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Notes of the fruticose and foliose lichen flora of
North Carolina and adjacent mountainous areas

by

Jonathan P. DEY

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1. Introduction

As the participants of this phytogeographical excursion have seen, the fruticose and foliose lichens often form a very conspicuous component of the vegetation of the southeastern United States. Rock outcrops in the mountains, the trunks of hardwood trees in open stands on xeric sites in the mountains, and the sandy soils in the coastal plain sandhills are often covered with lichens.

This paper provides a preliminary overview of the fruticose and foliose lichen flora of North Carolina and the adjacent mountainous areas. Literature studied by DEY (1976) and lichen specimens located in the United States National Herbarium, in the Duke University Herbarium and in the author's personal herbarium, show that the North Carolina-southern Appalachian Mountain macrolichen flora includes approximately 325 species in 54 genera. The species level taxonomy of most genera is quite good. Taxonomic

problems remain in *Usnea* and *Ramalina* and to lesser degree in the genus *Cladonia*. When the taxonomies of the two further genera are most satisfactorily resolved, the number of macrolichens is likely to exceed 325 species. Compared to Florida with its macrolichen flora of over 150 species (MOORE 1968), the macrolichen flora of North Carolina is very rich in diverse. This is, of course, a reflection of the mountainous area of North Carolina which gives it greater ecological and climatic diversities and a different geological history than Florida.

An examination of the distributional patterns of these lichens in the continental United States and Canada will provide some insights into phyto-geographical relationships of the lichen flora. Additionally, a consideration of fruticose and foliose lichens typical of different types of substrates will provide a sampling of the taxa in flora as well as some ecological observations.

2. Distributional patterns

The fruticose and foliose lichens of North Carolina and the southern Appalachian Mountains have distributional ranges in the continental United States and Canada which generally conform to distributional patterns which are well known to North American lichenologists (HALE 1961, THOMSON 1963, BRODO 1968, WETMORE 1968). The first lists of lichens in the southern Appalachians grouped by distributional type were prepared by SKOREPA (1972) and DEY (1975), and later they were expanded and refined by DEY (1976). When the distributions of the fruticose and foliose lichens of the entire state of North Carolina are considered, a southeastern coastal plain distribution pattern must be recognized in addition to the ten patterns recognized for species occurring in the southern Appalachian Mountains (DEY 1976). The following treatment, largely from DEY (1976), includes only a sampling of taxa representative of the major distributional patterns of the North Carolina-southern Appalachian Mountain fruticose and foliose lichens in the continental United States and Canada:

2. 1. Appalachian Mountains (Maps 1 and 2)

Thirteen species are narrowly endemic to the Appalachian Mountains: *Alectoria fallacina**, *Cetraria culbersonii*, *Cladonia psoromica* Dey, *Ephebe americana*, *Heterodermia appalachensis*, *Gymnoderma lineare*, *Hypogymnia krogii* Ohlssen, *Hypotrachyna dentella* (Hale and Kurok.) Hale, *H. virginia* (Hale) Hale, *Parmelia appalachensis*, *Pseudoparmelia alabamensis* (Hale and McCull.) Hale, *Xanthoparmelia monticola* (Dey) Hale and *X. piedmontensis* (Hale) Hale.

Over twice as many additional species, known in the Appalachian Mountains in North America north of Mexico only have disjuncts elsewhere. For example, *Stereocaulon tennesseense* has the well-known Appalachian-Japanese disjunctive pattern, *Anzia americana* occurs elsewhere only in Mexico and *Heterodermia propagulifera* (Vain.) Dey, *Leptogium laceroides* B. de Lesd. and *Parmelia reddenda*, have disjunct populations on at least three other continents.

2. 2. Appalachian Mountains-Great Lakes (Maps 3 and 4)

Six species, *Cetraria aurescens*, *Cladonia cylindrica*, *Melanelia halei* (Ahti) Essl., *Parmotrema margaritatum* (Hue) Hale, *Platismatia tucker-mani* and *Umbilicaria mammulata*, are endemic to this region. Examples of species which are common in the Appalachian Mountain-Great Lakes region and disjunctively distributed to other areas of the world include *Cetrelia chici-tae*, *Cladonia incrassata*, *Phaeophyscia pusilloides* (Zahlbr.) Essl., *Pycnothelia papillaria* and *Stereocaulon pileatum*.

2. 3. Appalachian Mountains-Ozark Mountains (Maps 5 and 6)

Cladonia apodocarpa, *Dirinaria frostii*, *Leptogium apalachense* and *L. juniperinum* are the only fruticose and foliose lichens endemic to this region. *Heterodermia echinata*, *H. granulifera*, *Pannaria rubiginosa* and

* Nomenclature and authorities as given in HALE and CULBERSON (1970) unless otherwise noted.

Parmelina dissecta (Nyl.) Hale are representative of species which are also found elsewhere in the world.

