

## History, biogeography, and species of Montana mosses (1880–2018)

Joe C. Elliott  
Conservation Biology Research, Missoula, Montana 59802  
Email: [mtje10@gmail.com](mailto:mtje10@gmail.com)

Andrea K. Pipp  
Montana Natural Heritage Program, 1515 E Sixth Ave, Helena, Montana 59601  
Email: [apipp@mt.gov](mailto:apipp@mt.gov)

**Abstract.** This article chronicles the Montana history of moss exploration, notes on biogeographical distributions, and a checklist of documented moss taxa from 1880 to 2018. Montana has 522 unique moss taxa represented at the species, subspecies, and variety levels by 488, 8, and 26 taxa respectively. This checklist is a revision to the second preliminary moss checklist (Elliott 1993), which listed 408 taxa.

**Key words.** Checklist, bryology, bryophyte, herbarium, databases.

### INTRODUCTION

Montana has one of the richest recorded moss floras of the western United States (Eckel et al. 1997), even though large areas of the state remain under surveyed. The *Flora of North America* (FNA) volumes 27 (2007) and 28 (2014) include 1,402 species found in the continental United States (U.S.), Canada, Greenland, and St. Pierre and Miquelon, of which 508 species have been recorded in Montana. Including varieties and subspecies, Montana has 522 moss taxa. The rich moss flora is due to the habitat and climatic diversity across the state and a long history of bryological exploration that began in the late 1800s.

This article describes a history of the explorers, their surveys, notes on moss biogeographical distributions, and a checklist of documented moss taxa in Montana. This checklist is a revision to the second preliminary checklist (Elliott 1993), which listed 408 taxa. The substantial increase in the number of moss taxa since 1993 indicates that, as in much of the western United States, our knowledge of the Montana moss flora continues to expand with increased field and herbarium studies. The discovery of mosses in eastern North America appears to be reaching saturation, but this is not true for western North America, where the accumulation of new species has continued to rise steeply over the last three decades (Carter et al. 2016).

### METHODS

The primary author, Joe Elliott, examined collection records for mosses found in Montana and deposited in herbaria by searching the Consortium of Pacific Northwest Herbaria (CPNWH; [www.pnwherbaria.org](http://www.pnwherbaria.org)) and the Consortium for North American Bryophyte Herbaria (CNABH; <http://bryophyteportal.org>) databases from 2016-2017. Searches for scientific names and synonyms listed in FNA (2007, 2014) were conducted in 2016.

Collection records from herbaria that are not included in the CPNWH and CNABH databases were researched in 2016-2017. The University of Montana herbarium (MONTU) houses approximately 2,500 Montana specimens, and many from outside the state. During 2016 and 2017 Joe Elliott reviewed the entire MONTU moss collection to verify identifications and update nomenclature. A grant from the Institute of Museum and Library Services is allowing this collection to be digitized and geo-referenced with a project completion date of November 2019. The

Yellowstone National Park herbarium (YELLO-HRC) houses collections of 289 taxa from Park and Gallatin Counties in Montana. Montana collections from the herbaria at the University of Alberta (ALTA) and Royal Alberta Museum (PMAE) in Edmonton also were reviewed.

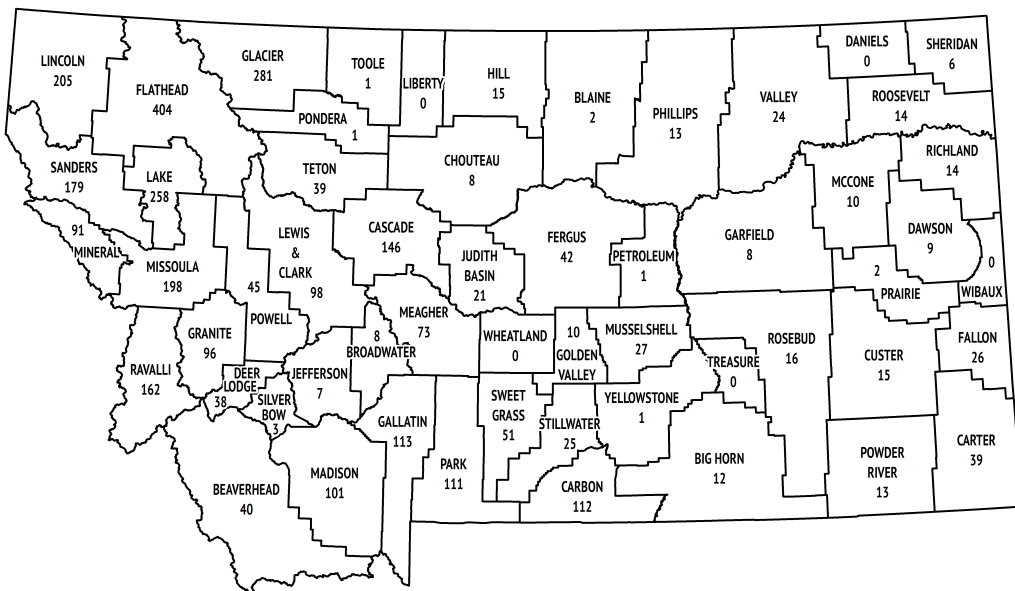
Collection records and specimens from personal herbaria were reviewed. These herbaria belong to Joe Elliott, Gerald Moore, Bruce McCune, Bonnie Heidel, Drake Barton, Peter Lesica, Michael Arvidson, Toby Spribille, Judy Hoy, Maria Mantas, Craig Odegard, and John Pierce. Field notes from collections made by Seville Flowers in 1967 from western Montana and by Dale Vitt in 1978 from Montana were reviewed.

The checklist also includes taxa for which specimens or their locations remain uncertain. Several old specimens have vague locations where the county is unknown. Another 16 taxa are present in Montana according to the FNA (2007, 2014), but the authors could not find the source of this information though attempts will continue.

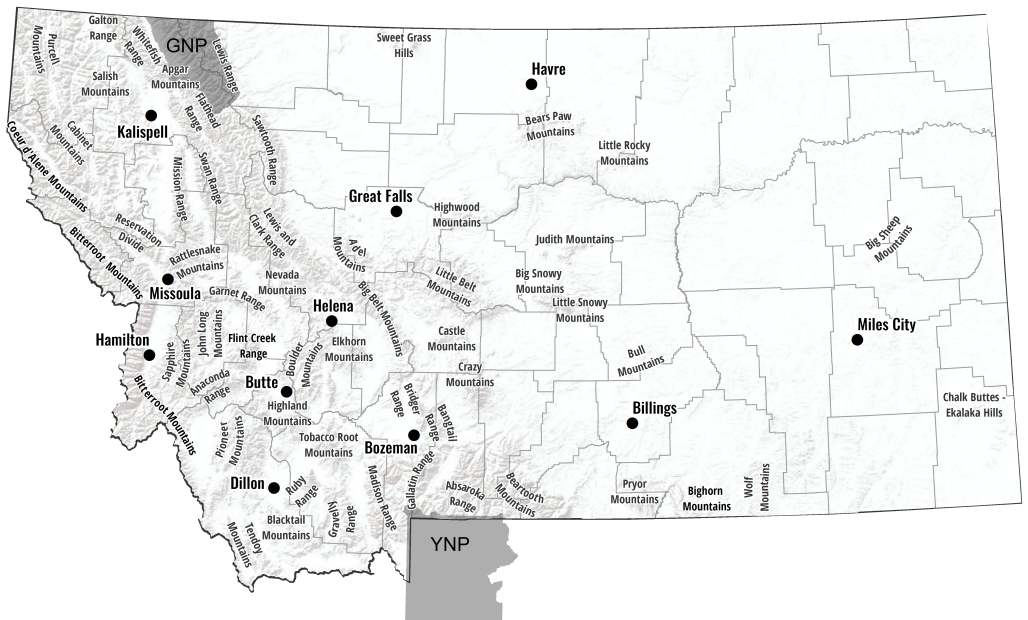
This article identifies mosses tracked by the Montana Natural Heritage Program (MTNHP) as Species of Concern (SOC). The last update to the moss SOC list was made in 2010 (MTNHP 2010). Moss SOC are considered rare and/or at risk of extirpation in Montana due to declining population trends, threats to populations or their habitats, restricted distribution, and/or other factors (MTNHP 2018). This revised checklist has identified the majority of existing herbarium specimens and records and is allowing the MTNHP to update its database, and eventually revise the moss SOC list.

### HISTORY OF MOSS EXPLORATION IN MONTANA

The exploration of bryology in Montana began in the pioneering days prior to statehood (1889), and has helped to document our rich moss flora. Several of these early botanists have their biographies and journeys through Montana portrayed and illustrated in “Montana’s Pioneer Botanists”, a book of the Montana Native Plant Society (Potter and Lesica 2017). Montana’s counties and many geographical names used in this article are referenced in **Figures 1 and 2**.



