



5-10-1991

## A Morphological and Chemical Study of the Lichen Genus Hypogymnia in North America North of Mexico

Melinda McFarlin '91  
*Illinois Wesleyan University*

Follow this and additional works at: [https://digitalcommons.iwu.edu/bio\\_honproj](https://digitalcommons.iwu.edu/bio_honproj)



Part of the [Biology Commons](#)

---

### Recommended Citation

McFarlin '91, Melinda, "A Morphological and Chemical Study of the Lichen Genus Hypogymnia in North America North of Mexico" (1991). *Honors Projects*. 29.  
[https://digitalcommons.iwu.edu/bio\\_honproj/29](https://digitalcommons.iwu.edu/bio_honproj/29)

This Article is protected by copyright and/or related rights. It has been brought to you by Digital Commons @ IWU with permission from the rights-holder(s). You are free to use this material in any way that is permitted by the copyright and related rights legislation that applies to your use. For other uses you need to obtain permission from the rights-holder(s) directly, unless additional rights are indicated by a Creative Commons license in the record and/ or on the work itself. This material has been accepted for inclusion by faculty at Illinois Wesleyan University. For more information, please contact [digitalcommons@iwu.edu](mailto:digitalcommons@iwu.edu).

©Copyright is owned by the author of this document.

A Morphological and Chemical Study of the  
Lichen Genus *Hypogymnia* in North America  
North of Mexico

Melinda McFarlin  
Research Honors in Biology  
Illinois Wesleyan University  
Advisor: Jonathan P. Dey  
10 May 1991

## INDEX

Abstract.....	3
Introduction.....	4
<i>Hypogymnia</i> in North America.....	5
Studies of the Genus <i>Hypogymnia</i> throughout the World .....	10
Methods .....	11
Taxonomic Characters .....	13
Morphology.....	13
Chemistry .....	14
Taxonomic Treatment.....	18
Description of Genus.....	18
Key to Species Identification.....	19
Species Description.....	22
Species Distribution Patterns.....	53
North American .....	53
World .....	54
Literature Cited.....	56

## FIGURES

Figures 1-9 Structures of Lichen Substances .....	16
---	----

## TABLES

Table 1. Comparison of <i>Brodoa</i> with <i>Hypogymnia</i> and Allied Genera.....	9
Table 2. Lichen Substances Detected in <i>Hypogymnia</i> Species.....	17

## ABSTRACT

The lichen genus *Hypogymnia* is widely distributed throughout the world, in such places as Europe, Asia, Africa, Australia, New Zealand, Japan, and North America. Currently, there are twenty-one recognized species of *Hypogymnia* in North America, but no comprehensive study of the genus in North America has been published.

My study of the genus *Hypogymnia* was performed on a sample of 784 North American specimens collected from the western United States, southern Canada, the Great Lakes region, and the eastern United States. The morphological characteristics of each lichen specimen were examined. Chemical studies included preliminary spot test screening of the cortex and medulla of each lichen specimen, followed by thin layer chromatographic procedures to attempt to identify the lichen substances present in each specimen, and to evaluate the chemical variation within each species.

In this preliminary study of the genus *Hypogymnia* in North America, specimens of fifteen of the twenty-one described species of *Hypogymnia* have been examined as well as specimens of four new, undescribed species tentatively recognized by Lawrence Pike (on loan from the U.S. National Herbarium at the Smithsonian Institution). Patterns of morphological variation and chemical variation were identified for each species. New chemical strains have been detected in *Hypogymnia imshaugii*. My examination of Pike's undescribed, new species leads me to support the recognition of three of the four species as valid species worthy of publication. Thus, I recognize a total of 24 species of *Hypogymnia* in North America north of Mexico. The first comprehensive key to all of these species of *Hypogymnia* has been prepared. Additionally a brief description of the morphology, chemistry and geographical distribution of each species is provided.

## A Morphological and Chemical Study of the Lichen Genus *Hypogymnia* in North America, North of Mexico

Species belonging to the genus *Hypogymnia* are foliose lichens that are firmly attached to the substrate at the center of the thallus. Lobes radiating outward from the center of the thallus are either firmly attached to the substrate or loosely attached to suberect. The lobes are typically hollow and often inflated. Some species of *Hypogymnia* reproduce asexually by dispersal of soredia which are clusters of algal and fungal cells, originating from either the disintegration of the upper cortex or from burst lobe tips. A few species disperse finger-like projections of the thallus called isidia as their means of asexual reproduction. Species that lack soredia and isidia may reproduce asexually by fragmentation. Apothecia and pycnidia, sexual reproductive structures involved in propagating only the fungus, are common in some *Hypogymnia* species. Species of *Hypogymnia* are typically corticolous, growing on the bark of trees.

Lichens now placed in the genus *Hypogymnia* were first studied by Europeans in the mid 1700's and the 1800's. In 1753, Linnaeus recognized and named the species *Lichen physodes* (Imshaug, 1957). Then in 1803, Acharius proposed the genus *Parmelia* in which he included *Lichen physodes* as well as three new species: *Parmelia duplicata*, *P. enteromorpha*, and *P. vittata* (Krog, 1968). In the late 1800's Nylander elevated the group of *Parmelia* species that he had previously placed in the subgenus *Hypogymnia* to the generic level as *Hypogymnia* (Krog, 1968). Additionally, he described two new species: *H. austerodes* and *H. subcapitata*. Most lichenologists did not accept the classification of *Hypogymnia* as a genus, continuing to classify it as a subgenus of *Parmelia*. However, in the 1960's, two noted, influential

lichenologists--J. Poelt, a German, and M. Hale, an American--began treating *Hypogymnia* as a separate genus from *Parmelia* as Nylander had proposed. This is a view supported by virtually all lichenologists today.

*Hypogymnia* is widely distributed throughout the world. Currently, there are twenty-one recognized species of *Hypogymnia* in North America, north of Mexico, of which seven were newly described within the last eighteen years, and one was recently reported new in North America (Egan, 1987; Brodo, 1989). Additionally, there are at least three new species from western North America, tentatively recognized by Lawrence Pike, which have not yet been described. A comprehensive study of the genus *Hypogymnia* in North America has not been published. The goals of my research were: (1) to identify and to compare the patterns of morphological variation and chemical variation within and between each species, based on a sample of over 750 specimens, and (2) to prepare a comprehensive key to the *Hypogymnia* species of North America, north of Mexico.

## HYPOGYMNIA IN NORTH AMERICA

The earliest studies of *Hypogymnia* of North America included that of the European lichenologist Acharius. Menzies collected specimens of *Hypogymnia* in North America which he sent to Acharius. Based on these specimens, Acharius described the North American species now known as *H. enteromorpha*. (Krog, 1968). Later, in the early 1900's, Fink, in his study of the lichen flora of the United States, recognized three inflated species of *Parmelia*: *P. physodes*, *P. encausta*, and *P. pertusa*. However, he did recognize two varieties of *P. physodes* --var. *enteromorpha* and var. *vittata*; these varieties

had been recognized as species of *Parmelia* by Acharius. (Fink, 1935). Berry, in his 1940 monograph of the genus *Parmelia* in North America, recognized four species belonging to the subgenus *Hypogymnia*: *P. encausta*, *P. enteromorpha*, *P. lophyrea*, and *P. physodes*. In addition, he recognized var. *vittata* of *P. physodes*, and he classified *P. pertusa* in *Parmelia* subgenus *Menegazzia* (Berry, 1940).

In the mid 1950's, Hale and Culberson began preparing checklists of the lichens of North America, north of Mexico. In their first checklist (1956), they recognized 85 species of *Parmelia*, seven belonging to the subgenus *Hypogymnia*, and one belonging to the subgenus *Menegazzia* (Hale & Culberson, 1956). Their second checklist, prepared in 1960, recognized 122 *Parmelia* species, nine belonging to the subgenus *Hypogymnia*, and one belonging to the subgenus *Menegazzia* (Hale & Culberson, 1960). In their third checklist, Hale and Culberson (1966) recognized *Hypogymnia* as a genus, following Nylander's proposal. Thirteen species of *Hypogymnia* were recognized in this checklist, and one species of *Menegazzia*--*M. terebrata*, previously known as *P. pertusa* (Hale & Culberson, 1966).

In the late 1960s, Krog made several revisions to the genus *Hypogymnia* during her study of Alaskan macrolichens. Noting the extensive morphological and chemical variation in the species *H. enteromorpha*, Krog separated *H. imshaugii* from *H. enteromorpha*. She also recognized a new variation of *H. imshaugii*: var. *inactiva*, and described *Hypogymnia oroarctica* as a new species (Krog 1968). In their fourth checklist of the lichens of North America, Hale and Culberson (1970) included sixteen species of *Hypogymnia*, and one of *Menegazzia*.

In 1973, a preliminary study of the species of *Hypogymnia* in the United States and Canada was published by Ohlsson. Ohlsson described a

new species, *H. krogii*, found only in the eastern United States, and also introduced a new combination, *H. inactiva*. In addition, he produced a key to fourteen of the sixteen species of *Hypogymnia* that were reported in North America at that time. He summarized the lichen substances found in the North American species of *Hypogymnia* as well (Ohlsson, 1973).

Recently, many *Hypogymnia* specimens from western North America were carefully studied by Lawrence Pike and Mason Hale. In 1979, Pike recognized *H. rugosa*, previously known as *P. enteromorpha* f. *rugosa*. (Hale, 1979). In 1982, Pike and Hale, together, described *Hypogymnia mollis*, and, in the same paper, Pike described *H. heterophylla* and *H. occidentalis* (Pike & Hale, 1982). Pike's studies are still incomplete. On herbarium labels of specimens borrowed from the U.S. National Herbarium at the Smithsonian Institute, I found Pike's annotations, tentatively recognizing four new species of *Hypogymnia* from North America.

Twenty *Hypogymnia* species and one species of *Menegazzia* were recognized in the fifth checklist of the lichens of North America, prepared by Egan (1987). Additionally, three other species, *H. atrofusca*, *H. intestiniformis*, and *H. oroarctica* were removed from the genus *Hypogymnia* and were placed in the new genus *Brodoa* (Goward, 1986). Recently, Goward (1988) described another new species, *H. oceanica*, which earlier was known as *H. pseudophysodes*, a species originally described by Asahina in eastern Asia and Japan. Goward noted that the North American specimens could be distinguished from the east Asian specimens both morphologically and chemically. Thus he concluded that *H. pseudophysodes* and the North American material were not of the same species (Goward, 1988). In addition, Goward produced the most inclusive key to the *Hypogymnias* of North America to date, which included nineteen of the twenty reported species of



*Hypogymnia*. Most recently, *Hypogymnia pulverata*, was reported new to North America by Brodo (1989).

