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Rhizoplaca weberi Photo: Linna Weber Müller-Wille

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Rare Disjunct Cryptogams in Colorado (Mosses, Hepatics, and Lichens)

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Abstract

The concept of rarity is discussed, particularly in regard to disjunct species, eco-niches, habitats, and preservation thereof. A detailed explanatory list of rare disjunct mosses, hepatics, and lichens present in Colorado is provided. The hope is that the species lists presented here will be of practical use to local botanists and amateurs intrigued by cryptogams and their intriguing distributions.

Note from the Editors

Acta Botanica Weberi is published by members of the Weber family and distributed free of charge through the williamaweber.com website. It was specifically founded to publish hitherto unpublished papers by William A. Weber. It was decided that at the age of 99, Dr. Weber could no longer wait on the peer review process to see his latest writings published if they were not to become posthumous works. Instead he and we felt that publication in this form to be the most appropriate at his age. The resulting dissemination of these works among his botanical colleagues, known and unknown, and the uses, references and discussions thus arising will be enough of a peer review and contribute to the continuing endeavors to research scientific questions.

As Bill Weber embarks on his second century, he finds he has over the years written on various topics that he never published. With the editorial and technical help of family members versed in the world of computers, he would like to bring some of those writings to light. The present article had its beginnings around the time when he began work with Ron Wittmann on the manual *Bryophytes of Colorado: Mosses, Liverworts, and Hornworts* (2007). That project took precedence at the time, hence this present work lay patiently waiting to be resurrected now.

We wish to give special thanks to Bill Weber's friend and colleague Irwin Brodo for help in checking the current nomenclature of the lichens mentioned in this article.

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I. Introduction:

Cryptogamic plants, for my purpose of this essay, are only the mosses, hepatics, and lichens.

We must understand that the cryptogamic plants are an aspect of the flora in which our present knowledge is really primitive. While serious systematic study of the flowering plants goes back nearly three hundred years, at least to 1735 when Linnaeus published his *Systema Naturae*, study of the cryptogams has drawn less interest. Cryptogams are much smaller than most vascular plants, less showy, and therefore more easily overlooked, except by botanists specializing in their study. Some of the best collectors and specialists of the world have dealt with the Colorado flora, and, luckily a few of those botanists knew the cryptogams as well.

For Colorado cryptogams there are very few college courses, only a handful of local knowledgeable botanists, and even fewer specialists. There is no up-to-date manual for the lichens, though lichenological work began here in 1953. The first primitive manual for the mosses (Weber 1973) has since been replaced by the updated *Bryophytes of Colorado: Mosses, Liverworts, and Hornworts*. See Weber & Wittmann (2007). The field coverage of Colorado for bryophytes and lichens is limited to easily accessible sites, and the work is extremely undermanned, underfunded, and still poorly understood by any but a very few local botanists.

I have been very fortunate to have been able to make field studies of lichens and bryophytes in the eastern United States, Iowa, Washington and Oregon, California, Arizona, New Mexico and Texas, Hawaii, Scandinavia, Switzerland, Great Britain, France, Italy, Greece, the North American Arctic, Mexico, Chile, Peru, Tierra del Fuego, the Canary Islands, the Galapagos Islands, Siberia, the Nepal Himalayas, Japan, Australia, and New Guinea. A cryptogamist needs just this kind of experience to become proficient.

Lichens, except for the most conspicuous ones growing unattached or hanging from the trees, are not the object of a Sunday collecting outing. To collect lichens one needs not only a knife to take bark lichens, but a soil solidifier for soil lichens, and a hammer and cold chisel for rock lichens. Even with the proper tools, lichens may be extremely difficult to collect because they may grow on smooth granite river boulders, crumbling sandstone, friable soil, or on exceedingly hard quartzite. One can't just hike along and collect as one goes. Lichen collecting requires getting down on hands and knees and chopping; very little mileage is accrued per day.

To start to identify Colorado's lichens, the little book *A Rocky Mountain Lichen Primer* (Weber & Corbridge 1998) is an invaluable tool to quickly learn the most common species. For more advanced identification the *Keys to Lichens of North America: Revised and Expanded* (Brodo 2016) is recommended, and for a most beautiful excursion into the wonderland of lichens *the Lichens of North America* (Brodo 2001). Nevertheless, to make proper identifications these points are recommended: access to an excellent herbarium with world-wide coverage is essential; a library containing the relevant books and journals; a reading knowledge of German, Russian, French, Spanish, Swedish, and Latin is certainly an asset; and correspondence with foreign specialists is also important. Nowadays one needs to do sophisticated chemical analysis and use high-powered microscopes. The University of Colorado Herbarium houses over 100,000 lichen specimens amassed through my personal collecting in many parts of the world and through exchanging specimens with other herbaria. Here, at least, are the means to make correct identifications, but the field leg work has only begun.

Bryophytes are more user-friendly. Mosses and hepatics are very easy to collect, but it is not easy to separate similar species without microscopic dissection. Most Colorado bryophytes are well-known and there are many books that aid in identification, but only one specifically for Colorado, Weber & Wittmann (2007). For more advanced studies of Colorado bryophytes it is useful to consult manuals covering other parts of the world, such as the eastern United States, Utah, Mexico, Europe, and Asia, and not all of them are in English. The Herbarium at the University of Colorado contains over 100,000 bryophytes from all over the world, an invaluable resource in the quest to know these elusive plants.

II. The Question Of Rarity

Rarity actually is the end result of many interacting factors. These may be characteristics of the species itself: its genetic diversity or homogeneity which may make it resistant or vulnerable to changes in the habitat or environment; its mode and recentness of origin; and its reproductive strategy. Other factors may have to do with externals: alteration of the habitat, either natural (fire, flood, climatic change) or induced by the hand of man (livestock grazing, introduction of exotic animals, pollinators, introduced plants, cultivation and site "improvements"; exploitation of wild plants for food, drugs, or firewood; in the instance of lichens, removal of rocks to use for beautification of homes or gardens). These changes in the habitats make it more difficult to make detailed studies of the autecology and population biology of rare plant species of Colorado. See Weber & Wittmann 2012 (Eastern Slope: pp. xxxvi-xxxvii ; Western Slope: pp. xxxiv-xxxv).