**Figure 1.** Montana’s 56 counties with the number of moss taxa documented from herbarium specimens and collection records (1880-2018).



**Figure 2.** Geographical locations for Montana’s larger cities, mountain ranges, Glacier National Park (GNP), and Yellowstone National Park (YNP).

The first bryological records for Montana are Sereno Watson’s 1880 collections from Beaverhead County and the southern Bitterroot Range. As part of the forestry evaluation for the tenth census, he collected a few mosses, but he was primarily interested in the vascular flora of southwestern Montana, Utah, and Nevada. Twenty-seven of Watson’s moss collections are recorded in the CPNWH database and represent common Montana mosses.

John Leiberg first collected mosses in Montana in 1883 and in 1892, while working for the U.S. Department of Agriculture (USDA) and the Smithsonian Institution to survey and describe the flora of the Pacific Northwest. He was employed by the U.S. Geological Survey (USGS) to explore and inventory the newly established Bitterroot Forest Reserve that encompassed much of northern Idaho and western Montana. In 1903, he conducted botanical surveys of the Little Belt Mountains and Absaroka and Beartooth Ranges. The CPNWH and CNABH databases contain 92 and 67, respectively, of Leiberg’s Montana moss collections. His collections of rare mosses include *Hennediella heimii*, found several times from the Absaroka Range; the first collection of *Tortula acaulon*, from near the “Lost Fork River”; and one of the most beautiful Montana mosses, *Paludella squarrosa*, from the Beartooth Plateau. Many of Leiberg’s collections have vague locations making county determinations difficult.

Robert S. Williams, arguably the father of Montana bryology, published the earliest account of mosses found in and around Glacier National Park (GNP) and the Belt Mountains of central Montana, over the period from 1892 to 1897. He spent at least five months each year in Montana collecting mosses, which resulted in the 1902 publication of “A Preliminary List of Montana Mosses” (Williams 1902). In this publication, he listed over 300 mosses, including seven new species. This major contribution to Montana bryology was preceded by the publication of “Two New Species of *Grimmia* from Montana” (Williams 1900), which described *Grimmia brittoniae*, a species new to Montana. Williams’ collections have been distributed to many herbaria

throughout the United States, with 1,092 and 603 specimens recorded in the CPNWH and CNABH databases, respectively. In addition to *Grimmia brittoniae*, other rare and noteworthy species include *Aloina brevirostris*, *Catascopium nigratum*, *Funaria americana*, *Hennediella heimii*, *Hygromablystegium varium* subsp. *notorophyllum*, and *Tayloria splachnoides*.

A contemporary of R. S. Williams, Professor John M. Holzinger, from Winona Normal School in Minnesota, intensively collected mosses in GNP during the summers of 1898 and 1899. Holzinger authored numerous articles in the peer-reviewed journal *The Bryologist*, and wrote a book, "On Some Mosses at High Altitudes" (1898). The CPNWH and CNABH databases contain 176 and 376, respectively, of his Montana collections. His noteworthy collections include: *Sarmentypnum exannulatum*, *Paraleucobryum enerve*, *Paraleucobryum longifolium*, *Conostomum tetragonum*, *Schistostega pennata*, *Pseudocalliergon turgescens*, and *Drepanocladus (Hypnum) cardotii*. His collection of *Schistostega pennata* is Montana's only record. Almost a century later, Lars Hedenas, bryologist at the Swedish Museum of Natural History, prepared a partial revision of the genus *Campylium* and identified Holzinger's collection at Avalanche Basin in GNP as a new species, *Hypnum cardotii* (Hedenas 1997). Taxonomic revisions in FNA (2014) renamed it as *Drepanocladus cardotii*. It remains the only known occurrence in the world (FNA 2014).

Wilson Harris, while associated with the New York Botanical Garden, collected lichens and 39 moss species from Missoula, Lake, and Flathead Counties during the summer of 1901 (Harris and Harris 1904). Specimens were identified by Elizabeth Britton and deposited at the New York Botanical Garden herbarium (NY). *Pseudotaxiphyllum elegans (Plagiothecium elegans)* from Lake County was the first collection for Montana. The Harris' collections also were included in a 1910 publication by Marcus Jones.

Professor L. M. Umbach, from Northwestern College at Naperville, Illinois, collected mosses and vascular plants in GNP in 1901 and 1903, mostly on the eastern side. The CPNWH and CNABH databases include 69 and 280, respectively, of his moss and liverwort collections, including five SOC: *Sarmentypnum exannulatum*, *Sphagnum angustifolium*, *S. contortum*, *S. fimbriatum*, and *S. fuscum*.

Marcus Jones, a wide-ranging scientist, identified 221 Montana moss species, which included those found by Wilson Harris and John Holzinger (Jones 1910). Jones reported, "Considerable attention has been given to the moss flora, though the knowledge is not by any means complete." This statement appears to accurately reflect the bryological priorities of the time, as R. S. Williams, John Leiber, John Holzinger, L. M. Umbach, and W. Harris were actively establishing the richness of the moss flora of northwestern Montana, centered on GNP.

Paul Standley, primarily a vascular plant botanist with the U.S. National Museum in Washington, now the Smithsonian Institution, collected four *Sphagnum* species in GNP from Johns and Fish Lakes (Standley 1920), as well as other mosses in the park.

T. C. Frye, botanist at the University of Washington, collected Montana mosses and liverworts from 1925 to 1942, mostly from western counties. The CNABH database includes 501 of his Montana collections. Some of his interesting collections include *Syntricia norvegica* in GNP, and *Meiотrichum lyalli* from Park and Missoula Counties and several locations in GNP.

Elva Lawton, bryologist at the University of Washington, authored the "Moss Flora of the Pacific Northwest" (Lawton 1971) and periodically collected mosses in Montana from 1925 to 1954. She dedicated her book on Pacific Northwest mosses to T. C. Frye. The CPNWH and CNABH databases include 105 and 114, respectively, of her Montana specimens. Her collections include the rare "copper moss," *Haplodontium macrocarpum*, from near Silver Gate in Park County. It is the only known Montana location for this arctic-alpine species (Brassard and Hedderson 1983) though it has been found in Colorado, Utah, and Canada.



James C. Whitham, of the U.S. Forest Service, collected mosses in the Gallatin National Forest and Gallatin, Park, and Madison Counties from 1931 to 1935 (Eversman and Sharp 1980). Whitham was a talented photographer and mountaineer, being the first to climb Granite Peak, Montana's highest mountain. His Gallatin County collections include 16 and 87 specimens recorded in the CPNWH and CNABH databases, respectively.

Winona Welch, botanist from DePauw University and expert on the genus *Fontinalis*, collected mosses in Montana from 1937 to 1955, mostly in Park, Carbon, and Gallatin Counties. Her collections include 177 specimens in the CPNWH database, including *Pohlia proligera*, Montana's only record.

LeRoy Harvey, professor of botany and curator of the University of Montana herbarium (1946 to 1977), collected mosses from western Montana from the late 1940s to the early 1950s. He also deposited at MONTU many Michigan moss specimens that he and his wife, Maria Ruisanchez, collected while students at the University of Michigan. Although most of his botanical work focused on vascular plants, particularly grasses, his Montana and Michigan moss collections reveal that he was an incipient bryologist who got mislead early in his career. Prominent bryologists, such as William Steere and Frederick Hermann, verified many of his collections. As a University of Montana student in the 1960s, Joe Elliott knew LeRoy well and remembers his enthusiastic moss stories from field studies in Michigan. Apparently, bryology during LeRoy's student days was a popular social and scientific endeavor.

Frederick Hermann, botanist with the U.S. Forest Service, conducted a comprehensive study of the mosses and liverworts in GNP and identified 390 taxa, of which 24 species were new to Montana (Hermann 1969). His research was conducted during the summers of 1962, 1966, and 1968. He reported many of the earlier collections by J. Holzinger, R. S. Williams, and W. Schofield, along with his own noteworthy collections, which include: *Sarmentypnum exannulatum*, *Scorpidium revolvens*, *Meesia uliginosa*, *Myurella tenerrima*, *Paludella squarrosa*, *Paraleucobryum enerve*, *P. longifolium*, *Meiotrichum lyallii*, and *Syntricia norvegica*.

Wilfred Schofield, professor at the University of British Columbia and a contemporary of Frederick Hermann, taught bryology classes at the University of Montana Biological Station on Flathead Lake and collected mosses extensively in northwestern Montana from 1961 to 2003. He authored "Some Common Mosses of British Columbia" (Schofield 1992) and "Phytogeography of Mosses of North America (North of Mexico)" (Schofield 1980). Most of his collections were from the Cabinet Mountains, the Swan Range, and GNP. Schofield deposited 385 Montana moss and liverwort specimens in the University of British Columbia herbarium (UBC) and many duplicates at MONTU. Schofield's Montana collections include *Eucladium verticillatum*, which grows on dripping limestone faces and calcareous tufa; *Hamatocaulis vernicosus*, a rich-fen species; *Paraleucobryum enerve*; *Dicranella grevilleana*, a widespread species endemic to northwestern United States and Canada; *Tortula acaulon*, a tiny soil-growing moss; and *Meiotrichum lyallii*, a widespread species endemic to western North America.

