

BRYOFLORA OF THE SHOSHONE NATIONAL FOREST, WYOMING. PART 1.
A CATALOGUE OF MOSSES AND LIVERWORTS OF THE BEARTOOTH PLATEAU AREA

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ABSTRACT

This work is the first in a series of catalogues on the bryophytes of the oldest National Forest of the USA, the Shoshone National Forest. Bordering Yellowstone National Park and being a part of the Greater Yellowstone System, the Forest has retained a wide spectrum of its pristine representative areas, which support a unique bryophyte flora. Based on over 4600 specimens, the catalogue of the bryophytes of the Wyoming's Beartooth Plateau, the northernmost territories of the Forest, has been produced. This bryoflora is composed of 282 species (45 liverworts and 237 mosses) in the study area, representing approximately 53% of the Wyoming bryophyte flora. The richness of the flora is due to the high diversity of habitats, caused by the geological history of this portion of the Central Rocky Mountains, location of the study area essentially in the subalpine and alpine belts, climatic and hydrologic features, and low anthropogenic disturbance. The high elevations and associated habitat conditions allow for many disjunct arctic-alpine species (approximately 25% in the bryophyte flora). Remarkable extensions of upper elevation limits for 72 taxa are registered. Fifteen species, two subspecies, and two varieties of liverworts, as well as 56 species and eight varieties of mosses have not previously been reported for Wyoming in Flora of North America and Synopsis of Liverwort Flora of North America North of Mexico. Thirty-nine taxa (five species of liverworts and 32 species and two varieties of mosses) are of potential conservation concern in Wyoming, including two rare species with Pacific coastal affinities, *Philonotis yezoana* Besch. & Cardot and *Sphagnum miyabeana* Warnst., and one species of extreme northern habitats, *Sciuro-hypnum glaciale* (Schimp.) Ignatov & Huttunen, being a novelty for continental North America. *Brachythecium erythrorrhizon* Schimp. var. *alpinum* Kosovich-Anderson & Ignatov was recently described, using material collected as part of this study.

Key Words: Beartooth Plateau, bryophytes, Central Rocky Mountains, Shoshone National Forest, Wyoming.

Wyoming being a world-renowned land of national parks and natural monuments, which attracts researchers from all across the world, has undergone multi-disciplinary studies for decades. However, until recently, this state has been a bryological frontier – many of its territories, including environmentally protected ones, have remained “blank gaps” bryologically. So far, bryophyte distribution and conservation status have not been determined for either of the National Park Service or U.S. Forest Service units in the state.

The Shoshone National Forest (SNF) is the oldest federally protected National Forest in the United States. It was created by an act of Congress and signed into law by U.S. President Benjamin Harrison in 1891. The Forest covers part of three major mountain ranges in the Central Rocky Mountains of northwestern Wyoming; these include, in order of diminishing areal extent – Absaroka, Wind River, and Beartooth Mtns., all three are geologically distinct from each other. Elevation ranges from 1400 m (4600 ft) near Cody to 4207 m (13,800 ft) at the top of Gannett Peak. The Forest occupies a vast landscape of nearly 9983.23 km² (2,466,909 acres); it lies within five counties of the state: Fremont, Hot Springs, Park, Sublette, and Teton. Bordering Yellowstone National Park and being a part of the Greater Yellowstone System, the SNF has never been heavily exploited, and has retained a wide

spectrum of its pristine representative areas. Fifty-six percent of the Forest area is designated wilderness. With its picturesque and largely undeveloped natural landscapes, from sagebrush plains through dense fir and spruce forests, willow- and moss-lined streams, glacial lakes, alpine tundra and fens, to steep mountain slopes and peaks, the Forest is extremely rich in biodiversity. Since 1970's, the SNF has been actively studied botanically, however, a bryophyte inventory has never been performed.

A systematic survey of the bryoflora in the SNF was initiated by the U.S. Forest Service (USFS), Rocky Mountain Region (R2), in 2008, as one of the few bryophyte inventories ever conducted in the U.S. Rocky Mountains. As a Wyoming resident bryologist, I was invited to do research toward developing a bryoflora of the first National Forest of the United States. The study was conducted on subsequent contracts with the USFS and the Wyoming Natural Diversity Database (WYNDD) from 2008–2016. Distribution and documentation of the bryophytes (mosses and liverworts) of the SNF has been the subject of this project.

The present work is based on the results of my expeditions to the mountains of the Wyoming's Beartooth Plateau, the northernmost territories of the SNF (Fig. 1). Much of the preliminary information is derived from an earlier technical report (Kosovich-Anderson 2011a), which was updated

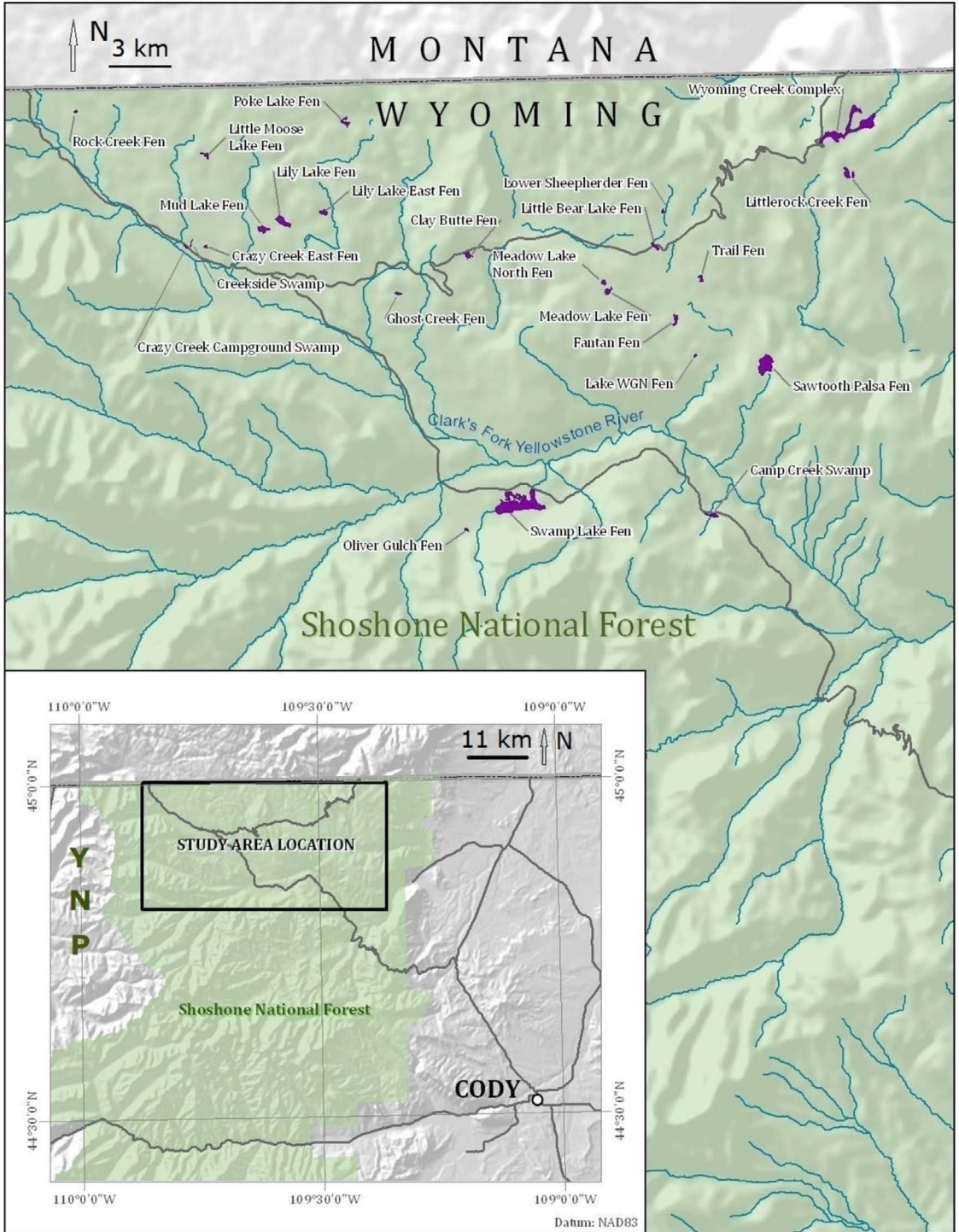


FIG. 1. Map of the study area. The Shoshone National Forest, with its northernmost Beartooth Plateau area, borders Yellowstone National Park (YNP) and is part of the Greater Yellowstone System.

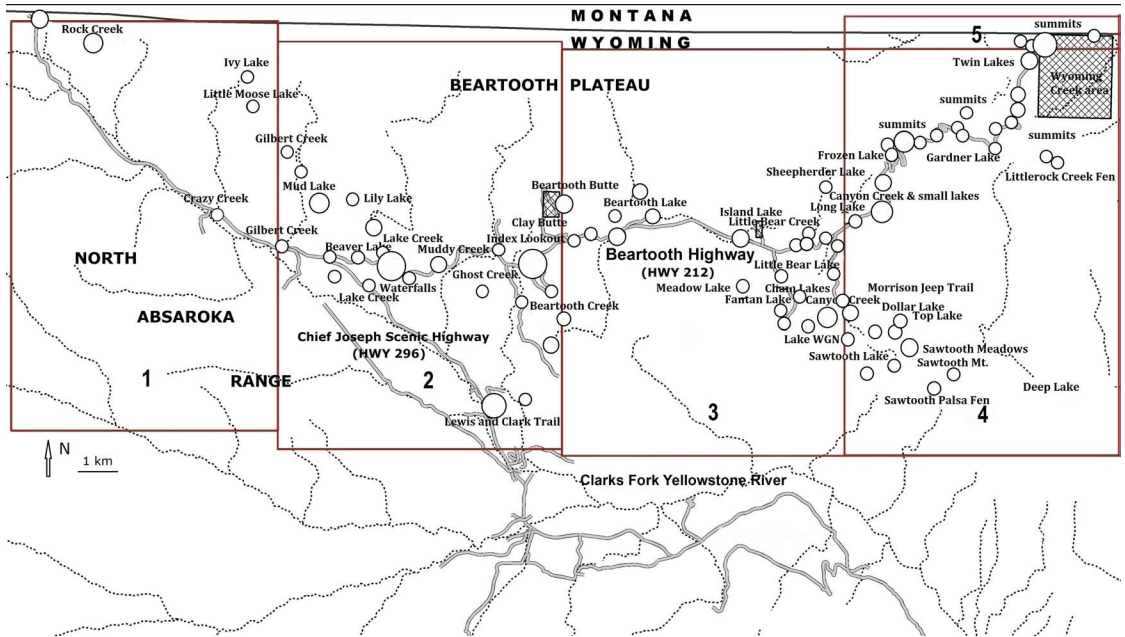


FIG. 2. Bryophyte collecting localities. Quadrangles: 1 – Jim Smith Peak, 2 – Muddy Creek, 3 – Beartooth Butte, 4 – Deep Lake, 5 – Black Pyramid Mountain. Geographic names included for reference in association with collections in catalogue. Two and more collecting sites located in close proximity to each other are marked with a bigger circle.

over the course of additional field and laboratory research. This publication is the first work in a series of catalogues on the bryophytes of the SNF.

STUDY AREA: A BRIEF PHYSIOGEOGRAPHIC OVERVIEW

The Beartooth Plateau (hereafter referred to as the study area) is a part of the Beartooth-Absaroka mountain complex in the Central Rocky Mountains, located in south central Montana and northwest Wyoming, immediately northeast of Yellowstone National Park. The total size of the Plateau is about 130 km long and about 64 km wide. The Wyoming portion represents the small southern end of the whole formation, which comprises less than 20% of the mountain range. The contiguous valley of the Clarks Fork of Yellowstone River (Missouri River Basin) is the natural boundary between the Beartooth Plateau and the North Absaroka Range. The Plateau is drained by multiple south-trending tributaries of the Clarks Fork (e.g., Crazy Creek, Lake Creek, Gilbert Creek and others).

The bryophyte inventory embraced the territory of the Plateau of approximately 700 km², within 44°52'00"–45°01'00"N and 109°23'00"–109°50'30"W and elevations ranging from about 2000 to 3400 m (6550–11,150 ft). The general study area falls almost entirely within five USGS topographic quadrangle maps (7.5') as shown in Fig. 2 – Jim Smith Peak, Muddy Creek, Beartooth Butte, Deep Lake, and Black Pyramid Mountain Quadrangles. The area is

managed as part of the Clarks Fork Ranger District, SNF.

The U.S. Highway 212 (Beartooth Highway/Beartooth Pass) and the western portion of the State Highway 296 (Chief Josef Scenic Highway) transverse the Plateau, providing access to USFS roads and trails making a variety of sites readily accessible. Much of the wilderness remains trailless.

Climate

Located in the Central Rocky Mtns., east of the Continental Divide, the Beartooth Plateau experiences a cold, dry, continental climate regime; summers are warm, but dry and short, winters are cold and moist (Bryson and Hare 1974). Annual precipitation ranges from 25 to 157 cm, with increasingly dry conditions toward the eastern side of the Plateau and a strong elevation gradient. Most of the annual precipitation falls as snow. In montane environments, aspect and the direction of the prevailing winds play a role in the movement and deposition of the winter snow pack (Johnson and Billings 1962). Prevailing winds are from the southwest, west, and northwest throughout the year. Windward slopes in the alpine and upper subalpine are commonly swept clear of snow, while snow banks on leeward slopes and depressions may persist until August. Leeward areas have higher available water throughout the growing season. South-facing slopes receive higher levels of radiation and melt-off earlier than more sheltered northerly slopes. The number of frost-free days between 1986 and 1998, using the data from the weather station at

the Beartooth Lake Campground, ranged from 41 to 89 d; frost may occur any month of the year (Mellmann-Brown 2004). There is extensive alpine habitat with low temperatures during the short growing season, with similarities relative to arctic latitudes (Billings 1973). Cold snow-melt water that seasonally fills the streams and elevates groundwater table affects the microclimate of habitats, moderating summer temperatures and supporting humidity in plant communities.

Geology

Beartooth Plateau represents a northwest-trending uplifted fault block of Precambrian granite and crystalline metamorphic rocks, which was partially blanketed with lava from Yellowstone's volcanoes and eroded by glaciers (Lageson and Spearing 1991). The core of the Beartooth Plateau is composed predominantly of granitic gneiss and schist, which are well exposed.

Three stages of Pleistocene glaciation have been provisionally recognized in the Beartooth Plateau. Recent glacial episode – the Pinedale Glaciation – probably remained at full glaciation until 15,000–20,000 yr ago. Streamlined hills with gentle, abraded up-ice slopes and steep, plucked down-ice faces are characteristic of glaciation and common on the Beartooths. Quarternary morainal deposits are dominated by granitic materials that originated at higher elevations.

An extensive, gentle surface, partially dissected by canyons and glacial cirques, occupies most of the Plateau, a substantial part of which is above 3000 m. Numerous alpine and subalpine lakes, high peaks, persistent snowfields, moist north-facing slopes, waterfalls and cascades, riparian corridors are the major features of the area (Figs. 3A–D, 4A–D). The Beartooths contain a broad area of alpine habitats that include boulder fields, talus slopes, moist and dry meadows and tundra, snowbeds, patterned ground, and bedrock outcrops (Eversman 1995). Alternating freezing and thawing of moist soils over long periods (the process of cryoturbation) leads to the formation of characteristic stone polygons and frost boils in the alpine landscape (Knight et al. 2014). On slopes in alpine tundra, solifluction lobes or terraces develop over fellfields. Ancient granite is overlain in places by Cambrian-Devonian carbonates and shales forming limestone cliffs like Clay Butte and Beartooth Butte (Carson et al. 1998, Fig. 3E). Similar formations also occur on the eastern flank of the Beartooth uplift. Base-rich rock at high altitudes supports distinctive flora.

Plant Communities

The range of altitudes within the study area comprises four life zones: the foothills at 2000–2100 m (6550–6900 ft), roughly estimated, through the montane, 2100–2600 m (6900–8550 ft), and subal-

pine, 2600–3000 m (8550–9850 ft), up to the alpine tundra – 3000 m (9850 ft) and above. On the scale accepted in *Flora of North America North of Mexico* (Flora of North America Editorial Committee 2007, 2014), the altitudinal range corresponds to “high elevations” zone (1600 m and more).

The Beartooths are largely above the timberline, and cryophyte-dominated tundra and alpine meadows are the characteristic vegetation (Figs. 3C, D). The growing season at high elevations is as brief as about 45 d. Of the primary alpine vegetation types, Johnson and Billings (1962) describe Alpine Avena (*Geum rossii* (R.Br.) Ser.) turfs on summits, ridges and upper slopes, Tufted Hairgrass (*Deschampsia cespitosa* (L.) P.Beauv.) meadows on lower mesic slopes and basins, Mountain Sedge (*Carex scopulorum* Holm) fens on wet, mineral bog and peat soils, and Diamondleaf Willow (*Salix planifolia* Pursh) thickets along drainages and in the lakesides. The Beartooth Plateau is one of the largest contiguous areas of alpine grassland on the SNF; the Idaho Fescue (*Festuca idahoensis* Elmer)/Spike Tristeum (*Trisetum spicatum* (L.) K.Richt.) community type prevails. The dwarf willows, Rocky Mountain Willow (*Salix petrophila* Rydb.) and Snow Willow (*Salix reticulata* L. var. *nana* Andersson), occur in rocky alpine tundra, alpine and subalpine meadows, and fellfields. Lichen diversity has been studied by Eversman (1995); in alpine meadows, species of the genera *Cetraria* Ach., *Evernia* Ach., and *Vulpicida* Mattsson & M.J.Lai are the most common.

At the highest elevations, alpine soils on Precambrian formations are weakly developed and are loamy and sandy textured. The plants and the soil are sensitive to trampling in this area, especially in the harsh conditions of wind-swept summits. Disturbance of the habitats can also be caused by animal activity (Pocket Gophers, Ground Squirrels, and others) and natural events (like fires, annual flood scouring of stream banks, etc.). Natural springs can be heavily used by wildlife at all elevations. On most visits, we noted wildlife tracks, footprints, trails, bear and deer bedding adjacent to seeps and springs. Anthropogenic impact on the Beartooth Plateau can be estimated as low; it includes few roads, ditches, very limited grazing, and some noxious weeds (Heidel et al. 2017; Kosovich-Anderson unpublished data). The generally low level of disturbance allows many rare and relic species to survive here.

Lower elevations have grass and sagebrush-dominated communities, while forested areas are dominated by combinations of species: Lodgepole Pine (*Pinus contorta* Douglas ex Loudon var. *latifolia* Engelm.), Douglas Fir (*Pseudotsuga menziesii* (Mirb.) Franco var. *glauca* (Mayr) Franco), and Trembling Aspen (*Populus tremuloides* Michx.), found at elevations up to 2800 m; at higher elevations Subalpine Fir (*Abies lasiocarpa* (Hook.) Nutt.) and Engelmann Spruce (*Picea engelmannii* Engelm.), frequently hybridizing in this region with White Spruce (*P. glauca* (Moench) Voss), are common, each

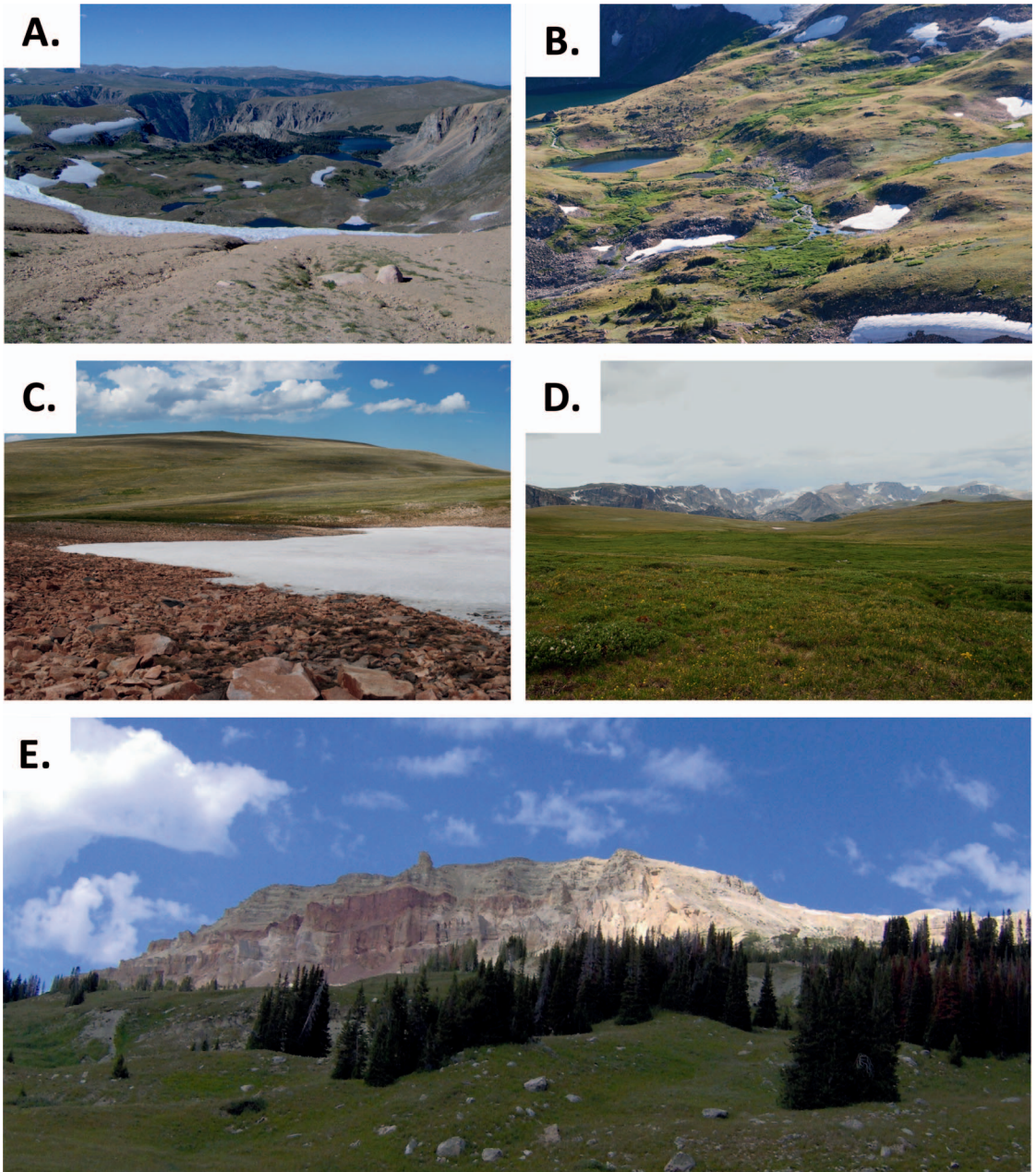


FIG. 3. Beartooth Plateau, Wyoming: typical landscapes. A, B. Glacial landscapes: view of the Plateau from Beartooth Highway (Hwy 212), elev. 2900–3300 m. C. Zone of persistent snowfields at the base of talus slope, elev. 3350 m. Jul. 28, 2010. D. *Geum rossii* (+ *Salix* spp.)-dominated moist alpine tundra, elev. 3300 m. Jul. 28, 2010. E. Limestone cliffs of Beartooth Butte, view from the northern shore of Beartooth Lake, elev. 2750–2900 m. Aug. 23, 2009.

occurring up to the timberline (Fig. 4A). Shady coniferous woods with scattered rock outcrops and decaying fallen trees under their dense canopy are usually crossed by creeks, streams and cataracts fed by snow banks. This habitat type offers a variety of ecotopes to bryophytes and furnishes sufficient moisture for an abundant and taxonomically diverse bryophyte flora (Fig. 4B). Granitic ridges between

subalpine lakes are often occupied by pine forests (Fig. 4C).