I believe survival among Colorado's rare cryptogams is definitely a function of the availability and the preservation of the proper micro-habitat over extremely long periods of time. This, I am convinced, is the only reasonable explanation for the large number of highly disjunct species in the Rocky Mountain flora. Certainly there is little logic in a hypothesis of independent origin of such species, or of migration of whole floras over huge expanses of land and sea. One very convincing observation is that these disjunct species have special micro-habitats or eco-niches, and they could hardly have migrated without their habitats going along with them.

Endemism

There are virtually no endemic species of bryophytes or lichens in Colorado.

Disjunct Species

Most of Colorado's rare cryptogams are simply widely disjunct species whose main areas are the Arctic, Europe, middle Asia, South Africa, and Australasia. None are globally threatened, but these outlying populations may eventually prove to be important for studies in biogeography and genetics. However, we know so little about genetic variability in the bryophytes and lichens that conservation efforts of the species themselves are hardly justified at the present time. We do suspect, with ample justification, that bryophytes and lichens show very little tendency to vary in the ways flowering plants do. Part of this comes from the primarily haploid chromosome situation in most mosses during the major portion of the growing period. In lichen species most of the demonstrated variability appears to be due to environmental modification.

In very few places in the world are cryptogam distributions well enough known to be able to confirm a status of true rarity. One I am personally acquainted with is the case of the moss *Andreaea rupestris* an exclusively rock-inhabiting moss, that in all of Holland is found only on a single boulder in a field in

Friesland. Ben O. Van Zanten showed me the moss, "Look at that rock over there — that is the only *Andreaea* in Holland!" Needless to say we left it alone.

In many instances of disjunct distributions, presuming the field observations have been adequate, one can safely state that some species are very rare, at least in this area, although not at all on the world scene. In Colorado, the moss *Leptodon smithii* is known from only two collections in Clear Creek Canyon, on an outcrop of calcareous schist, and one other collection in nearby Bear Creek Canyon. These are the only localities in North America where this moss is known to occur. However, we do know that it is a calciphile from its occurrence elsewhere on limestone and on trees that pick up limestone dust. Its world distribution includes the Mediterranean region, eastern Australia, New Zealand, Chile, Africa, Europe, and Russia. It is not at all rare in those places. But in Colorado, despite many subsequent searches, we have not succeeded in finding a "mother lode". Limiting factors are the substrate and perhaps the altitude, but we have not adequately explored Clear Creek Canyon (the work requires rock-climbers), nor other similar areas where the proper rock type occurs. See Nelson 1973 and Weber 2018.

Some rarities of the disjunct kind are simply the result of incomplete knowledge. The lichen *Candelariella spraguei* was thought to be endemic to Colorado, where it is found on seeping rock surfaces in the lower slopes of the outer Front Range. But it has since been discovered in the Tian Shan Mountains of Central Asia! Conversely, the moss *Didymodon anserinocapitatus* had to be considered a rarity of China, where it was first discovered, until we found it in Colorado in Phantom Canyon north of Canyon City. An alpine lichen that, for many years, we had incorrectly assumed was a variety of the common *Dactylina madreporiformis* turned out to be *Allocetraria stracheyi*, known thus far only from the Himalaya and Taiwan!

What is Rare?

A species may be considered to be rare if one or only a few collections are known to exist in Colorado. This does not mean that every species will remain in this category. Species, for example, that have been found only once or twice in the San Juans may not be critical simply because collectors have not been active there (*Campylophyllum halleri*, *Encalypta procera*). On the other hand, iron fens in the San Juans are not common and they support several very rare species. The special substrate provided by mining dumps and even metal mine trams is a unique habitat that supports the only known station for the "copper moss" *Mielichhoferia elongata* in Colorado.

Species will be rare when first encountered and become less rare with time. The history of many so-called rarities is that they become less rare as we learn more about their nature and the location of their habitats. If the site is not unique then we can expect to find the species more often as we gain experience in recognizing it in the field. A prime example is that of the alpine rarity *Oreas martiana*, a moss that is rare world-wide. See Weber (1961, 1973).

The rich alpine flora of Colorado has a concentration point on Mount Evans and the Indian Peaks. Intrigued by this phenomenon of rare occurrences, many foreign botanists have visited the area and found *Phippsia algida*, *Saxifraga foliolosa*, *Koenigia islandica*, and other rare alpine vascular plants at Summit Lake. Norwegian phytosociologist Eilif Dahl and I discovered *Koenigia* there in 1953. See Weber (1952, 1955).

Visiting specialists, with their familiarity of species seen elsewhere in the world, sometimes find species which local botanists have missed. Noted Danish bryologist Kjeld Holmen visited the Mount Evans site with me in 1960. Holmen had just been in northern Greenland, where he had discovered *Oreas martiana* for the first time. He came to Colorado via Lake Peters, Alaska, where, a few days before, he had discovered the genus for the first time in North America. Having just gotten out of the car at Summit Lake,

Kjeld was on his knees looking for *Koenigia,* when he suddenly exclaimed that he thought he had found *Oreas*! To confirm his identification he then hunted around for several minutes until he found the distinctively shaped capsules, usually exceedingly uncommon yet definitive for the identification. Thus a second locality for North America was established.

For several years, Summit Lake was the only site in the contiguous United States where this rare moss was known to occur. However, when Vera Komárková began to investigate the plant associations of the Indian Peaks area in the 1970s, she found that *Oreas* was often a dominant feature of wet tundra. See Komárková (1976). Judging from the two full drawers of Colorado *Oreas* in the herbarium it would be hard to justify the claim that *Oreas* is a rare moss. Certainly it is very restricted in its distribution, even in Colorado, but rare it is not.

Recommendations

What is really needed at the present time is for observers to notify an expert of potential sites for investigation. It should be easy to train people to recognize critical areas, thus saving much valuable time in our searches for rare cryptogams.