Seville Flowers, professor at the University of Utah and author of "Mosses: Utah and the West" (Flowers 1973), taught a moss and fern course at the University of Montana Biological Station during the summer of 1967. During that summer Joe Elliott was fortunate to be his teaching assistant for the bryology class. While in Montana, Flowers collected mosses in Lake, Flathead, and Lincoln Counties. Flowers' 416 Montana collections are deposited at the University of Colorado herbarium (COLO).

Sharon Eversman, professor at Montana State University, and A. J. Sharp, botany professor at the University of Tennessee, published the first Montana moss checklist, which listed 328 moss taxa (Eversman and Sharp 1980). The taxa were based on published and unpublished records and specimens deposited at the Montana State University herbarium (MONT). The MONT moss

specimens now reside at the University of Wisconsin–Madison herbarium (WIS) and are available through the CNABH. Eversman collected mosses from 1972 to 2001 and many are jointly collected with A. J. Sharp. The CNABH database contains 88 of her collections.

A. J. Sharp collected mosses and liverworts in Montana in 1972, and his 667 Montana specimens are in the CNABH database. His rare moss collections include *Dicranella grevilleana* from near Hungry Horse and *Meiotrichum lyallii* from the Jewel Basin in the Swan Range.

Bruce McCune, professor of botany and lichenology at Oregon State University, was an active bryologist and lichenologist as a student attending the University of Montana. He identified 137 moss species from the Swan Valley in Lake County, including three new state records (McCune 1979). With another student, Joe Antos, they studied the ecology of epiphyte communities in coniferous forests of the Swan Valley, which included mosses (McCune and Antos 1982). They identified species associated with forest layers in the Swan Valley (McCune and Antos 1981a, 1981b). McCune's interesting collections include *Grimmia incurva* from Saint Mary's and Sweeney Peaks; *Meesia uliginosa*, *Scorpidium revolvens*, *Hamatocaulis vernicosus*, and *Pseudocalliergon brevifolium* from GNP; *Scorpidium scorpioides* from the Swan Valley; *Hygroamblystegium notorophilum* from the Mission Mountains; *Syntrochia norvegica* from Saint Mary's Peak; and *Meiotrichum lyallii* from Mount Aeneas in the Swan Range. In the Bitterroot Range near Bass Creek he collected Montana's only record of *Hedwigia detonsa*, and near Bear Creek he collected Montana's second record of *Porotrichum bigelovii*. The CPNWH and CNABH databases contain 730 and 20, respectively, of McCune's collections.

Jan Janssens, bryologist at the University of Minnesota, reported on the distribution of *Drepanocladus* in North America and noted that *Drepanocladus exannulatus* (*Sarmentypnum exannulatum*) and *Drepanocladus* (*Scorpidium*) *revolvens* are arctic-alpine species with ranges that do not extend south of the glacial limit (Janssens 1983). The distribution of these and five other species includes Montana.

Steven Churchill, research bryologist at the Missouri Botanical Garden, collected 57 species from eastern Montana, including three new Montana records (Churchill 1983). Although the grasslands remain undersurveyed for mosses, Churchill's research is the most extensive study of mosses in the prairie and rangeland environments of Montana.

Peter Lesica, botanist with Conservation Biology Research in Missoula and co-author of the "Manual of Montana Vascular Plants" (Lesica et al. 2012) has conducted extensive and often remote field surveys on vascular plants, and at times on mosses. Lesica investigated the flora of the Pine Butte Swamp, a minerotrophically rich fen in a dry climatic region along the Front Range of Montana (Lesica 1986). The Pine Butte studies concentrated on the vascular flora but also documented *Scorpidium scorpioides* and *Scorpidium revolvens*, rare mosses indicative of rich fens. Collectively, Peter Lesica, Bruce McCune, Stephen Cooper (ecologist for Conservation Biology Research), and Won Shic Hong (liverwort expert and professor at College of Great Falls in Montana) studied differences in lichen and bryophyte communities between old-growth and managed, second-growth forests in the Swan Valley of Lake County (Lesica et al. 1991). Their work suggests that many lichens and bryophytes find optimum habitat in old-growth forests and become less common as silvicultural practices convert old growth to younger forests. Twenty-five species of mosses were reported.

Peter Lesica and Bruce McCune established permanent transects at three alpine sites in GNP to study global warming (Lesica and McCune 1989, 2004). They recorded 22 mosses, of which *Hypnum bambergii*, *Hypnum hamulosum*, and *Pseudocalliergon brevifolium* are rare in Montana. The occurrence of *Pseudocalliergon brevifolium* is a substantial range expansion from the known distribution (subarctic regions of Alaska, Canada, and Greenland) in FNA (2014). Lesica and McCune (2004) later published their monitoring results; however, moss data were not presented

because cover was sparse and thought to not be a good indicator of changes in community composition. The most common moss species on their study sites are *Sphagnum russowii*, *Paraleucobryum enerve*, and *Polytrichum juniperinum*.

Dale Vitt, formerly of the University of Alberta and currently at Southern Illinois University, studied the distribution of the genus *Orthotrichum* (Vitt 1973) and *Dryptodon patens* (Vitt and Belland 1991) in North America. His collections occurred during 1958, 1976, 1978, 1984, and 1990 in 13 counties throughout Montana, and are found in the CPNWH database, Royal Alberta Museum, and University of Alberta herbarium. His collection of the rare *Seligeria calcarea* in Lewis and Clark County is Montana's second known location.

Gerald Moore, a botanist, made the first systematic *Sphagnum* collections from western Montana. During the 1970s, he documented the *Sphagnum* flora from numerous wetlands, including ecologically important fens (i.e., Mary's Frog Pond, ShooFly Meadows, Mud Lake/Skalkaho Fen, Sheep Mountain Fen, John's Lake, and the Needles/Mount Edith Fen). Moore collected the first Montana records of *Sphagnum mendocinum*, *S. compactum*, and *S. platyphyllum*. His collections were verified by Richard Andrus, a *Sphagnum* scholar from the State University of New York. His work contributed greatly to our current knowledge of the *Sphagnum* flora in Montana.

Gerald Moore and Joe Elliott reported 21 mosses new to Montana and noted their geographic distribution in North America (Elliott and Moore 1989). Their work documented the only known Montana occurrences for *Fabronia pusilla*, *Cinclidium stygium*, and *Tetraplodon angustatus*. The *Tetraplodon angustatus* collection is also the only known occurrence in the western U.S. (Marino 2014). *Cinclidium stygium* has also been reported from rich, calcareous fens in Wyoming.

Joe Elliott identified mosses from Skull Creek Meadows, a patterned fen in the Pioneer Range of the Beaverhead National Forest (Elliott 1992). Collections included Montana SOC: *Sphagnum angustifolium*, *Sphagnum fimbriatum*, and *Sarmentypnum sarmentosum*. He compiled the *Second Checklist of Montana Mosses*, which listed 408 taxa (Elliott 1993).

Earle Layser, U.S. Forest Service, reported on the occurrence of *Sphagnum* species in the northern Rocky Mountains. Andrus and Layser (1976) addressed biogeography for 17 *Sphagnum* species from Idaho, Washington, and Montana, including *S. platyphyllum* and *S. mendocinum*, which are rare in Montana. Andrus and Layser (1971) reported *S. riparium* in Washington as a new record for the western U.S. which has since been found in Montana.

Judy Hoy, landowner and amateur bryologist, maintains an active moss checklist for her property and other sites in Ravalli County, Montana. Her noteworthy collections include: *Henediella heimii*, *Didymodon brachyphyllus*, *Coscinodon calyptratus*, *Tortula acaulon*, *Physcomitrium pyriforme*, *Pterygoneuron subsessile*, *Syntricia bartramii*, *Syntricia papillosissima*, *Pseudocrossidium obtusulum*, and *Tortula truncate* (Hoy 2017, Hoy and Elliott 2003). These are understudied arid-land mosses associated with cryptobiotic crusts and soils derived from volcanic ash in the Bitterroot Valley. Hoy's collection of *Pseudocrossidium obtusulum* is the first record for Montana and resulted in a publication co-authored by Patricia Eckel, bryologist at the Missouri Botanical Garden, Joe Elliott, and Judy Hoy (1997). Hoy's specimens are deposited at the Clinton Herbarium (Buffalo Museum of Science) [BUF] in New York and at MONTU.

Mike Arvidson, botanist for the Kootenai National Forest, collected mosses from fens in the Purcell and Whitefish Ranges in northwest Montana. His *Sphagnum* collections include the first Montana record for *S. wulfianum*. Montana's two occurrences are the only western U.S. locations, though it occurs in the eastern and mid-western U.S. and several Canadian provinces (FNA 2007).