COMPARISON OF *BRODOA* WITH *HYPOGYMNIA* AND ALLIED GENERA

	<i>Brodoa</i>	<i>Hypogymnia</i> s. str.	<i>Menegazzia</i>
Cortical chemistry	atranorin present	atranorin present	atranorin present
Structure of lower cortex*	palisade plectenchy- ma	( <i>mesodermatous</i> ) <i>paraplectenchyma</i>	( <i>mesodermatous</i> ) <i>paraplectenchyma</i>
'Polysaccharide layer'**	present above, absent below	present above and be- low	present above and be- low
Thallus detail	nonperforate, non- cavernulate	<i>perforate</i> , noncaver- nulate	<i>perforate</i> , noncaver- nulate
Medullary detail	stuffed, compact	<i>hollow or rarely lax</i>	<i>hollow</i>
Medullary sub- stances	orcinol depsidones & $\beta$ -orcinol depsi- dones	orcinol depsidones & $\beta$ -orcinol <i>para-dep-</i> <i>sides</i> & depsidones	$\beta$ -orcinol depsidones
Spore size ( $\mu$ m)	8–12 $\times$ 6–8	5–9 $\times$ 3–5	45–60 $\times$ 20–30
Ecology	saxicolous	predominantly <i>cortic-</i> <i>olous</i>	predominantly <i>cortic-</i> <i>olous</i>
Main distribution	arctic-alpine	predominantly <i>tem-</i> <i>perate and boreal</i>	predominantly <i>tem-</i> <i>perate-montane</i>

\* Cortical terminology follows Hale 1976.

\*\* See discussion.

(Goward, 1986)

The table above compares the genera: *Brodoa*, *Hypogymnia*, and *Menegazzia*. Although similar in some aspects, these genera differ in thallus and medullary detail, medullary substances, spore size, ecology, and distribution. While *Brodoa* is nonperforate with a stuffed medullary cavity, both *Hypogymnia* and *Menegazzia* are often perforate and have a hollow medullary cavity. *Menegazzia* has very large spores, whereas both *Hypogymnia* and *Brodoa* have considerably smaller spores. *Brodoa* is saxicolous with an arctic-alpine distribution. *Hypogymnia* and *Menegazzia* are both predominantly corticolous and mainly have a temperate and boreal distribution.

## STUDIES OF THE LICHEN GENUS *HYPOGYMNIA* THROUGHOUT THE WORLD

*Hypogymnia* is widely distributed throughout the world. It has been estimated that 45 species of *Hypogymnia* exist worldwide (Galloway, 1985). Significant studies have included work on the *Hypogymnia* species occurring in Japan, India and Nepal, Australasia, and New Zealand. In 1964, Mariko Nuno performed a thin layer chromatographic study on twelve species of *Hypogymnia* to determine what lichen substances were present. Specimens examined in this study had been collected throughout the world, in such places as Japan, the United States, Norway, India, and New Zealand. This was one of the earliest chemical studies performed on species of *Hypogymnia* (Nuno, 1964). In 1984, the *Hypogymnia* species of India and Nepal were studied by Awasthi. He provided morphological descriptions of each species as well as a key to the thirteen *Hypogymnia* species that occur in India and

Nepal (Awasthi, 1984). Australian, John Elix is one of the leading researchers of *Hypogymnia* today. In 1979, Elix performed a comprehensive study of the species of *Hypogymnia* and *Parmelia* in Australasia. In this paper, Elix described two new species of *Hypogymnia*, and six new combinations were made. He provided thorough morphological and chemical descriptions of these species. In addition, he identified several previously unknown chemicals. A key to the eleven species of *Hypogymnia* was also prepared (Elix, 1979). Most recently, in 1989, Elix described two new species of *Hypogymnia* in Australia, as well as one new combination. In addition, two species were reported for the first time in New Guinea (Elix & Jenkins, 1989). Elix recognizes eight species of *Hypogymnia* in New Zealand. In 1985, D.J. Galloway, provided thorough morphological and chemical descriptions, as well as a key to these species (Galloway, 1985).

## METHODS

In total, 784 specimens of *Hypogymnia* were available for examination from J. Dey's Herbarium at Illinois Wesleyan University and from the U.S. National Herbarium at the Smithsonian Institution. All specimens examined were collected in the United States or southern Canada.

Initially, each lichen specimen was examined using a dissection microscope to determine its morphological characteristics, both vegetative and reproductive. In conjunction with the morphological study, preliminary spot test screening for unique lichen chemical substances was performed on the cortex and medulla of each specimen. Three chemical reagents were used: potassium hydroxide (K), Clorox bleach (C), and paraphenylenediamine (PD).

Potassium hydroxide comes as dry pellets. Small pieces can be dissolved in water. The solution should be made fairly concentrated. Clorox bleach can be used straight from the bottle. The active ingredient in Clorox bleach is sodium hypochlorite. Paraphenylenediamine is a powder. To prepare the solution, a small amount is dissolved in approximately 5-10 ml of ethyl alcohol (Hale, 1979). After applying the reagent with a micropipet to the cortex or medulla of the specimen, the presence or absence of color changes were noted. Based on the morphological characteristics and the results of the spot test screening, a preliminary identification of each specimen was made using the key to the North American species of *Hypogymnia*, produced by Goward in 1988.

Next, a thin layer chromatographic study was performed to identify the chemicals present in each specimen as an aid in identification of each specimen, and to determine chemical patterns found within species of *Hypogymnia*. The thin layer chromatography procedure followed the standardized procedures (Culberson & Kristinsson, 1970). It involved, first preparing an acetone extract from each specimen, which was then spotted onto silica gel, thin-layer, glass-backed plates. Three solvent systems were used in this study. Solvent A contained 180 ml of benzene, 45 ml of dioxane, and 5 ml of acetic acid. Solvent B contained 120 ml of hexane, 90 ml of diethyl ether, and 20 ml of formic acid. Solvent C contained 200 ml of toluene and 30 ml of acetic acid. The thin-layer plates were run separately in these solvent systems and then examined under short and long wave Ultraviolet light (254 nm and 366 nm). Then the plates were sprayed with 10% sulfuric acid and allowed to dry. Finally, they were heated for approximately eight to ten minutes at 110 degrees Celsius until colors developed. Chemical substances were then identified by comparing

experimental  $R_f$  values (the distance a substance runs on the plate in reference to controls) with known  $R_f$  values in conjunction with colors of spots and possible fluorescence (Culberson & Kristinsson, 1970; Elix, 1979). In addition, substances were run next to authentic source controls.

## TAXONOMIC CHARACTERS

### MORPHOLOGY

Vegetative characteristics such as the characteristics of the upper and lower cortices, color of the medullary cavity walls, the type of branching pattern, and the presence or absence of perforations are useful in identifying and distinguishing between species of *Hypogymnia*. Characteristically, the upper cortex of species of *Hypogymnia* is mineral gray in coloration, although in some species it is brown, for example *H. austerodes*. The medullary cavity wall is white in several species of *Hypogymnia*, such as *H. imshaugii* and *H. duplicata*. However, in most species it is darkened, as it is in *H. enteromorpha* and *H. krogii*. In *Hypogymnia*, the branching pattern may be dichotomous, splitting in two or lateral, branching out to the sides. *Hypogymnia imshaugii* and *H. inactiva* exhibit dichotomous branching, whereas *H. enteromorpha* and *H. heterophylla* exhibit lateral branching. Both apical and lower perforations are common in species of *Hypogymnia*, although several species lack perforations. *Hypogymnia occidentalis* is commonly apically perforate, while *H. vittata* commonly has lower perforations. *Hypogymnia imshaugii* typically lacks perforations.

Soredia, an asexual reproductive structure, are present in several species of *Hypogymnia*. Soredia may arise from the disintegration of the upper cortex or from burst lobe tips. *Hypogymnia austerodes* and *H. bitteri*

have soredia which arise from the disintegration of the upper cortex.

*Hypogymnia physodes* and *H. vittata* have soredia that arise from burst lobe tips.

Isidia, another asexual reproductive structure, are rare in species of *Hypogymnia*. *Hypogymnia farinacea* and *H. subcapitata* are the only species which have isidia.

Several species of *Hypogymnia* reproduce sexually by means of apothecia. Apothecia are cup-shaped reproductive structures which produce ascospores in asci. In *Hypogymnia* species, apothecia are found on the upper cortex, and often reach very large sizes. Apothecia are commonly found in *H. imshaugii*, *H. inactiva* and *H. enteromorpha*.

Pycnidia are flask-shaped reproductive structures that produce conidia. In species of *Hypogymnia*, the pycnidia are typically black and embedded in the upper cortex of the thallus. Pycnidia are commonly found in many species of *Hypogymnia*, for example, *H. occidentalis* and *H. inactiva*.

## CHEMISTRY

There are several lichen substances which are commonly found in species of *Hypogymnia* (Table 2). These substances are typically depsides and depsidones, two major categories of lichen substances (Elix, 1979). All species of *Hypogymnia* contain the depside, atranorin (Fig.1) in the upper cortex. It has been noted by both Elix (1979) and Ohlsson (1973) that most also contain the depside, chloroatranorin in the upper cortex. I was unable to identify chloroatranorin (Fig. 2) in this study because it runs too close on the thin-layer chromatography plates to atranorin. The depsidones, physodic acid (Fig. 3), physodalic acid (Fig. 4), and protocetraric acid (Fig. 5) are commonly found