More time, however, will be needed for teaching local amateurs to be able to recognize the cryptogams and their eco-niches. Learning the bryophytes can be easily achievable. Summer moss walks and workshops would go far in accomplishing this important task. To this end the manual *Bryophytes of Colorado: Mosses, Liverworts, and Hornworts* is an essential tool. A beginner's guide to Colorado's easily recognized bryophytes is in progress and will become available through the williamaweber.com website. The lichens will be more of a challenge.

My hope is that the species lists presented here will be of practical use to local botanists and amateurs intrigued by cryptogams.

III. Preservation of Habitats and Eco-Niches

We do know that a number of specific localities in Colorado are notable for harboring significant numbers of disjunct species that, according to our present knowledge, may be considered to be rare in Colorado, North America, or the world. Most of these localities are small in extent, and microclimatically or edaphically special for Colorado. Examples of these eco-niches may be very small, a crack in a rock, the edge of a stream, or the base of a tree. If we can manage to save these special sites, the survival of these species should be assured.

Site categories requiring preservation include at least the following, with a few examples:

1. Fens of various types: Iron fens and calcareous subalpine willow fens

Guanella Pass

Upper subalpine fens along the trail from the summit down to the saddle west of Mt. Bierstadt. Here we find several species of rare aquatic mosses. The Guanella Pass site should be considered critical because it is easily accessible and close to the road.

High Creek Fen in South Park

This is a prime sight for several aquatic mosses.

Iron Fens

San Juan Mountains between Silverton and the south side of Red Mountain Pass, and near Telluride; between Geneva Park Ski Basin and Guanella Pass.

2. Alpine or upper subalpine wetlands and sites seasonally overrun by melting snow, particularly over calcareous bedrock.
   Blue Lake Dam
      Valley of Monte Cristo Creek at the north base of Hoosier Pass: calcareous area overflowed by snowmelt.
   Mount Evans
      Summit lake and the saddle of Mount Evans and Epaulet Mountain.

3. Old-growth spruce-fir forests.
   Gothic Natural Area

4. North-facing forested slopes and cliffs in the outer foothills of the Front Range.
   Boulder Canyon, South St. Vrain Canyon, Bear Creek Canyon, Clear Creek Canyon, and doubtless others not yet visited.

5. Moist sandstone and limestone cliffs, particularly with seeping alcoves, in the western desert-steppe region.
   Many such areas occur in the Dolores, Colorado, and San Juan River drainages.

6. Gypsum-salt domes.
   The most important of these is in Paradox Valley. Another is in the vicinity of Eagle.

7. Sites that are routinely altered, damaged, or destroyed by humans for economic reasons.
   Front Range *cuestas*
      Areas of sandstone that are being mined for "moss rock". This is a real threat to the survival of crustose lichens and xerophytic mosses, and at the same time a waste of money to buyers, for the lichens do not stand a chance to survive for long periods of time and are a nonrenewable resource.
   Mud flats on the piedmont valleys
      These have been altered by deepening the shorelines, and those mud flats that remain are terribly polluted by goose droppings. Several species of liverworts (*Riccia*) have become extirpated.
   Alkaline flats
      Some sites, especially in Delta and Montrose Counties, harbor rare species of *Crossidium*. Few of these sites, for some reason, contain any mosses whatsoever; flats with scattered shrubs of *Sarcobatus* and *Atriplex* are favored.

8. Mineral deposits and specific rock types.
   Mine tailings of copper ore
      Red Mountain Pass: *Mielichhoferia elongata*
   Mine debris of certain forms of granodiorite associated with mineral mines.
      St. Elmo and Silverton: *Coscinodon cribrosus*
   Limestone cliffs
      Blue Lake and Schofield Pass: *Haplodontium macrocarpum*

V. Species List

I only list those species below which most dramatically exhibit a disjunct pattern, or the greatest rarity as we now know it. I do not consider it wise at this time to give precise localities because of the chance of giving away the only localities to unscrupulous collectors. World distributions are still very incompletely known, and those I have given (following an m-dash) are gleaned from a few fairly reliable sources.

Our knowledge of distributions and rarity will be updated and expanded by professional and amateur botanists around the world communicating through internet communities (see reference list). The lists offered here below can be expected to change as more collectors, locally and internationally, become aware of the field characteristics of these rare cryptogams and the eco-niches they occupy.

Nomenclature follows *Bryophytes of Colorado: Mosses, Liverworts, and Hornworts* (Weber & Wittmann 2007).

Mosses

Aloina bifrons (De Notaris) Delgadillo (Pottiaceae)

On calcareous soils, steppe-desert. One collection: southwest Colorado. — Central and South America, Mediterranean region, South Africa, Australia, New Zealand. See Delgadillo (1975).

Aloina rigida (Hedwig) Limpricht (Pottiaceae)

On calcareous soils and limestone rubble. Two localities: Pawnee Buttes (plains), Blue Lake (subalpine). — Eurasia, Northern Africa.

Amblyodon dealbatus (Hedwig) Bruch & Schimper (Meesiaceae)

Subalpine willow carrs. Two collections: Independence Pass, Collegiate Range. — Greenland, Eurasia.

Amphidium mougeotii (Bruch, Schimper) Schimper (Orthotrichaceae)

On sandstone cliffs, at low altitude, outermost foothills of the Front Range. One collection: Castlewood Canyon State Park. — Northern North America, Eurasia, Greenland.

Anacolia laevisphaera (Taylor) Flowers (Bartramiaceae)

On granite rubble, outer foothills. Known from one locality: Boulder Falls. The site has been destroyed by trampling, but we have hopes of finding the plant nearby. — Very rare in the southwestern United States, but widely disjunct over most continents; Mexico, Alaska, South America, Dominican Republic, Ethiopia, Réunion, India.

Anacolia menziesii (D. Turner) Paris (Bartramiaceae)

North-facing granite cliffs. Known from a few localities in the eastern Front Range foothills. — Alaska, New Mexico, California, Mexico

Andreaea heinemannii Hampe & Müller Halle (Andreaeaceae)

Granite boulders, alpine tundra. Two collections: Pikes Peak, Mount Evans. Probably truly rare, but the habitats are numerous. — Eurasia. See Murray (1988).