A U.S. Forest Service study on the vascular plants and dominant mosses in peatlands (fens) of western Montana and Idaho national forests resulted in a General Technical Report (Chadde et.

1998). Their study identified 17 *Sphagnum* species in Montana and documented five SOC: *Paludella squarrosa*, *Meesia triquetra*, *Scorpidium scorpioides*, *Hamatocaulis vernicosus*, and *Scorpidium revolvens*.

Toby Spribille, former U.S. Forest Service botanist and currently at the University of Alberta, reported on 56 mosses found during a bryology course conducted by Dale Vitt and Lars Soderstrom at the University of Montana Biological Station (Spribille 1998). The collection of *Herzogiella striatella* is Montana's first record. Spribille (1996) also compiled the "Bryophytes of the Whitefish Range," which listed 170 species with locations and habitat associations and reported (1997) the first Montana record of *Sphagnum lindbergii* from a fen in Lincoln County.

Henk Greven and Toby Spribille reported on the rediscovery of *Grimmia brittoniae* in Bad Rock Canyon, 100 years after it was first collected at this site by R. S. Williams (Greven and Spribille 1999). This rare moss, endemic to northwest Montana and adjoining Idaho, has 49 reported occurrences in Montana (MTNHP 2018).

Toby Spribille and Joe Elliott published on the rich-fen mosses of *Scorpidium scorpioides* and *Meesia triquetra* (Elliott and Spribille 2000). They reported 14 occurrences of *Meesia triquetra* and 20 occurrences of *Scorpidium scorpioides* in Montana. They also prepared a "Preliminary List of Mosses for the Kootenai National Forest," which identified 202 taxa, with 8 species being new state records (Elliott and Spribille 1997). In 2000, they prepared an unpublished draft of "New or Noteworthy Bryophyte Records from Montana" which included: *Andreaea blytii*, *Atrichum tenellum*, *Brachythecium calcareum*, *Brachythecium campestre*, *Campylium radicale*, *Leucolepis acanthoneuron*, *Orthotrichum pallens*, *Pohlia tundrae*, *Sphagnum wulfianum*, and *Tortula caninervis*.

Judy Harpel, bryologist and currently curator at the University of British Columbia bryophyte herbarium, and Wilf Schofield conducted a bryology workshop in western Montana for federal agency botanists in 2003. During this workshop Schofield and Harpel jointly collected 141 specimens from Missoula, Granite, Mineral, and Lake Counties. Their collections included two SOC, *Eucladium verticillatum* and *Hamatocaulis vernicosus*. Harpel conducted an extensive moss survey of Yellowstone National Park (YNP) from 2005 to 2008. Her 222 moss specimens from Gallatin and Park Counties within YNP (YELLOW-HRC) include two new species *Grimmia lisae* and *Tortula inermis*, and five SOC *Syntricia norvegica*, *Syntricia papillosissima*, *Hennediella heimii*, and *Tortula acaulon* for Montana.

Emily Elliott and Brian Elliott in 2007 and 2008 collected mosses in the Abasaroka and Beartooth Ranges in Montana and Wyoming. Their 45 collections are recorded in the CPNWH database, and include two Montana SOC, *Syntricia papillosissima* and *Sarmetypnum exannulatum*.

Yelena Kosovich-Anderson, research associate at the University of Wyoming, studies the Wyoming moss flora and that of the Abasaroka and Beartooth Ranges in Montana. She has published several papers on high-elevation mosses that are relevant to Montana (Kosovich-Anderson and Weber 2011, Kosovich-Anderson and Ignatov 2010, and Andrus and Kosovich-Anderson 2011). Outside of GNP, the alpine moss flora in Montana has scarcely been studied.

Craig Odegard, Lolo National Forest botanist, has deposited at MONTU more than 130 specimens that are mostly from Sanders and Mineral Counties, Montana. Along with associated vascular plants and detailed habitat data, his collections include the first Montana record for *Pohlia filum* and locations of eight Montana SOC: *Leucolepis acanthoneuron*, *Meesia triquetra*, *Meiotrichum lyallii*, *Neckera douglasii*, *Tortula acaulon*, *Sphagnum centrale*, *Homalothecium megaptilum*, and *Sarmetypnum exannulatum*.

The first documented moss and lichen survey in Musselshell County occurred on the Milton Ranch, northeast of Roundup, in September 2016. Organized by Andrea Pipp, MTNHP botanist, and assisted by Northwest Lichenologists, Bruce McCune, Roger Rosentreter, Daphne

Stone, Ann DeBolt, Rob Smith, Katherine Glew, and Wendy Velman spent three days surveying and identifying the moss and lichen flora. Their 86 moss collections were verified by Joe Elliott with a few examined by Patricia Eckel and John Spence, scientist for the National Park Service. This initial exploration found 27 moss species of which four are rare: *Syntrichia papillosissima* (SOC), a second Montana location for *Pseudocrossidium obtusulum*, and the first Montana records for *Didymodon tectorum* and *Gemmabryum kunzei*.

### MOSS BIOGEOGRAPHY IN MONTANA

Botanists have long been interested in the geographic distribution of plant species and their influence on the earth's surface (phytogeography) (Lesica et al. 2012). Floristic analysis classifies a flora into groups that share distinct geographic patterns, and the patterns are known as “floristic provinces”. Specifically these are areas with a distinct flora that is thought to have evolved under relatively static climate and soils over long periods of time. A species whose geographic range mostly corresponds to a particular floristic pattern is considered to have affinities with that floristic region and is assumed to have evolved primarily with species of the same affinity.

Montana, encompassing the Cordilleran and Great Plains floristic provinces and bordering on the Boreal floristic province, has a rich moss flora created by habitat diversity that reflects the ecological integration of elevation, substrate, and climate. Species that associate with the three floristic provinces will also occur in other places when the elevation, substrate, and/or climate resemble their floristic province. For example, many species with affinities for coniferous forests of western Montana (Cordilleran and Boreal species) also are present in the isolated mountain ranges of central Montana where the montane environment is cooler and wetter than the surrounding prairie and steppe.

The biogeography of mosses and vascular plants differ in that mosses tend to have wider distributions, often including several continents in both hemispheres, with many species being cosmopolitan (Carter et al. 2016). More than 75 percent of bryophyte families occur in both hemispheres. More than half of the North American species also occur outside of this continent (Medina et al. 2011). Like vascular plants, mosses exhibit one of three distribution patterns: widespread in several floristic provinces (cosmopolitan), discontinuous among floristic provinces (disjunct), and restricted to a floristic province or part of a floristic province (endemic).

A comparison of species found in the FNA (2007, 2014) and *Manual of Montana Vascular Plants* (Lesica et al. 2012) indicates there are biogeographical differences between mosses and vascular plants in Montana (**Table 1**). Differences in affinities between vascular and moss plants are most pronounced in the Boreal and North American Cordilleran provinces. Only 1 percent of moss and 5 percent of vascular plant species have affinities for the Great Plains floristic province. When compared to vascular plants (45 percent), fewer moss species (30 percent) have an affinity to the North American Cordilleran province that extends from Alaska south to California and Arizona. Of this approximately 14 percent of moss and 5 percent of vascular plants are mostly restricted to the Pacific Northwest portion of the Cordilleran province. Cosmopolitan moss and vascular plant species comprise similar percentages of the Montana flora. Cosmopolitan mosses include a group characterized as “weedy” because they colonize disturbed soils, bare rock, concrete, and roofs. One of these is the “sidewalk moss,” a tiny, silvery *Bryum argenteum* that is ubiquitous in sidewalk cracks throughout Missoula, Montana and many urban towns.

Mosses differ from vascular plants in exhibiting lower levels of endemism, which is probably due to the spore's ability to disperse long distances. Peaks of endemic richness in the North American moss flora are found in northern California, the Pacific Northwest, and in the southern Appalachian Mountains. Montana has only two moss species that are narrow endemics (restricted to small areas within a floristic province). *Grimmia brittoniae* is endemic to western

Montana and central Idaho. This rare moss grows on rock faces that are wet in spring (**Figure 3**), and has been documented at 49 locations in western Montana since its re-discovery in 1997 (Greven and Spribille 1999, MTNHP 2018). *Drepanocladus cardotii* is perhaps the rarest Montana moss. It was collected once from Avalanche Basin in GNP in 1898 and has not been found anywhere else in the world.

**Table 1.** Biogeographic affinities of vascular plants and mosses as a percentage of the total number of species in Montana.

Floristic Province	Vascular Plants (%) <sup>1</sup>	Mosses(%)
Arctic-Alpine	5	10
Boreal	18	34
North American Cordilleran	45	30
Great Plains	5	1
Widespread/Undetermined	27	25

<sup>1</sup> Lesica et al. 2012



**Figure 3.** The Montana endemic moss *Grimmia brittoniae* on a wet cliff along the Thompson River, Montana. Photograph courtesy Craig Odegard.