2. 4. Southeastern United States Coastal Plain

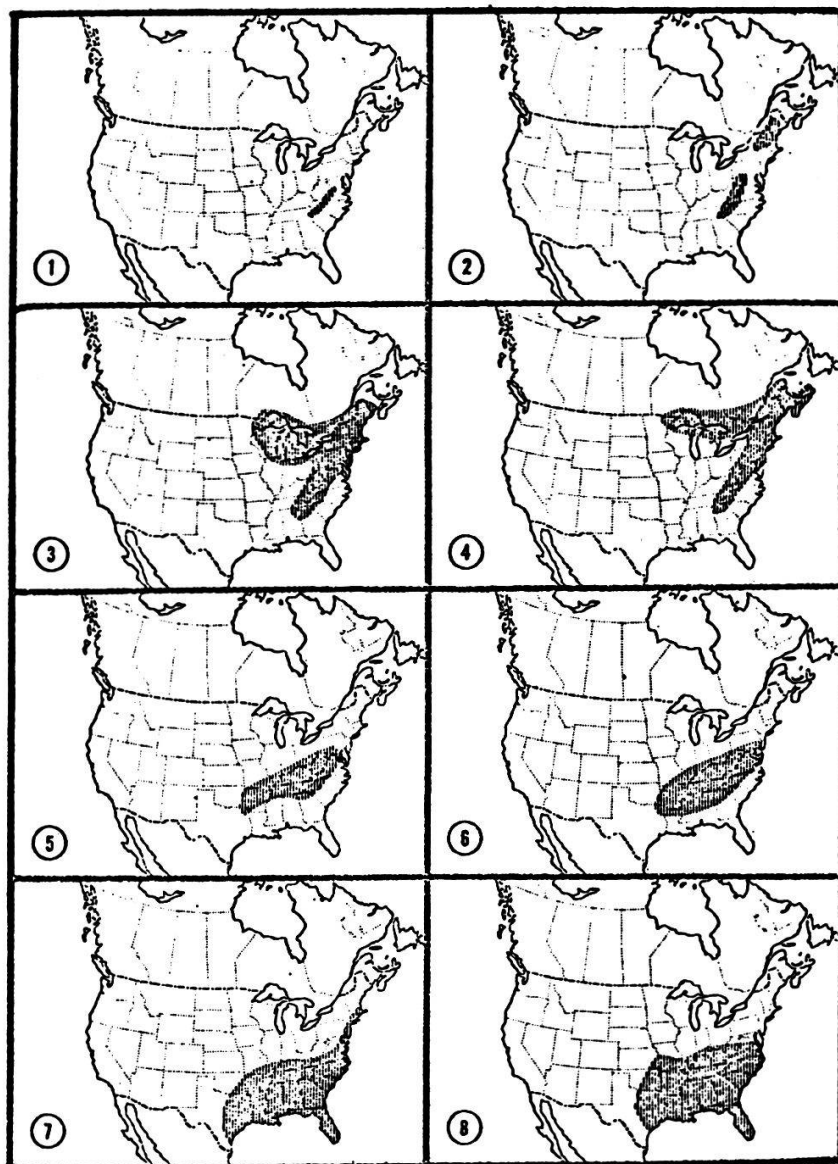
Many species of this group occur in the coastal plain and less commonly the adjacent area of the lower piedmont from Texas to Florida and north to the middle Atlantic States of Virginia and North Carolina. Some species extend further north along the Mississippi River and Ohio River Valleys and/or along the coast to the Cape Cod area of Massachusetts.

Bulbothrix confoederata (W. Culb.) Hale, *Cladonia beaumontii*, *C. pachycladodes*, *C. perlomera* and *C. subsetacea* are endemic to portions of the coastal plain region. Other species typically have either North American-tropical American distributions or pantropical distributions. Examples include *Bulbothrix goebelii* (Zenk.) Hale, *B. laevigatula* (Nyl.) Hale, *Cladonia balfourii*, *C. evansii* Abb., *C. leporina*, *Dirinaria aegialita*, *D. aspera*, *Heterodermia albicans* (Pers.) Swinsc. and Krog, *Leptogium millegranum*, *L. phyllocarpum*, *Lobaria ravelinii* (Tuck.) Yoshim., *Parmotrema dilatatum* (Vain.) Hale, *P. hypoleucinum* (J. Stein) Hale, *P. praesorediosum* (Nyl.) Hale, *P. ram-poddense* (Nyl.) Hale, *P. rigidum* (Lynge) Hale, *P. tinctorum* (Nyl.) Hale, *Physciopsis syncolla*, *Teloschistes chrysophthalmus* and *T. flavicans*.

2. 5. Southeastern United States (Maps 7 and 8)

In contrast to the previously described distribution patterns, species of this group may be collected in the coastal plain, the piedmont and the lower mountains of the southeastern United States.

Endemic to the southeastern United States are *Cladonia atlantica*, *Hypotrachyna livida* (Tayl.) Hale, *Parmeliopsis halei*, *Parmotrema perforatum* (Jacqu.) Mass. sens. str. and *Xanthoparmelia hypomelaena* (Hale) Hale. Other species, such as *Anzia ornata*, *Coccocarpia cronia*, *Heterodermia casarettiana*, *Leptogium chloromelum*, *Parmotrema subisidiosum* (Mull. Arg.) Hale, *P. ultralucens* (Krog) Hale, *Pseudocyphellaria aurata* and *Pseudoparmelia caroliniana* (Nyl.) Hale, also occur in the American tropics and/or are pantropical.



Maps 1-8. 1. *Hypotrachyna virginica* (Hale) Hale. 2. *Pseudevernia cladonia* (Tuck.) Hale and W. Culb. north of Mexico (after HALE 1968). 3. *Platismatia tuckermanii* (Oakes) W. Culb. and C. Culb. (after CULBERSON and CULBERSON 1968). 4. *Stereocaulon dactylophyllum* Florke north of Mexico (after HALE 1969). 5. *Heterodermia granulifera* (Ach.) W. Culb. (after KUROKAWA 1962). 6. *Parmelina dissecta* (Nyl.) Hale north of Mexico (after HALE 1969). 7. *Parmotrema perforatum* (Jacq.) Mass. Sens. str. (after CULBERSON and CULBERSON 1973). 8. *Pyxine caesiopruinosa* (Nyl.) Imsh. north of Mexico (after CULBERSON and HALE 1965). (Maps 1-8 from DEY 1976. Copyright by University of Virginia. Used with permission.)

2. 6. Eastern United States-Southernmost Eastern Canada (Map 9)

Species of this group occur seemingly with the boundary of the eastern deciduous forest. *Anzia colpodes*, *Cladonia caroliniana*, *Leptogium dactylinum*, *Parmelina obsessa* (Ach.) Hale, *Parmotrema michauxianum* (Zahlbr.) Hale and *Pseudoparmelia baltimorensis* (Gyeln. and For.) Hale are endemic species. *Anaptychia palmulata*, *Cladonia clavulifera* and *Parmelina galbina* (Ach.) Hale have the well-known eastern North American-Japanese disjunctive distribution. Other species with disjunctive distributions include *Cladonia strepsilis*, *Leptogium corticola*, *Pannaria leucosticta*, *Parmelina aurulenta* (Tuck.) Hale and *Pyxine soorediata*.

