to olive when wet; branching irregular. Lobes 1-3 cm wide, large and robust, rotund, undulate; margins ascending, crenulate; lobe tips frequently vertical. Lower surface buff; veins dark to charcoal colored, broad and flattened, almost covering the entire lower surface leaving buff interspaces; rhizines occasional brown to blackish, simple, in fascicles on the veins. Upper surface smooth and shiny, leathery, frequently

splitting; lobules occasional, produced along wounds and tears; apothecia common, marginal, up to 6 mm or larger in diameter, oval-shaped with the longest axis parallel to the margin; disc reddish brown; rim wrinkled, ecorticate and tomentose, lacerated; lower surface of immature apothecia peach colored. Cortex K-; medulla K-, C-, KC-, PD-.

Chemical composition, tenuiorin and 5-6 unidentified terpenes reported by Dey (1975).

Not common but locally abundant, collected on soil with moss on roadbank and trailside and in deciduous forest between 3500 and 4900 ft. elevations. Dey (1975) reports this species as rare throughout the southern Appalachians. In North America it occurs in the New England, Great Lakes, Appalachian region and the Pacific Northwest and Rocky Mountains. It also is known from Europe, Asia, and New Zealand (Dey, 1975).

Peltigera horizontalis when fertile is quickly recognized by its horizontally-oriented, marginal apothecia. P. polydactyla differs only in its vertical, saddle-shaped apothecia. Sterile specimens are indistinguishable and usually referred to the more common species P. polydactyla. The broad, flattened veins of this species distinguish it from P. canina.

Specimens examined. Tennessee. Unicoi Co.: Cherry Gap Trail 1279, 1375; Roadside 3328; Rock Creek Headwaters 3329; Summit 3326*; Switchback 3327.

4. Peltigera polydactyla (Neck.) Hoffm.

Peltigera polydactyla (Neck.) Hoffm., Desc. Adumbr. Plant Lich. 1: 19. 1790.

Lichen polydactyla Neck., Meth. Musc. 85. 1771.

Thallus foliose, 10-30 cm wide, frequently in extensive mats, loosely adnate, brown to greenish gray when dry, bright green to olive when wet; branching irregular. Lobes 8-20 mm wide, rotund, frequently erect; margins ascending and inrolled, crenate; lobe tips often vertical. Lower cortex buff; veins dark brown in the center to tan at the lobe tips, flattened and broad but distinct, reticulate with very small buff interspaces; rhizines occasional, brown, simple, in fascicles. Upper surface shiny and waxy, etomentose, smooth or undulating, cortex occasionally splitting and cracking; lobules occasional, along wounds and tears; apothecia not observed, reported by Thomson (1950) as medium-sized, 2-5 mm in diameter, on erect narrow lobules at the ascending tips of the lobes, vertical in orientation, sides reflexed; disc reddish or chestnut brown to black; rim crenate. Cortex K-; medulla K-, C-, KC-, PD-.

Chemical composition, tenuiorin, 4-6 unidentified terpenes, and trace amounts of unidentified substances reported by Dey (1975).

Widespread and common, collected on rock and soil in spruce and deciduous forest and heath gardens across the entire elevational range. Dey (1975) reported this species as common at all elevations in the southern Appalachians. It occurs throughout North America excluding arid regions in the Southwest. Also it is known from

Central and South America, Europe, Asia, Australia, and New Zealand (Dey, 1975).

Peltigera polydactyla differs from P. canina only in the absence of tomentum on its marginal apothecia. P. horizontalis is distinguished by the horizontal orientation of its marginal apothecia. Nonfertile specimens have been included in the species P. polydactyla.

Specimens examined. Tennessee. Unicoi Co.: Cherry Gap Trail 1279, 1375; Roadside 3328; Rock Creek Headwaters 3329; Switchback 3327; Summit 3326*.

## IV. STICTACEAE

Members of the Stictaceae have a tomentose lower surface which is cyphellate, pseudocyphellate, or lenticellular-like. Three genera are represented in the southern Appalachians. Pseudocyphellaria has pseudochyphellae on both the lower and upper surfaces exposing a yellow medulla. Sticta, represented by Sticta weigelii on Unaka Mountain, has cyphellae on the lower surface only. Three species of Lobaria were collected in the study area. This genus can be recognized by its short tomentum which may be pitted, undulate, or smooth. This genus may have a blue-green or green phycobiont. North American species of Lobaria were studied by Jordan (1973).

## 6. Lobaria (Schreb.) Hoffm.

Key to the Species of Lobaria in the southern Appalachians

1. Thallus sorediate and, occasionally, isidiate; medulla PD+ stictic and norstictic acids present . . . . . 2

1. Thallus not isidiate or sorediate; medulla PD-, gyrophoric acid present. . . . . 3

   2. Phycobiont blue-green; upper surface undulate, not reticulately ridged. . . . . .[L. scrobiculata (Schop.) DC.]

   2. Phycobiont green; upper surface reticulately ridged . . . . . .1. L. pulmonaria (L.) Hoffm.

3. Lobes 5-10 mm wide, light brownish gray; upper surface undulate . . . . . .2. L. quercizans Michx.

3. Lobes 3-6 mm wide, brown; upper surface rugose and wrinkled . . . . . 3. L. ravenelii (Tuck.) Yoshim.

### 1. Lobaria pulmonaria (L.) Hoffm.

Lobaria pulmonaria (L.) Hoffm., Deutschl. Flora 2: 146. 1796.

Lichen pulmonarius L., Sp. Pl. 2: 1145. 1753.

Thallus foliose, 5-8 cm in diameter, loosely attached brownish green when dry, bright apple green when wet; branching irregular. Lobes 5-15 mm wide, rounded; margin raised, forming a rim. Lower surface mottled brown and light tan, forming a reticulate pattern of dark depressions and light raised areas; tomentum, short, felty; rhizines occasional on ridges. Upper surface leathery, reticulately wrinkled with narrow ridges and wide depressions, soredia abundant, occasionally isidiate, marginal and in laminal pustules along ridges or splits in the cortex; lobules occasional, 1 mm long and 1 mm wide,

marginal; apothecia reported by Dey (1975) as up to 3 mm broad; disc red-brown; rim pustulate-sorediate. Cortex K-; medulla K+ yellow turning orange or orange-red, C-, PD+ orange-red.

Chemical composition, norstictic acid, stictic acid, constictic acid, connorstictic acid, two unidentified substances, and trace amounts of Parmelia quintaria unknown reported by Dey (1975).

Widespread and locally abundant, collected on maples and other hardwoods in mature hardwood forest between 3000 and 4500 ft. elevations. Dey (1975) reported this taxon as common in most community types above 5500 ft. and in deciduous forest at lower elevations. In North America this species occurs in the Appalachian-Great Lakes region and the Pacific Coast and Rocky Mountains, as well as Europe, Africa, Asia, and Australia (Dey, 1975).

Lobaria pulmonaria is easily recognized by its reticulate upper surface and mottled white and brown lower surface. One other species in the southern Appalachians with this combination of characters, Platismatia tuckermanii differs in having a shiny lower cortex lacking tomentum, and commonly producing apothecia which are submerged and marginal.

Two other species of Lobaria occur in the southern Appalachians. L. quercizans Michx. lacks soredia and isidia and is frequently fertile. The thallus is undulate and produces gyrophoric acid. Widespread only at high elevations, L. scrobiculata has a blue-green phycobiont and sparse soredia on the margins and weakly ridged surface. It produces K+ yellow, KC+ red, PD+ orange, stictic acid and scrobiculin.

Specimens examined. Tennessee. Unicoi Co.: Cherry Gap Trail 1335, 1336*, 3177.

2. Lobaria quercizans Michx.

Lobaria quercizans Michx., Flora Bor. Am. 2: 324. 1803.

Thallus foliose, 7-12(-30) cm in diameter, adnate, grayish brown when dry, bright apple green when wet; branching irregular. Lobes 4-10(-20) mm wide; margins entire to crenulate. Lower surface brown to buff, darker near the center, occasionally with yellow-orange pigment spots; tomentum concolorous with the lower surface, dense, short and felty; rhizines occasional, brown, squarrosely branched. Upper surface leathery, undulate to wrinkled, rugose near the center, frequently cracked; apothecia abundant, to 5(-6) mm in diameter, laminal; disc reddish brown; rim yellowish brown, tomentose or pruinose; pycnidia common, immersed or protruding. Cortex K+ yellow; medulla K+ pale yellow-pink or K-, C+ faint pale pink or C-, KC+ pink turning dirty yellow, PD-; lower cortex K+ reddish where pigmented.

Chemical composition, trace amounts of accessory atranorin, gyrophoric acid, and trace amounts of unidentified substances reported by Dey (1975).

Widespread and locally abundant, often collected on maple, and occasionally on buckeye, hickory, and oak in deciduous communities between 3500 and 4900 ft. elevations. This species was reported by Dey (1975) as common at all elevations in the southern Appalachians.

In North America it occurs throughout the Appalachian-Great Lakes region. It is also present in Central and South America, eastern Asia, and Australia (Dey, 1975).

Initially Lobaria quercizans may seem to be a broad-lobed Parmotrema or Parmelia. Examination of the tomentose lower surface along with the thick, leathery quality of the brownish thallus will identify this species.

Specimens examined. Tennessee. Unicoi Co.: Cherry Gap Trail 1337, 1338, 1339, 1340, 1341; North Beauty Spot 1015*; Rock Creek Trail 3178.

3. Lobaria ravenelii (Tuck.) Yoshim.

Lobaria ravenelii (Tuck.) Yoshim., J. Hattori Bot. Lab. 34: 320. 1971.

Sticta ravenelii Tuck., Am. J. Sci. Arts ser. 2, 28: 203. 1859.

Thallus foliose, up to 10 cm in diameter, loosely adnate, grayish brown when dry, bright green when wet; branching irregular. Lobes 1-3(-6) mm wide, rounded to sublinear; margins crenate to lobed, crowded to somewhat imbricate. Lower surface light brown to tan; tomentum dense, short; bare areas occasional. Upper surface undulate to wrinkled, rugose, shiny; apothecia reported by Hale (1979) as common; marginal rim crenate, lobulate. Cortex K-; medulla K-, C+ rose, KC+ rose, PD-.

Chemical composition, gyrophoric acid, 4-O-methylgyrophoric acid and occasionally atranorin, reported by Jordan (1973).

Rare, collected only on hardwood trees in a secondary successional deciduous forest at ca. 3700 ft. elevation. This species was not reported by Dey (1975). It is common on trees such as oak, beech, and magnolia in the coastal plain region of North America (Hale, 1979).

Lobaria ravenelii can be recognized by its small brown lobes (up to 6 mm wide) and tomentose lower surface. Lobaria quercizans is lighter in color and has larger lobes up to 10 mm wide. Lobaria pulmonaria and L. scrobiculata are sorediate and much larger. Species of Nephroma are superficially similar but produce apothecia on the lower surface (Wetmore, 1960).

Specimens examined. Tennessee. Unicoi Co.: Cherry Gap Trail 3174*.

## 7. Sticta (Schreb.) Ach.

Key to the Species of Sticta in the southern Appalachians

1. Thallus sorediate. . . . . 2
1. Thallus isidiate . . . . . 3
   2. Soredia powdery, laminal and marginal . . . . . [S. limbata (Sm.) Ach.]
   2. Soredia granular or isidiate, marginal . . . . . 1. S. weigelii (Ach.) Vain.
3. Isidia laminal . . . . . [S. fuliginosa (Licks.) Ach.]
3. Isidia marginal, occasionally along wounds . . . . . 1. S. weigelii (Ach.) Vain.

1. Sticta weigelii (Ach.) Vain.

Sticta weigelli (Ach.) Vain., Acta Soc. Fauna Flora Fenn. 7: 189. 1890.

Sticta damaecornia β weigelii Ach., Lich. Univ. 446. 1810.

Thallus foliose, up to 10(-16) cm in diameter, adnate to appressed, yellow-brown to ashy gray; branching irregular. Lobes 4-8(-12) mm across, irregular to somewhat linear; margins crenate. Lower surface light brown to tan; tomentum dense, short and felty, covering the lower surface; cyphellae common, white or tan. Upper surface wrinkled to undulate, finely tomentose near the lobe tips; isidia dense, pale to dark brown, coralloid, in clumps along margins and wounds; soredia sparse, granular, mixed with isidia; lobules occasional; apothecia reported by Dey (1975) as rare. Cortex K+ pale yellow; medulla K+ dingy yellow or red-purple, C-, PD+ pale red-orange or PD-; lower cortex pigment K+ purple.

Chemical composition in isidiate thalli, trace amounts of accessory orange-red unidentified pigment and in lobulate thalli, eight unidentified substances reported by Dey (1975).

Not common, collected only on a roadside maple near the mountain summit, ca. 4600 ft. elevation. Dey (1975) reported this species as common at all elevations in the southern Appalachians. In North America it occurs throughout the eastern United States, Southwest, and Pacific Coast, as well as, Central and South America, Europe, Africa, Asia, Australia, and New Zealand (Dey, 1975).

Sticta weigelii has been variously interpreted as having granular and isidioid soralia or granular to coralloid isidia.

Dey (1975) noted that specimens which are predominately lobulate have a distinct chemical composition from the isidiate specimens and possibly represent a separate taxon.

Two other species in the southern Appalachians with cyphellae present only on the lower surface are S. limbata and S. fuliginosa. S. limbata has marginal soralia with powdery soredia and S. fuliginosa has laminal isidia. The latter is common only at elevations above 5500 ft. Collections with pseudocyphellae only on the upper surface belong to the genera Parmelia or Cetrelia, while those with pseudocyphellae on the upper and lower surfaces and a yellow medulla belong to Pseudocyphellaria.

Specimens examined. Tennessee. Unicoi Co.: Roadside 3408*.

## V. STEREOCAULACEAE

The Stereocaulaceae, represented by Stereocaulon and Pilophoron in the southern Appalachians, can be recognized by its solid pseudopodetia bearing phyllocladia and cephalodia. The primary thallus is areolate-crustose. Stereocaulon, recently treated by Lamb (1951, 1976, 1977, 1978), has lateral, terminal apothecia. Pilophoron, collected in other areas in the southern Appalachians, differs in having shorter pseudopodetia with apical apothecia.

### 8. Stereocaulon (Schreb.) Hoffm.

1. Thallus sorediate. . . . . .[S. pileatum Ach.]
1. Thallus not sorediate. . . . . 2

2. Cephalodia sacculate . . . . . .[S. ramulosum (Sw.) Rausch.]

2. Cephalodia not sacculate . . . . . 3

3. Medulla PD+, stictic and norstictic acids present . . . . . 1. S. dactylophyllum Flk.

3. Medulla PD-, lobaric acid present. . . 2. S. tennesseense Magn.

1. Stereocaulon dactylophyllum Flörke

Stereocaulon dactylophyllum Flörke, Deutschl. Lich. 4: 13. 1819.

Thallus fruticose, with a squamulose primary thallus, forming cushion-like mats or tufts, whitish to mineral gray; branching irregular or dichotomous. Pseudopodetia up to 7 cm tall, solid, repeatedly branching; surface white to yellow with age, ecorticate, fibrous, bare or tomentose; phyllocladia abundant and dense, whitish to grayish, verruculate to coralloid or flattened, palmate-digitate; cyphellodia occasional, concolorous with the pseudopodetia, commonly dark-spotted on the surface, singular or botryose, ridged and tomentose, appearing erose; phycobiont Stigonema. Apothecia abundant, initially pale and translucent, turning dark brown with age, globose, terminal on branches. Pseudopodetia K+ yellow, C-, KC-, PD+ yellow-orange.

Chemical composition, atranorin, norstictic acid, stictic acid determined by TLC, trace amounts of 5-6 unidentified substances reported by Dey (1975).

Locally abundant, collected on exposed granitic rock in the grassy bald, heath gardens, and rockslide areas between the elevations

of 4200 and 4900 ft. This species was reported by Dey (1975) as common on rock and gravelly soil at high elevations in the southern Appalachians while not common at lower elevations. It occurs in the New England, Great Lakes, and Appalachians of eastern North America, as well as Europe and Asia (Dey, 1975).

Stereocaulon dactylophyllum can be recognized by its cylindric-coralloid phyllocladia and production of stictic acid. Three other species of Stereocaulon are known from the southern Appalachians. S. pileatum is the only species in this area which is sorediate. This species, most commonly found at moderately high elevations while infrequent above 5500 ft., forms short, irregular colonies and has PD- lobaric acid. One very rare species S. ramulosum is known in North America only from three collections on Roan Mountain. The only specimen examined (Sharp s.n., 1957 [TENN]) is fragmentary but displays the sacculate cephalodia which define this species (see Lamb, 1976). Phyllocladia are very sparse in Central American specimens of this species and atranorin, norstictic, and stictic acids are produced in the thallus. S. tennesseense is similar to S. dactylophyllum but is usually smaller, to 1 cm, but occasionally reaches 4 cm. It differs in its production of lobaric acid (PD-).

Specimens examined. Tennessee. Unicoi Co.: Beauty Spot 1075, 3406, 3407; Horseback Ridge 1257, 1273, 1288*; Rockslide Area 1076, 1131, 1133, 1134.

2. Stereocaulon tennesseense Magn.

Stereocaulon tennesseense Magn. in Degel., Ark. Bot. 30A(1): 48. 1941.

Thallus fruticose, colonies low-tufted cushions, up to 3 cm in diameter, attached by a holdfast, gray to whitish gray, darkening at the base; branching irregular. Pseudopodetia up to 3(-4) cm tall, erect or prostrate, moderately to sparsely branched. Surface ecorticate, esorediate, verruculose and maculate; phyllocladia moderately abundant to dense, sparse at the base, coralloid and terete; cephalodia common, capitate to botryoid, light gray to charcoal black near the base. Apothecia frequent, to 2 mm in diameter, capitate, terminal; disc reddish to dark brown, convex. Primary thallus not persistent. Medulla K+ dingy yellow or K-, C-, KC+ pinkish, fast fading or KC-, PD-.

Chemical composition, atranorin, lobaric acid, and two unknowns determined by TLC.

Rare, collected only on exposed bedrock on Horseback Ridge at ca. 4800 ft. elevation. Dey (1975) reported this species as widespread but not common at elevations above 5500 ft. elevation, while rare at lower elevations. Lamb (1977) listed its distribution as disjunct-bicentric, including eastern North America and eastern Asia. In North America it is known from Newfoundland, New York, Virginia, North Carolina, and Tennessee.

Stereocaulon tennesseense is similar to S. dactylophyllum which is common on Unaka Mountain. It is distinguished by its

stunted size and production of lobaric acid. Specimens appear consistent with var. migrofastgiatum Lamb of this species.

Specimens examined. Tennessee. Unicoi Co.: Horseback Ridge 3409*.

## VI. BAEOMYCETACEAE

Baeomycetaceae is represented on Unaka Mountain by the genus Baeomyces. This genus can be recognized by its areolate, crustose primary thallus which produces short solid podetia. The podetia are tan or pink and lack algae. Baeomyces was revised for North America by Thomson (1967a). One other southern Appalachian genus, Icmadophila, is represented by Icmadophila ericetorum (L.) Zahlbr. This taxon bears small sessile apothecia.

### 9. Baeomyces Pers.

Key to the Species of Baeomyces in the southern Appalachians

1. Apothecia tan or brown; stictic acid present; thallus saxicolous . . . . . [B. rufus (Huds.) Rebent]

1. Apothecia pink or pinkish, baeomycesic and squamatic acids present; thallus usually terricolous . . . . . 2

   2. Apothecia capitate; podetia conspicuous . . . . . .1. B. fungoides (Sw.) Ach.

   2. Apothecia flattened; podetia small and inconspicuous . . . . . .[B. absolutus Tuck.]

1. Baeomyces fungoides (Sw.) Ach.

   Baeomyces fungoides (Sw.) Ach., Meth. Lich. 320. 1803.

   Lichen fungoides Sw., Prodr. Beg. Ind. Occ. 146. 1788.

Thallus fruticose with a crustose primary thallus, forming extensive mats, whitish to mineral gray. Pseudopodetia up to 6 mm tall; stipe, solid, white (lacking algae), fibrous to ridged and twisted, unbranched; apothecia common, to 5 mm in diameter, peach to rose color, initially flesh color, pruinose, capitate. Primary thallus crustose, areolate to verruculose and pustulate, pruinose. Pseudopodetia K+ yellow, C-, KC-, PD+ yellow-orange or orange.

Chemical composition, baeomycesic acid, squamatic acid, and trace amounts of unidentified substances reported by Dey (1975).

Widespread and locally abundant, collected in extensive mats on the soil of the grassy bald at Beauty Spot, ca. 4200 ft. elevation. Dey (1975) reported this species as widespread throughout the southern Appalachians while locally abundant in disturbed sites at high elevations. In North America it ranges throughout New England, the Appalachians, and Tennessee Valley. It also occurs in Central America, Europe, Asia, and Australia (Dey, 1975).

Baeomyces fungoides previously was called B. roseus Pers. in North America. This species was found to be conspecific with the European taxon which has nomenclatural priority.

Other species of Baeomyces found in the southern Appalachians are B. absolutus and B. rufus. B. absolutus, found only at lower elevations bears small inconspicuous pseudopodetia with flattened, pink apothecia. Brown apothecia distinguish the saxicolous species, B. rufus. This species, present at high elevations, produces stictic, constictic, and norstictic acids.

Specimens examined. Tennessee. Unicoi Co.: Beauty Spot 1031*, 3001, 3002; Roadcut 1046.

## VII. CLADONIACEAE

Members of the Cladoniaceae can be recognized by their round, hollow podetia which bear red, tan, brown, or dark blackish brown apothecia. The primary thallus may be squamulose or crustose, and occasionally is absent at maturity. Most species form podetia, although a few taxa have aborted podetia or lack podetia entirely.

In the southern Appalachians four genera are present: Cladina, Cladonia, Gymnoderma, and Pycnothelia. Cladina, studied by Ahti (1961) and recently segregated from Cladonia by Hale and Culberson (1970), has richly branched podetia that lack a continuous cortex. At maturity the primary thallus is absent.

Cladonia is a large and varied genus. All species have a true cortex which occasionally is exfoliated and replaced by soredia. Basal squamules are usually present and podetial squamules sparse to dense.

Pycnothelia, represented by P. papillaria in the study area, is also a segregate of Cladonia. The primary thallus is crustose and the podetia, short and inflated.

Gymnoderma has strap-shaped squamules with blackened bases. Apothecia are sessile or short stipitate on the subapical portions of the squamules. One species, G. lineare, is widespread but rare on shady, vertical rock faces at high elevations in the southern Appalachians.

Cladonia, including Cladina and Pycnothelia, has been monographed for North America by Thomson (1967b). Gymnoderma was revised by Yoshimura and Sharp (1968a, 1968b).

## 10. Cladina Nyl.

Key to the Species of Cladina in the southern Appalachians

1. Podetia ashy white, atranorin present . . . . . .2. C. rangiferina (L.) Harm.

1. Podetia yellow-green, usnic acid present . . . . . 2

   2. Axils open; ultimate branches in fours and recurved in one direction. . . . . 1. C. arbuscula (Walbr.) Hale & Culb.

   2. Axils closed; ultimate branches in twos or fours, erect or curving in one or more directions . . . . . 3

3. Podetia PD+ red, fumarprotocetraric acid present; ultimate branches in twos . . . . . .[C. subtenuis (Abb.) Hale & Culb.]

3. Podetia PD-, fatty acids present; ultimate branches in fours. . . . . 3. C. submitis (Evans) Hale & Culb.

### 1. Cladina arbuscula (Walbr.) Hale & Culb.

Cladina arbuscula (Walbr.) Hale & Culb., Bryologist 73: 510. 1970.

Patellaria foliacea var. m. arbuscula Walbr., Naturgesch. Saulchen-Flecht. 169. 1829.

Thallus fruticose, in tufts or extensive mats, light greenish yellow to pale green; primary thallus crustose, not present at maturity; branching anisotomic di- to polychotomous. Podetia robust, 3-5(-10) cm tall; main axes forming a sympodium with unilateral growth and uneven branching; axils open; branchlets coarse, in

whorls of 2-3 or more around an open axil, widely divergent, reflexed in one direction, branch tips brown, frequently pycnidiate. Podetial surface ecorticate, fibrous to arachnoid, green areolate to verruculate with age. Apothecia reported by Thomson (1967b) as small, dark brown, solitary or in a corymbose arrangement at the branch tips. Podetia K-, C-, KC+ yellow, PD+ orange-red.

Chemical composition, usnic acid and fumarprotocetraric acid, determined by TLC; two accessory unidentified substances reported by Dey (1975).

Locally abundant, collected on soil, rock, and duff in the heath garden, rockslide, and outcrop areas of Horseback and Stamping Ground Ridge above 4400 ft. elevation. Dey (1975) reported this species as common and widespread at all elevations of the southern Appalachians. In North America it ranges across Canada and Alaska and extends southward along the Appalachians and the West Coast. Known also from Europe and Asia, its distribution is circumpolar from the arctic to temperate regions of the northern hemisphere (Thomson, 1967b).

Cladina arbuscula, formerly known as Cladonia sylvatica (L.) Hoffm., can be distinguished from other yellow-green, fumarprotocetraric acid containing species by its open, often flaring axils, and unidirectionally recurved branchlets. The uneven branching of the distinctive main axis results in a sympodial arrangement with unilateral growth (Thomson, 1967b).

Cladina subtenuis also is yellow-green and produced fumarprotocetraric acid but its colonies are tangled and the podetia

slender. The branches are widely spreading and curved, and while its branching is uneven, there is no strongly defined central axis. The branchlets are produced in pairs and may curve in any direction or be erect. Typically the closed axils of C. subtenuis distinguish it from C. arbuscula. C. subtenuis is a temperate species which is common and widespread throughout the Southeast but rare at moderate to high elevations in the mountainous regions.

One other yellow-green species, C. submitus present in the southern Appalachians, forms short, tangled tufts with ascending central podetia and prostrate peripheral branches. Its coarse podetia have ultimate branches in 4's which may curve in one direction or be erect with closed axils. It can be easily distinguished by its production of K- fatty acids and lack of fumarprotocetraric acid.

Superficially, this species may resemble Cladonia uncialis and its closely related species. However, they have a true cortex and lack fumarprotocetraric acid.

Specimens examined. Tennessee. Unicoi Co.: Beauty Spot 3030; Horseback Ridge 1224, 1256, 1284; Stamping Ground Ridge 1044, 1058, 1059*, 1060.

2. Cladina rangiferina (L.) Harm.

Cladina rangiferina (L.) Harm., Bull. Soc. Sci. Nancy, ser. 2, 14: 387. (1895) 1896.

Lichen rangiferina L., Sp. Pl. 1153. 1753.

Thallus fruticose, in tufts or extensive mats, ashy gray to white; primary thallus crustose, soon disappearing. Podetial branching anisotomic di- to polytomous; podetia robust, to 6(-10) cm tall; main axes well defined, rebranched; axils open; branchlets coarse, in whorls of 2 to 3 or more around an open axil, curved in the same direction; branch tips reddish brown, frequently pycnidiate, rarely apotheciate. Apothecia reported by Thomson (1967b) as small, dark brown or black, solitary or in corymbs on the branch tips. Podetial surface ecorticate, fibrous to arachnoid, with green areoles or verruculae on older areas. Podetia K+ yellow, C-, KC-, PD+ orange-red.

Chemical composition, atranorin, fumarprotocetraric acid, and trace amounts of two unidentified substances, reported by Dey (1975).

Locally abundant but not widespread, collected on soil or duff over rock at the picnic area of Stamping Ground Ridge, rockslide and heath garden community. Dey (1975) noted that this species is widespread in high elevation heath balds and fire cherry communities and common at lower elevations in the southern Appalachians. This circumpolar species occurs from the Arctic to temperate regions of North America, Europe, and Asia (Thomson, 1967b).

Cladina rangerferina is distinguished by its ashy gray to white color. Other species of Cladina common in the southern Appalachians produce usnic acid and have a yellow-green color.

Specimens examined. Tennessee. Unicoi Co.: Stamping Ground Ridge 1045, 1078*.

3. Cladina submitis (Evans) Hale & Culb.

Cladina submitis (Evans) Hale & Culb., Bryologist 73: 510. 1970.

Cladonia submitis Evans, Rhodora 45: 435. 1943.

Thallus fruticose, in compact to loose tufts, yellowish to whitish yellow; primary thallus lacking; branching somewhat anisotomic, usually unequally tetrachotomous near base, equally tri- or dichotomous above. Podetia 2-3 cm tall, ascending or rarely, prostrate; peripheral branches prostrate; branchlets divergent, coarse, short, usually not curved; axils perforate and occasionally expanding into a shallow cup; branch tips brown, occasionally pycnidiate. Podetial surface ecorticate, fibrous, green areolate, occasionally verruculose. Podetia K-, C-, KC-, PD-.

Chemical composition, usnic acid and unidentified fatty acids, determined by TLC.

Rare, collected only on roadside soil and duff over rock on Horseback Ridge, ca. 4500 ft. elevation. Dey (1975) reported this species as rare in the southern Appalachians. This species is known only from the Appalachians and Asia.

Cladina submitis is distinguished by its K- reaction and production of fatty acids. In the field it can be recognized by its short, frequently prostrate and spreading habit.

Specimens examined. Tennessee. Unicoi Co.: Horseback Ridge 1260*.

## 11. Cladonia (Hill) Hill

Key to the Species of Cladonia in the southern Appalachians

1. Apothecia red. . . . . 2

1. Apothecia brown or absent. . . . . .10

2. Podetia blunt or pointed . . . . . 3

2. Podetia cup shaped . . . . . 9

3. Podetia sorediate. . . . . 4

3. Podetia not sorediate. . . . . 7. C. cristatella Tuck.

4. Podetia K+ yellow, thamnolic acid present. . . . . 5

4. Podetia K-, thamnolic acid absent. . . . . 6

5. Ecorticate areas of the podetia sorediate or opaque and cottony. . . . . 14. C. macilenta Hoffm.

5. Ecorticate areas of the podetia frequently bare, translucent, and darkening. . . . . 24. C. vulcanica Zoll. & Mer.

6. Exposed medulla UV+ brilliant white, squamatic and didymic acids present. . . . . .[C. incrassata Flk.]

6. Exposed medulla UV-, barbatic and didymic acids present. . 7

7. Podetia corticate at the base and apex; apothecia wider than the diameter of the podetia. . . . .11. C. floerkeana (Fr.) Flk.

7. Podetia corticate at the base only, apothecia not wider than the diameter of the podetia. . . . . 8

8. Ecorticate areas sorediate, opaque and cottony. . . . . .1. C. bacillaris (Ach.) Nyl.

8. Ecorticate areas often bare, translucent, and darkening. . . . . .9. C. didyma (Fee) Vain.

9. Cups deep, regular and expanded; podetia K-, PD-, thamnolic acid absent. . . . . .[C. pleurota (Flk.) Schaer.]

9. Cups shallow, irregular with marginal proliferations; podetia K+, PD+ deep yellow, thamnolic acid present . . . . . [C. digitata (L.) Hoffm.]

10. Podetia absent or aborted; apothecia occasional on squamules. . . . . .11

10. Podetia present and well developed; apothecia, if present on podetia . . . . . .15

11. Squamules finely divided; margins dissected . . . . . .12

11. Squamules strap-shaped; margins entire or granular. . . . . .13

12. Medulla UV+ brilliant white, PD-, squamatic acid present. . . . . .20. C. squamosa (Scop.) Hoffm.

12. Medulla UV-, PD+ red; fumarprotocetraric acid present. . . . . .2. C. caespiticia (Pers.) Flk.

13. Squamules KC+ blue-green, strepsilin present . . . . . .21. C. strepsilis (Ach.) Vain.

13. Squamules KC-, strepsilin absent. . . . . .14

14. Squamules yellow-green, PD-, usnic acid present. . . . . .[C. piedmontensis Merr.]

14. Squamules mineral green, PD+ red, fumarprotocetraric acid present . . . . . [C. apodocarpa Robb.]

15. Podetia blunt or pointed. . . . . .16

15. Podetia forming cups. . . . . .26

16. Podetia sorediate. . . . . .17

16. Podetia esorediate . . . . . .19

17. Soredia coarse; ecorticate areas translucent and darkening . . . . . 16. C. pityrea (Flk.) Fr.

17. Soredia farinose, ecorticate areas opaque and cottony . . . .18

18. Podetia finely pointed; squamules dark green, 2-5 mm long; only fumarprotocetraric acid present . . . . . 6. C. coniocraea (Flk.) Spreng.

18. Podetia blunt; squamules mineral gray or green, less than 2 mm long, fumarprotocetraria acid present . . . . . [C. cylindrica (Evans) Evans]

19. Podetia repeatedly and richly branched. . . . . .20

19. Podetia sparsely branched or unbranched . . . . . .24

20. Primary squamules persistent; podetia sparsely to densely squamulose . . . . . .23

20. Primary squamules lacking at maturity; podetia lacking squamules. . . . . .21

21. Podetia irregularly inflated; secondary branches bristle-like. . . . . [C. caroliniana (Schwein.) Tuck.]

21. Podetia not or only slightly inflated; secondary branches attenuate . . . . . .22

22. Inner cavity of podetia with longitudinal, cartilaginous ribs; UV-, only usnic acid present . . . . . .[C. dimorphoclada Robb.]

22. Inner cavity smooth and cartilaginous; UV+ brilliant white, usnic and squamatic acids present . . . . . .22. C. uncialis (L.) Wigg.

23. Podetia densely squamulose; surface with exposed white, cartilaginous ribs; UV+ brilliant white, PD-, squamatic acid present. . . . . .20. C. squamosa (Scop.) Hoffm.

23. Podetia sparsely squamulose; surface smooth and corticate; UV-, PD+ red, fumarprotocetraric. . . . . .12. C. furcata (Huds.) Schrad.

24. Apothecia pale brown; podetia twisted with exposed cartilaginous ribs . . . . 3. C. capitata (Michx.) Spreng.

24. Apothecia dark brown; podetia not twisted, and cartilaginous ribs rarely exposed. . . . . .25

25. Apothecia capitate; podetia K+ yellow turning red, norstictic acid present. . . . . 17. C. polycarpoides Nyl.

25. Apothecia flattened; podetia K-, fumarprotocetraric acid present . . . . . 5. C. clavulifera Vain.

26. Podetia sorediate. . . . . .27

26. Podetia not sorediate. . . . . .33

27. Podetia abruptly expanding, deeply cup-shaped . . . . . [C. conista (Ach.) Robb.]

27. Podetia gradually expanding, funnel-shaped. . . . . .28

28. Soredia granular; podetia up to 1.5 cm tall, cups stout . . . . . .29

28. Soredia farinose; podetia 1 to 3 cm tall, cups thin. . .32

29. Podetia KC+ pink, fast fading . . . . . .30

29. Podetia KC- . . . . . .31

30. Cryptochlorophaeic acid present, with or without fumarprotocetraric acid. . . 8. C. cryptochlorophaea Asah.

30. Merochlorophaeic acid present, with or without fumarprotocetraric acid. . . . .[C. merochlorophaea Asah.]

31. Grayanic acid, with or without fumarprotocetraric acid . . . . . .13. C. grayi Merr.

31. Only fumarprotocetraric acid present . . . . . .4. C. chlorophaea (Flk.) Spreng.

32. Cups deep and elongate; margins expanded, not proliferating. . . . . 10. C. fimbriata (L.) Fr.

32. Cups shallow; margins flaring and proliferating . . . . . .19. C. rei Schaer.

33. Cups proliferating from the center and occasionally from the margin. . . . . .34

33. Cups, if proliferating, only from the margin. . . . . .35

34. Podetia squamulose; cups proliferating from the center and margins; cups often aborted and replaced by squamules. . . . . .15. C. mateocyatha Robb.

34. Podetia not squamulose; cups proliferating only from the center; cups well developed . . . . . .23. C. verticillata (Hoffm.) Schaer.

35. Cups deep and stout, infrequently proliferating at the margins . . . . . 18. C. pyxidata (L.) Hoffm.

35. Cups shallow, perforate or not, frequently proliferating at the margins . . . . . .36

36. Podetia densely squamulose; surface with cartilaginous ribs exposed; cups open; UV+ brilliant white, squamatic acid present . . .20. C. squamosa (Scop.) Hoffm.

36. Podetia not or sparsely squamulose, surface with a continuous cortex; cups closed; UV-, fumarprotocetraric acid present . . . . . [C. gracilis (L.) Willd.]

1. Cladonia bacillaris (Ach.) Nyl.

Cladonia bacillaris (Ach.) Nyl., Not. Sallsk. Fauna Flora Fenn. Forn. 8: 179. 1866.

Baeomyces bacillaris Ach., Meth. Lich. 329. 1803.

Thallus fruticose; primary thallus squamulose, mineral gray; branching irregular. Podetia 5-10(-50) mm tall, cylindrical, pointed to blunt, simple or sparingly branched near the apex; branches diverging greatly, frequently tipped by apothecia, surface corticate near base, becoming verruculose or small squamulate, decorticate above, cottony and opaque (darkening but never translucent), often with a yellow pigment; soredia abundant, powdery, green, covering decorticate areas completely. Apothecia frequent, bright red, not exceeding the podetial width, often four or more imbedded in the tip of the podetia. Primary squamules to 6 mm wide, darker mineral green, maculate; margins crenate; soredia occasional, granular; pycnidia occasional. Podetia K-, C-, KC- or yellowish, PD-.

Chemical composition, barbatic acid, accessory didymic acid, trace amounts of 4-O-demethylbarbatic acid, and trace amounts of accessory usnic acid, determined by TLC, and 2-3 accessory unidentified substances, and accessory unidentified pigment reported by Dey (1975).

Widespread but not common, collected on duff over rock, soil, and trees in heath garden and rockslide areas, and the white pine plantation between 4000 and 4700 ft. elevations. Dey (1975) reported that this species was widespread but not common at all elevations in the southern Appalachians. It occurs throughout southern Canada and the United States except for the Great Basin and the Great Plains. This cosmopolitan species is also known from Asia, Europe, Australia, and South America.

Cladonia bacillaris is identified by its production of soredia along its ecorticate but never translucent podetia, small red apothecia, and barbatic acid complex and didymic acid. Other PD- species with red apothecia always produce didymic acid in addition to the barbatic acid complex. Cladonia floerkeana is corticate at the podetial base and apex, and decorticate areas are sparsely sorediate. The apothecia of this species exceed the width of the podetia. In Cladonia didyma the apothecia are usually small as in C. bacillaris but the ecorticate areas are sparsely sorediate, cartilaginous and translucent to darkening. Corticate areas are restricted to the base of the podetia and often squamulate. The primary squamules are maculate and have isidioid granules. Nonsorediate, barbatic acid complex and didymic acid-containing specimens are C. cristatella. Podetia of this taxon are corticate to areolate, frequently squamulate, and branched near the apex.

Two other red-fruited species have thamnolic acid in addition to the barbatic acid complex. C. macilenta has unbranched to

sparsely branched podetia which are entirely sorediate except for corticate areas at the base or adjacent to the apothecia. Morphologically it is indistinguishable from C. bacillaris but can be identified by its K+ deep yellow reaction. C. vulcanica has translucent, esorediate-ecorticate areas, which are white to darkening as in C. didyma. The presence of thamnolic acid easily separates these species. C. incrassata is rare in the southern Appalachians and not found on Unaka Mountain. It differs in producing UV+ squamatic acid in addition to didymic acid. Its red apothecia slightly exceed the width of the podetia and its ecorticate areas are sorediate or naked and translucent. Also distinct are its large, branched apothecia.

No southern Appalachian species with brown apothecia produce barbatic acid. For this reason all sterile, PD+ collections have been called C. bacillaris.

Specimens examined. Tennessee. Unicoi Co.: Horseback Ridge 1315, 1324; Rockslide Area 1164*; Stamping Ground Ridge 1062; White Pine Plantation 1483, 1502.

2. Cladonia caespiticia (Pers.) Flörke

Cladonia caespiticia (Pers.) Flörke, Clad. Comm. 8. 1823.

Baeomyces caespiticius Pers., Ann. Bot. (Usteri) 7: 155. 1794.

Thallus rarely fruticose, with a squamulose primary thallus, mineral gray. Podetia reported by Dey (1975) and Thomson (1967b) as light tan, very tiny, 0.5-1(-2) mm tall, subcylindrical to

club-shaped, unbranched, corticate, esorediate, rarely squamulose; apothecia tan to dark brown, capitate. Primary squamules 2-3 mm long, 0.5-1 mm wide, linear, fragile and ascending, pruinose; margins irregularly or subdigitately incised and crenate, often granular; apothecia medium to reddish brown, to 5 mm in diameter, marginal or short stipitate on proliferations; pycnidia dark brown, marginal; lower surface white. Squamules K-, C-, KC-, PD+ orange-red.

Chemical composition, fumarprotocetraric acid determined by TLC, and trace amounts of two accessory unidentified substances reported by Dey (1975).

Common, collected on rock, in duff layer, and on hardwoods in red oak-hickory, white pine, and hardwood dominated forest, and rock-slides across the entire elevational range. Dey (1975) reported this species as common at high elevations while widespread at lower elevations. In North America this species occurs throughout the eastern United States excluding the coastal plain. It is also known from Europe, Asia, and South Africa (Thomson, 1967b).

Cladonia caespitica has finely divided and incised squamules, dark brown apothecia, and PD+ fumarprotocetraric acid. Other primarily squamulose species include C. robbinsii, C. apodocarpa, and C. strepsilis. C. robbinsii produces usnic acid which gives the strap-shaped squamules a yellowish cast. C. apodocarpa differs in having large, strap-shaped squamules with a chalky white lower surface. It also produces fumarprotocetraric acid. The KC+ green reaction of C. strepsilis due to strepsilin identifies this species.

Other species occasionally present only as squamules can be identified by their spot test reaction. C. polycarpoides has a K+ yellow turning red reaction due to norstictic acid, and C. turgida (Ehrh.) Hoffm. a K+ yellow, PD+ red reaction due to atranorin and occasionally fumarprotocetraric acid. Squamules with barbatic acid (PD+ yellowish) should be referred to C. bacillaris and those with squamatic acid to C. squamosa.

Specimens examined. North Carolina. Yancey Co.: Beauty Spot Forest 3032; Tennessee. Unicoi Co.: Cherry Gap Trail 1407, 1597; Rockslide Area 1119; White Pine Plantation 1539, 3031*.

3. Cladonia capitata (Michx.) Spreng.

Cladonia capitata (Michx.) Spreng. in L., Syst. Veg. 16 ed. 4: 271. 1827.

Helopodium capitatum Michx., Flora Bor. Am. 2: 329. 1803.

Thallus fruticose with a persistent squamulose primary thallus; mineral gray; branching irregular. Podetia to 1.5 cm tall, 1.5 mm in diameter, cylindrical, simple to sparingly branched; apothecia large, exceeding the width of the podetia, convex, capitate, flesh to light brown in color. Surface corticate to dispersed aerolate, exposing cartilaginous ribs which are translucent and twisted, becoming fissured and appearing interlaced, esorediate. Primary squamules mineral green, small, rounded. Podetia K+ dingy brown, C-, KC-, PD+ orange-red.

Chemical composition, fumarprotocetraric acid determined by TLC, two accessory unidentified substances reported by Dey (1975).

Not common but locally abundant, collected on soil in the grassy bald at Beauty Spot, ca. 4200 ft. elevation. Dey (1975) reported that this species is widespread but not common on roadbanks at high elevations, and common at lower elevations in the southern Appalachians. In North America it occurs throughout the eastern United States with populations in California and southern Canada. The range of this species includes Central and South America, the West Indies, Europe, Asia, and Australia (Thomson, 1967b).

Cladonia capitata is distinguished by its pale brown apothecia and twisted cartilaginous ribs. All other esorediate species in the southern Appalachians have dark brown apothecia.

Specimens examined. Tennessee. Unicoi Co.: Beauty Spot 3033*, 3034; Rockslide Area 1169.

4. Cladonia chlorophaea (Flörke) Spreng.

Cladonia chlorophaea (Flörke) Spreng. in L., Syst. Veg. ed. 16. 273. 1827.

Cenomyce chlorophaea Flörke in Sommerf., Suppl. Flora Lappon. 130. 1826.

Thallus fruticose with a persistent squamulose primary thallus, mineral gray. Podetia 2-5 cm tall, robust, gradually flaring into cups up to 2(-4) mm in diameter, goblet-shaped; cup interior closed; margins entire or irregular and proliferating; apothecia occasional, brown, not exceeding the width of the margin; pycnidia occasional, dark brown, marginal. Surface corticate at the base, areolate or verruculose, decorticate above and inside the cup; decorticate areas

white and somewhat cottony, covered by granular or areolate soredia. Primary squamules darker green, small, margins dissected to lobulate. Podetia K-, C-, KC-, PD+ orange-red.

Chemical composition, fumarprotocetraric acid determined by TLC, two accessory unidentified substances reported by Dey (1975).

Not common, collected only on hickory bark in a red oak-hickory forest at Beauty Spot, ca. 4000 ft. elevation. At higher elevations this species is common on rock, soil, and hardwood trees in a variety of communities (Dey, 1978) while widespread at lower elevations. This species occurs throughout North America, Alaska, Canada, and the United States (Bowler, 1972), as well as Central and South America, Europe, Asia, Australia, and New Zealand (Dey, 1975).

Cladonia chlorophaea is one of five morphologically indistinguishable species which can be separated only by identification of their lichen acids through techniques such as TLC. C. chlorophaea with the widest distribution across North America, has only fumarprotocetraric acid. The most common species in the southern Appalachians is C. grayi which produces grayanic acid with or without fumarprotocetraric acid. This species occurs in the eastern United States as does C. cryptochlorophaea which has cryptochlorophaeic acid with or without fumarprotocetraric acid and C. perlomera Dey with merochlorophaeic acid, 4-O-methylcryptochlorophaeic acid, and perlatolic acid. A boreal and western species in this complex, C. merochlorophaea Asah., has merochlorophaeic with or without fumarprotocetraric acid. In Dey's 1975 study the following

frequencies were found in high mountain areas: C. grayi 43%, C. chlorophaea 27%, C. merochlorophaea 23%, and C. cryptochlorophaea 7%.

Other sorediate, cup-producing species present in the southern Appalachians include C. fimbriata, C. rei, and C. conista. C. fimbriata has distinct, tall cups which are not expanded and occasionally proliferating along the margins. It has farinose soredia and produces fumarprotocetraric acid. C. rei has shallow small cups with flaring margins which are dentate or proliferating. The podetia are sparsely branched and often have bare ecorticate areas. Fumarprotocetraric acid or homosekikaic acid are produced. C. conista has robust podetia with deep, expanded cups and fumarprotocetraric acid.

C. pyxidata is very similar to C. cholorphaea except the granular soredia are replaced by small areoles. Fumarprotocetraric acid is produced in the podetia.

Specimens examined. North Carolina. Yancey Co.: Beauty Spot Forest 3035; Tennessee. Unicoi Co.: Beauty Spot 1033*; White Pine Plantation 1449.

5. Cladonia clavulifera Vain.

Cladonia clavulifera Vain. in Robb., Rhodora 26: 145. 1924.

Thallus fruticose with a squamulose primary thallus; gray-green; branching irregular. Podetia to 2 cm tall, robust, club-shaped, appearing inflated at the apex, simple to sparingly branched at the tip; apothecia apical, flat, occasionally perforate, medium to

dark brown, solitary, not or slightly exceeding the width of the podetia. Surface corticate, continuous or patchy and verruculose, esorediate; medulla cottony where exposed beneath the apothecia; inner cavity cartilaginous and darkening. Primary squamules darker grayish to bright green, very thick and appearing inflated; margins crenate to lobed. Podetia K+ dingy, C-, KC-, PD+ orange-red.

Chemical composition, fumarprotocatraric acid determined by TLC, and two accessory unidentified substances reported by Dey (1975).

Not common but locally abundant, collected on soil along roadbanks and in the grassy bald of Beauty Spot at elevations between 4300 and 4600 ft. Dey (1975) noted that this species is rare at all elevations in the Southeast. In North America this species is known from the eastern United States and southeastern Canada. It also occurs in eastern Asia.

Cladonia clavulifera has distinctive flat, dark brown apothecia which appear to have been painted onto the blunt podetial tips. Other esorediate, brown-fruited species with blunt, well developed podetia in the southern Appalachians include Cladonia capitata, C. polycarpoides, and C. piedmontensis. C. capitate differs in having pale brown, capitate apothecia and twisted cartilaginous ribs exposed on the podetia. C. polycarpoides can be easily distinguished by its K+ yellow turning red, norstictic acid, and capitate, dark brown apothecia. Not found in the study area, the yellowish cast of the podetia due to the presence of usnic acid is

unique to C. piedmontensis in the southern Appalachians. This species occurs throughout the eastern United States (excluding the Coastal Plain) and at low elevations in the mountains.

Two other esorediate species are easily distinguished from C. clavulifera, C. furcata, widespread and abundant in eastern North America, is richly branched, forming open cup-like axils, sparsely squamulate, and has an unmistakable brownish green color. Apothecia are brown, but rarely seen. A similar species known only from the high elevation areas in the southern Appalachians, Cladonia gracilis, is highly variable. The tall podetia are sparsely branched with closed axils forming a distinct or abortive cup with a brownish tinged continuous shiny cortex.

Specimens examined. Tennessee. Unicoi Co.: Beauty Spot 3036, 3037; Horseback Ridge 1278*.

6. Cladonia coniocraea (Flörke) Spreng.

Cladonia coniocraea (Flörke) Spreng. in L., Syst. Veg. ed. 16. 4: 272. 1827.

Cenomyce coniocraea Flörke, Deutschl. Lich. 7: 14. 1821.