Mountain Big Sagebrush (*Artemisia tridentata* Nutt. var. *vaseyana* (Rydb.) B.Boivin) is widespread on the moderately rolling topography and till soils of the glaciated granites from the foothills through the subalpine zone. On the same elevations in mesic conditions of creek valleys, Shrubby Cinquefoil

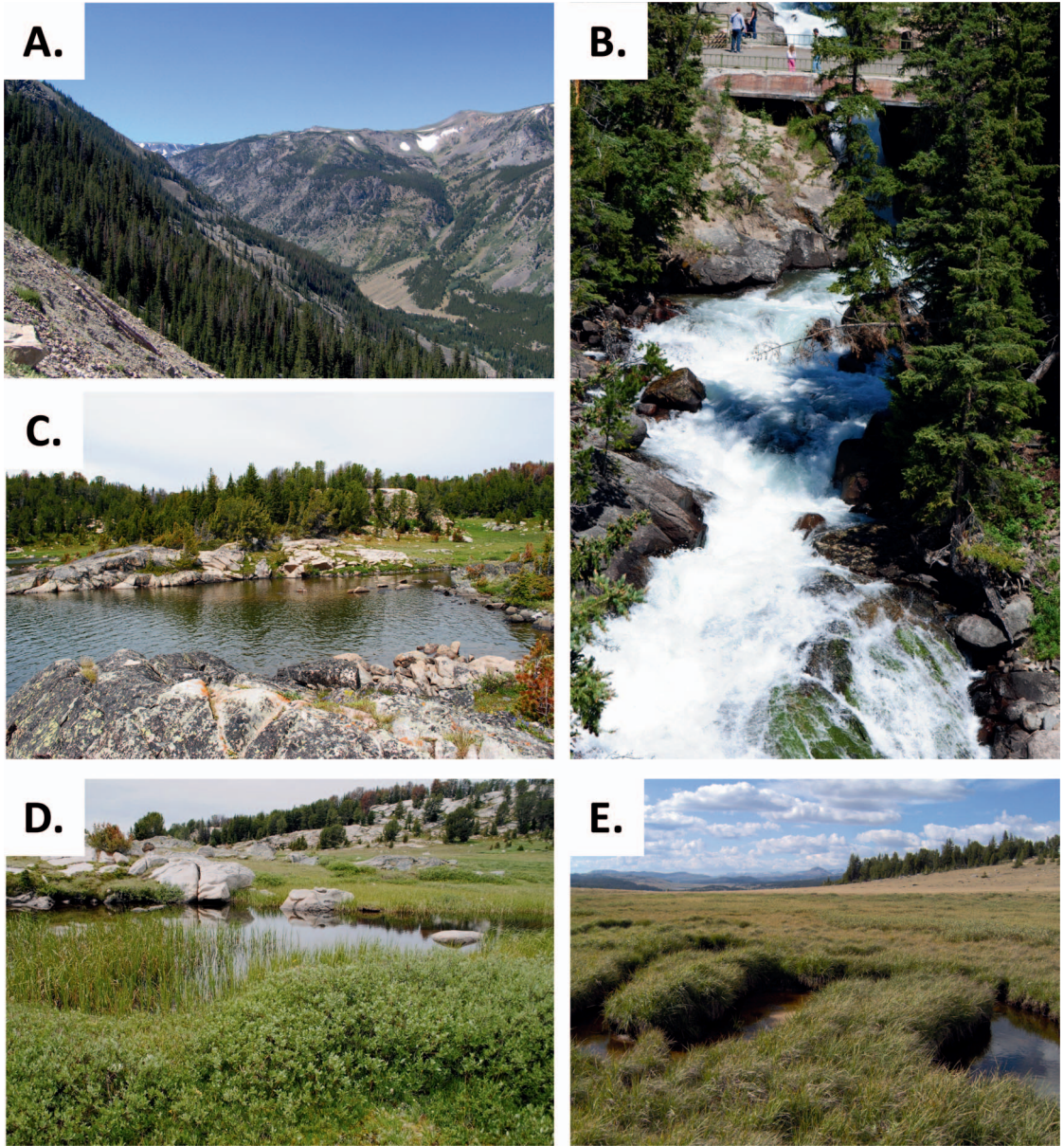


FIG. 4. Major biotic communities supporting bryophytes on the Beartooth Plateau at montane and subalpine elevations. A. Old-growth *Picea engelmannii* (+ *Abies lasiocarpa*) forest descending from subalpine north-western slope to the bottom of deep valley, elev. 2300–2900 m. Aug. 13, 2008. B. Creeks and streams crossing shady coniferous forests are hot spots for bryophyte biodiversity, and some of them can be home for rare species. On photo: spectacular rushing cataracts of Lake Creek on steep southern slope of the Plateau. In difficult to access splash zone on granite debris of the waterfalls *Philonotis yezoana* was discovered, a regionally rare moss of essentially oceanic habitats, elev. 2280 m. Aug. 3, 2010. C. Fantan Lake, east edge. Granitic ridges forested with *Pinus contorta* var. *latifolia*, *P. flexilis* and *Picea engelmannii*, elev. 2900 m. Jul. 26, 2010. D. Minerotrophic *Salix planifolia*/Bryidae fens are major communities supporting bryophytes at montane and subalpine elevations. On photo: boggy valley north-east of Fantan Lake, elev. 2900 m. Jul. 26, 2010. E. Sawtooth Fen on the Wyoming’s Beartooth Plateau is the only palsa-type fen in conterminous United States. On photo: edge of the Fen, elev. 2950 m. Aug. 25, 2009.

(*Pentaphylloides floribunda* (Pursh) Á.Löve) and willows co-dominant.

The Beartooth Plateau has well-pronounced lacustrine features. Lakes with their numerous inlets

and outlets, riparian and peatland systems are very extensive (Figs. 3A–B, 4C–E). Most fens are circum-neutral minerotrophic fens. The majority of Beartooth fen sites formed in basin-filling processes (e.g.,

Rock Creek Fen, Mud Lake Fen, Clay Butte Fen, Ghost Creek Fen, Lake WGN Fen, Little Moose Lake Fen, and Sawtooth Palsa Fen), but there are also fens in a wide variety of sloping settings (e.g., Meadow Lake Fen, Lily Lake Fen, Fantan Fens, Little Bear Lake Fen, and Littlerock Creek Fen). Typically for the Rocky Mountain region, fens are seasonally flushed with abundant snow-melt water. Wyoming fens are often in glaciated mountain landscapes (Knight et al. 2014). One of such fens on the Beartooths is Sawtooth Palsa Fen (Fig. 4E). It has a dome shape, referred to as “palsa”. The fen lies in a broad subalpine basin underlain by deeply weathered Precambrian gneiss rock surrounded by Quarternary glacial deposits with a raised peat deposit and permafrost (Heidel et al. 2008, 2017). This is the only palsa fen, or remnant of true bog formed under past climates, in the contiguous United States (Collins et al. 1984).

Shrub and graminoid vegetation is widely spread in fens at elevations 2000–3300 m. Short-Fruit Willow (*Salix brachycarpa* Nutt.), Diamondleaf Willow, Wolf’s Willow (*S. wolfii* Bebb), and Resin Birch (*Betula glandulosa* Michx.) are usual dominants, and often associated with Northwest Territory Sedge (*Carex utriculata* Boott), Water Sedge (*C. aquatilis* Wahlenb. var. *aquatilis*), and Mountain Sedge. Ground layer dominated by bryophytes is typical for many Beartooth fens. Bryophytes act as foundational species in fens and largely control many ecosystem functions as well as form the majority of organic matter sequestered in many of these systems (Vitt 2014). *Sphagnum*-dominated associations are described in Fantan Fens, Ghost Creek Fen, East Lily Peatland, Little Bear Lake Fen, Littlerock Creek Fen and others. Circumboreal species *Sphagnum warnstorffii* Russow, *Aulacomnium palustre* (Hedw.) Schwägr., *Ptychostomum pseudotriquetrum* (Hedw.) J.R.Spence & H.P.Ramsay ex Holyoak & N.Pedersen, and *Tomentypnum nitens* (Hedw.) Loeske are consistently dominant, especially in aapamires of the subalpine zone, where they occur on the linear mounds. In swales and pools, *Sarmentypnum exannatum* (Schimp.) Hedenäs and *Sphagnum platyphylum* (Lindb. ex Braithw.) Sull. ex Warnst. are widespread. In alpine fens, the role of arctic-alpine taxa increases, e.g., *Oncophorus virens* (Hedw.) Brid., *Polytrichastrum alpinum* (Hedw.) G.L.Sm. var. *septentrionale* (Sw. ex Brid.) G.L.Sm., and *Sarmentypnum sarmentosum* (Wahlenb.) Tuom. & T.J.Kop. The detailed habitat data for each bryophyte taxon can be found in the original report (Kosovich-Anderson 2011a).

RESEARCH HISTORY

There has never been a systematic inventory of the bryophyte flora of the study area to date, but sporadic and short-term collecting was performed by visiting bryologists and local botanists. The oldest traceable specimen from the Wyoming’s Beartooth

Plateau was made in 1939. This collection of the most common moss on the Plateau, arctic-alpine *Tortula hoppeana* (Schultz) Ochyra (originally determined as *Desmatodon latifolius* (Hedw.) Brid. var. *muticus* (Brid.) Brid.) was made by an unknown collector; this specimen is at the University of Washington Herbarium (WTU).

Among the most notable early collectors of bryophytes of the Wyoming’s Beartooth Plateau were Elva Lawton, Winona H. Welch, Eula Whitehouse, Henry S. Conard, Frederick J. Hermann, and William A. Weber.

Elva Lawton visited the Wyoming’s Beartooth Plateau in 1953, at the starting point of her monumental project on mosses of the Pacific Northwest (Lawton 1971). From her trip during August 20–26 she returned with a trophy of interesting findings, like *Amblyodon dealbatus* (Hedw.) P.Beauv., *Pohlia longicolla* (Hedw.) Lindb. (both are regional rarities), *Coscinodon calyptatus* (Drumm.) C.E.O.Jensen, *Meiotrichum lyallii* (Mitt.) G.L.Merr., and *Mnium arizonicum* J.J.Amann (all three are endemics to the North American flora). As her team members, three other professional bryologists collected on the Beartooths: H.S. Conard, W.H. Welch, and E. Whitehouse. Beartooth Butte, Crazy Creek Valley, Beartooth Lake vicinity, and summits east of the Beartooth Lake were most intensively worked by this expedition. Many of their records, however, tended to gravitate towards the area adjacent to the Beartooth Pass (the present Hwy 212). The core of the Beartooth collections of Lawton’s research group is at WTU.

In 1965, Frederick J. Hermann briefly visited the Wyoming’s Beartooth Plateau. Of ten moss specimens, known to be collected by him in this area and kept at WTU, there was the endemic to North America *Homalothecium aeneum* (Mitt.) E.Lawton.

In 1973, William A. Weber, Professor of Botany from the University of Colorado and acute field observer, brought from the alpine zone of the Plateau a herbarium collection with another set of uncommon species: *Brachythecium turgidum* (Hartm.) Kindb., *Didymodon asperifolius* (Mitt.) H.A.Crum, Steere & L.E.Anderson, *Paraleucobryum enerve* (Thed.) Loeske, *Pohlia obtusifolia* (Vill. ex Brid.) L.F.Koch, and others (a total of more than 50 taxa). The duplicates of this extraordinary collection were distributed by W.A. Weber to herbaria of NY, RM, TENN and US, with voucher specimens deposited at COLO. Weber’s specimens were partially annotated by Patricia Eckel in 1980’s–1990’s. Some of the moss collections of 1950’s–1970’s were referenced in Eckel (1996).

There were very few studies of the Hepaticae of Wyoming before the 1960’s. In 1967, Won Shic Hong, the hepaticologist from the College of Great Falls, Great Falls, Montana, made his first of the series of more than 10 collecting trips throughout Wyoming. Major mountains in the northwestern part of the state were of his special attention. Thirteen

species and one variety of liverworts have been reported by Hong from the Wyoming's Beartooth Plateau, based on his collections from two mountain creeks, Lake Creek and Beartooth Creek (Hong 1977).

Among the most informative publications addressed to the bryophytes of the Wyoming's Beartooth Plateau, there was a technical report on the biology of fens in the Beartooth Mtns., by the WYNDD, which summarized the studies on Beartooth fens from 1962, and included the names of common and dominant mosses from 12 representative fens (Heidel et al. 2008). This list cites 36 species, including three liverworts, based on identification by Joe Elliott, Judy Harpel, and the present author.

A study worthy of note was the interdisciplinary work of Booth and Zygmunt (2005) that investigated the biogeography and comparative ecology of testate amoebae inhabiting *Sphagnum*-dominated peatlands in the Great Lakes and Rocky Mountain regions. As a result of this research, several species of *Sphagnum* – *S. angustifolium* (Russow) C.E.O.Jensen, *S. russowii* Warnst., *S. squarrosum* Crome, and *S. warnstorffii* (all determined by Richard Andrus) – have been reported from East Lily Peatland and Little Moose Lake Fen of the Wyoming's Beartooth Plateau.

Over the course of preparation for this project, it was possible to also involve small herbarium resources provided by my colleagues from the University of Wyoming (UW). About 50 of the contributed moss specimens, that had been brought from the Beartooth floristic expeditions in 2000's by B. Heidel (WYNDD), R.L. Hartman (RM), S.T. Jackson's palynology group, and the recent graduates of the UW Botany Department, B. and E. Elliott, have been taken into account in present studies. Recent collections and publications from the year 2000 and onward marked the beginning of the modern history of bryological explorations of the Wyoming's Beartooth Plateau.

METHODS

During four field seasons of July–August of 2008, 2009, 2010, and 2016 approximately 4400 bryophyte specimens (including about 800 specimens of liverworts and many packets containing multiple taxa) were collected, along with a herbarium of dominant, co-dominant, and typical vascular plants and lichens from sites where bryophytes were studied. Initial vascular plant identifications were made using Dorn (2001). The goal of systematic field sampling was to document as fully as possible the bryophyte species composition of the study area, with the emphasis on rare species. The alpine bryophyte flora was of special interest, since it was the most poorly documented in the state and the least studied. My attention has been largely focused on the east flank of the Plateau, the vast area of relatively accessible alpine sites.

Traditional specimen collecting methods were used. The coordinates and elevation were determined using a hand-held Global Positioning System (Garmin GPS set to UTM NAD 83). UTMs were also estimated by plotting the location using USGS topographic and aerial maps. Collection data recorded on herbarium specimens include legal location (township, range, and section), elevation, substrate, and habitat. Coordinates were recorded in 644 different locales; 149 sites were explored. Transportation on USFS roads during collecting trips was provided on personal RV vehicles and an ATV/four-wheeler (Fig. 5A). The length of hiking routes stretched to about 140 km. Initial specimen processing work was carried out in the improvised conditions of two USFS campgrounds, Island Lake Campground and Beartooth Lake Campground (Fig. 5B). Bryophyte collecting was authorized by the USFS.

All representative samples of habitat types have been attempted during collecting. However, certain parts of the Wyoming's Beartooth Plateau remain unvisited.

“Anyone acquainted with the topography of the Rocky Mountains must appreciate the fact that, given the terrain, the short seasons and the capricious weather phenomena, complete coverage of the major area is impossible in the short run.” – Hermann (1987, p. 220).

Paucity or absence of collections from some areas of the Beartooth Plateau also reflects the intense seasonal activity of Grizzly (*Ursus arctos* L. subsp. *horribilis* Ord) and Black Bear (*Ursus americanus* Pal.) (Fig. 5C). The occurrence of large populations of both species is well reflected in the toponymy of the study area: Beartooth Plateau.

Information on all earlier bryophyte collections from the Wyoming's Beartooth Plateau was obtained prior to fieldwork. Many of the previously collected materials were reviewed by the author, particularly, the available portion of W.A. Weber's bryophyte collections, materials of S.T. Jackson's palynology group, and collections made by the WYNDD, RM, and USFS staff members in the 2000's, within the framework of the inventory project on the Beartooth Mtns. fens (Heidel et al. 2008, 2017). Individual specimens of different collectors from COLO were borrowed and have been examined.

Herbarium searches were conducted online for WTU. Collection records for bryophytes found in Wyoming and deposited in herbaria by searching the Consortium of Pacific Northwest Herbaria (CPNWH 2021) and the Consortium for North American Bryophyte Herbaria (CNABH 2021) databased by January 2021, were also examined.

Identification of specimens has been accomplished using various moss and liverwort floras from North America and beyond (Savich-Lyubitskaya and Smirnova 1970; Lawton 1971; Flowers 1973; Crum and Anderson 1981; Nyholm 1986+; Damsholt 2002; Weber and Wittmann 2007, Flora of North America



FIG. 5. Working routine on an expedition to the Beartooths. A. Means of transportation and part of field equipment for bryophyte collecting in the bear country (including a rifle). B. Recently collected specimens hanging to dry at Beartooth Lake Campground. The same station used by Elva Lawton's research team in 1953. C. Grizzly bears habitually visiting Beartooth Lake Campground. Aug. 20, 2009. Photo by the author.

Editorial Committee 2007, 2014, *in prep.*, provisional publication, and others). Morphological techniques have been largely applied, along with chemical tests (KOH) on selective Pottiaceae specimens and methylene blue (1% aqueous) solution dyeing on *Sphag-*

num species identification. Three reference herbarium collections have been used: Grimmiaceae of Wyoming, RM (annotated by J. Muñoz), mosses of California, CAS (annotated by different authorities, provided by J.R. Shevock on specimen exchange program), and rare bryophyte taxa of Colorado, COLO (annotated by different authorities, provided by W.A. Weber). About 60% of previous identifications of the material cited in the present catalogue have been critically reviewed by the author in 2018–2020. Problematic collections were sent to taxonomy experts for verification or identification.

Voucher specimens are located in Kosovich-Anderson's personal herbarium in Cheyenne, WY, and UW Rocky Mountain Herbarium in Laramie, WY (RM). Duplicates of selective systematic groups were freely distributed to major herbaria for further phylogeographic, systematic, and genetic studies: Northern Arizona University, Flagstaff, AZ (ASC), State University of New York, Binghamton, NY (BING), California Academy of Sciences, San Francisco, CA (CAS), University of Colorado Museum, Boulder, CO (COLO), Duke University, Durham, NC (DUKE), Missouri Botanical Garden, Saint Louis, MO (MO), University of Montana, Missoula, MT (MONTU), University of California, Berkeley, CA (UC), United States National Herbarium of Smithsonian Institution, Washington D.C. (US), University of British Columbia, Vancouver, Canada (UBC), Main Botanical Garden, Russian Academy of Sciences, Moscow, Russia (MHA), Botanical Garden-Institute, Vladivostok, Russia (VBGI), University of Helsinki, Helsinki, Finland (H), Swedish Museum of Natural History, Stockholm, Sweden (S), and University of Bonn, Bonn, Germany (BONN). The shipping of specimens abroad was partially organized through the Missouri Botanical Garden and the University of Colorado.

RESULTS AND DISCUSSION

Wyoming's national forests lying in the high country of the Rocky Mountains harbor some of the greatest topographic variations, wettest climates and geological complexity of federal lands in the state, and therefore favor bryophyte diversity. The Beartooth Plateau in the SNF has one of the richest recorded bryophyte floras of Wyoming, even though large areas of the Plateau still remain under-surveyed. The uniqueness of the studied bryoflora is maintained by the high diversity of habitats, from arid granitic, limestone, sandstone, etc. outcrops and slopes to hydrophytic sites. This variation is caused by the ancient geological history of the country, climatic and hydrological features, the broad spectrum of vegetation communities, varied topography, the range of elevations (comprising of foothills, montane, subalpine, and alpine life zones), and generally low anthropogenic disturbance.

As a result of the analysis of the author's herbarium, along with materials of preceding re-

searchers, 282 species, four subspecies, and 22 varieties (totaling 308 bryophyte taxa) were registered in the bryoflora of the Wyoming's Beartooth Plateau. The information on the bryoflora is summarized in the catalogue and three appendices: Appendix 1 represents taxonomic diversity of bryophytes, Appendix 2 provides the list of excluded taxa, and Appendix 3 arranges the most frequent bryophytes by habitats.

Bryophytes belong to 131 genera and 53 families of two phyla: Hepaticae/Marchantiophyta, or hepatics/liverworts – 45 species, three subspecies, and four varieties from 29 genera and 20 families, and Musci/Bryophyta, or mosses – 237 species, one subspecies, and 18 varieties from 102 genera and 33 families. The most frequently collected family is Amblystegiaceae with 26 species, followed by Pottiaceae (23 species), Grimmiaceae (22 species), Brachytheciaceae and Dicranaceae (with 19 species in each), Bryaceae (17 species), Scapaniaceae (13 species), Mniaceae (12 species), Mielichhoferiaceae (11 species), and Sphagnaceae (10 species). The most richly collected genus is *Grimmia* Hedw. (12 species); species of *Grimmia* are mostly distributed in cold and mountain regions of the world, where rocky substrates are widespread. *Brachythecium* Schimp. and *Pohlia* Hedw. include 11 species each, *Sphagnum* L. (10 species), *Ptychostomum* Hornsch. (nine species), *Hygrohypnum* Lindb., *Scapania* (Dumort.) Dumort., *Schistidium* Bruch & Schimp., and *Syntrichia* Brid. (seven species each), and *Dicranum* Hedw., and *Mnium* Hedw. (six species each) (Appendix 1). The leading families and genera of the studied bryoflora form an important part of the vegetation in arctic, boreal, and high altitude floras around the Northern Hemisphere.