Andreaea nivalis Hooker (Andreaeaceae)

On seepy rocks of snowmelt streams, alpine. spruce forest. Two collections: San Juan Mountains. — Circumpolar regions, North Pacific Rim, the Northwest Coast of the United States and Canada, northeastern Canada, Greenland, Scandinavia, Europe, Siberia.

Andreaea rupestris Hedwig (Andreaeaceae)

Granite boulders, most alpine but also on rocks in shaded subalpine sites. Few collections: alpine on Mount Evans, subalpine on outcrops in Fraser Forest. Undoubtedly rare, but not to be considered threatened because the habitats for these species are numerous. The plants are inconspicuous and can easily be mistaken for common species of *Grimmia*. — Widely distributed in the Northern and Southern Hemispheres.

Anomodon attenuatus (Hedwig) Hübener (Anomodontaceae)

Granite boulders near streams, outer foothills at low altitudes. One collection: Boulder Canyon. — Eastern United States, Eurasia.

Anomodon rostratus (Hedwig) Schimper (Anomodontaceae)

Rimrock cliffs, southeastern Colorado. One collection: Baca County. — Eastern North America, Central America, Eurasia.

Aulacomnium palustre (Hedwig) Schwäg. var. ***imbricatum*** Bruch & Schimp. (Aulacomniaceae)

Wet tundra basins fed by snowmelt water, very high altitudes. Known only from Mt. Evans, saddle below Mt. Epaulet. I believe "variety *imbricatum*" to be a good species, but this is the only place we have found it. — Described from Austria; a few occurrences in Scandinavia, Italy, Lake Baikal in Russia.

Bartramia potosica Montagne (Bartramiaceae)

Granite north-facing cliff faces, outer foothills. Two or three collections from the cliffs of the Front Range foothills. — Mexico, South America.

Bartramia subulata Bruch & Schimper subsp. ***americana*** Fransén (Bartramiaceae)

Moist moss tundra. An alpine species. Collections from Mount Evans, Blue Lake, Lost Creek, and Indian Peaks Wilderness. — Rocky Mountains Colorado to Alaska, northern Scandinavia, Eurasia, Alps, Himalaya, Altai, Tian Shan Mountains.

Brachythecium turgidum (C. J. Hartman) Kindberg (Brachytheciaceae)

Moist moss tundra. One locality: Mount Evans. An alpine species. — Arctic North America, Eurasia.

Bryoerythrophyllum ferruginascens (Stirton) Giacomini (Pottiaceae)

Moist moss tundra. Two localities: Summit Lake on Mt. Evans, and Blue Lake. — Iceland, Great Britain, the Alps, Greenland, northern Russia.

Bryoxiphium norvegicum (Bridel) Mitten (Bryoxiphiaceae)

Sandstone cliffs. One locality: Upper tributary of Navajo River at 11,500 ft., McPhee Reservoir, Conejos County. The site has been destroyed by water impoundment. This is one of the most celebrated disjunctive species in the world, rare almost everywhere it occurs. — Greenland, Iceland, Japan, China, Aleutian Islands, Dominican Republic, central United States. See Löve & Löve (1953).

Bryum julaceum Schrader ex Gärtner, Meyer & Schreber (Bryaceae)

Moist tundra. Few collections: Mount Evans and Blue Lake. — Scattered across North America, Aleutian Islands, British Columbia, Europe, Himalaya, Japan, Greenland, Africa.

Buxbaumia aphylla Hedwig (Buxbaumiaceae)

Lodgepole pine and spruce-fir forests, on well decayed wood. Probably not rare, but inconspicuous. Three collections: Gothic, Niwot Ridge, and Tenmile Range in Summit County. — Scattered in old growth forests across North America, Europe, Japan, Siberia.

Campylophyllum halleri (Hedwig) Kanda (Amblystegiaceae)
Precise habitat not noted. One collection: San Juan Mountains. — Across northern North America and in the Rocky Mountains, central Europe, Caucasus, Himalaya. China, Japan.

Campylopus schimperi Milde (Dicranaceae)
Moist tundra at very high altitudes. Two localities: Mount Evans, Blue Lake. — Baffin Island, St. Paul Island, high mountains of Europe, Arctic North America, Eurasia.

Cnestrum schisti (Wahlenberg) Hagen (Dicranaceae)
Sandstone cliffs, outermost foothills. One collection: vicinity of Lyons. — Rocky Mountains of Canada and Alaska, New England, eastern and northern Canada, Greenland, Eurasia.

Codriophorus fascicularis (Hedwig) Bednarek-Ochyra & Ochyra (Grimmiaceae)
Moist moss tundra, associated with screes. One collection: Summit Lake. — Across boreal North America, northern and montane Europe, Greenland, Azores, Japan, Hawaii, Madeira, Siberia, China, southern South America, New Zealand.

Coscinodon cribrosus (Hedwig) Spruce (Grimmiaceae)
Restricted to certain igneous rocks associated with mining sites, and possibly limestone. Three localities: Silverton, Blue Lake, St. Elmo. — Disjunct from Canadian Rocky Mts. and Eurasia. See Hastings (1999).

Crossidium aberrans Holzinger & Bartram (Pottiaceae)
Alkaline flats, desert-steppe. One collection from Delta Co. This species is rare because of the rarity of its particular substrate. — It is common in the Southwestern United States, Egypt, Algeria, Spain, Italy. See Delgadillo (1975).

Crossidium squamiferum (Viviani) Juratzka var. ***pottioideum*** (De Notaris) Mönk. (Pottiaceae)
Crevices of sandstone cliffs, low altitudes. Two collections: Boulder, Montezuma counties. — Southwestern United States, northwestern Mexico, North Africa, Canary Islands, southeastern Europe, Russia, Pakistan.

Dicranum montanum (Hedwig) (Dicranaceae)
Granite cliffs in the outer Front Range foothills. Two collections: Boulder County. — Northeastern United States, Arizona, Alaska, British Columbia, northeastern Europe, Kamtchatka.