Thallus fruticose with a persistent squamulose primary thallus, mineral green to green, usually unbranched. Podetia 0.5-2 cm tall, usually simple and tapering to a fine point, or rarely, blunt to forming a narrow open cup; tips brown, frequently pycnidiate; apothecia rare, brown, solitary, apical or marginal on apical cups. Surface corticate at the base of the podetia, becoming areolate, and

occasionally sparsely squamulate, decorticate over half the length; soredia farinose, whitish or pale green, covering in part the decorticate areas; medulla, when exposed, white and cottony, darkening. Primary squamules olive to brownish green, maculate, rounded, ascending to convex, lobulate; margins crenate; lower surface white, becoming sorediate; podetia produced on the center of the upper surface. Podetia K+ dingy or K-, C-, KC-, PD+ orange-red.

Chemical composition, fumarprotocetraric acid determined by TLC, trace amounts of unidentified substances reported by Dey (1975).

Common, collected on a variety of substrates, rock, soil, and decaying wood, and infrequently on hardwoods and white pines, in many communities including spruce and white pine forest, roadbanks, rock-slides, heath gardens, and grassy balds between 4200 and 5200 ft. elevations. Also common at lower elevations, this species occurs throughout the Northern Hemisphere and also is known from Australia and Argentina (Thomson, 1967b).

Cladonia coniocraea has distinctively dark to brownish green squamules, which are well developed, large, and persistent. The podetia are born on the center of the upper surface, and the dark green color continues up the corticated base. This cortex is absent from most of the podetia and is replaced by white, farinose soredia. The podetia have a sharp point which is usually brown-tipped, or rarely, may open into narrow cups. Degelius (1941) and Thomson (1967b) recognized specimens with scattered corticate patches on the podetia and corticate apices and cup interiors as

C. ochrochlora Flörke. However, Dey (1975) noted a continuous range of variation between the extremes. In this study, as in Dey's (1975) treatment, all collections have been recognized as C. coniocraea.

One other species with brown apothecia and soredia collected in the study area, Cladonia pityrea, has small squamules which are mineral gray, podetia which are twisted and blunt-tipped, translucent and darkening where ecorticate, and coarsely sorediate. This species also produces fumarprotocetraric acid, as does C. farinacea (Vain.) Evans, not collected in the study area. This latter species has podetia which are irregularly to furcately branched with open axils, sorediate over most of the surface, and opaque in the decorticate areas of the podetia. Its branching is similar to that of C. furcata which is completely corticate and esorediate.

Two other species known from the southern Appalachians differ in their chemical composition. C. parasitica has short podetia arising from isidioid squamules, translucent ecorticate areas, and thamnolic acid. Not present at high elevations, C. cylindrica with blunt podetia, isidioid squamules, and an ashy white color, produces grayanic acid in addition to fumarprotocetraric acid.

Specimens examined. Tennessee. Unicoi Co.: Beauty Spot 3044; Horseback Ridge 1233; Stamping Ground Ridge 1067; Summit 3043, 1051; White Pine Plantation 1536, 1561, 1564, 1566, 3038, 3039, 3040*, 3041, 3066.

7. Cladonia cristatella Tuck.

Cladonia cristatella Tuck., Am. J. Sci. Arts, ser. 2. 25: 428. 1858.

Thallus fruticose with a squamulose primary thallus, forming large mats, mineral gray to yellow-green; branching irregular. Podetia to 2.5 cm tall, robust, cylindrical, simple to sparingly branched near the top; surface corticate, often areolate to sparsely squamulose, esorediate; apothecia terminal, bright red or rarely colorless to pale orange, solitary, large and exceeding the width of the podetia or clustered and smaller. Primary squamules small, to 2-3 mm long, mineral green to yellowish green, maculate, linear and much-lobed, esorediate; margins crenate; lower surface white, rarely yellow-pigmented (K+ red-purple) at the base (Dey, 1975). Podetia K+ dingy or K-, C-, KC-, PD-.

Chemical composition, usnic acid, barbatic acid, didymic acid, and trace amounts of 4-O-demethylbarbatic acid determined by TLC, and trace amounts of unidentified substances reported by Dey (1975).

Locally abundant, collected in extensive mats on soil and decorticated wood in the grassy meadow at Beauty Spot, ca. 4200 ft. elevation and on soil in rock slide areas at elevations around 4800 ft. Dey (1975) reported this species as common at all elevations throughout the southern Appalachians. Thomson (1976b) noted that it is common in old fields and open areas. This North American endemic is known from southern Canada, and the Great Lakes-Appalachian area.

Cladonia cristatella is distinguished from other red-fruited species by its lack of soredia. See C. bacillaris for comparison to other blunt, red-fruited species.

Specimens examined. Tennessee. Unicoi Co.: Beauty Spot 1034, 3045*.

8. Cladonia cryptochlorophaea Asah.

Cladonia cryptochlorophaea Asah., Jpn. Bot. 16: 711. 1940.

Thallus fruticose with a persistent squamulose primary thallus, mineral gray. Podetia 2-5 cm tall, robust, gradually flaring into cups up to 2(-4) mm in diameter, goblet-shaped; cup interior closed; margins entire or irregular and proliferating; apothecia occasional, brown, not exceeding the width of the margin; pycnidia occasional, dark brown, marginal. Surface corticate at the base, areolate or verruculose, decorticate above and inside the cup; decorticate areas white and somewhat cottony, covered by granular or areolate soredia; cup interiors infrequently with squamules and areoles. Primary squamules darker green, small, margins dissected to lobulate. Podetia K+ dingy pinkish brown, C-, KC+ pink fast fading, PD+ orange-red.

Chemical composition, fumarprotocetraric acid and cryptochlorophaeic acid determined by TLC, trace amounts of paludosic acid and an accessory unidentified substance reported by Dey (1975).

Not common, collected only on soil in the grassy bald of Beauty Spot, ca. 4200 ft. elevation. Dey (1975) reported that this

species is rare but widespread at all elevations in the southern Appalachians. It occurs in the eastern seaboard and midwest of the United States, eastern Canada, and Alaska (Bowler, 1972), Europe, Eastern Asia, and New Zealand (Dey, 1975).

Cladonia cryptochlorophaea is the cryptochlorophaeic acid-containing morph of the C. chlorophaea complex. See the discussion of the latter for comparison to the other species.

Specimen examined. Tennessee. Unicoi Co.: Stamping Ground Ridge 1064*.

9. Cladonia didyma (Fee) Vain.

Cladonia didyma (Fee) Vain, Acta Soc. Fauna Flora Fenn. 4: 137. 1887.

Scyphophorus didymus Fee, Essai Crypt. Ecorces Exot. Offic. 98. 1824.

Thallus fruticose, with squamulose primary thallus, mineral green; branching irregular. Podetia 3-3.5 mm tall, to 1 mm wide, thin-cylindrical, simple to sparsely branched near the apex; branches diverging greatly, pointed and sterile or blunt and frequently tipped by groups of small apothecia; surface corticate at the base and up to half the length of the podetia, smooth to verruculose and squamulose, decorticated above, cartilaginous, translucent to gold or darkening; soredia farinose, loosely covering the decorticated areas causing them to appear inflated; apothecia red, frequently less than the diameter of the podetia, occasionally solitary and exceeding the podetial width. Primary squamules darker mineral green, 2.4 mm

long, linear and lobulate, maculate; margins crenate to dissected; granular isidia or isidioid branchlets frequent. Podetia K-, C-, KC-, PD-.

Chemical composition, barbatic acid, accessory didymic acid, trace amounts of 4-O-demethylbarbatic acid, determined by TLC, 2-4 accessory unidentified substances reported by Dey (1975).

Widespread; collected on soil, duff, decorticated woods, and white pine in exposed areas of rockslides, roadbanks, heath gardens and in the white pine plantation between 4200 and 4900 ft. elevations. Dey (1975) noted that this species is widespread but rare at all elevations in the southern Appalachians. This species is pantemperate and pantropic, occurring in eastern North America and the Rocky Mountains, and Central and South America and Australia (Thomson, 1967b).

Cladonia didyma is distinguished by the following combination of characters: production of the barbatic acid complex and didymic acid, red apothecia rarely exceeding the width of the podetia, cortex only at the podetial base, ecorticate areas bare and darkening. The squamules are distinctively narrow and covered with coralloid isidiate-granules. Squamules are also common and well developed on the podetia.

Sterile specimens with the barbatic acid complex, bare and darkening areas on the podetia, and soredia should be included here.

See the discussion of C. bacillaris for comparison to other red-fruited species.

Specimens examined. Tennessee. Unicoi Co.: Beauty Spot 1032*; Rockslide Area 1148, 1162, 1163; White Pine Plantation 1505, 1545, 1576, 3045, 3046.

10. Cladonia fimbriata (L.) Fr.

Cladonia fimbriata (L.) Fr., Lich. Eur. Ref. 222. 1831.

Lichen fimbriata L., Sp. Pl. 2: 1152. 1753.

Thallus fruticose with a persistent squamulose primary thallus, gray-green; branching irregular. Podetia up to 2 cm tall, 3 mm in diameter, tall and narrow, unbranched or sparingly branched, expanding gradually into a narrow, trumpet-shaped cup; cup interior closed; margin entire to lacerate; apothecia occasional on the margins of proliferations, dark brown, small, not exceeding the width of the margin. Surface corticate at the base, ecorticate above; soredia farinose; medulla when exposed fibrous, white to darkening. Primary squamules middle sized, 2-10 mm long, digitately lobed, shiny, thick; margins dissected; tips ascending; podetia produced on the upper surface. Podetia K+ dingy brown, C-, KC-, PD+ orange-red.

Chemical composition, fumarprotocetraric acid determined by TLC, trace amounts of two accessory unidentified substances reported by Dey (1975).

Not common but locally abundant, collected on soil and decorticated wood in the grassy bald at Beauty Spot, ca. 4200 ft. elevation. Dey (1975) reported that this species is rare at high elevations and not common at lower elevations. Thomson (1967b) noted

that while this species is reported as cosmopolitan, the exact range is not known. It is at least circumpolar in the Northern Hemisphere. In North America it extends across Canada to Alaska and follows the mountain ranges south.

Cladonia fimbriata can be identified by its tall, narrow cups, covered by farinose soredia. For comparison to other sorediate, cup-bearing species see the discussion of C. chlorophaea.

Specimens examined. Tennessee. Unicoi Co.: Beauty Spot 3047, 3048*.

11. Cladonia floerkeana (Fr.) Flörke

Cladonia floerkeana (Fr.) Flörke. Clad. Comm. 99. 1828.

Cenomyce floerkeana Fr., Sched. Crit. Lich. Exs. Suec. 18. 1824.

Thallus fruticose, with a squamulose primary thallus, mineral gray; branching irregular. Podetia to 15(-40) mm tall, 1 mm in diameter, cylindrical, simple to sparsely branched; branches widely divergent; tipped by large apothecia; surface corticate, often extensively at base and beneath the apothecia, decorticate areas opaque, partially covered by granular soredia, occasionally squamulose; apothecia red, solitary, convex and bulging, to 1.5 x the diameter of the podetia. Primary squamules small to mid-sized, to 2 mm long; margins crenate to deeply incised, sparsely sorediate. Podetia K-, C-, KC-, PD-.

Chemical composition, barbatic acid, accessory didymic acid, accessory usnic acid, trace amounts of 4-O-demethylbarbatic acid

determined by TLC, accessory unidentified pigment, trace amounts of 4-5 unidentified substances reported by Dey (1975).

Widespread but not common, collected in the duff layer over rock in heath gardens and rockslide areas on Stamping Ground and Horseback Ridge between 4400 and 4600 ft. elevations. This cosmopolitan species occurs in eastern North America, South America, Asia, Australia, Europe, and Africa.

Cladonia floerkeana can be distinguished from other PD-, sorediate, red-apotheciate species by its larger apothecia and retained cortex at the apex as well as at the base.

See the discussion of C. bacillaris for comparison to related species.

Specimens examined. Tennessee. Unicoi Co.: Horseback Ridge 1247, 1299; Rockslide Area 1149; Stamping Ground Ridge 1069.

12. Cladonia furcata (Huds.) Schrad.

Cladonia furcata (Huds.) Schrad., Spec. Flora Berm. 107. 1794.

Lichen furcatus Huds., Flora Angl. 458. 1762.

Thallus fruticose with a squamulose primary thallus, in extensive loose mats, grayish to brownish green or brown, branching isotomic dichotomous or sympodial. Podetia up to 5(-8) cm tall, robust and elongate, often splitting linearly and appearing blade-like, richly branched; axils open; ultimate branches widely diverging, in whorls around open cuplike structures; tips pointed or open;

apothecia occasional, pale to dark brown, apical on branchlets; pycnidia frequent, dark brown, apical on branchlets. Surface corticate, continuous to somewhat verruculose near the tips; squamules sparse, well developed; esorediate. Primary squamules usually not present, brownish or dark green, rounded, 2 mm across; margins crenate; podetia produced submarginally; dying basally while growing apically. Podetia K+ dingy brown, C-, KC-, PD+ orange-red.

Chemical composition, fumarprotocetraric acid determined by TLC and 2-3 accessory substances reported by Dey (1975).

Common, collected on roadbank and trailside soil on Horseback Ridge and in the duff layer over rock at the rockslide area, frequently with moss. This species is common and widespread throughout the mountains and piedmont of the southern Appalachians (Dey, 1975). Thomson (1967b) reported this species as boreal and temperate.

Cladonia furcata is a distinctive lichen although practice may be required to identify its many forms in the field. Its tall podetia are richly branched and esorediate and with varying development of squamules. The axils of the branches open into the inner cavity and near the branch tips may form shallow cuplike structures with encircling branchlets. The brownish green color of the podetia is a reliable character for field identification.

Variation within the species is great and from personal observations appears to be a response to environmental conditions. The podetial shape ranges from sparsely branched and elongate-cylindrical to broad with open axils. Both erect and prostrate forms may be

collected. Branch tips may be finely pointed, with or without apothecia, or open into the inner cavity. Squamules on the podetia may be dense or absent.

One form, Cladonia furcata forma fissa (Florke) Aigr, has podetia which are split lengthwise, and opening into bladelike surfaces, exposing the inner surface. When dark in color and present in large mats initially the thalli resemble the convoluted and channeled lobes of brown fruticose Cetrariae. Cetraria islandica (L.) Ach. and C. arenaria Karnef. are distinguished by their browner color, spinulate margins, pseudocyphellae, and basal rhizines.

Superficially C. furcata seems closely related to species of Cladina. Both form extensive mats of richly branched podetia which die at the base producing a duff layer under the colony. C. furcata differs in producing a true cortex, and podetial squamules, while lacking atranorin or usnic acid which is found in Cladina species.

One other species found in the southern Appalachians has the brownish tinge of C. furcata. Cladonia gracilis can be identified by its shiny, continuous cortex, distinctive to abortive cups, and large dark brown apothecia.

Specimens examined. Tennessee. Unicoi Co.: Horseback Ridge 1283; Rockslide Area 1144; Stamping Ground Ridge 3049, 3050*.

13. Cladonia grayi Merr.

Cladonia grayi Merr. in Sandst., Clad. Exs. 1847. 1929.

Thallus fruticose with a persistent squamulose primary thallus, mineral gray. Podetia 2-5 cm tall, robust, gradually

flaring into cups up to 2(-4) mm in diameter, goblet-shaped; cup interior closed; margins entire or irregular and proliferating; apothecia occasional, brown, not exceeding the width of the margin; pycnidia occasional, dark brown, marginal. Surface corticate at the base, areolate or verruculose, decorticate above and inside the cup; decorticate areas white and somewhat cottony, covered by granular or areolate soredia. Primary squamules darker green, small, margins dissected to lobulate. Podetia K+ dingy brown or K-, C-, KC-, PD+ orange-red or PD-.

Chemical composition, grayanic acid and accessory fumarprotocetraric acid determined by TLC, trace amounts of 2-3 accessory unidentified substances reported by Dey (1975).

Common, collected on soil and in duff layers, hardwood and white pines in the white pine plantation, heath gardens and rockslide areas, between 4400 and 4900 ft. elevations. Dey (1975) reported that this species is common throughout the mountains and the entire Southeast. Its range includes eastern North America and midwestern United States (Bowler, 1972), South America, Europe, and Asia (Dey, 1975).

Cladonia grayi is the most common member of the C. chlorophaea complex in the southern Appalachians. For comparison of this grayanic acid-containing species with other chemical morphs see C. chlorophaea.

Specimens examined. Tennessee. Unicoi Co.: Rockslide Area 1166, 1171; Stamping Ground Ridge 1063*, 1065, 1066; White Pine Plantation 1549, 1614, 3051, 3052.

14. Cladonia macilenta Hoffm.

Cladonia macilenta Hoffm. Deutschl. Flora 2: 126. 1796.

Thallus fruticose with a squamulose primary thallus; mineral gray to green; branching irregular. Podetia to 3(-4) cm tall, cylindrical, blunt, simple to sparingly branched near the tip; branches widely divergent; apothecia occasional, red, usually slightly smaller than the podetia. Surface corticate at the base and occasionally to one half the length, areolate to verruculose, rarely squamulose, decorticate areas opaque and cottony, covered in part by farinose soredia. Basal squamules medium-sized, 4 mm long and 3 mm wide, darker green, lobed; margins crenate, rarely sorediate; lower surface white, darkening near the base. Podetia K+ yellow, C-, PD+ yellow-orange.

Chemical composition, thamnolic acid, barbatic acid, 4-O-demethylbarbatic acid, determined by TLC and trace amounts of an accessory unidentified substance reported by Dey (1975).

Not common, collected in the duff at Beauty Spot ca. 4200 ft. elevation. Dey (1975) reported this species as common in all community types at high elevations, but less common at lower elevations. It occurs throughout eastern North America, boreal Canada, the southern Rockies, and the Pacific Northwest. Thomson (1967b) described its distribution as nearly cosmopolitan boreal and north and south temperate.

Cladonia macilenta is morphologically similar to C. bacillaris but differs chemically in its production of thamnolic acid. One

other red-fruited species known from the southern Appalachians, C. vulcanica, produces thamnolic acid, but can be distinguished by its translucent and often darkening decorticate areas.

Specimens examined. Tennessee. Unicoi Co.: Beauty Spot 3053, 3054*.

15. Cladonia mateocyatha Robb.

Cladonia mateocyatha Robb., Rhodora 27: 50. 1925.

Thallus fruticose with a persistent squamulose primary thallus, dark mineral to greenish gray; branching irregular. Podetia to 2.5(-3.5) cm tall, forming asymmetrical cups; axils closed; margins lacerated and appearing inflated; proliferations numerous, marginal and occasionally central; tips blunt or cup-forming; primary cups often replaced by clusters of branches. Apothecia dark brown, capitate, on margins and proliferations, not exceeding the width of the marginal rim or proliferation. Surface corticate, areolate near the cup margins, squamules numerous, near the base, on the margins and proliferations, well-developed, crenate to lobed, chalky white beneath. Primary squamules frequently disappearing, when persistent darker brownish green to mineral green, variable in size, esorediate; margins with rounded lobes or crenate (Thomson, 1967b) not much divided, lower surface white. Podetia K-, C-, KC-, PD+ orange-red.

Chemical composition, fumarprotocetraric acid determined by TLC, two accessory unidentified substances reported by Dey (1975).

Widespread but not common, collected on soil in the rockslide area, roadbanks, heath garden, and grassy bald of Beauty Spot between

4200 and 4900 ft. elevations. In the high elevation areas of the southern Appalachians this species is not common and at lower elevations only relatively common (Dey, 1975). This North American endemic occurs in the Appalachian-Ohio Valley region and the Rocky Mountains.

Cladonia mateocyatha can be recognized by its irregular or aborted cups and large squamules. The podetia may have marginal and central proliferations. C. verticillata differs in having exclusively central proliferations.

Specimens examined. Tennessee. Unicoi Co.: Beauty Spot 3055*, 1035, 1036; Horseback Ridge 1318; Rockslide Area 1174.

16. Cladonia pityrea (Flörke) Fr.

Cladonia pityrea (Flörke) Fr., Nov. Sched. Crit. Lich. Suec. 21. 1826.

Capitularia pityrea Flörke, Ges. Naturf. Freunde Berlin Mag. Neuesten Gesammten Naturk. 2: 135. 1808.

Thallus fruticose with a squamulose primary thallus, mineral green; branching sparse, irregular. Podetia to 1.5(-5) cm tall, 1(-4) mm wide, cylindrical, blunt, reported by Thomson (1967b) as rarely forming shallow cups with irregular margins, frequently twisted, simple to sparsely branched; apothecia apical, smaller than the podetial width, one to several produced on each tip, medium to dark brown. Surface corticate from the base up to over half the podetia, often verruculose, areolate, and infrequently squamulose, decorticate above with exposed cartilaginous ribs which are twisted and

translucent to darkening; soredia granular, covering, in part, ecorticate areas. Primary squamules mineral green, narrow and delicate, deeply incised to lobes. Podetia K-, C-, KC-, PD+ orange-red.

Chemical composition, fumarprotocetraric acid determined by TLC, and two unidentified substances reported by Dey (1975).

Not common, collected on soil and in the duff layer of heath gardens and rockslide areas between 4400 and 4800 ft. elevations. Dey (1975) reported this species as rare at high elevation, and rare but widespread at lower elevations in the southern Appalachians. It occurs throughout eastern North America but is lacking in arctic and alpine regions (Thomson, 1967b). Almost cosmopolitan, its range includes Central and South America, the West Indies, Europe, Asia, Australia, and New Zealand.

Cladonia pityrea is distinguished by its coarse soredia and ecorticate areas which are translucent and darkening. Often the podetia are twisted and the primary squamules are narrower and more delicate than those of related species. In the southern Appalachians two other brown-fruited, blunt-podetiated species may be confused with this species. Both C. coniocraea and C. cylindrica have decorticate areas which are opaque and covered with farinose soredia. All three species produce fumarprotocetraric acid, but C. cylindrica also produces grayanic acid.

See the discussion of C. coniocraea for comparison to other sorediate, brown-fruited species in the southern Appalachians.

Specimens examined. Tennessee. Unicoi Co.: Rockslide 1147*; Stamping Ground Ridge 1068.

17. Cladonia polycarpoides Nyl.

Cladonia polycarpoides Nyl. in Gasilien, F. G., Lich. St. Omer. 125. 1894.

Thallus fruticose with a squamulose primary thallus, gray-green; branching irregular. Podetia to 2 cm tall, 1.5 mm in diameter, club-shaped, simple to moderately branched near the top; branchlets short, equal in size; apothecia terminal, only slightly larger than the podetia, dark brown, capitate. Surface corticate, often verruculose but not areolate. Primary squamules darker mineral green, large, 3-17 mm long and up to 4 mm wide, lobed; margins crenate; pycnidia numerous on the surface of the squamules, dark brown, isidioid. Podetia K+ yellow turning red, C-, KC-, PD+ yellow-orange.

Chemical composition, norstictic acid determined by TLC.

Not common, collected in the duff layer of the grassy bald at Beauty Spot, ca. 4200 ft. elevation. This species did not occur at high elevations in Dey's (1975) study but is known from lower elevations in the southern Appalachians. In North America it ranges throughout the eastern United States and the southernmost part of eastern Canada. Also it is documented for the West Indies and Honduras, Europe, Asia, North Africa, and Australia (Thomson, 1967b).

Cladonia polycarpoides differs from the other brown-fruited, blunt, esorediate species of the southern Appalachians in its

production of norstictic acid. There is much confusion over the use of the names C. polycarpoides, C. polycarpia Merr., and C. subcariosa Nyl. Following Thomson (1967b) and Hale (1979) the name C. polycarpoides has been used for specimens producing only norstictic acid. This taxon seems to correspond to C. subcariosa as reported by Dey (1975) for low elevations in the southern Appalachians.

Specimens examined. Tennessee. Unicoi Co.: Beauty Spot 3056*, Roadcut 1018.

18. Cladonia pyxidata (L.) Hoffm.

Cladonia pyxidata (L.) Hoffm., Deutschl. Flora 2: 121. 1796.

Lichen pyxidatus L., Sp. Pl. 2: 1151. 1753.

Thallus fruticose with a persistent squamulose primary thallus, greenish mineral gray. Podetia up to 1.5 cm tall, flaring gradually into a cup up to 5 mm in diameter, goblet-shaped; cup interior closed; margin entire to proliferating; apothecia uncommon, dark brown, small, not exceeding the width of the margin, marginal or on proliferations; pycnidia occasional, dark brown, marginal. Surface corticate at the base, areolate and squamulose above and inside the cup, esorediate. Primary squamules persistent, brownish green, small, 2-7 mm long and up to 4 mm wide, lobed; margins dissected, podetia borne on the upper surface. Podetia K+ dingy brown, C-, KC-, PD+ orange-red.

Chemical composition, fumarprotocetraric acid determined by TLC, trace amounts of two accessory unidentified substances reported by Dey (1975).

Not common, collected on soil and in the duff layer at the grassy bald of Beauty Spot, ca. 4200 ft. elevation. Dey (1975) reported this species as rare at all elevations in the southern Appalachians. This species is cosmopolitan (Thomson, 1967b) and in North America occurs across Canada and Alaska, following the mountain ranges southward.

Cladonia pyxidata can be identified by its stout, goblet-shaped cups covered by areoles and "peltate" soredia. It is quite similar to members of the C. chlorophaea group which differ in producing granular soredia, a distinction which is often elusive.

Specimens examined. Tennessee. Unicoi Co.: Beauty Spot 3057*.

19. Cladonia rei Schaer.

Cladonia rei Schaer., Lich. Helvet. Spic. 34. 1823.

Thallus fruticose with a squamulose primary thallus, mineral gray; branching irregular. Podetia up to 2.5(-9) cm tall, 2 mm in diameter, tall and narrow, flaring into shallow cups, or subulate; cup interior closed; margin dentate to proliferating; proliferations often subulate; apothecia small, not exceeding the width of the margin, dark brown, marginal or apical on subulate proliferations; pycnidia occasional, dark brown, marginal or apical. Surface corticate at the base, decorticate above, cartilaginous and

darkening; soredia granular, covering decorticate areas. Primary squamules persistent or disappearing, darker mineral green, middle-sized, to 3 mm long, lobed; margins crenate to deeply incised; tips ascending. Podetia K-, C-, KC-, P+ red or P-.

Chemical composition, fumarprotocetraric acid or homosekikaic acid reported by Dey (1978).

Not common, collected on the soil and in the duff layer in the grassy bald at Beauty Spot and in with the pine plantation between 4200 and 4400 ft. elevations. This species did not occur in Dey's (1975) study of high elevational areas. In North America this species, occurring throughout Canada, the northeastern United States and south along the mountain chains to Tennessee and North Carolina and Colorado, is described as circumpolar boreal to temperate (Thomson, 1967b). It is also known from Europe, Asia, Africa, and Australia.

Cladonia rei is identified by its sorediate, shallow cups with flaring margins. This name is synonymous with Cladonia nemoxyna (Ach.) Nyl. reported by Dey (1975) as common at lower elevations in the southern Appalachians.

For comparison to other sorediate, cup-producing species see C. chlorophaea.

Specimens examined. Tennessee. Unicoi Co.: Beauty Spot 3059*; White Pine Plantation 3058.

20. Cladonia squamosa (Scop.) Hoffm.

Cladonia squamosa (Scop.) Hoffm., Deutschl. Flora 2: 125. 1796.

Lichen squamosus Scop., Flora Corn. ed. 2.2: 368. 1772.

Thallus fruticose with a squamulose primary thallus, mineral, dark or brownish green; branching radiate or irregular. Podetia 1-4(9) cm tall, varying greatly from delicately elongate-cylindrical to robust, erect or prostrate; branching polyotomous; axils perforate or frequently flaring into narrow, funnel-shaped cups; cup margins proliferating; ultimate branches and proliferations blunt, subulate, or open; apothecia occasional, flesh-colored to light brown, small, apical; pycnidia common, dark brown, apical or marginal. Surface corticate at the base, scattered aerolate and squamulose above; squamules dense, well developed, fragile, covering the podetia; medulla exposed over large portions of the podetia, arachnoid, fibrous, and darkening esorediate. Primary squamules darker green, up to 8 mm long and 2 mm wide, narrow and linear; margins finely incised and lobed, ascending; lower surface greenish to white and darkening, granular. Podetia arising from the upper surface, or, occasionally, aborted with apothecia produced on squamules. Podetia dying at the base, growing at the apex. Podetia K-, C-, KC-, PD+ pale yellow or PD-, UV+ white.

Chemical composition, squamatic acid determined by TLC, occasional barbatic acid with trace amounts of two unidentified substances reported by Dey (1975).

Abundant, collected on rock, duff, decaying wood, hardwoods, and white pine in a variety of community types, including spruce, white pine, and successional hardwood forest, and heath gardens and

rockslides, across the entire elevational range. Dey (1975) noted that this species is common in high elevational areas, as well as throughout the southern Appalachians. This species is arctic to temperate, circumpolar (Thomson, 1967b) and in North America extends across Greenland, Canada, and Alaska, and southward throughout the eastern United States and Pacific Northwest. It is also reported from Central and South America, Europe, Asia, and Australia (Dey, 1975).

While quite variable, Cladonia squamosa can be reliably identified by its production of UV+ squamatic acid.

Specimens examined. Tennessee. Unicoi Co.: Cherry Gap Trail 3067; Horseback Ridge 1221, 1227, 1246, 1248, 1255, 1265, 1282, 1297, 1309*, 1319; Rockslide Area 1080, 1096; Stamping Ground Ridge 1070, 1071, 3061, 3062, 3063, 3064, 3065; White Pine Plantation 1450, 1493, 1519, 1615, 3060.

21. Cladonia strepsilis (Ach.) Vain.

Cladonia strepsilis (Ach.) Vain., Acta Soc. Fauna Flora Fenn. 10: 403. 1894.

Baeomyces strepsilis Ach., Meth. Lich. Suppl. 52. 1803.

Thallus infrequently fruticose, usually with a squamulose primary thallus, forming a compact cushion yellow-green to greenish gray; branching irregular. Podetia rarely produced, up to 2(-4) mm tall and 1 mm in diameter, small and diminutive, club-shaped to blunt, appearing inflated, unbranched to sparsely branched near the apex;

axils usually closed; branches short; apothecia dark brown with a lighter rim, clustered, apical. Surface corticate, verruculose, with or without squamules. Primary squamules extensive and crowded, bright yellow-green, 1-4 mm long and 1 mm wide, strap-shaped, thick and convex with ascending tips, warty to maculate; margins crenate to incised, lobulate; apex pruinose; pycnidia blackish brown, marginal. Lower surface cream-colored to dingy. Squamules K-, C+ green, KC+ coppery green, PD+ yellow.

Chemical composition, baeomycesic acid, squamatic acid, strepsilin, and 1-2 unidentified substances reported by Dey (1975).

Widespread, collected on soil and in duff layer of the heath gardens and rockslide areas between 4400 and 4900 ft. elevations. Dey (1975) noted that this species is rare at high elevations while widespread throughout the southeastern United States. In North America this species occurs in eastern Canada, New England, the Great Lakes, Appalachians west to Missouri. It also occurs in Central America, Europe, and Asia (Dey, 1975).

Cladonia strepsilis usually exists as compact mats of strap-shaped squamules, unique in their C+ greenish reaction. The small, inflated podetia when present may be confused with C. piedmontensis also yellow-green in color due to the presence of usnic acid.

Specimens examined. Tennessee. Unicoi Co.: Horseback Ridge 1243, 1251, 1252, 1253; Stamping Ground Ridge 3068*.

22. Cladonia uncialis (L.) G. Web.

Cladonia uncialis (L.) G. Web. in Wigg., Primit. Flora Holsat. 90. 1780.

Lichen uncialis L., Sp. Pl. 2: 1153. 1753.

Thallus fruticose with a squamulose primary thallus, bright yellow-green to mineral green; forming compact and tangled mats; branching dichotomous to polychotomous, sympodial to somewhat isotomous. Podetia to 2 cm tall, cylindrical, appearing inflated and brittle, repeatedly branching; axils perforate exposing a continuous cartilaginous sheath inside; branches diverging greatly; ultimate branches spikelike, in whorls around open axils, pointing in different directions; pycnidia frequent, brown, apical. Primary squamules lacking at maturity; podetia dying at the base and growing at the apices, colonies produced over fragments of dead podetia. Podetia K-, C-, KC-, PD-.

Chemical composition, usnic acid and squamatic acid determined by TLC and trace amounts of accessory unidentified substances reported by Dey (1975).

Rare, collected only in moss and duff layer over exposed bedrock on Horseback Ridge at ca. 4800 ft. elevation. In the high elevation areas of the southern Appalachians this species is widespread, while common at lower elevations (Dey, 1975). Thomson (1967b) reported the distribution as arctic to temperate, circumpolar. In North America it occurs from Alaska to Baffin Island and Greenland and south through the Great Lakes, Appalachians, and the Tennessee Valley in the east and the Pacific Northwest and northern Rockies in the west. In a worldwide sense the species is circumpolar.

Cladonia uncialis can be identified by richly branched, frequently prostrate podetia. The ultimate branch tips are spikelike.

It differs from the richly branched species of Cladina in its production of a continuous cortex.

A similar species C. caroliniana is usually irregularly inflated and lacerated with bristlelike secondary branches. When the podetia are narrow, however, it intergrades completely with C. uncialis.

A robust form of C. uncialis with longitudinal ribs of cartilaginous tissue on the inner surface and lacking squamatic acid has been called C. dimorphoclada Robbins. While in the field these species cannot be separated, chemical techniques such as TLC offer reliable identification.

Dey (1975) reported a related species C. psoromica Dey which is rare at lower elevations. This species produces PD+ yellow, psoromic acid.

Specimens examined. Tennessee. Unicoi Co.: Horseback Ridge 1223, 1317*.

23. Cladonia verticillata (Hoffm.) Schaer.

Cladonia verticillata (Hoffm.) Schaer., Lich. Helvet. Spic. 31. 1823.

Cladonia pyxidata * C. verticillata Hoffm., Deutschl. Flora 2: 122. 1796.

Thallus fruticose with a squamulose primary thallus, yellowish green to white. Podetia to 3(-5) cm tall and 3 mm in diameter, robust, flaring abruptly or gradually into broad shallow cups, up to 9 mm in diameter; cup interiors closed; margins dentate to lacerate;

secondary cups single or in groups, proliferating from the center of the previous cup; cup tiers usually 2-3, occasionally 5; apothecia dark brown to blackish, middle-sized, up to 3 mm in diameter, marginal or on marginal proliferations; pycnidia blackish brown, marginal. Surface corticate, shiny and continuous at base, cracked, eroded, and areolate near the apex, esorediate; squamules occasional near the base, infrequently dense on older podetia. Primary squamules darker green, to 8 mm long, 1-3 mm in diameter, tapering to the point of attachment; margins crenate to minutely lobed; podetia borne on the upper surface. Podetia K-, C-, KC-, PD+ orange-red.

Chemical composition, fumarprotocetraric acid determined by TLC, trace amounts of two accessory unidentified substances reported by Dey (1975).

Common and locally abundant, collected on soil along road-banks, rockslides, and in the grassy bald at Beauty Spot between 4200 and 4900 ft. elevations. Dey (1975) reported this species as infrequent at high elevations, while common at lower elevations in the southern Appalachians. In North America it ranges across Greenland, Canada, and Alaska, and southward throughout the eastern United States excluding the coastal plain, the Pacific Northwest, and the Rocky Mountains. Its worldwide distribution is cosmopolitan (Thomson, 1967b).

Cladonia verticillata is identified by its cups which proliferate from the center forming stacks 3-5 cups tall. As Dey (1975) noted there is much intergradation between this species and

C. calycantha Nyl. known only from the coastal plain. This species is described as having abruptly flaring cups with deeply dentate margins, a morphotype occasionally collected in the study area. Tentatively all specimens with central proliferations have been included under C. verticillata.

C. mateocyantha, frequently with aborted cups, occasionally produces shallow cups with central and marginal proliferations. Its smaller size and larger squamules are helpful in identification.

Specimens examined. Tennessee. Unicoi Co.: Beauty Spot 1037*, 1038, 3069, 3070, 3071; Roadcut 1050; Rockslide 1143, 1167.

24. Cladonia vulcanica Zoll. & Mer.

Cladonia vulcanica Zoll. & Mer. in Hasskarl., Naturr-Geneesk. Arch. Ned.-Indie 1: 396. 1844.

Thallus fruticose with a persistent squamulose primary thallus, yellowish to mineral gray; branching irregular. Podetia to 3 cm tall, cylindrical, blunt, simple to sparingly branched; branches near the podetial tip widely divergent; axils closed. Apothecia terminal, bright red, narrower than or exceeding the branch width, solitary or clustered. Surface corticate near the base and beneath the apothecia, decorticate areas translucent and darkening; soredia farinose, scattered over the decorticate areas; squamules sparse to covering the entire length of the podetia. Primary squamules darker green, medium sized, lobed, esorediate; margins crenate. Podetia K+ immediately yellow, C-, PD+ yellow-orange.

Chemical composition, barbatic acid, thamnolic acid, accessory didymic acid, trace amounts of 4-O-demethylbarbatic acid, trace amounts of 4-5 unidentified substances reported by Dey (1975).

Not common, collected in duff layer over rock and soil along the roadside of the rockslide area and in the grassy bald at Beauty Spot, between 4200 and 4800 ft. elevations. Dey (1975) reported this species as rare at all elevations in the southern Appalachians. In North America it is known from the eastern United States and southernmost eastern Canada. Its worldwide distribution includes South and Central America, the Pacific Islands, Indian Ocean, and southeast Asia (Thomson, 1967b; Dey 1975).

Cladonia vulcanica has esorediate-ecorticate areas which are cartilaginous and darkening as does C. didyma. Both species also have granular or isidioid, podetial squamules. Production of thamnolic acid by C. vulcanica, in addition to barbatic and didymic acids found in both species, distinguishes this species. The brilliant K+ yellow reaction of thamnolic acid easily separates the two.

One other southern Appalachian species with red apothecia, C. macilenta produces thamnolic acid but is entirely sorediate except for corticate areas at the base and occasionally adjacent to the apothecia. When exposed by erosion of the soredia, the medulla is never translucent, but opaque and cottony. This cosmopolitan species is reported by Dey (1975) as common at high elevations in the southern Appalachians.

See the discussion of C. bacillaris for comparison to other blunt, red-fruited species.

Specimens examined. Tennessee. Unicoi Co.: Beauty Spot 3072, 3073*; Rockslide Area 1168.

## 12. Pycnothelia (Ach.) Duf.

### 1. Pycnothelia papillaria (Ehrh.) Duf.

Pycnothelia papillaria (Ehrh.) Duf., Ann. Gen. Sci. Phys. 8: 46. 1821.

Lichen papillaria Ehrh., Hannover. Mag. 218. 1783.

Thallus fruticose, with a crustose primary thallus, whitish to gray. Pseudopodetia to 4(-10) mm tall, hollow, and inflated, constricted at the base, simple or sparingly branched near the apex; tip occasionally perforate; pycnidia common, black, surrounded by a translucent to brown zone, sessile to stipitate at the apex. Primary thallus crustose, chinked to areolate or verruculose, pseudopodetia arising from wartlike projections. Pseudopodetia K+ yellow, C-, KC-, PD-.

Chemical composition, atranorin and two unidentified fatty acids (one similar to protolichesterinic acid) reported by Dey (1975).

Rare, collected only on the thin soil layer over exposed bedrock on Horseback Ridge at ca. 4900 ft. elevation. Dey (1975) reported this species as rare at high elevations while widespread at lower elevations. In North America it occurs only in the

Appalachians and Great Lakes region. Also this species is found in Europe and Australia (Dey, 1975).

Pycnothelia papillaria, formerly considered a species in Cladonia, differs from that genus in its production of a persistent crustose primary thallus. The warty, whitish gray crust is similar to that produced by species of Baeomyces and Stereocaulon. These can be distinguished only when pseudopodetia are present. Baeomyces has apothecia which are pink or flesh-colored supported by pseudopodetia which lack algae. Pseudopodetia of Stereocaulon are tall and coarse, and covered by phyllocladia and often cephalodia.

Specimens examined. Tennessee. Unicoi Co.: Horseback Ridge 1232*, 1294.

## VIII. UMBILICARIACEAE

The Umbilicariaceae is characterized by the umbilicate attachment of the foliose thallus. The lower surface may be bare, papillate, laminate, or rhizinate, but a central holdfast anchors the orbicular thallus to the substrate.

The family has been divided into a number of genera by Llano (1950). Of these only two are commonly recognized. Lasallia has a pustulate and pitted thallus which has a bare or papillate lower surface. Umbilicaria, with a smooth, undulate, or wrinkled thallus, has a lower surface with rhizines, papillae, or flattened plates.

## 13. Lasallia Mer.

Key to the Species of Lasallia in the southern Appalachians

1. Lower surface tan or brown . . . . . 1. L. papulosa (Ach.) Llano
1. Lower surface black. . . . . .[L. pensylvanica (Hoffm.) Llano]

1. Lasallia papulosa (Ach.) Llano

Lasallia papulosa (Ach.) Llano, Monogr. Lich. Fam. Umbilicariaceae West. Hemisphere 32. 1950.

Gyrophora papulosa Ach., Lich. Univ. 226. 1810.

Thallus foliose, 2-7(-11) cm in diameter, umbilicate, grayish to dark or reddish brown, unbranched. Lobe monophyllous, orbicular, rigid, often reflexed, rigid; umbo elevated; margin entire to dissected or lacerate. Lower surface light to medium or reddish brown, pruinose, papillate, deeply pitted in a radiating pattern; rhizines lacking; umbilicus small. Upper surface strongly pustulate and warty, pustules occasionally fenestrate, purinose; lobules coralloid and isidiate, produced along tears and lacerated margins; apothecia numerous, to 2(-5) mm in diameter, sessile; disc brownish black to reddish, convex; rim concolorous with the disc. Cortex K-; medulla K+ pale dirty pink, C+ red, KC+ red turning dirty yellow-orange, PD+ yellow-pink or yellow-orange or PD-.

Chemical composition, gyrophoric acid and unidentified substances reported by Dey (1975).

Widespread and locally abundant, collected on rock in the grassy bald, heath gardens, and rockslide areas between 4200 and 4900

ft. elevations. Dey (1975) reported this species as common on rock at all elevations in the southern Appalachians. This North American endemic occurs throughout the New England, Great Lakes, and Appalachian areas, and in the Southwest and southern Rockies.

Lasallia papulosa is easily recognized by its strongly pustulate, umbilicate thallus. Frequently it has rust-colored pustules and apothecia. One other pustulate species L. pensylvanica (Hoffm.) Llano differs in having a dark brown to black lower surface and is rare in the southern Appalachians.

Specimens examined. Tennessee. Unicoi Co.: Beauty Spot 3170; Horseback Ridge 1241, 1268, 1301, 1311; Roadcut 1052*; Rockslide Area 1140.

## 14. Umbilicaria Hoffm.

Key to the Species of Umbilicaria in the southern Appalachians

1. Lower surface brown, covered by raised, often perforate, plates . . . . . 2. U. muhlenbergii (Ach.) Tuck.

1. Lower surface black, bare or rhizinate . . . . . 2

   2. Thallus polyphyllous; lobes crowded and fusing; rhizines in scattered tufts . . . . . .[U. caroliniana Tuck.]

   2. Thallus monophyllous; lobes not crowded, rhizines dense, covering the lower surface . . .1. U. mammulata (Ach.) Tuck.

1. Umbilicaria mamulata (Ach.) Tuck.

   Umbilicaria mamulata (Ach.) Tuck., Proc. Am. Acad. Arts 1: 261. 1847.

   Gyrophora mamulata Ach., Syn. Meth. Lich. 67. 1814.

Thallus foliose, up to 30 cm in diameter, umbilicate, light to reddish brown, unbranched. Lobes monophyllous, orbicular, leathery; umbo not elevated; margins entire to lacerate, inrolled when dry. Lower surface black, smooth to minutely papillate; rhizines dense, black, simple or furcately branched; umbilicus distinct but small. Upper surface plane to undulate or folded, slightly pruinose, dull or shiny, occasionally perforate with rhizines protruding through the upper surface. Apothecia reported by Dey (1975) as rare, to 3 mm in diameter; disc black, gyrate; rim concolorous with the disc. Cortex K-; medulla K+ faint pink or K-, C+ red-pink turning yellow-orange, KC+ red turning pale yellow-orange, PD-.

Chemical composition gyrophoric acid and unidentified substances reported by Dey (1975).

Widespread and locally abundant, collected on vertical rock faces along a roadcut at ca. 4700 ft. elevation. Dey (1975) reported this species as common throughout the southern Appalachians. This North American endemic occurs in the New England, Great Lakes, and Appalachian regions.

Umbilicaria mamulata with its large orbicular thallus and dense short rhizines is easily distinguished from other umbilicate species in the southern Appalachians. U. muhlenbergii has flattened plates covering the lower surface and U. caroliniana is a smaller, darker plant, with many crowded lobes and an irregular umbilici.

U. vellea (L.) Ach. is a whitish gray umbilicate lichen common in western and boreal North America. Its rhizines are coarser with rounded tips and its upper surface is strongly pruinose. This species has been reported for the southern Appalachians, however its presence is questionable (see Dey, 1975, p. 249).

Specimens examined. Tennessee. Unicoi Co.: Roadcut 1300*.

2. Umbilicaria muhlenbergii (Ach.) Tuck.

Umbilicaria muhlenbergii (Ach.) Tuck., Enumer. N. Am. Lich. 55. 1845.

Gyrophora muhlenbergii Ach., Lich. Univ. 227. 1810.

Thallus foliose, 3-5(-12) cm in diameter, umbilicate, light tan in the center to dark brown at the margins; unbranched. Lobe monophyllous, orbicular, rigid; umbo pronounced with heavy folds or creases; margin entire to lacerate, revolute when dry. Lower cortex dark brown in the center to light tan along the margins, papillose; umbilicus small; lamellae papillate, flattened, raised and horizontal, covering the surface near the umbilicus, perforate and fissured, and becoming tuberculate near the margin. Upper surface plane to undulate, dull; apothecia common, 4-6 mm in diameter, sunken; disc black, radially gyrate; rim lighter brown often convoluted; pycnidia abundant, immersed forming darkened papillae. Cortex K-; medulla K-, C+ red turning orange, KC+ red turning yellow, PD-.

Chemical composition, gyrophoric acid, and unknowns reported by Dey (1975).

Not common, collected on rock in heath gardens and rockslide areas between 4600 and 4900 ft. elevations. In Dey's (1975) survey of the southern Appalachians this species was widespread at all elevations but not common. In North America it is known from New England, Great Lakes, and Appalachian regions as well as adjacent areas in Canada. This north temperate species also occurs in Europe and Asia (Llano, 1950).

Umbilicaria muhlenbergii is easily recognized by the flattened, raised plates on its lower surface which frequently are perforate and reticulate near the margins. The radiating, gyrate apothecia lacking a common margin identify this species as a member of the segregate genus Actinogyra Scholander used by Llano (1950) in his monograph. In contrast to U. mamulata which is usually found on vertical rock surfaces, U. muhlenbergii prefers horizontal surfaces.

Specimens examined. Tennessee. Unicoi Co.: Horseback Ridge 1275*; Rockslide Area 1132.

## IX. HYPOGYMNIACEAE

Members of this family have narrow-elongate lobes which are inflated and hollow or solid and strongly canaliculate. The thalli, radially foliose to subfruticose, are attached to the substrate by a central haptera and lack both rhizines and cilia. The lower surface, black at least in the center, is totally corticate.

Two genera in the family have inflated lobes, Hypogymnia and Menegazzia. Menegazzia, represented by M. terebrata, has perforations on the upper surface which open into the inner cavity.

Soralia are laminal and orbicular around these pores. Hypogymnia does not produce these openings, however, the lobes are often apically perforate. Soredia, when present, may be labriform or orbicular and erose, but are always terminal or subterminal.

Pseudevernia is solid and strongly canaliculate. The lobes are subfruticose and often intricately branched. Hale (1968) has produced a worldwide treatment of this genus.

## 15. Hypogymnia Nyl.

Key to the Species of Hypogymnia in the southern Appalachians

1. Thallus sorediate, rarely apotheciate. . . . . 2
1. Thallus not sorediate, occasionally apotheciate. . . . . 5
    2. Soralia ring-shaped on the lobe surface . . . . . 3. H. tubulosa (Schaer.) Hav.
    2. Soralia labriform on the lower surface of perforate lobes. 3
3. Medulla PD+ orange-red, physodalic and protocetraric acids present; lateral lobes not widely divergent. . . . . 4
3. Medulla PD+ yellow or PD-, physodalic and protocetraric acids present; lateral lobes widely divergent. [H. vittata (Ach.) Gas.]
    4. Lobe tips terete; lobes narrow and elongate . . . . . .1. H. krogii Ohlsson
    4. Lobe tips flattened and digitate, lobes spreading . . . . . .2. H. physodes (L.) Nyl. [=H. appalachensis Pike]
5. Lobe tips terete; thallus frequently apotheciate . . . . . .1. H. krogii Ohlsson
5. Lobe tips flattened and digitate; thallus very rarely apotheciate. . . . . .2. H. physodes (L.) Nyl.

1. Hypogymnia krogii Ohlsson

Hypogymnia krogii Ohlsson, Bryologist 76: 377. 1973.

Thallus foliose, 2-4.5 cm in diameter, adnate to loosely attached and descending, suberect at the lobe tips, mineral to whitish gray; branching dichotomous. Lobes hollow and inflated, elongate-cylindrical, 0.5-2 mm broad; lobe tips terete and bulbate, occasionally perforate. Lower surface black in the center, brown to tan at the lobe tips, rugose and puffy, in part, attached directly to the substrate. Medullary cavity white above, black beneath. Upper surface faintly wrinkled, weathered on older lobes; lobules occasional, terete, inflated; soredia rare, granular, in labriform soralia inside perforated lobe tips; pycnidia numerous, black, immersed; apothecia reported by Dey (1975) as common, to 7 mm in diameter; disc brown. Cortex K+ yellow; medulla K-, C-, KC+ dingy, PD+ orange-red.

Chemical composition, atranorin, physodic acid, physodalic acid, protocetraric acid, and unidentified substances determined by TLC.