Ten taxa in the studied flora are endemics to North America. Seventy-one species, two subspecies and 10 varieties (15 species, two subspecies and two varieties of liverworts, and 56 species and eight varieties of mosses) have not previously been reported for Wyoming in *Flora of North America North of Mexico* (2007, 2014, *in prep.*, provisional publication) and by Stotler and Crandall-Stotler (2017). Three species – *Sphagnum miyabeianum* Warnst., *Syntrichia calcicola* J.J.Amann, and *S. virescens* (DeNot.) Ochyra – have not been included in *Flora of North America North of Mexico* (2007). The compiled list represents approximately 53% of the currently known bryophyte flora in Wyoming (Kosovich-Anderson unpublished data.). In total, 39 taxa (five liverwort species and 32 species and two varieties of mosses) listed in the catalogue are of potential conservation concern in Wyoming (Kosovich-Anderson 2011a).

The Plateau is the largest continuous area above 3000 m, and one of the largest alpine tundra regions in North America. The typical Central Rocky Mountains boreal-montane bryoflora is represented here by a large proportion of arctic-alpine, essentially arctic or alpine taxa. According to Marr et al. (2012),

the Beartooth Plateau is an alpine periplain that hosts a number of arctic-alpine plant species that are disjunct between British Columbia and Colorado. In the bryophyte flora, these are: *Anthelia juratzkana* (Limpr.) Trevis., *Bartramia ithyphylla* Brid., *Brachythecium cirrosum* (Schwägr.) Schimp., *Campylopus schimperi* Milde, *Cephaloziella varians* (Gottsche) Steph., *Clevea hyalina* (Sommerf.) Lindb., and many others, totaling 69 species, one subspecies, and five varieties, or approximately 25% of the studied bryophyte flora. Interestingly, a highly specialized habitat for the Beartooth Plateau arctic-alpine bryophytes is provided by the fine-grained calcareous silt which is extruded in the form of “frost boils”, a topic to be developed in our upcoming papers (Kosovich-Anderson unpublished data).

In the catalogue there are also reported remarkable extensions of upper elevation limits in North America for 72 bryophyte taxa from the study area – 10 species of liverworts, as well as 60 species and two varieties of mosses. The new information essentially updates altitudinal ranges of the taxa, provided in *Flora of North America North of Mexico* (2007, 2014, *in prep.*, provisional publication).

Significant extensions of geographical distribution for many little-known or otherwise noteworthy species of bryophytes have been registered. Of these, 20 taxa – four liverworts, *Jungermannia borealis* Damsh. & Vána, *Saccobasis polita* (Nees) H.Buch, *Scapania hyperborea* Jørg., *S. scandica* (Arnell & H.Buch) Macvicar, and 16 mosses, *Brachythecium brandegeei* (Austin) H.Rob., *B. erythrorrhizon* Schimp. var. *alpinum* Kosovich-Anderson & Ignatov, *B. udum* I.Hagen, *Campylopus schimperi*, *Didymodon asperifolius*, *Kiaeria blyttii* (Bruch & Schimp.) Broth., *K. starkei* (F.Weber & D.Mohr) I.Hagen, *Plagiobryum zierii* (Dicks. ex Hedw.) Lindb., *Pohlia ludwigii* (Spreng. ex Schwägr.) Broth., *Pseudocalliergon angustifolium* Hedenäs, *P. turgescens* (T.Jensen) Loeske, *Rhizomnium andrewsianum* (Steere) T.J.Kop., *Sanionia nivalis* Hedenäs, *Sciuro-hypnum glaciale* (Schimp.) Ignatov & Huttunen, *Stegonia latifolia* (Schwägr.) Venturi ex Broth. var. *pilifera* (Brid.) Broth., and *Tayloria lingulata* (Dicks.) Lindb. – are restricted to the most northern and/or alpine habitats and reported from the upper elevations of Wyoming's Beartooth Plateau, are rare or rarely collected in the conterminous United States. The rare arctic-alpine species *Sciuro-hypnum glaciale* is a novelty for continental North America, with the nearest known localities being in Greenland. Its occurrence on the Wyoming's Beartooth Plateau extends the known range by no less than 4400 km, representing an extraordinary arctic-alpine disjunction in the Rocky Mountains (Kosovich-Anderson and Ignatov 2010). The other rare disjunct in Wyoming, *Plagiobryum zierii*, is probably relictual in the Rocky Mountains south of the glacial maximum. Presumably, the species reached its current distribution during the Pleistocene; populations south of the glacial ice sheets in the

Rockies survived in refugia such as Colorado and expanded north during the Holocene (Kosovich-Anderson and Weber 2011).

Two species of oceanic element, *Philonotis yezoana* Besch. & Cardot and *Sphagnum miyabeianum* Warnst., are worthy of special mention. The Bear-tooths' occurrences of mosses with oceanic affinities are unusual in being so far inland and quite a distance east of the Continental Divide. These species were discovered approximately 1100–1150 km away from the nearest coast, in the interior mountains of the state, far east of their known major range in the Pacific West. This phenomenon, attributable to westerly winds that carry an oceanic climatic influence well inland to the northern Rocky Mountains, has been observed in both vascular plants and bryophytes (Schofield 1965; Ahti and Fagersten 1967). A huge and almost level area of the northwest-trending Plateau formation facilitates this floristic intrusion.

The materials of the present study were partially published (Kosovich-Anderson and Ignatov 2010, Kosovich-Anderson and Weber 2011, Kosovich-Anderson 2011b, c, 2015, 2019). In two projects, the author's specimens (*Sphagnum* and *Dicranum*) were involved in phylogenetic analyses (Shaw et al. 2014, 2015, Ignatova et al. 2015). Partially, the materials were used for the preparation of the recently published volume 28 of *Flora of North America North of Mexico* (Flora of North America Editorial Committee 2014). On the FNA distribution maps, seven taxa were indicated in Wyoming for the first time, based exclusively on the author's materials from the Wyoming's Beartooth Plateau. These are *Brachythecium brandegeei*, *Brachythecium erythrorrhizon* var. *alpinum*, *Hygrohypnum styriacum* (Limpr.) Broth., *Imbricium muehlenbeckii* (Bruch & Schimp.) N.Pedersen, *Plagiobryum zieri*, *Sciurohypnum glaciale*, and *Thuidium recognitum* (Hedw.) Lindb. So far, one new taxon – *Brachythecium erythrorrhizon* var. *alpinum* – was described (Kosovich-Anderson and Ignatov 2010).

Results from this work are proposed for use throughout the Rocky Mountains, as the first bryophyte flora of a national forest in the USFS Rocky Mountain Region (R2), to update a checklist of mosses and liverworts for the state of Wyoming, develop a prototype for the Wyoming bryophyte species of concern list, and inform prospective management designations for refugial habitats.

Catalogue of Bryophyte Flora

The catalogue is composed on the basis of approximately 4600 collections. Of these, 4400 were made by the author and approximately 200 by preceding researchers (H.S. Conard, B. and E. Elliott, S. Eversman, T.C. Frye, B. Heidel, R.L. Hartman, F.J. Hermann, E. Lawton, W.A. Weber, W. Welch, and E. Whitehouse). Additionally, the

information from published works has been used: Hong (1977), Booth and Zygmunt (2005), and Heidel et al. (2008, 2017). Some of the author's findings from the Beartooth Plateau have been published earlier (see above). The entire catalogue is represented for the first time in this publication.

In the catalogue, bryophyte species are arranged alphabetically within two principal bryophyte subdivisions – Hepaticae/Marchantiophyta and Musci/Bryophyta. Specific Latin name and the synonym (for some taxa) is followed by the date of first record for the study area, distribution (rare – taxon was encountered in 1–2 sites, sporadic – in 3–5 sites, frequent – in 6–10 sites, common – in >10 sites), and habitat preferences. The sites where the taxon occurs are arranged within five study quadrangles (in bold), with collection year, altitudinal data (“!” means updated upper altitudinal limit for North America), the representative specimen number and specimen location (if specimens are located in herbaria outside Wyoming) and “S+” means presence of sporophytes/capsules. For interesting taxa with limited distribution in the study area, more detailed labels are provided, with names of plant communities (the online Tropicos database [Tropicos 2021] was consulted to help clarify valid taxa for vascular plants). Herbarium citations are generally standard. Collection numbers are those of the author, except where otherwise stated. In old labels, “Road from Bear Tooth to Red Lodge”, “Rte 212”, “Cooke City to Red Lodge Highway”, or “Road to Red Lodge” mean Highway 212 and referred in text as [Hwy 212]; similarly, old name “Cody Road” is referred as [Hwy 296]. Also, an out-of-date spelling “Bear Tooth” has been corrected for “Beartooth”. Collections of S.T. Jackson's palynologists group are referred as to “*Jackson s.n.*”. Additional information, such as morphological features, geographic distributions, and altitudinal updates, are discussed in the Notes section of many taxa. Abbreviation “FNA” is used for *Flora of North America North of Mexico*.

The nomenclature and classification generally follow that of *Flora of North America North of Mexico* (2007, 2014, *in prep.*, provisional publication) and Synopsis of Liverwort Flora of North America North of Mexico (Stotler and Crandall-Stotler 2017). The asterisk “*” prior to Latin names of bryophytes means the taxon has not been reported for Wyoming in the above mentioned publications. The double asterisk “**” means the taxon is of potential conservation concern in Wyoming (Kosovich-Anderson unpublished data.). Endemics to the North American flora are marked with “E”. NatureServe (2021) was consulted to help clarify formal rarity assessment for some species.

Some taxa were left unlisted: revision of forms of *Philonotis fontana* (Hedw.) Brid. s.l., *Sarmentypnum exannulatum*, the subgenera *Acutifolia* (Russow) A.J.Shaw and *Subsecunda* (Lindb.) A.J.Shaw of the genus *Sphagnum*, and the *ruralis* group of the genus *Syntrichia* Brid., that occur in this part of the Rocky

Mountains, is necessary. Poorly-studied liverwort taxa (e.g., Gymnomitriaceae spp.) were also left beyond the scope of the catalogue. Species which can be identified only if gametangia or sporophytes are present (e.g., Pelliaceae spp., Orthotrichaceae spp., and Bryaceae spp.) also tend to be under-recorded. In terms of the genus *Philonotis* Brid., I maintain *P. caespitosa* Jur., the specific status of which have been confirmed by the molecular phylogenetic studies by Koponen et al. (2012). In treatment of the genus *Syntrichia*, I follow Gallego et al. (2006) and Kellman (2009).

The catalogue has been revised to exclude collections not actually made from the Beartooth Plateau (e.g., many records from the Clarks Fork of Yellowstone River, which are technically from the North Absaroka area).

HEPATICAE

Anthelia juratzkana (Limpr.) Trevis.

First record: 1973. Sporadic; in late snow-melt zone, forms mats and crusts on rocks and moist peaty soil along lakes and streams; arctic-alpine.

Beartooth Butte: boggy shore of Island Lake, 2008, 9500 ft, 2365. **Deep Lake:** [Hwy 212], W side, on steep slope N of switchback, 1973, 3200 m.s.m., *Weber B-44321* (COLO, RM); inlet of Frozen Lake, 2008, 10,500 ft, 2556; unnamed alpine lake S of Hwy 212, 2008, 10,000 ft, 2668 (MO, VBGI), det. V. Bakalin.

* ***Apollia alpicola*** (R.M.Schust. ex L.Söderstr., A.Hagborg & von Konrat) Nebel & D.Quandt

First record: 2009. Rare, single collection from subalpine zone; arctic-alpine.

Deep Lake: 4WD Rd 149, Sawtooth Lake, boggy shore, on wet soil in shaded niche between rocks, 2009, 9200–9250 ft, 6039 (MO, VBGI), initial det. V. Bakalin as *Pellia endiviifolia* (Dicks.) Dumort.

Note: A taxon with poorly known distribution in North America. "This species is verified only from arctic-alpine areas of northwest Canada, including the Northwest Territories, the Yukon, British Columbia, and Alberta. It is often reported as *Pellia endiviifolia*..." (Stotler and Crandall-Stotler 2017, p. 584).

Barbilophozia barbata (Schmidel ex Schreb.) Loeske
First record: 2010. Sporadic; on boulders and logs, or among other mosses on duff in coniferous forests, fens, and wet grasslands, from foothills through the alpine.

Jim Smith Peak: Crazy Creek-2, 2010, 6900 ft, 7966.

Beartooth Butte: 4WD Rd 149: NE slope, subalpine meadow, 2010, 9650 ft, 7050. **Deep Lake:** summits: Gravel Pit vicinity, alpine fen, 2010, ! 10,300–10,400 ft (3140–3170 m), 7293.

Note: Altitudinal update – 3170 m vs. "0–1000 m" (FNA *in prep.*, provisional publication).

Barbilophozia hatcheri (A.Evans) Loeske

First record: 2008. Common; on soil in tundra and subalpine and alpine fens, willow wetlands, on humus, logs and rocks, often in deep shade, in old-growth montane and subalpine fir-spruce forests, in streamsides, from foothills through the alpine; essentially arctic-alpine, subarctic-subalpine to boreal montane. Gemmae common.

Jim Smith Peak: Ivy Lake, SE edge, 2010, 8000 ft, 7553 (MO, VBGI), det. V. Bakalin, gemm.; Crazy Creek-2, 2010, 6900 ft, 7945, gemm. **Muddy Creek:** Lake Creek-1, 2010, 7650–7700 ft, 7157, gemm.

Beartooth Butte: boggy shore of Island Lake, 2008, 9500 ft, 2373; Beauty Lake Trail, 2009, 8900 ft, 5221, gemm.; Beartooth Lake CG: coniferous forest, 8900 ft, 2009, 6213. **Deep Lake:** sky-lift scenic point, alpine tundra, 2008, ! 10,850–10,900 ft (3300–3320 m), 2356, gemm.; summits: alpine tundra-3, 2008, 10,350 ft, 2412; inlet of Frozen Lake, 2008, 10,500 ft, 2545; summits: alpine fen-1, 2008, 10,500 ft, 3269; Wyoming Creek-1, 2008, 10,300 ft, 3479, gemm.; head of unnamed creek-1, 2010, 10,250 ft, 6747 (MO, VBGI), det. V. Bakalin, gemm.; Long Lake, NW slope, willow wetlands, 2010, 9750 ft, 8294, gemm.

Note: Altitudinal update – 3320 m vs. "300–3000 m" (FNA *in prep.*, provisional publication).

Barbilophozia lycopodioides (Wallr.) Loeske

First record: 2008. Frequent; mainly on forest floor and rock ledges in mature undisturbed moist coniferous forests, from montane through subalpine elevations; arctic-alpine or high subarctic-subalpine.

Jim Smith Peak: Ivy Lake, SE edge, 2010, 8000–8100 ft, 7539 (US), det. R. Ireland. **Muddy Creek:** Lake Creek-1, 2010, 7700 ft, 7143. **Beartooth Butte:** boggy shore of Island Lake, 2008, 9500 ft, 2378; Beauty Lake Trail, 2009, 8950 ft, 5210 (CAS, COLO, MO, VBGI), ver. V. Bakalin; Beartooth Lake CG: spruce forest, 2009, 8950 ft, 6219. **Deep Lake:** Top Lake Fen-1, 2009, ! 9450 ft (2880 m), 5781 (MO, VBGI), det. V. Bakalin, gemm.

Note: In my experience, this is the largest leafy liverwort on the Beartooth Plateau; well-developed plants being 4–5 mm wide and 5–8 cm long. Altitudinal update – 2880 m vs. "0–1500 m" (FNA *in prep.*, provisional publication).

Blepharostoma trichophyllum (L.) Dumort.

First record: 1977. Common; on shaded rocks, peaty banks, on thin soil over ledges and decaying wood in forests, in filtered light, from montane through the alpine.

Muddy Creek: Lake Creek (Hong 1977); Lily Lake Swamp Forest, 2008, 7700 ft, 3039; Ghost Creek Fen, 2008, 7900 ft, 3753. **Beartooth Butte:** Little Bear Creek-1, 2008, 9700 ft, 2694 (MO, VBGI), det. V. Bakalin; pine forest along Hwy 212, 2008, 8950 ft, 3916; Beauty Lake Trail, 2009, 8900 ft, 5211; Long Lake: E shore, 2010, 9600 ft, 6813; Fantan Lake: E shore, 2010, 9500 ft, 6879; Chain Lake: S shore, 2010, 9500 ft, 6998 (MO, VBGI), ver. V. Bakalin; Long Lake: S edge, 2010, 9650 ft, 8307 (MO, VBGI), det. V. Bakalin. **Deep Lake:** unnamed alpine lake S of

Hwy 212, 2008, 10,000 ft, 2666; summits: alpine fen-4, 2008, 10,400 ft, 3310; Sawtooth Lake, 2009, 9300 ft, 5982; Gravel Pit vicinity, alpine tundra, 2010, 10,350 ft, 7292; Top Lake Fen-2, 2010, 9450 ft, 7741 (MO, VBG1), ver. V. Bakalin. **Black Pyramid Mountain:** WY-MT state line: unnamed lake, 2010, 9800 ft, 8092 (MO, VBG1), ver. V. Bakalin.

* ** **Calypogeia neogaea** (R.M.Schust.) Bakalin
First record: 2008. Sporadic; on boggy and loamy soil near subalpine and alpine lakes and streams.

Beartooth Butte: Little Bear Creek-1, 2008, 9700 ft, 2684; boggy valley near small subalpine lake, 2010, 9500 ft, 6853 (MO, VBG1), det. V. Bakalin. **Deep Lake:** alpine lake along Hwy 212, boggy shore, 2008, 10,000 ft, 2672 (MO, VBG1), det. V. Bakalin.

Note: A rare disjunct in Wyoming (Kosovich-Anderson unpublished data). "This species is from California, and in eastern North America from Texas, Arkansas, and southern Illinois to Florida and north to New York and New England" (Stotler and Crandall-Stotler 2017, p. 591).

Cephalozia bicuspidata (L.) Dumort.

First record: 2008. Frequent; on shaded rocks of creek banks, rotten logs in old-growth coniferous forests, on rich soil under tall herbs, on wet peaty soil along trails in alpine wetlands and fens.

Beartooth Butte: Little Bear Lake Fen, 2008, 9600 ft, 2838 (MO, VBG1), det. V. Bakalin; Beartooth Lake: W-SW shore, 2010, 8850 ft, 6625; Long Lake: E shore, 2010, 9600 ft, 6782 (MO, VBG1), det. V. Bakalin. **Deep Lake:** unnamed lake S of Hwy 212, 2008, 10,000 ft, 2662; summits: small alpine lake, 2008, 10,500 ft, 3506; Canyon Creek, 2009, 9400 ft, 5655 (MO, VBG1), det. V. Bakalin; creek connecting Dollar and Sawtooth Lakes, 2009, 9400 ft, 5790 (MO, VBG1), det. V. Bakalin; head of unnamed creek-1, 2010, 10,250 ft, 6756 (MO, VBG1), det. V. Bakalin; tributary of Canyon Creek-2, 2010, 9400 ft, 7780 (MO, VBG1), det. V. Bakalin; head of unnamed creek-2, 2010, 10,300 ft, 8229.

Cephaloziella divaricata (Sm.) Schiffn.

First record: 2008. Common; on different kinds of soil, often between rocks, in alpine tundra and fens, subalpine forests and meadows, also in relatively xeric areas in montane zone.

Muddy Creek: Lake Creek CG: wet coniferous forest, 2009, 6950 ft, 5911 (MO, VBG1), det. V. Bakalin. **Beartooth Butte:** boggy shore of Island Lake, 2008, 9500 ft, 2358; Little Bear Lake Fen, 2008, 9600 ft, 2768; 4WD Rd 149: NE slope, subalpine meadow, 2010, 8200 ft, 7052. **Deep Lake:** summits: alpine tundra-3, 2008, 10,350 ft, 2408; unnamed alpine lake S of Hwy 212, 2008, 10,000 ft, 2665; summits: alpine fen-5, 2008, 10,750 ft, 3450; summits: small alpine lake, 2008, 10,500 ft, 3519; Littlerock Creek Fen, 2008, 10,650 ft, 3673; Canyon Creek valley: subalpine meadow, 2010, 9450 ft, 7768 (MO, VBG1), det. V. Bakalin. **Black Pyramid Mountain:** summits: alpine tundra-4, 2008, 10,300 ft, 2459.

Cephaloziella varians (Gottsche) Steph.

[*Cephaloziella arctica* Bryhn & Douin ex Müll.Frib.]
First record: 2008. Sporadic; on damp and peaty soil in fens and along creeks, in rock crevices on ledges, from montane through alpine elevations; arctic-alpine.

Jim Smith Peak: Crazy Creek-2, 2010, 6900 ft, 7980 (MO, VBG1), det. V. Bakalin. **Deep Lake:** inlet of Frozen Lake, 2008, 10,500 ft, 2551; summits: alpine fen-5, 2008, 10,750 ft, 3461; Littlerock Creek Fen, 2008, 10,650 ft, 3636.

Chiloscyphus pallescens (Ehrh. ex Hoffm.) Dumort.
First record: 2008. Frequent; on wet rocks along streams and streamlets in forested areas, from montane through the subalpine.

Jim Smith Peak: Crazy Creek CG Swamp, 2008, 6950 ft, 3189. **Muddy Creek:** Lily Lake Fen, 2008, 7700 ft, 3062; Ghost Creek Fen, 2008, 7900 ft, 3745; tributary of Beartooth Creek-1, 2010, 8400 ft, 7107. **Beartooth Butte:** pine forest along Hwy 212, 2008, 8950 ft, 3909; Beartooth Falls, 2009, 8900 ft, 5452.

Chiloscyphus polyanthos (L.) Corda

- var. **polyanthos**

First record: 1977. Sporadic; in forested areas on rocks close to springs and in streams, just above water and fully submerged, from montane through the subalpine.

Muddy Creek: Lake Creek (Hong 1977); Lily Lake Fen, 2008, 7700 ft, 3081; Ghost Creek Fen, 2008, 7900 ft, 3747 (MO, VBG1), det. V. Bakalin. **Beartooth Butte:** Beartooth Creek (Hong 1977); Fantan Lake: N shore, 2010, 9500 ft, 7015.

* - var. **rivularis** (Schrad.) Nees

First record: 2010. Rare, single collection from montane zone.

Muddy Creek: Muddy Creek-2, coniferous forest, on rocks fully submerged in running water of creek, 2010, 7700 ft, 7245 (MO, VBG1), det. V. Bakalin.

* **Clevea hyalina** (Sommerf.) Lindb.

[*Athalamia hyalina* (Sommerf.) S.Hatt.]

First record: 2010. Rare, single collection from subalpine zone; arctic-alpine.

Beartooth Butte: Beartooth Lake CG, *Picea engelmannii* forest, seasonally dry stream, on wet loamy soil on the base of spruce, assoc.: *Pohlia cruda* (Hedw.) Lindb., 2010, 8950-9000 ft, 8026, with multiple carpocephala.

Conocephalum salebrosum Szwedk., Buczk. & Odrzyk.