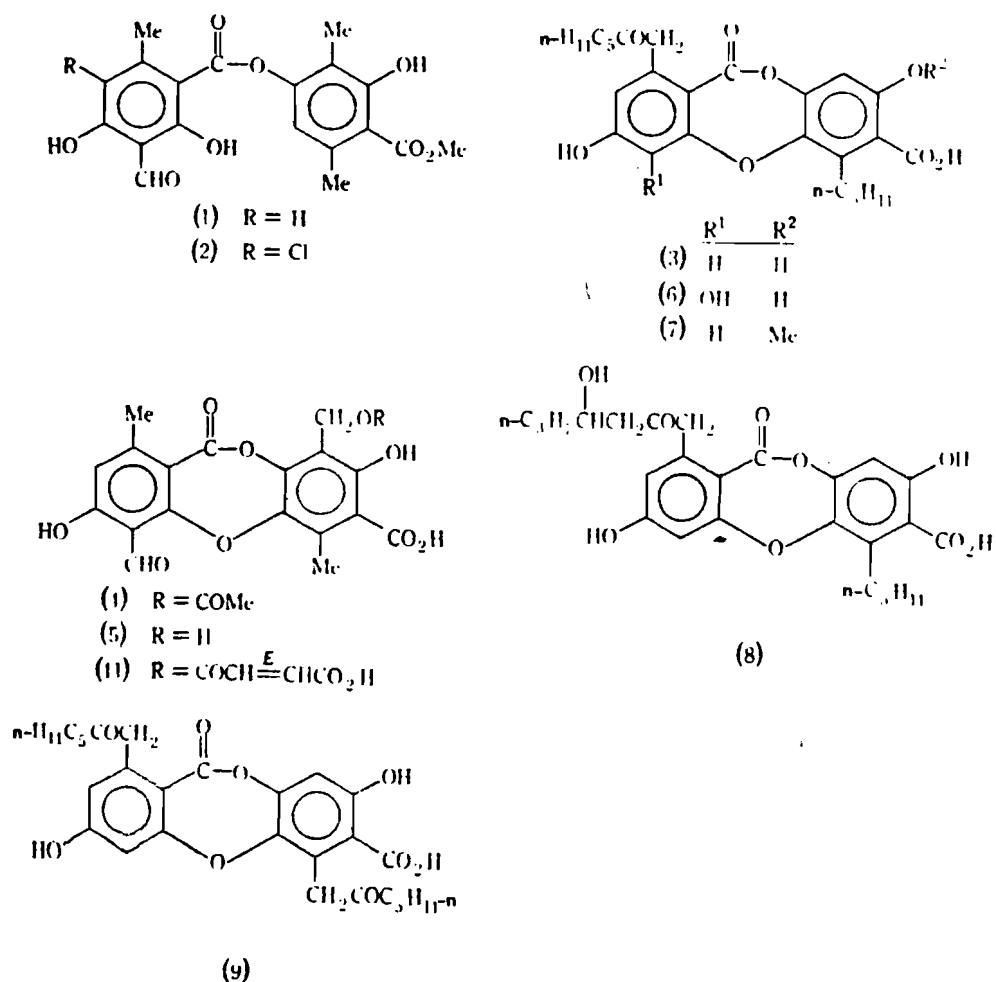
in the medulla of species of *Hypogymnia* (Elix, 1979). 3-hydroxyphysodic acid (Fig. 6), another depsidone, has also been identified in several species of *Hypogymnia*: *H. physodes*, *H. tubulosa*, and *H. vittata* among others. The depsidone, 2-O-methylphysodic acid (Fig. 7) was first identified in several species of *Hypogymnia* by Elix in 1979. I have also identified this substance in several species of *Hypogymnia*, for example, *H. inactiva*, *H. metaphysodes*, *H. subobscura*, and *H. tubulosa*. I was unable to identify 2-O-methylphysodic acid in specimens of several North American species of *Hypogymnia* that Elix had identified it in. This is probably due to substances running closely together (Elix, 1979). Also, Elix (1979) identified vittatolic acid (Fig. 8) in *H. vittata*. I confirmed the presence of vittatolic acid in North America specimens of *H. vittata*. I did not identify vittatolic acid in any other North American species of *Hypogymnia*. Elix (1979) also identified the depsidone, alectoronic acid running closely with physodic acid in many species of *Hypogymnia*. I was unable to identify alectoronic acid (Fig. 9) in any of the North American species of *Hypogymnia*. In my study, I ran a species of *Hypogymnia* next to *Parmelia arnoldii*, which is known to contain alectoronic acid. Next to this the species of *Hypogymnia* was run again, but with the *Parmelia arnoldii* spotted on top of it. Alectoronic acid was noted in only the later two. This was performed for all species of *Hypogymnia* available to me for study. Under long range ultraviolet light, alectoronic acid fluoresces blue. This fluorescence was only noted in *Parmelia arnoldii* and the *Hypogymnia* species with *Parmelia arnoldii* spotted on top of it.

Chemical variation within a species may or may not be significant, depending on whether or not it corresponds to some morphological or geographical variation. When there is chemical variation within a species, but no other variation is noted, the different chemical patterns are usually



just considered to be different chemical strains of that species. However, if the chemical variation correlates with morphological differences within a species or differences in geographical distribution, this chemical variation may be very significant, possibly meriting the elevation of this chemical strain to the species level (Culberson, 1986).

### FIGURES 1-9. STRUCTURES OF LICHEN SUBSTANCES



#### Key to Figures 1-9.

Fig. 1=atranorin, Fig. 2=chloroatranorin, Fig. 3=physodic acid, Fig. 4=physodalic acid, Fig. 5=protocetraric acid, Fig. 6=3-hydroxyphysodic acid, Fig. 7=2-O-methylphysodic acid, Fig. 8=vittatolic acid, Fig. 9=alectoronic acid. (Elix, 1979)

TABLE 2. LICHEN SUBSTANCES DETECTED IN *HYPOGYMNIA* SPECIES

Hypogymnia	Atr	Ph	3H	Pd	2M	Pro	Dif	Vit	U1	U2	U3	U4	U5	U6	U7	U8
austerodes	+	+	+						+	+						
bitteri	+	+							+	+						
"californica"	+	+		+		+				+						
duplicata	+			+		+			+	+		+				
enteromorpha	+	+		+		+	+		+	+	+		+	+		
farinacea*	+	+														
heterophylla	+	+		+		+			+	+			+		+	
imshaugii																
I	+			+		+	+		+	+					+	
II	+	+													+	
III	+	+		+		+	+		+	+					+	+
IV	+	+		+		+			+	+					+	+
V	+			+		+			+	+					+	
inactiva	+	+			+											+
krogii	+	+		+		+			+	+				+		
lubruberis*	+	+		+												
metaphysodes	+	+			+											+
mollis*																
"montana"	+	+														+
occidentalis	+	+													+	+
oceanica	+	+		+		+										
physodes	+	+	+	+		+			+	+					+	
rugosa	+	+														
"sierrae"	+	+	+	+		+			+	+						
subobscura	+	+			+											+
subcapitata	N	O		D	A	T	A									
tubulosa	+	+	+		+					+					+	
vittata	+	+	+					+		+						

Atr=atranorin, Ph=physodic acid, 3H=3-hydroxyphysodic acid, Pd=physodalic acid, 2M=2-O-methyl physodic acid, Pro=protocetraric acid, Dif=diffRACTAIC acid, Vit=vittatolic acid, U1=B2, U2=B3-4, U3= A2-3:C4, U4=A2-3:B4-5:C4-5, U5=C4-5, U6=B6:C5-6, U7=A6:B6:C6, U8= B4:C2-3, \*=Data from literature

## TAXONOMIC TREATMENT

### DESCRIPTION OF THE GENUS

*Hypogymnia* (Nyl.) Nyl., 1896

"Thallus foliose, lobate, heteromerous, attached by adhesive discs below, or rarely by the whole lower cortex. Lobes inflated, +/- solid in some species, without perforations in the upper surface, with or without soredia or isidia or. Medulla white, loose, arachnoid. Lower surface black, corticate, wrinkled, thin, often fissured or perforate, without rhizines. Photobiont green, *Trebouxia*. Apothecia lecanorine, sessile or subpedicellate, disc concave to plane, rarely perforate, red-brown to yellowish-brown, epriunose. Ascospores simple, colourless, 8 per ascus. Pycnidia common in fertile species, minute, black, punctiform immersed in upper surface. Conidia cylindrical straight."

(Galloway, 1985)

## KEY TO SPECIES IDENTIFICATION

1. Thallus solid throughout ..... 2
1. Thallus hollow ..... 3
  2. (1) Thallus sorediate, developing from disintegration of the upper cortex;  
dichotomous branching; medulla white; apothecia rare ..... *H. pulverata* (Nyl. ex Crombie) Elix
  2. (1) Thallus lacking soredia; dichotomous branching; medulla white;  
apothecia common ..... a rare form of *H. imshaugii* Krog
3. (1) Thallus sorediate ..... 4
3. (1) Thallus lacking soredia ..... 11
  4. (3) Soredia developing from disintegration of upper cortex ..... 5
  4. (3) Soredia developing from inner surface of burst lobe tips ..... 9
5. (4) Soredia laminal ..... 6
5. (4) Soredia terminal or subterminal ..... 8
  6. (5) Lobes elongate, apically perforate; medullary cavity walls white darkening  
toward thallus center, PD+ red, containing physodalic acid; ..... *H. oceanica* Goward
  6. (5) Lobes short, lacking perforations; medulla PD-, lacking physodalic acid..... 7
7. (6) Medullary cavity walls white; soredia developing from papillae, upper cortex gray,  
more commonly brown, smooth; apothecia rare ..... *H. austerodes* (Nyl.) Rasanen
7. (6) Medullary cavity brown to black; soredia, profuse, covering entire surface;  
upper cortex gray, more commonly white, often cracked;  
apothecia absent ..... *H. mollis* Pike & Hale
8. (5) Soralia terminal; medullary cavity walls usually white throughout; lobes suberect;  
lacking perforations; thallus contains 3-hydroxyphysodic acid..... *H. tubulosa* (Schaer.) Hav.
8. (5) Soralia subterminal; medullary cavity walls white, darkening toward  
thallus center; lobes adnate and apically perforate; thallus lacks  
3-hydroxyphysodic acid..... *H. bitteri* (Lyngae) Ahti
9. (4) Lobes generally short, lacking perforations; medullary cavity walls white; medulla  
PD+ orange, contains physodalic acid and 3-hydroxyphysodic acid..... *H. physodes* (L.) Nyl.
9. (4) Lobes elongate, perforate; medullary cavity walls dark; ..... 10
  - 10.(9) Apically perforate; apothecia and pycnidia common;  
medulla PD+ orange, contains physodalic acid;  
lacks 3-hydroxyphysodic acid and vittatolic acid ..... a rare form of *H. krogii* Ohlsson
  - 10.(9) Lower perforations common; apothecia and pycnidia absent; medulla PD-,  
lacks physodalic acid, contains 3-hydroxyphysodic acid  
and vittatolic acid ..... *H. vittata* (Ach.) Gas.