Infrequent, collected on spruce, pitch pine, and fallen twigs in spruce and heath communities above 4400 ft. elevation. This Appalachian endemic is common in spruce-fir forest and fire cherry communities (Dey, 1975).

Hypogymnia krogii is frequently fertile and only occasionally sorediate in the southern Appalachians. In this study three collections out of a total of six identified as H. krogii were sorediate, none were fertile. In other studies the name H. appalachensis Pike has been used for sorediate specimens. H. krogii is

characterized by its narrow, terete lobes with inflated tips. H. physodes is usually sorediate and non-fertile with flattened "digitate" lobes. While both are PD+ orange-red, H. physodes has conphysodic acid in addition to the physodia acid, physodalic acid, and protocetraric acid of H. krogii.

See the description of H. physodes for comparison to other sorediate species of Hypogymnia.

Specimens examined. Tennessee. Unicoi Co.: Horseback Ridge 3087, 3088*; Stamping Ground Ridge 3083, 3084, 3085, 3086*.

2. Hypogymnia physodes (L.) Nyl.

Hypogymnia physodes (L.) Nyl., Lich. Envir. Paris 39. 1896.

Lichen physodes L., Sp. Pl. 2: 1144. 1753.

Thallus foliose, 2-5.5 cm in diameter, adnate to loosely adnate and suberect, ashy white to mineral green, branching dichotomous or irregular. Lobes hollow, appearing inflated 0.5-3(-4) mm wide; lobe tips flattened, frequently perforate and flaring, sinuses teardrop-shaped. Lower surface black in the center, occasionally brown at the lobe tips, rugose and puffy, in part, attached directly to the substrate; rhizines lacking. Inner medullarly cavity white above, black beneath. Upper cortex maculate to weathered, rugose on older lobes, tan at the tips of new lobes; soredia granular; soralia labriform at the lobe tips, developing inside perforate lobes; lobules rare, on older, rugose lobes. Pycnidia occasional, black immersed, present on older lobes or secondary lobe tips near the thallus center; apothecia not seen. Cortex K+ yellow; medulla K-, C-, KC+ dingy, PD+ orange-red.

Chemical composition, atranorin, physodic acid, physodalic acid, conphysodic acid, protocetraric acid, and unidentified substances reported by Dey (1975).

Very common, collected on hardwoods, fallen branches, white and other pines, spruce, hemlock, and rock in most communities across the entire elevational range. This boreal species ranges across Canada and extends southward into the United States in the mountainous regions. It also occurs in South America, Europe, Asia, Australia, and New Zealand (Dey, 1975).

Hypogymnia physodes can be recognized by its labriform soralia and flattened, "digitate" lobes. Other sorediate species include the sorediate morph of H. krogii which is called H. appalachensis, an Appalachian endemic which is smaller and darker and greener mineral gray. H. krogii is usually fertile and has narrow terete lobes. It lacks the conphysodic acid of H. physodes.

Two sorediate species also occurring in the Appalachian Mountains differ in their PD- reaction. H. vittata has apical, labriform soralia, a conspicuous black margin, and adventitious linear-elongate side branches. Also reacting PD- is H. tubulosa which has ring-shaped soralia on non-perforate lobes.

One other sorediate, hollow-lobed taxon occurs in the Appalachians, Menegazzia terebrata. It can be distinguished by its darker green color, regularly perforate lobes, laminal soralia, and production of K+ yellow stictic acid.

Specimens examined. Tennessee. Unicoi Co.: Beauty Spot 3097; Cherry Gap Trail 1325, 1377; Chestnut Knob 3089, 3090, 3091; Horseback Ridge 1295, 1321, 1326, 3092, 3093, 3094, 3095; Rockslide Area 1082, 1097, 1098, 1099, 1165; Stamping Ground Ridge 1039, 3100*, 3101, 3102, 3103; Summit 3096; White Pine Plantation 1455, 1484, 1487, 1512, 1515, 1532, 1537, 1547, 1580, 1582, 1591, 1617, 1622, 3098.

3. Hypogymnia tubulosa (Schaer.) Hav.

Hypogymnia tubulosa (Schaer.) Hav., Bergens Mus. Arbok, Heftel, Naturvid. Raekke. 2: 31. 1918.

Parmelia ceratophyllae ε tubulosa Schaer., Lich. Helvet. Spic. 459. 1840.

Thallus foliose, 2 cm in diameter, adnate to suberect at the lobe tips, mineral green; branching dichotomous. Lobes hollow and inflated, 0.5-1(-3) mm wide, lobe tips terete, not perforate; sinuses teardrop-shaped. Lower surface black in the center, occasionally brown at the lobe tips, wrinkled to rugose, in part, directly attached to the substrate; rhizines lacking. Inner medullary cavity completely black inside. Upper cortex weathered to wrinkled; soredia farinose; soralia erose, ring-shaped, subterminal or terminal, leaving white cottony patches of medulla after soredia are dispersed. Pycnidia sparse, black, immersed; apothecia not reported. Cortex K+ yellow; medulla K- or K+ dingy, C- or C+ faint yellow, KC+ pink turning dingy, PD- or PD+ pale yellow.

Chemical composition, atranorin, physodic acid, conphysodic acid, and an unidentified substance, determined by TLC.

Very rare, collection only on a fallen twig along headwaters of Rock Creek ca. 4700 ft. elevation. This circumboreal lichen occurs in Europe, Asia, and south along the mountain ranges of North America.

Hypogymnia tubulosa is distinguished by its cuff-like, or ring-shaped soralia produced on short, semi-erect, hollow lobes. H. vittata and H. tubulosa are the only species of Hypogymnia in the southern Appalachians which react PD-. The former differs in having labriform soralia, on apically perforate lobes. See the discussion of H. physodes for comparison to other sorediate species of Hypogymnia.

Specimens examined. Tennessee. Unicoi Co.: Rock Creek Headwaters 3104*.

## 16. Menegazzia Mass.

### 1. Menegazzia terebrata (Hoffm.) Mass.

Menegazzia terebrata (Hoffm.) Mass., Neag. Lich. 3. 1854.

Lichen terebrata Hoffm., Deutschl. Flora 151. 1796.

Thallus foliose, 2-3.5(-10) cm in diameter, adnate, usually flattened against the substrate, mineral green to green; braching irregular. Lobes hollow and perforate, confluent to fused, 1-2(-3) mm wide. Lower surface black in the center, brown at the lobe tips, inflated and wrinkled, appearing as a matrix between fused, adjacent lobes, attaching directly to the substrate; rhizines lacking. Inner

medullary cavity white above, black beneath. Upper surface shiny, smooth, waxy, brown at new lobe tips, perforate, except at the lobe tips. Soredia granular; soralia orbicular, capitate, perforate in the center, laminal and rarely apical; pustules occasional; apothecia and pycnidia not seen. Cortex K+ yellow; medulla K+ yellow, C-, PD+ orange.

Chemical composition, atranorin, stictic acid, constictic acid, norstictic acid, and unidentified substances, determined by TLC.

Not common, collected on hardwoods and white pine, and rarely, on rock in spruce, white pine, and heath communities between 4200 ft. and 4800 ft. elevations. Dey (1975) reported this species as common in spruce-fir and fire cherry communities above 5500 ft. elevation, while rare at lower elevations. In North America this species occurs in the Appalachians, Great Lakes, and West Coast. Additionally it is found in South America, Europe, Africa, Asia, Australia, and New Zealand (Dey, 1975).

Menegazzia terebrata is distinguished from the other hollow lichens by its regular perforations into or through the medullary cavity. It is also characterized by a darker mineral green color, flattened, radiating lobes, and laminal soralia around the pores. Chemically its production of K+ yellow stictic acid separates it from species of Hypogymnia which have K-, physodic acid and accessory compounds. See the discussion of Hypogymnia physodes for comparison to the sorediate Hypogymnia species.

Specimens examined. Tennessee. Unicoi Co.: White Pine Plantation 1461*, 3180, 3181.

## 17. Pseudevernia Zopf

Key to the Species of Pseudevernia in the southern Appalachians

1. Thallus isidiate; lobe tips flattened
. . . . . .2. P. consocians (Vain.) Hale & W. Culb.

1. Thallus not isidiate; lobe tips terete
. . . . . .1. P. cladonia (Tuck.) Hale & W. Culb.

1. Pseudevernia cladonia (Tuck.) Hale & W. Culb.

Pseudevernia cladonia (Tuck.) Hale & W. Culb., Bryologist 69: 165. 1966.

Evernia furfuracea cladonia Tuck., Proc. Am. Acad. Arts 1: 204. 1847.

Thallus subfruticose, 2-3(-10) cm in diameter, loosely attached at the center of the thallus, grayish white; branching dichotomous and isotomous. Lobes finely branched, elongate, 0.1-0.6 mm wide, convex to flattened near the center, subterete at the tips; margins rounded and entire. Lower surface, dark brown to black in the center, white or grayish white near the lobe tips, canaliculate, short tomentose; rhizines lacking. Upper surface dull, maculate, irregular to pitted; pycnidia common, immersed; apothecia reported by Dey (1975) as not common, 1.5-4.5(-6) mm in diameter; disc green-brown. Cortex K+ yellow, medulla K-, C+ red, KC+ red, PD-.

Chemical composition, atranorin, lecanoric acid, and unidentified substances, determined by TLC.

Not common, collected on spruce branches in the spruce forest above 4700 ft. elevation. Dey (1975) reported this species as common

above 5500 ft. In North America this species is endemic to the Appalachian region. It is also found in Mexico and the Dominican Republic.

Pseudevernia cladonia is characterized by its very narrow, Cladina-like, intricately branched lobes. It is restricted to high elevational areas of the Appalachians and the New World tropics. Common at moderate elevations in the mountainous areas of North America, P. conscocians has somewhat wider lobes (0.5-2.5 mm) and isidia.

This species may be confused in the field with Everniastrum catawbiense which occurs in the same habitats. E. catawbiense can be easily distinguished by its shiny, black, canaliculate lower surface, marginal cilia, and truncate lobe tips. Species of Ramalina may grow mixed with P. cladonia but differ in their yellow-green color and lack of dorsi-ventral definition.

Specimens examined. Tennessee. Unicoi Co.: Rock Creek Headwaters 3364, 3365*; Stamping Ground Ridge 3366.

2. Pseudevernia consocians (Vain.) Hale & W. Culb.

Pseudevernia consocians (Vain.) Hale & W. Culb., Bryologist 69: 165. 1966.

Parmelia consocians Vain., Dan. Bot. Ark. 4(1): 6. 1926.

Thallus subfruticose 3-5(-14) cm in diameter, loosely attached at the center with branch tips touching the substrate, grayish white; branching dichotomous, sinuses teardrop-shaped.

Lobes narrow, elongate, 0.5-2.5 mm wide; adjacent lobe branches frequently fused; lobe tips dorsiventrally flattened; margins entire to lobulate. Lower surface purple-black in the center, white at the lobe tips, mottled, short-tomentose, canaliculate; rhizines lacking. Upper surface dull, irregular, maculate; isidia moderate to dense, granular to coralloid or lobulate, black-tipped, marginal and laminal; pycnidia common, immersed; apothecia not see. Cortex K+ yellow; medulla K+ dirty pink or K-, C+ red, KC+ red, PD-.

Chemical composition, atranorin, lecanoric acid, and unidentified substances determined by TLC.

Common and locally abundant, collected on branches of hardwoods, pines, and decaying wood in moderate elevational hardwood, heath, and white pine communities, as well as trees along the rockslide margins from 3000 to 4900 ft. elevations. In North America this species occurs in the Great Lakes-Appalachian region. It also is known from the higher pine-covered mountains of Mexico (Hale, 1968).

Pseudevernia consocians is distinguished from P. cladonia by its dorsiventrally flattened lobe tips, isidia, and wider lobes. The canaliculate, mottled lower surface allows this species to be readily identified in the field. See P. cladonia for comparison to other taxa.

Specimens examined. Tennessee. Unicoi Co.: Chestnut Knob 3368, 3369; Horseback Ridge 3370, 3371, 3372*, 1277; Indian Grave Gap 3367; Rockslide Area 1108; White Pine Plantation 1509.

# X. PARMELIACEAE

The Parmeliaceae is the largest and most well represented family in the Southeast. It is comprised of lichens with narrow, medium, or broad lobes which are yellow-green, mineral gray, olivaceous, or brown in color. The lower surface is both corticate and rhizinate. When fertile the asci produce simple, colorless spores.

Three genera produce apothecia and pycnidia marginally, Cetraria, Cetrelia, and Platismatia. Cetraria has narrow lobes which are foliose, flattened, or fruticose. Pycnidia are usually cylindrical and exserted on the margin. The lower surface is white to brown in color and sparsely rhizinate. Cetrelia, a segregate of Cetraria, differs in having pseudocyphellae on the upper surface and a black lower surface. All representatives of this genus in the southern Appalachians have marginal, linear soralia. Platismatia has a mottled black, tan, and white lower surface and in the Southeast produces broad, suberect lobes. Cetrelia and Platismatia have been monographed by Culberson and Culberson (1968).

The composite genus Parmelia has recently been divided into 11 genera, nine of which are present in the southern Appalachian region. Delineation of the genera are based on the lobe shape and color, rhizine location and branching patterns, pseudocyphellae presence and shape, and the epicortex condition (Hale, 1973).

Evernastrum, represented by E. catawbienses, has narrow, subfruticose lobes which are distinctly canaliculate and have

marginal cilia (Hale, 1976d). Hypotrachyna, delimited and revised by Hale (1974a, 1975), has linear, narrow lobes which are frequently apically truncate. However, the presence of dichotomously branched rhizines on the lower surface distinguishes this group. A similar genus Parmelina, described and monographed by Hale (1974c, 1976a), has simple rhizines and marginal cilia on its narrow, somewhat appressed lobes.

Xanthoparmelia forms narrow lobes and produces usnic acid giving the thallus a yellow-green color (Hale, 1974c). The rhizines are simple and the margins eciliate. The members of this genus are obligate saxicoles. Not clearly distinguished from this genus, Pseudoparmelia, monographed by Hale (1976b), also has narrow, eciliate lobes with simple rhizines. In the southern Appalachians the most conspicuous species, P. caperata and P. baltimorensis are broad-lobed with laminal soredia or pustules and a yellow-green color.

The genus Parmelia retains the species producing pseudocyphellae or angular maculentations. Formerly it comprised the subgenus Parmelia (Hale and Kurokawa, 1964). Broad-lobed species, frequently with marginal cilia and a bare marginal zone on the lower surface, form the genus Parmotrema (Hale, 1974, 1977). This genus also includes species with reticulate crackings.

The brown Parmelias in the southern Appalachians comprise the genus Melanelia. The upper cortex lacks both atranorin and usnic acid. One other genus of brown lichens, Neofuscelia, has its

greatest diversity in the desert southwest and is absent from the southern Appalachians. Esslinger (1974, 1978, 1980a) has revised these genera and elevated them to their present rank.

Bulbothrix and Recilina not collected in the study area, produce inflated marginal, bulbate cilia. Thalli with a mineral gray color and atranorin are included in Bulbothrix. B. goebelii (Zenk.) Hale is known from lower elevations in the southern Appalachians. The genus Recilina, with a yellow-green color due to the presence of usnic acid, is not known from this area.

Parmeliopsis is closely allied to other Parmeliaceous genera. The narrow lobes are appressed to the substrate and have a pale lower surface. In the southeastern United States representatives of this genus produce either thamnolic or usnic acids.

## 18. Cetraria Ach.

Key to the Species of Cetraria in the southern Appalachians

1. Thallus fruticose and erect; always terricolous. . . . . 2
1. Thallus foliose, adnate to suberect; occasionally terricolous. 3
    2. Medulla PD+ red; fumarprotocetraric acid present . . . . . .[C. islandica (L.) Ach.]
    2. Medulla PD-; fumarprotocetraric acid absent . . . . . .[C. arenaria Kärnef]
3. Thallus sorediate. . . . . 4
3. Thallus not sorediate, occasionally lobulate . . . . . 5
    4. Thallus yellow-green, usnic acid present in the upper cortex; corticolous and occasionally saxicolous . . . . . 3. C. oakesiana Tuck.

4. Thallus brown, usnic acid absent; exclusively saxicolous . . . . . [C. culbersonii Hale]

5. Thallus yellow-green, usnic acid present. . . . . 6

5. Thallus mineral green or green-brown, usnic acid absent . . . 7

6. Medulla yellow; thallus lobulate . . [C. virides Schwein.]

6. Medulla white; thallus not lobulate. 1. C. aurescens Tuck.

7. Thallus suberect; margins ciliate . . . . . 8

7. Thallus adnate; margins not ciliate . . . . . .10

8. Medulla C+ red; olivetoric and physodic acid present. . . . . 2. C. ciliaris Ach.

8. Medulla C- red; alectoronic or fatty acids present . . . 9

9. Alectoronic acid present. . . . .[C. halei W. Culb. & C. Culb.]

9. Fatty acids present . . . . . 4. C. orbata (Nyl.) Fink.

1. Cetraria aurescens Tuck.

Cetraria aurescens Tuck., Proc. Am. Acad. Arts. 1: 208. 1847.

Thallus foliose, 2 cm in diameter, loosely attached to subfruticose, yellow-green; branching irregular. Lobes irregularly rounded, 2-4 mm across; margins dissected. Lower surface light tan to whitish, shiny, becoming yellow-green at the margins; rhizines sparse, light tan, simple, arising from vein-like wrinkles. Upper surface wrinkled; pycnidia abundant, black and cylindrical, exserted, produced on marginal (or occasionally laminal) isidia or lobules. Apothecia common, 1-3 mm in diameter, marginal; disc light reddish brown; rim dissected with pycnidia-producing lobules. Medulla white. Cortex K-; medulla K-, C-, KC-, PD-.

Chemical composition, usnic acid, caperatic acid, and fatty acids, reported by Dey (1975).

Rare, one collection from spruce in the spruce gap of Stamping Ground Ridge. Reported by Dey (1975) as common at lower elevations in the mountains, this North American endemic occurs in the Appalachian Mountains-Great Lakes region.

Cetraria aurescens is one of two nonsorediate, nonisidiate, yellow-green Cetrarias reported for the southern Appalachians. Cetraria viridis Schwein., known from lower elevations, can be distinguished by its yellow medulla and production of vulpinic acid. The most common Cetraria with a yellow-green color in the southern Appalachians is C. oakesiana which has marginal soredia.

Specimens examined. Tennessee. Unicoi Co.: Stamping Ground Ridge 2007*.

2. Cetraria ciliaris Ach.

Cetraria ciliaris Ach., Lich. Univ. 508. 1810.

Thallus foliose, 3-7 cm in diameter, loosely attached and erect at the margins, mineral to olive green; branching irregular. Lobes linear and narrow, 1-6 mm wide; margins entire to dissected, sparsely ciliate; cilia tan to dark brown. Lower cortex light tan, shiny, weakly veined and wrinkled; rhizines sparse, light tan, simple or occasionally dichotomously branched. Upper surface shiny, undulate; lobules laminal and marginal. Pycnidia numerous, black, cylindrical, exserted, marginal; apothecia frequent, marginal,

1.5-3.5 mm in diameter; disc reddish brown; rim pustulate. Cortex K+ yellow; medulla K-, C+ red, KC+ red, PD-.

Chemical composition, atranorin, olivetoric acid, physodic acid, and unidentified substances, reported by Dey (1975).

Abundant, collected on hardwoods, pines, hemlock, and fallen twigs in most community types. This common lichen is found in the Appalachian Mountains-Great Lakes region and the Rocky Mountain-Pacific Northwest as well as Europe and Asia.

Two southern Appalachian species are morphologically similar to Cetraria ciliaris but can be separated by chemistry. C. orbata is smaller and produces only fatty acids (K-, C-). C. halei differs in producing alectoronic acid (K-, KC+ pink, UV+).

Superficially this species resembles Platismatia tuckermanii. The latter has a mottled lower surface, broader and more wrinkled lobes, and caperatic acid. These two species are readily separated by their pycnidia. C. ciliaris produces erect cylindrical or subglobular pycnidia while P. tuckermanii has immersed or partially immersed irregular pycnidia (Dey, 1975).

Occasionally thalli of Parmotrema hypotropum, with erect lobe margins and wide white zones on the lower surface, may be confused with C. ciliaris. P. hypotropum, lacking the characteristic marginal pycnidia, is identified by its soredia and K+ yellow turning red reaction due to the presence of stictic and norstictic acids.

Specimens examined. Tennessee. Unicoi Co.: Cherry Gap Trail 1395*; Chestnut Knob 2004, 2005, 2006; Horseback Ridge 1234, 2008,

2009; Rock Creek Headwaters 3020; Rockslide 1090; Stamping Ground Ridge 2002, 2003, 3018, 3019; White Pine Plantation 1447, 1490.

3. Cetraria oakesiana Tuck.

Cetraria oakesiana Tuck., Boston J. Nat. Hist. 3: 445. 1841.

Thallus foliose, 2-6 cm in diameter, loosely adnate to sub-erect, yellow-green; branching of lobes irregular. Lobes narrow and linear-horizontal, 1-5 mm wide; margins undulate. Lower surface light brown in center, white at margins, shiny, wrinkled; rhizines sparse, simple to sparsely branched, concolorous with the cortex. Upper surface shiny, cortex thick and rigid. Soredia granular in linear, marginal soralia. Pycnidia cylindrical-elongate, marginal, occasionally in soralia. Apothecia not common, 1 mm in diameter; disc reddish brown, marginal. Medulla white to pale yellow near surface. Cortex K-; medulla K-, C-, PD-.

Chemical composition, usnic acid and fatty acids, reported by Dey (1975).

Abundant, collected on hardwoods and pines in all community types. This species occurs in the Appalachian Mountains-Great Lakes Region of North America, Europe, and Asia.

Cetraria oakesiana is the only sorediate, yellow-green Cetraria in the southern Appalachians. Other sorediate yellow-green species common in the area are Pseudoparmelia caperata which has diffuse, laminal soralia, and Parmelia flaventior with pseudo-cyphellae. Both have black lower surfaces.

Dey (1975) noted two "morphologically extreme patterns of variation" in this species. In the first the thalli are rarely fertile, abundantly sorediate, and sparsely pycnidiate. A second pattern referred to as "spinulose" has abundant apothecia, sparse soredia, and dense pycnidia. On Unaka Mountain all collections conformed to the first pattern.

Juvenile thalli are frequently encountered and can be identified by their yellow-green color, strap-shaped, and horizontal orientation.

Specimens examined. North Carolina. Yancey Co.: Beauty Spot Forest 3021; Tennessee. Unicoi Co.: Cherry Gap Trail 1396, 1397, 1398; Horseback Ridge 1262, 1293*; Rockslide 3028, 1091, 1160; Stamping Ground Ridge 3027; Summit 3024, 3025, 3026; White Pine Plantation 1448, 1497, 1574, 1587, 1595, 3022, 3023.

4. Cetraria orbata (Nyl.) Fink

Cetraria orbata (Nyl.) Fink, Mycologia 11: 298. 1919.

Platysma orbatum Nyl., Flora 52: 442. 1869.

Thallus foliose, 3.5 cm in diameter, loosely attached to ascending, olive green; branching irregular. Lobes subirregular to rounded, 1-5 mm wide, margins crenate to dissected and lobulate. Lower surface tan to white, shiny, wrinkled; rhizines sparse, white, simple, submarginal. Upper surface wrinkled, shiny; lobules marginal. Pycnidia numerous, on margins, lobules, and subapical on lobes; apothecia reported (Dey, 1975) as common, to 5 mm broad; disc brown. Cortex K+ yellow; medulla K-, C-, KC-, PD-.

Chemical composition, atranorin and fatty acids reported by Dey (1975).

Not common, one collection from hardwood branches in a northern red oak forest at ca. 4300 ft. elevation. Dey (1975) reported this species as common in the high elevation communities on Abies, Picea, Alnus, and Rhododendron. This North American endemic is known from eastern North America and the West Coast.

Cetraria orbata is superficially similar to C. ciliaris but has narrower lobes and lacks the C+ red olivetoric acid. See C. ciliaris for comparison to other taxa.

Specimens examined. Tennessee. Unicoi Co.: Chestnut Knob 3029*.

## 19. Cetrelia W. Culb. & C. Culb.

Key to the Species of Cetrelia in the southern Appalachians

1. Soralia linear and marginal; medulla C+, olivetoric acid present. . . . . 3. C. olivetorum (Nyl.) W. Culb. & C. Culb.

1. Soralia orbicular, submarginal to marginal; medulla C-, olivetoric acid absent . . . . . 2

   2. Alectoronic and α-collatolic acids present; soredia coarse; pseudocyphellae conspicuous . . . . . 2. C. chicitae (W. Culb.) W. Culb. & C. Culb.

   2. Imbricaric and perlatolic acids present; soredia fine; pseudocyphellae often inconspicuous. . . . . 3

3. Imbricaric acid present with accessory perlatolic acid . . . . . 1. C. cetrarioides (Del. ex Duby) W. Culb. & C. Culb.

3. Perlatolic acid present with accessory imbricaric acid . . . . . [C. monachorum (Zahlbr.) W. Culb. & C. Culb.]

1. Cetrelia cetrarioides (Del. ex Duby) Culb. & Culb.

Cetrelia cetrarioides (Del. ex Duby) Culb. & Culb., Contrib. U.S. Natl. Herb. 34: 498. 1968.

Parmelia perlata β cetrarioides Del. ex Duby., Bot. Gallic. ed. 601. 1830.

Thallus foliose, 4-8 cm in diameter, adnate with ascending lobe tips, mineral green to dark green; branching irregular. Lobes crowded and overlapping, rounded to irregular, 3-8 mm across; margins crenate; lobe tips frequently darkened. Lower surface black in center, mottled white or brown along the margins, very wrinkled; rhizines sparse, black, simple. Upper surface shiny, wrinkled to undulate; pseudocyphellae abundant. Soredia powdery; soralia linear and marginal or orbicular and developing around the pseudocyphellae. Pycnidia occasional, marginal. Apothecia not seen. Cortex K+ yellow; medulla K-, C-, KC-, PD-.

Chemical composition, atranorin, perlatolic acid, and imbricaric acid, determined by TLC.

Common, collected on white pine, hardwoods, and rock at elevations above 4000 ft. in all forest types. Dey (1975) noted that it was common above 5500 ft. and present, but not common, below this elevation. This widespread species occurs in North America in the Appalachian Mountains and on the West Coast.

The southern Appalachian Cetrelias are recognized by their distinctive mineral green color, marginal soralia, pseudocyphellae, and wrinkled black lower surface. These four species have only

minor morphological differences, but are distinct in their chemical composition. Cetrelia cetrarioides differs from C. monachorum only in the relative amounts of the acids produced (Culberson and Culberson, 1978). C. cetrarioides contains predominantly imbricaric acid with perlatolic acid as an accessory compound, while in C. monachorum imbricaric acid is the accessory and perlatolic acid the main product. Because standard TLC methods are not adequate for determining concentrations of compounds, all collections containing perlatolic and imbricaric acids have been included under the older name C. cetrarioides.

C. olivetorum is easily separated from C. cetrarioides by its C+ reaction due to the presence of olivetoric acid. Dey (1975) noted that this species has only marginal soralia while the other three species have orbicular, submarginal and marginal soralia. C. chicitae, with coarser soredia, larger pseudocyphellae, and UV+ alectoronic acid, can be reliably separated from C. cetrarioides only by thin layer chromatography.

These species of Cetrelia may be confused with the pseudocyphellate Parmelias with black lower surfaces. The latter group produces marginal and laminal soralia and has a very narrow bare zone at the margin of the lower surface. Parmelia borreri has a C+ rose reaction (gyrophoric acid), and P. reddenda a C- reaction (fatty acids) as well as subisidiate soredia. The most common sorediate, pseudocyphellate Parmelia, P. subrudecta, can be easily distinguished by its tan lower surface.

Specimens examined. Tennessee. Unicoi Co.: North Beauty Spot 1189*, 1182; Summit 3012; White Pine Plantation 1496.

2. Cetrelia chicitae (W. Culb.) Culb. & Culb.

Cetrelia chicitae (W. Culb.) Culb. & Culb., Contrib. U. S. Natl. Herb. 34: 504. 1968.

Cetraria chicitae W. Culb., Bryologist 68: 95. 1965.

Thallus foliose, 4-8 cm in diameter, adnate with ascending lobe tips, mineral to dark green; branching irregular. Lobes crowded and overlapping, rounded to irregular, 3-7 mm wide; margins crenate, darkening. Lower surface black in the center with a broad brown to tan margin, wrinkled; rhizines sparse, black to tan, simple. Upper surface shiny, faintly undulate; pseudocyphellae abundant, large, to 1 mm in diameter. Soredia powdery, in linear marginal soralia (occasionally submarginal and orbicular). Pycnidia occasional, marginal. Apothecia not seen. Cortex K+ yellow; medulla K-, C-, KC+ red, PD-.

Chemical composition, atranorin and alectoronic acid, determined by TLC; α-collatolic acid and three unidentified substances reported by Dey (1975).

Common, collected on white pine, hardwoods, twigs, and rock over a wide elevational range in all community types. This common species occurs in the Appalachian Mountains-Great Lakes region of North America, as well as Asia.

For comparison to other species of Cetrelia see C. cetrarioides.

Specimens examined. North Carolina. Yancey Co.: Beauty Spot Forest 3011; Tennessee. Unicoi Co.: Cherry Gap Trail 1399, 1400, 1402, 1403, 3008; Indian Grave Gap 3006, 3007; North Beauty Spot 1209, 1215; Rockslide 1092, 1093, 1094, 1128; Stamping Ground Ridge 3009; Summit 3004*, 3005; White Pine Plantation 3010.

3. Cetrelia olivetorum (Nyl.) Culb. & Culb.

Cetrelia olivetorum (Nyl.) Culb. & Culb., Contrib. U. S. Natl. Herb. 34: 515. 1968.

Parmelia olivetorum Nyl., Not. Sallsk. Fauna Flora Fenn. n. ser. 5: 180. 1866.

Thallus foliose, 3-6 cm in diameter, loosely adnate with ascending lobe tips, mineral green; branching irregular. Lobes crowded and overlapping, rounded and irregular, 3-10 mm across, margins crenate. Lower surface black in center with a broad brown to white, often mottled, marginal zone; rhizines sparse, black, simple to sparsely furcate. Upper surface shiny, faintly wrinkled to undulate; pseudocyphellae abundant, small. Soredia powdery; soralia linear and marginal or orbicular and submarginal. Pycnidia occasional, marginal; apothecia not seen. Cortex K+ yellow; medulla K-, C+ red, KC+ red, PD-.

Chemical composition, atranorin and olivetoric acid, determined by TLC, three unidentified substances reported by Dey (1975).

Widespread, collected on hardwoods and rock in a variety of community types throughout the elevational range. This species is

known from the Appalachian Mountains-Great Lakes region of North America, Europe, and Asia.

See the discussion of Cetrelia cetrarioides for comparison of Cetrelia olivetorum to other southern Appalachian species.

Specimens examined. North Carolina. Yancey Co.: Beauty Spot Forest 3016, 3017; Tennessee. Unicoi Co.: Cherry Gap Trail 1405, 1406, 3015; Horseback Ridge 1228; Roadcut 1011, 1047, 1048; Summit 3013*; White Pine Plantation 3014.

## 20. Everniastrum Hale

### 1. Everniastrum catawbiense (Degel.) Hale

Everniastrum catawbiense (Degel.) Hale, Mycotaxon. 3: 347. 1976.

Parmelia sorcheila var. catawbiensis Degel., Ark. Bot. 30A(3): 65. 1941.

Thallus foliose, 1-3 cm in diameter, loosely adnate to suberect, mineral gray; branching dichotomous. Lobes narrow and linear, 0.5-1.5 mm wide; margins inrolled and revolute at tips; cilia abundant, black, simple or dichotomously branched. Lower surface black in center, brown to tan at tips, faintly wrinkled, distinctly canaliculate, bare to sparsely rhizinate on older lobes; rhizines black, simple or dichotomously branched. Upper surface dull, frequently fissured; pustules subterminal or occasionally laminal, coalescing into soralia; soredia granular, often eroding and exposing the cottony, white medulla. Apothecia not seen. Cortex K+ yellow; medulla K-, C+ pale pink or C-, KC+ pink or KC-, PD-.

Chemical composition, atranorin and gyrophoric acid, determined by TLC, unidentified fatty acids reported by Dey (1975).

Widespread, collected on spruce branches, maple, pitch pine, and decaying wood in most community types above 4000 ft. elevation. Dey (1975) reported this species as common at elevations above 5500 ft., and present at lower elevations in the southern Appalachians. It is presently known only from the southern Appalachians and Chile.

Everniastrum catawbiense is easily identified by its suberect, linear lobes, subterminal soralia, and black canaliculate lower surface with marginal, dichotomous rhizines. Frequently it is compared to Hypotrachyna revoluta which also produces gyrophoric acid (Dey, 1975; Hale, 1979). However, H. revoluta has broader (2-5 mm wide) lobes or irregular shape, and lacks the canaliculate shape and marginal cilia. The divaricate branching is similar to that of the H. gyrophora group, which are larger and have a different type of lower surface.

Superficially E. catawbiense resembles Hypogymnia species. The solid lobes of the former readily distinguish it from the inflated, hollow lobes of Hypogymnia. This species frequently occurs on branches mixed with species of Hypogymnia, as well as Usnea and Pseudevernia.

Recently this species has been transferred into the genus Cetrariastrum (Culberson and Culberson, 1981).

Specimens examined. Tennessee. Unicoi Co.: Horseback Ridge 1222*; Rock Creek Headwaters 3077; Stamping Ground Ridge 3078, 3079; White Pine Plantation 1451.

## 21. *Hypotrachyna* (Vainio) Hale

Key to the Species of *Hypotrachyna* in the southern Appalachians

1. Thallus isidiate or sorediate. . . . . 2

1. Thallus not isidiate or sorediate, occasionally pustulate. . .16

2. Thallus isidiate . . . . . 3

2. Thallus sorediate. . . . . 6

3. Isidia cylindrical and laminal; barbatic acid complex present. . . . . 4

3. Isidia often lobulate and marginal; barbatic acid complex absent . . . . . 5

4. Medulla PD+ red; echinocarpic acid also present . . . . . .[*H. dentella* (Hale & Kurok.) Hale]

4. Medulla PD-; echinocarpic acid absent. . . . . .3. *H. imbricatula* (Zahlbr.) Hale

5. Medulla C+ red; anziaic acid present . . . . . .6. *H. prolongata* (Kurok.) Hale

5. Medulla C-; alectronic acid present.[*H. ensifolia* (Kurok.) Hale]

6. Thallus yellow-green, usnic and salazinic acids present. . . . . [*H. sinuosa* (Sm.) Hale]

6. Thallus mineral to whitish gray, atranorin present . . . . 7

7. Soralia terminal or subterminal. . . . . 8

7. Soralia laminal, often pustulate . . . . . .14

8. Soralia diffuse and irregular; sorediate lobes revolute; rhizines sparsely dichotomously branched . . . . . .7. *H. revoluta* (Flk.) Hale

8. Soralia orbicular and distinct; sorediate lobes not or slightly revolute; rhizines richly dichotomously branched. 9

9. Medulla C-, fumarprotocetraric acid present . . . . . 2. *H. gondylophora* (Hale) Hale

9. Medulla C+ orange, rose, or red, fumarprotocetraric acid absent . . . . . .10

10. Medulla C+ rose, gyrophoric acid present . . . . . .11

10. Medulla C+ orange or red, gyrophoric acid absent. . . .12

11. Medulla PD+ yellow; microphyllinic and echinocarpic acids present in addition to gyrophoric acid . . . . . .10. H. thysanota (Kurok.) Hale

11. Medulla PD-, alectoronic acid present in addition to gyrophoric acid . . . . . .5. H. oostingii (Dey) Hale

12. Medulla C+ orange, barbatic acid complex present . . . . . [H. laevigata (Sm.) Hale]

12. Medulla C+ red, barbatic acid complex absent . . . . . .13

13. Lecanoric and evernic acids present; upper surface maculate. . . . . 8. H. rockii (Zahlbr.) Hale

13. Anziaic acid present; upper surface not maculate . . . . . .[H. producta Hale]

14. Upper cortex UV+ brilliant yellow, lichexanthone and lividic acid complex present .[H. formosana (Zahlbr.) Hale]

14. Upper cortex UV-, lichexanthone and lividic acid complex absent . . . . . .15

15. Medulla C-, PD+ red, protocetraric acid present; medulla pigmented yellow-orange under the pustules . . . . . 1. H. croceopustulata (Kurok.) Hale

15. Medulla C+ rose, PD-, gyrophoric acid present, medulla white or darkening, not pigmented yellow-orange . . . . . .7. H. revoluta (Flk.) Hale

16. Upper surface pustulate; apothecia not common. . . . . .17

16. Upper surface not pustulate; apothecia common . . . . . 4. Hypotrachyna livida (Tayl.) Hale

17. Lobes dichotomously branched; pustules laminal. . . . . .18

17. Lobes subdichotomously or irregularly branched; pustules submarginal or subterminal. . . . . .19

18. Upper cortex UV+ brilliant yellow; lichexanthone, lividic, physodic, and 1-O-methylphysodic acids present . . . . . [H. formosana (Zahlbr.) Hale]

18. Upper cortex UV-, atranorin and protocetraric acid present. . . . . 1. *H. croceopustulata* (Kurok.) Hale

19. Medulla C+ orange; barbatic acid complex present . . . . . .11. *H. virginica* (Hale) Hale

19. Medulla C+ rose; gyrophoric acid present. .9. *H. showmanii* Hale

1. *Hypotrachyna croceopustulata* (Kurok.) Hale

*Hypotrachyna croceopustulata* (Kurok.) Hale, Smithson. Contrib. Bot. 25: 30. 1975.

*Parmelia croceopustulata* Kurok. in Hale & Kurok., Contrib. U.S. Natl. Herb. 36: 169. 1964.

Thallus foliose, 1.5(-4-8) cm in diameter, adnate, whitish mineral gray; branching somewhat dichotomous. Lobes linear-narrow, 0.5-2 mm across, sinuses teardrop-shaped to divergent; margins entire, revolute. Lower surface black in the center, dark brown at the apices; rhizines abundant, black densely dichotomously branched, extending beyond the lobe margins. Upper surface weakly maculate, rugose on older lobes; pustules common, laminal and orbicular, coalescing, occasionally producing soredia. Apothecia reported by Hale (1975) as rare, adnate, 1-6 mm in diameter. Cortex K+ yellow; medulla K+ dingy yellow or K-, C-, KC+ dingy pinkish brown, PD+ orange-red.

Chemical composition, atranorin, protocetraric acid, unidentified substances, and yellow-orange pigment (K+ red-purple) determined by TLC.

Rare, collected only on white pine in the white pine plantation at ca. 4300 ft. elevation. Hale (1975) reported that this species,

found in the southeastern United States, Mexico, and the West Indies, is most common on conifers in the southern Appalachians. In Dey's (1975) study it was common in the spruce-fir forest, but rare at lower elevations.

Hypotrachyna croceopustulata is distinguished from the other sorediate Hypotrachyna species by its laminal pustules, yellow-orange medullary pigment, and production of protocetraric acid. Other pustulate species represented in the southern Appalachians may be separated on the basis of chemistry. H. formosana produces lichexanthone in the upper cortex which gives a brilliant yellow UV reaction. H. pustulifera (Hale) Hale, along with H. formosana contain the complex lividic acid group, but have atranorin in the upper cortex. H. virginica, with a fragile and freely rupturing upper cortex (Dey, 1981), is distinguished by the presence of the barbatic acid complex. Another pustulate species, H. showmanii, differs in having C+ rose gyrophoric acid, as does the pustulate-sorediate H. revoluta. See the discussion of H. gondylophora (Hale) Hale for comparison to sorediate species in this genus.

In the closely related genus Parmelina, P. aurulenta also has laminal pustules, but differs from H. croceopustulata in having sparse marginal cilia, simple or furcate rhizines, and a pale yellow pigment, entothein.

Specimens examined. Tennessee. Unicoi Co.: White Pine Plantation 1609*, 3105.

2. Hypotrachyna gondylophora (Hale) Hale

Hypotrachyna gondylophora (Hale) Hale, Smithson. Contrib. Bot. 25: 40. 1975.

Parmelia gondylophora Hale, Bryologist. 70: 420. 1967.

Thallus foliose, 2.5-4(-15) cm in diameter, adnate, whitish mineral gray; branching dichotomous; sinuses teardrop-shaped. Lobes sublinear, 1.5-4 mm wide; margins entire; lobe tips revolute. Lower cortex black, occasionally brown at the lobe tips; rhizines dense, black, densely dichotomously branched, extending beyond the margins. Upper surface shiny, faintly maculate, plane to weakly undulate; pustules abundant, subterminal, produced by erosion of the cortex, coalescing into capitate, orbicular soralia; soredia erose, powdery. Cortex K+ yellow; medulla K+ dingy yellow-brown, C-, PD+ orange-red.

Chemical composition, atranorin, fumarprotocetraric acid, and unidentified substances, determined by TLC.

Rare, collected on mountain ash in the spruce forest at the mountain summit, ca. 5200 ft. elevation. Dey (1975) reported that this species is common above 5500 ft. elevation in the southern Appalachians. Its distribution includes the southeastern United States, Mexico, the West Indies, northeastern South America, and Africa.

Hypotrachyna gondylophora is morphologically similar to six sorediate species of Hypotrachyna found in the southern Appalachians. It differs in the subterminal position of its soralia on slightly

revolute lobes, but is most easily separated by the presence of fumarprotocetraric acid. Other members of this complex are: H. rockii (lecanoric and evernic acids), H. laevigata (barbatic acid), H. oostingii (gyrophoric acid), H. producta (anziaic acid), H. thysanota (gyrophoric, microphyllinic, and echinocarpic acids), and H. densirhizinata (Kurok.) Hale (alectoronic acid).

Specimen examined. Tennessee. Unicoi Co.: Summit 3106*, 3107.

3. Hypotrachyna imbricatula (Zahlbr.) Hale

Hypotrachyna imbricatula (Zahlbr.) Hale, Smithson. Contrib. Bot. 25: 41. 1975.

Parmelia imbricatula Zahlbr., Akad. Wiss. Wien. Math-Naturwiss. Kl. Denkschr. 83: 168. 1909.

Thallus foliose (2-)5-10 cm in diameter, adnate, mineral to whitish gray (occasionally appearing dark green because of algae on the surface); branching dichotomous. Lobes sublinear, 0.5-5 mm wide; margins crenate to dissected and lobulate, crowded and imbricate. Lower surface black in center, reddish brown at lobe tips; rhizines numerous, black, dichotomously branched, projecting beyond the margin. Upper surface shiny, maculate, plane to weakly undulate; isidia abundant, laminal, thin cylindrical, simple or coralloid, frequently lobulate, occasionally short ciliate at apices. Apothecia reported by Hale (1975) as infrequent, 2-10 mm in diameter. Cortex K+ yellow; medulla K-, C+ orange, PD-.

Chemical composition, atranorin and barbatic acid complex, determined by TLC; barbatic acid, 4-O-demethylbarbatic acid, obtusatic acid, trace amounts of accessory norobtusatic acid, and trace amounts of 2-4 accessory unidentified substances reported by Dey (1975).

Locally abundant, collected on white pine and various hardwoods in the white pine plantation at ca. 4500 ft. elevation, less common in hardwood dominated communities. Dey (1975) reported that this species is very common in the spruce-fir forest of the southern Appalachians but rare at lower elevations. Hale (1975) noted that H. imbricatula is widely distributed from Mexico southward to Chile, and occurs in the West Indies, southeast Asia, and Australia.

In the southern Appalachians Hypotrachyna imbricatula is distinguished by its laminal, cylindrical isidia and production of the barbatic acid complex. Two species from the closely related genus Parmelina, P. dissecta and P. horrescens differ in production of the "horrescens" unknown, simple or furcately branched rhizines, and marginal cilia.

The names Parmelia digitata Lynge and P. lobulifera var. luteoreagens Degel. previously were used for specimens producing the barbatic acid complex and bearing lobules as well as isidia. However, after examining types, Dey (1975) determined that all southern Appalachian collections should be referred to as H. imbricatula.

H. imbricatula is the isidiate morph in a complex which includes the presumed parent H. physcioides (Nyl.) Hale and the sorediate morph H. laevigata.

Specimens examined. North Carolina. Yancey Co.: Beauty Spot Forest 3116, 3117, 3118*; Tennessee. Unicoi Co.: Cherry Gap Trail 1379, 1381, 1385, 3115; Rock Creek Headwaters 3108, 3109; White Pine Plantation 1456, 1510, 1524, 1558, 1570, 1592, 1604, 1605, 1610, 3108, 3109, 3110, 3111, 3112, 3113, 3114, 3119.

4. Hypotrachyna livida (Tayl.) Hale

Hypotrachyna livida (Tayl.) Hale, Smithson. Contrib. Bot. 25: 45. 1975.

Parmelia livida Tayl. in Hook., Lond. J. Bot. 6: 171. 1847.

Thallus foliose, 4-7(-9) cm in diameter, adnate, mineral gray; branching dichotomous to irregular. Lobes sublinear, 1.5-4 mm wide; margins crenate. Lower surface black in the center, reddish brown at the lobe tips; rhizines dense, black, sparsely dichotomously branched. Upper surface smooth at the lobe tips, rugose and undulate in the center, occasionally lobulate; apothecia numerous, 0.5-4 mm in diameter; disc brown, rim crenate to dissected, appearing inflated; pycnidia abundant in rugose areas, brown, immersed. Cortex K+ yellow; medulla K-, C-, KD+ rose, PD-.

Chemical composition, atranorin and lividic acid, determined by TLC, colensoinic acid, norcolensoinic acid, 4-O-demethyl-physodic acid, physodic acid, and associated unknowns reported by Hale (1975).

Rare, one collection from maple in oak-hickory forest at ca. 4200 ft. elevation. While common at lower elevations in deciduous

forest, Dey (1975) did not report this species at high elevations in the southern Appalachians. This species occurs in the southeastern United States, Bahamas, Venezuela, southeastern Brazil southward to Argentina (Hale, 1975).

Hypotrachyna livida is the only Hypotrachyna commonly producing apothecia in the southern Appalachians. It is characterized by an adnate thallus, lack of vegetative diaspores, and complex chemistry. It may be confused with Parmelina galbina, also common in the eastern United States. This species differs in having simple rhizines, marginal cilia, a lighter brown apothecial disc, and occasionally, a pale orange pigment in the medulla. The K+, PD+ reactions of galbinic acid in P. glabina easily separates these two species.

H. livida is the presumed parent of three vegetative morphs: H. immaculata (Kurok) Hale, sorediate; H. dactylifera (Vainio) Hale, isidiate-pustulate; and H. pustulata (Hale) Hale, pustulate.

Specimens examined. North Carolina. Yancey Co.: Beauty Spot Forest 3121*; Tennessee. Unicoi Co.: White Pine Plantation 3122.

5. Hypotrachyna oostingii (Dey) Hale

Hypotrachyna oostingii (Dey) Hale, Smithson. Contrib. Bot. 25: 51. 1975.

Parmelia oostingii Dey, Castanea. 39: 362. 1974.

Thallus foliose, 4.5(-8-12) cm in diameter, loosely attached, whitish mineral gray; branching dichotomous; sinuses between lobes

"U" to "V" shaped, divergent. Lobes linear-elongate, 1-4 mm wide, frequently revolute; margins inflated, appearing canaliculate. Lower surface black in center, occasionally brown at the apices; rhizines numerous, black, densely dichotomously branched. Upper surface shiny, faintly maculate, plane to undulate on older lobes; pustules abundant, isidioid, produced subterminally, eroding and coalescing to form subterminal soralia, or infrequently, remaining as an open pit; soredia powdery, eroding leaving darkened areas. Apothecia not seen. Cortex K+ yellow; medulla K-, C+ faint pink or C-, PD+ pale orange or PD-.

Chemical composition, atranorin, gyrophoric acid, and alectoronic acid, determined by TLC.

Rare, one collection from white pine in the white pine plantation at ca. 4300 ft. elevation. This species is common on conifers at high elevations, above 5500 ft., in the southern Appalachians (Dey, 1975). It is found only at lower elevations in Chile, and at high elevations, ca. 6000 ft., in the southeastern United States (Hale, 1975).

Hypotrachyna oostingii may be recognized by its capitate soralia which are subterminal on non-revolute lobes. Initially the soralia are pustulate, and may remain as open pits with occasional, coarse soredia. It is very close morphologically and chemically to H. thysanota which differs only in the production of microphyllinic and echinocarpic acids in addition to gyrophoric acid. See the discussion of H. gondylophora for comparison to other sorediate Hypotrachyna species.

Specimens examined. Tennessee. Unicoi Co.: White Pine Plantation 1522*.

6. Hypotrachyna prolongata (Kurok.) Hale

Hypotrachyna prolongata (Kurok.) Hale, Smithson. Contrib. Bot. 25: 56. 1975.

Parmelia prolongata Kurok. in Hale and Kurok., Contrib. U.S. Natl. Herb. 36: 1802. 1964.

Thallus foliose, 4(-5-10) cm in diameter, loosely adnate, whitish mineral gray; branching dichotomous; sinuses linear to closed. Lobes sublinear, elongate, 1-3 mm wide; margins entire or lobulate and appearing dissected. Lower surface black in center, reddish brown at lobe tips; rhizines abundant, black, richly dichotomously branched. Upper surface shiny, plane and smooth; isidia sparse along margins and wounds, cylindrical, often flattened, branched, and lobulate. Apothecia not seen. Cortex K+ yellow; medulla K-, C+ red, PD-.

Chemical composition, atranorin, anziaic acid, and unknown substances, determined by TLC.

Rare, one collection on spruce in spruce forest on the mountain summit. This species is common in high elevational coniferous forest in the southern Appalachians (Dey, 1975). It is also known from high elevations, on conifer bark, in the Caribbean and Andean regions of the West Indies, Central, and South America (Hale, 1975).