First record: 2009. Frequent; on clay or rocks along creeks in forests, in small streams, waterfalls, on soil in willow thickets in flood valleys, from foothills through the subalpine.

Muddy Creek: Lake Creek CG: wet coniferous forest, 2009, 6950 ft, 5900 (MO, VBG1), ver. V. Bakalin; Beartooth Creek-3, 2010, 7550 ft, 7421; Gilbert Creek-2, 2010, 6900 ft, 8007. **Beartooth Butte:** Beauty Lake Trail, 2009, 8900 ft, 5251; Beartooth Falls,

2009, 8900 ft, 5466; Beartooth Lake: W-SW shore, 2010, 8900 ft, 6628.

Note: A recently described species related to the widespread *Conocephalum conicum* (L.) Dumort., distinguished on a genetic and morphologic basis (Szwejkowski et al. 2005). *Conocephalum conicum* is predominantly a boreal-temperate European-Siberian species collected more often below 600 m and not found above 1080 m, whereas *C. salebrosum* can be characterized as an arctic-boreal circumpolar species known from higher elevations (Borovichev et al. 2009). Sporadically distributed in Wyoming at foothills through subalpine elevations (Kosovich-Anderson unpublished data). Formerly, the species was reported for the state as *C. conicum* (Porter 1933; Hong 1977).

Fuscocephaloziopsis lunulifolia (Dumort.) Váňa & L.Söderstr.

[*Cephalozia lunulifolia* (Dumort.) Dumort.]

First record: 1977. Rare, two collections of Hong from montane zone.

Muddy Creek: Lake Creek, Hong 31189, 31192 (Hong 1977).

Note: Altitudinal update – approx. 2100–2300 m on the Beartooth Plateau vs. “low to moderate [0–1599 m]” elevation (FNA *in prep.*, provisional publication).

Fuscocephaloziopsis pleniceps (Austin) Váňa & L.Söderstr.

[*Cephalozia pleniceps* (Austin) Lindb.]

First record: 1973. Common; in coniferous forests, on bare soil and peat, on slightly acidic substrates – along trails, banks of streams, on lake shores among rocks, on sides of tussocks, from montane through the alpine.

Jim Smith Peak: Rock Creek Fen (Heidel et al. 2008); Rock Creek, 2016, 7700 ft, 21015. **Muddy Creek:** Lake Creek (Hong 1977); Lily Lake Swamp Forest, 2008, 7700 ft, 3038; Ghost Creek Fen, 2008, 7900 ft, 3745. **Beartooth Butte:** Little Bear Lake Fen, 2008, 9600 ft, 2764; Beartooth Lake CG: wet subalpine meadow, 2009, 8950 ft, 4904; Beauty Lake Trail, 2009, 8800 ft, 5305; Beartooth Lake, W-SW shore, 2010, 8850 ft, 6625 (MO, VBG1), det. V. Bakalin; Long Lake: E shore, 2010, 9600 ft, 6781; boggy valley NE of Fantan Lake, 2010, 9500 ft, 6834; Chain Lake: S shore, 2010, 9500 ft, 7002. **Deep Lake:** [Hwy 212], W side, steep slope N of switchback, 1973, 3200 m.s.m., *Weber B-44322* (COLO, RM); inlet of Frozen Lake, 2008, 10,500 ft, 2576; Littlerock Creek Fen, 2008, 10,650 ft, 3588; head of unnamed creek-1, 2010, 10,250 ft, 6754; Lower Top Lake Fen, 2010, 9450 ft, 7687; Top Lake Fen-2, 2010, 9450 ft, 7737 (MO, VBG1), det. V. Bakalin.

Gymnocolea inflata (Huds.) Dumort.

First record: 1973. Frequent; wet cliffs on lake shores, a co-dominant species in subalpine fens and meadows, in shallows or around the edges of rock

pools, on igneous rocks in seepage areas, on rills and snowbeds, from montane through the alpine.

Jim Smith Peak: Rock Creek Fen (Heidel et al. 2008). **Muddy Creek:** tributary of Beartooth Creek-1, 2010, 8400 ft, 7106. **Beartooth Butte:** boggy shore of Island Lake, 2008, 9500 ft, 2373 (MO, VBG1), det. V. Bakalin; Little Bear Lake Fen, NW portion, 2008, 9600 ft, 2744; Beartooth Lake CG: wet subalpine meadow, 2009, 8950 ft, 4904. **Deep Lake:** W side of Beartooth Pass, under late snow patch, 1973, 3200 m.s.m., *Weber B-44308* (NY).

* **Harpanthus flotovianus** (Nees) Nees

First record: 2009. Sporadic; on boggy and gravelly soil and wet non-calcareous rocks along stream banks and lakeshores, at subalpine elevations.

Beartooth Butte: boggy valley: small subalpine lake, 2010, 9500 ft, 6904 (MO, VBG1), det. V. Bakalin; Fantan Lake: N shore, 2010, 9500 ft, 7032. **Deep Lake:** Sawtooth Lake, 2009, 9200 ft, 6007; creek connecting Lower Top and Sawtooth Lakes, 2010, 9450 ft, 7640 (MO, VBG1), det. V. Bakalin.

* ** **Jungermannia borealis** Damsh. & Váňa

First record: 2008. Sporadic; on damp soil and sheltered rocks, on lake banks, at upper subalpine and alpine elevations; arctic-alpine.

Beartooth Butte: boggy valley: small subalpine lake, 2010, 9500 ft, 6844 (MO, VBG1). **Deep Lake:** two small lakes along Hwy 212, 2008, ! 10,000 ft (3050 m), 2668 (MO, VBG1); unnamed lake along Hwy 212, 2010, ! 10,000 ft (3050 m), 8255 (MO, VBG1). All det. V. Bakalin.

Note: This species is a rare disjunct in Wyoming (Kosovich-Anderson unpublished data). In Váňa and Hong (1999), distribution in western North America includes Alaska and British Columbia. Occurs “on shaded rocks and soil near streams, snowbed habitats, mostly unforested areas; elevation unknown; Greenland; B.C., Nunavut; Alaska, Calif.; Eurasia” (FNA *in prep.*, provisional publication). Altitudinal update – on the Beartooths, the species was registered at elevations 2900–3050 m.

Jungermannia exsertifolia Steph.

- **subsp. cordifolia** (Dumort.) Váňa

[*Jungermannia eucordifolia* Schljakov]

First record: 2008. Frequent; on wet rocks near streams, waterfalls, along pools in fens, at subalpine and alpine elevations.

Beartooth Butte: Little Bear Creek-1, 2008, 9700 ft, 2687 (MO, VBG1); Little Bear Creek-3, 2009, 9400 ft, 5324 (MO, VBG1). **Deep Lake:** Sawtooth Lake, 2009, 9200–9250 ft, 6058 (MO, VBG1); head of unnamed creek-1, 2010, 10,200 ft, 6736 (MO, VBG1); tributary of Canyon Creek-2, 2010, 9400 ft, 6778 (MO, VBG1); Lower Top Lake Fen, 2010, 9450 ft, 7655 (MO, VBG1). All det. V. Bakalin.

Lepidozia reptans (L.) Dumort.

First record: 1977. Rare, at montane elevations.

Muddy Creek: Lake Creek (Hong 1977); headwaters of Ghost Creek, Ghost Creek Fen, ecotone zone

between *Carex* spp. fen and swampy *Picea engelmannii* (+ *P. glauca*) forest, on duff and rotten wood, 2008, 7900 ft, 3753.

Lophocolea heterophylla (Shrad.) Dumort.

First record: 2008. Rare, single collection from subalpine zone.

Beartooth Butte: Hwy 212, S-facing slope, *Pinus contorta* var. *latifolia* forest, shaded brook bank, on wet sandy-clayey soil, 2008, 9000 ft, 3902a, gemm.

Lophocolea minor Nees

First record: 1977. Rare, single collection from montane zone.

Muddy Creek: Lake Creek, *Hong 31207* (Hong 1977).

Lophozia silvicola H.Buch

[*Lophozia ventricosa* var. *silvicola* (H.Buch) E.W.Jones]

First record: 1977. Rare, two collections of Hong, elevation unknown.

Beartooth Butte: Beartooth Creek, *Hong 31177, 31184* (Hong 1977).

Lophozia ventricosa (Dicks.) Dumort.

- var. **ventricosa**

First record: 1977. Common; on rotten logs and trunks in coniferous forests, sporadically on rocks and soil of stream and lake banks, often among mosses, from montane through the alpine. Gemmae common.

Muddy Creek: Ghost Creek Fen, 2008, 7900 ft, 3753, gemm. **Beartooth Butte:** Beartooth Creek (Hong 1977); Island Lake CG: spruce forest, 2008, 9500 ft, 2216, gemm.; boggy shore of Island Lake, 2008, 9500 ft, 2373 (MO, VBGI), det. V. Bakalin, gemm.; Clay Butte foothills: coniferous forest, 2009, 9000 ft, 5393; Beartooth Lake CG, coniferous forest, 2009, 8900 ft, 6217; Chain Lake: S shore, 2010, 9500 ft, 6998, gemm. **Deep Lake:** unnamed alpine lake S of Hwy 212, 2008, 10,000 ft, 2678 (MO, VBGI), det. V. Bakalin, gemm.; Wyoming Creek-2, 2009, 10,600 ft, 5061, gemm.; Sawtooth Palsa Fen, 2009, 9700 ft, 5741, gemm.; Top Lake Fen-1, 2009, 9450 ft, 5781; head of unnamed creek-1, 2010, 10,250 ft, 6747, gemm.; Lower Top Lake Fen, 2010, 9450 ft, 7687, gemm.

* - var. **longiflora** (Nees) Macoun

First record: 2008. Rare; on wet soil in boggy forested areas, on humus soil along creek, in montane zone.

Muddy Creek: Lily Lake Swamp Forest, 2008, 7700 ft, 3031 (MO, VBGI); Lake Creek-1, 2010, 7700 ft, 7163 (MO, VBGI), per. All det. V. Bakalin.

Lophozia wenzelii (Nees) Steph.

First record: 1965. Sporadic; in alpine meadows and fens, boggy banks of creeks, on wet soil and rocks; essentially arctic-alpine.

Deep Lake: unnamed alpine lake S of Hwy 212, 2008, 10,000 ft, 2678; Wyoming Creek-2, 2009, 10,600 ft,

5026. **Unclear location:** Beartooth Pass, 1965, *Hermann 20072* (RM, cited in: Hong 1977).

Marchantia polymorpha L.

* - subsp. **montivagans** Bischl. & Boissel.-Dub.

[*Marchantia alpestris* (Nees) Burgeff]

First record: 2008. Common; seepage areas in forests, in shaded niches along streamsides and lake shores on clayey, sandy, gravelly and peaty soil, on silty banks in willow thickets, from foothills through the alpine; essentially arctic-alpine.

Jim Smith Peak: Rock Creek, 2016, 7700 ft, 21019.

Muddy Creek: Lily Lake Swamp Forest, 2008, 7700 ft, 3032; Lily Lake Fen, 2008, 7700 ft, 3088, gemm.; Ghost Creek Fen, 2008, 7900 ft, 3747; Muddy Creek-1, 2009, 8100 ft, 6140; Lewis and Clark Trail vicinity: swampy mixed forest, 2009, 6550 ft, 6202, gemm.; tributary of Beartooth Creek-1, 2010, 8450 ft, 7106 (MO, VBGI), det. V. Bakalin; Gilbert Creek-2, 2010, 6900 ft, 8017; "Beaver Lake", 2010, 7300 ft, 8322.

Beartooth Butte: Little Bear Lake Fen, 2008, 9600 ft, 2843, gemm.; Little Bear Creek-2, 2008, 9500 ft, 3253; creek SW of Beartooth Butte, 2008, 9500 ft, 3858; Clay Butte foothills: coniferous forest, 2009, 9000 ft, 5416; Beartooth Falls, 2009, 8900 ft, 5451; Beartooth Lake: W-SW shore, 2010, 8900 ft, 6653; Fantan Lake: N shore, 2010, 9500 ft, 7027. **Deep Lake:** inlet of Frozen Lake, 2008, 10,500 ft, 2632; Wyoming Creek-1, 2008, 10,300 ft, 3478; Sawtooth Palsa Fen, 2009, 9700 ft, 5743; Sawtooth Lake, 2009, 9300 ft, 6007; head of unnamed creek-1, 2010, 10,200 ft, 6758, gemm.; tributary of Canyon Creek-1, 2010, 9900 ft, 6766.

* - subsp. **ruderalis** Bischl. & Boissel.-Dub.

[*Marchantia latifolia* Gray]

First record: 1977. Sporadic; on bare soil, both mineral and peaty, on disturbed or naturally denuded places, along streamsides, from foothills through the subalpine.

Jim Smith Peak: Crazy Creek CG Swamp, 2008, 7000 ft, 3191, gemm. **Muddy Creek:** Lake Creek, *Hong 31197, 31199* (Hong 1977); Gilbert Creek-2, 2010, 6900 ft, 8017 (1/2) (CAS), gemm. **Beartooth Butte:** Beartooth Creek (Hong 1977); Little Bear Lake Fen, edge of fen, roadside slope, 2008, 9600 ft, 2751, gemm.

Nardia geoscyphus (DeNot.) Lindb.

First record: 2008. Sporadic; on soil over rocks, on damp peaty soil and gravel along streams, on sides of sedge tussocks at lake shore; in upper subalpine and alpine zones; essentially arctic-alpine.

Beartooth Butte: Little Bear Lake Fen, 2008, 9600 ft, 2758; unnamed creek/"Dichelyma Creek-2", 2010, 9550 ft, 6971 (MO, VBGI), det. V. Bakalin. **Deep Lake:** head of unnamed creek-1, 2010, 10,200 ft, 6746; unnamed lake along Hwy 212, 2010, 10,000 ft, 8254 (1/2) (MO, VBGI), det. V. Bakalin.

* **Pellia neesiana** (Gottsche) Limpr.

First record: 2008. Frequent; in wet sites, including streambanks, willow carrs, and edges of pools, at subalpine elevations.

Beartooth Butte: boggy shore of Island Lake, 2008, 9500 ft, 2388; Little Bear Creek-1, 2008, 9700 ft, 2708; Little Bear Lake Fen, 2008, 9600 ft, 2750; Fantan Lake: N shore, 2010, 9500 ft, 7019 (MO, VBG), det. V. Bakalin. **Deep Lake:** Canyon Creek, 2009, 9400 ft, 5686 (MO, VBG), det. V. Bakalin; Sawtooth Lake, waterfall, 2009, 9250 ft, 6039.

* **Plagiochila porelloides** (Torr. ex Nees) Lindenb.

First record: 2008. Sporadic; in forests and swamps on duff, soil, fallen logs, among rocks in rock fields, from foothills through the montane.

Jim Smith Peak: Crazy Creek CG Swamp, 2008, 7000 ft, 3169; Crazy Creek-2, 2010, 6900 ft, 7942 (MO, VBG), det. V. Bakalin. **Muddy Creek:** Lake Creek Waterfalls, 2009, 7500 ft, 5840 (MO, VBG), det. V. Bakalin; Lake Creek CG: wet coniferous forest, 2009, 6950 ft, 5897.

Radula complanata (L.) Dumort.

First record: 2010. Rare; on rock outcrops and on soil among rocks along lake and creek, on trunks in willow wetlands, in foothills and montane zones.

Jim Smith Peak: Ivy Lake: SE edge, 2010, 8100 ft, 7551 (MO, VBG), det. V. Bakalin; Crazy Creek-2, 2010, 6900 ft, 7956.

Riccardia latifrons (Lindb.) Lindb.

First record: 1977. Sporadic; on boggy soil along creeks and on moist clayey soil in graminoid fen.

Muddy Creek: Lake Creek, *Hong 31192* (Hong 1977); Mud Lake Fen, 2008, 7700 ft, 3136. **Beartooth Butte:** Beartooth Creek, *Hong 31163* (Hong 1977).

* **Riccardia palmata** (Hedw.) Carruth.

First record: 1977. Rare, single collection from montane elevation.

Muddy Creek: Lake Creek, *Hong 31206* (Hong 1977).

* * **Saccobasis polita** (Nees) H.Buch

[*Tritomaria polita* (Nees) Jørg.]

First record: 2010. Rare; on soil over rocks in springy meadows along lakes in upper subalpine zone; arctic-alpine.

Beartooth Butte: Long Lake: E shore, 2010, ! 9600 ft (2930 m), 6810 (MO, VBG); Fantan Lake: E shore, 2010, 9500 ft, 6897 (MO, VBG). All det. V. Bakalin. Note: An infrequent disjunct in high mountains of Colorado and Wyoming (Hermann 1987; Weber and Wittmann 2007; Kosovich-Anderson unpublished data). According to Stotler and Crandall-Stotler (2017, p. 681), it is "found in Alaska, the Yukon, and British Columbia in the west, and from Greenland and Nunavut south to Quebec in the east. It is also in Great Britain and in northern to central Europe, especially in montane habitats". Altitudinal update – 2930 m vs. "500–1100 m" (FNA *in prep.*, provisional publication).

* * **Scapania hyperborea** Jørg.

First record: 2010. Rare, single collection from alpine zone; arctic or arctic-alpine.

Deep Lake: unnamed alpine lake along Hwy 212, on boggy soil, assoc.: *Nardia geoscyphus*, 2010, 10,000 ft, 8254 (½) (MO, VBG), det. V. Bakalin.

Note: A rare species with predominantly arctic distribution; in western United States was previously known from Alaska and Colorado (Hong 1980; Weber and Wittmann 2002, 2007). "Peaty and sandy moist soil in tundra and alpine communities; 0–3800 m; Greenland; N.W.T., Ont.; Alaska, Colo., Maine, N.H.; Europe (Iceland, Norway, Finland, n Russia, Svalbard, Sweden); Asia (n Russia)" (FNA *in prep.*, provisional publication).

Scapania irrigua (Nees) Nees

First record: 2008. Frequent; on open and shrubby banks of creeks in forests, on rocks in streams, in cliff crevices and in springy fens, near snow-melt streamlets, on decaying wet logs and moist peaty, sandy and gravelly soil, from montane through the alpine.

Muddy Creek: Lily Lake Fen, 2008, 7700 ft, 3038.

Beartooth Butte: boggy shore of Island Lake, 2008, 9500 ft, 2378; Little Bear Creek-1, 2008, 9700 ft, 2694 (MO, VBG), det. V. Bakalin; Little Bear Lake Fen, 2008, 9600 ft, 2743, gemm.; Beartooth Lake CG: wet subalpine meadow, 2009, 8900 ft, 4911. **Deep Lake:** inlet of Frozen Lake, 2008, 10,500 ft, 2551; unnamed alpine lake S of Hwy 212, 2008, 10,000 ft, 2677 (CAS, MO, VBG), det. V. Bakalin; Wyoming Creek-1, 2008, 10,300 ft, 3465; summits: small alpine lake, 2008, 10,500 ft, 3513 (MO, VBG), det. V. Bakalin.

Black Pyramid Mountain: summits: alpine fen-3, 2008, 10,100 ft, 2522, gemm.

Scapania mucronata H.Buch

First record: 2009. Rare, single collection from montane elevation.

Muddy Creek: Lake Creek Waterfalls, on granite ledges, in shade, 2009, 7500 ft, 5851 (MO, VBG), det. V. Bakalin.

* **Scapania paludicola** Loeske & Müll.Frib.

First record: 2008. Sporadic; on moist soil in meadows and fens along lakes, in crevices of wet cliffs, in subalpine and alpine zones.

Beartooth Butte: boggy shore of Island Lake, 2008, 9500 ft, 2373 (MO, VBG), det. V. Bakalin; Beartooth Lake CG: wet subalpine meadow, 2009, 8900 ft, 4911 (MO, VBG), det. V. Bakalin. **Deep Lake:** Littlerock Creek Fen, 2008, ! 10,650 ft (3250 m), 3644.

Note: Altitudinal update – 3250 m vs. "0–2000 m" (FNA *in prep.*, provisional publication).

* * **Scapania scandica** (Arnell & H.Buch) Macvicar

First record: 2010. Rare, single collection from subalpine zone.

Beartooth Butte: Clay Butte Fen, on soil over rock, 2010, ! 9000 ft (2740 m), 8264 (MO, VBG), det. V. Bakalin.

Note: A subarctic-montane species. In Hong (1980): distribution in western North America – Alaska,

Northwest Territories. "Mostly neutral to acid mineral, humic and peaty soils slightly covered by bryophytes; 0–1500 m; Greenland; B.C., Nfld., N.W.T., N.S., Ont., Que.; Alaska, Maine, Mass., N.Y., Wash., Wis.; Eurasia; Atlantic Islands" (FNA *in prep.*, provisional publication). Wyoming is the southernmost station where the species is rare (Kosovich-Anderson unpublished data). Altitudinal update – 2740 m.

Scapania subalpina (Nees ex Lindenb.) Dumort.

First record: 2008. Frequent; in subalpine fens, beside streams and on rocks in drying stream bed in alpine zone, on moist soil over rocks and rotten wood in wet montane and subalpine coniferous forests; subarctic-subalpine species/montane, subalpine, alpine.

Muddy Creek: Lake Creek CG: wet spruce forest, 2009, 6950 ft, 5900 (MO, VBG), det. V. Bakalin.

Beartooth Butte: Little Bear Creek-1, 2008, 9700 ft, 2684; Little Bear Lake Fen, 2008, 9600 ft, 2786; Little Bear Creek-3, 2009, 9400 ft, 5338; Fantan Lake: N shore, 2010, 9500 ft, 7033 (MO, VBG), det. V. Bakalin. **Deep Lake:** unnamed alpine lake S of Hwy 212, 2008, 10,000 ft, 2655 (MO, VBG), det. V. Bakalin; Sawtooth Lake, 2009, 9200 ft, 6037 (MO, VBG), ver. V. Bakalin; tributary of Canyon Creek-2, 2010, 9400 ft, 7779.

Scapania undulata (L.) Dumort.

First record: 1953. Frequent; on rocks adjacent to streams and springs, in crevices of cliffs, at subalpine elevations.

Beartooth Butte: N of Beartooth Lake, 1953, 9000 ft, *Lawton 1984* (WTU); Beartooth Creek (Hong 1977); boggy shore of Island Lake, 2008, 9500 ft, 2387; Beauty Lake Trail, 2009, 8900 ft, 5226 (MO, VBG), det. V. Bakalin; Fantan Lake: N shore, 2010, 9500 ft, 7015. **Deep Lake:** Canyon Creek, 2009, 9400 ft, 5667.

Schistochilopsis incisa (Schr.) Konstant.

[*Lophozia incisa* (Schr.) Dumort.]

First record: 2008. Sporadic; epixylic species, on shaded decaying logs, trunks and duff, in wet montane and subalpine forests and meadows, mainly in streambanks.

