THE HEPATIC FLORA OF WATAUGA COUNTY, NORTH CAROLINA

A Thesis

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Master of Arts

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by

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CHAPTER I

INTRODUCTION

The flora of the Southern Appalachian highlands is noted for its diversity and abundance. According to Douglas (6) a catalogue of the understory trees and shrubs in one cove hardwood stand in North Carolina numbered over 200 varieties, and mosses, liverworts and ferns were found in profusion.

I. THE PROBLEM

Most floristic studies include only vascular plants; relatively few studies have been made of the non-vascular plants. The great variety of microclimates in Watauga county make it especially suitable for a study of the bryophytes. The altitudinal range varies in the county from 5939 feet to 1320 feet above mean sea level.

The bryophytes constitute an important part of the plant kingdom and are found in nearly every part of the world, occupying habitats ranging from hydric to xeric. There are according to Bold (4) 8,500 species of liverworts. In North America, north of Mexico, the liverworts number about 460 (7).

Commercially, the bryophytes have few uses. In Watauga county some of the "log mosses" are collected in sheets and are sold for use by florists. The majority of

these plants, however, are of interest primarily to botanists, not only because of their evolutionary significance but also for their role in ecological successions. The ability of hepatics to absorb and hold large amounts of water retards run-off and aids in the establishment of other plants. Bryophytes are also known to be pioneers on bare rock, holding small amounts of soil that later supports other plants. These plants also add to the beauty of our forests, forming bright green carpets when other plants have lost their leaves. The exquisite symmetry and delicate beauty of a tiny liverwort, when first viewed under the microscope, cannot fail to impress botanist and amateur alike.

Statement of the problem. The objectives of this survey were (1) to collect and identify as many of the species of liverworts as possible growing in Watauga county, (2) to contribute to the scientific knowledge of the mountain flora of North Carolina and (3) to establish a bryophyte collection in the herbarium at Appalachian State Teachers College.

Significance. The bryophytes are important in the study of botany as the first group of plants to make the transition from an aquatic environment to a terrestrial environment. Lists of bryophytes have been made for many sections of the United States; however, such a list does not exist for Watauga county and no bryophyte herbarium exists in

the area. It is important that herbarium specimens be available to students in order that they might be able to identify common species. It was hoped that availability of herbarium specimens would stimulate interest and further study of these plants.

Limitations and assumptions. In this survey the author attempted to collect as many species as possible within the limits allowed by the method of collection. This collection will contain most of the species occuring within the county. It should serve as a beginning for further study of the bryophyte distribution within the county.

II. DEFINITION OF TERMS

Bryophyte. In this survey, the term bryophyte is used in the conventional manner. Recent authors (4) divide the plant kingdom into divisions; however, in this survey the divisions Bryophyta, which includes mosses, and Hepatophyta which includes the liverworts and hornworts, are included in the term bryophyte.

Hepatics. This term refers specifically to the liverworts and hornworts which Bold (4) includes in the division Hepatophyta.

III. PROCEEDURES AND ORGANIZATION

The collection of samples began in September 1962 and continued until March 1964. Samples of hepatics were collected during this time from all over the county.

United States Geological Survey topographic quadrangle maps, a North Carolina Highway Department map of Watauga county, and a United States Department of Agriculture soil type map (19) were utilized for the selection of collecting stations that would cover the various elevations, soil types, and vegetation types of the county. Samples were collected at various intervals along roads and streams. Collecting trips were made all over the county. An attempt was made to obtain specimens from a variety of elevations and soils. Samples were also taken from areas showing varying degrees of moisture, slope, and exposure. The specimens were placed in envelopes in the field for later identification. On these envelopes notations were made of elevation, habitat, and location of specimen. After identification many of the samples were sent to competent bryologists for verification when their identity was doubtful. The specimens were then placed in the herbarium of the biology department at Appalachian State Teachers College. The data from the packets were tabulated and a phylogenetic list of species was compiled. This list is included in Chapter V. An alphabetical

list of species found is included in the appendix.

IV. REVIEW OF THE LITERATURE

In searching the literature for lists of liverworts from Watauga county, the author found no recent lists including the area.

Early botanical explorations through the Carolinas were primarily for the investigation of vascular plants. Gray's Manual of Botany, sixth edition in 1889 (9) lists 45 genera and 141 species of hepatics for the northern United States. Current lists for North America, Canada and the Arctic include 114 genera and 460 species (7).