Hypotrachyna prolongata is the isidiate morph of H. ducalis (Jatta) Hale. Also included in this complex is the sorediate morph H. producta. H. prolongata is easily distinguished from other isidiate Hypotrachyna in the southern Appalachians by its C+ red reaction and marginal lobulate isidia. H. ensifolia is morphologically similar but has alectoronic acid which reacts C-, UV+. Other species which can be identified by their production of laminal, cylindrical isidia include H. imbricatula with the barbatic acid complex and H. dentella with echinocarpic acid.

Previously the name Hypotrachyna rachista (Hale) Hale was used for this taxon in the southern Appalachians, Central, and South America (see Dey, 1975; Hale, 1975). However, after chemical analysis documented the presence of anziaic acid in the type of H. prolongata, H. rachista was reduced to a synonym of this older name.

Specimens examined. Tennessee. Unicoi Co.: Summit 3120*.

7. Hypotrachyna revoluta (Flörke) Hale

Hypotrachyna revoluta (Flörke) Hale, Smithson. Contrib. Bot. 25: 60. 1975.

Parmelia revoluta Flörke, Deutschl. Lich. 1: 11. 1815.

Thallus foliose, 2-8(-12) cm in diameter, adnate, greenish mineral gray to whitish gray; branching subdichotomous to irregular. Lobes sublinear to subirregular, 1-4(-6.5) mm wide, occasionally subcanaliculate; margins entire to crenate, revolute; apices often

rounded, ascending and exposing the lower surface. Lower surface black in the center, brown in a broad marginal zone; rhizines sparse to moderately dense, black, simple or sparingly dichotomously branch, the number of dichotomously branched rhizines varies from few to many. Upper surface smooth, shiny or slightly maculate; cortex fragile and eroding; soredia yellowish green, farinose to granular, diffuse and eroded submarginal on revolute lobes; pustules frequent, apically eroding to produce soredia, coalescing; apothecia occasional, on pustulate thalli, to 4 mm in diameter, submarginal; disc reddish brown; rim lacerate, often pustulate. Medulla white, blackening when exposed under pustules and soredia. Cortex K+ yellow; medulla K+ yellow-pink or K-, C+ rose, KC+ rose, PD+ faint rose or PD-.

Chemical composition, atranorin, gyrophoric acid and unidentified substances determined by TLC.

Abundant, collected on rock, spruce, hardwoods, pines, and ericaceous shrubs in all community types across the entire elevational range. Dey (1975) reported this species as common and widespread at all elevations in the southern Appalachians. In North America the distribution is quite disjunct including the southern Appalachians, Central Rocky Mountains, and Northwest. Hale (1975) described its distribution as montane pantropical. It occurs in the West Indies, Central and South America, Europe, Africa, Asia, Australia, and New Zealand (Dey, 1975).

Hypotrachyna revoluta is a highly variable species in the southern Appalachians. The lobe shape ranges from short and rounded

to elongate and narrow. Soredia may be abundant and diffuse or sparse and pustulate. Submarginal production of soredia through erosion of the upper cortex results in the characteristic revolute lobe margins. However, when lacking soredia the margins often ascend exposing the light tan marginal zone of the lower surface. Dichotomously branched rhizines, which define the genus, may be sparse and outnumbered by simple rhizines, or abundant and predominant.

Production of gyrophoric acid unites the many morphological variants into one species. Only one other pustulate species in the southern Appalachians, Parmelina spumosa has a similar chemistry. This species, not recognized by Dey (1975, p. 433; 1981) as present in the southeastern United States, differs in having marginal cilia and simple or furcate rhizines. Pustules are present on the upper cortex and may erode apically but do not produce soredia. As is typical of the genus Parmelina the medulla is faint yellow in material from the New World tropics.

Other pustulate species in the southern Appalachians are distinguished by their chemistries. Hypotrachyna virginica produces the barbatic acid complex and has a fragile macculate upper cortex which bears esorediate pustules. Hypotrachyna showmanii, also with dense esorediate pustules and a fragile cortex, produces the "horrescens" unknown and has distinctly dichotomously branched rhizines and typically a whitish gray color. These species are endemic to the southern Appalachians.

Also pustulate, but producing soredia and larger, dichotomously branched lobes, H. formosana has lichexanthone and the lividic acid complex and H. croceopustulata, atranorin and protocetraric acid. Parmelina galbina has laminal pustular soralia, faint yellow medullary pigment, and produces atranorin, terpenes, and fatty acids.

Hale (1976, p. 2) in his monograph of the genus Parmelina discussed the problem of correctly assigning the pustulate specimens containing gyrophoric acid to a genus. The sparsely branched rhizines and sparse, marginally positioned "cilia" which form the basis of the generic classification are not easily determined in these specimens. These similar groups may be explained as an example of parallel evolution or as an extant ancestral group which is highly diverse in the southern Appalachians.

This group is in serious need of examination and revision in the southern Appalachians.

Specimens examined. North Carolina. Yancey Co.: Beauty Spot Forest 1332, 3125, 3126, 3127, 3128, 3129, 3130, 3131, 3132, 3133, 3134, 3135, 3136, 3137, 3138, 3150, 3151, 3159; Tennessee. Unicoi Co.: Beauty Spot 3145; Beauty Spot Gap 1021, 1023, 1024, 1025; Chestnut Knob 3154, 3155, 3156; Cherry Gap Trail 1327, 1328, 1329, 1330, 1386, 1387, 1388, 1389, 1390, 1511; Horseback Ridge 1287; Indian Grave Gap 3124; Stamping Ground Ridge 3142, 3143, 3144*, 3152, 3153; Summit 3123*, 3146, 3148, 3149; White Pine Plantation 1457, 1459, 1460, 1500, 1503, 1577, 1586, 1588, 1589, 1601, 1623, 3139, 3140, 3141, 3157, 3158.

8. Hypotrachyna rockii (Zahlbr.) Hale

Hypotrachyna rockii (Zahlbr.) Hale, Smithson. Contrib. Bot. 25: 62. 1975.

Parmelia rockii Zahlbr., Ann. Mycol. 10: 379. 1912.

Thallus foliose, 2.5(-5-12) cm in diameter, loosely attached, whitish mineral gray; branching dichotomous; sinuses teardrop-shaped. Lobes sublinear, 1-3 mm wide; margins entire. Lower surface black; rhizines dense, black, densely dichotomously branched, projecting beyond the margins. Upper surface shiny, maculate, plane; pustules subterminal or occasionally laminal, dark-tipped, inflated, eroding to form soralia or remaining as open pits; soredia coarse. Apothecia reported by Hale (1975) as rare, adnate, 2-8 mm in diameter. Cortex K+ yellow; medulla K-, C+ rose or C-, PD-.

Chemical composition, atranorin, evernic acid, and lecanoric acid, determined by TLC.

Rare, one collection from mountain ash in spruce forest on mountain summit. Dey (1975) reported that this species is common at elevations above 5500 ft. in the southern Appalachians, but rare at lower elevations. It ranges from the highlands of Mexico and Central America to southern Chile, with widespread populations in the West Indies, South Africa, southeast Asia and Hawaii (Hale, 1975).

Hypotrachyna rockii is the sorediate morph of the fertile H. pulvinata (Fee) Hale known from the southwestern United States, Central, and South America. It differs from other sorediate

Hypotrachyna species in its maculate upper surface and production of evernic and lecanoric acids. H. laevigata, also having a maculate surface, can be separated by the presence of the barbatic acid complex. See the discussion of H. gondylophora for comparison to other sorediate species of Hypotrachyna.

Specimens examined. Tennessee. Unicoi Co.: Cherry Gap Trail 1331; Summit 3160*.

9. Hypotrachyna showmanii Hale

Hypotrachyna showmanii Hale, Bryologist 79: 78-80. 1976.

Thallus foliose, up to 3(-4) cm in diameter, adnate, mineral green; branching irregular. Lobes sublinear and irregular, 0.7-2.5 mm wide, crowded or continuous, margins crenate, somewhat revolute. Lower surface black, brown at the lobe tips, wrinkled, shiny; rhizines black, lighter at the tips, sparsely dichotomously branched. Upper surface smooth to rugose, maculate, especially at the lobe tips; cortex fragile, eroding; pustules abundant to dense, isidioid, inflated, eroding apically to produce open pits and exposing cottony medulla, subterminal on revolute lobes. Apothecia not seen. Cortex K+ yellow, medulla K-, C-, KC+ pink or KC-.

Chemical composition, atranorin, the "horrescens" unknown, and trace amounts of gyrophoric acid determined by TLC.

Rare, collected on maple and white pine in the white pine plantation at ca. 4200 ft. elevation. This species was reported as very rare by Hale (1976c). It occurs in open deciduous oak forest

on hardwoods and white pine in the Appalachian region of North America from Pennsylvania south to Tennessee and North Carolina.

Hypotrachyna showmanii can be identified by its dense, esorediate pustules, dichotomous rhizines, and production of the "horrescens" unknown. In the field it will be confused with the highly variable species H. revoluta. This species differs by usually producing soredia, which are diffuse and laminal or subterminal. Though occasionally pustulate, this taxon produces gyrophoric acid and lacks the "horrescens" unknown. H. showmanii usually has a lighter grayish thallus and a more fragile cortex.

Morphologically, this species is very close to H. formosana. The latter has a distinct chemistry, lividic acid complex and lichexanthone in the upper cortex which fluoresces brilliant orange under UV light. Parmelina spumosa is also pustulate but has marginal cilia, simple or furcate rhizines, and gyrophoric acid.

Specimens examined. Tennessee. Unicoi Co.: White Pine Plantation 1616, 3161*, 3162.

10. Hypotrachyna thysanota (Kurok.) Hale

Hypotrachyna thysanota (Kurok.) Hale, Smithson. Contrib. Bot. 25: 68. 1975.

Parmelia thysanota Kurok. in Hale & Kurok. Contrib. U.S. Natl. Herb. 36: 186. 1964.

Thallus foliose, 5-15 cm in diameter, adnate to loosely adnate, whitish mineral gray; branching dichotomous. Lobes linear,

2-5 mm wide; sinuses divaricate; margins entire; apex notched. Lower surface black, brown at the lobe tip; rhizines dense, richly dichotomously branched, projecting beyond the margin. Upper surface smooth, shiny, occasionally pruinose near the lobe tips; soredia occasional, granular; soralia capitate, developing from pustules, coalescing, terminal or subterminal; apothecia not seen. Cortex K+ yellow; medulla K+ yellow, C+ faint dirty pink turning yellowish or C-, KC+ pink turning yellow-orange, PD+ yellow-orange.

Chemical composition, atranorin, gyrophoric acid, microphyllinic acid, and echinocarpic acid determined by TLC and three unidentified substances reported by Dey (1975).

Rare, collected on beech and maple trees in the white pine plantation at ca. 4200 ft. elevation. Dey (1975) reported this species as common and almost exclusively on Abies and Picea in the spruce-fir and fire cherry communities at high elevations in the southern Appalachians and not known from lower elevations. In North America it is reported from the southern Appalachians and on conifers in forests at ca. 6000 ft. elevation in Mexico (Hale, 1975).

Hypotrachyna thysanota includes specimens formerly called Parmelia nakanishii Hale from the southern Appalachians. H. thysanota can be distinguished from other sorediate species of Hypotrachyna in its production of microphyllinic and echinocarpic acids in addition to gyrophoric acid. See the description of H. gondylophora for comparison to other species.

Specimens examined. Tennessee. Unicoi Co.: White Pine Plantation 1526, 1618, 3163, 3164, 3165, 3166*.

11. Hypotrachyna virginica (Hale) Hale

Hypotrachyna virginica (Hale) Hale, Phytologia 28: 342. 1974.

Parmelia virginica Hale in Hale & Kurokawa, Contrib. U.S. Natl. Herb. 36: 186. 1964.

Thallus foliose, 2.5 cm in diameter, closely adnate, green to mineral gray; branching irregular. Lobes irregular to sublinear, 1-2(-4) mm wide, crowded; sinuses teardrop-shaped; margin crenate. Lower cortex black in the center, light brown at the lobe tips; rhizines sparse, black, sparsely dichotomously branched. Upper surface shiny to somewhat maculate, occasionally rugose; cortex fragile; pustules common, inflated, eroding apically and coalescing to form open pits; apothecia reported by Dey (1975) as 2.5 mm in diameter; disc brown; pycnidia rare, only on fertile specimens, immersed. Cortex K+ yellow; medulla K-, C+ pale yellow, KC+ orange, PD-.

Chemical composition, atranorin, barbatic acid, and 4-O-demethylbarbatic acid determined by TLC, obtusatic acid, norobtusatic acid, and trace amounts of three unidentified substances reported by Dey (1975).

Not common, collected on hardwoods, pines, and ericaceous shrubs in the red oak-hickory forest and heath gardens between 4200 and 4700 ft. elevations. Dey (1975) reported this species as widespread but not common at high elevations while rare at lower elevations in the southern Appalachians. It is an endemic of the southern Appalachians (Hale, 1975).

Hypotrachyna virginica differs from H. revoluta in producing esorediate pustules and the barbatic acid complex. H. laevigata with the same chemistry, has larger dichotomously branched lobes and subterminal soredia.

Specimens examined. Tennessee. Unicoi Co.: Cherry Gap Trail 3169; Stamping Ground Ridge 3167*, 3168.

## 22. Melanelia Essl.

Key to the Species of Melanelia in the southern Appalachians

1. Thallus sorediate or isidiate. . . . . 2
1. Thallus not sorediate or isidiate, occasionally papillate. . . 4
    2. Upper surface with warty papillae resembling isidia; medulla PD-, no lichen substances present . . . . . .1. M. exasperata (De Not.) Essl.
    2. Upper surface smooth, lacking warty papillae; medulla PD+ red. . . . . 3
3. Lobes less than 1 mm wide, subterete; caperatic acid present. . . . . .[M. stygia (L.) Essl.]
3. Lobes 1-4 mm wide, dorsiventrally flattened; fumarprotocetraric acid present. . . . . .2. M. halei (Ahti) Essl.
    4. Thallus pseudocyphellate; medulla C+ rose, gyrophoric acid present . . . . . [Parmelia stictica (Del.) Nyl.]
    4. Thallus not pseudocyphellate; medulla C+ red, lecanoric acid present . . . . . 5
5. Soredia diffuse, mixed with tiny isidia . . . . . .3. M. subaurifera (Nyl.) Essl.
5. Soredia absent, but isidia present . . . . . [M. glabratula (Lamy.) Essl.]

1. Melanelia exasperata (De Not.) Essl.

Melanelia exasperata (De Not.) Essl., Mycotaxon 7(1): 47. 1978.

Parmelia exasperata De Not., Bot. Ital. 2: 193. 1847.

Thallus foliose, 2 cm in diameter, closely adnate, pale olive green to brownish; branching irregular. Lobes rounded, 1-3 mm wide. Lower surface shiny, black in the center, cream-colored at the margins; rhizines sparse, black to light brown, simple. Upper surface shiny, wrinkled in the center, with numerous warty papillae (isidia from a broadened base) tipped with white pseudocyphellae. Apothecia common, to 6 mm in diameter; disc light brown; rim developing pseudocyphellate papillae; pycnidia common. Cortex K-; medulla K-, C-, KC-, PD-.

Chemical composition, no compounds detected.

Rare, one collection from hardwood branch along trail to Low Gap at ca. 4000 ft. elevation. This species was not reported by Dey (1975). It is widely distributed in Europe, Africa, and Russia. In North America it ranges from the Great Lakes and New England to northern Arkansas and northern Georgia in the Appalachians (Esslinger, 1977).

Melanelia exasperata is distinguished from other brown Parmelias by the presence of pseudocyphellate papillae, described by Esslinger (1977) as conical to short cylindrical. In the southern Appalachians it may be confused with M. subaurifera which has soredia mixed with isidia, or M. glabratula which bears only isidia.

Both of these species contain lecanoric acid and are easily identified by their C+ red reaction.

Specimens examined. Tennessee. Unicoi Co.: Cherry Gap Trail 3699.

2. Melanelia halei (Ahti) Essl.

Melanelia halei (Ahti) Essl., Mycotaxon. 3(1): 48. 1978.

Parmelia halei Ahti, Acta Bot. Fenn. 70: 38. 1966.

Thallus foliose, 2-6 cm in diameter, appressed, though occasionally raised at the lobe tips, light olive green when wet to yellow-brown when dry; branching irregular, lobules produced in the thallus center becoming secondary lobes. Lobes short and rounded, 1-4 mm wide, wrinkled to rugose on older lobes. Lower surface black in the center, brown to cream-colored at the margins; rhizines sparse, concolorous with the surface, simple or furcate. Upper surface shiny, especially at the lobe tips; pseudocyphellae sparse, becoming warty with age. Apothecia reported by Esslinger (1977) as common, to 5 mm in diameter; rim entire to crenulate or warted, the warts often pseudocyphellate. Cortex K-, medulla K-, C-, PD+ orange-red.

Chemical composition, fumarprotocetraric acid and protocetraric acid, determined by TLC.

Common, collected infrequently on hardwoods in northern hardwoods communities and the white pine plantation below 4500 ft. elevation. Dey (1975) noted that it is common at all elevations in the southern Appalachians. This North American endemic is found in southeastern Canada and the eastern United States.

Melanelia halei is the only isidiate, brown Parmelia in the southern Appalachians which produces fumarprotocetraric acid. One other species, M. stygia, gives a PD+ reaction due to the presence of caperatic acid. In the latter, an obligate saxicole, the lobes are narrower, less than 1 mm and subterete. Melanelia olivacea (L.) Essl., a northern species, has broader lobes and is darker in color.

Unless wet, this species is frequently overlooked because of its bark-color and closely appressed attachment.

Specimens examined. North Carolina. Yancey Co.: Beauty Spot Forest 3182, 3183; Tennessee. Unicoi Co.: Cherry Gap Trail 1349, 1351*; Chestnut Knob 3184; White Pine Plantation 1534.

3. Melanelia subaurifera (Nyl.) Essl.

Melanelia subaurifera (Nyl.) Essl., Mycotaxon 7: 53. 1978.

Parmelia subaurifera Nyl., Flora 56: 22, 1873.

Thallus foliose, 4(-10) cm in diameter, adnate to loosely adnate, greenish to chestnut brown; branching irregular. Lobes 1-4 mm wide rounded to sublinear, often continuous, margins crenate, sparsely ciliate, slightly reflexed. Lower surface dark brown to brownish black, brown in a narrow apical zone; rhizines moderately abundant, to 1 mm long, simple, concolorous with the lower surface. Upper surface smooth to rugose and warty near the margins, wrinkled in the center; pseudocyphellae common, conspicuous; soredia granular, brownish, often isidioid; soralia orbicular and laminal, produced around the pseudocyphellae; isidia frequent, cylindrical to coralloid, produced in soralia; apothecia reported by Esslinger

(1977) as rare, sessile, more or less flat, to 2.5 mm in diameter; rim often sorediate and isidiate; pycnidia rare. Cortex K-; Medulla K-, C+ red turning yellow-orange, PD-.

Chemical composition, lecanoric acid and trace amounts of 2-3 unidentified substances reported by Dey (1975).

Rare, collected on hardwoods in white pine plantation and high elevation deciduous forest along the rockslide, between 4200 and 4700 ft. elevations. Dey (1975) reported this species as rare at all elevations in the southern Appalachians. In North America Esslinger (1977) described the distribution of this species as boreal. It also occurs in boreal Europe.

Melanelia subaurifera can be recognized by its production of lecanoric acid and both soredia and isidia.

Specimens examined. Tennessee. Unicoi Co.: Rockslide Area 1177; White Pine Plantation 1598*.

## 23. Parmelia Ach.

Key to the Species of Parmelia in the southern Appalachians

1. Upper cortex with angular maculentations often becoming pseudocyphellate; medulla PD+ orange-red, salazinic acid present. . . . . 2

1. Upper cortex with punctate pseudocyphellae; medulla PD-, salazinic acid absent. . . . . 5

2. Thallus sorediate or isidiate, not usually apotheciate . . 3

2. Thallus not sorediate or isidiate, frequently apotheciate. . . . . 6. P. omphalodes (L.) Ach.

3. Thallus sorediate. . . . . .12. *P. sulcata* Tayl.

3. Thallus isidiate . . . . . 4

4. Rhizines squarrosely branched. . . . . .9. *P. squarrosa* Hale

4. Rhizines simple or sparsely furcately branched . . . . . .[*P. saxatilis* (L.) Ach.]

5. Thallus sorediate or isidiate. . . . . 6

5. Thallus not sorediate or isidiate, but occasionally lobulate .10

6. Thallus isidiate . . . . . .8. *P. rudecta* Ach.

6. Thallus sorediate. . . . . 7

7. Thallus yellow-green, usnic acid present . . . . . 4. *P. flaventior* Stirt.

7. Thallus slate to mineral gray or brown, atranorin present . . 8

8. Thallus light to grayish brown . 10. *P. stictica* (Del.) Nyl.

8. Thallus slate to mineral gray. . . . . 9

9. Lower surface black at least in the center; medulla C+ rose, KC+ rose, gyrophoric acid present. . . 3. *P. borreri* (Sm.) Turn.

9. Lower surface tan to brown; medulla C+ red or C-, KC+ red or KC-, gyrophoric acid absent. . . . . .10

10. Medulla C+ red, KC+ red, lecanoric acid present; soredia powdery. . . . . .11. *P. subrudecta* Nyl.

10. Medulla C-, KC-, fatty acids present; soredia granular to subisidiate. . . . . 7. *P. reddenda* Stirt.

11. Lower surface black, lobules dense and well developed . . . . . .1. *P. appalachensis* W. Culb.

11. Lower surface tan, lobules absent, or occasionally on older lobes, not well-developed. . . . . .12

12. Medulla C+ red, KC+ red, lecanoric acid present; lobules lacking. . . . . 5. *P. hypoleucites* Nyl.

12. Medulla C-, KC-, fatty acids present; lobules occasional . . . . . 2. *P. bolliana* Müll. Arg.

1. Parmelia appalachenisis W. Culb.

Parmelia appalachensis W. Culb., Nova Hedwigia 4: 571. 1962.

Thallus foliose, 5-7 cm in diameter, adnate, mineral green to mineral gray; branching irregular. Lobes irregular-elongate, 3-7 mm wide; margins crenate to dissected and lobulate. Lower surface black in the center, light brown to white at the margins; rhizines abundant, black, simple or furcate. Upper surface brittle, waxy; older lobes wrinkled to ridged; pseudocyphellae sparse, on lobe tips; lobules abundant around the pseudocyphellae and cracks, highly branched and dissected to coralloid, obscuring the lobe structure in older parts of the thallus. Pycnidia occasional on lobules; apothecia reported by Dey (1975) as common, to 5.5 mm in diameter, disc tan. Cortex K+ yellow, medulla K-, C-, PD-.

Chemical composition, atranorin and fatty acids, determined by TLC.

Abundant, collected on hardwoods in spruce and hardwood dominated communities over a wide elevational range. This species is endemic to the southern Appalachians (Dey, 1975).

The densely lobulate lobes, black lower surface, pseudocyphellae, and production of fatty acids identifies Parmelia appalachensis. Other pseudocyphellate lichens with a tan lower surface and lacking soredia are: P. rudecta, distinguished by the production of isidia and C+ red lecanoric acid; P. bolliana, a fertile species that occasionally produces lobules; and P. hypoleucites, which lacks both soredia and isidia and produces C+ red lecanoric acid.

Specimens examined. North Carolina. Yancey Co.: Beauty Spot Forest 3184, 3185, 3186, 3187, 3188*; Tennessee. Unicoi Co.: Beauty Spot Gap 1018; Cherry Gap Trail 1342, 1343, 1344, 1345, 1346, 1347, 1348, 1401; North Beauty Spot 1186, 1196, 1201, 1206, 1207, 1216, 1016, 1191.

2. Parmelia bolliana Müll. Arg.

Parmelia bolliana Müll. Arg., Flora 60: 78. 1877.

Thallus foliose, 6-12 cm in diameter, adnate, greenish mineral gray; branching irregular. Lobes 2-5 mm wide, sublinear, imbricate in the center; margins crenate to lobulate. Lower surface tan, shiny; rhizines moderately dense, tan, simple. Upper surface waxy, wrinkled, occasionally lobulate, pseudocyphellae common inconspicuous; apothecia reported by Hale as common; pycnidia common. Cortex K+ yellow; medulla K-, C-, KC-, PD-.

Chemical composition, atranorin and fatty acids reported by Hale (1979).

Rare, collected only on cherry bark in an oak-hickory forest at ca. 4000 ft. elevation. This species is reported by Dey (1981) as present but rare in the mountains of North Carolina. Its North American distribution includes the eastern, midwestern, and southwestern United States.

Parmelia bolliana can be distinguished from other pseudocyphellate Parmelias by its production of fatty acids. Other species lacking soredia and isidia in the southern Appalachians

include Parmelia hypoleucities which produces lecanoric acid, and P. appalachensis which has a black lower surface and dense lobules.

Specimens examined. North Carolina. Yancey Co.: Beauty Spot Forest 3189*.

3. Parmelia borreri (Sm.) Turn.

Parmelia borreri (Sm.) Turn. in Sm. & Sowerb., Engl. Bot. 25: tab. 1780. 1807.

Lichen borreri Sm. in Sm. & Sowerb., Engl. Bot. 25: tab. 1780. 1807.

Thallus foliose, up to 10 cm in diameter, adnate, mineral green; branching irregular. Lobes 2-5 mm wide, sublinear, continuous; margins crenate and undulate. Lower surface black in the center, dark brown in a bare marginal zone; rhizines moderately dense, black, simple. Upper surface waxy, thick, undulate; pseudocyphellae common, conspicuous; soredia abundant, granular; soralia linear and marginal or orbicular and laminal, around pseudocyphellae; apothecia not seen. Cortex K+ yellow; medulla K-, C+ rose, KC+ rose, PD-.

Chemical composition, atranorin and gyrophoric acid reported by Dey (1981).

Rare, collected only on red oak in the oak-hickory community at ca. 4000 ft. elevation. This species was reported as rare in the mountains of North Carolina (Dey, 1981). It is endemic to the southern Appalachians in North America.

Parmelia borreri can be distinguished from other sorediate and pseudocyphellate species by its black lower surface and production of gyrophoric acid. For comparison to other sorediate species see the description of P. subrudecta.

Specimens examined. North Carolina. Yancey Co.: Beauty Spot Forest 3190*.

4. Parmelia flaventior Stirt.

Parmelia flaventior Stirt., Scott. Nat. (Perth) 4: 254. 1877-78.

Thallus foliose, 5-7 cm in diameter, loosely adnate, yellow-green; branching irregular. Lobes rounded 5-15 mm wide, undulate to wrinkled; margins entire to crenate. Lower surface black in the center, brown to white and wrinkled at the margin; rhizines sparse, black, short, simple or furcate, produced where the thallus contacts the substrate. Upper surface thick and waxy, cracking along the margin; pseudocyphellae abundant; soredia granular; soralia laminal and orbicular, encircling pores, or marginal and linear. Apothecia not seen. Cortex K-; medulla K-, C+ red, PD-.

Chemical composition, usnic acid and lecanoric acid, determined by TLC.

Not common, collected on buckeye, oak, and beech in the northern red oak and high elevation deciduous communities at elevations above 4000 ft. Hale (1980) noted that this species occurs "throughout the Americas, central Europe, Africa, and Himalayan region."

Parmelia flaventior is the only pseudocyphellate species in the southern Appalachians which produces usnic acid in the upper cortex. It can only be confused with Pseudoparmelia caperata and P. baltimorensis which lack pseudocyphella and produce C- protocetraric and caperatic acids. P. caperata produces soredia in diffuse eroded soralia, while P. baltimorensis bears irregular pustules which lack soredia.

See Hale (1980) for further discussion of relationships between Parmelia flaventior and other species of Parmelia.

Specimens examined. Tennessee. Unicoi Co.: Horseback Ridge 3192*; North Beauty Spot 1017, 1208; Roadside 3193; Stamping Ground Ridge 3191.

5. Parmelia hypoleucites Nyl.

Parmelia hypoleucties Nyl. Flora 41: 379. 1858.

Thallus foliose, 3-5(-10) cm in diameter, adnate, dark mineral green; branching irregular. Lobes 2-5 mm wide, sublinear to rounded, imbricate in the center; margins crenate to lobulate, forming a slightly ascending rim. Lower surface light brown to tan, shiny; rhizines abundant in the center, sparse to absent at the margins; white to brown, simple. Upper surface rigid, somewhat fragile, slightly wrinkled, rugose in the center; pseudocyphellae common, conspicuous, somewhat raised; apothecia not seen, pycnidia common, immersed, black. Cortex K+ yellow; medulla K-, C+ red, KC+ red, PD-.

Chemical composition, atranorin and lecanoric acid determined by TLC.

Widespread, collected on hardwoods in deciduous communities between 4200 and 4500 ft. elevations. This species is reported by Dey (1981) as present but rare in the mountains of North Carolina.

Parmelia hypoleucities can be distinguished from other non-sorediate-nonisidiate, pseudocyphellate species by its production of lecanoric acid. It differs from P. rudecta or P. subrudecta, also producing lecanoric acid, in its dark greenish color as compared to their slate or bluish gray color.

Recently this taxon has been called P. semansiana W. Culb. & C. Culb. in the southern Appalachians (Dey, 1981).

Specimens examined. North Carolina. Yancey Co.: Beauty Spot Forest 3194, 3195; Tennessee. Unicoi Co.: Beauty Spot Gap 1026*; Chestnut Knob 3198; Stamping Ground Ridge 3196; Switchback 3197; White Pine Plantation 1462.

6. Parmelia omphalodes (L.) Ach.

Parmelia omphalodes (L.) Ach., Meth. Lich. 204. 1803.

Lichen omphalodes L., Sp. Pl. 2: 1143. 1753.

Thallus foliose, 4-20 cm in diameter, loosely adnate; mineral to bluish gray; branching subdichotomous. Lobes linear, 1.5-3 mm wide, slightly concave, margins smooth to slightly crenate, raised. Lower surface black in the center, dark brown in a narrow apical zone; rhizines dense, black, simple to squarrosely branched. Upper

surface weakly ridged, pruinose in the center; cortex often puffy and raised; maculentations angular, frequent near the margins and on laminal ridges; apothecia reported by Dey (1975) as rare, to 3 mm in diameter, disc brown. Cortex K+ yellow; medulla K+ yellow turning red, C-, PD+ orange.

Chemical composition atranorin, salazinic acid, consalazinic acid, accessory lobaric acid, and two accessory unidentified fatty acids reported by Dey (1975).

Rare, collected only on cherry bark in an oak-hickory forest at ca. 4000 ft. elevation. Dey (1975) reported this species as widespread but not common, at elevations above 5500 ft. in the southern Appalachians on exposed or sheltered rock. In addition to the southern Appalachians this species occurs throughout boreal North America. Its worldwide distribution includes South America, Europe, and New Zealand.

Parmelia omphalodes is distinguished from other species in the southern Appalachians producing angular maculentations by its lack of isidia and soredia. Like its isidiate morph, P. squarrosa, and sorediate morph P. sulcata it produces squarrosely branched rhizines. P. saxatilis, also present but not common, differs in having isidia and simple rhizines.

Specimens examined. North Carolina. Yancey Co.: Beauty Spot Forest 3199*.

7. Parmelia reddenda Stirt.

Parmelia reddenda Stirt., Scott. Nat. (Perth) 4: 298. 1877.

Thallus foliose, 3.5 cm in diameter, adnate, mineral green; branching irregular. Lobes rounded to sublinear, 2-5 mm wide; margins crenate. Lower surface black in the center, brown to tan at the margins, ridged; rhizines sparse, black with white tips, simple or moderately furcate. Upper surface thick and waxy, undulate, frequently splitting; pseudocyphellae conspicuous; lobulate pustules developing around pores, eroding into orbicular soralia; soredia granular. Cortex K+ yellow; medulla K-, C-, PD-.

Chemical composition, atranorin and fatty acids, determined by TLC.

Rare, one collection from hardwood at Beauty Spot Gap at ca. 4000 ft. elevation. This Appalachian endemic is reported to have "disjunct populations on at least three other continents" (Dey, 1979).

Parmelia reddenda is distinguished from other sorediate, pseudocyphellate species by its black lower surface and production of fatty acids. Its soredia are granular to subisidiate and produced in laminal and marginal soralia. One other species, Parmelia borreri combines the characters of pseudocyphellae, soredia, and a black lower surface, but is easily identified by its C+ rose gyrophoric acid. The widespread and abundant P. subrudecta differs in its tan lower cortex and C+ red lecanoric acid.

Specimens examined. Tennessee. Unicoi Co.: Beauty Spot Gap 1022*.

8. Parmelia rudecta Ach.

Parmelia rudecta Ach., Syn. Meth. Lich. 197. 1814.

Thallus foliose, 3.5-10 cm in diameter, adnate, mineral to blue-gray; branching dichotomous to irregular. Lobes linear to rounded (1-)1.5-6(-8) mm wide; margins entire to dissected and lobulate. Lower surface tan to whitish in the center, usually lighter (but occasionally gray-tan) at the margins, frequently with spots of yellow-orange pigment (K+ purple), shiny; rhizines sparse, evenly distributed or denser at the margins, to 3 mm long, brown to white with white frayed tips, or completely black, simple, branched or squarrosely branched. Upper surface thick and waxy, very shiny, often undulate, splitting; pseudocyphellae abundant; isidia abundant, often crowded and covering the entire surface, globose, coralloid, or lobulate, black-tipped, initiated around pseudocyphellae, wounded areas, and the margins. Pycnidia occasional, produced in pseudocyphellae; apothecia rare, laminal, to 5 mm in diameter; disc medium brown. Cortex K+ yellow; medulla K-, C+ red, PD-.

Chemical composition, atranorin and lecanoric acid, determined by TLC.

Abundant, collected on hardwoods, white pine, and rocks in all community types over the entire elevational range. This species is common throughout eastern North America and the southern Rocky Mountains, as well as Central and South America, Asia, Australia, and New Zealand (Dey, 1975).

Parmelia rudecta is easily recognized by its characteristic blue-gray color, pseudocyphellae, isidia, tan lower cortex, and production of lecanoric acid. Normally lacking apothecia, two collections from rock substrates on Unaka Mountain were fertile. Collections vary greatly in morphology from narrow, dichotomously branched lobes with a gray-brown lower surface and dark exerted rhizines, to broad irregular lobes with a whitish lower surface and short, blunt, white rhizines. This lichen is among the most common in the study area and occurs on all types of substrates.

P. rudecta is the isidiate morph in a complex which includes the sorediate morph P. subrudecta. They share a characteristic blue-gray color, waxy upper cortex, tan lower surface, pseudocyphellae, and production of lecanoric acid.

See the discussion of P. appalachensis for comparison to other non-sorediate species.

Specimens examined. North Carolina. Yancey Co.: Beauty Spot Forest 3211, 3212, 3213, 3214, 3215, 3216, 3217, 3218, 3219; Tennessee. Unicoi Co.: Beauty Spot 3208, 3209; Beauty Spot Gap 1027; Cherry Gap Trail 1352, 1353, 1354, 1355, 1356, 1357, 1358, 1359; Chestnut Knob 3210; Horseback Ridge 1261; North Beauty Spot 1183, 1188, 1204; Rock Creek Headwaters 3205, 3206, 3207; Rockslide 1103, 1137, 1158, 1087*; Stamping Ground Ridge 3221*, 3222; Summit 3218, 3219, 3220; Switchback 3204; White Pine Plantation 1563, 1573, 1606, 3200, 3201, 3202, 3203.

9. Parmelia squarrosa Hale

Parmelia squarrosa Hale, Phytologia 22: 29. 1971.

Thallus foliose, 2-6(-9) cm in diameter, loosely adnate, mineral gray to whitish; branching dichotomous. Lobes linear and narrow, 0.5-3.5 mm across; margin thickened, forming a rim. Lower surface black in the center, occasionally brown at the margins; rhizines abundant and dense, black, squarrosely branched, or sometimes mostly simple, frequently projecting beyond the margins. Upper surface thick, waxy; maculentations angular; isidia frequent, cylindrical, coralloid, or lobulate along margins, dark-tipped, produced along maculentations and splits in the cortex. Pycnidia occasional, black, submarginal on secondary lobes, erupting through the cortex; apothecia reported by Dey (1975), rare, to 2 mm in diameter; disc brown, rim isidiate. Cortex K+ yellow; medulla K+ yellow turning red, C-, PD+ orange.

Chemical composition, atranorin, salazinic acid, and consalazinic acid, determined by TLC.

Common, collected on rocks and trees in most community types over the entire elevational range. Hale (1971) noted that this species is common throughout the Great Lakes-Appalachian region and reported, but rare, on the West Coast. It is also known from Japan, Korea, and Nepal.

All specimens with squarrosely branched rhizines have been included in Parmelia squarrosa (after Dey, 1975). P. saxatilis, a closely related species, has simple rhizines and trace amounts of

lobaric acid and fatty acids. It shares the characteristic angular maculae, isidia, and salazinic and consalazinic acids of P. squarrosa. According to Dey (1975, 1978) P. saxatilis is restricted to high elevational areas in the southern Appalachians and is usually collected from rock or Abies.

Until 1971 all isidiate specimens with angular maculae were included under the name P. saxatilis. Hale erected this species, P. squarrosa, on the basis of its squarrosely branched rhizines. Since that time it has been documented that most individuals in the southern Appalachians should be referred to this new species, and that its distributional pattern is quite different from the cosmopolitan P. saxatilis.

Specimens examined. North Carolina. Yancey Co.: Beauty Spot Forest 3230, 3231, 3233, 3239; Tennessee. Unicoi Co.: Beauty Spot 3234; Cherry Gap Trail 1361, 1362, 1364, 3226; Horseback Ridge 1254*; North Beauty Spot 1211, 1195; Rockslide 1088, 1104, 1136, 1150; Stamping Ground Ridge 3235, 3236; Summit 3223, 3224, 3225; White Pine Plantation 1464, 1499, 1517, 1527, 1553, 1594, 3227, 3228, 3229.

10. Parmelia stictica (Duby) Nyl.

Parmelia stictica (Duby) Nyl., Bull. Soc. Linn. Normandie, ser. 2, 6: 270. 1872.

Parmelia borreri var. stictica Duby, Bot. Gallic. 2: 601. 1830.

Thallus foliose, 4-6 cm in diameter, adnate to closely adnate, light to grayish brown; branching subdichotomous to irregular. Lobes sublinear, 2-4 mm wide; margins crenate, slightly ascending. Lower surface black in the center, dark brown in a marginal zone; rhizines moderate, black to brown, simple. Upper surface shiny, slightly wrinkled to rugose in the center; pseudocyphellae abundant, conspicuous; soredia abundant, granular; soralia orbicular, developing around pseudocyphellae; apothecia not seen. Cortex K- yellow; medulla K-, C+ rose, KC+ rose, PD-.

Chemical composition atranorin and gyrophoric acid reported by Hale (1979).

Rare, collected only on hardwoods in the middle elevation deciduous forest along the Cherry Gap Trail at ca. 4000 ft. elevation. This species was not included in Dey's (1975) survey of high elevational areas. The disjunctive distribution of this species includes the southern Appalachians, Great Lakes, Central Rocky Mountains, and the West Coast.

Parmelia stictica is a brown Parmelia which produces atranorin. It also differs in producing gyrophoric acid and having conspicuous pseudocyphellae.

Specimen examined. Tennessee. Unicoi Co.: White Pine Plantation 1613*.

11. Parmelia subrudecta Nyl.

Parmelia subrudecta Nyl., Flora 69: 320. 1886.

Thallus foliose, 3-8 cm in diameter, adnate to loosely attached, mineral green to blue-gray; branching irregular. Lobes rounded, 3-10 mm wide; margins entire to crenate. Lower surface medium to light brown in the center, lighter at the margins; cortex infrequently exfoliating; rhizines sparse at the margins becoming dense in the center, white to brown, tips frayed and white, furcate. Upper surface thick and waxy, gently undulate, splitting along the margins; pseudocyphellae abundant. Soredia powdery; soralia orbicular, marginal and encircling pores. Pycnidia not common, black, spherical, embedded in the cortex, erupting when mature; apothecia reported by Dey (1975) as rare; to 3 mm in diameter; disc brown. Cortex K+ yellow; medulla K-, C+ red, KC+ red, PD-.

Chemical composition, atranorin and lecanoric acid, determined by TLC.

Widespread, collected on hardwoods in hardwood dominated communities and the white pine plantation at moderate elevations (up to ca. 4800 ft.). This species is reported from the Great Lakes, Appalachia, Rocky Mountains and West Coast region of North America, in addition to South America, Europe, and Australia.

Parmelia subrudecta is the sorediate morph of P. rudecta. Both have a tan lower surface, and lecanoric acid. However, in the Appalachians the isidiate morph, P. rudecta, is more common. Two closely related sorediate species are P. borreri with a black lower surface and C+ rose gyrophoric acid, and P. reddenda a rare species which has a tan lower surface, but produces only fatty acids which react C-.

Specimens examined. North Carolina. Yancey Co.: Beauty Spot Forest 3238, 3239; Tennessee. Unicoi Co.: Beauty Spot Gap 1028, 1029*; Cherry Gap Trail 1360; Stamping Ground Ridge 3240; White Pine Plantation 1492, 3237.

12. Parmelia sulcata Tayl.

Parmelia sulcata Tayl. in Mack., Flora Hibernica 2: 145. 1836.

Thallus foliose, 3-6 cm in diameter, loosely adnate, whitish to mineral gray; branching dichotomous. Lobes linear, 1-3(-5) mm wide, margins entire, swollen to form a rim. Lower surface black, occasionally dark brown at the margins, wrinkled; margins slightly inrolled; rhizines dense in the center, sparse at the margins, projecting beyond the margins, black, squarrosely branched. Upper surface thick and waxy, splitting along the margins, pruinose near the lobe tips, angularly maculate; soredia granular or erose, initially black-tipped, produced along the maculae and marginal splits. Apothecia rare, only immature apothecia seen. Cortex K+ yellow; medulla K+ yellow turning red, C-, PD+ orange.

Chemical composition, atranorin, salazinic acid, trace amounts of lobaric acid and unidentified substances, determined by TLC.

Widespread, collected on white pine, hardwoods, and decaying logs. In North America this boreal species extends southward along the mountain ranges, but is absent from the Great Basin and the Great Plains. It is also known from South America, Europe, Asia, and New Zealand.

Parmelia sulcata is the only species with both angular maculae and soredia. Like P. squarrosa, its rhizines are squarrosely branched. These two species are, respectively, the sorediate and isidiate morphs of the fertile, presumed parent, P. omphalodes.

Specimens examined. North Carolina. Yancey Co.: Beauty Spot Forest 3241, 3242; Tennessee. Unicoi Co.: Horseback Ridge 1239*; Rockslide 3244, 1105; Summit 3243; Switchback 3245, 3246; White Pine Plantation 1463, 1465, 1488, 1498, 1518, 1528, 1543, 1554, 1575, 1578, 1593, 1611.

## 24. Parmelina Hale

Key to the Species of Parmelina in the southern Appalachians

1. Thallus sorediate or isidiate. . . . . 2
1. Thallus neither sorediate or isidiate, occasionally pustulate. 7
   2. Thallus sorediate. . . . . .1. P. aurulenta (Tuck.) Hale
   2. Thallus isidiate . . . . . 3
3. Medulla yellow, galbinic acid present. .[P. obsessa (Ach.) Hale]
3. Medulla white, galbinic acid lacking . . . . . 4
   4. Isidia, in part, procumbant and lobulate . . . . . 5
   4. Isidia cylindrical . . . . . 6
5. Isidia with apical cilia; medulla C-, "horrescens" unknown present. . . . . 4. P. horrescens (Tayl.) Hale
5. Isidia lacking apical cilia; medulla C+ rose, gyrophoric acid present . . . . . .5. P. spathulata (Kurok.) Hale

6. Lobes subirregular to rotund; medulla K+ yellow turning red, norstictic acid and trace amounts of salazinic acid present . . . . . .[P. antillensis (Nyl.) Hale]

6. Lobes linear to subirregular, K-, C- rose, gyrophoric acid present . . . . . .2. P. dissecta (Nyl.) Hale

7. Thallus apotheciate; medulla yellow, galbinic acid present. . . . . 3. P. galbina (Ach.) Hale

7. Thallus pustulate; medulla white, galbinic acid absent . . . . . .6. P. spumosa (Asah.) Hale

1. Parmelina aurulenta (Tuck.) Hale

Parmelina aurulenta (Tuck.) Hale, Phytologia 28: 482. 1974.

Parmelia aurulenta Tuck., J. Am. Acad. Arts Sci. ser. 2, 25: 424. 1858.

Thallus foliose, 4-6(-10) cm in diameter, adnate, mineral gray to mineral green; branching subdichotomous to irregular. Lobes sublinear to irregular, 1-4 mm wide; margins entire to crenate; cilia sparse, more common in the lobe axils, black, to 1 mm long. Lower surface black in the center, light brown to cream-colored at the margin; rhizines abundant, black, simple or occasionally furcate. Medulla cottony, white, pale yellow when exposed in cracks or under pustules; pustules laminal to subapical, opening and coalescing into diffuse soralia; soredia corasely granular. Apothecia reported by Hale (1976a) as rare, 2-5 mm in diameter; rim sorediate-pustulate. Cortex K+ yellow; medulla K-, C-, PD-.

Chemical composition, atranorin, terpenes, and fatty acids determined by TLC, reported as zeorin, leucotylic acid, secalonic acid A, and related terpenes by Hale (1976a).

Not common, collected only on maples in hardwood dominated communities from 3500 to 4800 ft. Dey (1975) reported this species as rare in the high elevation areas above 5500 ft. but common at lower elevations in the deciduous forest. It occurs throughout eastern North America, as well as temperate and montane areas of Africa and Asia.

Parmelina aurulenta is the only sorediate species of Parmelina in the Southern Appalachians. Parmelina spumosa, reported for the mountainous regions, has dense, erupting but nonsorediate pustules, a faintly yellow medulla, and gyrophoric acid.

P. aurulenta most closely resembles the pustulate-sorediate species of Hypotrachyna which can be distinguished by the presence of dichotomously branched rhizines, absence of cilia, and distinctive chemistry. H. croceopustulata, with laminal pustules and a yellow-orange medullary pigment, produces protocetraric acid. H. formosana, present only at lower elevations in the southeast, lacks soredia and produces UV+ lichexanthone in the upper cortex, and the lividic acid complex in the medulla. H. pustulifera (Hale) Hale, morphologically similar to H. formosana, lacks lichexanthone, but produces atranorin and the lividic acid group. The widespread and abundant H. revoluta has diffuse soralia or pustules produced on revolute lobes and gyrophoric acid. See the discussion of H. revoluta for comparison to related species of Hypotrachyna.

Specimens examined. Tennessee. Unicoi Co.: Cherry Gap Trail 1365, 1366*, 1367, 1368, 3247; Rock Creek Headwaters 3248.

2. Parmelina dissecta (Nyl.) Hale

Parmelina dissecta (Nyl.) Hale, Phytologia 28: 482. 1974.

Parmelia dissecta Nyl., Flora 65: 451. 1882.

Thallus foliose, 3-7 cm in diameter, adnate, greenish mineral gray; branching irregular. Lobes sublinear to irregularly rounded, separate to continuous; margin entire to crenate, with a darker rim, cilia sparse. Lower surface black in the center, brown at the lobe apices; rhizines moderately abundant, black, simple or sparsely furcate. Upper cortex shiny, plane; isidia moderately dense, laminal, cylindrical, or occasionally coralloid, tips concolorous. Apothecia reported by Hale (1976a) as adnate, 1-4 mm in diameter; rim crenate and isidiate. Cortex K+ yellow; medulla K-, C+ pink, KC+ pink, PD-.

Chemical composition, atranorin, gyrophoric acid, trace amounts of the "horrescens unknown," and unknown substances, determined by TLC.

Frequently collected but not common; collected on rock, decaying logs, hardwoods, and white pine in most community types from 3500 to 4800 ft. elevation. This species is pantemperate and montane pantropical (Hale, 1976a). In North America it is found in the eastern United States.

Parmelina dissecta is characterized by its ciliate lobes, isidia lacking apical cilia, and production of gyrophoric acid. Recently the name Parmelia minarum Vain. has been used for this taxon (see Knox, 1982 and Krog and Swinscow, 1979). See the

discussion of Parmelina horrescens for comparison of P. dissecta to other isidiate, narrow-lobed species.

Specimens examined. Tennessee. Unicoi Co.: Cherry Gap Trail 1378, 1380, 1384; North Beauty Spot 3604; Roadcut 1007, 1008, 1009, 1054, 1056; Rockslide 1107, 3251; Stamping Ground Ridge 3252, 3253; White Pine Plantation 1466, 1504, 1506, 1508, 1533, 1584, 3249*, 3250.

3. Parmelina galbina (Ach.) Hale

Parmelina galbina (Ach.) Hale, Phytologia 28: 482. 1974.

Parmelia galbina Ach., Syn. Lich. 195. 1814.

Thallus foliose, 4-10 cm in diameter, closely adnate, yellowish to greenish mineral gray; branching irregular. Lobes short, sublinear, 1-2 mm wide, imbricate to confluent; cilia occasional, mostly in the axils, short to 0.5 mm long. Lower surface black in the center, brown in the marginal zone; rhizines numerous, black, simple. Upper surface shiny, occasionally pruinose, plane to rugose, somewhat convex; pycnidia numerous, submersed, black; apothecia abundant, to 6 mm in diameter; disc reddish brown; rim lacerate, inrolled. Medulla when exposed faint yellowish. Cortex K+ yellow; medulla K+ yellow, C- or C+ yellow, KC-, PD+ pale orange.

Chemical composition, atranorin, galbinic acid, zeorin, and unidentified substances determined by TLC.

Common, collected on hardwoods and white pine in a variety of forest types over a wide elevational range, 3500-5200 ft. Dey

(1975) reported this species as common on hardwoods at all elevations in the southern Appalachians. It occurs throughout eastern North America and Japan (Hale, 1976a).