Muddy Creek: Lily Lake Swamp Forest, 2008, 7700 ft, 3031 (MO, VBG), det. V. Bakalin; tributary of Beartooth Creek-1, 2010, 8400 ft, 7091; Lake Creek-1, 2010, 7700 ft, 7157. **Deep Lake:** Top Lake, N slope: subalpine meadow, 2010, 9500 ft, 7749.

* **Schljakovia kunzeana** (Huebener) Konstant.

[*Orthocaulis kunzeanus* (Huebener) H. Buch, *Barbilophozia kunzeana* (Huebener) Müll. Frib.]

First record: 2008. Frequent; on wet boggy soil over rocks in fens, wet meadows and along streams, on peaty ledges, at subalpine and alpine elevations; arctic-alpine to arcto-boreal-montane.

Beartooth Butte: Little Bear Lake Fen, 2008, 9600 ft, 2833 (CAS, MO, VBG); Beartooth Lake CG, wet subalpine meadow, 2009, 8950 ft, 4904 (MO, VBG). **Deep Lake:** Littlerock Creek Fen, 2008, ! 10,650 ft

(3250 m), 3588 (MO, VBG); Top Lake Fen-1, 2009, 9450 ft, 5777 (MO, VBG) & 2010, 9450 ft, 7741 (MO, VBG); Sawtooth Lake, 2009, 9250 ft, 6020 (MO, VBG); head of unnamed creek-1, 2010, 10,250 ft, 6751 (MO, VBG). All det. V. Bakalin.

Note: Altitudinal update – 3250 m vs. "0–1500 m" (FNA *in prep.*, provisional publication).

* **Solenostoma obovatum** (Nees) C. Massal.

[*Jungermannia obovata* Nees, *Plectocolea obovata* (Nees) Mitt., *P. subelliptica* (Lindb. ex Heeg) A. Evans]

First record: 2009. Rare, two collections from Morrison Jeep Trail area in subalpine zone; arctic-alpine (or arctic-montane) species.

Deep Lake: Canyon Creek, on shaded wet rocks lining the creek, assoc.: *Cephalozia bicuspidata*, 2009, 9400 ft, 5655 (MO, VBG); Top Lake Fen-2, on soil over granite rocks amongst the fen, 2010, ! 9450 ft (2880 m), 7737 (MO, VBG). All det. V. Bakalin.

Note: Altitudinal update – 2880 m vs. "0–2000 m" (FNA *in prep.*, provisional publication).

* **Tritomaria exsectiformis** (Bredl.) Schiffn. ex Loeske

First record: 1977. Rare, single collection from montane zone.

Muddy Creek: Lake Creek (Hong 1977).

MUSCI

Abietinella abietina (Hedw.) M. Fleisch.

First record: 2008. Frequent; in loose mats on loamy soil, on soil over rock outcrops, on the sides of grass tussocks in tundra and alpine and subalpine meadows.

Beartooth Butte: creek connecting Fort and Chain Lakes, 2010, 9500 ft, 7788. **Deep Lake:** summits: alpine fen-1, 2008, 10,500 ft, 2301; summits: alpine tundra-3, 2008, 10,350 ft, 2399; summits: alpine tundra-6, 2008, ! 10,850 ft (3310 m), 3339; Gravel Pit vicinity, alpine tundra, 2010, 10,400 ft, 7325; Canyon Creek valley: subalpine meadow, 2010, 9400 ft, 7773; summits: alpine tundra-9, 2010, 10,400 ft, 8119.

Black Pyramid Mountain: summits: alpine tundra-1, 2008, 10,200–10,300 ft, 2271; summits: alpine tundra-4, 2008, 10,300 ft, 2484.

Note: Altitudinal update – 3310 m vs. "low to moderate elevations [0–1599 m]" (FNA 2014, p. 375).

** **Amblyodon dealbatus** (Hedw.) P. Beauv.

First record: 1953. Rare; at subalpine elevations.

Beartooth Butte: S slope of Beartooth Butte, 1953, *Lawton 2057* (WTU). **Deep Lake:** Sawtooth Palsa Fen, wet calcareous substrate, 2009, 9700 ft, 5729.

Note: A rare boreal-montane species with disjunctive range, scattered distribution across the temperate part of Northern Hemisphere; characteristically found in calcareous fens and meadows (FNA 2014); sporadically occurs on rotting wood and organic soil in rich fens scattered across the boreal zone, also on wet gravelly substrates covered with

humus along streamsides. Known in Wyoming only from several occurrences in Carbon and Park counties (Porter 1937, Eckel 1996, Kosovich-Anderson unpublished data). Species of conservation concern in Montana (Elliott and Pipp 2019).

Amblystegium serpens (Hedw.) Schimp.

First record: 1953. Common; on tree trunks, rotten wood, exposed roots of trees in forests, on stem bases of willows in riparian willow communities and willow carrs, on rocks, clayey and boggy soil in fens, on wet tundra soil, from foothills through the alpine.

Muddy Creek: Mud Lake Fen, 2008, 7700 ft, 3132; Lewis and Clark Trail: swampy mixed forest, 2009, 6600 ft, 6196, S+; Hwy 212 and Rd 188 intersection: boggy valley, 2010, 7550 ft, 7208; Muddy Creek-2, 2010, 7700 ft, 7248; Beartooth Creek-3, 2010, 7550 ft, 7414; tributary of Gilbert Creek, 2010, 7800 ft, 7578; “Beaver Lake”, 2010, 7300 ft, 8335, S+; Ghost Creek, 2010, 7900 ft, 8443. **Beartooth Butte:** S slope of Beartooth Butte, 1953, *Lawton 2065* (WTU); Clay Butte Fen, 2008, 9000 ft, 2983; creek SW of Beartooth Butte, 2008, 9500 ft, 3857, S+. **Deep Lake:** summits: alpine tundra-6, 2008, ! 10,850 ft (3310 m), 3371. **Black Pyramid Mountain:** WY-MT state line: unnamed lake, 2010, 9800 ft, 8073.

Note: Altitudinal update – 3310 m vs. “0–3000 m” (FNA 2014, p. 301).

Amphidium lapponicum (Hedw.) Schimp.

First record: 2010. Rare, single collection from upper foothills.

Jim Smith Peak: Crazy Creek-2, on shaded granite cliffs lining the creek, 2010, 6850 ft, 7956.

* ** **Anomobryum julaceum** (Schrad. ex P.Gaertn., B.Mey. & Scherb.) Schimp.

[*Bryum julaceum* Schrad. ex P.Gaertn., B.Mey. & Scherb.]

First record: 2009. Rare, single collection from montane zone.

Muddy Creek: Lake Creek Waterfalls, on a layer of soil over granite rock, in splash zone of the waterfall, 2009, 7500 ft, 5847 (DUKE), ver. J. Shaw.

Note: A regionally rare montane species, usually occurring on slightly acidic rocks; known from a single station in Wyoming – on the Beartooth Plateau (Kosovich-Anderson unpublished data).

Aulacomnium palustre (Hedw.) Schwägr.

First record: 1953. Common; on moist soil in riparian wetlands, meadows, and fens, willow carrs, on boggy shores of lakes and ponds, in swampy forests, from foothills through the alpine.

Jim Smith Peak: bog between Reed Lake and Rock Creek, 2007, 7500–7800 ft, *E.Elliott* (with *B. Elliott & Heidel*) 3846 (RM), det. YKA; Little Moose Peatlands, 2002, 7960 ft, *Jackson s.n.* (RM), det. J. Harpel; Rock Creek Fen and Little Moose Lake Fen (Heidel et al. 2008); Crazy Creek CG Swamp, 2008, 7000 ft, 3167. **Muddy Creek:** East Lily Peatland, 2002, 8100 ft, *Jackson s.n.* (RM), det. J. Harpel; Ghost Creek Fen and Lily Lake East Fen (Heidel et

al. 2008); Lily Lake Swamp Forest, 2008, 7700 ft, 3019, S+; Lewis and Clark Trail: swampy mixed forest, 2009, 6600 ft, 6195. **Beartooth Butte:** NW side of Beartooth Lake, 1953, *Lawton 2072* (WTU); Clay Butte Fen, Fantan North Fen, Lower Shepherd Fen, and Meadow Lake Fen (Heidel et al. 2008).

Deep Lake: S of Sawtooth Mt., palsa peatbeds, 2007, 9670–9800 ft, *E.Elliott 3566* (RM), det. YKA, S+; Wyoming Creek and upstream, streamside, 2008, 10,000–10,170 ft, *Hartman 87880* (RM), det. YKA; Lake WGN Fen, Littlerock Creek Fen, and Sawtooth Palsa Fen (Heidel et al. 2008); summits: alpine fen-1, 2008, 10,500 ft, 2321 (CAS, COLO, MO), “*imbricatum*” expression; summits: drying creek in alpine tundra, 2008, 10,350 ft, 2427 (MHA, MO), “*imbricatum*” expression. **Black Pyramid Mountain:** summits: alpine fen-3, 2008, 10,100 ft, 2519, “*imbricatum*” expression; WY-MT state line: unnamed lake, 2010, 9800 ft, 8059, S+. **Unclear location:** Beartooth Pass, 1965, 10,000 ft, *Hermann 20073* (RM).

* **Barbula convoluta** Hedw.

* - var. **convoluta**

First record: 2008. Rare, two collections from montane and subalpine zones.

Muddy Creek: Lake Creek CG: wet coniferous forest, creek bank, on bare soil, 2009, 6950 ft, 5918.

Beartooth Butte: Little Bear Lake Fen, on wet clay at the roadside, assoc. *Polytrichum juniperinum* Hedw. and *Ceratodon purpureus* (Hedw.) Brid., 2008, 9600 ft, 2855.

* - var. **eustegia** (Cardot & Thér.) R.H.Zander

First record: 2009. Rare, single collection from subalpine zone. E.

Muddy Creek: seepage slope along Hwy 212, sandy bank of ditch, 2009, 8700 ft, 6104, det. P. Eckel.

Bartramia ithyphylla Brid.

First record: 1953. Frequent; on shaded granite cliffs and boulders in upper elevation forest habitats, on wet soil of lake and stream banks, in subalpine and alpine zones; arctic-alpine.

Beartooth Butte: Beartooth Lodge, near stream, 1953, *Lawton 1931* (WTU); Beartooth Lake, S slope, 1953, 9000 ft, *Whitehouse 27454a* (BRIT); Long Lake: E shore, 2010, 9600 ft, 6808; Fantan Lake: E shore, 2010, 9500 ft, 6879. **Deep Lake:** inlet of Frozen Lake, 2008, 10,500 ft, 2593, S+; Wyoming Creek-2, 2009, 10,600 ft, 5036, S+; Sawtooth Lake, 2009, 9300 ft, 5990; tributary of Canyon Creek-1, 2010, 9900 ft, 6770.

Blindia acuta (Hedw.) Bruch & Schimp.

First record: 1973. Rare, from montane through the alpine.

Muddy Creek: Lake Creek Waterfalls, on wet soil under *Picea engelmannii*, 2009, 7500 ft, 5825 (MO), det. B. Allen. **Deep Lake:** [Hwy 212], W side, under late snow patch on steep slope N of switchback, rills and snowbeds, 1973, ! 3200 m.s.m. (3200 m), *Weber B-44312* (COLO).

Note: Altitudinal update – 3200 m vs. “low to high elevations (0–3000 m)” (FNA 2007, p. 327).

Brachytheciastrum collinum (Schleich. ex Müll.Hal.) Ignatov & Huttunen

[*Brachythecium collinum* (Schleich. ex Müll.Hal.) Schimp.]

First record: 1953. Common; on soil over rocks (especially limestone) or in sheltered areas around boulders in *Artemisia tridentata* shrublands and *Festuca idahoensis* grasslands, in montane and subalpine aspen and coniferous forests; on rocky ridgcrests, stabilized talus and rock outcrops at alpine elevations.

Muddy Creek: Hwy 212 and Hwy 296 intersection: slope facing to S, 2009, 7200 ft, 5889; aspen stands along Hwy 212, 2009, 8300 ft, 6113; Lake Creek-1, 2010, 7700 ft, 7146; Rd 188: sparsely forested slope, 2010, 7600 ft, 7187, S+. **Beartooth Butte:** S slope of Beartooth Butte, 1953, *Lawton 2049* (WTU); Clay Butte Fen, 2008, 9000 ft, 2933; Clay Butte: slope facing to E, 2008, 9700 ft, 3832; Beartooth Butte-1, 2009, 9250 ft, 5259, S+; Beartooth Butte-2, 2010, 9000 ft, 6615; Beartooth Lake CG: coniferous forest-2, 2010, 8950 ft, 8022. **Deep Lake:** summits: Stockade area, 2010, 11,050 ft, 6702; Hwy 212: roadside granite debris, 2010, 10,200 ft, 6728, S+; inlet of Frozen Lake, dry portion of S-facing slope, 2008, 10,500 ft, 2593; Top Lakes: old-growth spruce-fir forest, 2010, 9600 ft, 7688, S+; Gardner Lake: head of USFS Trail, 2010, 10,600 ft, 8187. **Unclear locations:** [Hwy 212], 1953, 10,000 ft, *Whitehouse 27480* (WTU); [Hwy 212], *Picea* forest with *Pinus flexilis* E.James and *P. contorta*, 1973, *Weber B-44220* (COLO, RM).

Brachytheciastrum velutinum (Hedw.) Ignatov & Huttunen

[*Brachythecium velutinum* (Hedw.) Schimp.]

- var. **salicinum** (Schimp.) Ochyra & Zarnowiec

[*Brachythecium suberythrorrhizon* Renaud & Cardot] First record: 2009. Rare, single collection from montane zone.

Jim Smith Peak: Crazy Creek-1, on soil over granite rock, in shade, 2009, 7000 ft, 5614 (MHA, MO), det. M. Ignatov.

Brachythecium acutum (Mitt.) Sull.

[*Brachythecium pseudocollinum* Kindb.]

First record: 2010. Rare, single collection from montane zone. E.

Muddy Creek: Lake Creek-1, on wet sandy and humus soil in wet *Picea glauca* x *P. engelmannii*/*Vaccinium scoparium* Leiberg ex Coville forest along creek, 2010, ! 7700 ft (2350 m), 7111 (MHA, MO), det. M. Ignatov.

Note: Altitudinal update – 2350 m vs. “low to moderate elevations (0–1000 m)” (FNA 2014, p. 423).

** **Brachythecium brandegeei** (Austin) H. Rob.

[*Cirriphyllum brandegeei* (Austin) Grout]

First record: 2008. Sporadic; on soil at base of rock outcrops in alpine tundra, on clayey, loamy and soaked peaty soil along streams and in fens in late snow-melt areas, on debris of limestone rock; from upper subalpine through the alpine. E.

Muddy Creek: Clay Butte: slope facing to W, 2009, 9800 ft, 4934 (MHA, MO). **Deep Lake:** summits: small alpine lake, 2008, 10,500 ft, 3516 (MHA, MO); inlet of Frozen Lake, 2008, 10,500–10,550 ft, 2626 (CAS, MHA, MO). **Black Pyramid Mountain:** summits: alpine tundra-4, 2008, 10,250–10,300 ft, 2485 (MHA, MO). All det. M. Ignatov.

Note: A rare alpine species, highly localized endemic of North America, known only from Colorado and Wyoming (Kosovich-Anderson and Ignatov 2010).

* **Brachythecium campestre** (Müll.Hal.) Schimp.

First record: 2008. Rare, two collections from montane zone.

Muddy Creek: Ghost Creek Fen, on wet soil and duff, 2008, ! 7900 ft (2400 m), 3755; “Beaver Lake”, *Picea glauca* forest, on thin soil over decaying wood, 2010, 7300 ft, 8327 (MHA, MO), det. M. Ignatov.

Note: The Beartooth station of the species is located on the western border of its North American range. Altitudinal update – 2400 m vs. “low to moderate elevations (10–500 m)” (FNA 2014, p. 419).

Brachythecium cirrosum (Schwägr.) Schimp.

[*Cirriphyllum cirrosum* (Schwägr.) Grout]

First record: 2008. Rare (undercollected?), single collection from alpine zone; arctic-alpine.

Deep Lake: summit: alpine fen-4, on glacial till, shaded by granite outcrop, 2008, 10,400 ft, 3268.

Brachythecium erythrorrhizon Schimp.

- var. **erythrorrhizon**

First record: 1973. Common; on soil over acid and basic rocks, in forested areas, tundra and meadows, along stream banks and lake shores, mainly at subalpine and alpine elevations.

Beartooth Butte: Island Lake CG: spruce forest, 2008, 9500 ft, 2217 (MHA, MO), det. M. Ignatov; Clay Butte: slope facing to E, 2008, 9700 ft, 3839; Beartooth Butte-1, 2009, 8950–9250 ft, 5290 (MHA, MO), det. M. Ignatov; Little Bear Creek-3, 2009, 9400 ft, 5353 (MHA, MO), det. M. Ignatov; Beartooth Falls, 2009, 8900 ft, 5436; Beartooth Lake: W-SW shore, 2010, 8900 ft, 6636. **Deep Lake:** inlet of Frozen Lake, 2008, 10,500 ft, 2645A (MHA, MO), det. M. Ignatov; summits: snow-melt rill, 2010, 10,600 ft, 6723; Gravel Pit vicinity, alpine tundra, 2010, 10,400 ft, 7330; Top Lakes: old-growth spruce-fir forest, 2010, 9600 ft, 7689, S+; Long Lake, NW slope: subalpine meadow, 2010, 9750 ft, 8281 (MHA, MO), det. M. Ignatov. **Unclear location:** [Hwy 212], *Picea* forest with *Pinus flexilis* and *P. contorta*, 1973, *Weber B-44219* (COLO, RM).

** - var. **alpinum** Kosovich-Anderson & Ignatov

First record: 2008. Sporadic; in late snow-melt zone, on wet tussocks in tundra, on wet silt and peaty soil

along subalpine and alpine streams and lakes, in old-growth spruce forest. E.

Beartooth Butte: Island Lake CG: *Picea engelmannii* forest, 2008, 9500 ft, 2217 (MHA, MO). **Deep Lake:** inlet of Frozen Lake, 2008, 10,350–10,550 ft, 2635 (MHA, MO); summits: alpine snow melt area, small lake in vast depression, 2008, 10,500 ft, 3514 (MHA, MO). All det. M. Ignatov.

Note: A rare alpine taxon, highly localized endemic of North America, known only from Colorado and Wyoming. Recently described variety, type specimen is from Wyoming's Beartooth Plateau (Kosovich-Anderson and Ignatov 2010).

Brachythecium frigidum (Müll.Hal.) Besch.

First record: 1953. Rare, in montane zone.

Muddy Creek: Ghost Creek Fen, on soaked clayey soil along streamlet, 2008, 7900 ft, 3745. **Beartooth Butte:** Beartooth Lodge, near stream, 1953, *Lawton 1925* (WTU).

Brachythecium laetum (Brid.) Schimp.

[*Brachythecium digastrum* Müll.Hal. & Kindb.]

First record: 2008. Rare, in montane zone.

Muddy Creek: Ghost Creek Fen, edge, on wet humus soil, 2008, ! 7900 ft (2400 m), 3745; Rd 188: *Pinus contorta* var. *latifolia* (+ *Picea glauca* + *Pseudotsuga menziesii* + *Populus tremuloides*) forest in deep valley, on soil over rock, 2010, 7600 ft, 7180.

Note: Altitudinal update – 2400 m vs. “low to high elevations (0–2300 m)” (FNA 2014, p. 422).

Brachythecium rivulare Schimp.

First record: 1965. Sporadic; in moss-lined forest seeps, sedge swamps, on wet rocks and logs, alluvial sand, gravelly and rocky banks along streams, in temporary flooding depressions, from montane through the alpine.

Muddy Creek: Beartooth Creek-3, 2010, 7550 ft, 7421; Ghost Creek, 2010, 7900 ft, 8426. **Beartooth Butte:** Beartooth Falls, 2009, 8900 ft, 5463; Beartooth Lake: W-SW shore, 2010, 8900 ft, 6578. **Deep Lake:** streamlet through tundra below Beartooth Pass, 38 miles NW of Cody, 1965, 10,000 ft, *Hermann 20075* (RM).

* **Brachythecium salebrosum** (Hoffm. ex F.Weber & D.Mohr) Schimp.

First record: 1973. Frequent; on soil, rocks, tree bases, rotten logs, in exposed to quite shady habitats, from foothills through the alpine.

Muddy Creek: Rd 801: swampy mixed forest, 2009, 7000 ft, 6160; Lake Creek-1, 2010, 7700 ft, 7126; outlet of Lily Lake, 2010, 7700 ft, 7493 (MHA, MO), det. M. Ignatov; Gilbert Creek-2, 2010, 6900 ft, 8020 (CAS, MHA, MO), det. M. Ignatov; “Beaver Lake”, 2010, 7300 ft, 8326 (MHA, MO), det. M. Ignatov; Lake Creek-2, 2010, 6900 ft, 8416 (MHA, MO), det. M. Ignatov. **Beartooth Butte:** Clay Butte Fen, 2008, 9000 ft, 2940; Beartooth Lake CG: coniferous forest, 2010, 8950 ft, 8263 (MHA, MO), det. M. Ignatov. **Deep Lake:** [Hwy 212], W side, under late snow

patch, 1973, ! 3200 m.s.m. (3200 m), *Weber B-44307* (COLO, RM, US).

Note: Altitudinal update – 3200 m vs. “low to moderate elevations (0–1500 m)” (FNA 2014, p. 426).

Brachythecium turgidum (Hartm.) Kindb.

First record: 1953. Sporadic; on wet soil along creek in montane zone, in exposed wet habitats in moist tundra, rills and snowbeds, from upper foothills through the alpine; arctic-alpine.

Jim Smith Peak: W of Beartooth Butte, Crazy Creek CG, 1953, *Lawton 2023* (WTU); Crazy Creek-2, 2010, 6900 ft, 7964. **Deep Lake:** [Hwy 212], W side, under late snow patch, 1973, 3200 m.s.m., *Weber B-44306* (COLO, RM).

* * * **Brachythecium udum** I.Hagen

[*Brachythecium mildeanum* var. *udum* (I.Hagen) Mönk., *B. salebrosum* subsp. *udum* (I.Hagen) J.J.A-mann]

First record: 2008. Rare, in alpine zone; arctic-alpine.

Deep Lake: summits: *Salix* sp./Bryidae fen, bank of alpine pool, on peaty soil, assoc.: *Barbilophozia hatcheri*, *Climacium dendroides* (Hedw.) F.Weber & D.Mohr, *Plagiomnium ellipticum* (Brid.) T.J.Kop., *Polytrichastrum alpinum* (Hedw.) G.L.Sm., and *Sanionia nivalis* Hedenäs, 2008, ! 10,400 ft (3170 m), 3270 (MHA, MO). **Black Pyramid Mountain:** summits: drying creek in alpine tundra, on silt over rock, 2008, 10,100 ft, 2493 (MHA, MO). All det. M. Ignatov.