George F. Atkinson in 1901 made several collection trips in and around Watauga county. In a list by Leroy Andrews of the species collected by Atkinson, 40 species of hepatics were listed from altitudes ranging from 2500 feet to 6000 feet.

Paul C. Standley (17) listed 19 hepatics collected during a stay of several weeks in western North Carolina in 1909.

H. L. Bloomquist (3) in 1936 listed 140 species of hepatics for the state of North Carolina, and of these 45 species were collected in Watauga county.

Collections from counties in other areas vary greatly. In a collection from Clinton county, Ohio (11), nine hepatics

were listed, while 15 were listed from Muskogee county, Oklahoma (12). Cook county in Minnesota, a county with low temperature, high moisture and precipitation, adjacent to Lake Superior, contains at least 122 species according to Schuster (15), while Houston and Winona counties in Minnesota together contain about 40 species.

A. J. Sharp (14) listed 117 species of hepatics from eastern Tennessee, an area similar to western North Carolina.

Nelle Ammons (1) in an exhaustive study reported 111 species of hepatics from the state of West Virginia, which has topography similar to that of western North Carolina.

Conard (5) has estimated that one hundred bryophyte species (mosses and liverworts combined) for a county is about average. He found that the state of Iowa had about 250 mosses and 50 liverworts and probably only 100 of these abundant enough to be represented in the state's ten large herbaria.

According to Polunin (13), mosses grow "particularly, but by no means entirely in damp situations". Bryophytes have also been found to be conspicuous in arctic and boreal regions and high up on mountains.

According to Schuster (15), hepatic flora is richest in eastern North America in the mountains of New England and in the Appalachians where summer temperatures are low and the precipitation-evaporation ratio is favorable.

CHAPTER II

DESCRIPTION OF THE AREA

Watauga county is located in the northwest corner of North Carolina. It borders Tennessee on parts of its north and west sides and joins Ashe county on the north, Wilkes on the east, Caldwell on the south, and Avery on the south and west. The county includes nearly 205,000 acres in the Blue Ridge Section of the state.

I. GEOLOGY

The greater part of the rocks of the county are light colored, acidic igneous rocks that have been metamorphosed to some degree. Volcanic and sedimentary rocks occur in the southwest section of the county and crystalline igneous rocks underly the remainder. The underlying rocks fall into three main groups: (1) crystalline igneous and metamorphic rocks which include gneiss, schist, granite, diabase, diorite, metarhyolite, and metadiabase, (2) volcanic basaltic rocks, and (3) noncalcareous sedimentary rocks which include conglomerate, sandstone, and shale (19). There are no limestone deposits in the county (10).

II. PHYSIOGRAPHY

The general land features of the county are those of

a high irregular plateau. Mountains rise above this plateau to a maximum elevation of 5939 feet. There are eight mountains in the county with elevations exceeding 5,000 feet. The crest of the Blue Ridge extends across the southern part of the county, and south of this crest the relief is rough with very narrow mountain ridges and deep ravines (19). Much of the county is deeply sculptured by streams. These descend rapidly from the high elevations causing hilly, steep, and mountainous relief. Two rivers originate within the county, the New River, which flows from south to northeast, and the Watauga River, which flows through the western part of the county. The county has an uneven dendritic drainage pattern. The Eastern Continental Divide runs through the county. Streams on the eastern side of this divide ultimately flow into the Pedee River and streams on the west ultimately to the Ohio River. Elevations above mean sea level vary widely from 5939 feet at Grandfather Mountain to 1320 feet where Elk Creek leaves the county. Steep relief (grade of slope 30 to 60%) is found in 54% of the county and very steep (60% or more) in 12% (19). The remainder varies from undulating to hilly.

III. CLIMATE

Watauga county has a temperate, humid climate which is modified by high altitude. The average annual temperature

at Boone, North Carolina based on a 23-year record (1929 to 1951) is 51.7°F., with an average maximum temperature of 90°F. and an average minimum of 0°F. The average difference between January and July temperatures is 32 to 34 degrees Fahrenheit. About fifteen days each year the temperature remains below freezing throughout the day and about one hundred days each year the temperature is below freezing at some time during the day (19). Rainfall is mostly light to medium heavy and about thirty to forty days each year the area experiences dense fog. The rainfall is distributed fairly evenly throughout the year, but is somewhat heavier in summer. The average annual precipitation for a ten-year period was 54.42 inches and the average snowfall about 39 inches a year (18). The prevailing wind is from the southwest and is sometimes very strong, especially in the higher elevations.