11	(3) Thallus isidiate or having "isidioid projections".....	12
11	(3) Thallus lacking isidia .....	13
12.	(11) Thallus mineral gray, entire upper surface covered with sorediose isidia.....	<i>H. farinacea</i> Zopf
12.	(11) Thallus brownish, upper surface containing papillae or "isidioid projections" .....	<i>H. subobscura</i> (Vain.) Poelt
13	(11) Branching predominantly dichotomous .....	14
13	(11) Branching predominantly lateral .....	19
14.	(13) Lobes elongate, linear, and pendulous, very thin averaging 1-2 mm in width; black embedded pycnidia sparse; much expanded lower cortex, visible from the top; medulla KC-, lacking physodic acid; medullary cavity walls white .....	<i>H. duplicata</i> (Sm. ex Ach.) Rass.
14.	(13) Lobes elongate, rarely linear, never pendulous, typically sub-erect, averaging 1-3 mm in width, black embedded pycnidia very common .....	15
15	(14) Medullary cavity walls white .....	16
15	(14) Medullary cavity walls darkened or variably darkened.....	17
16.	(15) Apothecia common, fairly large, 1-12 mm in width; medulla PD+orange, containing physodalic acid, or PD-,medulla KC+ red, then containing physodic acid or KC-, lacking physodic acid; frequently containing diffractaic acid; branches thin averaging 1-3 mm in width; lacks lateral branching; upper cortex smooth .....	<i>H. imshaugii</i> Krog
16.	(15) Apothecia absent or if present, rare, very small, 0.5-2.0 mm; medulla PD+ orange, containing physodalic acid; lacks diffractaic acid; branches very thin, 0.1-1.5 mm; some lateral branching; upper cortex slightly wrinkled.....	<i>H. "californica"</i> Pike
17	(15) Medulla variably darkened, apothecia sparse to moderate, averaging 2-10 mm in width medulla PD+ red, contains physodalic acid; upper cortex often covered with black lines and patches .....	<i>H. lugubris</i> (Pers.) Krog
17	(15) Medulla darkened; apothecia common, often large, 1-10 mm in width, medulla PD+ red or PD-.....	18
18.	(17) Lobes apically perforate; medulla PD+ orange contains physodalic acid; lacks 2-O-methylphysodic acid; found only in eastern North America .....	<i>H. krogii</i> Ohlsson
18.	(17) Lower surface perforate; medulla PD-; often containing 2-O-methyl- physodic acid; found primarily western North America .....	<i>H. inactiva</i> (Krog) Ohlsson
19	(13) Lobes hollow, distinctly swollen .....	20
19	(13) Lobes hollow, never swollen .....	24
20.	(19) Lobes unevenly inflated, 2-6 mm in width; apothecia common, often large, . 5-14 mm in width; usually PD+ orange, containing physodalic acid, occasionally PD-, containing diffractaic acid.....	<i>H. enteromorpha</i> (Ach.) Nyl.
20.	(19) Lobes evenly inflated; 3-7 mm in width; PD+ orange or PD-, lacks diffractaic acid .....	21

- 21 (20) Upper surface smooth; apical perforations common; medulla PD-,  
lacking physodalic acid ..... *H. occidentalis* Pike
- 21 (20) Upper surface rugose or wrinkled ..... 22
22. (21) Medullary cavity walls white, darkening towards thallus center; medulla PD+ yellow;  
perforations and pycnidia absent ..... *H. rugosa* (Merr.) Pike
22. (21) Medullary cavity walls white throughout ..... 23
- 23 (22) Large gaping perforations in lower cortex; medulla PD-, lacking physodalic acid; apothecia  
common, 1-7 mm in width ..... *H. "montana"* Pike
- 23 (22) Lower cortex lacking perforations; medulla PD+ orange, containing physodalic acid;  
apothecia profuse, frequently covering entire thallus, 1-18 mm in width ..... *H. "sierrae"* Pike
24. (9) Lobes short, distinctly flattened; lacking perforations; medullary cavity walls  
white, PD-, lacking physodalic acid ..... *H. metaphysodes* (Asah.) Rass.
24. (9) Lobes elongate, not flattened, with apical and lower surface perforations  
common; medullary cavity walls darkened, medulla PD+ orange,  
containing physodalic acid ..... *H. heterophylla* Pike

*Hypogymnia austerodes* (Nyl.) Ras., Ann. Bot. Soc. Zool.-Bot. Fenn.  
"Vanamo" 18(1): 13. 1943. (not seen)

*Parmelia austerodes* Nyl., Flora 64(33): 537. 1881. (not seen)

Thallus gray to brownish, forming rosettes, closely adnate, 5-7 cm broad; lobes short, 3-5 mm in width; medullary cavity walls white; lower cortex brown to black, wrinkled. Laminar soredia present. Soredia arising from disintegrations in the upper cortex, concentrated in thallus center. Pycnidia absent. Apothecia absent or rare.

Cortex K<sup>+</sup> yellow; medulla C<sup>-</sup>, KC<sup>+</sup> red, PD<sup>-</sup>. Atranorin, physodic acid, 3-hydroxyphysodic acid, and two unidentified substances (H<sub>2</sub>SO<sub>4</sub> → yellow, B2) and (H<sub>2</sub>SO<sub>4</sub> → gray, B3-4).

Commonly found on bark and wood. North American distribution: western Canada and the western United States (west of the Rockies). World distribution: North America, Europe, and Asia.

Specimens examined (8)

COLORADO. CLEAR CREEK CO.: Mt. Evans Hwy., 13600A-C, 13602A-C, 13608A-C.

*Hypogymnia austerodes* did not exhibit any significant morphological or chemical variability.

*Hypogymnia bitteri* (Lynge) Ahti, Ann. Bot. Fenn. 1: 20. 1964.  
(not seen)

*Parmelia bitteri* Lynge, Skr. Vidensk.-Selsk. Christiana, Math.-  
Naturvidensk. Kl. 1921 (7): 138. 1921. (not seen)

Thallus mineral gray to brown, forming rosettes, closely adnate, 3-8 cm broad; lobes short, averaging 3-5 mm in width; medullary cavity walls darkened; lower cortex black and wrinkled. Lobes apically perforated. Subapical soralia. Soredia developing from disintegrations in the upper cortex. Apothecia absent. Pycnidia absent.

Cortex K+ yellow; medulla C-, KC+ red, PD-. Atranorin, physodic acid, and two unidentified substances (H<sub>2</sub>SO<sub>4</sub> -> yellow, B2) and (H<sub>2</sub>SO<sub>4</sub> -> gray, B3-4).

Commonly found on bark and wood. North American distribution: widespread across Canada with extensions southward into the United States in the Appalachian Mountains, the Rocky Mountains, and the far west mountain ranges. World distribution: North America, Europe, Asia, and Africa.

Specimens examined (10).

NEW MEXICO. SANTA FE CO.: Aspen Basin Recreational area and Santa Fe Ski Bowl in Santa Fe National Forest., 9677(A-H).

CANADA. ALBERTA.: Banff National Park., *Hale*, 49539, 49479 (U.S.).

*Hypogymnia bitteri* does not exhibit significant morphological or chemical variability. However, few specimens were available for examination. Many more specimens would need to be examined to confirm these results.



### *Hypogymnia "californica" Pike*

Thallus yellow to brown, 3-4 cm broad, upper cortex slightly wrinkled; Lobes thin, 0.5-1 mm; primarily dichotomous branching, but occasionally lateral branching. Medullary cavity wall white throughout. Lower cortex black and wrinkled. Lower perforations profuse. Soredia absent. Black embedded pycnidia common. Apothecia small or absent, 0.5-2.0 mm in width.

Cortex K+ yellow; medulla C-, KC+ red, PD+ orange. Atranorin, physodic acid, physodalic acid, protocetraric acid, and three unidentified substances: (H<sub>2</sub>SO<sub>4</sub> -> yellow, B2), (H<sub>2</sub>SO<sub>4</sub> -> gray, B3-4), and (H<sub>2</sub>SO<sub>4</sub> -> yellow, C2).

Commonly found on bark. North American distribution: pacific coast-California (endemic to North America).

Specimens examined (4).

CALIFORNIA. SAN DIEGO CO.: Cuyamaca Mt., Cota, 1422, 1975 (U.S.). FAWCETT CO.: Stanford University, Herre, 338, 10032 (U.S.).

*Hypogymnia "californica"* has been separated from *H. enteromorpha* and tentatively recognized as a new species by Pike. I examined specimens of *H. "californica"* on loan from the U.S. National Herbarium at the Smithsonian Institution. *Hypogymnia "californica"* differs significantly from *H. enteromorpha*. First, the branching pattern of *H. "californica"* is dichotomous, whereas that of *H. enteromorpha* is lateral. Additionally, the medullary cavity walls of *H. "californica"* are white; the walls of *H. enteromorpha* are darkened. Apothecia are commonly found in *H.*

*enteromorpha*, but are very rare in *H. "californica."* The chemical profile of *H. "californica"* and *H. enteromorpha* are very different, as well. *Hypogymnia "californica"* lacks diffractaic acid, as well as several unidentified substances noted in *H. enteromorpha*.

*Hypogymnia duplicata* (Sm. ex Ach.) Rass., Novitates Systematicae  
Plantarum non Vascularium, Acad. Sci. URSS, Inst. Bot. nomine V. L.  
Komarovii 1965: 200. 1965. (not seen)

*Lichen duplicatus* Sm. ex Ach., Meth. Lich. 252. 1803.

Thallus mineral gray, pendulous; lobes elongate and linear, averaging 1-2 mm in width, branching predominantly dichotomous; medullary cavity walls white throughout; lower cortex black and wrinkled, greatly expanded. Perforations lacking. Soredia absent. Sparse, black, embedded pycnidia. Apothecia present common.

Cortex K+ yellow, KC-; medulla C-, KC-, PD+ orange-red. Atranorin, diffractaic acid, physodalic acid, protocetraric acid, and three unidentified substances: (H<sub>2</sub>SO<sub>4</sub> -> gray, A2-3:B4-5:C4-5), and (H<sub>2</sub>SO<sub>4</sub> -> yellow, B2), and (H<sub>2</sub>SO<sub>4</sub> -> gray B3-4).

Commonly found on bark. North American distribution: pacific coast of the United States and Canada. World distribution: North America and Asia.

Specimens examined (3).

ALASKA. Ketchikan, Renellagigedo Island, *Eyerdam*, 271 A-B (U.S.).  
Thum Bay, Knight Island, *Eyerdam*, 235 (U.S.).

No morphological or chemical variation was noted, however only three specimens were examined. Many more specimens would need to be examined to confirm these results.

*Hypogymnia enteromorpha* (Ach.) Nyl., Acta Soc. Sci. Fenn. 26(10): 7. 1900.  
(not seen)

*Parmelia enteromorpha* Ach., Meth. Lich. 252. 1803. (not seen)

Thallus mineral gray, loosely adnate, 3-10 cm broad; lobes somewhat elongate and irregularly swollen, lobes usually 2-6 mm in width; branching predominantly lateral; medullary cavity walls white, but darkening toward interior of thallus; lower cortex black and wrinkled; apical perforation and lower surface perforations present. Soredia absent. Black embedded pycnidia present. Apothecia common, .5-14 mm in width.

Cortex K+ yellow, KC+ red; medulla C-, KC+ red, PD+ orange.