Note: A rare species of arctic and alpine habitats, with poorly known distribution in North America (so far it has been reported only from Alaska and Yukon). Specimens from the Beartooth Plateau are represented by not a typical form, genetic analysis is needed. Altitudinal update – 3170 m vs. “low elevations (100 m)” (FNA 2014, p. 427).

Bryoerythrophyllum recurvirostrum (Hedw.) P.C.Chen

First record: 1953. Frequent; on soil and rocks (especially limestone) in forested and boggy areas, meadows, stream banks, lake shores, from montane through the subalpine.

Muddy Creek: W of Beartooth Butte, Lake Creek at [Hwy 296], 1953, *Lawton 2093 & 2101* (WTU); Rd 801: swampy mixed forest, 2009, 7000 ft, 6162; Hwy 212 and Rd 188 intersection: boggy valley, 2010, 7550 ft, 7208, S+. **Beartooth Butte:** boggy shore of Island Lake, 2008, 9500 ft, 2372; Clay Butte Fen, 2008, 9000 ft, 2934, S+; Beartooth Lake CG: coniferous forest, 2010, 8950 ft, 8021, S+.

Note: In several collections from subalpine elevations leaves are without apiculus.

Bryum argenteum Hedw.

- var. **argenteum**

First record: 2008. Common; in various habitats – in crevices of limestone, sandstone and granite debris and outcrops, on humus soil and decaying wood in forests, on loamy soil in *Artemisia tridentata* shrub-

lands and *Festuca idahoensis* grasslands; on disturbed substrates: near animals' burrows, dens and nests, on animal trails, on decaying excrements and corpses of animals, in different anthropogenic habitats: along highways, on hard-packed soil along trails, at fireplaces in campgrounds; from foothills through the alpine.

Muddy Creek: Clay Butte: slope facing to W, 2009, 9550–9800 ft, 4919; Lake Creek Waterfalls, 2009, 7500 ft, 5872; Rd 801: swampy mixed forest, 2009, 6800–7000 ft, 6168; SE slope: sagebrush thickets, 2010, 7700 ft, 7405. **Beartooth Butte:** pine forest along Hwy 212, 2008, 8950 ft, 3899; Beartooth Butte-1, 2009, 9250 ft, 5269. **Deep Lake:** Wyoming Creek-1, 2008, 10,300 ft, 3469.1, S+; Sawtooth Lake, 2009, 9300 ft, 5957 (ASC), det. J. Spence; summits: Stockade area, alpine tundra, 2010, 11,050 ft, 6705; summits: alpine tundra-11, 2010, 10,750 ft, 8156. **Black Pyramid Mountain:** summits: alpine tundra-4, 2008, 10,250–10,300 ft, 2468 (ASC), det. J. Spence, S+.

* - var. *muticum* Brid.

First record: 2008. Rare, single collection from subalpine zone.

Beartooth Butte: Clay Butte, slope facing to E, on calcareous soil, 2008, 9550–9700 ft, 3843, det. J. Spence.

Note: "Variety *muticum* is widespread in extreme environments, but the world distribution is not well known" (FNA 2014, p. 127).

* **Bucklandiella sudetica** (Funck) Bedn.-Ochyra & Ochyra

[*Racomitrium heterostichum* (Hedw.) Brid. var. *sudeticum* (Funck) Dixon ex E.Bauer]

First record: 1973. Rare, single collection from subalpine zone.

Beartooth Butte: [Hwy 212], swales around small lakes, subalpine zone between Long Lake and lower Shepherd Lakes, over irrigated rocks, small cascades between lakes, 1973, 2900 m.s.m., *Weber B-44279* (COLO, WTU).

* **Calliergon cordifolium** (Hedw.) Kindb.

First record: 1973. Frequent; on soaked and boggy soil in swamp coniferous and mixed forests, wet meadows and graminoid fens, willow wetlands along streams and lakes, over irrigated rocks, in subalpine zone.

Beartooth Butte: subalpine zone between Long Lake and lower Shepherd Lakes, 1973, 2900 m.s.m., *Weber B-44279* (COLO, WTU); Beartooth Falls, 2009, 8900 ft, 5468; Beartooth Lake: W-SW shore, 2010, 8900 ft, 6634; boggy valley NE of Fantan Lake, 2010, 9500 ft, 6830; unnamed creek/"Dichelyma Creek-2", 2010, 9550 ft, 6968. **Deep Lake:** Canyon Creek, 2009, 9400 ft, 5671.

Calliergon giganteum (Schimp.) Kindb.

First record: 2007. Frequent; submerged in swales of fens, pools, in open habitats of bogs and fens, on boggy shores of lakes, on rocks along streams, on

floating bogs, wet sedge meadows, from montane through the subalpine.

Muddy Creek: bog ca. 1 air mi W of Lily Lake, 2007, 7680–7760 ft, *E.Elliott & B.Elliott 574* (RM), det. YKA; Mud Lake Fen, 2008, 7700 ft, 3107; Gilbert Creek-1, 2010, 7700 ft, 7582. **Beartooth Butte:** Clay Butte Fen (Heidel et al. 2008); Beartooth Lake: E shore, 2009, 8900 ft, 4854; Beartooth Lake CG: wet subalpine meadow, 2009, 8950 ft, 4857. **Deep Lake:** creek connecting Lower Top and Sawtooth Lakes, 2010, 9450 ft, 7630.

** **Calliergon richardsonii** (Mitt.) Kindb. ex G.Roth First record: 2008. Rare, single collection from subalpine zone; arctic and subarctic to arctic-alpine.

Beartooth Butte: Little Bear Lake Fen, SE edge, in low hummocks on boggy soil, assoc.: *Hypnum pratense* W.D.J.Koch ex Spruce, 2008, 9600 ft, 2887 (MO), det. B. Allen.

Note: Predominantly arctic and subarctic species rarely found in boreal zone and in mountains southward. Known from few stations in Wyoming, all in high mountains: Medicine Bow Mtns., Bighorn Mtns., and Beartooth Plateau (M. Lenz, personal communication, Kosovich-Anderson 2018). Species of conservation concern in Montana (Elliott and Pipp 2019).

Calliergonella cuspidata (Hedw.) Loeske

First record: 2010. Rare, single collection from subalpine zone.

Beartooth Butte: Beartooth Lake: W shore, on wet sandy soil over rock outcrops along stream, assoc.: *Cratoneuron filicinum* (Hedw.) Spruce, 2010, 8900 ft, 6575.

Campyliadelphus chrysophyllus (Brid.) Kanda

[*Campyllum chrysophyllum* (Brid.) Lange]

First record: 2008. Frequent; on rocks and soil, often temporarily wet, vertical walls of ditches in fens and willow wetlands, on soaked peaty soil along pools and lakes, from montane through the subalpine.

Muddy Creek: Lily Lake Fen, 2008, 7700 ft, 3053; Ghost Creek Fen, ecotone zone with spruce forest, 2008, 7900 ft, 3756; Beartooth Creek-3, 2010, 7550 ft, 7420. **Beartooth Butte:** Beartooth Lake: W-SW shore, 2010, 8900 ft, 6592; Fantan Lake: N shore, 2010, 9500 ft, 7018. **Deep Lake:** Long Lake, NW slope: willow wetlands, 2010, 9750 ft, 8291. **Black Pyramid Mountain:** WY-MT state line: unnamed lake, 2010, 9800 ft, 8075.

Campyllum protensum (Brid.) Kindb.

[*Campyllum stellatum* var. *protensum* (Brid.) Bryhn]

First record: 2008. Sporadic; on mineral-rich wet soil, in swampy forests, boggy lake shores and fens, from subalpine through the alpine; boreal to arctic-alpine. **Beartooth Butte:** Beartooth Lake: W-SW shore, 2010, 8900 ft, 6579. **Deep Lake:** summits: alpine fen-1, 2008, 10,500 ft, 2308; Sawtooth Lake, 2009, 9200 ft, 5993.

Campyllum stellatum (Hedw.) Lange & C.E.O.Jensen

First record: 1953. Common; on boggy soil in mineral-rich fens, decaying stumps in swampy forests, along the shores of subalpine lakes, creek banks and montane *Nuphar* sp. pools, rills and snowbeds in alpine tundra, from montane through the alpine.

Muddy Creek: Mud Lake Fen, 2008, 7700 ft, 3104. **Beartooth Butte:** up the Beartooth Butte, 1953, *Welch 16770* (WTU); Little Bear Creek-1, 2008, 9700 ft, 2701; Little Bear Lake Fen, 2008, 9600 ft, 2791; Clay Butte Fen, 2008, 8950 ft, 2995; Meadow Lake Fen, 2008, 9850 ft, 3761; Beartooth Falls, 2009, 8900 ft, 5437; Long Lake: E shore, 2010, 9600 ft, 6814; Chain Lake: S shore, 2010, 9500 ft, 7001. **Deep Lake:** [Hwy 212], W side, under late snow patch, 1973, 3200 m.s.m., *Weber B-44345* (COLO, RM); summits: alpine fen-4, 2008, 10,400 ft, 3277; Sawtooth Lake, 2009, 9300 ft, 6004; inlet of Sawtooth Lake, 2009, 9400 ft, 6064.

* **Campylophyllum hispidulum** (Brid.) Hedenäs

First record: 2010. Rare, two collections from upper foothills zone.

Jim Smith Peak: Crazy Creek-2, in crevice of wet granite cliff, in deep shade, assoc.: *Schistidium agassizii* Sull. & Lesq., 2010, 6850–6900 ft, 7951.

Muddy Creek: Gilbert Creek-2, on loamy soil on ledge of granite boulder, 2010, ! 6900 ft (2100 m), 8012.

Note: Altitudinal update – 2100 m vs. “low to high elevations (0–1700 m)” (FNA 2014, p. 316).

* * * **Campylopus schimperi** Milde

First record: 2008. Rare, single collection from upper subalpine zone; arctic-alpine.

Beartooth Butte: Little Bear Lake Fen, aapamire, *Carex scopulorum*/*Sphagnum warnstorffii* + *Aulacomnium palustre*, in pure mats on saturated boggy soil at base of low moss hummock around swale, 2008, 9600 ft, 2896 (BONN, COLO, MO), ver. J.-P. Frahm.

Note: A rare species, global conservation rank G3. Occurs in mountain systems of the Northern Hemisphere at elevations from 2700–3400 m. On the Beartooth Plateau is the only known station of the species in Wyoming (Kosovich-Anderson unpublished data). Periodic reconstruction of Hwy 212, which crosses Little Bear Lake Fen, is negatively affecting the fen ecosystem. The condition of the *C. schimperi* population may be characterized as vulnerable (Kosovich-Anderson 2011b).

Ceratodon purpureus (Hedw.) Brid.

First record: 2008. Common; on packed, recently disturbed forest, meadow and tundra soils, on wet soil in minerotrophic fens; in campsites, burned areas, sidewalk cracks and on neglected ground; on bare, naturally disturbed, soil of stream banks; in *Geum rossii*-dominated alpine tundra on till, frost boils and solifluction lobes; on disturbed soil near mammals' burrows, dens and birds' nests, along animal trails, on well-decaying excrements and corpses of wild animals. Sporophytes common.

Jim Smith Peak: Ivy Lake: SE edge, 2010, 8100 ft, 7565, S+. **Muddy Creek:** Lily Lake Fen, 2008, 7700 ft, 3087, S+; Lake Creek-1, 2010, 7700 ft, 7118.

Beartooth Butte: Island Lake CG: spruce forest, 2008, 9500 ft, 2220; Little Bear Lake Fen, 2008, 9600 ft, 2855; Clay Butte Fen, 2008, 9000 ft, 2937, S+; Little Bear Creek-2, 2008, 9500 ft, 3239; Meadow Lake Fen, 2008, 9850 ft, 3768; Beartooth Lake: W-SW shore, 2010, 8900 ft, 6646, S+. **Deep Lake:** Littlerock Creek Fen, Sawtooth Palsa Fen (Heidel et al. 2008); summits: alpine fen-2, 2008, 10,800 ft, 2335; summits: granite outcrops in alpine tundra-1, 2008, 10,900 ft, 2531; inlet of Frozen Lake, 2008, 10,550 ft, 2578; summits: wet alpine meadow, 2008, 10,750 ft, 3399, S+; Littlerock Creek Fen, 2008, 10,650 ft, 3572, S+; Wyoming Creek-2, 2009, 10,600 ft, 5011; Sawtooth Palsa Fen, 2009, 9700 ft, 5760; W summit and vicinity, 2010, 11,100 ft, 6695; summits: Stockade area, alpine tundra, 2010, 11,100 ft, 6714, S+. **Black Pyramid Mountain:** summits: alpine tundra-1, 2008, 10,250–10,300 ft, 2279, S+; summits: alpine fen-3, 2008, 10,100 ft, 2513, S+; summits: alpine tundra-4, 2008, 10,300 ft, 2481.

Note: In many specimens variability of costa length within one plant was observed - from percurrent to longly excurrent, that put under question mark the taxonomic value of this character. In addition, based on this study, I find debatable the statement by Vitt (2014, p. 129) that in North American peatlands “*Ceratodon* never occurs in rich fen lawns”.

Climacium americanum Brid.

First record: 1953. Rare, single collection from montane zone.

Jim Smith Peak: W of Beartooth Butte, Crazy Creek CG, 1953, *Lawton 2016* (WTU).

Note: Specimen not seen. Occurrence of this species in Wyoming is questioned (Kosovich-Anderson unpublished data).

Climacium dendroides (Hedw.) F. Weber & D. Mohr

First record: 1953. Common; on soil and duff in wet, moist and swampy forests; on wet clayey, sandy and gravelly substrates in stream-sides of forests, fens and willow wetlands, from foothills through the alpine.

Jim Smith Peak: W of Beartooth Butte, Crazy Creek CG, 1953, *Lawton 2025* (WTU); Crazy Creek CG Swamp, 2008, 7000 ft, 3182. **Muddy Creek:** Lily Lake Fen, 2008, 7700 ft, 3080; Ghost Creek Fen, 2008, 7900 ft, 3729; Lake Creek Waterfalls, 2009, 7500 ft, 5857; Muddy Creek-1, 2009, 8100 ft, 6132; outlet of Lily Lake, 2010, 7700 ft, 7505. **Beartooth Butte:** [Hwy 212], subalpine zone between Long Lake and lower Shepherd Lakes, 1973, 2900 m.s.m., *Weber B-44278* (COLO, RM), ver. R. Zander; Fantan North Fen (Heidel et al. 2008); Little Bear Lake Fen, 2008, 9600 ft, 2872; Beauty Lake Trail, 2009, 8900 ft, 5233; Beartooth Falls, 2009, 8900 ft, 5463; Chain Lake: S shore, 2010, 9500 ft, 6997. **Deep Lake:** summits: alpine fen-1, 2008, 10,500 ft, 2298; summits: alpine fen-4, 2008, 10,400 ft, 3284; Littlerock Creek Fen, 2008, 10,650 ft, 3668; Wyoming Creek-2, 2009,

10,600 ft, 4976; Sawtooth Lake, 2009, 9250 ft, 5994; Gravel Pit vicinity, alpine tundra, 2010, 10,400 ft, 7292; Dollar Lake: SW shore, 2010, 9400 ft, 7761. **Black Pyramid Mountain:** WY-MT state line: unnamed lake, 2010, 9750 ft, 8061 (CAS).

Coscinodon calyptratus (Drumm.) C.E.O.Jensen
First record: 1953. Sporadic; on shaded granitic boulders in pine stands and along the shore of subalpine lake; essentially arctic-alpine. E.
Muddy Creek: W of Beartooth Butte, [Hwy 296], at Lake Creek, 1953, *Lawton 2040* (WTU); Gilbert Creek-2, 2010, 6900 ft, 8017, S+.
Black Pyramid Mountain: WY-MT state line: unnamed lake, 2010, 9800 ft, 8101, S+.

Cratoneuron filicinum (Hedw.) Spruce
First record: 1953. Common; on soil and soil over rocks in streams, in wet sites in coniferous forests, willow carrs, and fens (especially calcareous), from upper foothills through the subalpine.
Muddy Creek: tributary of Beartooth Creek-1, 2010, 8400 ft, 7085; Beartooth Creek-3, 2010, 7550 ft, 7434; tributary of Gilbert Creek, 2010, 7800 ft, 7569; Gilbert Creek-2, 2010, 6900 ft, 8017 (CAS). **Beartooth Butte:** S slope of Beartooth Butte, 1953, *Lawton 2059* (WTU); NW side of Beartooth Lake, 1953, *Lawton 2070* (WTU); Little Bear Creek-2, 2008, 9450 ft, 3235; Creek SW of Beartooth Butte, 2008, 9500 ft, 3856; Beauty Lake Trail, 2009, 8900 ft, 5240; Beartooth Butte-1, 2009, 8950 ft, 5256; Clay Butte foothills, 2009, 9000 ft, 5417; Beartooth Lake: W-SW shore, 2010, 8900 ft, 6579.

* **Cynodontium strumiferum** (Hedw.) Lindb.
First record: 2008. Rare, two collections from upper subalpine and alpine elevations.
Deep Lake: Little Rock Creek Fen, in ditch, on soil over granite rocks, 2008, 10,650 ft, 3620. **Black Pyramid Mountain:** WY-MT state line: unnamed lake, peaty bank of lake, 2010, 9800 ft, 8090.

Dichelyma falcatum (Hedw.) Myrin
First record: 1953. Common; on granite rocks in cold, rocky streams, in wet depressions and on stream banks, from montane through the alpine.
Jim Smith Peak: Ivy Lake, SE edge, 2010, 8100 ft, 7538. **Muddy Creek:** Lake Creek CG: wet spruce forest, 2009, 6950 ft, 5896. **Beartooth Butte:** NW side of Beartooth Lake, 1953, *Lawton 2082* (WTU); [Hwy 212], subalpine zone between Long Lake and lower Shepherd Lakes, 1973, 2900 m.s.m., *Weber B-44282* (COLO, RM, WTU); Little Bear Lake Fen, 2008, 9600 ft, 2880 (COLO); unnamed creek/"Dichelyma Creek-1", 2009, 9500 ft, 6082; Fantan Lake: E shore, 2010, 9500 ft, 6893; unnamed creek/"Dichelyma Creek-2", 2010, 9550 ft, 6968; Long Lake: S edge, 2010, 9650 ft, 8302. **Deep Lake:** creek connecting Dollar and Sawtooth Lakes, 2009, 9400 ft, 5800; Sawtooth Lake, 2009, 9200 ft, 5985; Lower Top Lake Fen, 2010, 9450 ft, 7662; unnamed alpine lake along Hwy 212, 2010, 10,000 ft, 8248.

* **Dichodontium pellucidum** (Hedw.) Schimp.
First record: 2008. Sporadic; on wet sandy and clayey soil over stones along willow-lined creek banks, in snow-melt streams, at montane to subalpine elevations.

Muddy Creek: tributary of Beartooth Creek-1, 2010, 8400 ft, 7097. **Beartooth Butte:** Little Bear Creek-2, 2008, ! 9500 ft (2900 m), 3262; Little Bear Creek-3, 2009, 9400 ft, 5371.
Note: Altitudinal update – 2900 m vs. "low to high elevations (to 2300 m)" (FNA 2007, p. 385).

* **Dicranella heteromalla** (Hedw.) Schimp.
First record: 2008. Rare, single collection from alpine zone.

Deep Lake: Hwy 212, summits: small alpine lake, on shaded silt over rocks along lake shore, 2008, 10,500 ft, 3520.

* **Dicranella palustris** (Dicks.) Crundw. ex E.F.Warb.
First record: 2010. Rare, single collection from montane zone.

Muddy Creek: Gilbert Creek-1, *Carex* spp./Bryidae fen along creek bank, on damp clayey soil in seepage, 2010, ! 7700 ft (2350 m), 7591 (US), det. R. Ireland (Kosovich-Anderson 2011c).
Note: Altitudinal update – 2350 m vs. "low to medium elevations [0–1599 m]" (FNA 2007, p. 388).

Dicranella subulata (Hedw.) Schimp.
First record: 1953. Sporadic, at subalpine and alpine elevations; on damp sandy and loamy soil.
Beartooth Butte: NW side of Beartooth Lake, 1953, *Lawton 2074* (WTU); Little Bear Lake Fen, 2008, 9600 ft, 2799. **Deep Lake:** inlet of Frozen Lake, 2008, ! 10,550 ft (3220 m), 2551.
Note: Altitudinal update – 3220 m vs. "low to medium elevations [0–1599 m]" (FNA 2007, p. 392).

* **Dicranoweisia cirrata** (Hedw.) Lindb. ex Milde
First record: 1953. Frequent; on rocks and decaying trunks and logs in forests and shrublands, from foothills through the subalpine. Gemmae common.
Jim Smith Peak: Beartooth Lodge, near stream, 1953, *Lawton 1950* (WTU); W of Beartooth Butte, Crazy Creek CG, 1953, *Lawton 2033* (WTU); Crazy Creek CG Swamp, 2008, 7000 ft, 3226, S+. **Muddy Creek:** aspen grove along Hwy 212, 2008, 7700 ft, 3927, gemm.; Gilbert Creek-2, 2010, 6900 ft, 8019, gemm. **Beartooth Butte:** Clay Butte foothills, subalpine forest, 2009, ! 9000 ft (2740 m), 5391 (US), det. R. Ireland, gemm.
Note: Altitudinal update – 2740 m vs. "1–1900 m" (FNA 2007, p. 396).

Dicranoweisia crispula (Hedw.) Milde
First record: 1953. Common; on rocky ridgecrests, outcrops, stabilized talus, forming cushions on shaded granite rocks in alpine tundra and forested communities below the tree line; occasionally epixylic or growing on burnt wood, from montane through the alpine; essentially arctic-alpine. Sporophytes common.

Jim Smith Peak: Crazy Creek CG Swamp, 2008, 7000 ft, 3214, S+. **Muddy Creek:** Clay Butte: slope facing to W, 2009, 9800 ft, 4932, S+; aspen stands along Hwy 212, 2009, 8350 ft, 6108, S+; Lake Creek-1, 2010, 7700 ft, 7167 (US), det. R. Ireland; outlet of Lily Lake, 2010, 7700 ft, 7485 (US), det. R. Ireland; “Beaver Lake”, 2010, 7300 ft, 8340, S+. **Beartooth Butte:** Beartooth Lodge, near stream, 1953, *Lawton 1928* (WTU); [Hwy 212], granitic ridges with *Picea* and *Pinus flexilis*, vicinity of Long Lake and lower Shepherd Lakes, 1973, 2900 m.s.m., *Weber B-44232* (COLO, RM); Island Lake CG: spruce forest, 2008, 9500 ft, 2222, S+; Beauty Lake Trail, spruce forest, 2009, 8950 ft, 5227; 4WD Rd 149-1A: forested SW slope, 2010, 9650 ft, 7005 (US), det. R. Ireland. **Deep Lake:** Top Lakes: old-growth spruce-fir forest, 2010, 9600 ft, 7690, S+. **Black Pyramid Mountain:** summits: alpine fen-3, 2008, ! 10,100 ft (3080 m), 2511. **Unclear location:** granite bluff along [Hwy 212], 47 miles NW of Cody, 1965, 7500 ft, *Hermann 20050* (RM).