2. 7. Eastern North America-Southern Rocky Mountains (Map 10)

Besides having representatives in the southern Rocky Mountains (including the Black Hills), lichen species grouped here have varied ranges in eastern North America. Species occurring in the East only in the Appalachian Mountains include *Heterodermia squamulosa*, *Hypotrachyna laevigata* (Sm.) Hale and *H. revoluta* (Florke) Hale; species restricted in eastern North America to the Appalachian Mountains-Great Lakes region include *Cetraria ciliaris*, *Lasallia papulosa*, *L. pennsylvanica*, *Lobaria quercizans*, *Pseudevernia consocians* and *Ramalina intermedia*; species restricted in the East to the Appalachian Mountains-Ozark Mountains include *Cladonia robbinsii* and *Xanthoparmelia subramigera* (Gyeln.) Hale; species restricted in the East to the southeastern United States are *Cladonia didyma* and *Heterodermia obscurata*; lastly species such as *Cetraria fendleri*, *Cladonia cristatella*, *Dermatocarpon tuckermanii*, *Pannaria pityrea* and *Parmelia rudecta*, are widely distributed in the eastern United States and southernmost eastern Canada in addition to their disjunctive representatives in the southern Rocky Mountains. Only five species with eastern American-southern Rocky Mountain distributions are endemic to North America north of Mexico; *Cladonia cristatella*, *C. mateocyatha*, *C. robbinsii*, *Physcia halei* and *P. subtilis*.

2. 8. Eastern North America-West Coast (Map 11)

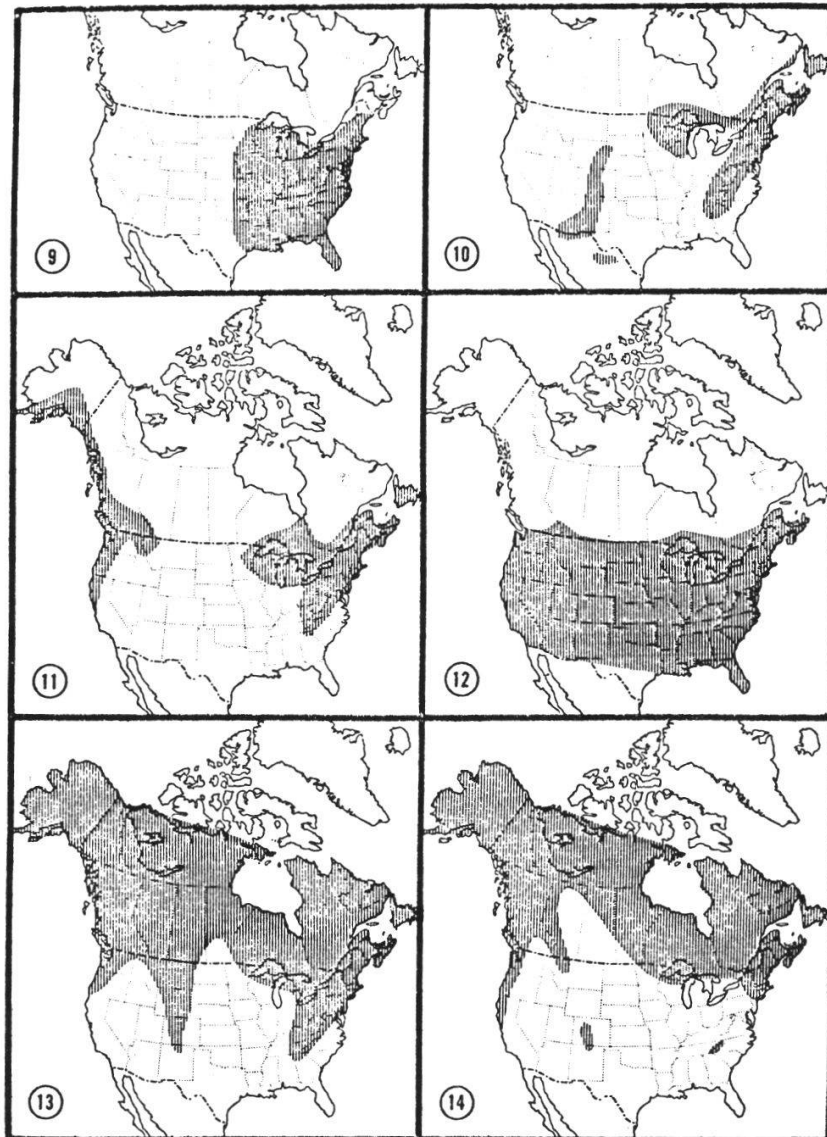
Species in this group have disjunctive representatives along the west coast and in some other regions of eastern North America. Four such species - *Cetralia cetrarioides*, *Hydrotheria venosa*, *Hypotrachyna sinuosa* (Sm.) Hale, and *Sticta limbata* - are restricted in eastern North America to the Appalachian Mountains. *Cetraria orbata*, *Menegazzia terebrata*, *Parmotrema arnoldii* (Du Rietz) Hale, *Pseudocyphellaria crocata*, and *Sticta fuliginosa* are examples of species restricted in the East to the Appalachian Mountains-Great Lakes region. *Cetraria viridis* occurs in the southeastern United States and the Pacific Northwest. Examples of species which are widespread in eastern North America are *Cladonia capitata* and *Physcia tribacoides*. Three lichens - *Cetraria orbata*, *C. viridis*, and *Hydrotheria venosa* - are endemic to the continental United States and Canada.

2.9. Continental United States-Southern Canada (Map 12)

Of this group only *Xanthoparmelia cumberlandia* (Gyeln.) Hale is endemic to North America. Other broadly ranging species in temperate North America include *Candelaria concolor*, *Cladonia macilenta*, *Physcia aipolia*, *Pseudoparmelia caperatum* (L.) Hale, and *Xanthoparmelia conspersa* (L.) Hale. Some temperate species, such as *Cladonia squamosa*, *Heterodermia leucomela*, *Parmelia flaventior*, *Peltigera horizontalis* and *Sticta weigeli*, occur at least sporadically in the East, the southern Rocky Mountains, and the West Coast.