Parmelina galbina is most readily confused with Hypotrachyna livida, which also is nonsorediate-isidiate. The latter differs in having dichotomously branched rhizines, lacking marginal cilia, and producing the lividic acid complex. More subtile characteristics of H. livida include its darker brown apothecial disc, lack of medullary pigment, and more robust, whiter lobes. P. galbina has a reddish brown apothecial disc, faint yellow pigmentation of the medulla, and rugose, somewhat convex lobes which are mineral green in color.

Specimens examined. North Carolina. Yancey Co.: Beauty Spot Forest 3256, 3257, 3258, 3259; Tennessee. Unicoi Co.: Cherry Gap Trail 1369, 3262; Horseback Ridge 1250; Summit 3263; Switchback 3260*, 3261; White Pine Plantation 1467, 1468, 1579, 1540, 1542, 1555, 1562.

4. Parmelina horrescens (Tayl.) Hale

Parmelina horrescens (Tayl.) Hale Phytologia 28: 482. 1974.

Parmelia horrescens Tayl., Flora Hibernica. 144. 1836.

Thallus foliose, 2-5 cm in diameter, closely adnate, greenish to whitish gray, or occasionally yellowish; branching subdichotomous. Lobes sublinear to irregularly rounded, 0.5-4 mm wide, crowded to imbricate; secondary lobes abundant, elongate; margins crenate to dissected; cilia sparse, black, present mainly in the

axils. Lower surface black in the center, brown in a narrow marginal zone; rhizines abundant, black, simple or sparsely furcate. Upper cortex shiny, plane, isidia dense, covering the laminal surface and abundant on the margins, narrow and cylindrical or procumbent and lobulate, dark-tipped, frequently short ciliate at apices; lobules frequent, laminal and marginal, occasionally isidiate. Apothecia reported by Hale (1976a) as rare, 2-4 mm in diameter; disc brown; rim isidiate. Cortex K+ yellow; medulla K-, C-, KC pink or KC-, PD-.

Chemical composition, atranorin, "horrescens unknown," trace amounts of gyrophoric acid, and unidentified substances, determined by TLC.

Very common, collected on rock pines, white pine, hardwoods, and spruce in all community types over the entire elevational range. It is also common at elevations above 5500 ft. (Dey, 1975). This species has a pantemperate and montane pantropical distribution (Hale, 1976a). In North America it is found throughout the eastern United States and southernmost eastern Canada.

Parmelina horrescens is characterized by its dense isidia with short apical cilia which may be either cylindrical or lobulate. Parmelina dissecta, reported as uncommon at elevations above 5500 ft. by Dey (1975), differs in having only cylindrical, eciliate isidia, large amounts of gyrophoric acid, and a medulla tinged yellow-pink.

Three species of Hypotrachyna also produce lobules in addition to isidia. H. prolongata produces C+ anziaic acid and eciliate, marginal isidia and lobules. H. ensifolia, reported by Dey (1975) as very rare and known only at lower elevations in the southern Appalachians, has laminal and marginal lobules and lobulate isidia and KC+ pink alectoronic acid. Hypotrachyna imbricatula with KC+ orange barbatic acid, has laminal isidia and occasional lobules. All of these species differ from Parmelina horrescens by the presence of dichotomously branched rhizines and absence of marginal cilia.

Specimens examined. Tennessee. Unicoi Co.: Cherry Gap Trail 1370, 1383; Horseback Ridge 1240; Indian Grave Gap 3271; Roadcut 1055; Rockslide 1141; Stamping Ground Ridge 3264, 3265, 3266, 3267; Summit 3268; White Pine Plantation 1469, 1495, 1521, 1530, 1550, 1583, 1585, 1590, 1596*, 1621, 3269, 3270.

5. Parmelina cf. spathulata (Kurok.) Hale

Parmelina spathulata (Kurok.) Hale, Phytologia 28: 483. 1974.

Parmelia spathulata Kurok. in Hale and Kurok., Contrib. U.S. Natl. Herb. 36: 133. 1964.

Thallus foliose, 2-5 cm in diameter, adnate, mineral green; branching irregular. Lobes sublinear, 1-3 mm wide, continuous to crowded; margins entire to dissected and lobulate; cilia sparse 0.5 mm long. Lower surface black; rhizines moderately abundant, black,

simple or sparsely furcate. Upper surface shiny, emaculate, fragile; isidia sparse cylindrical and erect; lobules abundant, dorsiventrally flattened procumbent and often branched, frequently horizontal on the lobe surface, laminal or marginal; apothecia not seen. Cortex K+ yellow; medulla K-, C+ rose, KC+ red, PD-.

Chemical composition, atranorin and gyrophoric acid determined by TLC and reported by Hale (1976a).

Very rare, collected on hardwoods and white pine in the white pine plantation at ca. 4200 ft. elevation. This species is presently reported only in South Africa (Hale, 1976a).

Parmelina spathulata differs from P. horrescens in having eciliate isidia and lobules, and in producing only atranorin and gyrophoric acid. These specimens exhibit these characteristics and need to be examined for range extension of this species.

Specimen examined. Tennessee. Unicoi Co.: White Pine Plantation 3276*, 3425.

6. Parmelina spumosa (Asah.) Hale

Parmelina spumosa (Asah.) Hale, Phytologia 28: 483. 1974.

Parmelia spumosa Asah., J. Jpn. Bot. 26: 259. 1951.

Thallus foliose, 2-6 cm in diameter, closely adnate, whitish gray; branching irregular. Lobes sublinear, 0.5-2 mm wide, continuous; margins entire to crenate; cilia sparse, 0.5 mm long, simple. Lower surface black in the center, brown at the apices; rhizines moderately dense, black, simple or furcate. Upper surface

smooth, somewhat dull; pustules dense, inflated, eroding apically, esorediate, usually submarginal; apothecia reported by Hale (1976a) as rare, 1-3 mm in diameter; rim pustulate. Medulla faintly yellow. Cortex K+ yellow; medulla K-, C- rose, KC+ red, PD-.

Chemical composition, atranorin, gyrophoric acid, unidentified pigment, and unidentified compound determined by TLC.

Rare, collected on hardwoods and ericaceous shrubs in the heath gardens and in the white pine plantation between 4500 and 4800 ft. elevations. This species was not included in Dey's (1975) treatment. Its distribution in North America remains obscure. Hale (1976a) reported this species as pantropical at higher elevations.

Parmelina spumosa appears to be distinct from Hypotrachyna revoluta because of its simple, or sparsely furcate, rhizines has a whiter, fragile cortex which often erodes marginally exposing a darkened medulla.

This species was not recognized by Dey (1975, 1981) but represents a distinct morphology. Re-examination of H. revoluta and this species is needed to clarify its taxonomic position.

Specimens examined. Tennessee. Unicoi Co.: Stamping Ground Ridge 3274, 3275; White Pine Plantation 1458, 1531, 1586, 3272, 3273*.

## 25. Parmeliopsis (Stizenb.) Nyl.

Key to the Species of Parmeliopsis in the southern Appalachians

1. Thallus yellow-green, sorediate; divaricatic and usnic acids present. . . . . .[P. halei (Tuck.) Hale]

1. Thallus mineral gray, not sorediate; thamnolic acid present. . . . . 2

   2. Thallus isidiate . . . . . 1. P. aleurites (Ach.) Nyl.

   2. Thallus not isidiate, usually apotheciate . . . . . .2. P. placorodia (Ach.) Nyl.

1. Parmeliopsis aleurites (Ach.) Nyl.

Parmeliopsis aleurites (Ach.) Nyl., Syn. Lich. 2: 53. 1863.

Lichen aleurites Ach., Lich. Suec. Prodr. 117. 1798.

Thallus foliose, 1-5(-7) cm in diameter, adnate to loosely adnate at the lobe tips, mineral green to whitish gray, branching subdichotomous. Lobes irregularly elongate, 0.5-2 mm wide, margin entire to dissected by secondary lobes. Lower surface white to buff, mottled; rhizines sparse, brown with white frayed tips, furcately branched, submarginal, arising from vein-like ridges. Upper surface shiny but irregular; isidia thin cylindrical to coralloid, brown-tipped, laminal and marginal on older lobes, marginal on tips of secondary lobes; pycnidia occasional, dark brown, marginal on secondary lobes; apothecia not seen, reported by Hale (1979) as very rare. Cortex K+ yellow; medulla K+ immediately deep yellow, C-, P+ yellow-orange or orange-red.

Chemical composition, atranorin, thamnolic acid, decarboxy-thamnolic acid, and unidentified substances, determined by TLC.

Frequent, collected on pines, maple, spruce, and decaying log in spruce and heath bald communities above 4700 ft. While not collected at lower elevations Dey (1975) reported this species as

common in that zone. This boreal species extends southward along the mountain chains in North America. It is also known from Europe and Australia.

Parmeliopsis aleurites is quickly recognized by its immediate K+ deep yellow reaction, light mottled, lower surface, and production of isidia. Other species of Parmeliopsis in the southern Appalachians include P. placorodia which lacks isidia and frequently bears apothecia, and P. halei which is sorediate, yellow-green, and lacks thamnolic acid.

Superficially, this species may be confused with Pseudevernia species which are characterized by a canaliculate, mottled lower surfaces and K-, C+ red, lecanoric acid. Heterodermia species differ in having marginal rhizines and usually lacking a lower cortex.

Specimens examined. Tennessee. Unicoi Co.: Horseback Ridge 1259, 1271, 1320; Rockslide Area 1083*; Stamping Ground Ridge 3277, 3278; Summit 3279.

2. Parmeliopsis placorodia (Ach.) Nyl.

Parmeliopsis placorodia (Ach.) Nyl., Syn. Meth. Lich. 2: 55. 1863.

Parmelia placorodia Ach., Syn. Meth. Lich. 196. 1814.

Thallus foliose, 1(-2-4) cm in diameter, adnate, mineral green; branching irregular. Lobes irregularly rounded, 0.5-1.5 mm broad, margins dissected. Lower surface medium brown to whitish,

irregular; rhizines moderately abundant, brown with white tips, simple or furcate, arising from vein-like ridges. Upper surface shiny, faintly undulate; pycnidia abundant, dark brown, immersed; apothecia abundant, deep, 1-3 mm in diameter, laminal; disc yellowish to buff-colored; rim irregularly cracked. Cortex K+ yellow; medulla K+ immediately deep yellow, C-, PD+ yellow.

Chemical composition, atranorin, thamnolic acid, and unidentified substances, determined by TLC.

Rare, one collection from a fallen twig in heath bald at ca. 4700 ft. This species may be locally more abundant at low elevations. In North America this species occurs in the Appalachian-Great Lakes region and the Southwest.

Parmeliopsis placorodia is distinguished by production of K+ keep yellow, thamnolic acid and apothecia. Parmeliopsis aleurites differs in having isidia and narrow-elongate lobes.

In the field this taxon may be confused with Parmelina galbina but is easily separated by its light brown to white lower surface.

Specimens examined. Tennessee. Unicoi Co.: Horseback Ridge 1270*.

## 26. Parmotrema Mass.

Key to the Species of Parmotrema in the southern Appalachians

1. Thallus sorediate or isidiate, rarely apotheciate. . . . . 2
1. Thallus not sorediate or isidiate, frequently apotheciate. . .20

2. Thallus sorediate. . . . . 3

2. Thallus isidiate . . . . . .14

3. Upper surface reticulately cracked . . . . . 4

3. Upper surface not reticulately cracked . . . . . 8

4. Medulla K+ yellow turning red, salazinic acid present. . . . . 5

4. Medulla K-, salazinic acid absent. . . . . 6

5. Soredia powdery to granular. . . 5. *P. reticulatum* (Tayl.) Choisy

5. Soredia isidiate in part . .7. *P. subisidiosum* (Müll. Arg.) Hale

6. Upper cortex UV+ brilliant yellow, lichexanthone and diffractaic acids present. . [*P. diffractaicum* (Essl.) Hale]

6. Upper cortex UV-, lichexanthone and diffractaic acids absent . . . . . 7

7. Medulla KC+ pink, norlobaridone present . . . . . .[*P. commensuratum* (Hale) Hale]

7. Medulla KC-, caperatic acid present. . [*P. simulans* (Hale) Hale]

8. Lower surface white or mottled in a broad marginal zone. . 9

8. Lower surface brown to dark brown in the marginal zone . .10

9. Marginal zone white; margins usually ascending to suberect; medulla K+ yellow turning red, PD+ red, norstictic and stictic acid present . . . . . .3. *P. hypotropum* (Nyl.) Hale

9. Marginal zone mottled tan, brown, and white; margins not ascending; medulla K-, PD+ red, protocetraric acid present. . . . . .[*P. robustum* (Degel.) Hale]

10. Medulla K+ yellow or yellow turning red, stictic or salazinic acid present . . . . . .11

10. Medulla K-, alectoronic acid present . . . . . .13

11. Medulla K+ yellow, stictic acid present . . . . . 4. *P. perlatum* (Huds.) Choisy

11. Medulla K+ yellow turning red, salazinic acid present. . . . .12

12. Soralia linear and marginal; lobes suberect and broadly rounded, 10-12 mm wide . . . . 6. P. stuppeum (Tayl.) Hale

12. Soralia submarginal, linear to orbicular; lobes revolute, 8-10 mm wide . . . . . .[P. margaritatum (Hue) Hale]

13. Soredia isidiose, marginal or submarginal . . . . . [P. mellissii (Dodge) Hale]

13. Soredia farinose, submarginal on dissected lobes . . . . . 1. P. arnoldii (DR.) Hale

14. Lower surface brown. . . . . .15

14. Lower surface black. . . . . .16

15. Norlobaridone, with or without salazinic acid, present . . . . . [P. subtinctorium (Zahlbr.) Hale]

15. Salazinic acid present. . . . . [P. neotropicum Kurok.]

16. Lobe margins lacking cilia, lecanoric acid present. . . . . 8. P. tinctorum (Nyl.) Hale

16. Lobe margins with cilia, lecanoric acid absent . . . . .17

17. Isidia sorediate. . . . . .18

17. Isidia not sorediate, cylindrical or coralloid. . . . . .19

18. Medulla K-, alectoronic acid present; upper surface without reticulate cracking. . [P. mellissii (Dodge) Hale]

18. Medulla K+ yellow turning red, salazinic acid present; upper surface with reticulate crackings . . . . . .7. P. subisidiosum (Müll. Arg.) Hale

19. Isidia cylindrical, lacking apical cilia; upper surface UV+ brilliant yellow; medulla K+ yellow turning red, lichexanthone and salazinic acids present . . . . . .[P. ultralucens (Krog) Hale]

19. Isidia coralloid and cylindrical with apical cilia; upper surface UV-, medulla K+ yellow, atranorin and stictic acid present . . . . . .2. P. crinitum (Ach.) Choisy

20. Lower surface with a bare white marginal zone; norstictic and connorstictic acid present . . . . . [P. perforatum (Jacq.) Mass.]

20. Lower surface with a brown marginal zone; salazinic acid or protocetraric acids present . . . . . .21

21. Medulla K-, PD+ orange, protocetraric acid present . . . . . .[P. michauxianum (Zahlbr.) Hale]

21. Medulla K+ yellow turning red, PD+ orange-red, salazinic acid present . . . . . .22

22. Upper surface reticulately cracked to the margins . . . . . [P. cetratum (Ach.) Hale]

22. Upper surface reticulately cracked only in the center of older lobes. . . . . [P. eurysacum (Hue) Hale]

1. Parmotrema arnoldii (DR.) Hale

Parmotrema arnoldii (DR.) Hale, Phytologia 28: 339. 1974.

Parmelia arnoldii DR., Nytt. Mag. Naturvidensk. 62: 80. 1924.

Thallus foliose, 5(-8-20) cm in diameter, loosely adnate, whitish mineral gray; branching irregular. Lobes broadly rounded to irregular, 4-10(-15) mm wide; margins entire to dissected; cilia common, 1-2.5 cm long, black. Lower surface black and rhizinate in the center, brown and bare in a broad zone at the margins; rhizines common to sparse, black, simple or furcate. Upper surface shiny, faintly maculate, plane to faintly wrinkled; soredia granular; soralia submarginal, subcapitate on short revolute lobes. Apothecia reported by Hale (1965) as rare, but not discribed. Cortex K+ yellow; medulla K-, C-, KC+ red, PD-.

Chemical composition, atranorin and alectoronic acid, determined by TLC.

Not common, one collection from hardwood in northern red oak-hickory forest at Breauty Spot, elevation 4200 ft. Dey (1975) reported this species as common at elevations above 5500 ft., while

less common at lower elevations in the southern Appalachians. This temperate species occurs in the Great Lakes-Appalachian region and the West Coast of North America, South America, Europe, Africa, Asia, and New Zealand (Dey, 1975).

Parmotrema arnoldii is the only species with submarginal soralia on short revolute lobes and alectoronic acid. P. margaritata shares its morphology and differs only in producing salazinic acid which has a K+, yellow turning red, reaction. Other sorediate Parmotremas in the southern Appalachians with a PD- reaction have distinctive morphologies. P. commensurata (norlobaridone) and P. simulans (caperatic acid) both have reticulate cracks on their upper surfaces. P. diffractaicum can be distinguished from P. arnoldii by its reticulate cracking in the center of the thallus, occasionally branched cilia, and diffractaic acid. The presence of isidia mixed with the soredia separates P. mellisii which also produces alectoronic acid.

See Parmotrema reticulatum for discussion of PD+ species.

Specimen examined. Tennessee. Unicoi Co.: North Beauty Spot 1212*.

2. Parmotrema crinitum (Ach.) Choisy

Parmotrema crinitum (Ach.) Choisy, Bull. Mens. Soc. Linn. Lyon 21: 175. 1952.

Parmelia crinita Ach., Syn. Meth. Lich. 196. 1814.

Thallus foliose, 5-20 cm in diameter, loosely adnate, greenish to whitish mineral gray; branching irregular. Lobes round to

irregular, 5-15 mm wide; margins dissected to lobulate; cilia abundant, 1-2 mm long. Lower surface black in the center, brown along a narrow, bare marginal zone; rhizines moderately abundant to dense, black, simple or sparsely furcate. Upper surface shiny, maculate, faintly wrinkled to rugose, reticulately cracked on older lobes; isidia abundant to crowded, laminal and marginal, cylindrical, becoming procumbent or lobulate, apically ciliate and dark-tipped, appearing sorediate when eroded. Apothecia reported by Hale (1965) as rare, 3-8 mm in diameter; disc imperforate; rim isidiate. Cortex K+ yellow; medulla K+ yellow, C-, PD+ orange.

Chemical composition, atranorin, stictic acid, and constictic acid determined by TLC; trace amounts of norstictic acid and trace amounts of unidentified substances reported by Dey (1975).

Common, collected on white pine, hardwoods, and rock in all community types over the entire elevational range. In Dey's (1975) survey this lichen was common at all elevations in the southern Appalachians. This cosmopolitan species occurs in eastern North America and the Pacific Northwest, as well as Latin and South America, Europe, Africa, Asia, and Australia.

Parmotrema crinitum is the only isidiate species which produces stictic acid. Its isidia are characteristically branched or lobulate with apical cilia. In the southern Appalachians P. haitensis (Hale) Hale and P. subtinctorum with brown lower surfaces and norlobaridone, may be confused with P. crinitum. Discrete taxonomic differences among these two species remain unclear.

P. mellissii differs in production of sorediate isidia and alectoronic acid which reacts K- and PD-. P. subisidiosa also has sorediose isidia, but produces salazinic acid and reticulate crackings similar to P. reticulatum. P. crinitum may also be confused with a broader, flatter species, P. ultralucens (Krog.) Hale, which produces lichexanthone and salazinic acid.

Specimens examined. North Carolina. Yancey Co.: Beauty Spot Forest 3288, 3289, 3290; Tennessee. Unicoi Co.: Beauty Spot 3285, 3266, 3299; Cherry Gap Trail 1371*, 1372, 1374; Horseback Ridge 3280; Indian Grave Gap 3284; Rock Creek Headwaters 3294; Rockslide 1146, 1155, 3283; Stamping Ground Ridge 3287, 3297, 3298; Summit 3295, 3296; Switchback 3281, 3282; White Pine Plantation 1471, 1472, 1478, 1482, 1523, 1552, 1565, 3291, 3292, 3293.

3. Parmotrema hypotropum (Nyl.) Hale

Parmotrema hypotropum (Nyl.) Hale, Phytologia 28: 338. 1974.

Parmelia hypotropa Nyl., Syn. Lich. 379. 1860.

Thallus foliose, 6-10(-12) cm in diameter, loosely adnate, 8-12 cm in diameter, light greenish mineral gray; branching irregular. Lobes broad, 10-15 mm wide; margins crenate, ascending; cilia frequent, 1-3 mm long, black, simple. Lower surface black in the center, white or tan in a broad (1 cm) marginal zone, rugose in the center; cortex exfoliating; rhizines sparse, black, simple or furcate. Upper surface plane to strongly rugose and wrinkled, maculate; soredia abundant, powdery; soralia linear, marginal;

apothecia reported by Hale (1965) as extremely rare, to 4 mm in diameter; disc perforate. Cortex K+ yellow; medulla K+ yellow turning red, C-, KC-, PD+ orange-red.

Chemical composition, atranorin, norstictic acid, and stictic acid determined by TLC.

Rare, one collection from oak in the middle elevational forest at ca. 4300 ft. elevation. This species was not reported at elevations above 5500 ft. in the southern Appalachians (Dey, 1975). In North America this species occurs throughout the eastern United States and is reported from southern California and Mexico. Its worldwide distribution includes the Mediterranean region and one locality in Taiwan (Hale, 1965).

Parmotrema hypotropum is characterized by broad lobes with marginal soredia and cilia, with a broad white marginal zone on the lower surface. It is the sorediate morph of P. perforatum which is usually fertile and frequently collected in the coastal regions of the southeastern United States.

When the lobes are rugose and ascending the species can be confused with Platismatia tuckermanii, especially when the black lower cortex is exfoliated revealing more and more mottled white and tan. These species can be easily separated by the K+ yellow turning red reaction of P. hypotropum.

Specimen examined. Tennessee. Unicoi Co.: Cherry Gap Trail 1373*.

4. Parmotrema perlatum (Huds.) Choisy

Parmotrema perlatum (Huds.) Choisy, Bull. Mens. Soc. Linn. Lyon 21: 174. 1952.

Lichen perlatus Huds., Flora Angl. 448. 1762.

Thallus foliose, 5-15 cm in diameter, loosely adnate, whitish mineral gray; branching irregular. Lobes rounded to irregular, 4-10 mm wide, overlapping and crowded; margins entire to somewhat dissected and revolute; cilia sparse, 0.3-2.0 mm long. Lower surface black in the center, brown on the bare marginal zone; rhizines dense, to 1 mm long, simple or sparsely furcate; lower cortex exfoliating to expose the white medulla. Upper surface shiny, faintly maculate; weakly wrinkled to rugose in the center of the thallus. Soredia powdery; soralia capitate, submarginal on revolute lobes. Apothecia reported by Hale (1965) as very rare, 3-5 mm in diameter; disc imperforate. Cortex K+ yellow; medulla K+ yellow, C-, PD+ orange.

Chemical composition, atranorin, stictic acid, constictic acid, trace amount of norstictic acid, and unidentified substances, determined by TLC.

Common, collected on rock and wood substrates in various communities above 4000 ft. elevation. Dey (1975) reported this species as common at all elevations in the southern Appalachians. This widespread species is found in the Great Lakes-Appalachian region and along the West Coast of North America, Latin and South America, Europe, Africa, Asia, Australia, and New Zealand.

Parmotrema perlatum can be identified by its submarginal soralia produced on revolute lobes and stictic acid. Because of its chemistry and narrow, shiny, often rugose naked zone on the lower surface, it is considered a close relative of the isidiate P. crinitum. Only two other sorediate K+, P+ species occur in the area. P. stuppeum has linear marginal soralia on nonrevolute lobes and produces salazinic acid. Sharing the salazinic acid chemistry, P. margaritata has submarginal orbicular soralia on short, marginal laciniae which are frequently revolute. Morphologically P. margaritata is identical to P. arnoldii which has soralia considerably larger than P. perlatum and alectoronic acid.

Specimens examined. Tennessee. Unicoi Co.: Beauty Spot 3301; Rockslide Area 1121, 1126, 1159, 1161, 1170; Stamping Ground Ridge 3300; White Pine Plantation 1479, 1557, 1572, 1473, 1507*, 1619, 3302, 3303, 3304.

5. Parmotrema reticulatum (Tayl.) Choisy

Parmotrema reticulatum (Tayl.) Choisy, Bull. Mens. Soc. Linn. Lyon, XXI: 175. 1952.

Parmelia reticulata Tayl. in Mack., Flora Hibernica 2: 148. 1836.

Thallus foliose, 5-10 cm in diameter, loosely adnate to adnate, greenish to whitish mineral gray; branching irregular. Lobes rounded to irregular, 3-15 mm across; margins with a narrow brown border, angular to lacerate; cilia abundant, black, simple.

Lower surface black in the center, dark brown in a rhizinate marginal zone; rhizines dense, black, simple or sparsely squarrosely branched. Upper surface strongly maculate, reticulately cracked, rugose and fissured with age. Soredia powdery to granular; soralia variable, subcapitate and terminal, or eroded and submarginal. Apothecia reported by Dey (1975) as not common, to 4.5 mm in diameter; disc brown; rim sorediate. Cortex K+ yellow; medulla K+ yellow turning red, C-, PD+ orange.

Chemical composition atranorin, salazinic acid, consalazinic acid, and trace amounts of lobaric acid, determined by TLC.

Very common, collected on hardwoods, white pine, and rock in most hardwood dominated forest, shrub communities, and rockslides over a wide elevational range 3500-5000 ft., not found in spruce dominated communities. Dey (1975) noted that this species is widespread in deciduous forest and occurs in North and South America, Europe, Africa, Asia, and Australia. In North America it is common in the eastern and southwestern United States.

Production of soredia, reticulate cracking, and salazinic acid identify Parmotrema reticulatum. Only two sorediate species of Parmotrema have the same chemistry, P. stuppeum and P. margaritatum, but both lack reticulate fissures.

P. reticulatum is the sorediate morph in a complex which includes the fertile morph P. cetratum, and the isidiate morph P. subisidiosum. All three share the production of salazinic acid, reticulate cracking, squarrosely branched rhizines, and a lower

surface rhizinate or papillate to the margin. This complex comprises the section Irregulares (Vain.) Vain. in the collective genus Parmelia.

Specimens examined. Tennessee. Unicoi Co.: Beauty Spot 3311; Cherry Gap Trail 1363, 1404; Horseback Ridge 1313, 3312; North Beauty Spot 1175, 1202, 1213, 1220; Rockslide Area 1151; Switchback 3305; White Pine Plantation 1474, 1480, 1501, 1529, 1544, 1556*, 1559, 1568, 3306, 3307, 3308, 3309, 3310.

6. Parmotrema stuppeum (Tayl.) Hale

Parmotrema stuppeum (Tayl.) Hale, Phytologia 28: 339. 1974.

Parmelia stuppea Tayl., Lond. J. Bot. 6: 175. 1847.

Thallus foliose, 8(-10-20) cm in diameter, loosely adnate to suberect at margins, greenish mineral gray; branching irregular. Lobes short-rounded, 4-7(-10-15) mm wide; margins entire to crenulate; lobe tips ascending and overlapping to crowded; cilia sparse, 2-3 mm long, black. Lower surface black in the center, brown in a bare marginal zone; rhizines dense, black, simple or furcate. Upper surface faintly maculate, plane to faintly wrinkled, cracked with age. Soredia somewhat powdery; soralia linear, marginal and apical. Apothecia reported by Dey (1975); very large, 10-30 mm in diameter; disc usually perforate. Cortex K+ yellow; medulla K+ yellow turning red, C-, PD+ orange.

Chemical composition, atranorin, salazinic acid and consalazinic acid, determined by TLC.

Not common, one collection from hardwood in red oak-hickory forest at Beauty Spot, elevation ca. 4200 ft. Dey (1975) noted that this species is widespread, but not common at elevations above 5500 ft. in the southern Appalachians. Hale (1965) gave the distribution as common in the mountains of North America, Central America, and Europe, and more rarely in southern Africa and India.

Parmotrema stuppeum is the only K+, PD+ species producing linear, marginal soralia on non-revolute, ascending lobes. See the discussion of P. perlatum for comparison to other PD+ sorediate species.

Specimens examined. Tennessee. Unicoi Co.: North Beauty Spot 1214*; Switchback 3313.

7. Parmotrema subisidiosum (Müll. Arg.) Hale

Parmotrema subisidiosum (Müll. Arg.) Hale, Phytologia 28: 339. 1974.

Parmelia cetrata var. subisidiosa Müll. Arg., Bot. Jahrb. Engler 20: 256. 1894.

Thallus foliose, 5-10 cm in diameter, loosely adnate, greenish mineral gray; branching irregular. Lobes rounded to irregular, 4-10 mm wide, ascending and overlapping; margins crenate to lacerate; cilia sparse, to 2 mm long, black, simple. Lower surface black in the center, dark brown in the marginal zone; rhizines dense throughout, black, simple or sparsely branched. Upper surface shiny, faintly maculate, wrinkled to faintly

reticulately cracked in older portions; isidia abundant along the cracks and margins, globular to short-cylindrical, black-tipped, occasionally apically ciliate; pustulate initially, eroding and exposing the medulla and becoming sorediate. Apothecia not seen or reported. Cortex K+ yellow; medulla K+ yellow turning red, C-, PD+ orange.

Chemical composition, atranorin, salazinic acid, consalazinic acid, and unidentified substances, determined by TLC.

Not common, collected on rock, soil, and fire cherry in high elevation deciduous and shrub communities above 4600 ft. elevation. Dey (1975) noted that this species is widespread but not common above 5500 ft., and common at lower elevations in deciduous forest. In North America it is found in the southeastern United States and along the east coast of Mexico. Elsewhere, it occurs in South America and Africa.

Parmotrema subisidiosum is identified by its sorediose isidia, reticulate crackings, and production of salazinic acid. It differs from P. reticulatum only in the production of isidia mixed with the soredia. P. commensuratum also has the reticulate crackings and soredia, but produces norlobaridone. One other species P. mellissii is characterized by sorediose isidia but has alectoronic acid and lacks the reticulate cracking. See the discussion of P. crinitum for comparison to other isidiate species.

Specimens examined. Tennessee. Unicoi Co.: Horseback Ridge 1226, 1235, 1285, 1296, 1304; Rock Creek Headwaters 3314; Rockslide Area 1086*.

8. Parmotrema tinctorum (Nyl.) Hale

Parmotrema tinctorum (Nyl.) Hale, Phytologia. 28: 339. 1974.

Parmelia tinctorum Nyl., Flora. 55: 547. 1872.

Thallus foliose, 4(-8-20) cm in diameter, loosely adnate, mineral gray; branching irregular. Lobes rounded to irregular, 10-15 mm wide; margins entire to crenate, ascending, eciliate. Lower surface black in the center, tan in a broad, bare marginal zone; rhizines sparse, black, simple or sparsely furcate. Upper surface dull, faintly wrinkled; isidia sparse, short granular to cylindrical, dark-tipped, laminal. Apothecia reported by Hale (1965) as very rare, to 20 mm in diameter; disc imperforate; rim isidiate-dentate. Cortex K+ yellow; medulla K-, C+ red, KC+ red, PD-.

Chemical composition, atranorin and lecanoric acid, determined by TLC.

Not common, one collection from rock at a road-cut at ca. 4800 ft. elevation. This pantropical species is common in the southeastern United States on trees and rocks, but is absent at high elevations in the southern Appalachians (Dey, 1975). Hale (1965) reported it from Latin and South America, Africa, Asia, Pacific Islands, and Australia.

Parmotrema tinctorum is the only Parmotrema species in the southern Appalachians producing lecanoric acid. It is easily recognized by its granular isidia and lack of marginal cilia.

Specimen examined. Tennessee. Unicoi Co.: Roadcut 1053*.

## 27. Platismatia Culb. & Culb.

Key to the Species of Platismatia in the southern Appalachians

1. Thallus sorediate. . . . . [P. glauca (L.) W. Culb. & C. Culb.]

1. Thallus not sorediate, usually apotheciate . . . . . .1. P. tuckermanii (Oakes) W. Culb. & C. Culb.

1. Platismatia tuckermanii (Oakes) Culb. & Culb.

Platismatia tuckermanii (Oakes) Culb. & Culb., Contrib. U.S. Natl. Herb. 34: 549. 1968.

Cetraria tuckermanii Oakes in Tuck., Am. Sci. Arts 45: 48. 1843.

Thallus foliose, 3-8(-12) cm in diameter, loosely adnate to suberect, whitish to greenish mineral gray; branching irregular. Lobes broadly rounded, 4-6(-20) mm wide; margin entire to dissected and lacerate; cilia sparse. Lower surface black and dark brown near the center, mottled with brown, tan, and white near the margins, shiny, pitted and ridged; rhizines sparse, black to tan, white-tipped, furcate to coralloid. Upper surface maculate, irregularly or reticulately pitted; pycnidia abundant, black, immersed, marginal to submarginal; apothecia frequent, marginal or submarginal 0.5-1.5 (-10) mm in diameter, immersed, deep and little expanded; disc reddish brown; rim dissected, pycnidiate. Cortex K+ yellow; medulla K-, C-, KC-, PD-.

Chemical composition, atranorin and caperatic acid, determined by TLC.

Common, collected on white pine, fire cherry, maple, spruce, pitch pine branches, and frequently along trailsides on twigs or exfoliated bark, in white pine plantation, deciduous forest, spruce forest, and heath balds at elevations above 4000 ft. It is also common at all elevations in the southern Appalachians (Dey, 1975). This North American endemic occurs in the Appalachian-Great Lakes region, particularly in conifer-dominated forest.

Platismatia tuckermanii is one of the few broad lobed lichens with a mottled lower surface. It can be conclusively identified by its reticulately pitted surface, immersed, marginal apothecia and pycnidia, and production of caperatic acid. Superficially it may resemble the Cetraria ciliaris group which differs in having a smooth, shiny surface, a darker green to olive color, a uniformly tan to white lower surface, and exserted barrel-shaped, marginal pycnidia and apothecia. Members of this complex may be distinguished from Platismatic tuckermanii by their chemistry. Cetraria ciliaris has C+ red olivetoric acid, C. halei has UV+ alectoronic acid, and C. orbata (Tuck.) Nyl produces fatty acids. Frequently the lower surface of Parmotrema hypotropum appears mottled when the cortex exfoliates along the margin. This species which is rare at high elevations, has linear, marginal soralia and a K+ yellow turning red reaction due to the presence of norstictic acid.

One other species of Platismatia may be collected at high elevations in the southern Appalachians. Platismatic glauca has marginal soredia and occasionally produces isidia.

Specimens examined. Tennessee. Unicoi Co.: Beauty Spot 3358*, Chestnut Knob 3360; Horseback Ridge 1267, 1291; Rock Creek Headwaters 3356; Rockslide Area 1081, 1516; Summit 3357; White Pine Plantation 1624, 3359.

## 28. Pseudoparmelia Lynge

Key to the Species of Pseudoparmelia in the southern Appalachians

1. Thallus yellow-green; usnic acid present . . . . . 2
1. Thallus mineral green; atranorin present . . . . . 3
    2. Soredia present, pustulate or diffuse and erose; pustules when present opening apically to form soralia . . . . . .2. P. caperata (L.) Hale
    2. Soredia absent; pustules isidioid or granular, opening apically to form pits . . . . . 1. P. baltimorensis (Gyel. & For.) Hale
3. Thallus isidiate; medulla PD-, perlatolic acid present. . . . . .[P. caroliniana (Nyl.) Hale]
3. Thallus sorediate; medulla PD+ red or orange . . . . . 4
    4. Lobes weakly reticulately ridged; soredia present along the ridges; medulla K+ yellow, stictic acid present. . . . . [P. crozalsiana (Lesd.) Hale]
    4. Lobes not reticulately ridge; soredia in capitate, laminal soralia; medulla K-, protocetraric acid present . . . . . .[P. alabamensis (Hale & McCull.) Hale]

1. Pseudoparmelia baltimorensis (Gyel. & For.) Hale

Pseudoparmelia baltimorensis (Gyel. & For.) Hale, Phytologia 29: 189. 1974.

Parmelia baltimorensis Gyel. & For., Ann. Crypt. Exot. 4: 167. 1931.

Thallus foliose, 4-12 cm in diameter, loosely adnate, yellow-green; branching irregular. Lobes rounded to irregular, 2-7 cm wide; margins entire to crenate, lacerate on secondary lobes. Lower surface black in the center, medium brown in a marginal zone, faintly to strongly wrinkled; rhizines sparse, black to brown with white, frayed tips, simple. Upper surface shiny, undulate to strongly rugose; pustules numerous, especially on older portions of the thallus, isidioid, fragile, eroding apically to form open pits, never sorediate. Apothecia reported by Hale (1976b) as rare, substipitate, 1-3 mm in diameter; rim pustulate. Cortex K-; medulla K-, C- or C+ rose, KC+ rose, PD+ red.

Chemical composition, usnic acid, protocetraric acid, caperatic acid, and trace amounts of gyrophoric acid, reported by Culberson and Culberson (1982).

Not common, collected on granitic rock, decaying wood, Amelanchier, and Ostrya, in a variety of community types above 4200 ft. elevation. Dey (1975) described this species as rare at elevations above 5500 ft. and infrequent but widespread on rock at lower elevations. This North American endemic is found in eastern and southwestern United States, and southeastern Canada.

Pseudoparmelia baltimorensis differs from P. caperata only in its production of pustules which do not become sorediate. Dey (1975) noted that the sinuses of P. baltimorensis are "V shaped" as opposed to the "teardrop-shaped" sinuses of P. caperata; however, this difference is difficult to detect.

Culberson and Culberson (1982) reported that P. baltimorensis is more common than P. caperata on rock substrates in the southeastern United States. Based on their observations they concluded that past competitive pressure from the rock-inhabiting P. baltimorensis eliminated the rock-adapted gamodemes of P. caperata (which are still represented in other parts of North America and Europe).

Individual collections of these two species from Unaka Mountain have proven difficult to distinguish. While there are collections which express the extremes of variation, from two collections with clusters of bulbose pustules to numerous examples of diffuse erosional soredia, most of the collections are intermediate. Of the eight collections of P. baltimorensis five were from rock and three from woody substrates. Three juvenile specimens from rock substrates, which lacked pustules and soredia, have tentatively been called P. baltimorensis.

See the discussion of P. caperata for comparison to other usnic acid containing Parmelias.

Specimens examined. Tennessee. Unicoi Co.: Beauty Spot 3373, 3374; Horseback Ridge 1281, 1312; Rockslide Area 3375; Stamping Ground Ridge 1072, 1074, 3377, 3378*, 3379*; Switchback 3376*.

2. Pseudoparmelia caperata (L.) Hale

Pseudoparmelia caperata (L.) Hale, Phytologia 29: 189. 1974.

Lichen caperatus L., Sp. Pl. 1147. 1753.

Thallus foliose, 4-10 cm in diameter, loosely adnate to suberect, yellow-green; branching irregular. Lobes rounded to irregular, 2-7 mm across; margins crenate, producing secondary lobes, revolute when diffusely sorediate. Lower surface black in the center, medium brown in a marginal zone, wrinkled, especially at the lobe tips; rhizines sparse and usually submarginal, black to brown with white, frayed tips, simple. Upper surface shiny, plane to undulate, faintly wrinkled to rugose on older lobes. Soredia powdery to granular; soralia, produced by erosion of the cortex or opening of pustules into ring-shaped coalescing soralia, or pustules occasionally persistent on rugose lobes. Apothecia reported by Hale (1976b) and Dey (1975), rare, 2-5 mm in diameter; disc brown; rim pustulate-sorediate. Cortex K-; medulla K+ dingy yellow or K-, C-, KC+ rose, P+ red.

Chemical composition, usnic acid, protocetraric acid, caperatic acid, and unidentified substances, reported by Dey (1975).

Abundant and widespread, collected on a wide variety of substrates in all sites. This species is common throughout the southern Appalachians (Dey, 1975) and is known from all temperate areas of the world (Hale, 1976b).

Pseudoparmelia caperata seems to be the sorediate morph of P. rutidota (Hook. & Tayl.) Hale. It is easily confused with the pustulate morph of this complex, P. baltimorensis.

P. caperata can be distinguished from usnic acid producing species of Parmotrema by its adnate lobe margins, narrow, bare marginal zone on the lower surface, rhizines with frayed tips, and adnate nonperforate apothecia (Hale, 1976b). Parmelia flaventior, superficially quite similar, has pseudocyphellae on the upper surface and exclusively marginal soralia. While the genus Xanthoparmelia is not easily distinguished from yellow Pseudoparmelia, only one species, X. incurva, is sorediate. This endemic of Grandfather Mountain, North Carolina, is distinguished by its strongly capitate soralia, narrow, subterete lobes, and the presence of alectoronic acid (Dey, 1975).

Specimens examined. North Carolina. Yancey Co.: Beauty Spot Forest 3392, 3393; Tennessee. Unicoi Co.: Beauty Spot Gap 1019; Cherry Gap Trail 1428, 1429; Horseback Ridge 1266, 1300*, 3391; North Beauty Spot 1210; Pleasant Gardens 1001; Rockslide 1109, 1110, 1118, 1154, 1172, 1085*; Stamping Ground Ridge 1073, 3387*, 3388, 3389, 3390; Summit 3385, 3386; Switchback 3383, 3384; White Pine Plantation 1476, 1489, 1514, 1560, 1567, 1535, 1607, 3380, 3381, 3382.

## 29. Xanthoparmelia (Vain.) Hale

Key to the Species of Xanthoparmelia in the southern Appalachians

1. Thallus sorediate or isidiate. . . . . 2
1. Thallus not isidiate or sorediate. . . . . 6

2. Thallus sorediate. . . . . [X. incurva (Pers.) Hale]

2. Thallus isidiate . . . . . 3

3. Lower surface black. . . . . 4

3. Lower surface tan or brown . . . . . 5

4. Medulla K+ yellow turning yellow-orange or orange-red, stictic acid and often norstictic acid present . . . . . 1. X. conspersa (Ach.) Hale

4. Medulla K+ dingy brown or K-, fumarprotocetraric acid present. . . . . .[X. piedmontensis (Hale) Hale]

5. Medulla K+ yellow turning orange-red, stictic and norstictic acids present. . . . . .4. X. plittii (Gyel.) Hale

5. Medulla K+ dingy brown or K-, fumarprotocetraric acid present. . . . . [X. subramigera (Gyel.) Hale]

6. Lower surface black. . . . . 7

6. Lower surface white, tan, or brown . . . . . 9

7. Medulla K+ dingy brown or K-, fumarprotocetraric acid present. . . . . .[X. hypomelaena (Hale) Hale]

7. Medulla K+ yellow turning yellow-orange, orange, or red, fumarprotocetraric acid absent . . . . . 8

8. Salazinic acid present . [X. tasmanica (Hook. & Tayl.) Hale]

8. Stictic and norstictic acids present . . . . . 3. X. hypopsila (Müll. Arg.) Hale

9. Medulla K+ dingy or K- . . . . . .10

9. Medulla K+ yellow turning yellow-orange, orange, or red. . . .11

10. Medulla PD+ red, fumarprotocetraric acid present, lower surface tan. . . . . [X. monticola (Dey) Hale]

10. Medulla PD-, alectoronic acid present, lower surface white. . . . . [X. centrifuga (L.) Hale]

11. Salazinic acid produced, lobes loosely attached, long and linear . . . . . .[X. taractica (Krempih.) Hale]

11. Stictic and norstictic acids produced, lobes tightly attached, short and crowded . . 2. X. cumberlandia (Gyel.) Hale

1. Xanthoparmelia conspersa (Ach.) Hale

Xanthoparmelia conspersa (Ach.) Hale, Phytologia 28: 485. 1974.

Lichen conspersus Ach., Lich. Suec. Prodr. 118. 1798.

Thallus foliose, 2(-3-14) cm in diameter, closely adnate, yellow-green; branching irregular. Lobes linear-elongate, 0.5-2 mm across; margins lacerate to lobulate, dark brown along the border. Lower surface black in the center, dark brown at the margins; rhizines sparse, black, simple. Upper surface shiny, plane to wrinkled; isidia abundant, barrel-shaped, to 0.2 mm tall, laminal, when abraded leaving small, dark pits at the point of attachment. Apothecia common, 1-2(-7.5) mm in diameter; disc reddish brown. Cortex K-; medulla K+ yellow turning red, C+, PD+ orange-red.

Chemical composition, atranorin, norstictic acid, stictic acid, connorstictic acid, constictic acid, and unidentified substances determined by TLC.

Common, collected on granitic rock at high elevational rockslides. This widely distributed temperate species occurs at all elevations in the southern Appalachians (Dey, 1975) and throughout the United States and southern Canada excluding the southeastern coastal plain, Great Plains, and Great Basin regions.

Xanthoparmelia conspersa is characterized by a black lower surface and production of isidia. The very rare X. piedmontensis

shares both of these traits. It is easily distinguished from X. conspersa by its production of fumarprotocetraric acid which reacts K-, PD+ red. In the southern Appalachians only one other isidiate, usnic acid-containing species with a black lower surface is Pseudoparmelia baltimorensis which differs in having pustulate isidia, broadly rounded lobes, and protocetraric acid (K+ dingy). All other isidiate Xanthoparmelia species have a light lower surface (see X. plittii).

Specimens examined. Tennessee. Unicoi Co.: Beauty Spot 3419; Horseback Ridge 1310*.

2. Xanthoparmelia cumberlandia (Gyel.) Hale

Xanthoparmelia cumberlandia (Gyel.) Hale, Phytologia 28: 487. 1974.

Parmelia subconspersa var. cumberlandia Gyel. Fedde Repert. Specierum Nov. Regni Veg. 36: 164. 1934.

Thallus foliose, 5(-8) cm in diameter, adnate, yellow-green; branching irregular. Lobes linear to subirregular; margins crenate to dissected, densely lobulate on the older lobes. Lower surface light to medium gray-brown; rhizines sparse, light gray-brown to dark brown, simple. Upper surface shiny, faintly wrinkled to undulate, slightly maculate. Apothecia reported by Dey as common, to 5 mm in diameter; disc dark brown; pycnidia abundant, black, immersed. Cortex K-; medulla K+ yellow or yellow turning red, C-, PD+ orange.

Chemical composition, usnic acid, norstictic acid, stictic acid, connorstictic acid, constictic acid, and unidentified substances, trace amounts of accessory Parmelia quintaria unknown 1, reported by Dey (1975).

Not common, one collection from granitic rock at a high elevational rockslide. Dey (1975) reported that this species is common at lower elevations on rock. Found throughout the United States and southern Canada excluding the southeastern coastal plain, Great Plains, and Great Basin, this species is a North American endemic.

Xanthoparmelia cumberlandia is one of four southern Appalachian Xanthoparmelias which have a tan or brown lower surface and lack isidia and soredia. These species are separated by chemistry as well as lobe configuration. X. taractica has a looser attachment, crowded or heaped lobes, and produces K+ red salazinic acid. X. monticola, a rare species found in the southern Appalachians, produces K+ dingy fumarprotocetraric and physodalic acids. X. centrifuga which extends only as far south as the mountains of West Virginia has a white lower surface and K- alectoronic acid.

Specimens examined. Tennessee. Unicoi Co.: Rockslide Area 3420*.

3. Xanthoparmelia hypopsila (Müll. Arg.) Hale

Xanthoparmelia hypopsila (Müll. Arg.) Hale, Phytologia 28: 488. 1974.

Parmelia hypopsila Müll. Arg., Flora 70: 317. 1887.

Thallus foliose, 4.5(-8) cm in diameter, closely adnate, yellow-green; branching somewhat dichotomous. Lobes linear to subirregular, narrow, 0.2-2 mm wide, crowded; margins crenate to dissected by secondary lobes. Lower surface black to dark brown; rhizines sparse, short, black to dark brown, simple. Upper surface shiny, faintly wrinkled, convex and appearing inflated. Apothecia reported as common by Hale (1979). Cortex K-; medulla K+ yellow or yellow turning red, C-, PD+ orange-red.

Chemical composition, usnic acid, stictic acid, and norstictic acid, determined by TLC.

Rare, one collection from granitic rock of rockslide. Dey (1981) reported this species as rare in the mountains and piedmont of North Carolina. In North America it occurs in the southwestern and eastern United States (excluding the coastal plain) and southeastern Canada.

Xanthoparmelia hypopsila and X. cumberlandia are thought to be closely related because they differ only in the color of their lower surfaces. X. hypopsila has a black lower surface and X. cumberlandia a tan to brown lower surface. Other non-isidiate/sorediate species with a black lower surface can be distinguished by their chemistry. X. hypomelaena produces fumarprotocetraric acid which reacts K-, and X. tasmanica produces salazinic acid which reacts K+ red.

Specimen examined. Tennessee. Unicoi Co.: Beauty Spot 3421*.

4. Xanthoparmelia plittii (Gyel.) Hale

Xanthoparmelia plittii (Gyel.) Hale, Phytologia 28: 488. 1974.

Parmelia plittii Gyel., Fedde Repert. Specierum Nov. Regni Veg. 29: 287. 1931.

Thallus foliose, 2-7 cm in diameter, closely adnate, yellow-green; branching somewhat dichotomous. Lobes linear-elongate, 0.5-2(-3) mm wide, separate to radiating at the margins, crowded in the center; margins crenate to lacerate, with a darker border. Lower surface medium brown to tan, wrinkled; rhizines sparse, brown, simple. Upper surface shiny, convex to wrinkled; isidia abundant to dense, often completely covering the surface, barrel-shaped to cylindrical, simple or branched and lobulate. Apothecia common, up to 9 mm in diameter; disc dark brown; rim papillose to isidiate; pycnidia common, immersed. Cortex K-; medulla K+ yellow turning red, C-, PD+ orange-red.