Didymodon anserinocapitatus (X. J. Li) Zander (Pottiaceae)
Sandstone cliffs and ledges, outermost foothills. One collection: Phantom Canyon near Canyon City. — Another collection is from northern New Mexico. The only other collection known for the species is the type, collected in China. See Zander & Weber (1997),

Didymodon nevadense Zander (Pottiaceae)
Gypsum/salt domes, steppe-desert. One collection: Paradox Valley. Type collected in Nevada. A Great Basin species limited to gypsum soils. — See Zander et al. (1995).

Didymodon subandreaeoides (Kindberg) Zander (Pottiaceae)
Limestone terraces fed by seepage from snowmelt, upper subalpine. One locality: limestone terraces at Blue Lake. — Alaska North Slope and the Canadian Rocky Mountains. Not yet known from other continents. See Zander (1998).

Entodon concinnus (De Notaris) Paris (Entodontaceae)
Moist moss tundra, alpine. Two localities, Mount Evans and Blue Lake. — Few localities

in North America. Alpine, western and central Europe, Spain, Portugal, northern, western, and Central Asia.

Fissidens osmundoides Hedwig (Fissidentaceae)

Mossy borders of small alpine pools. One locality: Loveland Pass, on edge of a tarn. — Europe, Asia, northern North America, Greenland.

Funaria muhlenbergi D. Turner (Funariaceae)

Mossy alpine tundra. Two localities: north of Gibbler Gulch and Unaweep Canon. — Alpine disjunct ranging from Alaska and Yukon down to Central America, also in Europe and Morocco.

Grimmia incurva Schwägrichen (Grimmiaceae)

Granite boulders, alpine. One locality: Summit Lake, Mount Evans. — Arctic and alpine Europe, Caucasus, Nova Zemlya, Greenland.

Grimmia teretinervis Limpricht (Grimmiaceae)

On calcareous sandstone, medium altitudes. Few localities, Rocky Mountain National Park. — Rare and scattered in North America (Kansas, Oklahoma, Missouri, Minnesota, Wisconsin; Québec, Alberta), Europe.

Haplodontium macrocarpum (Hooker) J. R. Spense (Bryaceae)

Limestone cliffs, subalpine. Two localities, Schofield Pass and Blue Lakes. — Greenland, Ellesmere Island, Alaska, Alberta, Utah; Mexico. See Brassard (1971).

Hennediella heimii (Hedwig) Zander (Pottiaceae)

On limestone soils, medium altitudes. One collection: Rifle State Park. — Eurasia, South America, Greenland, Tasmania, new Zealand.

Hydrogrimmia mollis (Bruch & Schimper) Loeske (Grimmiaceae)

Seasonally submerged in alpine rivulets fed by snowmelt. One locality: Mount Evans (Summit Lake and Epaulet Saddle). Semiaquatic in snowmelt rills. — A species of high mountains, widely disjunct in Eurasia, absent from the North American Arctic.

Hylocomiastrum pyrenaicum (Spruce) Fleischer (Hylocomiaceae)

Subalpine spruce forests, in spray zone of waterfalls. One collection: Ouzel Falls, Rocky Mountain National Park. — Northern North America, Eurasia, northern and Middle Asia, Japan.

Hylocomium splendens (Hedwig) Bruch & Schimper (Hylocomiaceae)

Forest floor in old growth spruce forests, and on moist subalpine and alpine sites. About five localities: Rocky Mt. National Park, Boulder Canyon, St. Vrain Canyon, Mt. Evans, Blue Lake. Very restricted ecologically. — An abundant species in northwestern North America.

Imbibryum alpinum (Withering) Pederson (Bryaceae)

Granite outcrops wet by seepage water. Few collections: lower foothills of Front Range. — Canadian Rocky Mountains, European Alps, alpine Eurasia.

Isopterygiopsis pulchella (Hedwig) Iwatsuki (Hypnaceae)

This is the closest thing we have to an endemic moss species. It is still very little known, being very inconspicuous and rarely collected. Two collections: the type specimen collected by Grout near Tolland, Gilpin County, and from gravelly substrates at the base of the dam at Blue Lake. Although the species is still fully recognized, it is very close to *O. intricatum* of the northern Rocky Mountains and Europe. — Also reported from Montana.

Jaffueliobryum raui (Austin) Thériot (Grimmiaceae)
Crevices in sandstone rimrock in eastern Colorado; few collections. — An endemic of the North American Great Plains and Southwest. See Churchill (1987).

Leptodon smithii (Hedwig) F. Weber & Mohr (Neckeraceae)
Cliffs of calcareous schist, outer foothills. Three collections: two in Clear Creek Canyon and one in Bear Creek Canyon. These are the only localities known in North America. The calcareous schist at the altitude and exposure on which it grows is a limited substrate, and continued searches have failed to discover the "mother lode". — Disjunct, Mediterranean, South America. Africa, Australia, New Zealand, Europe, Russia. See Nelson (1973) and Weber & Weber Müller-Wille (2018).

Leptopterigynandrum austroalpinum Müller Halle (Pterigynandraceae)
Granite cliffs, middle altitudes. Inconspicuous and little collected throughout its range: Alaska, South America, southeast Asia. See Weber (2000).

Mielichhoferia elongata (Hoppe & Hornschuch) Nees & Hornschuch (Bryaceae)
Associated only with copper tailings, subalpine. One locality: on mine tailings and rusty iron, Red Mountain pass (a "copper" moss). — Scandinavia, Pyrenees, Italy, western and central Europe. See Hartman (1969).

Mnium blyttii Bruch & Schimper (Mniaceae)
Moist streamsides throughout the forested areas but small and inconspicuous. Few collections: scattered from the foothills to subalpine. — Northern North America, northern Eurasia.

Mnium spinosum (Voit) Schwägrichen (Mniaceae)
Moist moss tundra. One collection: Summit Lake, Mt. Evans. — Disjunct, Alaska, Yukon, Europe, northern and middle Asia, Japan. See Steere (1978).

Molendoa sendtneriana (Bruch & Schimper) Limpricht (Pottiaceae)
Sandstone rimrock, outermost foothills. One collection: Steamboat Mt., Lyons. — Eurasia, Mexico.