Twenty-five moss species are regional endemics with distribution centers in the Pacific Northwest, reaching Montana on the eastern edge of their range. These include four species of *Homalothecium* and additional species of *Plagiomnium*, *Rhytidiopsis*, *Kindbergia*, *Roellobryon*, *Scelopodium*, *Fontinalis*, *Neckera*, *Porotrichum*, *Isothecium*, *Hypnum*, *Dichelyma*, *Sphagnum*, *Leucolepis*, *Buxbaumia*, and *Bryolawtonia*. These mosses are associated with a variety of moist substrates in Pacific maritime forests, such as, lower tree boles, decaying logs, litter and duff, rock, and wetlands. Unlike many endemic vascular plants, most of these mosses do not appear restricted to a narrow range of substrates, such as limestone or serpentine soils. *Buxbaumia piperi* and *B. viridis*, or “bug-on-a-stick” are exceptions, as they are only found on large, downed logs in a specific stage of decay.

Forty-two moss species have been recorded from a single location in Montana. This could be explained by insufficient surveys, or by ecological or geological processes that influence a species’ distribution. In Montana five moss species are known from isolated collections that are disjunct from their primary centers of distribution based on FNA maps: a) *Grimmia pilifera* is associated with granite and limestone substrates in the mountains. It was collected once in Lake County, Montana which is disjunct from the Appalachian Mountains. b) *Grimmia teretinervis* grows on limestone throughout the United States and Canada on sites that were inundated by oceans during the Cretaceous, and have uplifted and eroded to expose calcareous sediments (Hastings 2002). It was collected once in Ravalli County, Montana. c) *Pohlia lescuriana*, collected once near Columbia Falls, Montana is an inconspicuous woodland species disjunct from its eastern North America distribution. d) *Sanionia nivalis* collected once in GNP, is an arctic species often associated with areas that hold snow late into the season or along glacier-fed streambanks (Hedenas 1989). For arctic-alpine mosses information on their specific substrate requirements is largely not available, but they could be similar to many arctic-alpine vascular plants that occupy restricted habitats where year-round cold surface water from snow melt is present. e) *Cyrtomnium hymenophylloides* is a circumpolar arctic-alpine moss (FNA 2014) that was recently collected in the Tobacco Root Mountains, Montana. Disjunct populations in the northeastern U.S. occur on mountain-tops or at lower elevation, unglaciated sites remnant of the pre-glacial period (Miller 1996). Sporophytes are unknown in North America and asexual dispersal from its main distributional center to Montana seems unlikely. More likely the isolated population in Montana may represent an unglaciated site with a microclimate similar to the cooler, wetter pre-glacial period.

Other moss species known from a single location in Montana are widespread, have widely separated occurrences, but are restricted to specific substrates. Some examples include: a) *Cinclidium stygium*, a species found in rich-fens that form where cold water percolates through limestone, upwells, and forms peatlands. *Cinclidium stygium* is found at Pine Butte fen near Choteau, Lee Creek Fen in GNP, and Cathedral Cliffs fen in the Beartooth Range in Wyoming. b) *Tetraplodon angustatus* and *T. mnioides* colonize the dung of forest carnivores. They are not restricted to a specific carnivore, but coyote dung is commonly cited (Marino 1988). They are most often recorded from Alaska and Canada, particularly along the Pacific Coast. *Tetraplodon mnioides* has also been found on leopard dung from Mount Kilimanjaro in Tanzania (Crum and Anderson 1981). In Montana where carnivore dung and other suitable organic substrates (such as owl pellets) are abundant, *T. angustatus* and *T. mnioides* have each been found once. It might just indicate that the average botanist doesn’t spend enough time checking scat for bryological life. c) *Haplodontium macrocarpa* one of the “copper mosses” is known from 26 collections made from 1905 to 1991, but representing two areas around Silver Gate–Cooke City in Park County. These collections come from six different bryologists who have scrambled over slippery rocks made by waterfalls and



streams that drain the mineral rich soils. Historically, the Silver Gate–Cooke City area was actively mined for gold, often in conflict with YNP’s mission.

Most biogeographical reports of mosses have not relied on molecular, phylogenetic, and population genetic analyses to provide insight into species distribution patterns. It has predominately been assumed that wide-spread species growing on different continents yet geographically separated by barriers of ocean, desert, or mountain range, are genetically similar. Given inquisitive bryologists and advances in research, interpretations in the patterns of moss distributions may be called into question or refined.

In western North America the discovery of new species has continued to rise steeply over the last three decades, based on traditional approaches of field and herbarium studies. There is still a place in bryological research for a botanist with a hand lens, sturdy shoes, and an affinity for mossy places. The notion of “mossy places” should not be limited to areas like the Hoh River rainforest on the Olympic Peninsula, where mosses festoon every available surface, but should include the dry prairie and steppe habitats of eastern Montana and every mountain peak in Montana’s mountain ranges. These are the understudied habitats that have the most potential to harbor new moss records for Montana.

### MONTANA MOSS CHECKLIST

The checklist of 522 taxa are presented alphabetically by scientific name without authorities; however, the checklist with authorities, synonyms, habitat associations, herbarium records for rare/unique species, and Montana county distribution maps is available for download on the MTNHP website (<http://mtnhp.org/reports.asp>). In addition moss taxa profiles and photographs can be found on the Plant Field Guide at the MTNHP website (<http://fieldguide.mt.gov/>). The unexpanded checklist is anticipated to be posted to the CNABH portal (<http://bryophyteportal.org/portal/projects/index.php?>). Taxonomic nomenclature follows FNA (2007, 2014) and bolded names are MTNHP SOC (2010).

There are 56 counties in Montana (**Figure 1**), yet the 10 most frequently collected mosses are documented in 27 or fewer counties, except for *Syntrichia ruralis* which has been found in 31 counties (**Table 2**). Many moss species in Montana are represented by three or fewer collections. This may indicate a sparsity of bryologists more than a scarcity of mosses.

**Table 2.** Summary of the most frequently collected moss species in Montana.

Species	Number of Counties Where Collected	Number of Herbarium Records <sup>1</sup>
<i>Dicranum scoparium</i>	17	310
<i>Syntrichia ruralis</i>	31	279
<i>Ceratodon purpureus</i>	27	254
<i>Polytrichum juniperinum</i>	19	245
<i>Mnium spinulosum</i>	17	244
<i>Scouleria aquatica</i>	16	207
<i>Timmia austriaca</i>	20	197
<i>Eurhynchiastrum pulchellum</i>	18	193
<i>Cratoneuron filicinum</i>	20	192
<i>Brachythecium albicans</i>	17	183

<sup>1</sup>Number of herbarium records does not include collections made after 2015.