Atranorin, +/- diffractaic acid, physodic acid, physodalic acid, protocetraric acid, and five unidentified substance: (H<sub>2</sub>SO<sub>4</sub> -> yellowish gray, +/- A2-3:C4), (H<sub>2</sub>SO<sub>4</sub> -> yellow, B2), (H<sub>2</sub>SO<sub>4</sub> -> gray, B3-4), (H<sub>2</sub>SO<sub>4</sub> -> yellow, C4-5), and (H<sub>2</sub>SO<sub>4</sub> -> yellow, +/- B:6:C5-6).

Common on bark and wood. North American distribution: west coast mountain ranges and the Northern Rocky Mountains in the United States and Canada. World distribution: North America, Asia, and India.

Representative specimens examined (14 out of 75).

OREGON. BENTON CO.: Mary's Peak west of Corvallis, *N. Dey*, 1 (IWU). DESCHUTES CO.: Elk Lake at Elk Lake Forest Campgrounds, 16289. JEFFERSON CO.: Suttle Lake on U.S. Hwy. 20. LANE CO.: Jessie Honeyman State Park, 9108, 9109. LINCOLN CO.: east of Tidewater at Boat Launch on Alsea River, 16358. LINN CO.: Snow Peak, 8693, 8699. MULTNOMAH CO.: Wenoma Falls in Columbia River, 9025, 9031. MARION CO.: near North Fork of Santiam River., 9305, 9306. POLK CO.: on Mill Creek Road, 16374. TILLAMOOK CO.: near Cape Kivanda State Park north of Pacific City, 16329. UNION CO., near Kamela on Mt. Emily Rd., 16554.

CANADA. ALBERTA.: Lake Louise Banff National Park, *N. Dey* 9.

Pike has tentatively recognized on herbarium specimen labels four new species of *Hypogymnia* closely related to *H. enteromorpha*. I would only recognize three of the four as new. The fourth tentatively new species, *H. "tumidula"* does not appear to differ morphologically or chemically from *H. enteromorpha*. Morphologically, it has irregularly inflated lobes, primarily lateral branching, medullary cavity walls that darken towards the interior. It lacks soredia. Both apothecia and pycnidia are commonly present. *Hypogymnia "tumidula"* has the same spot tests as *H. enteromorpha* and the same chemical profile, containing, atranorin, diffractaic acid, physodic acid, physodalic acid, and protocetraric acid.

*Hypogymnia farinacea* Zopf (not seen)

Thallus whiteish gray; thallus hollow. Perforations lacking. Sorediose isidia present, covering entire upper surface (Brodo, 1981).

Cortex K+; medulla C-, KC+, PD-. Atranorin and physodic acid (Dahl & Krog 1973).

Common on bark of trees. North American distribution: west coast mountain ranges along western United States and Canada. World distribution: North America, Europe, and Asia.

There were no specimens of *H. farinacea* available for examination. Additionally, little mention of this species was made in the literature. Currently, I am starting a search for articles in which this species was originally and more completely described.

*Hypogymnia heterophylla* Pike, Mycotaxon 16(1), 157. 1982.

Thallus mineral gray, loosely adnate, 5-12 cm broad; lobes elongate; averaging .5-2.5 mm; branching predominantly lateral; medullary cavity walls darkened; lower cortex black and wrinkled. Apical perforations and lower cortex perforations present. Soredia absent. Black embedded pycnidia common. Apothecia common, 1-10 mm in width. .

Cortex K+ yellow; medulla C-, KC+ red, PD+ orange. Atranorin, physodic acid, physodalic acid, protocetraric acid, and five unidentified substances: (H<sub>2</sub>SO<sub>4</sub> -> gray, B3-4), (H<sub>2</sub>SO<sub>4</sub> -> yellow, B2), (H<sub>2</sub>SO<sub>4</sub> -> yellow, +/- A6:B6:C6), (H<sub>2</sub>SO<sub>4</sub> -> yellow, +/- C4-5).

Commonly found on bark of trees. North American distribution: west coast mountain ranges along the western United States and Canada (endemic to North America).

Representative specimens examined (10 of 42).

OREGON. COOS CO.: Cape Argo State Park north of Bandon, 9112, 9113. LANE CO.: Jessie Honeyman State Park, 9102, 9103. LINCOLN CO.: Ona Beach State Park north of Walport, 16352, 16353. POLK CO.: up Mill Creek Rd. from Buell, 16367, 16398. TILLAMOOK CO.: near Cape Kiwanda State Park north of Pacific City, 16324, 16353.

*Hypogymnia heterophylla* exhibits some variation in morphology. The lobe branching pattern is primarily lateral, however, occasionally dichotomous branching is noted. Additionally, the lower cortex is typically perforate. The apical perforations are variably noted. There is also chemical variation in *H. heterophylla*, the unidentified substances (A6:B6:C6) and (C4-5) were not always present in the chemical profile.

*Hypogymnia imshaugii* Krog, Norsk Polarinst. Skr. 144: 96. 1968.

Thallus mineral gray, loosely adnate to suberect, 2-8 cm broad; lobes elongate, averaging 1-3 mm in width, dichotomous branching; medullary cavity walls white throughout; lower cortex black and wrinkled. Perforations absent. Soredia absent. Black embedded pycnidia common. Apothecia common, 1-12 mm in width.

Cortex K+ yellow, KC +/- red; medulla C-, KC+/- red, PD +/- orange. Atranorin, +/- diffractaic acid, +/- physodic acid, +/- physodalic acid, +/- protocetraric acid, and four unidentified substances: (H<sub>2</sub>SO<sub>4</sub> -> yellow, +/- B2), (H<sub>2</sub>SO<sub>4</sub> -> gray, +/- B3-4), (H<sub>2</sub>SO<sub>4</sub> -> yellow, +/- B4:C2-3), (H<sub>2</sub>SO<sub>4</sub> -> yellow, +/- A5-6:B5-6:C5-6). (See Table 2. for profiles of chemical strains.)

Commonly found on bark and wood. North American distribution: west coast mountain ranges and the northern Rocky Mountains in the United States and Canada, (endemic to North America).

Representative specimens examined (31 of 164).

CALIFORNIA. PLUMAS CO.: Massak Rest Area on California Hwy. 89, 15988, 15989. SAN LUIS CO.: Cerro Alto Campground in Los Padres National Forest, 15872. SHASTA CO.: near Castle Craigs State Park near Sacramento River, 16125, 16137. SIERRA CO.: northwest of Calpine on California Hwy. 89, 15951, 15952. SISKIYOU CO.: south of Lava Beds National Monument on Forest Service Road, 16179, 16185. TUOLUMNE CO.: near Big Oak Flat entrance to Yosemite National Park, 15927, 15928.

IDAHO. BOISE CO.: campground at Mile Post 79 on Idaho Hwy. 21, 16620, 16623. IDAHO CO.: south of Riggins, Payette National Forest, Hale, 48768, 48529, 48521 (U.S.).

OREGON. BAKER CO.: Wetmore Camp North of Unity on U.S. Hwy. 26, 8641, 8627. BENTON CO.: north of Wren on State Rd. 23, 8716. CLACKAMUS CO.: Timberline Lodge Ski Area, 16535, 16537. HOOD RIVER CO.: near Hood River Meadows Campgrounds northeast off Oregon Hwy. 35, 16543. JEFFERSON CO.: Suttle Lake on U.S. Hwy. 20, 8903, 8894. KLAMATH CO.: north of Fort Klamatio on road to Klamath State Park, 16267, 16271. LINN CO.: northwest of Snow Peak on Upper Neal Creek Rd., N. Dey,



82. MARION CO.: Silver Falls State Park south of Silverton, 9137. POLK CO.: Mill Creek Rd, 16371, 16376. UNION CO.: near Kamela on Mt. Emily Road, 16575, 16549.

Five distinct chemical strains of *H. imshaugii* were noted in my thin layer chromatographic study (Table 2). These chemical strains were examined to determine whether or not any morphological characteristics could be correlated with these chemical patterns. No distinct morphological patterns were noted at the gross anatomical level. However, besides the gross anatomical features, samples of ascospores and conidia, from both apothecia and pycnidia respectively were examined to determine any variation in size and shape. Five pycnidia containing conidia from each chemical strain were examined. Conidia in all five strains ranged in length from (5.9-) 7-8.2 (-10.6)  $\mu\text{m}$  and in width from (3.6-) 4.7-5.9 (-7.1)  $\mu\text{m}$ . Conidia were typically cylindrical or fusiform in shape. There was no obvious correlation between chemical strain and conidia size or shape. Typically there were eight ascospores per ascus in each apothecium examined. In strains I, III, IV, and V, ascospores ranged in both length and width from 3.6 to 5.6  $\mu\text{m}$ . In strain II, all specimens either had no apothecia or very small apothecia in which I was unable to locate any asci with ascospores. The ascospores were fairly round in shape. There were no obvious correlations between chemical strain and ascospore shape and size. Thus, from this study, it appears that there is no morphological variation that corresponds to the chemical variation. Many more specimens would need to be examined and analyzed to confirm this statistically.

*Hypogymnia inactiva* (Krog) Ohlsson, Bryol., 76, 1973.

*Hypogymnia imshaugii* var. *inactiva* Krog, Norsk Polarinst. Skr. 144: 98. 1968.

Thallus mineral gray, loosely adnate, 5-12 cm broad; lobes elongate, averaging 1-4 mm in width; branching dichotomous; medullary cavity walls darkened; lower cortex black and wrinkled; lower surface perforated. Soredia absent. Black, embedded pycnidia present. Apothecia common, 1-10 mm in width.

Cortex K+ yellow, KC+ pink; medulla C-, KC+ rose, PD-. Atranorin, 2-O methylphysodic acid, physodic acid, one unidentified substance: +/- (B3-4:C2-3).

Commonly found on bark of trees. North American distribution: west coast mountain ranges along the western United States and Canada (endemic to North America).

Representative specimens examined (12 out of 71).

OREGON. JACKSON CO.: coastal dunes near Lily Lake, Pike, L-472 (U.S.). JEFFERSON CO.: Suttle Lake on U.S. Hwy. 20, 8891, 8899. LANE CO.: east of Eugene, Sipe, 819 (U.S.). LANE CO.: Eagle Point, Sipe, 642 (U.S.). LINN CO.: Snow Peak, 8657, 8669. MARION CO.: Silver Falls State Park, 9125, 9142. UNION CO.: near Kamela on Mt. Emily Rd., 16597, 16585.

No significant morphological variation was noted in *H. inactiva*. However, some chemical variation was noted; the unidentified substance (B3-4:C2-3) was not always present in the chemical profile.