IV. EDAPHIC FACTORS

Most of the soils have either a loam or stony loam surface soil and a reasonably permeable subsoil. The soils are mainly a product of the parent rocks found in the county. About 50% of the soil is stony and about 18% has bedrock outcrops, with about .1% bare bedrock outcrop (19). The climate is such that leaching by water occurs during much of the year. The soil has been found to vary from moderately

acid to strongly acid (pH 6.0 to 4.5). Many of the soils have developed under forest vegetation and have relatively low to medium content of organic matter. The soils are deficient in calcium ions because of the lack of limestone parent material in the area.

V. BIOTIC FACTORS

Approximately half of the 205,000 acrea of the county is forested. The forests of Watauga county are classified in the United States Department of Agriculture Soil Survey (19) as (1) upland hardwoods which comprise 75%, (2) cove hardwoods which comprise 15%, (3) white pine-hardwoods which are mainly in the section southeast of the Blue Ridge in the extreme eastern section of the county, and (4) fraser fir-red spruce which is found in the higher elevations. Approximately one-half of the forests are second or third growth. Farms cover an area of 163,426 acres, of which 57,456 acres are cropland and 28,071 acres are pasture (19).

CHAPTER III

PROCEEDURES USED

Bryophytes were found in nearly every habitat in the county from bare granite outcrops to the rapidly descending mountain streams. It was found that these plants could be collected any time of year because the gametophytes or vegetative parts of most of the species were in suitable condition for collection even during severe weather.

I. METHOD OF COLLECTION

When this survey began in September, 1962, the author investigated different methods of phytological sampling but it soon became apparent that the usual methods of sampling were not suitable. The factor most influencing their distribution within the county seemed to be the microclimate in which the plant grew rather than the macroclimate. Because of this, these microclimates had to be searched out. During preliminary collecting it was found that in a sizeable area of uniform topography a representative number of plants could be found in a small part of the area and further penetration into the larger area turned up few or no new species; however in an area where there was a variety of micro environments, regardless of how small or large the total area, examination of these different types of microenvironments or microclimates

turned up a representative collection of those to be found in the whole area of a given altitude, soil type, cover type, etc. For this reason, the microenvironments considered representative of those to be round in each area were examined for specimens. These microenvironments included dry soil, moist soil, dry banks, moist banks, shaded woods, stones in creeks, creek banks, grassy areas, fallen logs, rocks, bark of living trees and any other formation that might represent a variation of environment. Figures I, II, and III show some representative environments.

Figure I. Fallen log with bryophyte flora.

Figure II. Granite outcrop supporting bryophyte flora.

Figure III. Road bank with bryophyte flora.

It was found that most moist places were especially rich in liverworts although many were found in extremely xeric situations such as the tree shown in Figure IV.

Figure IV. Living tree with *Porella* growing on the bark.

On the county map, Figure V, the areas of various soil types were marked from the information on the United States Department of Agriculture soil map (19 for Watauga county. Each collection station was marked by a circle on the map. Many of the collection stations were visited more than once in an effort to find plants with sporophytes. Most of the stations were along roads and streams since these were examined first; however, the large areas bisected by roads were penetrated farther to see if there were any new