- Abietinella abietina*  
*Aloina aloides* var. *ambigua*  
***Aloina brevirostris***  
*Aloina rigida*  
***Amblyodon dealbatus***  
*Amblystegium serpens*  
*Amphidium lapponicum*  
*Amphidium mougeotii*  
*Anacolia menziesii*  
*Andreaea blyttii*  
*Andreaea rupestris*  
*Anomobryum concinatum*  
*Anomobryum julaceum*  
*Antitrichia californica*  
*Antitrichia curtispindula*  
*Arctoa fulvella*  
*Atrichum selwynii*  
*Atrichum tenellum*  
*Atrichum undulatum*  
*Aulacomnium androgynum*  
*Aulacomnium palustre*  
*Barbula convoluta*  
 var. *eustegia*  
*Barbula unguiculata*  
*Bartramia ithyphylla*  
*Bartramia pomiformis*  
*Blindia acuta*  
*Brachytheciastrum collinum*  
*Brachytheciastrum fendleri*  
*Brachytheciastrum leibergii*  
*Brachytheciastrum velutinum*  
 var. *salicinum*  
*Brachythecium acutum*  
*Brachythecium albicans*  
*Brachythecium asperrimum*  
*Brachythecium campestre*  
*Brachythecium cirrosum*  
*Brachythecium erythrorrhizon*  
 var. *erythrorrhizon*  
*Brachythecium frigidum*  
*Brachythecium laetum*  
*Brachythecium rivulare*  
*Brachythecium rutabulum*  
*Brachythecium salebrosum*  
***Brachythecium turgidum***
- Bryoerythrophyllum recurvirostrum*  
*Bryolawtonia vancouveriensis*  
*Bryum argenteum*  
*Bryum blindii*  
*Bryum calobryoides*  
*Bryum lanatum*  
*Bryum veronense*  
*Buckiella undulata*  
*Bucklandiella affinis*  
*Bucklandiella brevipes*  
*Bucklandiella heterosticha*  
*Bucklandiella macounii*  
 subsp. *alpina*  
*Bucklandiella macounii*  
 subsp. *macounii*  
*Bucklandiella microcarpa*  
*Bucklandiella occidentalis*  
*Bucklandiella pacifica*  
*Bucklandiella sudetica*  
*Buxbaumia aphylla*  
*Buxbaumia piperi*  
*Buxbaumia viridis*  
***Callicladium haldanianum***  
*Calliergon cordifolium*  
*Calliergon giganteum*  
***Calliergon richardsonii***  
*Calliergonella cuspidata*  
*Campyliadelphus chrysophyllus*  
*Campylium protensum*  
*Campylium stellatum*  
*Campylophyllum halleri*  
*Campylophyllum hispidulum*  
*Campylopus flexuosus*  
***Catoscopium nigrum***  
*Ceratodon purpureus*  
***Cinclidium stygium***  
*Claopodium bolanderi*  
*Claopodium crispifolium*  
*Climacium americanum*  
*Climacium dendroides*  
*Codriophorus acicularis*  
*Codriophorus fascicularis*  
*Codriophorus rysardii*  
*Conardia compacta*
- Conostomum tetragonum*  
*Coscinodon calyptratus*  
*Cratoneuron filicinum*  
*Crumia latifolia*  
*Cynodontium glaucescens*  
*Cynodontium jenneri*  
*Cynodontium polycarpon*  
*Cynodontium schisti*  
*Cynodontium strumiferum*  
***Cynodontium tenellum***  
*Cyrtomnium hymenophylloides*  
***Dendroalsia abietina***  
*Dichelyma uncinatum*  
***Dichodontium olympicum***  
*Dichodontium pellucidum*  
*Dicranella crispa*  
*Dicranella heteromalla*  
*Dicranella palustris*  
***Dicranella schreberiana***  
*Dicranella subulata*  
*Dicranella varia*  
*Dicranoweisia cirrata*  
*Dicranoweisia crispula*  
***Dicranum acutifolium***  
*Dicranum bonjeanii*  
*Dicranum brevifolium*  
*Dicranum elongatum*  
*Dicranum flagellare*  
***Dicranum fragilifolium***  
*Dicranum fuscescens*  
 var. *fuscescens*  
*Dicranum howellii*  
*Dicranum majus*  
*Dicranum montanum*  
*Dicranum muehlenbeckii*  
*Dicranum pallidisetum*  
*Dicranum polysetum*  
*Dicranum rhabdocarpum*  
*Dicranum scoparium*  
***Dicranum spadiceum***  
*Dicranum tauricum*  
*Dicranum undulatum*  
*Didymodon brachyphyllus*  
*Didymodon fallax*  
*Didymodon ferrugineus*

- Didymodon nicholsonii  
 Didymodon rigidulus  
   var. gracilis  
 Didymodon rigidulus  
   var. icmadophilus  
 Didymodon tectorum  
 Didymodon tophaceus  
 Didymodon vinealis  
   var. vinealis  
 Didymodon vinealis  
   var. rubiginosus  
 Distichium capillaceum  
**Distichium inclinatum**  
 Ditrichum ambiguum  
 Ditrichum flexicaule  
 Ditrichum gracile  
 Ditrichum heteromallum  
 Drepanocladus aduncus  
 Drepanocladus cardotii  
 Drepanocladus longifolius  
 Drepanocladus polygamus  
 Drepanocladus sordidus  
 Elodium blandowii  
 Encalypta affinis  
 Encalypta alpina  
 Encalypta ciliata  
 Encalypta procera  
 Encalypta rhaptocarpa  
 Encalypta spathulata  
 Encalypta vulgaris  
**Entosthodon rubiginosus**  
**Eucladium verticillatum**  
 Eurhynchiastrum pulchellum  
   var. pulchellum  
 Eurhynchiastrum pulchellum  
   var. barnesii  
**Fabronia pusilla**  
 Fissidens adianthoides  
 Fissidens bryoides  
 Fissidens crispus  
**Fissidens fontanus**  
 Fissidens grandifrons  
 Fissidens osmundioides  
 Fontinalis antipyretica  
 Fontinalis howellii  
 Fontinalis hypnoides  
 Fontinalis neomexicana  
 Funaria americana  
 Funaria hygrometrica  
 Funaria muhlenbergii  
 Gemmabryum caespiticium  
 Gemmabryum dichotomum  
 Gemmabryum kunzei  
 Gemmabryum violaceum  
 Grimmia alpestris  
 Grimmia anodon  
 Grimmia anomala  
 Grimmia attenuata  
**Grimmia brittoniae**  
 Grimmia caespiticia  
 Grimmia donniana  
 Grimmia elatior  
 Grimmia funalis  
**Grimmia incurva**  
 Grimmia laevigata  
 Grimmia leibergii  
 Grimmia lisae  
 Grimmia longirostris  
**Grimmia mollis**  
 Grimmia montana  
 Grimmia orbicularis  
 Grimmia ovalis  
 Grimmia pilifera  
 Grimmia plagiopodia  
 Grimmia pulvinata  
 Grimmia ramondii  
 Grimmia sessitana  
 Grimmia teretinervis  
 Grimmia torquata  
 Grimmia trichophylla  
 Gymnostomum aeruginosum  
**Hamatocaulis vernicosus**  
**Haplodontium macrocarpum**  
 Hedwigia ciliata  
 Hedwigia detonsa  
**Henediella heimii**  
 Herzogiella seligeri  
 Herzogiella striatella  
 Herzogiella turfacea  
 Heterocladium dimorphum  
 Heterocladium procurrens  
 Homalothecium aeneum  
 Homalothecium aureum  
 Homalothecium fulgescens  
**Homalothecium megaptilum**  
 Homalothecium nevadense  
**Hygroamblystegium varium**  
   **subsp. noterophilum**  
 Hygroamblystegium varium  
   subsp. varium var. humile  
 Hygroamblystegium varium  
   subsp. varium var. varium  
 Hygrohypnum alpestre  
 Hygrohypnum alpinum  
 Hygrohypnum bestii  
**Hygrohypnum cochleariifolium**  
 Hygrohypnum duriusculum  
 Hygrohypnum luridum  
 Hygrohypnum molle  
 Hygrohypnum ochraceum  
 Hygrohypnum smithii  
 Hygrohypnum styriacum  
 Hylocomium splendens  
 Hymenostylium recurvirostrum  
 Hypnum bambergeri  
 Hypnum callichroum  
 Hypnum circinale  
 Hypnum cupressiforme  
 Hypnum hamulosum  
 Hypnum lindbergii  
 Hypnum pallescens  
 Hypnum pratense  
 Hypnum procerrimum  
 Hypnum recurvatum  
 Hypnum revolutum var. ravaudii  
 Hypnum subimponens  
 Hypnum vaucheri  
 Imbribryum alpinum  
 Imbribryum gemmiparum  
 Imbribryum miniatum  
 Imbribryum muehlenbeckii  
 Isopterygiopsis pulchella  
 Isothecium myosuroides  
 Isothecium stoloniferum  
 Jaffuelobryum raii