*Hypogymnia krogii* Ohlsson, Bryol., 76, 377. 1973.

Thallus mineral gray, typically sub-erect, 3-7 cm broad; lobes somewhat elongate, averaging 1-3 mm in width; dichotomous branching predominant; medullary cavity walls darkened; lower cortex black and wrinkled, lightening at tips; occasionally apically perforate. Soredia usually lacking. Black embedded pycnidia present. Apothecia common, 1-8 mm in width, light brown disk.

Cortex K<sup>+</sup> yellow; medulla C<sup>-</sup>, KC<sup>+</sup> pink, PD<sup>+</sup> orange. Atranorin, physodic acid, physodalic acid, protocetraric acid, and three unidentified substances: (H<sub>2</sub>SO<sub>4</sub> → yellow, B2), (H<sub>2</sub>SO<sub>4</sub> → gray, B3-4), (H<sub>2</sub>SO<sub>4</sub> → yellow, +/- B6:C5-6).

Commonly found on bark. North American distribution: eastern United States-Appalachian Mountains (endemic to North America).

Representative specimens examined (20 out of 92).

NEW HAMPSHIRE. COOS CO.: west slope of Mt Clay in Presidential Range, 14048, 14053.

NORTH CAROLINA. AVERY CO.: between Calloway Peak and McCray Gap of Grandfather Mountains, 1793. BUNCOMBE CO.: Potato Knob in the black Mountains, 651, 697. HAYWOOD CO.: Plott Balsam in the Plott Balsam Mountains, 4411. SWAIN CO.: Forney Ridge below Clingman's Dome, 6771. TRANSYLVANIA CO.: Devil's Courthouse in Balsam Mountains, 5067. YANCEY CO.: Cattail Peak in the Black Mountains, 1187, 1189.

WEST VIRGINIA. POCAHONTAS CO.: Gaudineer Scenic Area off Forest Rd. 27, 19674, 19659. PENDLETON CO.: Spruce Knob Picnic Area, 19517, 19515. RANDOLPH CO.: Gaudineer Knob Picnic Area, 19624, 19629.

CANADA. ALBERTA: Lake Moraine, N. Dey, 10 (IWU).

*Hypogymnia krogii* most often lacks soredia. However, I noted several specimens of *H. krogii* that contained soredia which arose on the inner surface of burst lobe tips. Initially, these specimens might be classified as *H. physodes*, a sorediate species of *Hypogymnia*, which is morphologically similar to *H. krogii*. However, upon closer examination, the medullary cavity of these sorediate specimens darkened toward the thallus center. In addition, these specimens had the chemical profile of *H. krogii*, not *H. physodes*. On the basis of morphological and chemical characteristics, these specimens were classified as a sorediate variation of *H. krogii*. Pike studied sorediate specimens of *H. krogii*, and initially separated the variation from *H. krogii* as *H. "appalachensis."* However, he never published this. I believe that this sorediate variation of *H. krogii* has not been described as a new species because chemically there is no variation between the sorediate and the non-sorediate specimens, and morphologically, there are no other significant differences.

*Hypogymnia lugubris* (Pers.) Krog, Norsk Polarinst. Skr. 144: 99, 1968. (not seen)

*Parmelia lugubris* Pers, Gaudichaud, Voy Uranie Bot.: 196, 1827. (not seen)

Thallus gray to white, loosely adnate, up to 20 cm broad; branches up to 3 mm in width, dichotomous to irregular branching; medullary cavity walls variably darkened; lower cortex black and wrinkled. Occasionally apically perforate. Soredia absent. Black embedded pycnidia common. Apothecia sparse, 2-20 mm in diameter.

Cortex K+ yellow; medulla K-, C-, KC+ red, PD+ red. Atranorin, chloroatranorin, physodic acid, physodalic acid (Galloway, 1985).

Commonly found on bark of trees. North American distribution: arctic northern Canada and Alaska. World distribution: North America, South America, New Zealand, Australia, and New Guinea.

No specimens were available for examination.

*Hypogymnia metaphysodes* (Asah.) Rass., Novitates Systematicae Plantarum non Vascularium, Acad. Sci. URSS, Inst. Bot. nomine V. L. Komarovii 1967: 291. 1967.

*Parmelia metaphysodes* Asah., Acta Phytotax. Geobot. 14(2): 33. 1950.

Thallus mineral gray, adnate, 4-7 cm in width; lobes short, averaging 1-2 mm in width. Predominantly lateral branching; medullary cavity walls white throughout; lower cortex black and wrinkled. Perforations absent. Soredia absent. Black, embedded pycnidia common. Apothecia present.

Cortex K+ yellow; medulla C-, KC+ pink-red, PD-. Atranorin, physodic acid, 2-O-methylphysodic acid, and two unidentified substances: (H<sub>2</sub>SO<sub>4</sub> -> yellow, B3-4) and (H<sub>2</sub>SO<sub>4</sub> -> yellow, C2-3) fluorescent blue.

Commonly found on bark and wood. North American distribution: west coast mountain ranges along the western United States and Canada. World distribution: North America and Asia.

Specimens examined (6).

MONTANA. LINCOLN CO.: road into Ross Creek, *Hale*, 49278, 4899 (U.S.).

OREGON. BAKER CO.: Wetmore Camp northwest of Unity on U.S. Hwy. 26, 8650. JEFFERSON CO.: Headwaters of Jack River near Camp Sherman, 8926. LANE CO.: Fir forest, *Hale*, 49714 (U.S.) LINN CO.: Santiam Pass Junction on U.S. Hwy. 20, 9313.

No morphological or chemical variation was noted in *H. metaphysodes*. However, only six specimens were available for examination. More specimens would need to be examined to confirm these results, statistically.

*Hypogymnia mollis* Pike & Hale, Bryol., 16(1), 161. 1982.

Thallus white to grayish-white, closely adnate, 3-6 cm broad; upper cortex wrinkled and cracked; lobes short, averaging 1-3 mm in width; sparse branching; medullary cavity walls brown to black; lower cortex black and wrinkled. Lower cortex perforate. Laminar soredia covering entire upper surface. Pycnidia absent. Apothecia absent.

Medulla PD-. Atranorin, physodic acid (Pike & Hale, 1982).

Commonly found on twigs. North American distribution: coastal United States-California (endemic to North America).

No specimens of *H. mollis* were available for examination.

### *Hypogymnia "montana"* Pike

Thallus mineral gray, rugose, closely adnate, 5-7 cm broad; lobes short, averaging 1-2.5 mm in width; predominantly lateral branching; medullary cavity walls white throughout; lower cortex black and wrinkled. Large, gaping perforations in lower cortex. Soredia absent. Black, embedded pycnidia common. Apothecia large, averaging 1-7 mm in width.

Cortex K+ yellow; medulla C-, KC+ red, PD-. Atranorin, physodic acid, and one unidentified substances: (H<sub>2</sub>SO<sub>4</sub> -> yellowish brown, B3-4:C2-3).

Common on bark of trees. Northern Rocky Mountains, (endemic to North America).

Specimens examined (3).

IDAHO. IDAHO CO.: Fayette National Forest, *Hale*, 48795 (U.S.).

MONTANA. LEWIS & CLARK CO.: Forest at Vigilante Campground, *Hale*, 48385 (U.S.). MEAGHER CO.: Porphegry Peak, *Hale*, 48144 (U.S.).

*Hypogymnia "montana"* has been separated from *H. enteromorpha* and tentatively recognized as new by Pike. Specimens were available for examination from the U.S. National Herbarium at the Smithsonian Institution. *H. "montana"* differs significantly from *H. enteromorpha* in morphology. The upper cortex of *H. "montana"* is very rugose; the upper cortex of *H. enteromorpha* is smooth. The medullary cavity walls of *H. "montana"* are white whereas those of *H. enteromorpha* are darkened. The chemical profiles differ significantly as well. *Hypogymnia "montana"* lacks diffractaic acid, and protocetraric acid. Additionally, it lacks several of the unidentified substances present in the chemical profile of *H. enteromorpha*.



*Hypogymnia occidentalis* Pike, Bryol., 16(1), 158. 1982.

Thallus mineral gray to grayish, closely adnate, 3-7 cm broad; lobes very short and irregularly inflated, averaging 2-5 mm in width; medullary cavity walls dark; lower cortex black and wrinkled. Apical perforations common. Soredia absent. Black embedded pycnidia present. Apothecia common, 1-10 mm in width.

Cortex K+ yellow; medulla C-, KC+ red, PD-. Atranorin, physidic acid, two unidentified substance: (H<sub>2</sub>SO<sub>4</sub> -> yellow, A5-6:B5-6:C5-6) and (H<sub>2</sub>SO<sub>4</sub> -> yellow-orange, B3-4:C2-3).

Commonly found on bark. North American distribution: west coast mountain ranges and the Northern Rocky Mountains in the United States and Canada, endemic to North America.

Representative specimens examined (10 out of 51).

IDAHO. BOISE CO.: Campground at Mile Post 79 on Idaho Hwy. 21, 16606, 16621.

MONTANA. Glacier National Park: McDonald Creek, *Hale*, 48787 (U.S.). LINCOLN CO.: Howard Lake campground along road to Ross Creed on Hwy. 202, *Hale*, 49896, 49942 (U.S.). SANDERS CO.: Thompson Falls Recreational Area, *Hale*, 48757 (U.S.).

OREGON. JEFFERSON CO.: Suttle Lake on U.S. Hwy., 8879, 8881. MULTNOMAH CO.: Wenoma falls in Columbia River, 9042. UNION CO.: near Kamela on Mt. Emily Road, 16557, 16562.

No significant morphological or chemical variation was noted in *H. occidentalis*.

*Hypogymnia oceanica* Goward, Bryol., 9(3), 229. 1988.

Thallus mineral gray, closely adnate, 5-8 cm broad; lobes elongate, averaging 1.5-3.0 mm broad; medullary cavity walls darkened. Lower cortex black and wrinkled. Apically perforate. Laminar soredia present.

Cortex K+ yellow; medulla K-, C-, KC+ red, PD+ red. Atranorin, physodic acid, physodalic acid, and protocetraric acid (Goward, 1988).

Commonly found on bark. North American distribution: west coast mountain ranges along western United States and Canada, (endemic to North America).

No specimens were available for examination.

*Hypogymnia physodes* (L.) Nyl., Lich. Envir. Paris 1896: 39. 1896. (not seen)

*Lichen physodes* L., Spec. Plant. 1144. 1753. (not seen)

Thallus mineral gray, nearly suberect; 3-9 cm broad; lobes generally short, averaging 1-3 mm in width; medullary cavity walls generally white throughout; lower cortex black and wrinkled, usually lacking perforations. Soredia present on the lower surface of burst lobe tips. Sparse black, embedded pycnidia present. Apothecia usually lacking.