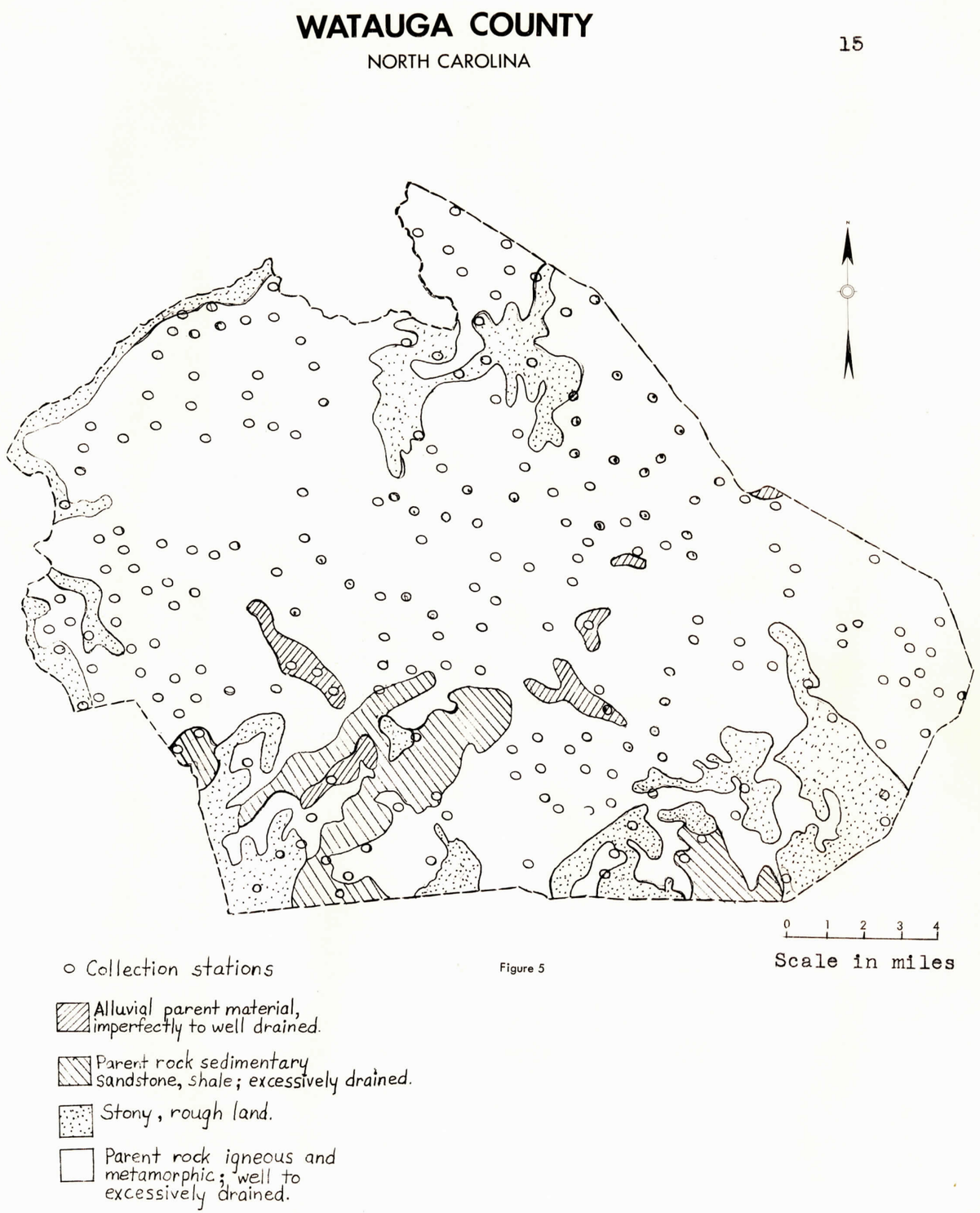

Figure 5

microenvironments. If an area appeared uniform, no new stations were established or marked on the map.

Field collection equipment included a pouch for carrying specimens, a pen knife, envelopes, plastic bags and a 20X Hastings pocket magnifier. Collection samples ranged in size from a few strands of small plants to 4" x 4" mats of mixed or unmixed bryophytes. These samples were examined in the field with the pocket magnifier to tentatively determine genus. In many instances the sample contained two or more genera intermingled and this was noted on the envelope. For a pouch, a nail apron was used which could be tied around the waist. This was found to be easier to carry than a vasculum. The envelopes from each habitat at a station were placed in plastic bags containing tags noting date, location, and habitat of collection. Nothing further was done with the samples in the field. In the laboratory the envelopes were numbered and recorded in a record book with date and elevation of collection.