- Jaffuelobryum wrightii*  
*Kiaeria blyttii*  
*Kiaeria falcata*  
*Kiaeria starkei*  
*Kindbergia oregana*  
*Kindbergia praelonga*  
*Leptobryum pyriforme*  
*Leptodictyum riparium*  
*Lescurea saxicola*  
*Leskea polycarpa*  
*Leskeella nervosa*  
**Leucolepis acanthoneura**  
**Meesia longiseta**  
**Meesia triquetra**  
**Meesia uliginosa**  
**Meiotrichum lyallii**  
*Mielichhoferia elongata*  
*Mnium arizonicum*  
*Mnium blyttii*  
*Mnium lycopodioides*  
*Mnium marginatum*  
*Mnium spinulosum*  
*Mnium thomsonii*  
*Myurella julacea*  
**Myurella tenerrima**  
**Neckera douglasii**  
*Neckera menziesii*  
*Niphotrichum canescens*  
   subsp. *canescens*  
*Niphotrichum canescens*  
   subsp. *latifolium*  
*Niphotrichum elongatum*  
*Niphotrichum ericoides*  
*Niphotrichum pygmaeum*  
*Oligotrichum aligerum*  
*Oligotrichum hercynicum*  
*Oncophorus virens*  
*Oncophorus wahlenbergii*  
*Orthothecium chryseum*  
   var. *chryseum*  
*Orthotrichum affine*  
*Orthotrichum alpestre*  
*Orthotrichum anomalum*  
*Orthotrichum cupulatum*  
*Orthotrichum elegans*  
*Orthotrichum hallii*  
*Orthotrichum laevigatum*  
*Orthotrichum lyellii*  
*Orthotrichum obtusifolium*  
*Orthotrichum pallens*  
*Orthotrichum pellucidum*  
*Orthotrichum pumilum*  
*Orthotrichum pylaisii*  
*Orthotrichum rivulare*  
*Orthotrichum rupestre*  
*Orthotrichum speciosum*  
**Paludella squarrosa**  
*Palustriella falcata*  
**Paraleucobryum enerve**  
*Paraleucobryum longifolium*  
*Philonotis fontana* var. *fontana*  
*Philonotis fontana*  
   var. *americana*  
*Philonotis fontana* var. *pumila*  
*Philonotis yezoana*  
**Physcomitrium hookeri**  
*Physcomitrium pyriforme*  
*Plagiobryum demissum*  
**Plagiobryum zieri**  
*Plagiomnium ciliare*  
*Plagiomnium cuspidatum*  
*Plagiomnium drummondii*  
*Plagiomnium ellipticum*  
*Plagiomnium insigne*  
*Plagiomnium medium*  
*Plagiomnium rostratum*  
*Plagiomnium venustum*  
*Plagiopus oederianus*  
*Plagiothecium cavifolium*  
*Plagiothecium denticulatum*  
*Plagiothecium laetum*  
*Plagiothecium piliferum*  
*Platydictya jungermannioides*  
*Pleurozium schreberi*  
*Pogonatum urnigerum*  
*Pohlia andalusica*  
*Pohlia annotina*  
*Pohlia atropurpurea*  
*Pohlia camptotrachela*  
*Pohlia cruda*  
*Pohlia drummondii*  
*Pohlia elongata*  
*Pohlia filum*  
*Pohlia lescuriana*  
*Pohlia longibracteata*  
*Pohlia longicolla*  
*Pohlia ludwigii*  
*Pohlia nutans*  
*Pohlia obtusifolia*  
*Pohlia prolifera*  
*Pohlia tundrae*  
*Pohlia vexans*  
*Pohlia wahlenbergii*  
*Polytrichastrum alpinum*  
   var. *alpinum*  
*Polytrichastrum alpinum*  
   var. *septentrionale*  
*Polytrichastrum formosum*  
   var. *formosum*  
*Polytrichastrum formosum*  
   var. *densifolium*  
*Polytrichastrum longisetum*  
*Polytrichastrum sexangulare*  
*Polytrichum commune*  
*Polytrichum jensenii*  
*Polytrichum juniperinum*  
*Polytrichum piliferum*  
*Polytrichum strictum*  
**Porotrichum bigelovii**  
*Pseudocalliergon brevifolium*  
**Pseudocalliergon trifarium**  
**Pseudocalliergon turgescens**  
*Pseudocampyllum radicale*  
**Pseudocrossidium obtusulum**  
*Pseudoleskea atricha*  
*Pseudoleskea incurvata*  
   var. *incurvata*  
*Pseudoleskea incurvate*  
   var. *tenuiretis*  
*Pseudoleskea patens*  
*Pseudoleskea radicata*  
   var. *compacta*  
*Pseudoleskea radicata*  
   var. *denudata*  
*Pseudoleskea radicata*  
   var. *radicata*

- Pseudoleskea stenophylla*  
*Pseudoleskeella arizonae*  
*Pseudoleskeella rupestris*  
*Pseudoleskeella tectorum*  
*Pseudotaxiphyllum elegans*  
*Pterigynandrum filiforme*  
*Pterygoneurum lamellatum*  
*Pterygoneurum ovatum*  
*Pterygoneurum subsessile*  
*Ptilium crista-castrensis*  
*Ptychomitrium gardneri*  
*Ptychostomum arcticum*  
*Ptychostomum bimum*  
*Ptychostomum cernuum*  
*Ptychostomum creberrimum*  
*Ptychostomum cyclophyllum*  
*Ptychostomum inclinatum*  
*Ptychostomum lonchocaulon*  
*Ptychostomum pallens*  
*Ptychostomum pallescens*  
*Ptychostomum pendulum*  
*Ptychostomum pseudotriquetrum*  
***Ptychostomum schleicheri***  
*Ptychostomum turbinatum*  
*Ptychostomum weigeli*  
*Pylaisia polyantha*  
*Racomitrium lanuginosum*  
*Rhizomnium magnifolium*  
*Rhizomnium nudum*  
*Rhizomnium pseudopunctatum*  
*Rhizomnium punctatum*  
***Rhynchostegium aquaticum***  
*Rhytidiadelphus loreus*  
*Rhytidiadelphus squarrosus*  
*Rhytidiadelphus subpinnatus*  
*Rhytidiadelphus triquetrus*  
*Rhytidiopsis robusta*  
*Rhytidium rugosum*  
*Roellobryon roellii*  
*Rosulabryum capillare*  
*Rosulabryum laevifilum*  
*Sanionia nivalis*  
*Sanionia uncinata*  
***Sarmentypnum exannulatum***  
***Sarmentypnum sarmentosum***
- Schistidium agassizii*  
*Schistidium apocarpum*  
*Schistidium atrichum*  
*Schistidium crassipilum*  
*Schistidium dupretii*  
*Schistidium frigidum*  
*Schistidium occidentale*  
*Schistidium papillosum*  
*Schistidium rivulare*  
*Schistidium strictum*  
*Schistidium tenerum*  
*Schistidium trichodon*  
*Schistostega pennata*  
*Sciuro-hypnum curtum*  
*Sciuro-hypnum hylotapetum*  
*Sciuro-hypnum latifolium*  
*Sciuro-hypnum oedipodium*  
*Sciuro-hypnum plumosum*  
*Sciuro-hypnum populeum*  
*Sciuro-hypnum reflexum*  
*Sciuro-hypnum starkei*  
*Scleropodium obtusifolium*  
*Scleropodium touretii*  
*Scorpidium cossoni*  
***Scorpidium revolvens***  
***Scorpidium scorpioides***  
*Scouleria aquatica*  
*Scouleria marginata*  
*Seligeria calcarea*  
*Seligeria campylopora*  
*Seligeria donniana*  
***Sphagnum angustifolium***  
*Sphagnum annulatum*  
*Sphagnum capillifolium*  
***Sphagnum centrale***  
***Sphagnum compactum***  
*Sphagnum cuspidatum*  
***Sphagnum fimbriatum***  
***Sphagnum fuscum***  
***Sphagnum girgensohnii***  
*Sphagnum lindbergii*  
***Sphagnum magellanicum***  
***Sphagnum mendocinum***  
*Sphagnum platyphyllum*  
***Sphagnum riparium***
- Sphagnum russowii*  
*Sphagnum squarrosus*  
*Sphagnum subsecundum*  
*Sphagnum teres*  
*Sphagnum warnstorffii*  
***Sphagnum wulfianum***  
*Splachnum ampullaceum*  
*Splachnum luteum*  
*Splachnum sphaericum*  
***Stegonia latifolia***  
*Straminergon stramineum*  
***Syntrichia bartramii***  
*Syntrichia caninervis*  
*Syntrichia latifolia*  
*Syntrichia montana*  
***Syntrichia norvegica***  
*Syntrichia papillosa*  
***Syntrichia papillosissima***  
*Syntrichia princeps*  
*Syntrichia ruralis*  
***Tayloria acuminata***  
*Tayloria lingulata*  
*Tayloria serrata*  
*Tayloria splachnoides*  
*Tetraphis pellucida*  
 var. *trachypoda*  
*Tetraplodon angustatus*  
*Tetraplodon mnioides*  
***Thamnobryum neckeroides***  
*Thuidium recognitum*  
*Timmia austriaca*  
*Timmia megapolitana*  
 subsp. *bavarica*  
*Timmia norvegica*  
*Timmiella crassinervis*  
*Tomentypnum nitens*  
*Tortella alpicola*  
*Tortella fragilis*  
*Tortella inclinata*  
*Tortella tortuosa*  
***Tortula acaulon***  
***Tortula cernua***  
*Tortula hoppeana*  
*Tortula inermis*  
*Tortula laureri*