2.10. Alaska to Greenland or northeastern Canada; South along the West Coast, in the Rocky Mountains, and in the Appalachian Mountains

This type of distribution is usually referred to as the boreal pattern. The southward extension of species in the mountains is either more or less continuous as in *Cetraria islandica* (Map 13) or discontinuous with disjunctive representatives in the mountains to the south as in *Baeomyces rufus* (Map 14). Common boreal species include *Bryoria nadvornikiana* (Gyeln.) Brodo & Hawksw., *Cladonia arbuscula* (Wallr.) Rabh., *C. digitata*, *C. gracilis*, *Ephebe*



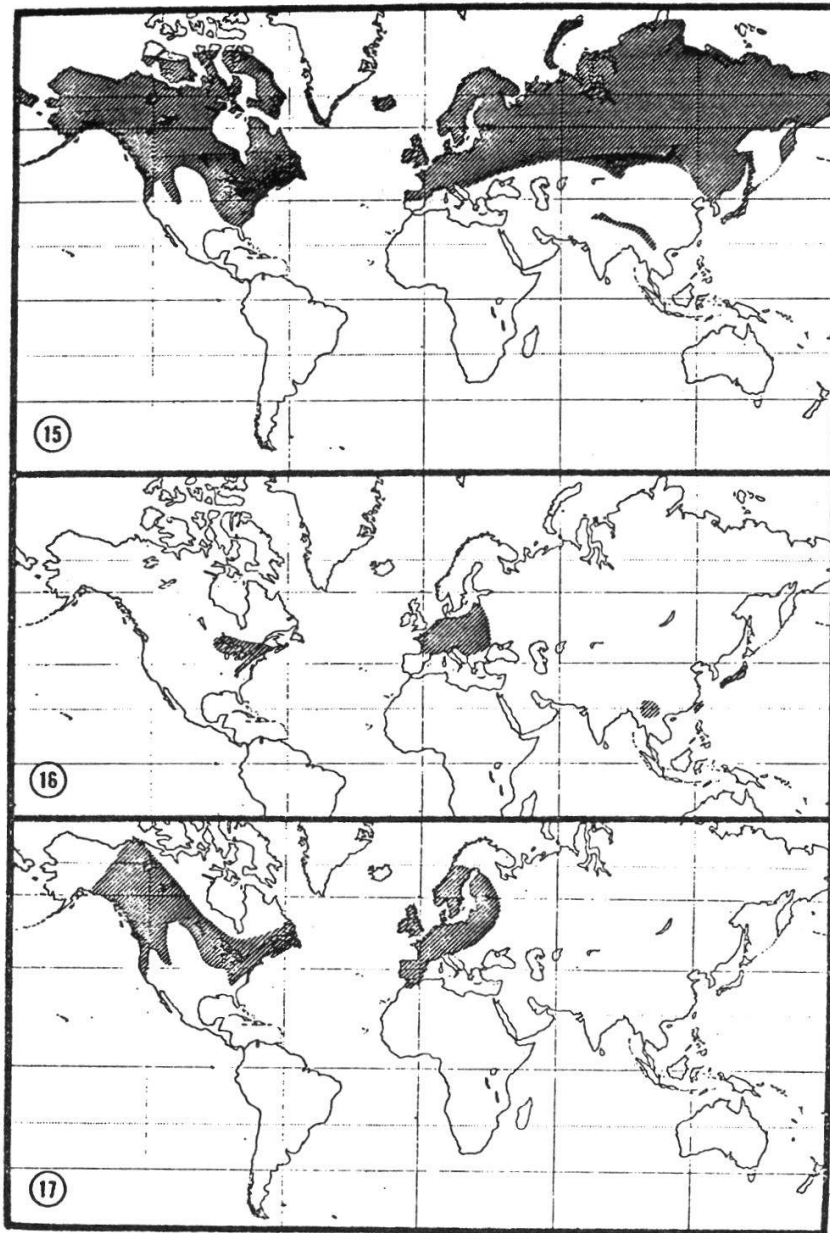
Maps 9-14. 9. *Parmelina aurulenta* (Tuck.) Hale north of Mexico (after HALE 1969). 10. *Lasallia papulosa* (Ach.) Llano north of Mexico (after HALE 1969). 11. *Lobaria pulmonaria* (L.) Hoffm. north of Mexico (after JORDAN 1973). 12. *Phaeophyscia ciliata* (Hoffm.) Moberg north of Mexico (after THOMSON 1963). 13. *Cetraria islandica* (L.) Ach. north of Mexico (after HALE 1969). 14. *Baeomyces rufus* (Huds.) Rebent. north of Mexico (after THOMSON 1967, expanded). (Maps 9-14 from DEY 1976. Copyright by University of Virginia. Used with permission.)

lanata, *Hypogymnia physodes*, *H. tubulosa*, *Melanelia stygia* (L.) Essl., *Parmelia omphalodes*, and *Platismatia glauca*. Many species are circumboreal and not one is endemic to North America.