Oreas martiana (Hoppe & Hornschuch) Bridel (Dicranaceae)
Moist alpine tundra. Front Range; Lake Peters, common in Indian Peaks area — Alaska; Greenland; Eurasia. See Weber (1961).

Orthothecium strictum Lorentz (Hypnaceae)
Precise habitat not noted. One collection: San Juan Mountains. — Eurasia, Arctic North America.

Paludella squarrosa (Hedwig) Bridel (Meesiaceae)
Submerged in subalpine calcareous fens. Two collections: fens of Guanella Pass, Herman Gulch. — Northern North America, Greenland, Europe, northern Asia.

Plagiobryum demissum (Hoppe & Hornschuch) Lindberg (Biyaceae)
Moist moss tundra. Two localities: Mount Evans, Blue Lake. — Eurasia, South Africa.

Plagiobryum zieri (Hedwig) Lindberg (Bryaceae)
Moist moss tundra. Two localities, Mount Evans, Blue Lake. — Arctic and boreal North America, Europe, Caucasus, China, Japan, Greenland, Turkestan, Siberia, India.

Plagiothecium cavifolium (Bridel) Iwatsuki (Plagiotheciaceae)
Granite cliffs, streamsides, subalpine. Two collections: Boulder Creek, Moffat Tunnel. Probably not uncommon — Alaska, Washington, eastern North America, Eurasia, Far East, Hawaii.

Pleurozium schreberi (Bridel) Mitten (Entodontaceae)
One locality: forest remnant at Hidden Valley Ski Area, Rocky Mountain National Park. — An abundant boreal forest moss of both hemispheres, disjunct here (also occasional in New Mexico).

Pohlia andalusica (Höhnel) Brotherus (Bryaceae)
Moist alpine tundra. One locality: Rollins Pass. — Alaska, Yukon, Washington, northeastern United States, Europe. See Shaw (1982).

Pohlia bolanderi (Lesquereux) Brotherus var. ***seriata*** Shaw (Bryaceae)
Moist alpine tundra. Several localities in the Front Range. Alpine, Rollins Pass is the type locality. — Pacific Northwest endemic.

Pohlia tundrae Shaw (Bryaceae)
Moist alpine tundra. One locality: Rollins Pass. — High mountains of western North America.

Ptilium crista-castrensis (Hedwig) De Notaris (Hypnaceae)
Shaded but not necessarily very moist subalpine forests in vicinity of cascades. One locality: upper Cache La Poudre Valley. — Common across boreal North America. Europe, Caucasus, northern Asia to Japan.

Ptychostomum cyclophyllum (Schwägrichen) J. R. Spense (Bryaceae)
Subalpine peat fens. One collection: Left Hand peat fen. — Europe, northern Asia, Korea, Greenland, Arctic and northern North America.

Rhytidium rugosum (Hedwig) Kindberg (Rhytidiaceae)
Similarly restricted in Colorado as *Hylocomium* and *Pleurozium*, but, like them, — a very abundant plant in boreal North America and Eurasia.

Roellia roellii (Brotherus ex Röll) A. L. Andrews ex Crum (Bryaceae)
Dry forest floors under lodgepole pine. Rocky Mountain National Park and North Park. — Southernmost limit of a Pacific Northwest species.

Schistidium tenerum (Zetterstedt) Nyholm (Grimmiaceae)
Few collections: Mt. Evans, — Arctic North America and northwestern Europe.

Seligeria Bruch & Schimper (Seligeriaceae)
Sandstone cliffs. Southwestern Colorado. Three species, *S. campylopoda* Kindberg ex Macoun & Kindberg, *S. donniana* (Smith) Müller Halle, and *S. tristichoides* Kindberg, have been collected by Jamieson but not reported in the literature. All species are extremely rare but also extremely inconspicuous. — Eurasia.

Sphagnum angustifolium (C. Jensen) C. Jensen (Sphagnaceae)
Iron fens, San Juan Mountains. This species was formerly known as a race of *S. fallax*. — Northern North America, Europe, South America. The distribution is not well delineated.

Sphagnum balticum (Russow) C. Jensen (Sphagnaceae)
Iron fens. One record: San Juan Mountains, south of Red Mountain Pass. The only site known in the contiguous United States. The only common species of *Sphagnum* in Colorado are *S. robustum* and *S. fuscum*. — Disjunct, Arctic, Alaska, British Columbia, and Eurasia.

Sphagnum contortum K. F. Schultz (Sphagnaceae)
Lake shore, subalpine. One collection: Rocky Mountain National Park. — Europe, Caucasus, northern and eastern Asia, Japan, northern North America.

Sphagnum girgensohnii Russow (Sphagnaceae)
Iron fens, subalpine. One collection: Park Co.: Geneva Creek fens. — Northern North America, Asia, Japan, Greenland, Java.

Sphagnum platyphyllum (Braithwaite) Warnstorf (Sphagnaceae)
One collection: Cross Creek fens. — Northern North America, Eurasia, Japan, Greenland.

Splachnum sphaericum Hedwig (Splachnaceae)
Associated with animal scat, subalpine. One collection: Boulder Co.: Moraine, University Camp. — Northern North America, northern Eurasia.

Syntrichia sinensis (Müller Halle) Ochyra (Pottiaceae)
Sandstone ledges, outer foothills. One collection: El Paso Co., Williams Canyon, (Jewett in 1913), the only collection known in North America. — Disjunct, southern Eurasia. See Kramer (1980).

Tayloria acuminata Hornschuch (Splachnaceae)
Moss tundra. Few collections: Clear Creek, Gunnison, Hinsdale Counties. — Central Europe (Alps), northern and arctic Eurasia and North America.

Tayloria froelichiana (Hedwig) Mitten ex Lindberg (Splachnaceae)
Moss tundra. Two collections: Mount Evans and Indian Peaks. — Scattered from Colorado to Alaska; northern and central Europe, Caucasus, Himalaya.

Tayloria hornschuchii (Greville & Arnott ex Arnott) Brotherus (Splachnaceae)
Moss tundra. Few collections: Mount Evans. — Scattered in Rocky Mts. to Alaska, Eurasia.