Tortula leucostoma

Tortula mucronifolia

Tortula muralis

Tortula obtusifolia

Tortula subulata

Tortula truncata

Trichodon cylindricus

Trichostomum tenuirostre

Tripterocladium leucocladulum

Warnstorfia fluitans

Weissia controversa

## LITERATURE CITED

- Andrus R.E. and E.F. Layser. 1976. *Sphagnum* in northern Rocky Mountains of United States. *The Bryologist* 79: 508-511
- Andrus R.E. and E.F. Layser. 1971. *Sphagnum riparium* Aongstr., a new record for the Western United States. *The Bryologist*. 74: 211
- Andrus, R. and Y. Kosovich-Anderson. 2011. Two *Sphagnum* sect. *Cuspidata*, new to the western conterminous United States. *Evansia* 28: 54–57.
- Brassard, G.R. and T. Hedderson. 1983. The distribution of *Mielichhoferia macrocarpa*, a North American endemic moss. *The Bryologist* 86: 273–275.
- Carter, B.E., B. Shaw and A. J. Shaw. 2016. Endemism in the moss flora of North America. *American Journal of Botany* 103: 769–779.
- Chadde, S., S. Shelly, R. Bursik, R. Moseley, A. Evenden, M. Mantas, F. Rabe and B. Heidel. 1998. Peatlands on national forests of the Northern Rocky Mountains: Ecology and conservation. USDA Forest Service. General Technical Report RMRS-GTR-11.
- Churchill, S. 1983. Mosses of the Great Plains IX: Eastern Montana. *Proceedings of the Montana Academy of Sciences* 42: 17–23.
- Crum, H. and L.E. Anderson. 1981. Mosses of Eastern North America (Vol. 1). New York: Columbia University Press, 1328 pp.
- Eckel, P., J. Hoy and J. Elliott. 1997. *Pseudocrossidium obtusulum* (Pottiaceae, Bryopsida) new to Montana with a key to North American species in the genus. *Great Basin Naturalist* 57: 259–262.
- Elliott, J. 1992. Mosses of Skull Creek Meadows: Patterned fens in the Pioneer Range, Montana. Prepared for the Beaverhead National Forest, Dillon, Montana.
- Elliott, J. 1993. Second checklist of Montana mosses (draft). Prepared for Montana Natural Heritage Program, Helena, Montana. [http://mtnhp.org/docs/1993\\_Moss\\_Checklist.pdf](http://mtnhp.org/docs/1993_Moss_Checklist.pdf).
- Elliott, J. and G. Moore. 1989. Additions to the moss flora of Montana. *The Bryologist* 92: 194–197.
- Elliott, J. and T. Spribille. 1997. Preliminary list of Montana mosses of Kootenai National Forest. Montana Natural Heritage Program, Helena. <https://www.biodiversitylibrary.org/bibliography/25048>.
- Elliott, J. and T. Spribille. 2000. Montana collections of *Scorpidium scorpioides* and *Meesia triquetra*. *Evansia* 17: 10–14.
- Eversman, S. and A. J. Sharp. 1980. First checklist of Montana mosses. *Proceedings of the Montana Academy of Sciences* 39: 12–24.
- Flowers, S. 1973. Mosses: Utah and the West. Brigham Young University Press, Provo, Utah.
- Flora of North America Editorial Committee, eds. (FNA). 2007. *Flora of North America North of Mexico*, Volume 27. Bryophytes: Mosses, part 1. New York: Oxford University Press.
- Flora of North America Editorial Committee, eds. (FNA). 2014. *Flora of North America North of Mexico*, Volume 28. Bryophytes: Mosses, part 2. New York: Oxford University Press.
- Greven, H. and T. Spribille. 1999. *Grimmia brittoniae*, a rare moss endemic to northwestern Montana. *The Bryologist* 102: 116–118.
- Harris, W. and C. Harris. 1904. Lichens and mosses of Montana: A list based on material collected during the summer of 1901, with additions. *Bulletin of the University of Montana* No. 19, Biological Series No. 7.
- Hastings, R. 2002. Biogeography of *Grimmia teretinervis* (Bryopsida, Grimmiaceae) in North America. *The Bryologist* 105: 262–266.
- Hedenas, L. 1989. The genus *Sanionia* (Musci) in northwestern Europe, a taxonomic revision. *Annales Botanici Fennici* 26: 399–419.



- Hedenas, L. 1997. A partial revision of *Campylium* (Musci). *The Bryologist* 100: 65–88.
- Hermann, F.J. 1969. The bryophytes of Glacier National Park. *The Bryologist* 72: 358–376.
- Holzinger, J. 1897. On some mosses at high elevations. *Minnesota Botanical Studies, Bulletin Number 9, Part X–XI*.
- Hoy, J. 2017. Mosses found on the Hoy Property, Ravalli County, Montana. Available from the Montana Natural Heritage Program, Helena, Montana.
- Hoy, J. and J. Elliott. 2003. Mosses of semiarid steppes of the Bitterroot Valley, Ravalli County. *Evansia* 20: 55–58.
- Janssens, J. 1983. Past and extant distribution of *Drepanocladus* in North America, with notes on the differentiation of fossil fragments. *Journal of the Hattori Botanical Laboratory* 54: 251–298.
- Jones, M. 1910. Montana botany notes. *Biological Service Bulletin* 14. *Bulletin of the University of Montana* no. 61: 1–75.
- Kosovich-Anderson, Y. and M. Ignatov. 2010. Three interesting Brachytheciaceae mosses from the Beartooth Plateau (Rocky Mountains, Wyoming, U.S.A.). *Arctoa* 19: 183–190.
- Kosovich-Anderson, Y. and W. Weber. 2011. Mosses of Wyoming's Beartooth Plateau: New noteworthy records for the Rocky Mountain Region. *Phytoneuron* 2011-58: 1–10.
- Lawton, E. 1971. *Moss Flora of the Pacific Northwest*. Nichinan, Japan: Hattori Botanical Laboratory.
- Lesica, P. 1986. Vegetation and flora of Pine Butte Fen, Teton County, Montana. *Great Basin Naturalist* 46: 22–32.
- Lesica, P. and B. McCune. 1989. Monitoring effects of global warming using peripheral rare plants in wet alpine tundra in Glacier National Park, Montana. 1989 Progress Report. Prepared for Glacier National Park, West Glacier, Montana.
- Lesica, P. and B. McCune. 2004. Decline of arctic-alpine plants at southern margin of their range following decade of climatic warming. *Journal of Vegetation Science* 15: 679–690.
- Lesica, P., B. McCune, S. Cooper and W. Hong. 1991. Differences in lichen and bryophyte communities between old-growth and managed second-growth forests in the Swan Valley, Montana. *Canadian Journal of Botany* 69: 1745–1755.
- Lesica, P., M. T. Lavin and P. F. Stickney. 2012. *Manual of Montana Vascular Plants*. Fort Worth, TX: Britt Press.
- Marino, P. 1988. The North American distribution of the circumboreal species of *Splachnum* and *Tetraplodon*. *The Bryologist* 91: 161–166.
- McCune, B. 1979. Comparative ecology of structural groups: Compositional patterns in the Swan Valley forests, Montana. Masters Thesis. University of Montana, Missoula.
- McCune, B. and J. Antos. 1981a. Correlations between forest layers in the Swan Valley, Montana. *Ecology* 62: 1196–1204.
- McCune, B. and J. Antos. 1981b. Diversity relationships of forest layers in the Swan Valley, Montana. *Bulletin of the Torrey Botanical Club* 108: 354–361.
- McCune, B. and J. Antos. 1982. Epiphyte communities in the Swan Valley, Montana. *The Bryologist* 85: 1–12.
- Medina, N., I. Draper and F. Lara. 2011. Biogeography of mosses and allies: Does size matter? Pp. 209–233. *In*: D. Fontaneto, ed. *Biogeography of Microorganisms: Is Everything Small Everywhere?* New York: Cambridge University Press.
- Miller, N.G. 1996. On the distributional history of the arctic-alpine moss *Cyrtomnium hymenophylloides* (Mniaceae) in North America. *The Bryologist* 99: 187–192.
- Montana Natural Heritage Program (MTNHP). 2010. Montana Moss Species of Concern list. Helena, Montana. <http://mtnhp.org/SpeciesOfConcern/?AorP=p>.

- Montana Natural Heritage Program (MTNHP). 2018. Query of the botany database. Helena, Montana.
- Potter, R. and P. Lesica, eds. 2017. *Montana's Pioneer Botanists: Exploring the Mountains and Prairies*. Montana Native Plant Society, Missoula, Montana. Dexter, Michigan: Thomas Shore. ISBN 9780692836903.
- Schofield, W. 1980. Phytogeography of mosses of North America (north of Mexico). Pp. 131–170. *In*: R. Taylor and A. Leviton (eds.), *The Mosses of North America*. San Francisco: American Association for the Advancement of Science.
- Schofield, W. 1992. *Some common mosses of British Columbia*. Victoria, BC: Royal British Columbia Museum.
- Spribille, T. 1996. Bryophytes of the Whitefish Range. Unpublished Manuscript.
- Spribille, T. 1997. New or noteworthy bryophyte records from Montana. Available from the Montana Natural Heritage Program, Helena, Montana.
- Spribille, T. 1998. List of bryophytes of Yellow Bay Biological Station, Lake County, Montana. *Evansia* 12: 1–3.
- Spribille, T. and J. Elliott. 2000. New or noteworthy bryophyte records from Montana (draft). Unpublished manuscript.
- Standley, P. 1920. *Sphagnum* in Glacier National Park, Montana. *The Bryologist* 72: 358–376.
- Vitt, D. 1973. A revision of the genus *Orthotrichum* in North America, north of Mexico. *Bryophytorum Bibliotheca*. Verlag Von J. Cramer, Germany.
- Vitt, D. and R. Belland. 1991. The distribution of North American bryophyte *Dryptodon patens* (Hedw.) Brid. *Evansia* 8: 41–44.
- Williams, R.S. 1900. Two new species of *Grimmia* from Montana. *Bulletin of the Torrey Botanical Club* 27: 316–317.
- Williams, R.S. 1902. A preliminary list of Montana mosses. *Bulletin of the New York Botanical Garden* 2: 351–380.