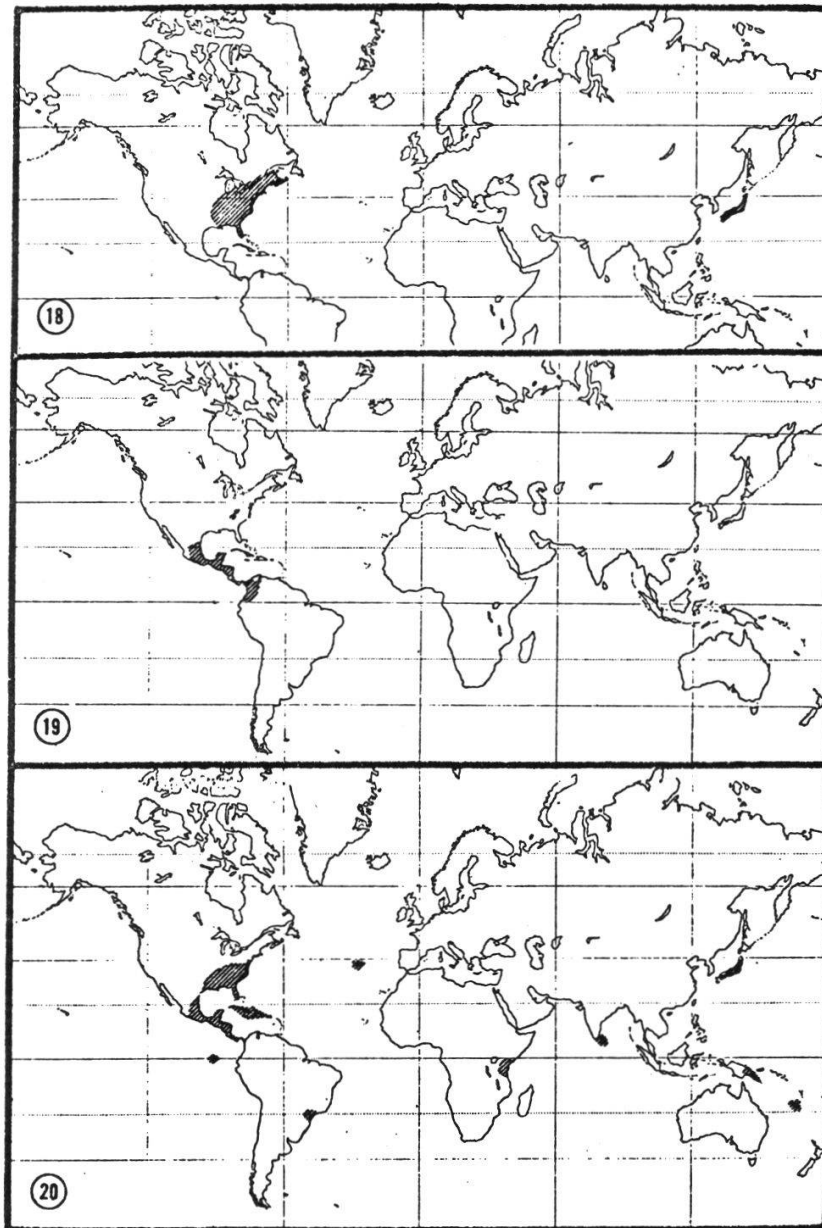
2.11. Continental United States-Canada

Species with widespread North American ranges include *Cladonia bacillaris*, *C. coniocraea*, *C. furcata*, *Peltigera canina*, *P. polydactyla*, and *Xanthoparmelia taractica* (Gyeln.) Hale.

Thus, the North Carolina-southern Appalachian Mountain fruticose and foliose lichen flora includes species with northern or circumboreal affinities as well as species with southern or tropical affinities. Several of the common world distribution patterns exhibited by these lichens clearly illustrate these affinities (DEY 1976). Species with circumboreal distributions are either more or less continuously distributed, like *Cladonia rangiferina* (Map 15), or discontinuously distributed, like *Cetrelia olivetorum* (Map 16). The amphiatlantic (North American-European) distribution pattern is illustrated by *Melanelia subaurifera* (Map 17). Some species, including *Parmelina galbina* (Map 18), have the well-known eastern North American-southeastern Asian or Japanese distribution. Another interesting distributional pattern is the disjunctive occurrence of nine *Hypotrachyna* species in the spruce-fir forest of the southern Appalachian Mountains and in Mexico or tropical America. *Hypotrachyna prolongata* (Map 19, = *Parmelia rachista*) is an example of this category. Over 120 species are widely distributed in the world, occurring on at least four continents. Many of these species are widely distributed in the tropics and are pantropical, such as *Parmotrema ultralucens* (Map 20); whereas many others are circumboreal with additional representatives in South America, Africa, and/or Australia-New Zealand (DEY 1976).



Maps 15-17. 15. *Cladonia rangifera* (L.) G. Web. (after AHTI 1961). 16. *Cetrelia olivetorum* (Nyl.) W. Culb. and C. Culb. (after CULBERSON and CULBERSON 1968). 17. *Melanelia subaurifera* (Nyl.) Essl. (after map and information in ESSLINGER 1974). (Maps 15-17 from DEY 1976. Copyright by University of Virginia. Used by permission.)



Maps 18-20. 18. *Parmelina galbina* (Ach.) Hale (after KUROKAWA 1972). 19. *Hypotrachyna prolongata* (Kurok.) Hale. 20. *Parmotrema ultralucens* (Krog) Hale (after KROG 1974). (Maps 18-20 from DEY 1976. Copyright by University of Virginia. Used by permission.)

3. Substrates and habitat preferences

The vegetation of the southern Appalachian Mountains and State of North Carolina is generally divided by botanists into community types which are recognized by plant growth forms and dominant species. Many investigators have studied the vegetational community types of North Carolina and these studies are cited elsewhere in the article by PEET in this volume (p. 263). Among such studies, there are relatively few papers which deal with lichens characteristic of vascular plant communities in North Carolina. Significant among papers dealing with the lichens are those concerning the following communities or geographic areas: the Great Smoky Mountain National Park (DEGELIUS 1941), the spruce-fir forest zone of the southern Appalachians (DEY 1978), the pine-inhabiting vegetation of North Carolina (CULBERSON 1958), and the *Cladoniae* of the sandy pine-oak forests of the coastal plain (EVANS 1947).

The distributions of the fruticose and foliose lichens are largely related to substrate distribution and climatic factors. Since substrate availability often reflects climatic conditions and also limits the potential local distribution of lichens, the lichens will be grouped and considered under their preferred substrate type.

3.1. *Saxicolous lichens*

Exposed rock surfaces are scattered throughout the mountains and the piedmont, and the larger rock outcrops are usually at least partially covered by lichens. Typical fruticose and foliose lichens on exposed, non-calcareous rocks in the mountains include the umbilicate lichens, the *Stereocaulon* species, and many yellow *Xanthoparmelia* species. *Umbilicaria caroliniana*, *U. mamulata*, *U. muhlenbergii* (Ach.) Tuck., *Lasallia papulosa*, and *L. pensylvanica* have umbilicate thalli. *Umbilicaria caroliniana* is restricted to the Appalachian Mountains with disjunctive populations in Alaska and eastern Asia. The fruticose *Stereocaulon* species, *S. dactylophyllum*, *S. pileatum*, and *S. tennesseense*, are restricted to higher elevations in the southern Appalachians. Another *Stereocaulon*, *S. ramulosum*, is known in North America only from Roan

Mountain on the North Carolina-Tennessee border. It has been collected there only three times, by Thaxter in 1887, by Dahl in 1953, and by Sharp in 1957. Subsequent attempts to relocate the population of this species on Roan Mountain have been futile to date (DEY 1978). *Xanthoparmelia conspersa*, *X. cumberlandia*, and *X. hypomelaena* occur both in the mountains and the piedmont while others, such as *X. monticola*, *X. plittii* (Gyeln.) Hale, and *X. taractica*, seem to be restricted to the mountains.