Tayloria lingulata (Dickson) Lindberg (Splachnaceae)
Moss tundra. Clear Creek, Grand, and Huerfano counties. Few collections. — Colorado, Arctic North America; Europe, Siberia.

Timmia norvegica Zetterstedt (Timmiaceae)
Irrigated soils over rocks on streamsides, subalpine. Known from a single locality along Monte Cristo Creek, north base of Hoosier Pass. Probably occurs elsewhere but very inconspicuous. — Disjunct from northern North America, northern Eurasia, Greenland. See Weber (1963).

Voitia nivalis Hornschuch (Splachnaceae)
Moss tundra, very high altitudes. Two localities: McClellan Ridge and Mount Evans. — Alberta, northern Alaska, and Nepal.

Hepatics

The hepatics (liverworts and hornworts) are very poorly known in North America, particularly in Colorado, and their world distributions are also not well known. Hepaticology has only a very few specialists. It is perfectly clear, though, that we have no endemic species. Nomenclature follows *Bryophytes of Colorado: Mosses, Liverworts, and Hornworts* (Weber & Wittmann 2007).

Asterella lindenbergiana (Corda) Arnell (Aytoniaceae)
Moss tundra. One collection: Summit Co.: Monte Cristo Creek. — Disjunct, Arctic North America, European Alps.

Cephaloziella varians (Gottsche) Stephani (Cephaloziellaceae)
Moss tundra. One collection: Blue Lake, Summit Co. — Disjunct, Arctic Eurasia. See Hong (1986).

Gymnomitrion corallioides Nees (Gymnomitriaceae)
Granite rocks at very high altitudes. Two records, Longs Peak; Summit Lake, Mt. Evans. On siliceous rocks, alpine. — Disjunct, Great Britain, Alps, northern Asia, Arctic North America.

Haplomitrion hookeri (J. E. Smith) Nees (Haplomitriaceae)
Moss tundra, solifluction lobes. One record: Green Lakes Valley. Probably not rare, but exceedingly difficult to find in dense wet tundra vegetation. Otherwise not known from the contiguous United States. — Great Britain, central Europe.

Jungermannia rubra Underwood (Jungermanniaceae)
Iron fens. south of Red Mountain Pass, San Juan Mts. A single record, locally abundant and dominant there; certainly not threatened. — The species also occurs in California, northwestern United States, and Canada. Evidently not known from other continents.

Nardia geoscyphus (De Notaris) Lindberg (Jungermanniaceae)
Moss tundra. Two collections: Long's Peak, Boulder Watershed. — Disjunct, Arctic North America, Europe.

Nardia scalaris (Schrader) Dumortier (Jungermanniaceae)
One record, "Colorado," collected by Roell. Specimen in British Museum. — Northern North America, Azores, Madeira, Canary Islands, Europe.

Notothylas orbicularis (Schweinitz) Sullivant (Anthocerotaceae)
Muddy stream-sides. One old record from the San Luis Valley. — Widely distributed in United States, Europe, Mexico, Galapagos Islands.

Phaeoceros laevis (L.) Proskauer (Anthocerotaceae)
Seeping overhang on sandstone cliffs. One old collection: Boulder Co., White Rocks. — Disjunct, "widely cosmopolitan" according to Arnell (1956).

Riccia frostii Austin (Ricciaceae)
Mud flats around drying ponds, piedmont. Probably almost extirpated on its known sites; it used to grow on mud flats around ponds near Boulder. Dredging of ponds leaving no flats, and contamination of flats by goose droppings is responsible. — Widespread in North America, southern Eurasia.

Scapania fulfordiae Hong (Scapaniaceae)
Precise habitat not stated. One locality: Lulu City Trail, Rocky Mountain National Park. — Distributional status not well known.

Lichens

Many of our lichens are known from only one or a few localities, but there are evidently no endemic species in Colorado. The few that were thought to have been endemic have been found to be disjunct, especially in middle Asia. Some of the species listed are not uncommon, but their distributions are interesting.

The only threat to lichens in Colorado is from development, particularly the harvesting of what has been called "moss rock" for decorations inside and outside of buildings. This should be **actively discouraged**, because the material is not a renewable resource.

Only a relatively few of the most extraordinary disjunct distributions are given here. Because of the difficulty of collecting and the few accomplished collectors, it is very difficult to pass judgment as to rarity. Nomenclature largely follows the most recent names recognized in Esslinger's online *Checklist of North American Lichens* (2018).

Acarospora moenium (Vainio) Räsänen (Megasporaceae)
: On mortar. One locality: University of Colorado campus. The only Western Hemisphere record. Threatened if walls are replaced. However, it is very likely that the species occurs more widely on old walls and buildings. — In Europe it occurs exclusively on old churches.

Acarospora nitida elevata H. Magn. (Acarosporaceae)
: In COLO as *Acarospora nitida,* but according to Knudsen North American records are *A. elevata*. Very hard granite rocks on summits of the high mountains. Especially abundant on the east end of Trail Ridge Road in Rocky Mountain National Park. — Described from Greenland, and the Continental Divide in Wyoming.

Allocetraria madreporiformis (Ach.) Kärnefelt & A. Thell (Parmeliaceae)
: A common alpine fruticulose lichen. — It does not occur in the Arctic, but rather in the southern mountains of Eurasia.

Allocetraria stracheyi (Bab.) Kurok. & M. J. Lai (Parmeliaceae)
: Tundra on the highest peaks. Three localities: Mount Evans, Trail Ridge, Hoosier Pass. — Disjunct from the Himalaya and Taiwan.

Anaptychia bryorum Poelt (Physciaceae)
: Granite rocks on canyonsides, Front Range. A few collections from Boulder Canyon. — Described from Europe.

Arctoparmelia subcentrifuga (Oxner) Hale (Parmeliaceae)
: Granite rocks. A few collections from the outer foothills and alpine. — Common in the Holarctic.

Aspicilia candida (Anzi) Hue (Megasporaceae)
: Common on mudstone, above timberline, vicinity of Gothic. — Abundant in the Holarctic.