Chemical composition, usnic acid, norstictic acid, stictic acid, constictic acid, determined by TLC: trace amounts of accessory unidentified substances reported by Dey (1975).

Not common but locally abundant, collected on granitic rock at high elevational rockslides. Dey (1975) noted that it is common at elevations below 5500 ft. This species occurs in the eastern United States, southeastern Canada, and the southern Rocky Mountain areas.

Xanthoparmelia plittii is the only high elevation species with isidia and a brown lower surface. Only X. subramigera, present at lower elevations in the southern Appalachians, shares these

characters, and can be distinguished from X. plittii only in its production of fumarprotocetraric acid.

Specimens examined. Tennessee. Unicoi Co.: Beauty Spot 3422, 3423*; Horseback Ridge 1230, 1274; Rockslide 1084.

## XI. ANZIACEAE

Anziaceae, represented by Anzia in the southern Appalachians, has a distinctive tomentum composed of anastomosing dark hyphae. The deep tomentum makes the lobes appear inflated and hollow. Other genera with long tomentum differ in having a blue-green phycobiont.

### 30. Anzia Stizenb.

Key to the Species of Anzia in the southern Appalachians

1. Thallus sorediate or isidiate. . . . . 2
1. Thallus not sorediate or isidiate. 1. A. colpodes (Ach.) Stizenb.
   2. Thallus isidiate . . . . . [A. ornata (Zahlbr.) Asah.]
   2. Thallus sorediate. . . . . .[A. americana Yoshim. & Sharp]

Anzia colpodes (Ach.) Stizenb.

Anzia colpodes (Ach.) Stizenb., Flora 45: 243. 1862.

Lichen colpodes Ach., Lich Suec. Prodr. 124. 1798.

Thallus foliose, 1.5-4(-10) cm in diameter, adnate to suberect, mineral green to greenish gray; branching compressed dichotomous. Lobes narrow-elongate, 0.7-2 mm wide, convex, solid but appearing inflated; lobe tips dorsiventrally flattened. Lower

surface white and ecorticate, covered completely by a dense black tomentum, appearing spongy; rhizines occasional, widely scattered. Upper surface leathery, thick, maculate, frequently cracked, pruinose at the lobe tips. Pycnidia abundant, immersed, subterminal, surrounded by pruina and slightly raised and swollen; apothecia reported by Dey (1975) as common and abundant, up to 7 mm in diameter; disc tan-brown. Cortex K+ yellow; medulla K-, C-, KC-, PD-.

Chemical composition, atranorin and divaricatic acid, determined by TLC.

Not common, collected on maple and hickory in white pine plantation and successional forest between 3500 and 4200 ft. elevations. This North American endemic occurs throughout the eastern United States and southernmost eastern Canada, and is common at all elevations in the southern Appalachians (Dey, 1975).

Anzia colpodes can be identified by its densely tomentose lower surface which quickly separates this taxon from other narrow lobed mineral green species of Physcia, Heterodermia, and Anaptychia. Its convex upper and lower surfaces give the lobes an inflated look, reminiscent of Hypogymnia species.

Two other species in this genus occur in the southern Appalachians. A. americana, a very rare species collected also in Mexico has apical labriform soralia. A. ornata, with marginal isidia, occurs at low elevations in the southern Appalachians.

Specimens examined. Tennessee. Unicoi Co.: Cherry Gap Trail 1394, White Pine Plantation 1446*.

# XII. USNEACEAE

The Usneaceae is characterized by a fruticose thallus which is pendulose or caespitose. Branches are round in cross section and attached by one to many holdfasts. Three genera are represented in the southern Appalachians, Alectoria, Bryoria, and Usnea.

Usnea is distinguished by the presence of a cartilaginous central cord surrounded by a lax medulla in most species. This genus is poorly understood in the southeastern United States and is in need of revision.

In Alectoria and Bryoria the central cord is absent, the medulla thin and compact, and the branch hollow. Alectoria fallacina Mot. is the only species of Alectoria in the southern Appalachians. This genus has a yellow-green color due to the presence of usnic acid in the cortex. The genus Bryoria lacks usnic acid and often produces atranorin. The thallus is brown to olivaceous in color. These two related genera have recently been treated by Brodo and Hawksworth (1977).

## 31. Bryoria Brodo & D. Hawksw.

Key to the Species of Bryoria in the southern Appalachians

1. Thallus sorediate. . . . . 2
1. Thallus not sorediate. . . . . 3
    2. Spinules present in the soralia; branching isotomic dichotomous. . . . 1. B. furcellata (Fr.) Brodo & D. Hawksw.
    2. Spinules absent; branching anisotomic dichotomous . . . . . .[B. nadvornikiana (Gyeln.) Brodo & D. Hawksw.]

3. Branches uniformly light brown in color, soft and thin . . . . . .[B. trichodes (Michx.) Brodo & D. Hawksw.]

3. Branches darker brown at the base, coarser . . . . . 4

4. Branches in a dense tuft, lateral branches perpendicular . . . . . [B. bicolor (Ehrh.) Brodo & D. Hawksw.]

4. Branches not in a dense tuft, lateral branches acute . . . . . .[B. tenuis (Dahl.) Brodo & D. Hawksw.]

1. Bryoria furcellata (Fr.) Brodo & Hawks.

Bryoria furcellata (Fr.) Brodo & Hawks., Opera Bot. 42: 103. 1977.

Cetraria furcellata Fr., Syst. Orb. Veg. 1: 283. 1825.

Thallus fruticose, 2-5(-6) cm long, caespitose, attached at several points, light to cervine brown, darkening to black at the base; branching isotomic dichotomous. Branches hollow and cylindrical, 0.1-0.2 mm and approximately equal in diameter, somewhat compressed near the base, repeatedly branching; sinuses between the basal dichotomies usually broad, between apical dichotomies usually acute; lateral branches occasional; soredia greenish, powdery; isidioid spinules frequent, mixed with soredia; soralia fissural, narrower than the branches. Surface smooth and shiny. Medulla lax. Apothecia not seen. Medulla K+ faint dingy yellow or K-, C-, KC-, PD+ orange-red.

Chemical composition, fumarprotocetraric acid, trace amounts of protocetraric acid, and trace amounts of unidentified substances reported by Dey (1975).

Not common, collected on fire cherry and white pine in high elevational deciduous forest and successional communities between 4700 and 4900 ft. elevations. Under the name Alectoria nidulifera Norrl., Dey (1975) reported this species as not common but widespread and often locally abundant at high elevations and also widespread at lower elevations. This species occurs across the boreal regions of Alaska and Canada and south in the eastern United States through the Great Lakes, New England and Appalachian regions, and in the west along the Pacific Coast and in the southern Rockies. This species is also known from Europe (Dey, 1975).

Bryoria furcellata can be recognized by the presence of isidioid spinules in the soralia. One other sorediate species found in the southern Appalachians, Bryoria nadvornikiana, lacks spinules and has a different chemistry.

Specimens examined. Tennessee. Unicoi Co.: Rockslide Area 1089, White Pine Plantation 1603*.

## 32. Usnea P. Br. ex Adans.

Key to the Species of Usnea in the southern Appalachians

1. Thallus sorediate, occasionally isidiate, rarely apotheciate . 2
1. Thallus not sorediate or isidiate, usually apotheciate . . . . 8
    2. Branches inflated; medulla lax . . . . . 3
    2. Branches not inflated; medulla compact . . . . . 4
3. Thallus short, less than 3.5 cm long; lateral branches inserted at right angles, often truncate . . 2. U. confusa Asah.

3. Thallus elongate, up to 9 cm long, lateral branches inserted acutely; usually attenuate . . . . . 5. U. mollis Stirt.

4. Cortex with annular cracks; central cord large, over half the diameter of the branch; medulla K-, PD+; protocetraric acid present . . . . . .4. U. hesperina Mot.

4. Cortex without annular cracks; central cord small to moderate-sized, not over half the diameter of the branch; medulla K- and PD-, or K+ yellow turning red and PD+ yellow turning orange or red, protocetraric acid absent. . 5

5. Medulla K+ yellow turning red, PD+ yellow turning orange or red; salazinic, salazinic and norstictic, or norstictic and diffractaic acids present. . . . . .16

5. Medulla K-, PD-, diffractaic acid present only . . . . . 1. U. ceratina Ach.

6. Norstictic and diffractaic acids present; soredia erose, isidia lacking . . . . . [U. fulvoreagens (Ras.) Mot.]

6. Salazinic acid present, norstictic acid present or absent; soredia granular, isidia occasional. . . . . 7

7. Norstictic acid present; branches stiff and coarse, falling in one direction; central cord narrow, pinkish . . . . . .3. U. diplotypus Vain.

7. Norstictic acid absent; lateral branches thin, not falling in one direction, central cord large, over half the diameter of the branch . . . . . 7. U. subfloridana Stirt.

8. Thallus pendulous, branches thin, lacking spinules . . . . . [U. trichodea Ach.]

8. Thallus caespitose; branches robust and spinulose. . . . . 9

9. Norstictic acid present. . . . . 6. U. strigosa (Ach.) Eaton

9. Salazinic acid present . . . . . 8. U. subfusca Stirt.

1. Usnea ceratina Ach.

Usnea ceratina Ach., Lich. Univ. 619. 1810.

Thallus fruticose, pendulous, to 30 cm long, attached at a single point with several major axes; yellow-green, light yellow-gray

at the holdfast; branching irregular. Branches curved, moderately branched; lateral branches darker greenish yellow, attenuate or broken and appearing short and stubby, inflated; pustules/tubercules abundant, raised, isidiate or granular on top, frequently coalescing; apothecia reported by Dey (1978) as rare, to 9 mm in diameter, lateral; disc tan; rim spinulate. Surface papillate, maculate, ridged and puffy around the pustules, occasionally with annular cracks. Medulla pink; central cord large, wider than half the diameter of the branch. Cortex K-; medulla K- or K+ dingy, C- or C+ dingy, KC- or KC+ dingy, CK+ yellow-orange, PD- or PD+ dingy.

Chemical composition, usnic acid, diffractaic acid determined by TLC, and 4-5 unidentified substances reported by Dey (1975).

Widespread, collected on hardwoods and white pine in deciduous forest and the white pine plantation between 3500 and 4800 ft. elevations. Dey (1975) reported this species as common on hardwoods and Abies at high elevations while widespread at lower elevations in the southern Appalachians. In North America it is found in the Great Lakes-Appalachian region, the Rocky Mountains and West Coast. Additionally it occurs in Central and South America, Europe, and Asia (Dey, 1978).

Usnea ceratina is easily identified by its production of diffractaic acid. The pendulous habit, short, stubby secondary branches, and production of isidia or granular soredia on tubercules are helpful in identification.

Specimens examined. Tennessee. Unicoi Co.: Cherry Gap Trail 1444, 1445; North Beauty Spot 3409; Rockslide Area 1122, 1123, 1111*, 1120; White Pine Plantation 1602, 1620.

2. Usnea confusa Asah.

Usnea confusa Asah., Lich. Jon., Vol. III. Usnea. 97. 1956.

Thallus fruticose, caespitose, 1-3.5(-8) cm long, attached at a single holdfast, with several main branches; yellowish to dark green; branching irregular. Main branches very inflated and curved, sparsely to moderately branched; isidia thin, cylindrical, produced on the upper side of curved branches; soredia granular and diffuse; papillae sparse to dense, small and rounded; apothecia not seen. Surface smooth to papillate; cortex thick. Medulla white, cottony, thick but lax; central cord, pinkish yellow, narrow, less than half the diameter of the branch. Cortex K-; medulla K+ yellow turning orange-red or red, C-, PD+ orange, or K+ yellow persistent, C-, PD+ orange.

Chemical composition, chemical race 1, usnic acid, salazinic acid, and consalazinic acid; chemical race 2, usnic acid, salazinic acid, alectorialic acid, and trace amounts of 3-4 unidentified substances; chemical race 3, usnic acid, stictic acid, constictic acid, and trace amounts of unidentified substance; chemical race 4, usnic acid, norstictic acid, and salazinic acid.

Rare, collected on maple bark in a deciduous forest at 3800 ft. elevation and on a shaded rock on Horseback Ridge at ca. 4800 ft.

elevation. Dey (1975) reported this species as very common on bark in spruce-fir forests and, less commonly, in fire cherry communities at high elevations in the southern Appalachians. In North America this species is restricted to the southern Appalachians. It also occurs in Japan (Dey, 1978).

Usnea confusa was first reported in North America by Dey (1975). It can be identified by its short, very inflated branches and the perpendicular insertion of secondary branches. Because of the number of races the chemistry is only an aid in identification. For comparison to related Asian species see Dey (1975, p. 485).

Specimens examined. Tennessee. Unicoi Co.: Cherry Gap Trail 1437*; Horseback Ridge 1305.

3. Usnea diplotypus Vain.

Usnea diplotypus Vain., Medd. Soc. Fauna Flora Fenn. 48: 172. 1924.

Thallus fruticose, caespitose, to 5(-8) cm long; attached at a single holdfast, with several major axes; yellow-gray to yellow-green, holdfast reddish to dark brown; branching irregular. Branches stiff, coarse, slightly inflated, sparsely to richly branched, frequently falling in one direction; lateral branches, moderate to abundant, short; isidia dense, papillate or fibrillate and long; apothecia not seen. Surface slightly ridged, pustulate or papillate; maculentations white, raised, puffy and distended, irregular to linear and forming bands. Medulla white, lax;

central cord pinkish, narrow, less than one third the diameter of the branch. Cortex K-; medulla K+ yellow turning orange to red, C-, PD+ yellow-orange or orange.

Chemical composition, usnic acid, salazinic acid, and norstictic acid, determined by TLC, and trace amounts of 1-3 accessory unidentified substances reported by Dey (1975).

Widespread and locally abundant; collected on boulders and exposed granitic rock at rockslide areas between 4500 and 4900 ft. elevations. Dey (1975) reported this species as widespread on rocks or rock outcrops in the southern Appalachians. It occurs in the Ozark-Appalachian region of North America (Dey, 1977) and in Europe (Dey, 1975).

Usnea diplotypus is characterized by its stiff coarse branches, falling in one direction, and its band-like maculentations. Its chemistry, norstictic and salazinic acid, is very helpful in identification. This species has been referred to as Usnea herrei Hale (see Dey, 1975, p. 48, for a discussion of the nomenclature of this taxon).

Specimens examined. Tennessee. Unicoi Co.: Horseback Ridge 1264, 1289, 1298*, 1308, 1323; Rockslide Area 1130, 1135.

4. Usnea hesperina Mot.

Usnea hesperina Mot., Lich. Gen. Usnea Stud.: Monogr. 383. 193-38.

Thallus fruticose, pendulous, to 35 cm long, attached at one, or occasionally several holdfasts, with several main axes; light

yellow-gray, gray at the holdfast; branching irregular. Main branches richly divided, lateral branches abundant, appearing jointed, attenuate, isidia sparse to dense, cylindrical, often horizontal on the surface; apothecia reported for lower elevations by Dey (1975) as up to 4 mm in diameter, lateral; disc tan, rim spinulate. Surface with annular cracks, maculate, papillate to warty; cortex thick, shiny. Medulla white, thin and compact; central cord large, white or darkening, exposed along raised white stripes on the surface, covered only by a translucent cortex. Cortex K-; medulla K+ dingy yellow or K-, C-, KC+ faint pink, PD+ orange.

Chemical composition, usnic acid, protocetraric acid determined by TLC, and trace amounts of unidentified substance reported by Dey (1975).

Common, collected on maple, birch, and fire cherry bark, decaying wood, and rock in all community types between 4000 and 5000 ft. elevation. Dey (1975) reported this species as common in deciduous forest at high elevations and widespread at lower elevations in the southern Appalachians. It also occurs in Central America and Europe (Dey, 1975).

Usnea hesperina, though variable in morphology, is easily identified by its production of protocetraric acid. The thallus is pendulous with annular cracks. The most distinctive characteristic is the large central cord with cartilaginous ribs extending to the surface.

Specimens examined. Tennessee. Unicoi Co.: Cherry Gap Trail 1436; Horseback Ridge 1225, 1242, 1272, 1306, 1307*; Rockslide Area 1112, 1113, 1114, 1124, 1138, 1139, 1142; Stamping Ground Ridge 1077; White Pine Plantation 3410.

5. Usnea mollis Stirt.

Usnea mollis Stirt., Scott. Nat. (Perth) 6: 109. 1881.

Thallus fruticose, caespitose or subpendulous, to 9 cm long, attached at a single holdfast with one or several main axes; yellow-green, gray to black at the holdfast; branching irregular. Main branches inflated; sparsely to moderately branched; lateral branches long and attenuate or short and inflated, curved; soredia granular to isidiate; soralia slightly raised, band-shaped, often coalescing; isidia occasional, mixed with the soredia; apothecia not seen. Surface papillate. Medulla white, lax; central cord narrow, less than half the diameter of the branch. Cortex K-; medulla K+ pale yellow or yellow often turning orange or orange-red, C-, PL+ pale to deep orange.

Chemical composition, chemical race 1, usnic acid and salazinic acid; chemical race 2, usnic acid, salazinic acid, and norstictic acid; chemical race 3, usnic acid, salazinic acid, and unidentified substances; chemical race 4, usnic acid, norstictic acid, and stictic acid, reported by Dey (1975).

Widespread and frequent, collected on the twigs and bark of maple and beech trees and the dead branches of pines in northern

deciduous and spruce-fir forest and heath balds between 4000 and 5000 ft. elevation. Dey (1975) reported this species as widespread, but not common in the southern Appalachians. The distribution of this species in North America is not known. The species also occurs in South America, Europe, and Asia (Dey, 1975).

Usnea mollis seems to be a collection of taxa which have long, inflated branches and a corticolous habit. The large amount of variation in morphology and chemistry illustrate the need for taxonomic examination of this complex.

Specimens examined. Tennessee. Unicoi Co.: Horseback Ridge 1237, 1258, 1263, 1269*, 1290, 3411, 3412; Stamping Ground Ridge 3414; Summit 3413; Switchback 3415.

6. Usnea strigosa (Ach.) Eaton

Usnea strigosa (Ach.) Eaton, Manual Bot. ed. 4. 491. 1824.

Usnea florida var. strigosa Ach., Meth. Lich. 310. 1803.

Thallus fruticose, caespitose, to 5(-7) cm long, attached at one point by a holdfast; yellow-green to brownish, gray to light brown at the holdfast; branching irregular. Branches robust, to 2 mm in diameter, sparsely to richly branched; lateral branches abundant to dense; spinules dense, attenuate; papillae frequent on the main axes, dense on lateral branches and often pustulate and yellow-tipped; apothecia common, terminal, to 13 mm in diameter; disc yellow to tan; rim spinulate. Medulla compact, frequently red; central cord less than half the diameter of the branch,

frequently red. Cortex K-; medulla K+ yellow turning orange, C-, PD+ yellow-orange.

Chemical composition, usnic acid, norstictic acid, and trace amounts of 1-2 unidentified substances, determined by TLC.

Common, collected on twigs and bark of white pine and hardwoods in the white pine plantation, heath garden, and hardwood forest between 3500 and 4800 ft. elevations. Dey (1975) reported this species as rare at high elevations in the southern Appalachians while more common at lower elevations. This species occurs throughout the eastern United States and adjacent Canada. A New World endemic, it is known from North, Central, and South America (Dey, 1975).

Usnea strigosa is one of the few distinct and well defined species of Usnea in the southern Appalachians. Its robust, nonsorediate-isidiate, frequently fertile thallus differs from U. subfusca only in its production of norstictic acid and a red medullary pigment. U. subfusca produces salazinic acid and is more common in the southern Appalachians.

One other fertile species is present in the southern Appalachians, U. trichodea, which has thin flaccid branches and a pendulous habit.

Specimens examined. Tennessee. Unicoi Co.: Cherry Gap Trail 1438, 1439; Horseback Ridge 1229*, 1231, 1236; Stamping Ground Ridge 3416; White Pine Plantation 1494, 1548, 3417.

7. Usnea subfloridana Stirt.

Usnea subfloridana Stirt., Scott. Nat. (Perth) 6: 294. 1882.

Thallus fruticose, caespitose, up to 5 cm long, occasionally longer, attached at a single holdfast, with several main axes; yellow-green, lighter on lateral branches, darker gray to the holdfast; branching irregular. Base constricted, main branches not inflated, sparsely to moderately branched; lateral branches dense, thin, bending and branching, or short and tipped by soralia; fibrils dense; soredia granular to isidiate, tubercules capitate, containing soredia and isidiate fibrils, well-spaced on main branches. Surface papillate. Medulla compact, central cord large, over half the diameter of the branch. Apothecia reported by Dey (1975) as rare, to 1.3 mm broad; disc brown. Cortex K-; medulla chemical race 1, K+ yellow, C-, PD+ yellow-orange, chemical race 2, K-, KC-, PD-; chemical race 3, K+ yellow turning yellow-orange, C-, PD+ orange, or chemical race 4, K+ yellow turning orange-red or red, C-, PD+ orange.

Chemical composition, chemical race 1, usnic acid and thamnolic acid; chemical race 2, usnic acid and squamatic acid; chemical race 3, usnic acid and norstictic acid; chemical race 4, usnic acid and salazinic acid, reported by Dey (1975).

Widespread, collected on twigs and bark of fire cherry, beech, and maple trees in high elevation deciduous forest and heath gardens between 4000 and 4800 ft. elevations. Dey (1975) reported this species as widespread but not common throughout the southern Appalachians. In North America it occurs throughout the boreal

regions of Canada and southward along the mountain ranges. Also, this species is known from South America, Europe, and Asia.

Usnea subfloridana is not well defined in the southern Appalachians. The thin lateral branches, large central cord, dark base, and noninflated branches are useful characters. However, the variation in morphology and chemistry implies that a number of taxa are included in this complex.

Specimens collected in this study correspond to chemical races 2, 3, and 4.

Specimens examined. Tennessee. Unicoi Co.: Cherry Gap Trail 1440*; Horseback Ridge 1238, 1292; Rockslide Area 1115, 1116.

8. Usnea subfusca Stirt.

Usnea subfusca Stirt., Scott. Nat. (Perth) 6: 108. 1881.

Thallus fruticose, caespitose, 2-15 cm long, usually to 5 cm, attached at a central holdfast with several main branches; yellow-green to dark green, yellowish to reddish brown or black at the holdfast; branching irregular. Branches robust, to 2 mm wide, sparingly to richly divided; lateral branches abundant to dense, whorled and stubby; spinules dense, occasionally robust and elongate, up to 2 cm long. Surface densely papillate and occasionally maculate; apothecia common, to 1 cm across, terminal; disc pale to light yellow; rim spinulose; immature apothecia pustulate, yellow-tipped. Medulla compact; central cord dense, pinkish. Cortex K-; medulla K- yellow turning orange-red, C-, PD+ orange.

Chemical composition usnic acid, salazinic acid, and consalazinic acid determined by TLC.

Not common, collected on twigs and bark of hardwoods in the white pine plantation and heath gardens between 4200 and 4800 ft. elevations. Dey (1975) reported this species as "widespread but not common, often locally abundant on hardwood trees in most community types, rare in the spruce-fir forest," at high elevations while widespread at lower elevations in the southern Appalachians. This species is known only from the Appalachians.

Usnea subfusca is a chemical variant of U. strigosa. It differs in producing salazinic acid, and according to Hale (1979), more distinct papillae.

Specimens examined. Tennessee. Unicoi Co.: Horseback Ridge 1244*, 1245, 1249; White Pine Plantation 1485, 1513, 1541, 1569, 3418.

## XIII. RAMALINACEAE

Members of the family Ramalinaceae have flattened fruticose thalli which are erect to pendulous. The cortex is cartilaginous and striated. A single genus, Ramalina, occurs in the southern Appalachians.

### 33. Ramalina Ach.

Key to the Species of Ramalina in the southern Appalachians

1. Thallus sorediate, exclusively saxicolous . . . . . .[R. intermedia Del. in Nyl.]

1. Thallus not sorediate, usually apotheciate, corticolous or rarely saxicolous. . . . . .1. R. americana Hale

1. Ramalina americana Hale

Ramalina americana Hale, Bryologist 81: 599. 1978.

Thallus fruticose, 0.5-3(-5) cm tall, 1-3 cm in diameter, caespitose, attached by a central holdfast, yellow-green; branching subdichotomous to irregular. Lobes dorsiventrally flattened, (0.7-) 1.5-5(-10) mm wide, linear to rounded, somewhat canaliculate, striate; margins entire or lacerate and lobulate. Lower surface slightly lighter in color. Upper surface ridged and wrinkled, often with white spots or striate pseudocyphellae; pruinose at the lobe tips; apothecia terminal or subterminal, when immature isidiate and pustulate, when mature to 5 mm in diameter; disc light tan to flesh color, pruinose; rim tan to golden, wrinkled; pycnidia occasional. Cortex K-; medulla K-, C-, KC-, PD-, or K-, C+ yellow-orange, KC+ orange, PD+ yellow-orange.

Chemical composition, chemical race 1, usnic acid only; race 2, usnic acid and Parmelia quintaria unknown 1 and 2; race 3, usnic acid, sekikaic acid, and possibly homosekikaic acid; race 4, usnic acid and unidentified substance; race 5, usnic acid and four unidentified substances, reported by Dey (1975).

Widespread, collected on rock, twigs, and hardwoods in rock-slide and heath garden communities, the white pine plantation, and

moderate elevational deciduous forest between 3500 and 4900 ft. elevations. Under the name Ramalina fastigiata (Pers.) Ach., Dey (1975) reported this species as widespread but not common at high elevations and widespread at lower elevations in the southern Appalachians. It occurs throughout the eastern United States in North America.

Ramalina americana is nonsorediate, fertile, and usually corticolous. One other species R. intermedia occurring in the southern Appalachians differs in being sorediate, usually sterile, and exclusively saxicolous (Dey, 1975). The latter species is rare at high elevations and not known from lower elevations in the southern Appalachians.

Specimens examined. North Carolina. Yancey Co.: Beauty Spot Forest 3398, 3399, 3400, 3401, 3402, 3403, 3404; Tennessee. Unicoi Co.: Cherry Gap Trail 1434, 1435*, 1443*; Horseback Ridge 1314*, 1322; Rockslide Area 1194, 3405; Stamping Ground Ridge 3396; White Pine Plantation 1491, 3397.

## XIV. CANDELARIACEAE

The Candelariaceae may by crustose-squamulose, finely branched foliose, or subfruticose, and always with a distinctive yellow or yellow-orange color that reacts K-. One genus, Candelaria, is represented in the southern Appalachians.

## 34. Candelaria Mass.

Key to the Species of Candelaria in the southern Appalachians

1. Thallus sorediate. . . . . .1. C. concolor (Dicks.) Stein.
1. Thallus not sorediate. . . . . .[C. fibrosa (Fr.) Müll. Arg.]

1. Candelaria concolor (Dicks.) Stein.

Candelaria concolor (Dicks.) Stein. in Cohn, Krypt. Flora Schlesien 2: 84. 1879.

Lichen concolor Dicks., Fasc. Pl. Crypt. Brit. 3: 18. 1793.

Thallus minutely foliose, covering extensive areas, greenish lemon-yellow; branching subdichotomous to irregular. Lobes 0.8 mm wide, linear, squamiform, finely branching; margins dissected to granular and lobulate; lobe tips often ascending. Lower surface whitish, shiny; rhizines not common. Upper surface plane to puffy, slightly maculate; soredia common, often appearing to replace the lobes, concolorous with the thallus, scattered along the ascending margins; apothecia reported by Hale (1979) as rare. Cortex K-; medulla K+ pale pink or K-, C-, PD-.

Chemical composition, pulvinic acid and UV+ unidentified substances reported by Dey (1975).

Widespread, collected on hardwood bark in the spruce plantation at Pleasant Gardens on Rattlesnake Ridge, and in the hardwood forest at Beauty Spot Forest and Beauty Spot Gap, between 4000 ft. and 4800 ft. elevations. In the southern Appalachians this species is rare at elevations above 5500 ft. and widespread at lower

elevations (Dey, 1975). This species occurs throughout temperate North America excluding the Great Basin, as well as South America, Europe, Africa; and Asia (Dey, 1975).

Candelaria concolor is easily recognized by its finely branched, greenish yellow thallus with granular soredia. Sorediate species of Xanthoria and Caloplaca can easily be distinguished by their K+ purple reaction and oranger thallus color.

Found at lower elevations in the southern Appalachians and throughout the eastern United States, Candelaria fibrosa is non-sorediate and frequently fertile. Xanthoria polycarpa (Ehrh.) Oliv. also produces apothecia and reacts K+ purple.

Specimens examined. North Carolina. Yancey Co.: Beauty Spot Forest 3003; Tennessee. Unicoi Co.: Beauty Spot Gap 1040*.

## XV. PHYSCIACEAE

The Physciaceae is composed of narrow-lobed lichens which produce brownish, two-celled or polarilocular spores when fertile. The thallus may be mineral gray, green, or brown and the lower surface may be corticate or ecorticate. When ecorticate the rhizines are produced marginally, and when corticate, laminally.

Anaptychia is represented in the southern Appalachians by one species, A. palmatula. This lobulate species is brown to greenish and produces little or no atranorin. The corticate lower surface is white to tan and rhizinate. A closely related genus Heterodermia differs in having a mineral gray color, producing

atranorin, and frequently having an ecorticate lower surface with marginal rhizines. The spores of Anaptychia are two-celled and thick-walled, while the spores of Heterodermia are two-celled and thin-walled.

Physcia produces polarlocular spores. The upper surface is maculate and the upper cortex paraplectenchymatous while the lower surface is prosoplectenchymatous and white. Atranorin is present in the upper cortex.

Three genera have recently been segregated from Physcia. Phaeophyscia lacks atranorin in the upper cortex and has a greenish brown color. The lower cortex is prosoplectenchymatous, but differs in being typically black. In Physciopsis, represented by P. syncolla in the eastern United States, the thallus is closely appressed with a dark brown lower surface and indistinct rhizines. Physconia has a black, or occasionally buff to dark brown, lower surface with simple or sparingly squarrosely branched rhizines. The narrow lobes are distinctly pruinose.

Pyxine, also producing a rhizinate, black lower surface, can be easily identified by the yellow-orange medulla of the southern Appalachian species. The upper cortex frequently splits and cracks exposing the pigmented medulla. Either atranorin or lichexanthone is produced in the upper cortex and the thallus has a mineral green color.

Anaptychia (including Heterodermia) has been monographed by Kurokawa (1962, 1973) and the chemistry and taxonomy of

Heterodermia and Anaptychia examined by W. Culberson (1966). The composite genus Physcia was revised for North America by Thomson (1963) and the genus Phaeophyscia studied by Esslinger (1977, 1980b) and Moberg (1977, 1978). Pyxine was studied for North America by Inshaug (1957).

## 35. Anaptychia Körb. in Mass.

1. Anaptychia palmatula (Michx.) Vain.

Anaptychia palmatula (Michx.) Vain., Termeszetrajzi Fur. 22: 299. 1899.

Psoroma palmatula Michx., Flora Bor. Am. 2: 321. 1803.

Thallus foliose, 3-7 cm in diameter, adnate to loosely attached, mineral to brownish green, green when wet; branching dichotomous to subdigitately irregular. Lobes very narrow, elongate, 0.5 to 1.0 mm wide; margins crenate or dissected to lobulate. Lower cortex corticate, tan to whitish, lighter at the lobe tips, blackish brown in the center; rhizines whitish to black, simple, squarrosely, or fasciculately branched, marginal. Upper cortex pruinose at the lobe tips, maculate; apothecia laminal, 1-2(-4) mm in diameter, disc brown to brownish black, epruinose; rim entire to dissected and densely lobulate. Cortex K-; medulla K-, C-, KC-, PD-.

Chemical composition, trace amounts of accessory atranorin and/or accessory unidentified substance reported by Dey (1975).

Common but not frequently collected on Unaka Mountain; collected on hardwoods in secondary hardwood forest between 3500 and

4000 ft. elevations. Dey (1975) reported that this species is common on trees and rocks in community types dominated by deciduous trees. This species occurs in eastern North America and the Japanese Archipelago of eastern Asia.

Anaptychia palmatula is the only species of this genus represented in the southern Appalachians. It can be identified by its distinctive brownish green color, marginal lobules, and light lower surface. Phaeophyscia imbricata differs in having erect lobules, dense rhizines, and a black lower surface. Two species of the closely related genus Heterodermia, H. tremulans and H. hypoleuca, are also frequently fertile and lobulate. They differ in their K+ cortical reaction due to the presence of atranorin and zeorin, and whitish gray color.

Specimens examined. Tennessee. Unicoi Co.: Cherry Gap Trail 1391*, 1392, 1393.

## 36. Heterodermia Trev.

Key to the Species of Heterodermia in the southern Appalachians

1. Thallus isidiate or sorediate. . . . . 2
1. Thallus not isidiate or sorediate. . . . . 9
   2. Thallus isidiate . . . . . .[H. granulifera (Ach.) W. Culb.]
   2. Thallus sorediate. . . . . 3
3. Lower surface corticate. . . . . 4
3. Lower surface ecorticate . . . . . 5
   4. Rhizines white . . . . 7. H. tremulans (Müll. Arg.) W. Culb.

4. Rhizines black . . . . [H. pseudospeciosa (Kurok.) W. Culb.]

5. Thallus suberect; lobes channeled beneath. . . . . 6

5. Thallus adnate, lobes plane to convex, not strongly channeled. . . . . 7

6. Soralia capitate and terminal on the upper surface; medulla K-, salazinic acid absent . . . . . 1. H. appalachensis (Kurok.) W. Culb.

6. Soredia diffuse on the lower surface, medulla K+ red, salazinic acid present . . . . 4. H. leucomelaena (L.) Poelt

7. Lower surface purple-black in the center, with a K-, yellow pigment . . . . . .2. H. casarettiana (Mass.) Trev.

7. Lower surface white with a K+ purple, yellow pigment . . . . . 8

8. Medulla K+ yellow turning red, PD+ orange-red; norstictic and salazinic acids present. .[H. propagulifera (Vain.) Dey]

8. Medulla K+ yellow, PD+ yellow, zeorin and unidentified terpenes present, norstictic acid occasional . . . . . .5. H. obscurata (Nyl.) Trev.

9. Thallus suberect; lobes usually channeled beneath. . . . . .10

9. Thallus adnate; lobes plane to convex, but not strongly channeled. . . . . .11

10. Thallus subfruticose; apothecia absent; medulla K+ yellow turning red, salacinic acid present . . . . . 4. H. leucomeleana (L.) Poelt

10. Thallus not subfruticose; apothecia common; medulla K-, salazinic acid absent. . . . .[H. echinata (Tayl.) W. Culb.]

11. Thallus lobulate; lobules erect and dense . . . . . .6. H. squamulosa (Degel.) W. Culb.

11. Thallus usually not lobulate; lobules when produced adnate and marginal . . . . . .3. H. hypoleuca (Ach.) Trev.

1. Heterodermia appalachensis (Kurok.) W. Culb.

Heterodermia appalachensis (Kurok.) W. Culb., Bryologist 69: 479. 1966.

Anaptychia appalachensis Kurok., Beih. Nova Hedwigia 6: 83. 1962.

Thallus foliose or subfruticose, up to 3 cm in diameter, attached at the center, loosely adnate to erect and ascending at the periphery, whitish to mineral gray; branching dichotomous to irregularly palmate. Lobes 0.5-2 mm wide, elongate and narrow or irregular, often strap-shaped, canaliculate; margin entire. Lower surface ecorticate; exposed medulla arachnoid, pigmented yellow, bordered by the reflexed margin of the upper cortex; rhizines common, black, up to 2(-3) mm long, simple, marginal, ciliate. Upper surface dull, smooth, turning-under at the margin, pruinose at the apex; soredia occasional, farinose; soralia capitate or labriform, apical. Apothecia not seen. Cortex K+ yellow; medulla K-, C-, KC-, PD-.

Chemical composition, atranorin, zeorin, and unidentified yellow pigment reported by Kurokawa (1962).

Rare, collected on hickory in the oak-hickory dominated community at 3500 ft. elevation. This species was not present in the high elevational zone studied by Dey (1975) but was listed as present at lower elevations. Esslinger (1981) reported this species as rare and found in the mountains and upper piedmont of North Carolina. It is endemic to the southern Appalachians of North America (Kurokawa, 1962).

Heterodermia appalachensis is distinguished by its capitate or labriform soralia and production of a K- yellow-orange pigment on

the lower surface. H. leucomelaena is very similar but produces K+ red salazinic acid and is sorediate only on the lower surface. Occasionally the cottony lower surface will have orange spots due to the decomposition of salazinic acid.

Specimens examined. Tennessee. Unicoi Co.: Cherry Gap Trail 3080*.

2. Heterodermia casarettiana (Mass.) Trev.

Heterodermia casarettiana (Mass.) Trev., Atti Soc. Ital. Sci. Nat. Malano 11: 624. 1868.

Anaptychia casarettiana Mass., Mém. Lich. 39. 1853.

Thallus foliose, 4 cm across, adnate, whitish gray; branching dichotomous or subdigitately irregular. Lobes sublinear, 0.5-3 mm wide; margins entire or notched. Lower surface ecorticate, white becoming purple-black in the center, exposed medulla tightly woven, slightly roughened near margin, somewhat cottony in darkened areas, occasionally spotted with orange pigment; rhizines black, squarrosely branched, marginal. Upper surface plane, smooth, leathery, occasionally pruinose at apices; soredia granular; soralia capitate to labriform on secondarily produced lobes. Apothecia reported by Kurokawa (1962) as laminal, 1-7 mm in diameter; disc brown and occasionally pruinose; rim lobulate-sorediate. Cortex K+ yellow; medulla K+ yellow, C-, KC-, PD+ yellow.

Chemical composition, atranorin, zeorin, unidentified terpene, determined by TLC.

Not common, collected on hardwoods in the white pine plantation at ca. 4300 ft. elevation. Dey (1975) noted that this species is rare at high elevations and more common at lower elevations. It is known throughout the southeastern United States and Africa, but is also common in the West Indies, Central and South America.

Heterodermia casarettiana is characterized by its ecorticate lower surface which is roughened and purplish black in the center. Occasionally in the white marginal zone a yellow pigment is present. This pigment has a K- reaction and is thought to be a pulvic acid derivative.

Two other ecorticate, noncanaliculate species of Heterodermia in the southern Appalachians have soredia. H. obscurata differs in having an arachnoid lower surface which is white with a K+ red, yellow-orange pigment. In many specimens the entire lower surface is deep or brownish yellow, however Dey (1975) noted that in high elevational specimens this pigmentation is reduced. H. obscurata lacks norstictic acid and has K-, PD- reactions. H. propagulifera, not collected in this study and reported by Dey (1975) as not common at high elevations and rare at lower elevations, produces both norstictic and salazinic acids and a (K+ red-purple) yellow-orange pigment on a woolly or arachnoid lower surface. A lower elevational species, Heterodermia albicans (Pers.) Swinsc. & Krog is distinguished by its linear-marginal soralia, production of salazinic acid, and lack of pigment on its white to buff lower surface.

Specimens examined. Tennessee. Unicoi Co.: Cherry Gap Trail 1413, 1414; North Beauty Spot 1198; White Pine Plantation 3081*, 1452.

3. Heterodermia hypoleuca (Ach.) Trev.

Heterodermia hypoleuca (Ach.) Trev., Atti Soc. Ital. Sci. Nat. Milano 11: 615. 1868 (1869).

Parmelia speciosa b. hypoleuca Ach., Syn. Meth. Lich. 211. 1814.

Thallus foliose, 6(-15) cm in diameter, adnate or imbricate to layered, greenish to grayish white; branching irregular. Lobes linear-elongate, convex, 1-2 mm wide; margin entire to notched with appressed, lobulate squamules. Lower surface ecorticate, white becoming dingy near center, cottony or arachnoid; rhizines 1-2 mm long, concolorous with thallus or dark to black at tips, simple or shortly squarrose, marginal. Upper surface verrucose, somewhat pruinose near margins, verrucules (warts) becoming pycnidia or squamules. Squamules sparse, appressed, laminal and marginal, frequently pycnidiate. Pycnidia numerous, immersed; ostiole medium brown, slightly indented. Apothecia numerous, 3-4 mm in diameter; disc dark brown; rim dissected, pruinose when mature; spores very thick walled, brownish. Cortex K+ yellow; medulla K+ yellow, C-, PD+ pale yellow.

Chemical composition, atranorin and zeorin, determined by TLC.

Rare, one collection from locust in the white pine plantation at ca. 4300 ft. elevation. Dey (1975) did not report this species

from the high mountain areas but included it in his key as present at lower elevations in the southern Appalachians. It is found across eastern North America and in eastern Asia (Kurokawa, 1962).

Heterodermia hypoleuca is frequently fertile and becomes sparsely lobulate-squamulose with age along the lobe margins and apothecial rim. Its lobes are somewhat convex, the lobe apices descending, and the rhizines short and sparsely branched.

Specimens examined. Tennessee. Unicoi Co.: Summit 3082; White Pine Plantation 1481*.

4. Heterodermia leucomelaena (L.) Poelt

Heterodermia leucomelaena (L.) Poelt, Nova Hedwigia. 9: 31. 1965.

Lichen leucomelos L., Sp. Pl. ed. 2. 2: 1613. 1763.

Thallus foliose or subfruticose, 1-3 cm in diameter, attached at center, lobes loosely adnate to erect and ascending, whitish to mineral gray; branching dichotomous. Lobes linear-elongate, strap-shaped, 0.5 to 1.5 mm wide, canaliculate beneath; margin entire. Lower surface ecorticate; exposed medulla white, occasionally yellow- or pinkish brown due to decomposition of salazinic acid, cottony to roughened, canaliculate, bordered by the reflexed margin of the upper cortex; rhizines black, up to 5 mm long, simple or sparsely squarrose, marginal, ciliate. Upper cortex dull, rigid, turning under at margins, cracking with age; soredia occasional, farinose, on lower surface of revolute lobes; lobules infrequent, marginal.

Apothecia not seen, reported by Kurokawa (1962) as rare, subterminal on revolute lobes, 1-5 mm in diameter; disc brown, pruinose; rim lobulate. Cortex K+ yellow; medulla K+ yellow turning red, C-, PD+ yellow-orange.

Chemical composition, atranorin, salazinic acid, zeorin, determined by TLC, trace amounts of terpenes reported by Dey (1975).

Widespread but not commonly collected; collected on oaks in oak and mixed hardwood dominated forest between 3500 and 4700 ft. elevations. Dey (1975) noted that this species is common at lower elevations in the southern Appalachians. It also occurs in the southwestern United States and adjacent Mexico. Kurokawa noted (1962) that H. leucomelaena is widely distributed across the temperate and tropical regions of North, Central, and South America, Europe, Australia, and New Zealand, and less commonly in Africa and Asia.

Heterodermia leucomelaena is distinguished by its elongate and somewhat subfruticose lobes with long (2-4 mm) ciliate rhizines. Its lower surface is ecorticate and canaliculate.

Two rare species of Heterodermia are similar but lack salazinic acid. H. appalachensis has capitate or labriform soralia and a yellow-orange pigment on the lower surface. H. echinata is frequently fertile, suberect, not subfruticose, and tufted. Its ciliate rhizines are concolorous with the thallus or darkening at the tips and 2-3 mm long. The lower surface is chalky white. Neither of these species are found in high elevation areas of the

southern Appalachians and are infrequent at lower elevations (Dey, 1975). H. echinata is most common on Juniperus in open glades (Kurokawa, 1962).

Specimens examined. Tennessee. Unicoi Co.: Cherry Gap Trail 1376; North Beauty Spot 1180*.

5. Heterodermia obscurata (Nyl.) Trev.

Heterodermia obscurata (Nyl.) Trev., Nuovo G. Bot. Ital. 1: 114. 1869.

Physcia obscurata Nyl., Ann. Sci. Nat. Bot. 4e ser. 19: 310. 1863.

Thallus foliose, 2(-10) cm in diameter, adnate, whitish to greenish gray; branching dichotomous or irregular. Lobes sublinear, 1-2 mm broad; margins entire or notched; lobe tips blunt. Lower surface ecorticate, arachnoid, with a yellow pigment encrusting the hyphae; rhizines tan to black, squarrosely branched, marginal. Upper surface plane to undulate or convex, epruinose; sorediate somewhat granular; soralia capitate or labriform on short lateral lobes, or occasionally marginal. Apothecia reported by Kurokawa (1962) as rare, laminal, 1-5 mm in diameter; disc blackish brown, epruinose; rim sorediate. Cortex K+ yellow; medulla K+ yellow, C-, PD+ yellow; lower surface pigment K+ red-purple.

Chemical composition, atranorin, zeorin, unidentified terpenes and pigment determined by TLC.

Not common, one collection from maple in the White Pine Plantation at ca. 4300 ft. elevation. Dey (1975) reported that

this species is rare in the spruce-fir forest, widespread but not common in high elevation deciduous forest, and common in lower elevational deciduous forest. It is widely distributed in tropical and temperate zones (Kurokawa, 1962). In North America it occurs in the southeastern and southwestern United States.

Heterodermia obscurata is similar to H. casarettiana. The undersurface of H. obscurata is arachnoid (woolly) and entirely yellow due to an undetermined K+ purple pigment, while the undersurface of H. casarettiana is only roughened and is purplish black in the center, and white, tinged with yellow, near the lobe tips. The pigment is K- or K+ yellow. Dey (1975) reported that high elevation specimens of H. obscurata often have only isolated pigment spots on a white lower surface. See the discussion of H. casarettiana for comparison of H. obscurata to other sorediate-ecorticate species.

Specimens examined. Tennessee. Unicoi Co.: White Pine Plantation 1453*, 1454.

6. Heterodermia squamulosa (Degel.) W. Culb.

Heterodermia squamulosa (Degel.) Culb., Bryologist 69: 484. 1966.

Anaptychia squamulosa Degel., Ark. Bot. 30A(1): 76. 1941.

Thallus foliose, 1-4(-12) cm in diameter, adnate, greenish gray; branching dichotomous or subirregular. Lobes sublinear-elongate, 0.5-1.5 mm broad; margins dissected and lobulate-squamulose. Lower surface ecorticate, white throughout or occasionally purplish black to brownish in the center, Dey (1975)

reported diffuse spots of yellow-orange pigment (K+ purplish-red); rhizines dark brown or black, initially white, densely squarrosely branched, often dense and forming a mat under the thallus. Upper surface appearing fibrose, dull; lobulate-squamules dense, marginal and occasionally laminal, often appearing to replace primary lobes to 5 mm wide, much branched, margins dissected. Lower surface ecorticate occasionally with marginal rhizines. Apothecia reported by Dey (1975) as common, to 5 mm in diameter; disc dark brown; rim densely squamulose. Cortex K+ yellow, medulla K+ yellow, C-, PD+ yellow; lower surface pigment K+ red-purple.

Chemical composition, atranorin, zeorin, unidentified terpenes, determined by TLC, and rarely an accessory unidentified yellow-orange pigment reported by Dey (1975).

Not common, collected on hardwoods bordering rockslides and in red oak-hickory communities between 3500 and 4300 ft. elevations. Dey (1975) reported that this species is common in all communities except spruce-fir. Kurokawa (1962) stated that it is almost completely restricted to dry oak woods of the Blue Ridge Mountains in North America. Its distribution according to Dey (1975) includes North, Central, and South America, and Africa while Kurokawa considers it a North American endemic.

Heterodermia squamulosa is identified by its ecorticate lower surface and numerous squamules. Sorediate and sorediate-isidiate specimens have been reported from high elevational areas of the southern Appalachians (Dey, 1975). Anaptychia palmatula is

superficially similar and may be confused with this species but has a lower cortex with laminal, tufted rhizines, narrower lobules, and a brownish gray color when dry. Heterodermia hypoleuca differs in having occasionally adnate lobulate-squamules, and convex lobes.

Specimens examined. Tennessee. Unicoi Co.: Cherry Gap Trail 1415, 1441*, 1442; North Beauty Spot 1179, 1185.

7. Heterodermia tremulans (Müll. Arg.) W. Culb.

Heterodermia tremulans (Müll. Arg.) W. Culb., Bryologist 69: 485. 1966.

Physcia hypoleuca var. tremulans Müll. Arg., Flora 63: 277. 1880.

Thallus foliose, 3.5(-9) cm in diameter, adnate, whitish gray; branching somewhat dichotomous. Lobes elongate, narrow, 0.7-1.0 mm wide; margins entire to notched. Lower surface corticate, white to dingy tan; rhizines dense, to 4 mm long, white or gray to black, squarrosely branched, marginal. Upper surface smooth, pruinose to white spotted at the lobe tips, soredia powdery, often charcoal gray; soralia labriform, apical on inrolled lobes. Apothecia not seen. Cortex K+ yellow; medulla K+ yellow, C-, PD+ yellow.

Chemical composition, atranorin, zeorin, and trace amounts of unidentified terpenes, determined by TLC.

Not common, collected on beech and oak in red oak-hickory forest at ca. 4300 ft. elevation. Dey (1975) reported that this species is widespread but not common in deciduous forests and common

at lower elevations. This species is known from eastern North America, Central and South America, and Asia (Kurokawa, 1962; Dey, 1975).

Heterodermia tremulans is one of two sorediate, corticate species of Heterodermia in the southern Appalachians. It is distinguished by its wider lobes, white or tan rhizines, and lack of norstictic acid. H. pseudospeciosa, a closely related saxicolous species has narrow lobes, brown or black rhizines, and usually produces norstictic acid (Dey, 1975).

There has been much confusion concerning the taxonomic position of this species. Initially it was described as a variety of Physcia hypoleuca (=H. hypoleuca). In 1893 it was transferred to a variety of Anaptychia speciosa (Müll. Arg., Engl. Bot. Jahrb. 15: 505. 1893). Kurokawa (1962) in his monograph of the genus Anaptychia (including Heterodermia) considered it a variety of his new species A. pseudospeciosa. This species was segregated from A. speciosa which he considers strictly European. A. speciosa has linear-elongate lobes while those of A. pseudospeciosa var. tremulans are short and flexuose. These taxa differ also in spore size and production of soredia on the apothecial margin. In 1966 Culberson raised this taxon to the rank of species.