II. METHOD OF IDENTIFICATION

The samples from the field were transferred to herbarium packets with date, habitat, altitude, and place of collection noted on the label. A tentative generic identification was assigned in most cases and the packets were then filed systematically for later identification. All packets

of the same tentative generic identity were examined at the same time. This comparison of samples aided in identification. By examining all samples of a genus at one time, variations within the species could be seen and identification of sterile material was facilitated. For identification, Frye and Clark's Hepaticae of North America (8) was primarily used. Schuster (16) was used for the identification of the Plagiochilaceae. The specimens were examined first under a binocular dissecting microscope using magnifications up to 40X for observation of general characteristics. More detailed studies of leaf, cell, and sporophyte characteristics were made with the use of an American Optical Company Microstar binocular microscope. Whole leaf mount slides were made of leaves and leafy shoots from the specimens. For more permanent slides, the conventional manner of mounting in a resinous medium proved unsatisfactory. Some of the material distorted badly during dehydration. Turtox CMC-10 non-resinous mounting media proved satisfactory for making whole mounts of material directly from water. In some cases free hand cross sections were made to show leaf cell characteristics. Comparison between samples and the descriptions in Frye and Clark were made to determine species. Those specimens of doubtful identity were sent to experts for further determination.

CHAPTER IV

I. SUMMARY

This survey was primarily for the purpose of identifying as many species as possible; however incidental to this the following factors were significant.

(1) Soil types apparently had little effect on species distribution. This may have been because the soils of the county were derived from parent material of similar chemical composition.

(2) The differences in species distribution at various elevations were significant. Some species were found only at high elevations on Grandfather Mountain while others were found only at the lowest elevations occuring in Elk Township.

A total of 96 hepatics were identified from Watauga county. These were distributed among 23 families and 46 genera. Seven of these have not previously been listed for the state and fifty-nine not previously listed for the county. The number of species found was larger than was expected from an area the size of Watauga county since the whole state of West Virginia adjacent to North Carolina contained 111 species. The number of species, however, compares favorably with the number from Cook county, Minnesota.

In the following list the elevations are listed by 1000 foot intervals and indicate that the plants were found

at several places within the range given. The classification of Hepaticae are according to the "List of Hepaticae found in the United States, Canada, and Arctic America" by Evans(7). Two stars indicates a species not previously listed for the state and one star those not previously listed for the county.

II. LIST OF HEPATICAE

PTILIDIACEAE

*Herberta tenuis Evans Found on peaty soil only on Grandfather Mountain. Not common. 5000-6000'.

*Ptilidium pulcherrimum (Weber) Hampe. Found on log and moist bank. Not common. 3000-5000'.

Blepharostoma trichophyllum (L.) Dum. Found intermingled with other bryophytes, commonly associated with Radula. Not common. 2000-6000'.

Tricholea tomentella (Ehrh.) Dum. Found on moist soil in patches. Not common. 3000-5000'.

LEPIDOZIACEAE

Bazzania denudata (Torr.) Trev. Found on moist soil in patches. Not common. 4000-6000'.

*Bazzania nudicaulis Evans Found on moist gravelly soil in patches. Not common. 4000-6000'.

Bazzania tricrenata (Wahl.) Trev. Found on moist soil. Not common. 5000-6000'.

Bazzania trilobata (L.) S.F. Gray Found on trees and moist soil in patches. Common. 2000-6000'.

Lepidozia reptans (L.) Dum. Found on rocks and moist soil. Common only in elevations above 5,000 feet. 5000-6000'.

*Lepidozia setacea (Web.) Mitt. Found on silty and rocky banks. Not common. 2000-4000'.

CALYPOGEIACEAE

*Calypogeia arguta var. sullivantii Aust. Found on soil at the edge of creek partially submerged. Not common. 2000-4000'.

*Calypogeia neesiana (M & C) K. Muell. Found on creek banks and moist soil. Common. 2000-4000'.

*Calypogeia sphagnicola (Arn. & Press) Warnst & Loeske Found with other bryophytes. Rare. 5000-6000'.

Calypogeia trichomanis (L.) Corda Found on rocks in creek and on moist soil. Common. 2000-4000'.

CEPHALOZIACEAE

*Cephalozia bicuspidata (L.) Dum. Found on fallen logs. Not common. 3000-4000'.

Cephalozia catenulata (Hueben.) Spruce Found on decaying log. Not common. 2000-4000'.

*Cephalozia convivens (Dicks) Lindb. Found on shady soil in moist woods. Not common. 4000-6000'.

Cephalozia media Lindb. Found on fallen log. Not common. 3000-4000'.

Nowellia curvifolia (Dicks) Mitt. Found in extensive patches on decaying logs. Common. 3000-6000'.

Odontoschisma denudatum Nees Found on logs and stumps in moist places. Not common. 2000-4000'.

Odontoschisma prostratum (Sw.) Trevis Found on logs and with other bryophytes. Not common. 3000-5000'.