Note: Altitudinal update – 3080 m vs. “10–2000 m” (FNA 2007, p. 396).

Dicranum bonjeanii DeNot.

First record: 2008. Sporadic; on calcareous soil in subalpine fens; essentially arctic-alpine.

Beartooth Butte: boggy shore of Island Lake, 2008, 9500 ft, 2365; Little Bear Lake Fen, 2008, ! 9600 ft (2930 m), 2756; Fantan Lake: E shore, 2010, 9500 ft, 6874 (US), det. R. Ireland.

Note: Altitudinal update – 2930 m vs. “60–1300 m” (FNA 2007, p. 404).

* **Dicranum elongatum** Schleich. ex Schwägr.

First record: 2008. Rare, single collection from alpine zone; arctic-alpine.

Deep Lake: Littlerock Creek Fen, *Salix planifolia*/*Carex scopulorum*/*Dicranum elongatum* community, in compact hummocks on peaty soil, abundant, 2008, 10,650 ft, 3593 (COLO, MO).

Dicranum muehlenbeckii Bruch & Schimp.

First record: 1953. Frequent; sandy soil on cliffs along streams, among rocks in montane forests; rills and snowbeds in subalpine meadows and alpine tundra.

Jim Smith Peak: Ivy Lake: SE edge, 2010, 8100 ft, 7539; Crazy Creek-2, 2010, 6900 ft, 7949 (MO, US).

Beartooth Butte: subalpine zone between Long Lake and lower Shepherd Lakes, 1973, 2900 m.s.m., *Weber B-44283* (COLO). **Deep Lake:** [Hwy 212], near summit, 1953, ! 11,000 ft (3360 m), *Lawton 2138* (WTU); W side of Beartooth Pass, under late snow patch, 1973, 3200 m.s.m., *Weber B-44303* (COLO, RM); summits: alpine fen-4, 2008, 10,400 ft, 3288; Littlerock Creek Fen, 2008, 10,650 ft, 3597; Wyoming Creek-2, 2009, 10,600 ft, 5092; Canyon Creek valley: subalpine meadow, 2010, 9450 ft, 7768 (US), det. R. Ireland; summits: alpine tundra-12, 2010, 10,700 ft, 8178 (US), det. R. Ireland.

Note: Altitudinal update – 3350 m vs. “10–3100 m” (FNA 2007, p. 414).

Dicranum scoparium Hedw.

First report: 1953. Frequent; on rotten wood, humus and peaty soil in forested areas, from foothills through the upper subalpine.

Jim Smith Peak: Crazy Creek-2, 2010, 6900 ft, 8001.

Muddy Creek: W of Beartooth Butte, along the Clarks Fork, 1953, 6940 ft, *Lawton 2001* (WTU); Lake Creek-2, 2010, 6900 ft, 8414. **Beartooth Butte:** Little Bear Lake Fen, forested edge of the fen, 2008, 9600 ft, 2841 (CAS, COLO, US), det. R. Ireland; Beauty Lake Trail, 2009, 8950 ft, 5215, S+; Fantan Lake: E shore, 2010, 9500 ft, 6875 (US), det. R. Ireland; Long Lake: S edge, 2010, ! 9650 ft (2940 m), 8311 (US), det. R. Ireland. **Deep Lake:** ? Littlerock Creek Fen (Heidel et al. 2008), report based on doubtful identification.

Note: Altitudinal update – 2940 m vs. “50–2900 m” (FNA 2007, p. 403).

Dicranum spadiceum J.E.Zetterst.

First record: 1973. Frequent; in fens, wet meadows, alpine tundra, on soil in rock fields and on ridges along lake shores, at subalpine and alpine elevations; arctic-alpine.

Beartooth Butte: [Hwy 212], granitic ridges near lower Shepherd Lakes, 1973, 2900 m.s.m., *Weber B-44241* (COLO, RM); boggy shore of Island Lake, 2008, 9500 ft, 2383. **Deep Lake:** summits: alpine fen-2, 2008, 10,850 ft, 2330; ski-lift scenic point, alpine tundra, 2008, ! 10,900 ft (3320 m), 2348 (MHA, US); summits: alpine tundra-3, 2008, 10,350 ft, 2394 & 2415 (both in MHA); summits: drying creek in alpine tundra, 2008, 10,350 ft, 2424 (MHA); Littlerock Creek Fen, 2008, 10,650 ft, 3604. **Black Pyramid Mountain:** summits: alpine tundra-1, 2008, 10,250–10,300 ft, 2275 (MHA), det. M. Ignatov.

Note: Altitudinal update – 3320 m vs. “10–2300 m” (FNA 2007, p. 414). Specimens 2348, 2394, 2415, and 2424 were used in phylogenetic studies (Ignatova et al. 2015).

Dicranum tauricum Sapjegin

First record: 2010. Rare, in foothills and montane zones.

Jim Smith Peak: Crazy Creek-2, wet *Picea glauca* + *Pinus contorta* var. *latifolia*/*Alnus incana* (L.) Moench forest, on decaying trunk, 2010, 6900 ft, 8001.1. **Muddy Creek:** Lake Creek-1, wet spruce forest, on decaying log along creek, 2010, ! 7700 ft (2350 m), 7150 (US), det. R. Ireland.

Note: Altitudinal update – 2350 m vs. “150–2200 m” (FNA 2007, p. 418).

* * * **Didymodon asperifolius** (Mitt.) H.A.Crum, Steere & L.E.Anderson

[*Barbula asperifolia* Mitt., *Didymodon rufus* Lorentz] First record: 1973. Frequent; in alpine tundra, on glacial till and calcareous silt (frost boils) at snowbeds; arctic-alpine.

Deep Lake: [Hwy 212], alpine bogs of E summit, head of Wyoming Creek, 1973, 3250 m.s.m., *Weber B-44226* (COLO, RM); W side of Beartooth Pass, under late snow patch, 1973, 3200 m.s.m., *Weber B-44293* (COLO); summits: alpine fen-1; 2008, 10,500 ft, 2317 (MO, US); summits: alpine fen-2, 2008, 10,800 ft, 2330; summits: alpine tundra-3, 2008, 10,350 ft, 2410. **Black Pyramid Mountain:** summits: alpine fen-3, 2008, 10,100 ft, 2499.

Note: A rare species of arctic and alpine habitats. In Colorado, it is "a characteristic species of snow-melt basins in the alpine tundra, occurring in loose mats, loosely attached to sandy gravels in periodically inundated meltwater rills" (Weber and Wittmann 2007, p. 124). In Wyoming, the species is known only from the Beartooth Plateau (Kosovich-Anderson unpublished data).

Didymodon fallax (Hedw.) R.H.Zander

First record: 2008. Rare, at alpine elevations.

Deep Lake: Wyoming Creek-1, on calcareous silt, 2008, 10,300 ft, 3491. **Black Pyramid Mountain:** summits: alpine tundra-4, on silt, 2008, 10,250–10,300 ft, 2465.

Didymodon rigidulus Hedw.

- var. **gracilis** (Hook. & Grev.) R.H.Zander

First record: 2009. Rare, single collection from upper subalpine zone.

Muddy Creek: Clay Butte: slope facing to W, grasslands below Rd 142, limestone debris, on loamy soil in crevice of rock, in shade, 2009, 9800 ft, 4936.

* - var. **icmadophilus** (Schimp. ex Müll.Hal.) R.H.Zander

First record: 2008. Rare, single collection from alpine zone; arctic-alpine.

Deep Lake: summits: alpine tundra-6, on loamy soil, 2008, ! 10,850 ft (3310 m), 3393, gemm., leaves with fragile flexuous subula.

Note: Altitudinal update – 3310 m vs. "low to high elevations (40–2800 m)" (FNA 2007, p. 545).

Didymodon vinealis (Brid.) R.H.Zander

First record: 2010. Rare, single collection from lower montane zone.

Jim Smith Peak: Crazy Creek-2, on soil over shaded granite rocks lining the creek, 2010, 6900 ft, 7967.

Distichium capillaceum (Hedw.) Bruch & Schimp.

First record: 1953. Common; in high altitude wetlands and seeping cliffs, debris and outcrops from foothills through the alpine. Sporophytes common.

Jim Smith Peak: 15 mi W of Beartooth Lake, 1953, *Conard, s.n.* (WTU). **Muddy Creek:** W of Beartooth Butte, [Hwy 296], at Lake Creek, 1953, *Lawton 2098* (WTU); Lily Lake Fen, 2008, 7700 ft, 3093. **Beartooth Butte:** S slope of Beartooth Butte, 1953, *Lawton 2047* (WTU); near top of Beartooth Butte, in sandstone pocket, 1953, *Welch 16773* (WTU); Clay Butte Fen, 2008, 9000 ft, 2935, S+; Beartooth Falls, 2009, 8900 ft, 5460; Beartooth Butte-2, 2010, 8950 ft,

6609, S+. **Deep Lake:** [Hwy 212], near summit, 1953, 10,900 ft, *Lawton 1978* (WTU); summits: alpine fen-2, 2008, 10,800 ft, 2328; Sawtooth Lake, 2009, 9200 ft, 6030, S+; summits: alpine tundra-9, 2010, 10,400 ft, 8135. **Black Pyramid Mountain:** summits: alpine tundra-4, 2008, 10,300 ft, 2459; WY-MT state line: unnamed lake, 2010, 9750 ft, 8088, S+. **Unclear location:** [Hwy 212], 1953, 10,000 ft, *Whitehouse 27476* (WTU).

Distichium inclinatum (Hedw.) Bruch & Schimp.

First record: 2009. Rare (?), single collection from subalpine zone.

Beartooth Butte: Beartooth Butte-1; scattered limestone debris on slope, on a thick layer of humus over rock, assoc.: *Brachytheciastrum collinum*, 2009, 8950–9250 ft, 5261, S+.

Note: Reliable identification is possible only when sporophytes are present.

Ditrichum flexicaule (Schwägr.) Hampe

First record: 2008. Frequent; forms compact mats or sods in seepage areas over rocks in wet forests, fens, and alpine tundra, also on soaked peaty soil along pools and lakes, from montane through the alpine.

Muddy Creek: Lake Creek CG: wet spruce forest, 2009, 6950 ft, 5934. **Deep Lake:** summits: alpine fen-1, 2008, 10,500 ft, 2292; summits: alpine fen-2, 2008, 10,800 ft, 2327 (COLO); two lakes along Hwy 212, 2008, 10,000 ft, 2665; summits: Overlook Roadside Park, 2008, 10,950 ft, 3532. **Black Pyramid Mountain:** summits: alpine tundra-4, 2008, 10,250–10,300 ft, 2459.

Ditrichum gracile (Mitt.) Kuntze

First record: 2008. Rare, in alpine zone.

Deep Lake: summits: alpine fen-2, on calcareous soil, 2008, 10,800 ft, 2330. **Black Pyramid Mountain:** summits: alpine fen-3, on till, 2008, 10,100 ft, 2520.

Drapanocladus aduncus (Hedw.) Warnst.

First record: 1942. Common; on mineral-rich wetlands, eutrophic fens, ditches, or submerged in pools and lakes, rills and snobeds, in swampy forests, willow wetlands, from foothills through the alpine.

Jim Smith Peak: Little Moose Lake Fen (Heidel et al. 2008). **Muddy Creek:** Lily Lake East Fen (Heidel et al. 2008); Mud Lake Fen, 2008, 7700 ft, 3120; seepage slope along Hwy 212, 2009, 8700 ft, 6101; Rd 801: swampy mixed forest, 2009, 7050 ft, 6158; Lewis and Clark Trail: swampy mixed forest, 2009, 6600 ft, 6187; Hwy 212 and Rd 188 intersection: boggy valley, 2010, 7550 ft, 7203; Gilbert Creek-1, 2010, 7700 ft, 7585; "Beaver Lake", 2010, 7250 ft, 8355. **Beartooth Butte:** Clay Butte Fen, 2008, 8950 ft, 2995; Creek SW of Beartooth Butte, 2008, 9500 ft, 3865; Beauty Lake Trail, 2009, 8950 ft, 5247; Beartooth Falls, 2009, 8900 ft, 5451. **Deep Lake:** [Hwy 212], W side, under late snow patch, 1973, 3200 m.s.m., *Weber B-44314* (COLO, RM); Wyoming Creek-2, 2009, 10,600 ft, 4985. **Unclear location** (incorrect either coordinates or elevation in the label): along

[Hwy 212], just across the line in Wyoming, in alpine rivulet, 1942, 9500 ft, *Frye 3164* (CAS, NY, WTU), det. A.J. Grout (!).

Drepanocladus longifolius (Wilson ex Mitt.) Broth. ex Paris

[*Drepanocladus capillifolius* (Warnst.) Warnst.]

First record: 2008. Rare, in montane and subalpine zones.

Muddy Creek: Mud Lake Fen, fully submerged in pool, 2008, 7700 ft, 3115. **Beartooth Butte:** Beartooth Lake: E shore, forms carpets on soaked peaty soil and submerged in swales, assoc.: *Sphagnum platyphyllum*. 2009, 8900 ft, 4846 (COLO).

Drepanocladus polygamus (Schimp.) Hedenäs

[*Campyllum polygamum* (Schimp.) Lange & C.E.O.-Jensen]

First record: 2008. Frequent; in riparian willow communities, nutrient-rich wetlands, fens, in ditches, submerged in pools and lakes, in swampy forests, from foothills through the upper subalpine.

Jim Smith Peak: Ivy Lake: SE edge, 2010, 8000 ft, 7539. **Muddy Creek:** Ghost Creek Fen (Heidel et al. 2008); Lily Lake Fen, 2008, 7700 ft, 3057; Mud Lake Fen, 2008, 7700 ft, 3124. **Beartooth Butte:** Clay Butte Fen, 2008, 9000 ft, 2983; Meadow Lake Fen, 2008, 9850 ft, 3823; Beartooth Falls, 2009, 8900 ft, 5436; Beartooth Lake: W-SW shore, 2010, 8900 ft, 6651. **Deep Lake:** Canyon Creek, 2009, 9400 ft, 5674. **Black Pyramid Mountain:** WY-MT state line: unnamed lake, 2010, 9750 ft, 8095 (COLO).

Elodium blandowii (F.Weber & D.Mohr) Eckel

[*Helodium blandowii* (F.Weber & D.Mohr) Warnst.]

First record: 2008. Sporadic; in riparian willow communities, fens, swampy coniferous and mixed forests in montane zone.

Jim Smith Peak: Crazy Creek CG Swamp, 2008, 7000 ft, 3166. **Muddy Creek:** Lily Lake Swamp Forest, 2008, 7700 ft, 3048; Ghost Creek Fen, 2008, 7900 ft, 3756.

Encalypta ciliata Hedw.

First record: 1953. Sporadic; on soil in crevices of granite rocks, from montane through the alpine.

Muddy Creek: W of Beartooth Butte, [Hwy 296], at Lake Creek, 1953, *Lawton 2045* (WTU), S+; Lake Creek-1, 2010, 7700 ft, 7117, S+. **Deep Lake:** Gravel Pit vicinity, alpine tundra, 2010, 10,400 ft, 7315.

Encalypta procera Bruch

First record: 2008. Rare, in subalpine and alpine zones; arctic-alpine.

Beartooth Butte: Island Lake CG: subalpine meadow, in crevice of rock, 2008, 9500 ft, 2917. **Deep Lake:** summits: alpine tundra-3, on calcareous loamy soil, 2008, 10,350 ft, 2393.

Encalypta rhyptocarpa Schwägr.

First record: 1942. Frequent; on rocky ridgecrests and slopes, stabilized talus, in small tufts in rock crevices, on mineral soil on rock ledges or cliffs, on

bare ground in tundra, from foothills through the alpine; essentially arctic-alpine. Sporophytes common.

Muddy Creek: Lake Creek-2, 2010, 6900 ft, 8404, S+. **Deep Lake:** Beartooth Pass, 48 km E of Cooke City, alpine meadow, 1993, 3340 m, *Eversman 93192* (ISC), det. D.G. Horton; summits: granite outcrops in alpine tundra, 2008, 10,900 ft, 2537, S+; summits: alpine tundra-6, 2008, 10,900 ft, 3347, S+; summits: Overlook Roadside Park, alpine tundra, 2008, 10,950 ft, 3538; summits: alpine tundra-11, 2010, 10,750 ft, 8148. **Black Pyramid Mountain:** summits: alpine tundra-4, 10,250–10,300 ft, 2471, S+. **Unclear location:** “E from Cooke along Hwy”, on soil among rocks, 1942, 9500 ft, *Frye s.n.* (WTU), det. D.G. Horton as *Encalypta intermedia* Jur.

Eurhynchiastrum pulchellum (Hedw.) Ignatov & Huttunen

[*Eurhynchium pulchellum* (Hedw.) Jenn.]

First record: 1953. Frequent; in forested areas: on tree trunks, decaying wood, duff, on soil over rocks, always in filtered light, rarely in alpine tundra, from montane through the alpine.

Jim Smith Peak: Crazy Creek CG Swamp, 2008, 6950 ft, 3167. **Muddy Creek:** Lily Lake Swamp Forest, 2008, 7700 ft, 3039; tributary of Beartooth Creek-1, 2010, 8450 ft, 7088; Lake Creek-1, 2010, 7750 ft, 7119; outlet of Lily Lake, 2010, 7700 ft, 7516; Ghost Creek, 2010, 7900 ft, 8441. **Beartooth Butte:** W of Beartooth Butte, along Clarks Fork, 1953, 6940 ft, *Lawton 2014* (WTU); pine forest along Hwy 212, 2008, 9000 ft, 3908. **Black Pyramid Mountain:** summits: alpine tundra-4, 2008, 10,250–10,300 ft, 2460.

Fissidens bryoides Hedw.

First record: 2008. Frequent; on shaded wet soil of stream banks and ditches, in fens and riparian willow communities, from montane through the alpine.

Muddy Creek: Lily Lake Fen, 2008, 7700 ft, 3053; Lake Creek-1, 2010, 7700 ft, 7141; outlet of Lily Lake, 2010, 7700 ft, 7474; Lake Creek-2, 2010, 6900 ft, 8395. **Deep Lake:** summits: alpine tundra-6, 2008, 10,850 ft, 3381. **Black Pyramid Mountain:** WY-MT state line: unnamed lake, 2010, 9750 ft, 8090.

* **Fissidens osmundioides** Hedw.

First record: 1953. Frequent; in riparian willow communities, on moist soil, shaded rocks and wood, peaty banks of ditches, from montane through the alpine.

Jim Smith Peak: W of Beartooth Butte, Crazy Creek CG, 1953, *Lawton 2019* (WTU); Ivy Lake: SE edge, 2010, 8100 ft, 7521. **Muddy Creek:** Lake Creek Waterfalls, 2009, 7500 ft, 5853. **Beartooth Butte:** boggy shore of Island Lake, 2008, 9500 ft, 2385; Long Lake: E shore, 2010, 9600 ft, 6808; Fantan Lake: E shore, 2010, 9500 ft, 6889. **Deep Lake:** Littlerock Creek Fen, 2008, 10,650 ft, 3636; Top Lake Fen-1, 2009, 9450 ft, 5782; Sawtooth Lake, rapids, 2009, 9300 ft, 6040.

Fontinalis antipyretica Hedw.

First record: 1953. Frequent; on submerged granite rocks, logs, roots in slow- or fast-moving streams, in ponds and ditches, at montane and subalpine elevations.

Muddy Creek: Gilbert Creek-1, 2010, 7700 ft, 7589.

Beartooth Butte: Crane Lake, 1953, *Welch 15079* (WTU); SE and E of Beartooth Lake, 1953, *Welch 16057* (WTU); on creek flowing past Beartooth Lodge into Beartooth Lake, 1953, *Welch 15083* (TENN); creek connecting Fort and Chain Lakes, 2010, 9500 ft, 7792. **Deep Lake:** creek connecting Dollar and Sawtooth Lakes, 2009, 9400 ft, 5799.

Fontinalis hypnoides Hartm.

First record: 2009. Rare, single collection from montane zone.

Muddy Creek: Muddy Creek-1, in slow-moving water of creek, on drowned woods and underwater granite boulders, locally abundant, 2009, 8100 ft, 6120.

Fontinalis neomexicana Sull. & Lesq.

First record: 1953. Rare, single collection, elevation unknown. E.

Beartooth Butte: Beauty Lake, an outlet of Beauty Lake into Crane Lake, attached to rock, submerged, 1953, *Welch 15078* (WTU).

Funaria hygrometrica Hedw.

First record: 2008. Sporadic: on disturbed habitats along highways and roads, on campfire sites; cosmopolitan species.

Jim Smith Peak: Crazy Creek CG, 2008, 7000 ft, 3231, S+. **Beartooth Butte:** Beartooth Lake CG, 2009, 8900 ft, 4914A; Little Bear Lake Fen, roadside, 2008, 9600 ft, 2751 (½).

Gemmabryum caespiticium (Hedw.) J.R.Spence

[*Bryum caespiticium* Hedw.]

First record: 2008. Frequent; in disturbed areas (near dens and burrows of animals, and on trail banks), on various soils in exposed habitats like dry grasslands, most collections from alpine zone, on lower elevations more likely undercollected.

Deep Lake: summits: alpine fen-2, 2008, 10,850 ft, 2338; summits: alpine tundra-3, 2008, 10,350 ft, 2396, S+; Gravel Pit vicinity, alpine tundra, 2010, 10,400 ft, 7257 (ASC), det. J. Spence; summits: alpine tundra-13, 2010, 10,900 ft, 8194 (ASC), det. J. Spence. **Black Pyramid Mountain:** summits: alpine tundra-4, 2008, 10,300 ft, 2468 (ASC), det. J. Spence, S+; summits: alpine fen-3, 2008, 10,100 ft, 2512.

Grimmia alpestris (F.Weber & D.Mohr) Schleich.

First record: 1953. Sporadic; rocky ridgecrests and slopes, stabilized talus, on open and sheltered granite outcrops in different plant communities, at subalpine and alpine elevations.

Beartooth Butte: Beartooth Lodge, near stream, 1953, *Lawton 1935* (WTU); pine forest along Hwy 212, 2008, 9000 ft, 3888, S+; Island Lake CG: subalpine meadow, 2008, 9500 ft, 2916. **Deep Lake:** [Hwy 212], on rock, 1953, 10,000 ft, *Whitehouse*

27478 (WTU); inlet of Frozen Lake, 2008, 10,350–10,500 ft, 2599, S+.