Following Dey (1975) I have chosen to use the name H. tremulans for this specimen.

Specimens examined. Tennessee. Unicoi Co.: North Beauty Spot 1184, 1203*.

## 37. Phaeophyscia Moberg.

Key to the Species of Phaeophyscia in the southern Appalachians

1. Thallus sorediate. . . . . 2

1. Thallus not sorediate, often lobulate. . . . . 9

   2. Medulla orange-red, K+ purple; skyrin present . . . . . 3. P. rubropulchra (Degel.) Moberg.

   2. Medulla white, not K+ purple; skyrin present . . . . . .3. P. rubropulchra (Degel.) Moberg

3. Lower surface pale to dark brown . . . . . 4

3. Lower surface black, occasionally light brown along the margin . . . . . 5

   4. Soralia laminal and capitate; lower surface pale to light brown. . . . . [P. insignis (Meresch.) Moberg]

   4. Soralia terminal and labriform, lower surface pale to dark brown . . . . . [P. hirsuta (Meresch.) Essl.]

5. Upper surface with cortical hairs; rhizines not projecting beyond the margins . . . . . 6

5. Upper surface lacking cortical hairs; rhizines often projecting beyond the margin . . . . . 7

   6. Soralia marginal and elongate . . . . . [P. cernohorskyi (Nadv.) Essl.]

   6. Soralia terminal and labriform .[P. hirsuta (Meresch.) Essl.]

7. Soredia farinose in capitate soralia . . . . . 8

7. Soredia granular in irregular soralia . . . . . .[P. adiastola (Essl.) Essl.]

   8. Lobes less than 1.5 mm wide; soralia terminal . . . . . 2. P. pusilloides (Zahlbr.) Essl.

   8. Lobes 1.5 to 3 mm wide; soralia submarginal . . . . . [P. hispidula (Ach.) Essl.]

9. Thallus lobulate, very rarely apotheciate . . . . . .[P. imbricata (Vain.) Essl.]

9. Thallus not lobulate, usually apotheciate. . . . . .10

10. Medulla orange-red, K+ purple, skyrin present. . . . . .11

10. Medulla white, K-, skyrin absent . . . . . .12

11. Lobes 0.2-0.3 mm wide; thallus saxicolous . . . . . [P. endococcina (Korb.) Moberg]

11. Lobes 0.5-1 mm wide; thallus corticolous . . . . . .[P. erythrodaria (Tuck.) Essl.]

12. Upper surface with cortical hairs, maculate . . . . . [P. hirtella Essl.]

12. Upper surface lacking cortical hairs, not maculate . . . . . 1. P. ciliata (Hoffm.) Moberg

1. Phaeophyscia ciliata (Hoffm.) Moberg

Phaeophyscia ciliata (Hoffm.) Moberg, Sym. Bot. Ups. 22 (1): 30. 1977.

Lichen ciliatus Hoffm., Enumer. Lich. 69. 1784.

Thallus foliose, 2.5 cm in diameter, closely adnate, brownish to greenish gray; branching irregular. Lobes short-linear, 0.2-0.7 mm wide; margins entire to notched. Lower surface black, shiny; rhizines dense, black with white tips, or all white at the margins, simple to sparsely furcate, forming a mat which extends beyond the margin. Upper surface leathery; apothecia reported by Dey (1975) as common, to 1 mm in diameter; disc dark brown or black; rim with basal rhizines. Cortex K-; medulla K-, C-, KC-, PD-.

Chemical composition, no lichen substances detected.

Rare, one collection from mountain ash in high elevational deciduous forest at ca. 4600 ft. Dey (1975) listed this species as rare at all elevations in the southern Appalachians. It occurs throughout eastern North America and in the southwestern United States, Asia, and Europe.

Phaeophyscia ciliata is a frequently fertile, esorediate-isidiate species with a white medulla. It is distinguished by its thallus size (2-3 cm), lobe size (0.2-0.7 mm wide), and lack of cortical hairs. P. hirtella differs in having fine cortical hairs at the lobe tips and along the apothecial margins and maculentations. An uncommon fertile species, P. decolor, has smaller lobes (0.2-0.5 mm wide), a darker gray-brown to dark brown color, and is exclusively saxicolous. P. imbricatula, formerly called P. lacinulata, is usually nonfertile and has marginal lobules. Superficially P. ciliate may be confused with Physciopsis syncolla which is more closely appressed. The lower surface of this species is tan to blackening and the rhizines few and poorly developed or lacking entirely.

Previously considered a variety of Phaeophyscia ciliata, P. erythrocardia differs only in producing skyrin which gives the medulla an orange-red color. See the discussion of P. rubropulchra for comparison to other species with an orange-red medulla.

Specimens examined. Tennessee. Unicoi Co.: Switchback 3330.

2. Phaeophyscia pusilloides (Zahlbr.) Essl.

Phaeophyscia pusilloides (Zahlbr.) Essl. Mycotaxon 7: 313. 1978.

Physcia pusilloides Zahlbr., Cat. Lich. Univ. 7: 678. 1931.

Thallus foliose, 1-2 cm in diameter, adnate, greenish to grayish brown; branching irregular. Lobes linear, 0.5-1 mm wide; apices ascending, margins entire to notched. Lower surface black, shiny; rhizines dense, black with white tips, simple to sparsely furcate, extending beyond the margins. Upper surface waxy, shiny; soredia fine-granular; soralia orbicular, capitate, terminal or subterminal. Apothecia reported by Dey (1975) as rare, to 0.7 mm in diameter; disc dark brown. Cortex K-; medulla K-, C-, KC-, PD-.

Chemical composition, no lichen substances detected.

Not common, collected on hardwoods in red oak-hickory forest from 3500 to 4200 ft. elevations. Dey (1975) noted that this species is rare at all elevations in the southern Appalachians. This species is known throughout eastern North America and from Europe.

Phaeophyscia pusilloides is distinguished by its terminal, capitate soralia produced on ascending lobe tips or lateral lobes, narrow-linear lobes, and projecting rhizines. P. hispidula (P. setosa sensu Dey, 1975) is more robust with a thallus 4-8(-14) cm wide and lobes 1-4 mm broad which appear concave to occasionally canaliculate. Soralia on this species are laminal. Coarse, isidioid soredia in diffuse marginal or terminal soralia are

characteristic of P. adiastola, as are appressed, non-ascending lobes. Formerly this taxon was called P. orbicularis which is now applied to specimens collected in the western United States which have fine-granular soredia in discrete punctiform to irregular, laminal and submarginal, soralia. P. luganensis Meresch has a pale lower surface and terminal, labriform soralia.

Sorediate specimens with an orange-red medulla were considered a variety of this species but have been elevated to the rank of species. P. rubropulchra differs from P. pusilloides only in production of skyrin. See P. rubropulchra for comparison to other skyrin-containing species.

Specimens examined. Tennessee. Unicoi Co.: Cherry Gap Trail 331*, 1417, 1418, 1419, 1420, 1421; North Beauty Spot 1190.

3. Phaeophyscia rubropulchra (Degel.) Moberg

Phaeophyscia rubropulchra (Degel.) Moberg, Bot. Not. 131: 260. 1978.

Physcia orbicularis forma rubropulchra Degel., Ark. Bot. 30A(1): 58. 1940.

Thallus foliose, to 5(-10) cm in diameter, adnate, greenish brown; branching irregular. Lobes short-linear, 0.5 to 1 mm with; apices ascending; margins crenate. Lower surface black in center, white in a narrow (0.5 mm) marginal zone; rhizines abundant, black with flayed, white tips, simple to furcately branched, flattened, projecting beyond the margin. Medulla spongy, bright orange, often

exposed by cracking. Upper surface leathery, somewhat undulate; soredia granular, erose; soralia irregular, pustulate, marginal and laminal on secondary lobes near the center of the thallus. Immature apothecia 0.5 mm in diameter, substipitate, laminal; disc medium brown. Cortex K-; medulla K+ purple, C+ purple, PD+ red turning purple.

Chemical composition, skyrin, unidentified fatty acids, and trace amounts of unidentified substances reported by Dey (1975).

Common, collected on hardwoods, logs, and rocks in all deciduous tree-dominated communities between 3500 and 4700 ft. elevations. This lichen is known from eastern North America, Europe, Asia, Australia, and New Zealand.

Phaeophyscia rubropulchra is easily identified by its orange red medulla. Previously it has been considered a variety of Phaeophyscia orbicularis (Neck.) Poetsch, a sorediate species which differs only in having a white medulla (Dey, 1975; Degelius, 1941). Two fertile taxa occurring in the southern Appalachians also produce skyrin in their medulla. P. endococcina is a very rare saxicolous species reported for the area which has lobes between 0.2 and 0.5 mm wide. P. erythrocardia is the skyrin-containing form of P. ciliata and has a paler thallus and lobes 1 mm wide. It is rarely collected.

Specimens examined. North Carolina. Yancey Co.: Beauty Spot Forest 3334, 3335, 3336, 3337*, 3338, 3339; Tennessee. Unicoi Co.: Beauty Spot Gap 1030; Cherry Gap Trail 1422, 1423, 1424,

3341; Rockslide Area 1178; Switchback 3332, 3333; White Pine Plantation 1475, 3340.

## 38. Physcia (Schreb.) DC. in Lam. & DC.

Key to the Species of Physcia in the southern Appalachians

1. Thallus sorediate, very rarely apotheciate . . . . . 2
1. Thallus not sorediate, frequently apotheciate. . . . . 6
    2. Thallus greenish brown; upper cortex lacking atranorin. . . . . [P. chloantha Ach.]
    2. Thallus mineral gray; upper cortex with atranorin. . . . . 3
3. Lobes small, 0.1-0.3 mm wide, finely branched. . . . . 4
3. Lobes larger, 0.5-3 mm wide, not finely branched . . . . . 5
    4. Thallus corticolous. . . . . .[P. millegrana Degel.]
    4. Thallus saxicolous . . . . . .[P. subtilis Degel.]
5. Soralia capitate and laminal . . . . . .[P. americana Merr.]
5. Soralia irregular, terminal and submarginal . . . . . .[P. pseudospeciosa Thoms.]
    6. Thallus saxicolous . . . . . 7
    6. Thallus corticolous. . . . . 8
7. Lobes small, 0.2-0.6 mm wide; upper surface not maculate . . . . . [P. halei Thoms.]
7. Lobes larger, 1-2 mm wide; upper surface maculate . . . . . [P. phaea (Tuck.) Thoms.]
    8. Medulla K+ yellow; upper surface distinctly maculate . . . . . 1. P. aipolia (Ehrh.) Hampe
    8. Medulla K-; upper surface not or only slightly maculate . . . . . 2. P. stellaris (L.) Nyl.

1. Physcia aipolia (Ehrh.) Hampe

Physcia aipolia (Ehrh.) Hampe in Furnr., Naturk. Topogr. Regensburg 2: 249. 1839.

Lichen aipolius Ehrh. in Humb., Flora Freburg Specim. 19. 1792.

Thallus foliose, 1-3 cm in diameter, adnate, whitish gray; branching irregular, in a radiating pattern. Lobes narrow-linear, 0.5-1.5 mm wide, often convex, lobe tips crenate; margin entire. Lower surface white to light tan; cortex shiny, black (paraplectenchymatous); rhizines white or darkening, simple to sparsely furcate, mainly submarginal but also laminal. Upper surface dull, strongly maculate, rugose or verrucose, often short pruinose; cortex thick, cartilaginous; apothecia abundant, laminal, up to 2 mm in diameter; disc medium to dark brown, rarely pruinose; rim smooth to crenulate; pycnidia abundant, immersed. Cortex K+ yellow; medulla K+ yellow, C-, PD+ pale yellow.

Chemical composition, atranorin and zeorin determined by TLC.

Widespread, collected on hardwoods in hardwood dominated forest and white pine plantation between 3500 and 4300 ft. elevations. This species is rare in high elevational areas of the southern Appalachians, but more common at lower elevations (Dey, 1975). It occurs throughout North America, and is generally distributed in the Northern Hemisphere and in Australia.

Physcia aipolia is characterized by its whitish gray color, white spotting (maculentations), and the presence of K+ yellow atranorin in its medulla. It is frequently confused with the more

robust species P. stellaris. The lobes of the latter reach widths of 2 mm while P. aipolia has a maximum of 1.5 mm. In P. stellaris the lobes are flatter and usually confluent compared to the more convex and separate-parallel lobes of P. aipolia. The thallus is a grayer color in P. stellaris, and at most weakly maculate, though when wet it does appear white spotted. Apothecia of these species show subtle differences. Those of P. stellaris are darker, usually black, and frequently pruinose. Apothecia of P. aipolia are at most dark brown and only occasionally pruinose. The medulla of P. stellaris is lax and K-, lacking atranorin, while that of P. aipolia is dense and K+ yellow. Hale (1979) noted that P. aipolia is usually found at the base of trees and P. stellaris in the canopy on small branches. While no one character is conclusive the correlation of morphological and distributional information implies that these species are well separated.

A less common species, Physcia phaea shares the K+ medullary reaction and maculentation of P. aipolia. It can be distinguished by saxicolous habit, bluer color, more closely adnate thallus, larger ascospores, 17-20X8-9 µm as compared to those of P. aipolia 20-25X8.5-11 µm.

Specimens examined. North Carolina. Yancey Co.: Beauty Spot Forest 3342, 3345; Cherry Gap Trail 1425*, 1426; White Pine Plantation 3343.

2. Physcia stellaris (L.) Nyl.

Physcia stellaris (L.) Nyl., Syn. Meth. Lich. 1: 424. 1860.

Lichen stellaris L., Sp. Pl. 2: 1144. 1753.

Thallus foliose, 1-3(-6) cm in diameter, adnate, whitish gray; branching subdichotomous or irregular, in a radiating pattern. Lobes narrow, linear, 0.5-1 mm wide, parallel to confluent, often slightly convex; margins entire; lobe tips crenulate, slightly ascending. Lower surface white to light tan, shiny; cortex thick (paraplectenchymatous); rhizines sparse, white or light tan, simple or sparsely furcate, laminal. Upper cortex somewhat dull and fibrous, rugose with age; apothecia abundant, to 1.5(-2.5) mm diameter, laminal; disc medium to blackish brown, frequently pruinose; rim entire to crenulate. Cortex K+ yellow; medulla K-, C-, KC-, PD-.

Chemical composition, atranorin and unidentified terpenes, determined by TLC.

Widespread but not common, collected on hardwoods, pines, and twigs in most communities between 3500 and 4800 ft. elevations, except grassy balds and spruce forest. This species occurs throughout North America, Central and South America, Europe, Asia, Australia, and New Zealand (Dey, 1975).

Physcia stellaris is a fertile species which lacks maculentations and has a K- medullary reaction. See discussion of P. aipolia for comparison to other fertile Physcia species.

Specimens examined. North Carolina. Yancey Co.: Beauty Spot Forest 3346*, 3347, 3348, 3349, 3350; Tennessee. Unicoi Co.: Cherry

Gap Trail 1427, 3353; Rockslide Area 1192, 1193; Stamping Ground Ridge 3351, 3352; White Pine Plantation 1599, 3354.

## 39. Physconia Poelt

Key to the Species of Physconia in the southern Appalachians

1. Thallus sorediate. . . . . .1. P. detersa (Nyl.) Poelt

1. Thallus not sorediate, usually apotheciate . . . . . .[P. pulverulenta (Schreb.) Poelt]

1. Physconia detersa (Nyl.) Poelt

Physconia detersa (Nyl.) Poelt, Nova Hedwigia 12: 123. 1966.

Physcia pulverulenta var. detersa Nyl., Syn. Lich. 1: 420. 1860.

Thallus foliose, up to 7 cm in diameter, adnate, greenish brown to whitish gray; branching subdichotomous to irregular, pinnatifid. Lobes 0.5-1(-3) mm wide, narrow and linear, occasionally imbricate; margins crenate, occasionally imbricate; margins crenate, occasionally ascending. Lower surface black, shiny; rhizines dense, dark brown to black, squarrosely branched, forming a dense mat. Upper surface plane or slightly concave, fragile and splitting along the margin, scabrid and infrequently white pruinose; soredia farinose to coarse, white to gray or darkening; soralia labriform and marginal, rarely laminal; apothecia reported by Thomson (1963) under the name Physcia grisea (Lam.) Zahlbr. as not common, up to 1.5 mm in diameter; disc brown-black to black, dull, naked to strongly pruinose; rim entire to crenulate, occasionally sorediate. Cortex K-; medulla K-, KC-, C-, PD-.

Chemical composition, no lichen substances detected.

Rare, collected on hardwood in the hemlock-cove hardwood forest near Indian Grave Gap at ca. 3000 ft. elevation. Esslinger (1981) in an unpublished key reported this species as present but rare in the mountains and piedmont of North Carolina. Its North American distribution includes the eastern United States and adjacent Canada, the West Coast, and northern Rocky Mountains.

Physconia detersa can be recognized by its squarrosely branched rhizines and black shiny lower surface, marginal soredia, and brownish color. Species of Phaeophyscia differ in having simple or sparsely branched rhizines and smaller, narrower lobes. One other genus in the Physciaceae, Pyxine, has a black lower cortex, but produces a yellow pigment in its medulla.

Formerly this species was known as Physcia grisea.

Specimen examined. Tennessee. Unicoi Co.: Indian Grave Gap 3355*.

## 40. Pyxine Fr.

Key to the Species of Pyxine in the southern Appalachians

1. Upper cortex UV+ brilliant yellow; soralia orbicular and laminal. . . . . 1. P. caesiopruinosa (Nyl.) Imsh.

1. Upper cortex UV-; soralia linear and marginal . . . . . .2. P. sorediata (Ach.) Mont.

Pyxine caesiopruinosa (Nyl.) Imsh.,

Pyxine caesiopruinosa (Nyl.) Imsh., Trans. Am. Microsc. Soc. 76: 262. 1957.

Pyxine cocoes var. caesio-pruinosa Nyl., Syn. Meth. Lich. 2: 2. 1863.

Thallus foliose, 2-3 cm in diameter, closely adnate, whitish to greenish mineral gray; branching dichotomous to irregular. Lobes narrow and linear, 1-2 mm wide, continuous near the center; margins splitting, entire to crenate. Lower surface black; rhizines sparse, black with white tips, fasciculate, flattened. Upper surface thick and leathery, smooth; pruinose at the lobe tips; cortex frequently cracking and splitting along the margins; soredia granular, yellowish; soralia orbicular and laminal, frequent in the thallus center; apothecia reported by Hale (1979) as rare. Medulla yellow, exposed in cracks along the margin. Cortex UV+ brilliant orange, K-; medulla K+ yellow, C+ yellow, KC+ yellow, PD-.

Chemical composition, lichexanthone, sekikaic acid, and unidentified pigments reported by Hale (1979).

Rare, collected only on hickory in a middle elevation deciduous forest at ca. 4000 ft. elevation. This species was not reported at elevations above 5500 ft. (Dey, 1975), but is present at lower elevations in the southern Appalachians. In North America it is known throughout the Southeast including the Coastal Plain.

Pyxine caesiopruinosa can be identified by its brilliant UV+ reaction due to the presence of lichexanthone in the upper cortex. In contrast to the marginal soredia of P. sorediate, P. caesio-pruinosa has orbicular and laminal soralia.

Specimens examined. Tennessee. Unicoi Co.: Cherry Gap Trail 3394.*

2. Pyxine sorediata (Ach.) Mont.

Pyxine sorediata (Ach.) Mont. in Sagra, Hist. Cuba 8: 188. 1838-42.

Lecidea sorediata Ach., Syn. Meth. Lich. 54. 1814.

Thallus foliose, 1.5-2.5(-10) mm in diameter, adnate to appressed, whitish to greenish mineral gray; branching dichotomous to irregular. Lobes narrow, linear, 0.5-1.5(-3) mm broad; margins splitting, entire to crenate. Lower surface black in the center, cream-colored in a 2 mm zone at lobe tips; rhizines abundant, flattened, black with white tips, branches fasciculately whorled usually projecting beyond the margins. Upper surface thick and leathery, smooth, pruinose at lobe tips, cortex frequently cracking and splitting along margins; medulla salmon orange, exposed in cracks along the margin. Soredia granular; soralia linear and marginal. Lobules occasionally present on older lobes. Apothecia reported by Dey (1975) as frequent, 1-2 mm in diameter; disc black. Cortex K+ yellow; medulla K+ faint purple, C-, KC-, PD+ dingy.

Chemical composition, trace amounts of atranorin, terp nes, and an unidentified yellow pigment, determined by TLC.

Not common, collected on hardwoods in the white pine plantation and second growth forest between 3500 and 4200 ft. Dey (1975) reported this species as common in high elevation deciduous forest,

but rare in spruce-fir communities. This species occurs in the eastern United States, excluding the Coastal Plain and southernmost eastern Canada. Elsewhere, its range includes Central and South America, Africa, and Asia.

Pyxine sorediata is easily recognized by its salmon yellow medulla, exposed by splitting of the margins and production of linear soralia. Morphologically it resembles Physcia with its narrow, pruinose lobes.

Pyxine caesiopruinosa, occurring at lower elevations in the southern Appalachians, differs by producing UV+ brilliant yellow lichexanthone in the upper cortex. While both are sorediate, P. caesiopruinosa has laminal orbicular soralia in contrast to the linear marginal soralia of P. sorediata.

Specimens examined. Tennessee. Unicoi Co.: Cherry Gap Trail 1430, 1431*, 1432, 1433; Switchback 3395; White Pine Plantation 1477.

# CHAPTER IV

# DISTRIBUTION

## I. UNAKA MOUNTAIN DISTRIBUTIONS

The macrolichen flora of Unaka Mountain, as from any area, is a result of the interaction of many factors. Climate, elevation, topography, soils, and disturbance history combine to determine the community structure and development in any particular site. Overall community development gives rise to the substrates and microclimates which make lichen colonization possible. On Unaka Mountain 142 macrolichen species in 40 genera reflect these interactions in an elevational zone between 3000 ft. and 5200 ft. Of these, 125 species were also reported in Dey's survey of macrolichens of elevations above 5500 ft.

Specific information for each species with regard to substrate, vascular plant community affiliations, and elevation is collected into Table II. Only distributions which are unusual or interesting will be discussed here.

### Beauty Spot

Beauty Spot has a well developed flora of terricolous species similar to that of high elevational grassy balds. A total of 33 species were documented for this site. Of these 15 belong to the genus Cladonia among which C. cristatella, C. fimbriata, C. macilenta, and C. pyxidata occurred only at this location. Exposed rock at this

Table II. Substrate, Community, and Elevational Preferences.

| | Substrate [a] | | | | | | | | | | | Vascular Plant Community [b] | | | | | | | | | Elevation [c] | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | A | B | C | D | E | F | G | H | I | J | K | A | B | C | D | E | F | G | H | I | 50 | 45 | 40 | 35 | 30 |
| Anaptychia palmatula (Mich.) Vain. | | | | | | | X | | | | | | | | | | | | | X | | | | | |
| Anzia colpodes (Ach.) Stizenb. | | | | | | | X | | | | | | | | X | | | | | X | | | | | |
| Baeomyces fungoides (Sw.) Ach. | | X | | | | | | | | | | | | | | X | | X | | | | | | | |
| Bryoria furcellata (Fr.) Brodo & Hawks. | | | | | | | X | | X | | | | | | X | | | | X | | | | | | |
| Candelaria concolor (Dicks.) Stein. | | | | | | | X | | | | | X | | X | | | | | | | | | | | |
| Cetraria aurescens Tuck. | | | | | | | | | | X | | X | | | | | | | | | | | | | |
| Cetraria ciliaris Ach. | | | | | | X | X | X | X | X | X | | X | X | X | | X | | X | X | | | | | |
| Cetraria oakesiana Tuck. | | | | | | | X | X | X | | | X | X | X | X | | X | | X | X | | | | | |
| Cetraria orbata (Nyl.) Fink | | | | | | X | | | | | | | | X | | | | | | | | | | | |
| Cetrelia cetrarioides (Del. ex Duby) Culb. & Culb. | X | | | | | | X | | X | | | X | X | X | X | | | | | | | | | | |
| Cetrelia chicitae (W. Culb.) Culb. & Culb. | X | | | | | X | X | | X | | X | X | | X | X | | X | | X | X | | | | | |
| Cetrelia olivetorum (Nyl.) Culb. & Culb. | X | | | | | | X | | | | | X | | X | X | | | | X | X | | | | | |
| Cladina arbuscula (Walbr.) Hale & Culb. | X | X | X | | | | | | | | | | | | | X | X | | X | | | | | | |
| Cladina rangiferina (L.) Harm. | | X | | | | | | | | | | | | | | | X | | X | | | | | | |
| Cladina submitis (Evans) Hale & Culb. | | X | X | | | | | | | | | | | | | | X | X | | | | | | | |
| Cladonia bacillaris (Ach.) Nyl. | X | X | | | | | X | X | | | | | | | X | | X | | X | | | | | | |
| Cladonia caespiticia (Pers.) Flörke | X | | X | | | | X | | | | | | | X | X | | | | X | X | | | | | |
| Cladonia capitata (Michx.) Spreng. | | X | | | | | | | | | | | | | | X | | | X | | | | | | |
| Cladonia chlorophaea (Flörke) Spreng. | | X | | | | | X | | | | | | | X | X | X | | | | | | | | | |
| Cladonia clavulifera Vain. | | X | | | | | | | | | | | | | | X | | X | | | | | | | |
| Cladonia coniocraea (Flörke) Spreng. | X | X | | X | | | X | | X | | | X | | | X | X | X | X | X | | | | | | | |
| Cladonia cristatella Tuck. | | X | | X | | | | | | | | | | | | X | | | | | | | | | |
| Cladonia cryptochlorophaea Asah. | | X | | | | | | | | | | | | | | | X | | | | | | | | |
| Cladonia didyma (Fee) Vain. | | X | X | X | | | | | X | | | | | | X | X | | X | X | | | | | | |
| Cladonia fimbriata (L.) Fr. | | X | | X | | | | | | | | | | | | X | | | | | | | | | |
| Cladonia floerkeana (Fr.) Flörke | | | X | | | | | | | | | | | | | X | X | | X | | | | | | |
| Cladonia furcata (Huds.) Schrad. | X | X | | | | | | | | | | | | | | | X | X | X | | | | | | |
| Cladonia grayi Merr. | | X | X | | | | X | | X | | | | | | X | | X | | X | | | | | | |
| Cladonia macilenta Hoffm. | | | X | | | | | | | | | | | | | X | | | | | | | | | |
| Cladonia mateocyatha Robb. | | X | | | | | | | | | | | | | | X | X | X | X | | | | | | |
| Cladonia pityrea (Flörke) Fr. | | X | X | | | | | | | | | | | | | | X | | X | | | | | | |
| Cladonia polycarpoides Nyl. | | | X | | | | | | | | | | | | | X | | X | | | | | | | |

Table II (Continued)

| | Substrate[a] | | | | | | | | | | | Vascular Plant Community[b] | | | | | | | | | Elevation[c] | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | A | B | C | D | E | F | G | H | I | J | K | A | B | C | D | E | F | G | H | I | 50 | 45 | 40 | 35 | 30 |
| Cladonia pyxidata (L.) Hoffm. | | X | X | | | | | | | | | | | | | X | | | | | | | | | |
| Cladonia rei Schaer. | | X | X | | | | | | | | | | | | X | X | | | | | | | | | |
| Cladonia squamosa (Scop.) Hoffm. | X | | X | X | | | X | | X | | | X | | | X | | X | | X | X | | | | | |
| Cladonia strepsilis (Ach.) Vain. | | X | X | | | | | | | | | | | | | | X | | X | | | | | | |
| Cladonia uncialis (L.) G. Web. | X | X | | | | | | | | | | | | | | | X | | | | | | | | |
| Cladonia verticillata (Hoffm.) Schaer. | | X | | | | | | | | | | | | | | X | | X | X | | | | | | |
| Cladonia vulcanica Zoll. & Mer. | X | | X | | | | | | | | | | | | | X | | X | X | | | | | | |
| Collema flaccidum (Ach.) Ach. | | | | | | | X | | | | | | X | | | | | | | | | | | | |
| Collema furfuraceum (Arn.) Du Rietz | | | | | | | X | | | | | | | X | | | | | | X | | | | | |
| Collema nigrescens (Huds.) DC | | | | | | | X | | | | | | | | | | | | | X | | | | | |
| Collema subflaccidum Degel. | | | | | | | X | | | | | | | X | | | | | | X | | | | | |
| Everniastrum catawbiense (Degel.) Hale | | | | | | X | X | X | | X | | X | X | | X | | X | | | | | | | | |
| Heterodermia appalachensis (Kurok.) W. Culb. | | | | | | | X | | | | | | | | | | | | | X | | | | | |
| Heterodermia casarettiana (Mass.) Trev. | | | | | | | X | | | | | | | X | X | | | | | X | | | | | |
| Heterodermia hypoleuca (Ach.) Trev. | | | | | | | X | | | | | X | | | X | | | | | | | | | | |
| Heterodermia leucomelaena (L.) Poelt | | | | | | | X | | | | | | | X | | | | | | X | | | | | |
| Heterodermia obscurata (Nyl.) Trev. | | | | | | | X | | | | | | | | X | | | | | | | | | | |
| Heterodermia squamulosa (Degel.) W. Culb. | | | | | | | X | | | | | | | X | | | | | | X | | | | | |
| Heterodermia tremulans (Müll. Arg.) W. Culb. | | | | | | | X | | | | | | | X | | | | | | | | | | | |
| Hypogymnia krogii Ohlsson | | | | | | | X | X | | X | | X | | | | | X | | | | | | | | |
| Hypogymnia physodes (L.) Nyl. | X | | | X | | X | X | X | X | X | X | X | | X | X | X | X | | X | X | | | | | |
| Hypogymnia tubulosa (Schaer.) Hav. | | | | | | X | | | | | | | X | | | | | | | | | | | | |
| Hypotrachyna croceopustulata (Kurok.) Hale | | | | | | | | | X | | | | | | X | | | | | | | | | | |
| Hypotrachyna gondylophora (Hale) Hale | | | | | | | X | | | | | X | | | | | | | | | | | | | |
| Hypotrachyna imbricatula (Zahlbr.) Hale | | | | | | | X | | X | X | | X | X | X | X | | | | | X | | | | | |
| Hypotrachyna livida (Tayl.) Hale | | | | | | | X | | | | | | | X | X | | | | | | | | | | |
| Hypotrachyna oostingii (Dey) Hale | | | | | | | | | X | | | | | | X | | | | | | | | | | |
| Hypotrachyna prolongata (Kurok.) Hale | | | | | | | | | | X | | X | | | | | | | | | | | | | |
| Hypotrachyna revoluta (Flörke) Hale | X | | | | | | X | X | X | X | X | X | X | X | X | X | X | | | X | | | | | |
| Hypotrachyna rockii (Zahlbr.) Hale | | | | | | | X | | | | | X | | | | | | | | X | | | | | |
| Hypotrachyna showmanii Hale | | | | | | | X | | X | | | | | | X | | | | | | | | | | |
| Hypotrachyna thysanota (Kurok.) Hale | | | | | | | X | | X | | | | | | X | | | | | | | | | | |

Table II (Continued)

| | Substrate[a] | | | | | | | | | | | Vascular Plant Community[b] | | | | | | | | | Elevation[c] | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | A | B | C | D | E | F | G | H | I | J | K | A | B | C | D | E | F | G | H | I | 50 | 45 | 40 | 35 | 30 |
| Hypotrachyna virginica (Hale) Hale | | | | | | | X | X | | | X | | | X | | | X | | | | | | | | |
| Lasallia papulosa (Ach.) Llano | X | | | | | | | | | | | | | | | X | X | X | X | | | | | | |
| Leptogium cyanescens (Ach.) Korb. | | | | | | | X | | | | | | | | | | | | | X | | | | | |
| Leptogium laceroides B. de Lesd. | | | | | | | X | | | | | | X | | | | | | | X | | | | | |
| Leptogium saturninum (Dicks.) Nyl. | | | | | | | X | | | | | | X | | | | | | | | | | | | |
| Lobaria pulmonaria (L.) Hoffm. | | | | | | | X | | | | | | | X | | | | | | X | | | | | |
| Lobaria quercizans Michx. | | | | | | | X | | | | | | X | X | | | | | | X | | | | | |
| Lobaria ravenelii (Tuck.) Yoshim. | | | | | | | X | | | | | | | | | | | | | X | | | | | |
| Melanelia exasperata (De Not.) Essl. | | | | | | | X | | | | | | | X | X | | | | | X | | | | | |
| Melanelia halei (Ahti) Essl. | | | | | | | X | | | | | | | | | | | | | X | | | | | |
| Melanelia subaurifera (Nyl.) Essl. | | | | | | | X | | | | | | | | X | | | | X | | | | | | |
| Menegazzia terebrata (Hoffm.) Mass. | X | | | | | | X | | X | | | X | | | X | | X | | | | | | | | |
| Normandina pulchella (Borr.) Nyl. | | | | | | | X | | | | | | | | | | | | | X | | | | | |
| Parmelia appalachensis W. Culb. | | | | | | | X | | | | | X | X | X | | | | | | X | | | | | |
| Parmelia bolliana Müll. Arg. | | | | | | | X | | | | | | | X | | | | | | | | | | | |
| Parmelia borreri (Sm.) Turn. | | | | | | | X | | | | | | | X | | | | | | | | | | | |
| Parmelia flaventior Stirt. | | | | | | | X | | | | X | | X | X | | | X | X | | | | | | | |
| Parmelia hypoleucites Nyl. | | | | | | | X | | | | | | X | X | X | | X | | | X | | | | | |
| Parmelia omphalodes (L.) Ach. | | | | | | | X | | | | | | | X | | | | | | | | | | | |
| Parmelia reddenda Stirt. | | | | | | | X | | | | | | | | | | | | | X | | | | | |
| Parmelia rudecta Ach. | X | | | | | | X | | X | | | X | X | X | X | X | X | | X | X | | | | | |
| Parmelia squarrosa Hale | X | | | | | | X | X | X | | | X | | X | | X | X | | X | X | | | | | |
| Parmelia stictica (Duby) Nyl. | | | | | | | X | | | | | | | | X | | | | | | | | | | |
| Parmelia subrudecta Nyl. | | | | | | | X | | | | | | X | X | X | | X | | | X | | | | | |
| Parmelia sulcata Tayl. | | | | | | | X | | X | | | X | X | X | X | | X | | X | | | | | | |
| Parmelina aurulenta (Tuck.) Hale | | | | | | | X | | | | | | X | | | | | | | X | | | | | |
| Parmelina dissecta (Nyl.) Hale | X | | | | X | | X | | X | | | X | | X | X | | X | X | X | X | | | | | |
| Parmelina galbina (Ach.) Hale | | | | | | X | X | | X | | | X | | X | X | | X | | | X | | | | | |
| Parmelina horrescens (Tayl.) Hale | X | | | | | | X | X | X | X | | X | | | X | | X | X | X | X | | | | | |
| Parmelina c.f. spathulata (Kurok.) Hale | | | | | | | X | | X | | | | | | X | | | | | X | | | | | |
| Parmelina spumosa (Asah.) Hale | | | | | | | X | | | | X | | | | X | | X | | | | | | | | |

Table II (Continued)

| | Substrate[a] | | | | | | | | | | | Vascular Plant Community[b] | | | | | | | | | Elevation[c] | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | A | B | C | D | E | F | G | H | I | J | K | A | B | C | D | E | F | G | H | I | 50 | 45 | 40 | 35 | 30 |
| Parmeliopsis aleurites (Ach.) Nyl. | | | | | | | X | X | | X | | X | | | | | X | | X | | | | | | |
| Parmeliopsis placorodia (Ach.) Nyl. | | | | | | X | | | | | | | | | | | X | | | | | | | | |
| Parmotrema arnoldii (DR.) Hale | | | | | | | X | | | | | | | X | | | | | | | | | | | |
| Parmotrema crinitum (Ach.) Choisy | X | | | | | | X | | X | | | X | X | X | X | X | X | X | X | X | | | | | |
| Parmotrema hypotropum (Nyl.) Hale | | | | | | | X | | | | | | | | | | | | | X | | | | | |
| Parmotrema perlatum (Huds.) Choisy | X | | | | X | | X | | X | | | | | | X | X | X | X | | | | | | | |
| Parmotrema reticulatum (Tayl.) Choisy | X | | | | | | X | | X | | | | | X | X | X | X | | X | X | | | | | |
| Parmotrema stuppeum (Tayl.) Hale | | | | | | | X | | | | | | | X | | | | | | | | | | | |
| Parmotrema subisidiosum (Müll. Arg.) Hale | X | X | | | | | X | | | | | | X | | | X | | X | | | | | | | |
| Parmotrema tinctorum (Nyl.) Hale | X | | | | | | | | | | | | | | | | | X | | | | | | | |
| Peltigera canina (L.) Willd. | | X | | | | | | | | | | | X | | | X | | X | | | | | | | |
| Peltigera evansiana Gyel. | | | | | X | | | | | | | | X | | | | | | | | | | | | |
| Peltigera horizontalis (Huds.) Baumg. | | X | | | | | | | | | | | X | | | | X | X | | X | | | | | |
| Peltigera polydactyla (Neck.) Hoffm. | X | X | | | | | | | | | | X | X | | | | X | | | X | | | | | |
| Phaeophyscia ciliata (Hoffm.) Moberg | | | | | | | X | | | | | | X | | | | | | | | | | | | |
| Phaeophyscia pusilloides (Zahlbr.) Essl. | | | | | | | X | | | | | | | X | | | | | | X | | | | | |
| Phaeophyscia rubropulchra (Degel.) Moberg | X | | | | X | | X | | | | | | X | X | X | | | | X | X | | | | | |
| Physcia aipolia (Ehrh.) Hampe | | | | | | | X | | | | | | | X | X | | | | | X | | | | | |
| Physcia stellaris (L.) Nyl. | | | | | | X | X | X | | | | | | X | X | | X | | X | X | | | | | |
| Physconia detersa (Nyl.) Poelt | | | | | | | X | | | | | | | | | | | | | X | | | | | |
| Platismatia tuckermanii (Oakes) Culb. & Culb. | | | | X | | X | X | X | X | X | | X | X | X | X | X | X | | X | | | | | | |
| Polychidium umhausense (Auersw.) Hennsen | | | | | | | X | | | | | | X | | | | | | | | | | | | |
| Pseudevernia cladonia (Tuck.) Hale & W. Culb. | | | | | | | | | | X | | X | X | | | | | | | | | | | | |
| Pseudevernia consocians (Vain.) Hale & W. Culb. | | | | | | X | X | X | | | | | | X | X | | X | | X | X | | | | | |
| Pseudoparmelia baltimorensis (Gyel. & For.) Hale | X | | | X | | | X | | | | | | X | | | X | X | | X | | | | | | |
| Pseudoparmelia caperata (L.) Hale | X | | | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | | | | | |
| Pycnothelia papillaria (Ehrh.) Duf. | | X | | | | | | | | | | | | | | | X | | | | | | | | |
| Pyxine caesiopruinosa (Nyl.) Imsh. | | | | | | | X | | | | | | | | | | | | | X | | | | | |
| Pyxine sorediate (Ach.) Mont. | | | | | | | X | | | | | | | | X | | | | | X | | | | | |
| Ramalina americana Hale | X | | | | | X | X | | | | | | | X | X | | X | | X | X | | | | | |
| Stereocaulon dactylophyllum Flörke | X | | | | | | | | | | | | | | | X | X | | X | | | | | | |
| Stereocaulon tennessensis Magn. | X | | | | | | | | | | | | | | | | X | | | | | | | | |

Table II (Continued)

| | Substrate[a] | | | | | | | | | | | Vascular Plant Community[b] | | | | | | | | | Elevation[c] | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | A | B | C | D | E | F | G | H | I | J | K | A | B | C | D | E | F | G | H | I | 50 | 45 | 40 | 35 | 30 |
| Sticta weigelli (Ach.) Vain. | | | | | | | X | | | | | | | | | | | X | | | — | | | | |
| Umbilicaria mamulata (Ach.) Tuck. | X | | | | | | | | | | | | | | | | | X | | | — | | | | |
| Umbilicaria muhlenbergii (Ach.) Tuck. | X | | | | | | | | | | | | | | | | X | | X | | — | | | | |
| Usnea ceratina Ach. | X | | | | | | X | | X | | | | | X | X | | | | X | X | — | — | | | |
| Usnea confusa Asah. | X | | | | | | X | | | | | | | | | | X | | | X | — | — | | | |
| Usnea diplotypus Vain. | X | | | | | | | | | | | | | | | | X | | X | | — | | | | |
| Usnea hesperina Mot. | X | | | X | | | X | | | | | | | | X | | X | | X | X | — | — | | | |
| Usnea mollis Stirt. | | | | | | X | X | X | | | | X | X | | | | X | | | | — | — | | | |
| Usnea strigosa (Ach.) Eaton | | | | | | | X | | X | | | | | | X | | X | | | X | — | — | | | |
| Usnea subfloridana Stirt. | | | | | | | X | | | | | | | | | | X | | X | X | — | — | | | |
| Usnea subfusca Stirt. | | | | | | X | X | | | | | | | | X | | X | | | | — | | | | |
| Xanthoparmelia conspersa (Ach.) Hale | X | | | | | | | | | | | | | | | X | X | | | | — | | | | |
| Xanthoparmelia cumberlandia (Gyel.) Hale | X | | | | | | | | | | | | | | | | | | X | | — | | | | |
| Xanthoparmelia hypopsila (Müll. Arg.) Hale | X | | | | | | | | | | | | | | | X | | | | | — | | | | |
| Xanthoparmelia plittii (Gyel.) Hale | X | | | | | | | | | | | | | | | X | X | | X | | — | | | | |
| TOTAL FLORA | 41 | 17 | 14 | 10 | 5 | 14 | 96 | 16 | 30 | 13 | 8 | 32 | 32 | 48 | 55 | 33 | 61 | 22 | 48 | 60 | 23 | 95 | 110 | 60 | 10 |
| EXCLUSIVE FLORA | 1 | 10 | 3 | 0 | 1 | 3 | 48 | 0 | 2 | 3 | 0 | 3 | 4 | 7 | 5 | 5 | 5 | 3 | 1 | 10 | 2 | 16 | 20 | 10 | 1 |

[a]Substrate: A = Rock
B = Soil
C = Duff
D = Decayed Wood
E = Decort. Wood
F = Twigs
G = Hardwood
H = Softwood
I = Wh. Pine
J = Spruce
K = Heath

[b]Vascular Plant Community: A = Spruce
B = H. El. Decid.
C = Red Oak-Hick.
D = Wh. Pine
E = Grass Bald
F = Heath
G = Roadbank
H = Rockslide
I = Hardwood

[c]Elevation: 50 = 5000 ft.
45 = 4500 ft.
40 = 4000 ft.
35 = 3500 ft.
30 = 3000 ft.

site provided the only collection of Xanthoparmelia hypopsila. Baeomyces fungoides, Peltigera canina, and P. polydactyla were the most abundant species and formed extensive colonies on the lower slopes along the road.

Beauty Spot Forest

Beauty Spot Forest was typical of the northern red oak dominated forest on Unaka Mountain. This forest type had a total flora of ca. 40 species, almost all corticolous. Three species were collected only in this site, Parmelia bolliana, P. borreri, and P. omphalodes. These species are widespread in the southern Appalachians but not commonly collected.

Beauty Spot Gap

The forest at Beauty Spot Gap is a northern red oak dominated community. Along the roadside a small grove of honey locust provided the only collection of P. reddenda. This species is endemic to the Appalachians in North America.

Cherry Gap Trail

The largest flora for any deciduous forest was recorded for the transitional forest along the trail to Cherry Gap. Passing through birch stands, and tulip poplar flats, a total of 55 species was collected with eight unique to this site: Anaptychia palmulata, Collema nigrescens, Heterodermia appalachensis, Leptogium cyanescens, Lobaria ravenelii, Melanelia exasperata, Parmotrema hypotropum, and

Pyxine caesiopruinose. These eight taxa are more typical of lower elevations in the southern Appalachians. Polychidium umhauense was collected on a trailside hickory tree with Lobaria pulmonaria, L. quercizans, Parmelina aurulenta, Parmotrema reticulatum, and Phaeophyscia pusilloides.

Chestnut Knob

A windfall in July 1980 in the Chestnut Knob area allowed examination of the tree-top lichen flora. The most abundant species was Pseudoparmelia caperata which is abundant throughout the study area. Also common were Melanelia halei and Hypotrachyna revoluta. Cetraria orbata was collected only at this site.

Horseback Ridge

Horseback Ridge, a heath dominated community, had a total flora of 61 species. This site differs in having a narrow backbone of exposed bedrock with steep slopes on either side densely covered with heath. Five species were unique to this site: Cladina submitis, Cladonia uncialis, and Pycnothelia papillaria found on soil and duff over rock; Stereocaulon tennessensis on the bedrock, and Parmeliopsis placorodia on fallen twigs.

North Beauty Spot

The mature grove of oak, maple, and buckeye supported a well developed lichen flora with large colonies of Lobaria pulmonaria, L. quercizans, and Parmelia appalachensis. The buckeye trees

supported the largest number of species (10) per tree in this area. It also was the only substrate for Parmotrema arnoldii. Heterodermia tremulans, exclusive to this site, occurred on buckeye and oak.

Roadcut

The exposed vertical rock face at this site was the only location for Parmotrema tinctorum which is common at lower elevations and throughout the southeastern United States. Areas of the roadcut shaded by dense Rhododendron supported a large population of Umbilicaria mamulata, and was its only site on the mountain.

Rock Creek Headwaters

The forest in this site is typical of high elevation deciduous forest consisting of maple, birch, and beech in varying amounts, with occasional spruce. A total flora of 32 species was collected in this forest type with four species restricted to the Rock Creek site. Hypogymnia tubulosa, Collema flaccidum, and Leptogium saturninum were collected on hardwoods in this mature forest. An extensive colony of Peltigera evansiana occurred only on a decorticate log in this location. This forest was one of two sites for the often over-looked species, Polychidium umhausense.

Rockslide Area

The large areas of rockslides and rockfields had a total flora of 48 species with approximately 25 collected from rock substrates. The remainder were collected on accumulated soil around the boulders

or on trees in the site. While the available rock substrate was extensive in this area, the flora was not significantly different from that found on rocks in other areas. Only Xanthoparmelia cumberlandia was unique to these boulders.

Stamping Ground Ridge

Boulder fields at Stamping Ground Ridge are surrounded by heath gardens. The exposed rock provides an excellent habitat for Stereocaulon dactylophyllum, Lasallia papulosa, and species of Xanthoparmelia. Areas shaded by blueberry and rhododendron are covered by mats of Cladina arbuscula and C. rangiferina. Soil accumulation around the rock at this site were the only locations for Cladonia cryptochlorophaea in the study area.

Summit

A total flora of 31 species was documented for the spruce forests which occur on the summit, Stamping Ground Ridge, and Rattlesnake Ridge. Of these three species were exclusive to the spruce forest and collected only at the mountain summit. Cetraria aurescens and Hypotrachyna prolongata were found only on Picea rubens, and H. gondylophora on mountain ash. The two species of Hypotrachyna are not known from low elevation areas in the southern Appalachians.

White Pine Plantation

The White Pine Plantation located at an elevation of 4200 ft. on the main ridge has a lichen flora of 55 species with 5 restricted

to this site. Heterodermia obscurata, Hypotrachyna showmanii, and Hypotrachyna thysanota were collected on hardwoods, while H. croceopustulata and H. oostingii were collected on white pines. H. thysanota and H. oostingii were listed by Dey (1975) as characteristic of, and almost exclusive to, the spruce-fir community. H. croceopustulata is normally found on Abies and only infrequently on spruce or deciduous trees or rock in the spruce-fir zone. In the New World Tropics these species occur on conifers including fir, spruce, and pine (Hale, 1975). White pine, when present at this elevation, may substitute as a substrate for Abies-associated species.

No general patterns of distributions are depicted over the elevational gradient in this study. Elevational ranges of the species may correspond to the availability of suitable substrate. For example species of Hypotrachyna exclusive to the White Pine Plantation formerly were thought to be present only at elevations within the spruce-fir zone. The presence of white pine provides a suitable substrate and extends their range to 4200 ft. elevation.

## II. NORTH AMERICAN AND WORLD DISTRIBUTIONS

The species represented in this study can be divided into eleven general distribution patterns for North America, north of Mexico (Skorepa, 1972; Dey, 1975). Of the 142 species, 27 (19%) are endemic to the Appalachians in North America. Seven species (5%) are narrowly endemic, Heterodermia appalachensis, Hypogymnia krogii, Hypotrachyna showmanii, H. virginica, Melenalia halei, Parmelia

appalachensis, and Usnea subfusca. Three species endemic to the southern Appalachians but with disjuncts in Asia are Cladonia submitis, Stereocaulon tennessensis and Usnea confusa. Parmelia reddenda occurs in the southern Appalachians, Mexico, and Asia. Six species of Hypotrachyna, H. croceopustulata, H. gondylophora, H. oostingii, H. prolongata, and H. thysanota, and Everniastrum catawbiensis have disjuncts elsewhere in the New World. Two other members of Hypotrachyna, H. imbircatula and H. rockii occur on at least three continents but in North America are limited to the southern Appalachians. Other endemics with widespread distributions are Parmelia borreri and Leptogium laceroides. Usnea hesperina is found in Europe and the New World, in addition to the Appalachians.

Other patterns of distribution which may be recognized for North America include: Appalachian-Great Lakes 11 species (8%); Appalachian-Ozark Mountains 1 (0.7%); Southeastern United States Coastal Plain 2 (1%); Southeastern United States 7 (5%); Eastern United States-Southeasternmost Canada 24 (17%); Eastern North America-Rocky Mountains 13 (9%); Eastern North America-West Coast 21 (15%); Continental United States-southern Canada 12 (8%). Boreal North America 15 (11%); and Continental United States and Canada 6 (4%).