CEPHALOZIELLIACEAE

**Cephaloziella hampeana (Nees) Schiffn. Found on fallen logs. Not common. 4000-5000'.

**Cephaloziella spinicaulis (Douin) Found on bark of tree. Collected only once in Laurel Creek Township. Rare. 4000'.

HARPANTHACEAE

*Lophocolea bidentata (L.) Dum. Found on banks, moist soil and logs. Common. 3000-5000'.

*Lophocolea heterophylla (Schrad.) Dum. Found on fallen log. Not common. 3000-4000'.

*Chiloscyphus pallescens (Ehrh.) Dum. Found on bark of trees, moist soil, and creek bank. Common. 2000-4000'.

*Chiloscyphus polyanthus (L.) Corda Found on decaying log. Not common. 4000-5000'.

Chiloscyphus rivularis (Schrad.) Loeske Found on rock in creek. Not common. 3000-4000'.

*Mylia cuneifolia Hook Found with other bryophytes on bark of Abies frazeri. Not common. 5000-6000'.

*Harpanthus scutatus (Web. & Mohr.) Spruce Found on bark of trees. Not common. 1000-4000'.

JUNGERMANNIACEAE

*Sphenobolus minutus (Cranz.) Steph. Found on moist soil. Not common. 4000-6000'.

Anastrophyllum michauxii (Web.) Buch Found on rocky creek bank. Not common. 4000-6000'.

Tritomaria exsecta (Schmid.) Schiffn. Found in patches on moist soil. Not common. 4000-6000'.

**Barbilophozia hatcheri (Evans) Loeske Found in patches on fallen log. Not common. 5000-6000'.

*Jungermannia lanceolata L. Found on base of tree and on moist rock. Not common. 3000-5000'.

*Jungermannia pumila With Found on rock in creek and on moist log. Not common. 3000-4000'.

Jamesoniella autumnalis (Dc.) Steph. Found on logs, soil and rocks. Common. 3000-6000'.

Plectocolea crenulata (Smith) Evans Found on moist banks on soil. Common. 2000-5000'.

*Plectocolea fossombronioides (Aust.) Mitt. Found on granitic rock in water. Rare. 3000-4000'.

MARSUPELLACEAE

Marsupella emarginata (Ehrh.) Dum. Found on moist rocky soil with other bryophytes. Not common. 5000-6000'.

PLAGIOCHILACEAE

Plagiochila asplenoides (L.) Dum. Found on moist granitic rock. Not common. 5000-6000'.

*Plagiochila tridenticulata Tayl. Found on moist rocky soil. Rare. 5000-6000'.

**Plagiochila virginica var. caroliniana Schuster Found on rock along edge of creek. Not common. 1000-3000'.

SCAPANIACEAE

*Diplophyllum andrewsii Evans Found on soil on road banks and in woods. Common. 1000-4000'.

Diplophyllum apiculatum (Evans) Steph. Found on soil, dry banks and road cuts. Common. 1000-4000'.

Scapania nemorosa (L.) Dum. Found on moist rock. Common. 3000-5000'.

Scapania undulata (L.) Dum. Found on rocky damp soil. Not common. 4000-6000'.

POREL LACEAE

Porella pinnata L. Found on soil on river bank and on wet rocks. Not common. 1000-3000'.

Porella platyphylla (L.) Lindb. Found on bark of trees, occasionally on rock. Common. 3000-5000'.

Porella platyphylla var. platyphylloidea Schweinitz Found on bark of trees. Common. 3000-5000'.

RADULACEAE

*Radula andicola Steph. Found on fallen log. Not common. 3000-4000'.

Radula complanata (L.) Dum. Found on moist rock with some soil. Not common. 2000-3000'.

*Radula obconica Sull. Found on bark of tree. Not common. 4000-5000'.

*Radula sullivantii Aust. Found on wet rock. Not common. 3000-5000'.

Radula tenax Lindb. Found on granitic rock. Not common. 2000-3000'.

FRULLANIACEAE

Frullania asagrayana Mont. Found on trees and logs. Common. 2000-6000'.

**Frullania bolanderi Aust. Found on trees. Not common. 2000-5000'.

Frullania brittoniae Evans Found on trees. Not common. 2000-4000'.

Frullania eboracensis Gottsche Found on trees. Common. 2000-6000'.