Cortex K+ yellow; medulla C-, KC+ pink-red, PD+ orange. Atranorin, physodic acid, +/- 3-hydroxyphysodic acid, physodalic acid, protocetraric acid, and three unidentified substances: (H<sub>2</sub>SO<sub>4</sub> -> yellow, B2), (H<sub>2</sub>SO<sub>4</sub> -> gray, B3-4), and (H<sub>2</sub>SO<sub>4</sub> -> yellow with blue edge +/- A6:B6:C6).

Commonly found on trees and some mosses. North American distribution: widespread across Canada with extensions southward into the United States in the Appalachian Mountains, the Rocky Mountains, and the far west mountain ranges. World distribution: North America, South America, Europe, Asia, Australia, and New Zealand.

Representative specimens examined (43 out of 194).

MASSACHUSETTS. BARNSTABLE CO.: Roadside Park on U. S. Hwy. 6, 6788, 6796.

MICHIGAN. ALGER CO.: Miners Beach, 8437. CHIPPEW CO.: deciduous tree pine forest on State Hwy. 123, 14523, 14548. KEWEENAW CO.: Mountain Drive overlooking Copper Harbor, 19064, 19065. LUCE CO.: forest north of Newberry State Hwy. 123, 14563, 14558.

MINNESOTA. COOK CO.: Whitesky Rock north of Lutsen, 9478, 9416.

NEW HAMPSHIRE. COOS CO.: west slope of Mt Clay in Presidential Range, 14061, 14067. GRAFTON CO.: northwest of Sugar Hill on Hwy. 117, 13924.

NEW YORK. ST. LAWRENCE CO.: Veterans Mountain Camp, 421.

NORTH CAROLINA. ASHE CO.: Bluff Mountain, 470. AVERY CO.: Calloway Peak of Grandfather Mountains, 1739. BUNCOMBE CO.: Craggy Comb in Great Craggy Mountains, 1512. HAYWOOD CO.: Wolf Bald in Balsam Mountains, 4865. JACKSON CO.: Long Sway in Balsam Mountains, 4600. SWAIN CO.: Andrews Bald in Great Smoky Mountains, 2788. YANCEY CO.: Deer Mountain in Black Mountains, 1123.

OREGON. BENTON CO.: north of Wren State Rd. 223, 8717. DOUGLAS CO.: town of Glide on Oregon State Hwy. 138, 9193. LINN CO.: Snow Peak, 8660. MARION CO.: north of fork of Santiam River. MULTNOMAH CO.: Wenoma Falls in Columbia Gorge, 9032, 9019. POLK CO.: Roadside Park on Hwy. 221, 16406, 16416. UNION CO.: near Kamela on Emily Rd., 16600. YAMHILL CO.: forested ridge north of Newburg, 15395.

TENNESSEE. CARTER CO.: Round Bald of Roan Mt., 7475.

WEST VIRGINIA. PENDLETON CO.: Spruce Knob Picnic Area, 19538. POCAHONTAS CO.: Gaudineer Scenic Area of Shaver Mountain, 19655, 19660. PRESTON CO.: Cathedral St. Park on U.S. Hwy. 50, 19125. RANDOLPH CO.: Gaudineer Knob Picnic Area, 19619, 19630. TUCKER CO.: Blackwater Falls St. Park, 19157, 19159.

WYOMING. WESTON CO.: Rest Area on U.S. Hwy 16 in Thunder Basin National Grasslands, 16707, 16712.

CANADA. ONTARIO. ALGOMA DISTRICT.: Rocky headland jutting into Lake Superior, 14904, 14891. RENFREW DISTRICT.: west of Deux Rivieres, 14157, 14106. SUDBURY DISTRICT.: hills west of McKerrow Junction, 14212.

There is little morphological and chemical variation noted in mature specimens of *H. physodes*. However, young specimens that are pre-sorediate look very similar to *H. metaphysodes* (Goward, 1988). However, *H. physodes* has less branching than *H. metaphysodes*. Also, the medulla of *H. physodes* is PD+ red, while the medulla of *H. metaphysodes* is PD-.

*Hypogymnia pulverata* (Nyl. ex Crombie) Elix, Brunonia 2: 217, 1979.

*Parmelia mundata* var. *pulverata* Nyl. ex Crombie, J. Linn. Soc. Lond. Bot. 17: 395, 1879. (not seen)

Thallus gray, solid throughout, suberect, up to 15 cm broad; branches elongate, averaging 1-2 mm in width, branching dichotomous; medullary cavity white throughout; lower cortex black and wrinkled. Soredia developing from disintegrations of upper cortex. Apothecia rare, averaging 3-7 mm in diameter.

Cortex K+ yellow; medulla K-, C-, KC+ red, PD+ red. Atranorin, chloroatranorin, physodic acid, 3-hydroxyphysodic, 2-O methylphysodic acid, +/- alectoronic acid, physodalic acid, and protocetraric acid (Elix, 1979).

Commonly found on bark of trees. North American distribution: arctic Northern Canada and Alaska. World distribution: North America and Australia.

No specimens were available for examination.

*Hypogymnia rugosa* (Merr) Pike in Hale. 1979. Lich. Amer. Exs. Fasc. 9: 212.

*Parmelia enteromorpha* f. *rugosa* (Merrill) Zahlbr. Cat. Lich. Univ. 6: 33. 1930.

Thallus mineral gray, adnate; lobes short, averaging 3-6 mm in width, branching predominantly lateral; medullary cavity walls dark; lower cortex black and wrinkled. Perforations lacking. Soredia absent. Pycnidia absent. Apothecia common, 5-14 mm in width.

Cortex K+ yellow; medulla C-, KC+ red, PD+ yellow (slow). Atranorin, physodic acid.

Common on bark. North American distribution: west coast mountain ranges and the Northern Rocky Mountains in Canada and the United States.

Specimens examined (3).

WASHINGTON. PEND OREILLE CO.: Salmo River Basin, Layser, 1468, 1477, 1473 (U.S.).

No morphological or chemical variation was noted, but more specimens need to be examined to confirm this.

*Hypogymnia "sierrae" Pike*

Thallus mineral gray to brownish, adnate; lobes slightly elongate; primarily lateral branching. Medullary cavity walls white throughout. Lower cortex black and wrinkled. Perforations lacking. Soredia absent. Black embedded pycnidia profuse. Apothecia profuse, ranging from 1-18 mm in width.

Cortex K+ yellow; medulla C-, KC+ red, PD+ orange or PD-. Atranorin, physodic acid, +/- physodalic acid, +/- protocetraric acid, +/- 3-hydroxyphysodic acid, and two unidentified substances: (+/- H<sub>2</sub>SO<sub>4</sub> -> yellow, B2) and (+/- H<sub>2</sub>SO<sub>4</sub> -> gray, B3-4).

Common on bark of trees. North American distribution: pacific coast-California, (endemic to North America).

Specimens examined (4).

CALIFORNIA. TULARE CO.: Sunset Campground, *Hale*, 57256 (U.S.). TULARE CO.: Oak Madrone roadside, 56016 (U.S.). TULARE CO.: pine forest south of Parker, *Hale*, 56232 (U.S.). TUOLUMNE CO.: on Hwy. 108, northeast of a long barn, *Hale*, 58070 (U.S.).

*Hypogymnia "sierrae"* has been separated from *H. enteromorpha* and tentatively described as new by Pike. *Hypogymnia "sierrae"* differs from *H. enteromorpha* in morphology. The medullary cavity of *H. "sierrae"* is white, while that of *H. enteromorpha* is darkened. In addition, *H. "sierrae"* lacks any perforation; *H. enteromorpha* is apically perforate and also has lower cortex perforations. Apothecia are much more profuse in *H. "sierrae"* than in *H. enteromorpha*. The chemical profile of *H. "sierrae"* is also significantly different from that of *H. enteromorpha*. *Hypogymnia "sierrae"* contains 3-hydroxyphysodic acid, which *H. enteromorpha* lacks. *Hypogymnia "sierrae"*

lacks diffractaic acid and several of the unidentified substances in the chemical profile of *H. enteromorpha*.



*Hypogymnia subcapitata* (Nyl.) Rass. (not seen)

*Parmelia subcapitata* Nyl. (not seen)

There is very little mention made of *H. subcapitata* in the literature. In the description by Hasse (1913), the thallus is described as small and closely adnate, orbicular and centrally isidiose. The upper cortex is K+ yellow. The lower cortex is black. Hasse noted that the specimen examined was very fragmentary, inhibiting a full description.

On bark of trees. North American distribution: pacific coast of California.

*Hypogymnia subobscura* (Vain.) Poelt, Mitt. Bot. Staatssaml. Munchen 4: 298. 1962. (not seen)

*Parmelia subobscura* Vain., Ark. Bot. 8(4): 33. 1909. (not seen)

Thallus brownish, papillate to isidioid projections present; lobes elongate, averaging 1-3 mm in width, predominantly dichotomous branching; medulla white throughout; lower cortex black and wrinkled. Perforations lacking. Soredia absent. Pycnidia absent. Apothecia absent.

Cortex K+ yellow; medulla C-, PD-, KC+ red. Atranorin, physodic acid, 2-O methylphysodic acid, and one unidentified substance: (H<sub>2</sub>SO<sub>4</sub> -> yellow, C2-3) fluorescent.

Common on soil and moss. North American distribution: arctic northern Canada and Alaska. World distribution: North America and Europe.

Specimens examined (2).

COLORADO. LARIMER CO.: northeast slope of Flattop Mountain, Anderson, 2767 (U.S.). SUMMIT CO.: northeast of Loveland Pass, Shushan, 1619 (U.S.).

No morphological or chemical variation was noted but only two specimens were examined. Many more specimens would need to be examined to confirm this.

*Hypogymnia tubulosa* (Schaer.) Hav., Bergens Mus. Arbok, Naturvid.  
Raekke 1917 18(2): 31. (not seen)

*Parmelia ceratophylla* var. *tubulosa* Schaer., Lich. Helvet. Spicil. 10:  
459, 1840. (not seen)

Thallus mineral gray, suberect, 2-3 cm broad; lobes elongate, averaging 1-4 mm in width; medullary cavity walls usually white throughout, occasionally slightly darkened; lower cortex black and wrinkled. No perforations noted. Ring-shaped, terminal soredia present at lobe tips. Sparse black, embedded pycnidia. Apothecia absent.