These species can be divided into world-wide distribution patterns including: Widespread 64 (45%); North America-Europe-Asia 14 (10%); North America-Europe 4 (3%); North America-Asia 9 (6%); North America-Europe-Australia 3 (2%); New World 10 (7%); New World-

Europe 1 (0.7%); New World-Africa 6 (4%); New World-Asia 2 (1%); and North America 19 (13%).

Information concerning the North American and world-wide distribution of each species is compiled and summarized in Table III.

Table III. North American and World Distributional Patterns.

| | North American[a] | | | | | | | | | | | World-wide[b] | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | A | B | C | D | E | F | G | H | I | J | K | A | B | C | D | E | F | G | H | I | J | K |
| Anaptychia palmatula (Michx.) Vain. | | | | | | X | | | | | | | | | | X | | | | | | |
| Anzia colpodes (Ach.) Stizenb. | | | | | | X | | | | | | | X | | | | | | | | | |
| Baeomyces fungoides (Sw.) Ach. | X | | | | | | | | | | | X | | | | | | | | | | |
| Bryoria furcellata (Fr.) Brodo & Hawks. | | | | | | | | | | X | | | | | X | | | | | | | |
| Candelaria concolor (Dicks.) Stein. | | | | | | | | | X | | | X | | | | | | | | | | |
| Cetraria aurescens Tuck. | | X | | | | | | | | | | | X | | | | | | | | | |
| Cetraria ciliaris Ach. | | | | | | | | X | | | | | | X | | | | | | | | |
| Cetraria oakesiana Tuck. | | X | | | | | | | | | | | | X | | | | | | | | |
| Cetraria orbata (Nyl.) Fink | | | | | | | | X | | | | | X | | | | | | | | | |
| Cetrelia cetrarioides (Del. ex Duby) Culb. & Culb. | | | | | | | | X | | | | X | | | | | | | | | | |
| Cetrelia chicitae (W. Culb.) Culb. & Culb. | | X | | | | | | | | | | | | | | X | | | | | | |
| Cetrelia olivetorum (Nyl.) Culb. & Culb. | | X | | | | | | | | | | | | X | | | | | | | | |
| Cladina arbuscula (Walbr.) Hale & Culb. | | | | | | | | | | X | | | | X | | | | | | | | |
| Cladina rangiferina (L.) Harm. | | | | | | | | | | X | | | | X | | | | | | | | |
| Cladina submitis (Evans) Hale & Culb. | X | | | | | | | | | | | | | | | X | | | | | | |
| Cladonia bacillaris (Ach.) Nyl. | | | | | | | | | | | X | X | | | | | | | | | | |
| Cladonia caespiticia (Pers.) Florke | | | | | X | | | | | | | X | | | | | | | | | | |
| Cladonia capitata (Michx.) Spreng. | | | | | | | | X | | | | X | | | | | | | | | | |
| Cladonia chlorophaea (Flörke) Spreng. | | | | | | | | | | | X | X | | | | | | | | | | |
| Cladonia clavulifera Vain. | | | | | | X | | | | | | | | | | X | | | | | | |
| Cladonia coniocraea (Flörke) Spreng. | | | | | | | | | | | X | X | | | | | | | | | | |
| Cladonia cristatella Tuck. | X | | | | | | | | | | | | X | | | | | | | | | |
| Cladonia cryptochlorophaea Asah. | | | | | | | | X | | | | X | | | | | | | | | | |
| Cladonia didyma (Fee) Vain. | | | | | | | X | | | | | | | | | | | | | | | X |
| Cladonia fimbriata (L.) Fr. | | | | | | | | | | X | | X | | | | | | | | | | |
| Cladonia floerkeana (Fr.) Flörke | | | | | | X | | | | | | X | | | | | | | | | | |
| Cladonia furcata (Huds.) Schrad. | | | | | | | | | | X | | X | | | | | | | | | | |
| Cladonia grayi Merr. | | | | | | X | | | | | | X | | | | | | | | | | |
| Cladonia macilenta Hoffm. | | | | | | | | | X | | | X | | | | | | | | | | |
| Cladonia mateocyatha Robb. | | | | | | | X | | | | | | X | | | | | | | | | |
| Cladonia pityrea (Flörke) Fr. | | | | | | X | | | | | | X | | | | | | | | | | |

Table III (Continued)

| | North American[a] | | | | | | | | | | World-wide[b] | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | A | B | C | D | E | F | G | H | I | J | K | A | B | C | D | E | F | G | H | I | J | K |
| Cladonia polycarpoides Nyl. | | | | | | X | | | | | | X | | | | | | | | | | |
| Cladonia pyxidata (L.) Hoffm. | | | | | | | | | | X | | X | | | | | | | | | | |
| Cladonia rei Schaer. | | | | | | | | | | X | | X | | | | | | | | | | |
| Cladonia squamosa (Scop.) Hoffm. | | | | | | | | X | | | | X | | | | | | | | | | |
| Cladonia strepsilis (Ach.) Vain. | | | | | | X | | | | | | | | X | | | | | | | | X |
| Cladonia uncialis (L.) G. Web. | | | | | | | | | | X | | | | X | | | | | | | | |
| Cladonia verticillata (Hoffm.) Schaer. | | | | | | | | X | | | | X | | | | | | | | | | |
| Cladonia vulcanica Zoll. & Mer. | | | | | | X | | | | | | | | | | | | | | | X | |
| Collema flaccidum (Ach.) Ach. | | | | | | X | | | | | | | | X | | | | | | | | |
| Collema furfuraceum (Arn.) Du Rietz | | | | | | | | X | | | | | | X | | | | | | | | |
| Collema nigrescens (Huds.) DC. | | | | | | | | X | | | | X | | | | | | | | | | |
| Collema subflaccidum Degel. | | | | | | X | | | | | | X | | | | | | | | | | |
| Everniastrum catawbiense (Degel.) Hale | X | | | | | | | | | | | | | | | | | X | | | | |
| Heterodermia appalachensis (Kurok.) W. Culb. | X | | | | | | | | | | | | X | | | | | | | | | |
| Heterodermia casarettiana (Mass.) Trev. | | | | | X | | | | | | | | | | | | | | | X | | |
| Heterodermia hypoleuca (Ach.) Trev. | | | | | | X | | | | | | | | | | X | | | | | | |
| Heterodermia leucomelaena (L.) Poelt | | | | | | | X | | | | | X | | | | | | | | | | |
| Heterodermia obscurata (Nyl.) Trev. | | | | | | | X | | | | | X | | | | | | | | | | |
| Heterodermia squamulosa (Degel.) W. Culb. | X | | | | | | | | | | | | | | | | | | | X | | |
| Heterodermia tremulans (Mull. Arg.) W. Culb. | | | | | | X | | | | | | | | | | | | | | | X | |
| Hypogymnia krogii Ohlsson | X | | | | | | | | | | | | X | | | | | | | | | |
| Hypogymnia physodes (L.) Nyl. | | | | | | | | | | X | | X | | | | | | | | | | |
| Hypogymnia tubulosa (Schaer.) Hav. | | | | | | | | | | X | | | | X | | | | | | | | |
| Hypotrachyna croceopustulata (Kurok.) Hale | X | | | | | | | | | | | | | | | | | X | | | | |
| Hypotrachyna gondylophora (Hale) Hale | X | | | | | | | | | | | | | | | | | | | X | | |
| Hypotrachyna imbricatula (Zahlbr.) Hale | X | | | | | | | | | | | X | | | | | | | | | | |
| Hypotrachyna livida (Tayl.) Hale | | | | | X | | | | | | | | | | | | | X | | | | |
| Hypotrachyna oostingii (Dey) Hale | X | | | | | | | | | | | | | | | | | X | | | | |
| Hypotrachyna prolongata (Kurok.) Hale | X | | | | | | | | | | | | | | | | | X | | | | |
| Hypotrachyna revoluta (Flörke) Hale | | | | | | | | X | | | | X | | | | | | | | | | |
| Hypotrachyna rockii (Zahlbr.) Hale | X | | | | | | | | | | | | | | | | | | | X | | |
| Hypotrachyna showmanii Hale | X | | | | | | | | | | | | X | | | | | | | | | |

Table III (Continued)

| | North American[a] | | | | | | | | | | | World-wide[b] | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | A | B | C | D | E | F | G | H | I | J | K | A | B | C | D | E | F | G | H | I | J | K |
| Hypotrachyna thysanota (Kurok.) Hale | X | | | | | | | | | | | | | | | | | X | | | | |
| Hypotrachyna virginica (Hale) Hale | X | | | | | | | | | | | | X | | | | | | | | | |
| Lasallia papulosa (Ach.) Llano | | | | | | | X | | | | | | X | | | | | | | | | |
| Leptogium cyanescens (Ach.) Korb. | | | | | | | X | | | | | X | | | | | | | | | | |
| Leptogium laceroides B. de Lesd. | X | | | | | | | | | | | X | | | | | | | | | | |
| Leptogium saturninum (Dicks.) Nyl. | | | | | | | | | X | | | | | X | | | | | | | | |
| Lobaria pulmonaria (L.) Hoffm. | | | | | | | | X | | | | X | | | | | | | | | | |
| Lobaria quercizans Michx. | | X | | | | | | | | | | X | | | | | | | | | | |
| Lobaria ravenelii (Tuck.) Yoshim. | | | X | | | | | | | | | | X | | | | | | | | | |
| Melanelia exasperata (De Not.) Essl. | | | | | | X | | | | | | X | | | | | | | | | | |
| Melanelia halei (Ahti) Essl. | | | | | | X | | | | | | | X | | | | | | | | | |
| Melanelia subaurifera (Nyl.) Essl. | | | | | | | | X | | | | | | | X | | | | | | | |
| Menegazzia terebrata (Hoffm.) Mass. | | | | | | | | X | | | | X | | | | | | | | | | |
| Normandina pulchella (Borr.) Nyl. | | | | | | | | | | | | X | | | | | | | | | | |
| Parmelia appalachensis W. Culb. | X | | | | | | | | | | | | X | | | | | | | | | |
| Parmelia bolliana Müll. Arg. | | | | | | | | | X | | | | | | | | | | | | | |
| Parmelia borreri (Sm.) Turn. | X | | | | | | | | | | | | | | | | | | | | | |
| Parmelia flaventior Stirt. | | | | | | | | | X | | | X | | | | | | | | | | |
| Parmelia hypoleucites Nyl. | | | | | | | | | X | | | | | | | | | | | | | |
| Parmelia omphalodes (L.) Ach. | | | | | | | | | | X | | X | | | | | | | | | | |
| Parmelia reddenda Stirt. | X | | | | | | | | | | | X | | | | | | | | | | |
| Parmelia rudecta Ach. | | | | | | | X | | | | | X | | | | | | | | | | |
| Parmelia squarrosa Hale | | | | | | | | X | | | | | | | | X | | | | | | |
| Parmelia stictica (Duby) Nyl. | | | | | | | | | X | | | | | | | | | | | | | |
| Parmelia subrudecta Nyl. | | | | | | | | X | | | | X | | | | | | | | | | |
| Parmelia sulcata Tayl. | | | | | | | | | | X | | X | | | | | | | | | | |
| Parmelina aurulenta (Tuck.) Hale | | | | | | X | | | | | | | | | | | | | | | | X |
| Parmelina dissecta (Nyl.) Hale | | | | | X | | | | | | | X | | | | | | | | | | |
| Parmelina galbina (Ach.) Hale | | | | | | X | | | | | | | | | | X | | | | | | |
| Parmelina horrescens (Tayl.) Hale | | | | | | X | | | | | | X | | | | | | | | | | |
| Parmelina c.f. spathulata (Kurok.) Hale | X | | | | | | | | | | | | | | | | | | | X | | |
| Parmelina spumosa (Asah.) Hale | X | | | | | | | | | | | X | | | | | | | | | | |

Table III (Continued)

| | North American[a] | | | | | | | | | | | World-wide[b] | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | A | B | C | D | E | F | G | H | I | J | K | A | B | C | D | E | F | G | H | I | J | K |
| Parmeliopsis aleurites (Ach.) Nyl. | | | | | | | | | | X | | | | | | | X | | | | | |
| Parmeliopsis placorodia (Ach.) Nyl. | | | | | | | X | | | | | | | | | | | | | | | |
| Parmotrema arnoldii (DR.) Hale | | | | | | | | X | | | | X | | | | | | | | | | |
| Parmotrema crinitum (Ach.) Choisy | | | | | | | | X | | | | X | | | | | | | | | | |
| Parmotrema hypotropum (Nyl.) Hale | | | | | X | | | | | | | | | X | | | | | | | | |
| Parmotrema perlatum (Huds.) Choisy | | | | | | | | X | | | | X | | | | | | | | | | |
| Parmotrema reticulatum (Tayl.) Choisy | | | | | | | X | | | | | X | | | | | | | | | | |
| Parmotrema stuppeum (Tayl.) Hale | | | | | | | | X | | | | X | | | | | | | | | | |
| Parmotrema subisidiosum (Müll. Arg.) Hale | | | | | X | | | | | | | | | | | | | | | X | | |
| Parmotrema tinctorum (Nyl.) Hale | | | | X | | | | | | | | X | | | | | | | | | | |
| Peltigera canina (L.) Willd. | | | | | | | | | | | X | X | | | | | | | | | | |
| Peltigera evansiana Gyel. | | | | | | X | | | | | | | | | | X | | | | | | |
| Peltigera horizontalis (Huds.) Baumg. | | | | | | | | X | | | | X | | | | | | | | | | |
| Peltigera polydactyla (Neck.) Hoffm. | | | | | | | | | | | X | X | | | | | | | | | | |
| Phaeophyscia ciliata (Hoffm.) Moberg | | | | | | | X | | | | | X | | | | | | | | | | |
| Phaeophyscia pusilloides (Zahlbr.) Essl. | | | | | | X | | | | | | | | | X | | | | | | | |
| Phaeophyscia rubropulchra (Degel.) Moberg | | | | | | X | | | | | | X | | | | | | | | | | |
| Physcia aipolia (Ehrh.) Hampe | | | | | | | | | X | | | X | | | | | | | | | | |
| Physcia stellaris (L.) Nyl. | | | | | | | | | | | X | X | | | | | | | | | | |
| Physconia detersa (Nyl.) Poelt | | | | | | | | X | | | | | | | | | | | | | | |
| Platismatia tuckermanii (Oakes) Culb. & Culb. | | X | | | | | | | | | | | | | | X | | | | | | |
| Polychidium umhausense (Auerse.) Hennsen | | | | | | | | | | | | | | | | | X | | | | | |
| Pseudevernia cladonia (Tuck.) Hale & W. Culb. | X | | | | | | | | | | | | | | | | | X | | | | |
| Pseudevernia consocians (Vain.) Hale & W. Culb. | X | | | | | | | | | | | | | | | | | X | | | | |
| Pseudoparmelia baltimorensis (Gyel. & For.) Hale | | | | | | | X | | | | | | | | | X | | | | | | |
| Pseudoparmelia caperata (L.) Hale | | | | | | | | | X | | | X | | | | | | | | | | |
| Pycnothelia papillaria (Ehrh.) Duf. | | X | | | | | | | | | | | | | | | X | | | | | |
| Pyxine caesiopruinosa (Nyl.) Imsh. | | | | | X | | | | | | | | | | | | | | | | | |
| Pyxine sorediata (Ach.) Mont. | | | | | | X | | | | | | X | | | | | | | | | | |
| Ramalina americana Hale | | | | | | X | | | | | | X | | | | | | | | | | |
| Stereocaulon dactylophyllum Flörke | | X | | | | | | | | | | | | | X | | | | | | | |
| Stereocaulon tennessensis Magn. | X | | | | | | | | | | | | | | | X | | | | | | |

Table III (Continued)

| | North American[a] | | | | | | | | | | | World-wide[b] | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | A | B | C | D | E | F | G | H | I | J | K | A | B | C | D | E | F | G | H | I | J | K |
| Sticta weigelii (Ach.) Vain. | | | | | | | | | X | | | X | | | | | | | | | | |
| Umbilicaria mamulata (Ach.) Tuck. | | X | | | | | | | | | | | X | | | | | | | | | |
| Umbilicaria muhlenbergii (Ach.) Tuck. | | X | | | | | | | | | | | | X | | | | | | | | |
| Usnea ceratina Ach. | | | | | | | | | X | | | X | | | | | | | | | | |
| Usnea confusa Asah. | X | | | | | | | | | | | | | | | X | | | | | | |
| Usnea diplotypus Vain. | | | X | | | | | | | | | | | | X | | | | | | | |
| Usnea hesperina Mot. | X | | | | | | | | | | | | | | | | | | X | | | |
| Usnea mollis Stirt. | | | | | | | | | | | | X | | | | | | | | | | |
| Usnea strigosa (Ach.) Eaton | | | | | | X | | | | | | | | | | | | X | | | | |
| Usnea subfloridana Stirt. | | | | | | | | | | X | | X | | | | | | | | | | |
| Usnea subfusca Stirt. | X | | | | | | | | | | | | X | | | | | | | | | |
| Xanthoparmelia conspersa (Ach.) Hale | | | | | | | | | X | | | X | | | | | | | | | | |
| Xanthoparmelia cumberlandia (Gyel.) Hale | | | | | | | | | X | | | | X | | | | | | | | | |
| Xanthoparmelia hypopsila (Müll. Arg.) Hale | | | | | | | X | | | | | | | | | | | | | | | |
| Xanthoparmelia plittii (Gyel.) Hale | | | | | | | X | | | | | | | | | | | | X | | | |
| TOTAL FLORA | 27 | 11 | 1 | 2 | 7 | 24 | 13 | 21 | 12 | 15 | 6 | 64 | 19 | 14 | 4 | 9 | 3 | 10 | 1 | 6 | 2 | 2 |

[a]North American: A = Appalachian Mt.
B = App. Mt.-Great Lakes
C = App. Mt.-Ozark Mt.
D = SE. U.S.-Coastal P.
E = SE. United States
F = E. U.S.-S. Canada
G = E. NA-S. Rocky Mt.
H = E. NA-West Coast
I = Continental US-S. Canada
J = Boreal
K = Continental US-Canada

[b]World-wide: A = Widespread
B = N. America
C = N. America-Europe-Asia
D = N. America-Europe
E - N. America-Asia
F = N. America-Europe-Australia
G = New World
H = New World-Europe
I = New World-Africa
J = New World-Asia
K = Other

# CHAPTER V

## SUMMARY

A floristic analysis of the macrolichen flora of Unaka Mountain was conducted within the elevational zone between 3000 and 5200 ft. A species list was produced which included information on the distributional patterns and species preferences for substrate, community, and elevation. Descriptions were prepared from the specimens to illustrate the species concepts used while indicating the range of variability within the species in the study area.

Other floristic studies of lichens in the southern Appalachians have included larger areas, such as the Great Smoky Mountains National Park (Degelius, 1941; Moore, 1963) or have examined the high mountain areas (Dey, 1975, 1978). Unaka Mountain, located centrally in the southern Appalachians and within ca. 100 miles of all of Dey's sites is an example of the mid-elevational zone which has not been intensively studied previously. Reaching a maximum of 5238 ft., it falls just short of the 5500 ft. lower elevational limit used by Dey (1975).

The mid-elevational mountain differs from the high elevational peaks climatically and vegetationally. Climatically, Unaka Mountain has a lower annual rainfall than the higher peaks. To the southwest and east these mountains block the moist air masses producing a rain shadow on adjacent mid-elevational mountains. The fraser fir forest, intensively studied by Dey, does not appear on the mountain and

mixed or pure fir communities common to the spruce-fir zone above 5000 ft. are absent. Between 3000 and 5200 ft. elevation, coniferous, deciduous, and heath communities normally present in the southern Appalachians are well represented.

The disturbance history of Unaka Mountain is extreme and well documented. The major disturbance factor was an extensive fire in 1925 which completely destroyed the vegetation on the mountain summit. On the steeper slopes the organic soil layer was incinerated and subsequent erosion exposed the granitic bedrock and boulders. Rockslides and rockfields have delayed re-invasion by spruce and deciduous trees and are dominant features on steeper slopes. These rock surfaces are a suitable substrate for lichen colonization. While frequency and abundance of some saxicolous species have increased, there have been no discoveries of new taxa or extensive enrichment of the macrolichen flora in these areas as compared to rock substrates of undisturbed habitats elsewhere in the study area.

Other residual effects of the fire disturbance, including establishment of secondary successional communities and plantations, have affected the lichen flora. Fire cherry, bordering the rockslides and occurring in heath communities, had the greatest diversity of lichens with up to 25 species per tree. The greatest diversity of species for any plant community was found in the secondary successional community along the Cherry Gap Trail, an area

completely destroyed by the fire. Spruce trees restocked after the fire did not support a large lichen flora, but were the only substrate for three species.

Logging and clearing was practiced in the area prior to its inclusion in the Unaka National Forest and is currently maintained by the National Forest Service. Restocking of cleared areas at moderate elevations with white pine has provided a suitable substrate for lichens associated with fraser fir and spruce at higher elevation in the southern Appalachians. This has enriched the lichen flora of the mountain by including five species of lichens normally absent below 5500 ft. elevation.

Clearing for pasture and maintenance, first by grazing and more recently by mowing, has produced grassy meadows which are similar to grassy balds of the southern Appalachians in their vascular plant flora. These unique habitats have allowed development of an extensive terricolous lichen flora. Over half of the species in the genus Cladonia present in the entire study area were found in the grassy bald at Beauty Spot. Presently, white pine encroachment threatens the grassy meadow at this site and without continued maintenance this community will be lost.

The most important factor in determining the distribution of the 142 species found in this study is the availability of a suitable substrate. Of the 78 exclusively corticolous species, 51 were restricted to hardwoods and five to conifers. Terricolous and saxicolous substrates produced 18 and 11 species, respectively. One

species, Peltigera evansiana, was collected only on decorticated wood. The remaining 34 species occurred on a variety of substrate types. Of these, only Cladonia coniocraea and C. squamosa occurred on all types of substrates.

Collections were made in 14 sites representing nine community types. Coniferous communities included spruce forest with a flora of 32 species with three species limited to this community, and white pine plantations containing 55 species with five limited to the community. Deciduous communities were high elevation deciduous types with 32 species and four species limited to this community, red oak-hickory forest with 48 species and seven limited, and secondary successional deciduous forest with 60 species and 10 species limited. Non-forest communities included heath gardens and balds with 61 species of which five were limited to this community, grassy meadows with 33 species and five limited, and roadbank communities with 22 species and three limited. Rockfield and rockslide communities had a total flora of 48 species with one species limited to those sites.

Elevational information for collections were compiled into elevational ranges for each species. These ranges are listed and summarized in Table II, page 280. While elevational preferences may be observed for individual species, no general patterns of elevational distribution are apparent in the elevational zone studied.

The species represent 11 general distributional patterns for North America and 10 world-wide patterns. The most common pattern for North America is endemic to the Appalachians. Of the total

flora 27 species (19%) exhibit this pattern with seven also endemic to North America. Widespread and occurring on at least four continents is the most common world-wide pattern with 64 species (44%) exhibiting this pattern. These distributional patterns include boreal, temperate, and tropical elements.

The 142 species collected in the study area represent 40 genera in 15 families. The largest number of species (24) were in the genus Cladonia. Other well represented genera include Parmelia (12 species), Hypotrachyna (11 species), Parmotrema (eight species), Usnea (eight species), Heterodermia (seven species), and Parmelina (six species).

A number of changes in nomenclature are recognized in this study. In Dey's (1975) survey the largest genus was Parmelia with 42 species. In the present study, 10 segregates of this genus published since 1975 have been adopted. Everniastrum, Hypotrachyna, Melanelia, Parmelina, Parmotrema, Pseudoparmelia, Xanthoparmelia, and Parmelia occurred in the study area, while Bulbothrix, Neofuscelia, and Recilina were not collected.

In addition to the segregates of Parmelia, four genera are recognized here which were not used in previous studies of the southern Appalachians. Cladina, representing Cladonia section Cladina, is used at the generic level. In the Physciaceae, Phaeophyscia and Physconia are separated from Physcia. In the Usneaceae, Bryoria is recognized as distinct from Alectoria.

These changes in generic concepts have resulted in nomenclatural changes in the specific epithet for Bryoria furcellata (Fr.) Brodo & Hawks and Physconia detersa (Nyl.) Poelt.

Of these segregate genera only Hypotrachyna and Parmelina are not well delimited in the southern Appalachians. In the groups containing gyrophoric acid and producing pustules, individuals are morphologically and chemically indistinguishable except for the presence of occasional dichotomously branched rhizines in H. revoluta and sparse marginal cilia in P. spumosa. These characteristics are often elusive. H. revoluta (sensu Dey) included all of these individuals producing gyrophoric acid as their primary chemical constituent. This highly polymorphic assemblage is in need of re-examination to determine the validity of and relationships between currently recognized taxa in this group.

In the genus Parmelina, specimens close to P. spathulata, a species known from Africa, were reported in this study. These specimens need to be re-examined and compared to type material because of the disjunct nature of this range extension.

Specimens of the Pseudoparmelia caperata-P. baltimorensis complex did not correspond to the substrate preferences described by Culberson et al. (1982). In this study over half of the collections of P. baltimorensis, including morphological extremes bearing bulbose pustules, occurred on substrates, while in Culberson et al. (1982) this species showed a preference for saxicolous substrates. This difference may be a result of differing

interpretations of the species, unavailability of accessory compound data in this study, or differences in population responses to the substrates.

The genus Usnea continues to be confusing and in need of examination and revision. Because of the diversity of chemical races in U. confusa, U. mollis, and U. subfloridana, these species may each represent a group of morphologically similar taxa. Conversely, species such as U. ceratina, U. diplotypus, and U. hesperina are delimited by their chemical composition with little regard for their polymorphic nature.

Also within the genus Usnea, U. strigosa and U. subfusca are well defined chemical species. Observations have been made on their distinct characteristics. Statistical analysis of morphological variation, distributional preferences, and chemical constituents are needed to evaluate the validity of their rank as species.

In the family Collemataceae, the genus Collema is a difficult group. The gelatinous nature and dark color of the thallus obscures many important characteristics. While the species concepts are well defined, practice and experience are required for successful taxonomic determinations.

Polychidium umhausense does not seem as rare as previously thought. Its olivaceous color and small size accounts for its rarity in herbarium collections. However, the report of a green dorsiventrally flattened lobe attached to the terete branches is the first for eastern North America. This modification of the

lichen form by the phycobiont calls into question many of the basic assumptions about the lichen symbiosis. This species should be collected for observation and determination of its distribution in the southern Appalachians and North America.

# LITERATURE CITED

## LITERATURE CITED


Ahti, T. 1961. Taxonomic studies on reindeer lichens (Cladonia subgenus Cladina). Ann. Bot. Soc. Zool. Bot. Fenn. "Vanamo" 32(1): i-iv & 1-160.

Becker, V. E. 1980. Nitrogen fixing lichens in forest of the southern Appalachian Mountains of North Carolina. Bryologist 83: 29-39.

Board of Review. 1925. Red Fork Fire, Unaka National Forest, October 29, 1925. United States Forest Service files, Erwin, Tenn.

Bowler, P. A. 1972. The distribution of four chemical races of Cladonia chlorophaea in North America. Bryologist 75: 350-354.

Brodo, I. M. and D. L. Hawksworth. 1977. Alectoria and allied genera in North America. Opera Bot. 42: 1-164.

Burchfiel, W. W., Jr. 1941. The Unaka Mountains of Tennessee and North Carolina. Master's Thesis. The University of Tennessee, Knoxville.

Culberson, C. F. 1969. Chemical and Botanical Guide to Lichen Products. Chapel Hill, N.C.

Culberson, C. F. 1970. Supplement to "Chemical and Botanical Guide to Lichen Products." Bryologist 73: 177-376.

Culberson, C. F. 1972. Improved conditions and new data for the identification of lichen products by a standardized thin-layer chromatographic method. J. Chromatogr. 72: 113-125.

Culberson, C. F. 1974. Conditions for the use of Merck silica gel 60 $F_{254}$ plates in the standardized thin-layer chromatographic technique for lichen products. J. Chromatogr. 97: 107-108.

Culberson, C. F., W. L. Culberson, and A. Johnson. 1977. Second Supplement to "Chemical and Botanical Guide to Lichen Products." St. Louis.

Culberson, C. F., W. L. Culberson, and A. Johnson. 1981. A standardized TLC analysis of β-orcinol depsidones. Bryologist 84: 16-29.

Culberson, C. F. and H. Kristinsson. 1970. A standardized method for the identification of lichen products. J. Chromatogr. 46: 85-93.

Culberson, W. L. 1966. Chemistry and taxonomy of the lichen genera Heterodermia and Anaptychia in the Carolinas. Bryologist 69: 472-487.

Culberson, W. L. and C. F. Culberson. 1968. The lichen genera Cetrelia and Platismatia (Parmeliaceae). Contrib. U.S. Natl. Herb. 34: 449-558.

Culberson, W. L. and C. F. Culberson. 1978. Cetrelia cetrarioides and C. monachorum (Parmeliaceae) in the New World. Bryologist 81: 517-523.

Culberson, W. L. and C. F. Culberson. 1981. The genera Cetrariastrum and Concamerella (Parmeliaceae): a chemosynthetic synopsis. Bryologist 84: 273-314.

Culberson, W. L. and C. F. Culberson. 1982. Evolutionary modification of ecology in a common lichen species. Syst. Botany 7: 158-169.

Dahl, A. C. and W. H. Stoneburner. 1925. Individual Fire Report, December 5, 1925, United States Forest Service file, Erwin, Tenn.

Degelius, G. 1941. Contributions to the lichen flora of North America. II. The lichen flora of the Great Smoky Mountains. Ark. Bot. 30(3): 1-80.

Degelius, G. 1954. The lichen genus Collema in Europe; morphology, taxonomy, ecology. Symb. Bot. Ups. 13: 1-499.

Degelius, G. 1974. The lichen genus Collema with special reference to the extra-European species. Symb. Bot. Ups. 20(2): 1-215.

Dennis, W. M., P. A. Collier, P. DePriest, and E. L. Morgan. 1981. Habitat notes on the aquatic lichen Hydrotheria venosa Russell in Tennessee. Bryologist 84: 402-403.

Dey, J. P. 1975. The Fruticose and Foliose Lichens of the High-Mountain Areas of the southern Appalachians. Ph.D. Dissertation. Duke University, Durham, N.C.

Dey, J. P. 1977. Phytogeographic relationships of the fruticose and foliose lichens of the southern Appalachian Mountains. IN B. C. Parker and M. K. Roans (eds.). The Distributional History of the Biota of the southern Appalachians. Part IV. Algae and Fungi. Virginia Poly. Inst. and State Univ., Res. Div. Monogr. pp. 398-416.

Dey, J. P. 1978. Fruticose and foliose lichens of the high-mountain areas of the southern Appalachians. Bryologist 81: 1-93.

Dey, J. P. 1979. Notes on the fruticose and foliose lichen flora of North Carolina and adjacent mountainous areas. Veröff. Geobot. Inst. Eidg. Tech. Hochsch. Stift. Rübel. Zür. 68. Heft. 185-205.

Dey, J. P. 1981. Key to the Parmelias (sen. lat.) of the Carolinas and adjacent mountainous areas. Unpublished Manuscript.

Esslinger, T. L. 1974. A Chemotaxonomic Revision of the Brown Parmeliae. Ph.D. Dissertation. Duke University, Durham, N.C.

Esslinger, T. L. 1977. Studies in the lichen family Physciaceae. II. The genus Phaeophyscia in North America. Mycotaxon 7: 283-320.

Esslinger, T. L. 1978. A new status for the brown Parmelae. Mycotaxon 7: 45-54.

Esslinger, T. L. 1980a. Proposal to conserve Melanelia Essl. over Pleurosticta Petrak (Lichens). Taxon 29: 692.

Esslinger, T. L. 1980b. On correct author citations for certain species of Phaeophyscia. Mycotaxon. 11: 423-424.

Esslinger, T. L. 1981. Key to the Carolina species of Physciaceae. Unpublished Manuscript.

Forest Service Timber Management Reports. Unpublished files, Erwin, Tenn.

Hack, J. T. 1965. Geomorphology of the Shenandoah Valley, Virginia and West Virginia and origin of the residual ore deposits. Geological Survey Professional Paper 484. Washington.

Hale, M. D., Jr. 1965. A monograph of Parmelia subgenus Amphigymnia. Contrib. U.S. Natl. Herb. 36: 193-358.

Hale, M. E., Jr. 1968. A synopsis of the lichen genus Pseudevernia. Bryologist 71: 1-11.

Hale, M. E., Jr. 1971. Parmelia squarrosa, a new species in section Parmelia. Phytologia 22: 29.

Hale, M. E., Jr. 1973. Fine structure of the cortex in the lichen family Parmeliaceae viewed with the scanning-electron microscope. Smithson. Contrib. Bot. No. 10.

Hale, M. E., Jr. 1974a. Delimitation of the lichen genus Hypotrachyna (Vainio) Phytologia 28: 340-342.

Hale, M. E., Jr. 1974b. New combinations in the lichen genus Parmotrema Massalongo. Phytologia 28: 334-339.

Hale, M. E., Jr. 1974c. Bulbothrix, Parmelina, Relicina, and Xanthoparmelia, four new genera in the Parmeliaceae (Lichens). Phytologia 28: 479-490.

Hale, M. E., Jr. 1975. A revision of the lichen genus Hypotrachyna (Parmeliaceae) in tropical America. Smithson. Contrib. Bot. No. 25.

Hale, M. E., Jr. 1976a. A monograph of the lichen genus Parmelina Hale (Parmeliaceae). Smithson. Contrib. Bot. No. 33.

Hale, M. E., Jr. 1976b. A monograph of the lichen genus Pseudoparmelia Lynge (Parmeliaceae). Smithson. Contrib. Bot. No. 31.

Hale, M. E., Jr. 1976c. Hypotrachyna showmanii, a new lichen from eastern North America. Bryologist 79: 78-80.

Hale, M. E., Jr. 1976d. Synopsis of a new lichen genus, Everniastrum Hale (Parmeliaceae). Mycotaxon 3: 345-353.

Hale, M. E., Jr. 1977. New species in the lichen genus Parmotrema Mass. Mycotaxon 5: 432-448.

Hale, M. E., Jr. 1979. How to Know the Lichens. Second edition. Dubuque, Iowa.

Hale, M. E., Jr. 1980. Taxonomy and distribution of the Parmelia flaventior group (Lichens: Parmeliaceae). J. Hattori Bot. Lab. No. 47: 75-84.

Hale, M. E., Jr. and W. L. Culberson. 1970. A fourth checklist of the lichens of the continental United States and Canada. Bryologist 73: 499-543.

Hale, M. E., Jr. and S. Kurokawa. 1964. Studies on Parmelia subgenus Parmelia. Contrib. U.S. Natl. Herb. 36: 121-191.

Imshaug, H. A. 1957. The lichen genus Pyxine in North and Middle America. Trans. Am. Microsc. Soc. 76: 246-269.

James, P. W. and A. Henssen. 1976. The morphological and taxonomic significance of cephalodia. IN D. H. Brown, D. L. Hawksworth, and R. H. Bailey (eds.). Lichenology: Progress and Problem. New York. pp. 27-77.

Jordan, W. P. 1973. The genus Lobaria in North America north of Mexico. Bryologist 76: 225-251.

Kelly. 1926. Letter to Forest Supervisor from the District Forester, Eastern District. March 1, 1926. Compiles from the Board of Review Report February 25, 1926. United States Forest Service files, Erwin, Tenn.

King, P. B. 1964. Geology of the Central Great Smoky Mountains, Tennessee. Geological Survey Professional Paper 349-c. Washington.

King, P. B. and H. W. Ferguson. 1969. Geology of Northeasternmost Tennessee. Geological Survey Professional Paper 311. Washington.

King, P. B., H. W. Ferguson, L. C. Craig, and J. Rodgers. 1941. Geology and manganese deposits of northeastern Tennessee. IN Tennessee Division of Geology Bulletin 52. Nashville, Tenn.

Knox, M.D.E. 1982. Three new species of Hypotrachyna (Vainio) Hale from South Africa. Bryologist 85: 118-121.

Krog, H. and T.D.V. Swincow. 1979. Parmelia subgenus Hypotrachyna in East Africa. Norw. J. of Bot. 26: 11-43.

Kurokawa, S. 1962. A monograph of the genus Anaptychia. Beih. Nova Hedwigia 6: 1-115.

Kurokawa, S. 1973. Supplementary notes on the genus Anaptychia. J. Hattori Bot. Lab. No. 37: 563-607.

Lamb, I. M. 1951. On the morphology, phylogeny and taxonomy of the lichen genus Stereocaulon. Can. J. Bot. 29: 522-584.

Lamb, I. M. 1976. Structurally unusual types of cephalodia in the lichen genus Stereocaulon (subgen. Holostelidium). J. Jpn. Bot. 51: 353-359.

Lamb, I. M. 1977. A conspectus of the lichen genus Stereocaulon (Schreb.) Hoff. J. Hattori Bot. Lab. 43: 191-355.

Lamb, I. M. 1978. Keys to the species of the lichen genus Stereocaulon (Schreb.) Hoffm. J. Hattori Bot. Lab. 44: 209-250.

Lefler, J. C. 1978. Growth and stand development of eastern white pine (Pinus strobus L.) on grass balds of Unaka Mountain in Unicoi Co., Tennessee. Unpublished M.S. Thesis, East Tennessee State University, Johnson City.

Llano, G. A. 1950. A monograph of the lichen family Umbilicariaceae in the Western Hemisphere. Office of Naval Research, Navexos P-831. Washington.

Michalek, D. D. 1968. Fanlike features and related periglacial phenomena of the Southern Blue Ridge. Master's Thesis. University of North Carolina, Chapel Hill.

Moberg, R. 1977. The lichen genus Physcia and allied genera in Fennoscandia. Sym. Bot. Up. 22: 1-108.

Moberg, R. 1978. Overlooked names and new combinations in Phaeophyscia (Lichens). Bot. Not. 131: 259-262.

Moore, B. J. 1963. A Preliminary Annotated Checklist of the Foliose and Fruticose Lichens in the Great Smoky Mountains National Park. Unpublished M.S. Thesis. The University of Tennessee, Knoxville.

National Oceanic and Atmospheric Administration. 1980. Local Climatological Data: Annual Summary with Comparative Data, Bristol, Johnson City, Kingsport, Tenn. Asheville, N.C.

Nylander, W. 1888. "Lichenes Novae Zelandize." Paris.

Payne, J. H. 1966. A Vegetational Analysis of the Rattlesnake Ridge Area of Unaka Mountain, Unicoi Co., Tennessee. Unpublished M.S. Thesis. East Tennessee State University, Johnson City.

Santesson, J. 1973. Identification and isolation of lichen substances. IN V. Ahmadjian and M. E. Hale (eds.). The Lichens. New York.

Sharp, A. J., H. R. DeSelm and R. C. Milici. 1973. Field Guide for a geobotanic transect to Fall Creek Falls, Tennessee. International Geobotany Conference, The University of Tennessee, Knoxville.

Sierk, H. A. 1958. The Collemataceae of Tennessee. Unpublished M.S. Thesis. The University of Tennessee, Knoxville.

Sierk, H. A. 1964. The genus Leptogium in North America north of Mexico. Bryologist 67: 245-315.

Skorepa, A. C. 1972. A catalog of the lichens reported from Tennessee. Bryologist 75: 481-500.

Smallshaw, J. 1953. Some precipitation-altitude studies of the Tennessee Valley Authority. Trans. Am. Geophysical Union 34(4): 583-588.

Tanner, J. T. 1963. Mountain temperatures in the southeastern and southwestern United States during late spring and early summer. J. Appl. Meterorol. 2: 473-483.

Tennessee Valley Authority, Division of Water Control Planning, Hydraulic Data Branch. 1955. Precipitation-altitude study, Snowbird Mountains, North Carolina. Report No. 0-5620. Knoxville, Tenn.

Tennessee Valley Authority, Hydraulic Data Branch. Monthly Precipitation, 224 Beauty Spot, N.C., 1934-1969. Tennessee Valley Authority files, Knoxville, Tenn.

Tennessee Valley Authority, Hydraulic Data Branch. Monthly Precipitation, 221 Erwin, Tenn., 1926-1980. Tennessee Valley Authority files, Knoxville, Tenn.

Tennessee Valley Authority, Hydraulic Data Branch. Monthly Precipitation, 672 Sams Gap (Radio), Tenn., 1953-1980. Tennessee Valley Authority files, Knoxville, Tenn.

Tennessee Valley Authority, Hydraulic Data Branch. Monthly Precipitation, 659 Poplar, N.C., 1945-1980. Tennessee Valley Authority files, Knoxville, Tenn.

Thomson, J. W. 1950. The species of Peltigera of North America north of Mexico. Am. Midl. Nat. 44: 1-68.

Thomson, J. W. 1963. The lichen genus Physcia in North America. Beih. Nova Hedwigia 7: 1-172.

Thomson, J. W. 1967a. The lichen genus Baeomyces in North America north of Mexico. Bryologist 70: 285-298.

Thomson, J. W. 1967b. The Lichen Genus Cladonia in North America. Toronto.

United States Forest Service. 1971. Forest Survey of Tennessee.

United States Department of Agriculture. 1941. Climate and Man. Yearbook of Agriculture. Washington.

United States Department of Commerce. Weather Bureau. 1930. Climatic Summary of the United States. Sections 76-77. Bulletin W. Washington.

United States Department of Commerce. Weather Bureau. 1941. Agricultural Yearbook Separate No. 1859. Climate of the States, Tennessee. Washington.

United States Department of Commerce. Weather Bureau. 1957. Climatography of the United States No. 10-77. Climatic Summary of the United States Section 77. Eastern Tennessee. Washington.

United States Department of Commerce. Weather Bureau. 1960. Climatography of the United States No. 60-40. Climates of the States, Tennessee. Washington.

United States Department of Commerce. Weather Bureau 1976-1978. Monthly Thermal Data, Unicoi, Tennessee. Weather Bureau files, Knoxville, Tennessee.

United States Department of Commerce. Weather Bureau 1980-1981. Monthly Thermal Data, Erwin, Tennessee. Weather Bureau files, Knoxville, Tennessee.

Weaver, G. T. 1972. Dry Matter and Nutrient Dynamics in the Red Spruce-Fraser Fir and Yellow Birch Ecosystems in the Balsam Mountains, Western North Carolina. Unpublished Ph.D. Dissertation, The University of Tennessee, Knoxville.

Wetmore, C. M. 1960. The lichen genus Nephroma in North and Middle America. Publ. Mus. Mich. State Univ., Biol. Ser. 1: 396-452.

Woods, F. W. 1953. Memo to acting Forest Supervisor, Cherokee National Forest, Watauga District, May 27, 1953. United States Forest Service files, Erwin, Tenn.

Yoshimura, I. and A. J. Sharp. 1968a. A revision of the genus Gymnoderma. Am. J. Bot. 5: 635-640.

Yoshimura, I. and A. J. Sharp. 1968b. Some lichens from the southern Appalachians and Mexico. Bryologist 71: 108-113.

# APPENDIX

## COLLECTING SITES

### 1. Beauty Spot

Beauty Spot, a maintained grassy bald located on a 4200 ft. elevational knob of the main ridge, was extensively pastured until 1965. The current vegetation consists of a grass-forb dominated community. The top of the bald is covered by Danthonia, and as the slope angle descends it is replaced by Fragaria and other creeping vines. Along the lower margin of the bald, Polytrichum spp., and Lycopodium spp. form dense mats under well-spaced Rhododendron shrubs. White pine encroachment is common along drainage areas. Clumps of hawthorn, blueberries, and blackberries occur along the western slope. Rocks are occasional, but the sedimentary bedrock is never exposed.

### 2. Beauty Spot Forest

The forest surrounding Beauty Spot constitutes a second growth forest dominated by red oak. The collecting site in this forest was located south of the main meadow and just east of the Appalachian Trail.

### 3. Beauty Spot Gap

Beauty Spot Gap is located in a narrow saddle between Beauty Spot and the mountain summit. It supports a red oak-hickory forest with maples, yellow birch, dogwood, and cherry. The shrub layer is

composed mainly of blueberry, blackberry, and greenbrier. Summer herbs include Urtica sp., Impatiens sp., and Scutellaria sp. Immediately northeast of the road is a small grove of honey locust.

Previous to 1925 this area was logged and the timber removed by narrow gauge railroad along the western slope. The 1925 fire was controlled and extinguished at the gap, otherwise known at that time as Deep Gap.

### 4. Cherry Gap Trail

Cherry Gap Trail leaves the service road at an elevation of ca. 4400 ft. and descends through deciduous forest to Low Gap at 3800 ft. elevation. This gap, situated on the main ridge, has a hardwood forest dominated by tulip poplar and supplemented by hickory, maple, magnolia, and oaks. Shrubs include viburnum, blackberry, and rhododendron. Summer herbs observed along the trail were Impatiens sp. and Urtica sp. At higher elevations along the trail the forest structure changes to yellow birch and occasional maples.

### 5. Chestnut Knob

Chestnut Knob is located along the service road between Beauty Spot and Beauty Spot Gap. A summer storm in 1981 produced a large windfall in the oak-hickory-maple canopy which was examined for lichens contained in the upper canopy.

### 6. Horseback Ridge

Horseback Ridge is a narrow ridge extending northwest from the summit with flat bedrock exposed along its backbone. Granitic rock outcroppings predominate from an elevation of 4800 ft. to 4500 ft. Rocky exposures are bordered by rhododendron, mountain laurel, and blueberry, as well as a variety of well-spaced trees including spruce, hemlock, pine, yellow birch, and maple.

### 7. North Beauty Spot

North Beauty Spot is a smaller meadow maintained by the U.S. Forest Service just north of Beauty Spot on the main ridge. A mature grove of oak, buckeye, and maple is located at the southern edge of this meadow and east of the service road was examined in this study.

### 8. Rattlesnake Ridge

The summit of this high elevational ridge, extending westward from the mountain top, reaches 4800 ft. elevation. It is an unmaintained turnout and picnic area which offers a scenic view of the Erwin valley and the Salsam Range of the Blue Ridge. Along the southwest slope is a dense heath bald dominated by rhododendron, blueberry, service berry, and fire cherry. On the northwest ridge this community is replaced by maple, beech, and yellow birch. Blueberry and rhododendron dominate the shrub layer, and a Danthonia

herb layer. The northeast slope is the site of a spruce plantation. The closed canopy produces a cool moist environment with a lush herb layer of ferns, bead lilies, Oxalis, club moss, Houstonia, and mosses and liverworts. Though replanted in the 1940's the community appears to be typical of spruce forest.

9. Roadcut

A vertical rock wall is located along the service road between Beauty Spot Gap and the Pleasant Gardens cut-off. This rock face is up to 20 ft. high and partially shaded by rhododendrons.

10. Rock Creek Headwaters

This site is located in the high elevation deciduous forest along the upper slopes near the summit at ca. 4800 ft. elevation. This forest, north of Beauty Spot Gap and west of the service road is composed of birch, beech, and maple and interspersed with spruce.

11. Rockslide Area

Boulder fields and slides occur along the service road just north of the summit at 4800 ft. elevation. These were carefully examined to determine their lichen flora. The eastern margins of this slide is defined by a mountain stream sparsely forested by fire cherry, birch, and maple.

## 12. Stamping Ground Ridge

Stamping Ground Ridge is a long spur off the main ridge. Its scenic views, blueberry gardens, and interesting flora make it a popular stop. A jeep trail runs along the crest of this ridge between 4800 and 4400 ft. elevations where it is replaced by a foot trail leading to Limestone Cove.

The picnic area and turnout are located in a heath garden largely composed of Vaccinium spp. and Rhododendron. Immediately below the garden on the northeast slope is a broad boulder field. The granitic boulders are on the average 6 in. square. Along the margins of the slide are fire cherry trees, Vaccinium, and occasional pines. Ferns are abundant in this area. This area of the ridge was completely destroyed in the fire.

Moving down the ridge top the non-forest community is replaced by a high elevation deciduous forest composed of yellow birch, maple, beech with occasional spruce and fire cherry. The understory in the closed forest is Rhododendron with ferns and grasses.

A spruce plantation is located in a narrow gap at ca. 4500 ft. elevation. The dense stand has few understory plants except along the margins where it grades into the high elevation deciduous forest. The presence of year-round puddles evidences persistent seeps. The bedrock is sedimentary but not exposed.

On either side of the gap the forest is composed of spruce, birch, maple, and hemlock. The canopy is closed but very low.

On the knobs of the ridge the forest grades into a dense rhododendron stand with well-spaced trees. Less than 5% of the ground is exposed rock.

At lower elevations, less than 4500 ft. elevation, the numbers of spruce trees diminish until there is a well-developed high elevation deciduous forest with an understory of Rhododendron, Vaccinium, and Rubus.

### 13. Summit

The summit of the mountain is covered by a closed canopy spruce forest. This area can be reached from the north or south by the Appalachian Trail. This trail cuts through high elevation deciduous and heath dominated communities.

### 14. White Pine Plantation

The White Pine Plantation is located on the east slope of Stamping Ground Ridge at an elevation of 4300 ft. Hardwoods present along the margins in low frequency include fire cherry, yellow birch, maple, hickory, beech, and magnolia. A sparse shrub layer includes greenbrier, blackberry, and rhododendron with a number of populations of Indian Pipe.

# VITA

Paula Teresa DePriest was born in Dyer, Tennessee on October 5, 1957. She attended elementary school in that city and was graduated from Dyer High School in May 1975. The following September she entered Union University in Jackson, Tennessee and in December 1978 received a Bachelor of Science degree in Biology.

In the Spring of 1979 she entered The Graduate School of The University of Tennessee, Knoxville and accepted a teaching assistantship there in September 1979. She received the Master of Science degree with a major in Botany in August 1983.

Currently she is employed by the National Park Service to study the lichens of the Great Smoky Mountains National Park.