*Frullania inflata Gottsche Found on trees. Not common. 3000-4000'.

*Frullania kunzei Lehn & Lindenb. Found on trees. Not common. 3000-5000'.

*Frullania plana Sull. Found on trees. Not common. 2000-6000'.

*Frullania riparia Hampe. Found on moist log. Not common. 2000-5000'.

Frullania squarrosa (R. Bl. & N.) Dum. Found on trees. Not common. 3000-4000'.

*Jubula pennsylvanica (Steph.) Evans Found with other bryophytes on rock in creek. Not common. 2000-4000'.

LEJEUNEACEAE

Leucolejeunea clypeata (Schweintz) Evans Found on rocks and bark of trees. Not common. 2000-4000'.

*Leucolejeunea conchifolia Evans Found on trees. Not common. 1000-2000'.

*Leucolejeunea unciloba (Lindenb.) Evans Found on trees. Not common. 1000-2000'.

*Lejeunea flava (Sw.) Nees Found on soil on road bank. Not common. 4000-5000'.

*Lejeunea patens Lindb. Found on log. Not common 4000-5000'.

**Microlejeunea bullata (Tayl.) Evans Found on bark of trees usually associated with other bryophytes. Rare. 2000-6000'.

*Microlejeunea laetivirens (Nees & Mont.) Evans Found on bark of living tree. Rare. 3000'.

Microlejeunea ruthii Evans Found on moist rocks and trees. Not common. 2000-5000'.

*Microlejeunea ulicina (Tayl.) Evans Found on trees. Not common. 2000-5000'.

Cololejeunea biddlecomiae (Aust) Evans. Found on underside of rock outcrop by creek and on trees. Not common. 2000-4000'.

FOSSOMBRONIACEAE

*Fossombronia foveolata Lindb. Found only once in patches on moist shady soil. Not common. 3000-4000'.

*Fossombronia wondrazeckii Corda Found only once with other bryophytes on creek bank. Rare. 3000-4000'

PELLIACEAE

*Pellia epiphylla L. Found on soil on moist banks and along creeks. Common. 2000-6000'.

*Pellia neesiana (Gottsche) Limpr. Found on moist soil and rocks. Common. 3000-5000'.

BLASIACEAE

**Blasia pusilla L. Found only in one area in Elk Township where it completely covers a moist road bank. Not common. 1000-2000'.

METZGERIACEAE

Metzgeria conjugata Lindb. Found on rocks in creek. Not common. 3000-5000'.

Metzgeria crassipilis Lindb. Found on trees and logs. Common. 2000-5000'.

*Metzgeria furcata (L.) Dum. Found on rocks and trees. Not common. 1000-5000'.

*Metzgeria hamata Lindb. Found on wet rocks. Not common. 4000-5000'.

RICCARDIACEAE

*Riccardia latifrons Lindb. Found on moist rocks. Not common. 3000-4000'.

*Riccardia multifida L. Found on wet rock cliff. Not common. 3000-4000'.

*Riccardia pinguis L. Found on a wet rocky hillside. Collected only once. Rare. 3800'.

*Riccardia sinuata Dicks Found on moist soil. Not common. 2000-4000'.

MARCHANTIACEAE

Marchantia polymorpha L. Found on moist soil and rocks. Collected only twice. Rare. 3000-4000'.

*Conocephalum conicum (L.) Dum. Found on moist rocks and soil. Common below 3000'.

*Dumorthera hirsuta (Lw.) Reinw. Found on moist shaded rocks along edge of creek. Not common. 3000-4000'.

REBOULIACEAE

*Reboulia hemisphaerica (L.) Raddi Found on moist rock cliff. Found only in Elk Township. Rare. 1000-2000'.

RICCIACEAE

*Riccia sullivantii Aust. Found on soil at edge of river. Not common. 2000-4000'.

ANTHOCEROTACEAE

*Anthoceros carolinianus Michx. Found on moist soil. Not common. 2000-4000'.

*Anthoceros laevis L. Found on moist shaded soil and along ditches. Common. 2000-5000'.

*Notothylas orbicularis (Schwein.) Sull. Found only once on moist soil along edge of river. Rare. 2400'.