Cortex K+ yellow, KC+ red; medulla C-, KC+ red, PD-. Atranorin, 2-O methylphysodic acid, physodic acid, 3-hydroxyphysodic acid, and two unidentified substances: ( H<sub>2</sub>SO<sub>4</sub> -> yellow, B3-4), ( H<sub>2</sub>SO<sub>4</sub> -> yellow, +/- A6:B6:C6).

Commonly found on bark and moss. North American distribution: widespread across Canada with extensions southward into the United States in the Appalachian Mountains, the Rocky Mountains, and the far west mountain ranges. World distribution: North America, Europe, Asia, and Africa.

Representative specimens examined (12 out of 36).

MINNESOTA. COOK CO.: East Bearskin Lake, 9358.

NEW HAMPSHIRE. COOS CO.: west slope of Mt. Clay in Presidential Range, 14028, 14065.

NORTH CAROLINA. YANCEY CO.: Halfback Mountain in Black Mountains, 6043, 6058.

OREGON. BENTON CO.: north of Wren on State Rd. 223, 8705. MARION CO.: Stayton, Fern Ridge Rd., 9203. MULTNOMAH CO.: Wenoma Falls in Columbia River Gorge, 9029, 9034. POLK CO.: north of Pedee on State Rd. 223, 8755. YAMHILL CO.: forested ridge north of Newburg, 15380, 15596.

No significant morphological variation was noted in the specimens examined. There was however, some chemical variation. The unidentified substance (A6:B6:C6) was not always present in the chemical profile.

*Hypogymnia vittata* (Ach.) Gas., Act. Soc. Linn. Bordeaux 53: 66. 1898.

*Parmelia physodes* var. *vittata* Ach., Meth. Lich. 251. 1803.

Thallus mineral gray, loosely attached; lobes elongate, averaging .5-3 mm wide, dichotomous and palmate branching; medullary cavity walls dark; lower cortex black and wrinkled; lower surface distinctly perforate. Labriiform soredia, arising on underside of burst lobe tips. Pycnidia absent. Apothecia absent.

Cortex K+ yellow, KC+ red; medulla C-, KC+ red, PD-. Atranorin, physodic acid, 3-hydroxyphysodic acid, vittatolic acid, one unidentified substance: (H<sub>2</sub>SO<sub>4</sub> -> gray B3-4).

Commonly found on bark. North American distribution: widespread across Canada, with extensions southward into the Appalachian Mountains, the Rocky Mountains, and the far west mountain ranges. World distribution: North America, South America, Europe, Asia, and Australia.

Representative specimens examined (4 out of 16).

NORTH CAROLINA. HAYWOOD CO.: Cataloochie Balsam in Great Smoky Mountains, 3522. SWAIN CO.: Mt. Chapman in Great Smoky Mountain National Park, 3889. YANCEY CO.: Mt. Mitchell in Black Mountains, 846.

TENNESSEE. SEVIER CO.: high top of Mt. Le Conte in Great Smoky Mountains, 3216.

No significant morphological or chemical variation was noted.

## SPECIES DISTRIBUTIONS

### NORTH AMERICA NORTH OF MEXICO

Information on the distribution of North American species of *Hypogymnia* was obtained from Goward (1988), Hale (1979), Hale & Cole (1988), Krog (1968) and Ohlsson (1973).

**ARCTIC NORTHERN CANADA AND ALASKA.**--*Hypogymnia lugubris*, *H. pulverata* and *H. subobscura*. *Hypogymnia pulverata* has only been reported near Hudson's Bay in eastern Canada. *Hypogymnia subobscura* also occurs as a disjunct in alpine areas in Colorado.

**WIDESPREAD ACROSS CANADA WITH EXTENSIONS SOUTHWARD INTO THE UNITED STATES ALONG THE APPALACHIAN MOUNTAINS, THE ROCKY MOUNTAINS AND THE FAR-WESTERN MOUNTAIN RANGES.**--*Hypogymnia bitteri*, *H. physodes*, *H. tubulosa* and *H. vittata*. *Hypogymnia bitteri* is widespread across Alaska and Canada but extends southward only in the Rocky Mountains. *Hypogymnia vittata* is less common and more widely scattered in the west from Alaska to Washington and in the east in Quebec, New Brunswick, and the southern Appalachian Mountains.

**WEST COAST MOUNTAIN RANGES AND NORTHERN ROCKY MOUNTAINS IN THE UNITED STATES AND CANADA.**--*Hypogymnia enteromorpha*, *H. imshaugii*, *H. occidentalis* and *H. rugosa*. The latter three species are endemic to North America.

### **NORTHERN ROCKY MOUNTAINS OF THE UNITED STATES.-**

*Hypogymnia "montana"*, an endemic.

**WEST COAST MOUNTAIN RANGES ALONG WESTERN UNITED STATES AND CANADA.--***Hypogymnia duplicata*, *Hypogymnia farinacea*, *H. heterophylla*, *H. inactiva*, *H. metaphysodes* and *H. oceanica*. *Hypogymnia heterophylla*, *H. inactiva* and *H. oceanica* are North American endemics.

**CALIFORNIA.--***Hypogymnia "californica"*, *H. mollis*, *H. "sierrae"* and *H. subcapitata*. The first three species are endemic to California.

**APPALACHIAN MOUNTAINS IN EASTERN NORTH AMERICA --**  
*Hypogymnia krogii*. *Hypogymnia krogii* is endemic to North America.

### **WORLD DISTRIBUTIONS**

Information on the world distribution of North American species of *Hypogymnia* was obtained from Awasthi (1984) for India and Nepal, Brodo (1981) for Russia, Dey (1978) for eastern United States, Elix (1979) for Australasia, Galloway (1985) for New Zealand, Nuno (1964) for Japan, Poelt (1969) for Europe, Santesson (1984) for Norway and Sweden and Swinscow & Krog (1988) for east Africa.

Many of the North American species of *Hypogymnia* are not endemic to North America; several species are widely distributed throughout the world. *Hypogymnia austerodes*, *H. bitteri*, *H. farinacea*, and *H. tubulosa* occur in Europe, and Asia, as well as in North America. In addition, *H.*

*tubulosa* and *H. bitteri* occur in East Africa. *Hypogymnia subobscura* has been identified in Europe as well as in North America. Three species that occur in western North America, *Hypogymnia duplicata*, *H. enteromorpha*, and *H. metaphysodes* occur in Asia as well. *Hypogymnia physodes* and *H. vittata* have wide distributions throughout the world, occurring in North America, South America, Europe, Asia, and Australia. Additionally, *H. physodes* has been reported in East Africa. *Hypogymnia pulverata* which is newly reported to North America, also occurs in Australia, New Zealand, and Asia.

*Hypogymnia lugubris* an arctic North American species of *Hypogymnia* has a wide distribution throughout the world, occurring in North America, South America, Australia, New Zealand, and New Guinea.



## LITERATURE CITED

- Awasthi, D. 1984. The Lichen genera *Hypogymnia* and *Menegazzia* from India and Nepal. *Kavaka* 12(2): 87-97.
- Berry, E. 1940. A monograph of the Genus *Parmelia* in North America, North of Mexico. *Annals of the Missouri Botanical Garden* 28: 45-52.
- Brodo, I.M (ed). 1981. *Translation of Keys Contained in Volumes 1, 3, 4 & 5 of the Handbook of the Lichens of the U.S.S.R.* pages 45-50.
- Brodo, I.M. 1989. *Hypogymnia pulverata* new to North America. *The Lichenologist* 21: 184-185.
- Culberson, C. & H. Kristinsson. 1970. A Standardized Method for the Identification of Lichen Products. *J. Chromatog.* 46: 85-93.
- Culberson, C. 1986. Biogenetic Relationships of the Lichen Substances in the Framework of Systematics. *Bryologist* 89(2): 91-98.
- Dahl, E. & H. Krog. 1973. *Macrolichens of Denmark, Finland, Norway, and Sweden.* Oslo.
- Dey, J. 1978. Fruticose and Foliose Lichens of the High-Mountain Areas of the Southern Appalachians. *Bryologist*. 81(1): 1-93.
- Egan, R. 1987. A Fifth Checklist of the Lichen-Forming, Lichenocolous and Allied Fungi of the Continental United States and Canada. *Bryologist* 90(2): 77-173.
- Elix, J. 1979. A Taxonomic Revision of the Lichen Genus *Hypogymnia* in Australasia. *Brunonia* 2: 175-245.
- Elix, J. & F. Jenkins. 1989. New Species and New Records of *Hypogymnia*. *Mycotaxon* 35(2): 469-476.
- Fink, B. 1935. *The Lichen Flora of the United States.* Ann Arbor.
- Galloway, D. 1985. *Flora of New Zealand, Lichens.* Wellington.
- Goward, T. 1986. *Brodoa*, a New Lichen Genus in the *Parmeliaceae*. *Bryologist* 89(3): 219-223.
- Goward, T. 1988. *Hypogymnia oceanica*, a New Lichen (Ascomycotina) from the Pacific Northwest of North America. *Bryologist* 91(3): 229-232.
- Hale, M. 1979. *How To Know the Lichens.* Dubuque.
- Hale, M. & M. Cole. 1988. *Lichens of California.* Los Angeles.

- Hale, M. & W. Culberson. 1956. A Checklist of the Lichens of the United States, Canada, and Alaska. *Castanea* 21: 73-105.
- Hale, M. & W. Culberson. 1960. A Second Checklist of the Lichens of the Continental United States and Canada. *Bryologist* 63(3): 137-172.
- Hale, M. & W. Culberson. 1966. A Third Checklist of the Lichens of the Continental United States and Canada. *Bryologist* 67: 141-182.
- Hale, M. & W. Culberson. 1970. A Fourth Checklist of the Lichens of the Continental United States and Canada. *Bryologist* 73(3): 10-111.
- Hasse, H. 1913. Contributions from the U.S. National Herbarium. Lichen Flora of Southern California 17(1): 1-132.
- Imshaug. 1957. Alpine Lichens of Western United States and Adjacent Canada. I. The Macrolichens. *Bryologist* 60(3): 177-272.
- Krog, H. 1968. The Macrolichens of Alaska. Oslo.
- Nuno, M. 1964. Chemism of *Parmelia* subgenus *Hypogymnia*. J. Japanese Bot. 39(4): 97-103.
- Ohlsson, K. 1973. New and Interesting Macrolichens of British Columbia. *Bryologist* 76: 366-379.
- Pike, L. & M. Hale. 1982. Three New Species of *Hypogymnia* from Western North America (Lichenes: *Hypogymniaceae*). *Mycotaxon* 16(1): 157-161.
- Poelt, J. 1969. Bestimmungsschlüssel Europäischer Flechten. Germany.
- Santesson, R. 1984. The Lichens of Sweden and Norway. Stockholm.