Grandfather Mountain, North Carolina is the southernmost North American locality for *Xanthoparmelia incurva* (Pers.) Hale, a small, yellow, sorediate lichen. This arctic-boreal circumpolar species is known elsewhere in the continental United States only at two New England mountain sites (DEY 1974b). Another lichen found on Grandfather Mountain is *Ramalina intermedia*, a small sorediate fruticose lichen occurring sporadically and rarely in the southern Appalachians. *Ramalina petrina* Bowler and Rundel, another sorediate lichen, is a southern Appalachian Mountain endemic which is rarely collected at lower elevations.

Only one *Usnea* species commonly occurs on rock in the southern Appalachians and, for lack of better taxonomic understanding, DEY (1978) was only able to refer to it as *Usnea diplotypus* Vain. This taxon is common in North America in the Ozark Mountain-southern Appalachian Mountain region.

Three rarely collected saxicolous lichens have brown foliose thalli. Both *Melanelia stygia* and *Cetraria hepatizon* are non-isidiate and non-sorediate lichens with boreal distributions. *Cetraria culbersonii* is a rare Appalachian endemic with marginal soralia.

Other saxicolous foliose lichens include *Dermatocarpon minatum*, *Ephebe americana*, *Heterodermia pseudospeciosa*, *Parmelia omphalodes*, *Parmelina obsessa*, *Physcia subtilis*, and *Pseudoparmelia baltimorensis*. Many typically corticolous lichens occasionally occur on rock.

Two species occur on shaded rocks. *Baeomyces rufus*, a small fruticose species with a northern boreal distribution, has disjunctive representatives on shaded rocks within the spruce-fir forest in the southern Appalachians. *Gymnoderma lineare* is a very interesting Appalachian endemic which was first described by EVANS (1947) as *Cladonia linearis* and later placed in the typically southeast Asian genus *Gymnoderma* by YOSHIMURA and SHARP (1968). This

lichen is usually, but rarely, found on rocks along shaded streams or on shaded rocks on steep slopes.

Hydrotheria venosa, a rarely collected North American endemic of the Appalachians and the Pacific Northwest, is a unique aquatic lichen. The thalli, which are frequently fertile with conspicuous apothecia, are dark brownish gray with noticeable vein-like patterns on their lower surface. In the southern Appalachians this species has been collected at two sites in Virginia, two sites in North Carolina, and one in Tennessee, always on submerged rocks in fast moving streams. *Ephebe lanata* and *E. solida* are rarely collected fruticose morphs found in the mist zone of waterfalls or near waters edge along streams. The only other macrolichen associated with streams is the much more conspicuous foliose *Dermatocarpon fluviatile*, a perithecial ascomycete lichen which is frequently collected throughout the southeastern piedmont and mountain region.

Calciphilic lichens are more or less restricted to the few scattered locations of exposed limestone in North Carolina and the southern Appalachian Mountains. Several members of the *Collemataceae* are rarely collected calciphiles. Included here are *Leptogium appalachense*, *L. dactylinum*, and *Collema pustulatum*. *Collema bachmanianum*, another calciphile, is restricted to limestone soils.

3.2. Terricolous-Lignicolous Lichens.

Many fruticose terricolous-lignicolous lichens have broad climatic tolerances and are collected throughout North Carolina. Examples include *Baeomyces fungoides* (Sw.) Ach., *Cladonia bacillaris*, *C. capitata*, *C. chlorophaea*, *C. coniocraea*, *C. cristatella*, *C. cryptochlorophaea*, *C. cylindrica*, *C. didyma*, *C. grayi*, *C. incrassata*, *C. squamosa*, *C. strepsilis*, *C. subcariosa*, *C. subtenuis* (Abb.) Evans, *C. uncialis*, *C. verticillata*, and *Pycnothelia papillaria*. Species restricted in North Carolina to the high elevation spruce-fir forest include *Cladonia digitata* which is typically lignicolous and *C. gracilis* which is terricolous. Other lichens found locally only in the mountains are *Cetraria islandica*, *Cladonia merochlorophaea*, *C. pleurota*, *C. psoromica*, and *C. submitis* Evans. Other *Cladonia* species, such as *C. apodocarpa*,

C. arbuscula, *C. clavulifera*, *C. furcata*, *C. macilenta*, *C. mateocyatha*, and *C. rangiferina*, occur throughout the mountains and the piedmont of North Carolina. *Peltigera canina* and *P. polydactyla*, two foliose species, are also common in the mountains and piedmont. Generally restricted to the coastal plain in North Carolina are *Cladonia balfourii*, *C. beaumontii*, *C. evansii*, *C. leporina*, *C. pachycladodes*, *C. perlomera*, and *C. subsetacea*.

Roadbanks, which are periodically disturbed through mowing and other activities, are ideal habitats for *Peltigera canina* and many of the previously mentioned *Cladonia* species such as *C. capitata*, *C. chlorophaea*, *C. fimbriata*, *C. mateocyatha*, and *C. verrucillata*. *Baeomyces fungoides* is characteristic of disturbed soil sites (DEY 1978).

Frequently, the open ground space of plant communities occurring on xeric sites in the mountains (ericaceous heath balds and *Pinus*-ericaceous heath communities) and in the piedmont (*Quercus*-*Pinus*-ericaceous heath, *Quercus*-*Carya*, and *Quercus*-*Pinus* communities) support a continuous to sporadic ground cover of large species of *Cladonia* such as *C. arbuscula*, *C. rangiferina*, *C. subtenuis*, and *C. uncialis*. In the mountains *Cetraria islandica* is often found growing among the *Cladonia* thalli.