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APPENDIX

ALPHABETICAL LIST OF HEPATICS

Anastrophyllum michauxii (Web.) Buch

Barbilophozia hatcheri (Evans) Loeske
Bazzania denudata (Torr.) Trev.
Bazzania nudicaulis Evans
Bazzania tricrenata (Wahl.) Trev.
Bazzania trilobata (L.) S.F. Gray
Blasia pusilla L.
Blepharostoma trichophyllum (L.) Dum.

Calypogeia arguta var. sullivantii Aust
Calypogeia neesiana (M & C) K. Muell.
Calypogeia sphagnicola (Arn. & Press.) Warnst & Loeske
Calypogeia trichomanis (L.) Corda
Cephalozia bicuspidata (L.) Dum.
Cephalozia catenulata (Hueben.) Spruce
Cephalozia convivens (Dicks.) Lindb.
Cephalozia media Lindb.
Cephaloziella hampeana (Nees) Schiffn.
Cephaloziella spinicaulis Douin.
Chiloscyphus pallescens (Ehrh.) Dum.
Chiloscyphus polyanthus (L.) Corda
Chiloscyphus rivularis (Schrad) Loeske
Cololejeunea biddlecomiae (Aust.) Evans
Conocephalum conicum (L.) Dum.

Diplophyllum andrewsii Evans
Diplophyllum apiculatum (Evans) Steph.
Dumorthera hirsuta (Sw.) Reinw.

Fossombronia foveolata Lindb.
Fossombronia wondrazeckii Corda
Frullania asagrayana Mont.
Frullania bolanderi Aust.
Frullania brittoniae Evans
Frullania eboracensis Gottsche
Frullania inflata Gottsche
Frullania kunzei Lehm. & Lindenb.
Frullania plana Sull.
Frullania riparia Hampe
Frullania squarrosa (Reinw., Bl., & Nees) Dum.

Harpanthus scutatus (Web. & Mohr.) Spruce
Herberta tenuis Evans

Jamesoniella autumnalis (DC.) Steph.
Jubula pennsylvanica (Steph.) Evans
Jungermannia lanceolata L.
Jungermannia pumila With.

Lejeunea flava (Sw.) Nees
Lejeunea patens Lindb.
Lepidozia reptans (L.) Dum.
Lepidozia setacea (Web.) Mitt.
Leucolejeunea clypeata (Schweintz) Evans
Leucolejeunea conchifolia Evans
Leucolejeunea unciloba (Lindenb.) Evans
Lophocolea bidentata (L.) Dum.
Lophocolea heterophylla (Schrad.) Dum.

Marchantia polymorpha L.
Marsupella emarginata (Ehrh.) Dum.
Metzgeria conjugata Lindb.
Metzgeria crassipilis Lindb.
Metzgeria furcata (L.) Dum.
Metzgeria hamata Lindb.
Microlejeunea bullata (Tayl.) Evans
Microlejeunea laetevirens (Nees & Mont.) Evans
Microlejeunea ruthii Evans
Microlejeunea ulicina (Tayl.) Evans
Mylia cuneifolia (Hook) S.F. Gray

Nowellia curvifolia (Dicks) Mitt.

Odontoschisma denudatum Nees
Odontoschisma prostratum (Sw.) Trev.

Pellia epiphylla L.
Pellia neesiana (Gottsche) Limpr.
Plagiochila asplenoides (L.) Dum.
Plagiochila tridenticulata Tayl.
Plagiochila virginica var. caroliniana Schuster
Plectocolea crenulata (Sw.) Buch.
Plectocolea fossombronioides (Aust.) Mitt.
Porella pinnata L.
Porella platyphylla (L.) Lindb.
Porella platyphylla var. platyphylloidea (Schweinitz) n. comb.
Ptilidium pulcherrimum (Web.) Hampe

Radula andicola Steph
Radula complanata (L.) Dum.
Radula obconica Sull.
Radula sullivantii Aust.
Radula tenax Lindb.

Reboulia hemisphaerica (L.) Raddi
Riccardia latifrons Lindb.
Riccardia multifida L.
Riccardia pinguis L.
Riccardia sinuata Dicks
Riccia sullivantii Aust.

Scapania nemorosa (L.) Dum.
Scapanis undulata (L.) Dum.
Sphenobolus minutus (Cranz.) Steph

Tricholea tomentella (Ehrh.) Dum.
Tritomaria exsecta (Schmid.) Schiffn.

Anthoceros carolinianus Michx.
Anthoceros laevis L.
Notothylas orbicularis (Schweinitz) Sull.