Candelariella spraguei (Tuck.) Zahlbr. (Candelariaceae)
: On seeping slopes of granite, outermost foothills. — Once thought to be a Colorado endemic, this has now been found in the Tian Shan Mountains.

Cetrariella commixta (Nyl.) Thell & Kärnefelt (Parmeliaceae)
: Granite boulders, alpine. Mount Evans is the only locality. — Disjunct in Holarctic and Alpine stations in the Northern Hemisphere.

Cladonia arbuscula (Wallr.) Flotow (Cladoniaceae)

Restricted to fens and north facing slopes. Collections from Boulder County and the San Juan Mountains. Relictual and rare in Colorado; protection of the habitats will protect the species. — Abundant in the Boreal and Arctic regions of Northern Hemisphere.

Cladonia stellaris (Opiz) Pouzar & V zda (Cladoniaceae)

Forest floor, subalpine. One locality: Lost Park, a branch of South Park. — Similarly relictual occurrence of a species very abundant in the northern regions of the Northern Hemisphere.

Glypholecia scabra (Pers.) Müll. Arg. (Acarosporaceae)

A common species on desert-steppe rimrock in western Colorado. — Holarctic, Gobi Desert.

Gowardia nigricans (Ach.) P. Halonen et al. (Parmeliaceae)

Dry tundra. One collection: Hoosier Pass — A widely distributed holarctic-alpine species.

Gypsoplaca macrophylla (Zahlbr.) Timdal (Gypsoplacaceae)

Restricted to gypsum domes. Eagle, Montrose, and San Miguel Co. — Disjunct from western China. See Timdal (1990).

Lobaria pulmonaria (L.) Hoffm. (Lobariaceae)

A species requiring very mesic situations. If still existent, it should occur on trees in very humid side canyons. Collected only once in 1880-1890 by Alice Eastwood, in "Jefferson County". Possibly exterminated. — A species of suboceanic climates, widespread in the Northern Hemisphere.

Lobaria scrobiculata (Scop.) DC. (Lobariaceae)

Steep north-facing, shaded foothills slopes. Very rare in upper canyons of Front Range, A species requiring very mesic situations. — Abundant in northern regions of the Northern Hemisphere.

Montanelia saximontana (R. Anderson & W. Weber) S. Leavitt, Essl. et al. (Parmeliaceae)

Anderson & Weber (1962) described this from Colorado as *Parmelia saximontana*. We found that it had, in fact, a large range across western North America. On an excursion to the Alps I discovered this again in northern Italy, and while visiting Edward Frey, a famous Swiss lichenologist in Bern, I found he had many specimens from Switzerland that were going under an incorrect name. Some years later Hildur Krog found that another lichenologist,Veli JPB Räsänen, had described it (from a scrappy piece) as *Parmelia substygia*. Eventually the group was segregated as a new genus, *Melanelia* ! — Northwestern North America, Switzerland, Finland.

Pleopsidium flavum (Bellardi) Körber (Acarosporaceae)

Infrequent on the highest granite peaks. — Well-known in high mountains, northwestern North America, Europe, Eurasia.

Rhizoplaca phaedrophthalma (Poelt) Leavitt, Zhao Xin & Lumbsch (Lecanoraceae)

Sandstone boulders, medium altitudes, Western Slope. Described from Rifle Canyon as *L. christoi*, but was later found to be a previously described species of the Gobi Desert. — Utah, Gobi Desert.

Rhizoplaca weberi (Ryan) Leavitt, Zhao Xin & Lumbsch (Lecanoraceae)

On Fountain Formation arkose rocks. Known pricipally from the type locality: Boulder Flatirons. The area is protected. — Québec, Canadian Rocky Mountains.

Toninia bullata (Meyen & Flotow) (Ramalinaceae)

Crevices of cliffs, north-facing slope in the outer foothills. This species occurs in the eastern foothills of the Front Range. It was not recognized until I collected the same species in Australia and received specimens of it from South America. Luckily it was never described as a new endemic Colorado species! — Australia, South America.

Toninia philippea (Mont.) Timdal (Ramalinaceae)

Sandstone rocks, outermost foothills, Boulder Co. Colorado collections were correctly identified with the Gobi Desert lichen then called *Catillaria kansuensis*, which was subsequently transferred into *Toninia*. — Central Europe, Gobi Desert.

Xanthomendoza trachyphylla (Tuck.) Frödén, Arup & Søchting (Teloschistaceae)

Abundant on sandstone rocks of the outer foothills and considered to be a North American endemic. — However, it occurs in the Gobi Desert and in the Chilean Andes under other names.

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Some Web Resources

Mosses

International Association of Bryologists
www.bryology.org

Discussion Group
Bryonet www.bryology.org/bryonet/

Lichens

International Association for Lichenology
www.lichenology.org

Discussion Group
Lichens-L www.mycology.net/Contacts/LichensL.html

Cumulative Checklist for the Lichen-forming, Lichenicolous and Allied Fungi of the Continental United States and Canada. Theodore L. Esslinger. 2018. www.ndsu.edu/pubweb/~esslinge/chcklst/chcklst7.htm

About the Author

William A. Weber was born in New York City in 1918. He began to study bryophytes in 1933 when he was shown a small collection by his high school biology teacher, Grace Esternaux (born 1901), who had taken a bryology course at Cornell University. His first botanical paper was published in 1940 (see below). He has field bryological experience in the United States including Alaska and Hawaii, Canada, Mexico, Costa Rica, the Galapagos Islands, Canary Islands, Chile, Australia, Papua New Guinea, Europe, Nepal, and Russia. His most recent book on bryophytes was published in 2007 (Weber & Wittmann). His field investigations have taken him to many parts of the world and have included lichens, bryophytes, vascular plants, as well as phytogeography. His long-standing flora of Colorado (2012) culminated in a two volume work that included keys, phytogeographical and historical background material and stories from the field. He has published biographical works on Wilhelm Suksdorf, T.D.A. Cockerell, and C. C. Parry. He has a broad base as a character actor, choral singer, recorder player, and loves to sing Gilbert and Sullivan at the drop of a hat. He is a unique specimen.

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