The sandy soils of the coastal plain often support a unique *Cladonia* ground cover. This is particularly true in the xeric *Quercus laevis**-*Pinus palustris* communities of the sandhills of the upper coastal plain and in the open *Quercus*-*Pinus taeda* forests surrounding Jones, White, and Singletary Lakes in Bladen County. Characteristic *Cladonia* species include *C. caroliniana* (= *C. dimorphoclada* Robb. of Ahti, 1973), *C. leporina*, *C. pachycladodes*, and *C. subsetacea* (EVANS 1947). *Cladonia evansii* is more common on exposed sandy soils on the coastal strand islands and some mainland coastal areas.

* The scientific names for woody plants follow the nomenclature in RADFORD, AHLES and BELL (1964)

3.3. Corticolous Lichens

For corticolous lichens, the major dichotomy in substrates is between the generally softer, more acidic, and resinous bark of evergreen coniferous trees, such as *Abies fraseri*, *Picea rubens*, *Tsuga* species, and *Pinus* species, and the generally harder, less acidic, non-resinous bark of deciduous hardwood trees, such as *Acer*, *Quercus*, *Carya*, *Fagus*, and *Betula* species (CULBERSON and CULBERSON 1973). In the following discussion, the fruticose and foliose lichens characteristic of conifer tree dominated plants communities are indicated, and then those of hardwood tree dominated plants communities:

At highest elevations in the southern Appalachian Mountains, a *Picea rubens*-*Abies fraseri* (spruce-fir) forest exists. Minor canopy component trees are *Betula lutea* and *Sorbus americana*. The diversity and abundance of lichens on *Abies* is much greater than on *Picea*. Evidently physical characteristics, such as flakiness, and chemical characteristics of the bark greatly reduce the ability of lichens both to colonize and to persist on *Picea* as compared to their ability to live on the bark of *Abies*. Corticolous lichens typical of the spruce-fir forest include *Alectoria fallacina*, *Bryoria trichodes* var. *americana* (Mot.) Brodo and Hawksw., *Bryoria nadvornikiana* (Gyeln.) Brodo and Hawksw., *Hypogymnia tubulosa*, *H. vittata*, *Lobaria scrobiculata*, *Melanelia halei*, *Menegazzia terebrata*, *Platismatia glauca*, *Pseudevernia cladonia*, and *Usnea confusa* (DEY 1978). Particularly interesting and characteristic are *Hypotrachyna croceopustulata* (Kurok.) Hale, *H. densirhizinata* (Kurok.) Hale, *H. gondylophora* (Hale) Hale, *H. imbricatula* (Zahlbr.) Hale, *H. oostingii* (Dey) Hale, *H. producta* Hale, *H. prolongata* (Kurok.) Hale (= *Parmelia rachista* Hale in DEY 1978), *H. rockii* (Zahlbr.) Hale, and *H. thysanota* (Kurok.) Hale. These nine *Hypotrachyna* species are known in North America north of Mexico only in the southern Appalachian Mountains, and they have disjunctive representatives in tropical America or in South America and/or Africa. Normally collected on *Abies fraseri* in the southern Appalachians, these interesting disjunctive *Hypotrachyna* species were very infrequently collected on *Picea rubens* and rarely or apparently not at all on either deciduous trees or rocks. In view of the continuing local devastation of *Abies fraseri* trees by the balsam woolly aphid, *Adelges picea* Ratz., will the numbers of these

lichens on *Picea* or other substrates increase or will the opening up of the forest canopy by the death of the *Abies* trees alter the environment to the point that the presence of some of these *Hypotrachyna* species in the southern Appalachians will be threatened (DEY 1974 a)?

Tsuga canadensis and *T. caroliniana* occur at lower elevations in the southern Appalachians. Systematic collections of lichens growing on them have not yet been made. Among lichens I have collected on hemlock trees are thalli of *Anzia americana*, a rare foliose lichen known only from the southern Appalachians and Mexico.

CULBERSON (1958) has sampled the lichens occurring on pine trees along a transect from the mountains to the coast in North Carolina. Along the transect, he encountered *Pinus rigida*, *P. strobus*, *P. virginiana*, and *P. echinata* in the mountains; mainly *P. virginiana* and *P. echinata* in the piedmont, and primarily *P. palustris* and *P. taeda* (including *P. serotina*) in the coastal plain. The corticolous lichen vegetation became richer in species from the ocean towards the upper coastal plain where it dropped suddenly, to less than one species per quadrat (tree), in the sandhills. The vegetation then became more diversified through the piedmont into the mountains. As evidenced by an average of 9 lichen species per quadrat (tree), the vegetation was most luxuriant on the pines at the highest elevations (1100 m) sampled (CULBERSON 1958). Of the 66 lichen species reported in the study, forty were fruticose and foliose lichens. *Cetraria fendleri*, *Cladonia parasitica* (as *C. delicata* (Ehr.) Florke), *Parmelia rudecta*, *Parmelina dissecta* (Nyl.) Hale (as *Parmelia dissecta* Nyl.), *Parmotrema perforatum* (Jacq.) Hale (as *Parmelia erecta* "B" Berry), *Parmotrema reticulatum* (Tayl.) Hale (as *Parmelia reticulata* Tayl.), *Pseudoparmelia caroliniana* (Nyl.) Hale (as *Parmelia caroliniana* Nyl.), and unidentified *Parmelia* thalli were collected on pines in the mountains, the piedmont, and the coastal plain. *Parmelina galbina* (as *Parmelia subquercifolia* Hue), *Parmeliopsis aleurites*, and *Pseudoparmelia caperatum* (as *Parmelia caperata* (L.) Ach.) occurred predominantly in the mountains and the piedmont. *Cetraria aurescens*, *C. ciliaris*, *C. oakesiana*, *Cladonia coniocraea*, *Menegazzia terebrata* (as *Parmelia pertusa* (Schränk.) Schaer), *Platismatia tuckermanni* (as *Cetraria tuckermanni* Oakes), and *Usnea* species were collected in the mountains and occasionally the upper piedmont. In contrast, *Parmeliopsis*

halei (as *Parmeliopsis ambigua*, usnic acid strain), *Parmotrema hypotropum* (Nyl.) Hale? (as *Parmelia trichotera* Hue), and *Parmotrema hypoleucinum*? (as *Parmelia erecta* "A" Berry) are reported on pines only in the coastal plain. CULBERSON (1958) attributed the increase in number of species in the mountains to factors associated with increasing elevation such as increased humidity, and he attributed the dearth of thalli on *Pinus palustris* in the sandhills to the great aerial aridity above the sandy soils (but did not rule out the effects of periodic fires).

The hardwood-inhabiting lichens are usually epiphytic on several hardwood species. Because substrate tree species, such as *Betula lutea* and *Quercus alba*, are frequently components of several different vascular plant communities, most corticolous lichen species show only generalized habitat preferences. Ecological studies are required in order to clarify the importance of individual lichen species in each community type and to identify lichen communities within the vascular plant communities (DEY 1978).

Characteristic fruticose and foliose lichens restricted to mountainous community types include *Bryoria furcellata* (Fr.) Brodo and Hawksw., *Collema flaccidum*, *Erioderma mollissimum*, *Everniastrum catawbiense* (Degel.) Hale, *Heterodermia squamulosa*, *Hypogymnia physodes*, *Leptogium chloromelum*, *L. lace-roides*, *Melanelia subaurifera*, *Menegazzia terebrata*, *Nephroma parile*, *N. resupinatum*, *Parmelia borrieri*, *P. flaventior*, *P. reddenda*, *P. sulcata*, *Parmotrema arnoldii*, *P. stuppeum* (Tayl.) Hale, and *Xanthoria polycarpa*. Additionally, many fruticose and foliose lichens, occurring in the mountains, also grow in plant communities of the piedmont. Included here are *Anaptychia palmutata*, *Heterodermia appalachensis*, *H. echinata*, *H. hypoleuca*, *H. propagulifera*, *Leptogium burnetiae* Dodge, *L. corticola*, *Lobaria pulmonaria*, *L. quercizans*, *Pannaria rubiginosa*, *Parmelia appalachensis*, *P. subrudecta*, *Parmeliella corallinoides*, *Parmotrema diffractaicum* (Essl.) Hale, *P. margaritatum*, *P. simulans* (Hale) Hale, *Phaeophyscia adiastrum* (Essl.) Essl., *Physconia deterosa*, *Platismatia tuckermanii*, *Pseudevernia consocians*, *Pseudoparmelia baltimorensis*, and *Sticta weigeli*. Other species found in the mountains are also collected in the piedmont and the coastal plain on hardwood trees. These species include *Anzia colpodes*, *Candelaria concolor*, *Cladonia coniocraea*, *C. squamosa*, *Coccocarpia cronia*, *Collema subflaccidum* Degel., *Heterodermia casarettia*-

na, *H. obscurata*, *H. tremulans*, *Hypotrachyna livida*, *Leptogium cyanescens*, *Nephroma helveticum*, *Parmelia rudecta*, *Parmelina aurulenta*, *P. galbina*, *Parmotrema crinitum* (Ach.) Hale, *P. hypotropum*, *P. madagascariaceum*, *P. michauxianum*, *P. perforatum*, *P. perlatum* (Huds.) Choisy, *P. reticulatum*, *P. subisidiosum*, *P. subtinctorum* (Zahlbr.) Hale, *P. ultralucens*, *Phaeophyscia pusilloides*, *P. rubropulchra* (Degel.) Essl., *Physcia aipolia*, *P. millegrana*, *P. tribacoides*, *Pseudocyphellaria aurata*, *Pseudoparmelia caperata*, *P. caroliniana*, and *Pyxine soredata*.

In the piedmont, most of the corticolous fruticose and foliose lichens occurring on hardwood trees were mentioned above as lichens also found in the mountains or in the mountains and coastal plain. Also important is a smaller group of species such as *Anzia ornata*, *Bulbothrix goebelii*, *Coccocarpia parmelioidea*, *Heterodermia albicans*, *Parmotrema haitiense* (Hale) Hale, *P. hypoleucinum*, *P. rampoddense*, *P. tinctorum*, *Phaeophyscia luganensis* (Mer.) Essl., *Pyxine caesiopruinosa*, and *Xanthoria candelaria*. The distributional ranges of some of these species are centered in the coastal plain and extend only into the lower piedmont.

Teloschistes chrysophthalmus and *T. flavicans* are restricted on the coastal maritime forest of *Quercus virginiana*, *Pinus taeda*, and species of *Ilex*, *Myrica*, *Persea*, and *Juniperus*. Other species restricted in North Carolina to the coastal plain include *Bulbothrix confoederata*, *B. laevigatula*, *Dirinaria aegialita*, *D. aspera*, *Leptogium phyllocarpum*, *Lobaria ravenelli*, *Parmotrema dilatatum*, *P. internexum* (Nyl.) Hale, *P. praesorediosum*, and *P. rigidum*.

Many of the corticolous lichens occurring on hardwood trees are also found occasionally on conifer trees.

Summary

The fruticose and foliose lichen flora of the North Carolina-southern Appalachian Mountains region is estimated to include 325 species representing 54 genera. The distributional ranges of most species in North America north of Mexico correspond closely to eleven well-known patterns. Examples of species with each pattern are provided. The fruticose and foliose lichen flora includes species with northern or circumboreal affinities as well as species with southern or tropical affinities. Examples of fruticose and foliose lichens typically occurring on the major substrate types- such as non-calcareous rocks, soils, conifer trees, and hardwood trees- in the mountains, the piedmont, and the coastal plain are provided.

Zusammenfassung

Die Flora der Strauch- und Blattflechten von Nordkarolina und den südlichen Appalachen umfasst etwa 325 Arten aus 54 Gattungen. Die Verbreitungsareale der meisten nordamerikanischen Arten nördlich von Mexiko können 11 gut fassbaren Verbreitungstypen zugeordnet werden. Für jeden Typ werden Beispiele angeführt. Die Strauch- und Blattflechten umfassen Arten mit nördlicher und zirkumborealer sowie solche mit südlicher und tropischer Affinität. Es werden Beispiele von Strauch- und Blattflechten auf einigen typischen Unterlagen, wie kalkarmen Felsen, Böden, Nadelbäumen und Hartholzbäumen, für alle drei Zonen des Gebietes, Gebirge, Hügelland (Piedmont) und Küstenebene, angegeben.

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