Grimmia anodon Bruch & Schimp.

First record: 1953. Frequent; mainly on calcareous rocks, in different communities, from montane through the alpine; essentially arctic-alpine. Sporophytes common.

Muddy Creek: Clay Butte: slope facing to W, 2009, 9800 ft, 4917, S+; Lake Creek Waterfalls, 2009, 7500 ft, 5805; Hwy 212 and Hwy 296 intersection: slope facing to S, 2009, 7200 ft, 5877, S+. **Beartooth Butte:** S slope of Beartooth Butte, 1953, *Lawton 2052* (WTU), annot. R. Ireland, 1975; Beartooth Butte-1, 2009, 9250 ft, 5267, S+; Little Bear Creek-3, 2009, 9400 ft, 5347, S+; Beartooth Lake CG: spruce forest, 2009, 8930 ft, 6218. **Deep Lake:** inlet of Frozen Lake, 2008, ! 10,550 ft (3220 m), 2599; Sawtooth Lake, 2009, 9300 ft, 6026.

Note: Altitudinal update – 3220 m vs. “low to high elevations (20–2700 m)” (FNA 2007, p. 232).

Grimmia anomala Hampe ex Schimp.

First record: 1953. Rare, single collection, elevation unknown.

Beartooth Butte: Beartooth Lodge, near stream, 1953, *Lawton 1949* (WTU), annot. R. Ireland.

Grimmia donniana Sm.

First record: 1953. Rare, based on two old collections, elevations unknown.

Muddy Creek: 2 mi W of Beartooth Lake, along stream, 1953, *Whitehouse 27478* (NY). **Unclear location:** ca. 11 miles SE of [Hwy 212], 33 miles NW of Cody, 1965, *Hermann 20027* (NY).

Grimmia elatior Bruch ex Bals.-Criv. & DeNot.

First record: 1953. Frequent; on often sloping, irrigated granite rock outcrops, from montane through the alpine.

Muddy Creek: W of Beartooth [Butte], [Hwy 296], at Lake Creek, 1953, *Lawton 2039* (WTU). **Beartooth Butte:** boggy shore of Island Lake, 2008, 9550 ft, 2435-I, S+. **Deep Lake:** [Hwy 212], near the summit, 1953, 10,940 ft, *Lawton 1980* (WTU); [Hwy 212], dry rocky tundra, head of Wyoming Creek, 1973, 3240 m.s.m., *Weber B-44246* (COLO); summits: alpine tundra-3, 2008, 10,350 ft, 2417; summits: Overlook Roadside Park, alpine tundra, 2008, 11,000 ft, 3527.

* ** **Grimmia incurva** Schwägr.

First record: 2008. Rare, at alpine elevations.

Deep Lake: summits: alpine tundra-5, shaded granite rocks, 2008, ! 10,700 ft (3260 m), 3320, det. M. Ignatov. **Black Pyramid Mountain:** summits: alpine tundra-1, in crevices of granite outcrop, 2008, 10,250–10,300 ft, 2281.

Note: A regionally rare species (Weber and Wittmann 2002, 2007; Elliott and Pipp 2019); in North America with east-west disjunct distribution, uncommon in the continental interior. Altitudinal update – 3260 m vs. “moderate to high elevations (500–2500 m)” (FNA 2007, p. 252).

Grimmia longirostris Hook.

First record: 1953. Frequent; on exposed, dry and wet surfaces of acidic/granite rocks in different plant communities, in splash zone of waterfall, from upper foothills through the alpine.

Jim Smith Peak: W of Beartooth Butte, Crazy Creek CG, 1953, *Lawton 2036* (WTU); Crazy Creek-2, 2010, 6900 ft, *8003*. **Muddy Creek:** SW of Beartooth Butte, on [Hwy 296] at Lake Creek, 1953, *Lawton 2095* (WTU); Lake Creek Waterfalls, 2009, 7500 ft, *5807*. **Deep Lake:** [Hwy 212], near summit, 1953, ! 10,940 ft (3330 m), *Lawton 1986* (WTU); summits: alpine tundra-6, 2008, 10,870 ft, *3384*.

Note: Altitudinal update – 3330 m vs. “low to high elevations (100–3100 m)” (FNA 2007, p. 239).

Grimmia montana Bruch & Schimp.

First record: 2008. Common; on rocky ridgecrests and slopes, stabilized talus, on exposed acidic granite rocks (and occasionally sandstone), at subalpine and alpine elevations.

Beartooth Butte: Island Lake CG, spruce forest, 2008, 9500 ft, *2224*, S+; boggy shore of Island Lake, 2008, 9500 ft, *2439.1*; 4WD Rd 149-1A: forested SW slope, 2010, 9650 ft, *7008*; Fantan Lake: N shore, 2010, 9550 ft, *7039*, S+. **Deep Lake:** summits: alpine tundra-3, 2008, 10,350 ft, *2403*; summits: alpine tundra-5, 2008, 10,700 ft, *3323*, S+; summits: Overlook Roadside Park, alpine tundra, 2008, 11,000 ft, *3526*; summits: granite outcrops in alpine tundra-3, 2009, 11,000 ft, *4950*; Wyoming Creek-2, 2009, 10,600 ft, *5105*; summits: alpine tundra-13, 2010, 10,900 ft, *8196*. **Black Pyramid Mountain:** summits: alpine tundra-1, 2008, 10,250–10,300 ft, *2273*; summits: alpine fen-3, 2008, 10,100 ft, *2498*.

Grimmia ovalis (Hedw.) Lindb.

First record: 1953. Rare, based on two old collections, from montane through the alpine.

Jim Smith Peak: W of Beartooth Butte, Crazy Creek CG, 1953, *Lawton 2036* (WTU). **Deep Lake:** [Hwy 212], near summit, 1953, ! 11,000 ft (3350 m), *Lawton 2141* (WTU).

Note: Altitudinal update – 3350 m vs. “(low to) moderate to high elevations (30–) 1000–2500 m” (FNA 2007, p. 245).

Grimmia plagiopodia Hedw.

First record: 1953. Rare, single collection, elevation unknown.

Beartooth Butte: S slope of Beartooth Butte, 1953, *Lawton 2050* (WTU).

Grimmia pulvinata (Hedw.) Sm.

First record: 1965. Rare, single collection, elevation unknown.

Unclear location: granite outcrop along Rd ca. 11 mi SE of [Hwy 212], 33 mi NW of Cody, 1965, *Hermann 20025* (RM).

Grimmia sessitana DeNot.

First record: 2008. Sporadic; on granite outcrops and debris in alpine tundra.

Deep Lake: summits: alpine tundra-5, 2008, 10,700 ft, *3323*, S+; summits: alpine tundra-6, 2008, 10,900 ft, *3388*, det. M. Ignatov; summits: massive granite outcrop in alpine tundra, 2008, 10,900 ft, *3494*, S+.

Homalothecium aeneum (Mitt.) E.Lawton

First record: 1965. Rare, single collection from montane elevation. E.

Unclear location: along [Hwy 212], 47 mi NW of Cody, 1965, 7500 ft, *Hermann 20051* (NY, WTU), det. H. Hofmann.

Hygroamblystegium varium (Hedw.) Mönk.

- var. *humile* (P.Beauv.) Vanderp. & Hedenäs

First record: 2010. Rare, single collection from upper subalpine elevation.

Black Pyramid Mountain: WY-MT state line: unnamed subalpine lake, in ditch, on clayey soil, 2010, 9750–9800 ft, *8075*.

Hygrohypnum bestii (Renauld & Bryhn) Holz.

[*Platyhypnum bestii* (Renauld & Bryhn) Ochyra]

First record: 1953. Sporadic; attached to inundated rocks in subalpine and alpine streams.

Beartooth Butte: NW side of Beartooth Lake, 1953, *Lawton 2079* (WTU); shore of Beartooth Lake, 1953, *Whitehouse & Lawton, s.n.* (WTU); Beauty Lake Trail, 2009, 8950 ft, *5236* (UBC), ver. D. Jamieson; Little Bear Creek-3, 2009, 9400 ft, *5334*.

Deep Lake: [Hwy 212], E of summit, near small glacial lake, 1953, ! 10,500 ft (3200 m), *Lawton 1972* (WTU).

Note: Altitudinal update – 3200 m vs. “moderate to high elevations (1500–3000 m)” (FNA 2014, p. 272).

Hygrohypnum duriusculum (DeNot.) D.W.Jamieson

[*Hygrohypnum dilatatum* (Wilson) Loeske, *Platyhypnum duriusculum* (DeNot.) Ochyra]

First record: 1973. Frequent; on rocks and wet soil over rocks along streams and lake shores, rills and snowbeds, from foothills through the alpine.

Jim Smith Peak: Crazy Creek-2, 2010, 6850 ft, *7941*.

Beartooth Butte: Beartooth Falls, 2009, 8900 ft, *5425* (UBC), det. D. Jamieson; Beartooth Creek-2, 2010, 8900 ft, *6657*.

Deep Lake: W side of Beartooth Pass, under late snow patch, 1973, 3200 m.s.m., *Weber B-44313* (TENN); inlet of Frozen Lake, 2008, 10,350–10,550 ft, *2648*; head of unnamed creek-1, 2010, 10,250 ft, *6738*; tributary of Canyon Creek-1, 2010, 9900 ft, *6764*.

Hygrohypnum luridum (Hedw.) Jenn.

First record: 1953. Sporadic; occurs attached to stones and soil banks of streams, inundated by water, often on calcareous substrates, at subalpine elevations.

Beartooth Butte: Beartooth Lodge, near stream, 1953, *Lawton 1929* (WTU); W end of Beartooth Lake, 1953, *Lawton 1955* (WTU); Beartooth Butte-1, 2009, 9250 ft, *5258* (UBC), det. D. Jamieson; Clay

Butte foothills: subalpine forest, 2009, 9000 ft, 5411; creek SW of Beartooth Butte, 2008, 9500 ft, 3876, S+.

* **Hygrohypnum molle** (Hedw.) Loeske

[*Platyhypnum molle* (Hedw.) Loeske, *Ochyraea mollis* (Hedw.) Ignatov]

First record: 1973. Sporadic; occurs attached to stones and soil banks of streams, inundated by water; rills and snowbeds in alpine tundra, at subalpine and alpine elevations.

Beartooth Butte: Beartooth Falls, 2009, 8900 ft, 5427.

Deep Lake: [Hwy 212], W side, under late snow patch, 1973, 3200 m.s.m., *Weber B-44313* (COLO, RM); inlet of Frozen Lake, 2008, 10,550 ft, 2643; Wyoming Creek-2, 2009, 10,550 ft, 5017; Sawtooth Lake, 2009, 9200 ft, 6009.

Hygrohypnum ochraceum (Turner ex Wilson) Loeske [*Hygrohypnella ochracea* (Turner ex Wilson) Ignatov & Ignatova]

First record: 1953. Common; on wet rocks in subalpine and alpine streams and rivulets, in riparian willow communities.

Beartooth Butte: Beartooth Lodge, near stream, 1953, *Lawton 1926* (WTU); Little Bear Creek-1, 2008, 9700 ft, 2700; Little Bear Lake Fen, 2008, 9600 ft, 2812, S+; Beartooth Lake: E shore, 2009, 8900 ft, 4836A; Beartooth Lake CG: wet subalpine meadow, 2009, 8950 ft, 4906 (CAS, COLO), S+; Long Lake: E shore, 2010, 9600 ft, 6784; Fantan Lake: N shore, 2010, 9500 ft, 7036; creek connecting Fort and Chain Lakes, 2010, 9500 ft, 7792.

Deep Lake: [Hwy 212], W of the summit, along a stream, 1953, 9000–10,000 ft, *Lawton 1991* (WTU); Sawtooth Palsa Fen (Heidel et al. 2008); inlet of Frozen Lake, 2008, 10,350 ft, 2622; Canyon Creek, 2009, 9400 ft, 5649; Wyoming Creek-1, 2008, 10,300 ft, 3487; inlet of Sawtooth Lake, 2009, 9400 ft, 6070; creek connecting Lower Top and Sawtooth Lakes, 2010, 9450 ft, 7639; Top Lake Fen-2, 2010, 9450 ft, 7730.

* **Hygrohypnum smithii** (Sw.) Broth.

[*Platyhypnum smithii* (Sw.) Ochyra, *Ochyraea smithii* (Sw.) Ignatov & Ignatova]

First record: 2008. Rare, at subalpine and alpine elevations.

Beartooth Butte: Little Bear Creek-3, on wet granite rocks, 2009, 9400 ft, 5381 (UBC), det. D. Jamieson.

Deep Lake: inlet of Frozen Lake, on soil over rocks, 2008, ! 10,550 ft (3220 m), 2650.

Note: Altitudinal update – 3220 m vs. “moderate to high elevations (500–3100 m)” (FNA 2014, p. 280).

** **Hygrohypnum styriacum** (Limpr.) Broth.

First record: 2009. Rare, at subalpine elevations; arctic-alpine or montane.

Beartooth Butte: Beartooth Falls, on wet granite rocks, in splash zone, 2009, 8900 ft, 5431 (UBC), ver. D. Jamieson; Beartooth Lake: W shore, *Picea engelmannii* forest along the shore, on wet clay and sandy soil over rock, 2010, 8900 ft, 6652.

Note: A species of alpine and subalpine habitats, distributed in the mountains of Northern Hemisphere, rare across most of its range. Known from two stations in Wyoming, both on the Beartooth Plateau (Kosovich-Anderson and Weber 2011).

Hylocomium splendens (Hedw.) Schimp.

First record: 2008. Rare; on soil, humus, litter-fall, duff and well-decayed wood in old-growth forests, in montane zone.

Muddy Creek: Lily Lake vicinity, swampy *Picea glauca*/*Alnus* sp./Bryidae forest, 2008, 7750 ft, 3024 (COLO); Lake Creek-2, *Picea* sp. + *Pinus contorta* var. *latifolia* forest, 2010, 6900 ft, 8423.

Hypnum lindbergii Mitt.

[*Calliergonella lindbergii* (Mitt.) Hedenäs]

First record: 2008. Frequent; on wet clayey and sandy soil in willow carrs, meadows, and on lake margins, on logs and decaying wood in swamp forests, on moist soil along snow-melt streamlets in the subalpine.

Jim Smith Peak: Ivy Lake: SE edge, 2010, 8000–8100 ft, 7528. **Muddy Creek:** Gilbert Creek-2, 2010, 6900 ft, 8006. **Beartooth Butte:** boggy shore of Island Lake, 2008, 9500 ft, 2388; Little Bear Creek-1, 2008, 9700 ft, 2683; Beartooth Lake CG: wet subalpine meadow, 2009, 8950 ft, 4868; Beartooth Lake: W shore, 2010, 8900 ft, 6601; Long Lake: S edge, 2010, 9650 ft, 8302. **Deep Lake:** Sawtooth Meadow, 2009, 9400 ft, 5767; Sawtooth Lake, N shore, 2009, 9250 ft, 6029. **Black Pyramid Mountain:** WY-MT state line: unnamed lake, 2010, 9750 ft, 8052.

Hypnum pallescens (Hedw.) P.Beauv.

[*Joehenia pallescens* (Hedw.) Hedenäs, Schlesak & D.Quandt]

First record: 2010. Rare, single collection from montane zone.

Jim Smith Peak: Crazy Creek-2, on bank of a dry streamlet, 2010, ! 6900 ft (2100 m), 7949.

Note: Altitudinal update – 2100 m vs. “low to high elevations (0–2000 m)” (FNA 2014, p. 545).

* **Hypnum pratense** W.D.J.Koch ex Spruce

[*Breidleria pratensis* (W.D.J.Koch ex Spruce) Loeske]

First record: 2008. Frequent; on moist soil in fens and calcareous sites, in willow carrs and wet tundra, from montane through the alpine.

Jim Smith Peak: Crazy Creek CG Swamp, 2008, 6950 ft, 3169. **Muddy Creek:** Lily Lake East Fen (Heidel et al. 2008); Lily Lake Fen, 2008, 7700 ft, 3066; Ghost Creek Fen, 2008, 7900 ft, 3718.

Beartooth Butte: Little Bear Lake Fen, 2008, 9600 ft, 2889; Beartooth Lake: E shore, 2009, 8850 ft, 4856. **Deep Lake:** summits: alpine fen-4, 2008, 10,400 ft, 3271; Littlerock Creek Fen, 2008, ! 10,650 ft (3250 m), 3674; Sawtooth Lake, 2009, 9200 ft, 5970.

Note: Altitudinal update – 3250 m vs. “low to high elevations (0–3000 m)” (FNA 2014, p. 546).

Hypnum revolutum (Mitt.) Lindb.

- var. **revolutum**

[*Roaldia revoluta* (Mitt.) P.E.A.S.Câmara & M.Carvalho-Silva]

First record: 1953. Common; on boulders, outcrops and rock debris in *Festuca idahoensis* grasslands and *Artemisia tridentata* shrublands, on tree bases and decorticated downed wood throughout the forested area, on soil over rocks in alpine tundra.

Jim Smith Peak: Crazy Creek CG Swamp, 2008, 7000 ft, 3225; WY-MT state line: spruce forest, 2009, 7750 ft, 5479. **Muddy Creek:** Ghost Creek Fen, 2008, 7900 ft, 3743; Lake Creek Waterfalls, 2009, 7500 ft, 5859; aspen stands along Hwy 212, 2009, 8300 ft, 6106; Muddy Creek-1, 2009, 8100 ft, 6130; Lewis and Clark Trail: Douglas-fir forest, 2009, 6800 ft, 6183; SE slope: aspen grove, 2010, 7750 ft, 7409; Beartooth Creek-3, 2010, 7550 ft, 7415; outlet of Lily Lake, 2010, 7750 ft, 7484. **Beartooth Butte:** S slope of Beartooth Butte, 1953, *Lawton 2056* (WTU); SW side of Beartooth Lake, 1953, *Lawton 2077* (WTU); Clay Butte Fen, 2008, 8950 ft, 2927; Beartooth Butte-1, 2009, 9250 ft, 5293; granite ridge, W slope: coniferous forest, 2010, 9550 ft, 6941. **Deep Lake:** [Hwy 212], near summit, 1953, 10,950 ft, *Lawton 1975* (WTU); summit, 1953, 11,000 ft, *Welch 16642* (WTU); ski-lift scenic point, alpine tundra, 2008, 10,900 ft, 2347; Wyoming Creek-1, 2008, 10,300 ft, 3479; summits: Overlook Roadside Park, alpine tundra, 2008, 10,950 ft, 3531; Littlerock Creek Fen, 2008, 10,650 ft, 3605; summits: Stockade area, alpine tundra, 2010, 11,100 ft, 6710; Gravel Pit vicinity, alpine tundra, 2010, 10,400 ft, 7328; Gardner Lake: head of USFS Trail, 2010, 10,600 ft, 8183. **Black Pyramid Mountain:** summits: alpine tundra-1, 2008, 10,200–10,300 ft, 2277; summits: alpine fen-3, 2008, 10,100 ft, 2505.

* - var. **ravaudii** (Boulay) Ando

[*Roaldia dolomitica* (Milde) Hedenäs, Schlesak & D.Quandt]

First record: 2008. Sporadic; in boulder fields at alpine elevations, on rocks and loamy soil.

Deep Lake: summits: alpine tundra-3, 2008, 10,350 ft, 2400; dry creek in alpine tundra, 2008, 10,350 ft, 2430. **Black Pyramid Mountain:** summits: alpine tundra-1, 2008, 10,200–10,300 ft, 2270; summits: alpine tundra-4, 2008, 10,300 ft, 2469.

Hypnum vaucheri Lesq.

[*Buckia vaucheri* (Lesq.) D.Rios, M.T.Gallego & J.Guerra]

First record: 2008. Common; on rocky ridgecrests and slopes, outcrops, stabilized talus in alpine tundra, on soil over stones (often limestones), from foothills through the alpine.

Muddy Creek: Lewis and Clark Trail: Douglas-fir forest, 2009, 6800 ft, 6182. **Beartooth Butte:** Clay Butte: slope facing to E, 2008, 9700 ft, 3847; Beartooth Butte-1, 2009, 9250 ft, 5268. **Deep Lake:** summits: alpine fen-1, 2008, 10,500 ft, 2298; summits: alpine fen-2, 2008, 10,800 ft, 2327 (COLO); ski-lift scenic point, alpine tundra, 2008, 10,900 ft, 2347; summits: dry creek in alpine tundra, 2008, 10,350 ft,

2439; summits: alpine tundra-5, 2008, 10,650 ft, 3330 (COLO), det. W. Weber; W summit and vicinity, 2010, 11,050 ft, 6692; summits: Stockade area, alpine tundra, 2010, 11,100 ft, 6704. **Black Pyramid Mountain:** summits: alpine tundra-1, 2008, 10,200–10,300 ft, 2273.

Imbribryum muelhenbeckii (Bruch & Schimp.) N.Pedersen

[*Bryum muelhenbeckii* Bruch & Schimp.]

First record: 2008. Rare, at subalpine and alpine elevations.

Beartooth Butte: SE shore of Island Lake, ecotone between willow wetlands and subalpine *Picea engelmannii* forest, on wet loamy soil, 2008, 9500 ft, 2371 (ASC, COLO, DUKE), det. J. Spence. **Deep Lake:** inlet of Frozen Lake, on moist soil over rock, 2008, ! 10,500 ft (3200 m), 2544.

Note: Infrequently collected montane species. First report for Wyoming was based on the author's collection from the Beartooth Plateau (Kosovich-Anderson and Weber 2011). Altitudinal update – 3200 m vs. “moderate to high elevations (500–3000 m)” (FNA 2014, p. 146).

Isopterygiopsis pulchella (Hedw.) Z.Iwats.

First record: 2008. Rare, from montane through the alpine; essentially arctic-alpine.

Muddy Creek: Lake Creek Waterfalls, steep bank of creek, on wet humus soil in shade under spruce, in splash zone of waterfall, 2009, 7500 ft, 5833, S+.

Deep Lake: summits: alpine fen, on bare peaty bank of alpine pool, 2008, ! 10,400 ft (3170 m), 3275.

Note: Altitudinal update – 3170 m vs. “low to high elevations (10–2300 m)” (FNA 2014, p. 551).

* ** **Kiaeria blyttii** (Bruch & Schimp.) Broth.

First record: 2008. Sporadic; on soil in crevices of granite rocks, from montane through the subalpine; montane and arctic-alpine.

Muddy Creek: Ghost Creek, on rocks, 2008, 7900 ft, 3752. **Beartooth Butte:** boggy shore of Island Lake, on granite outcrops, 2008, 9500 ft, 2365; small subalpine lake, on rock, 2010, 9500 ft, 6846.

Note: An infrequently collected and a regionally rare species, also known in Wyoming from the Bighorn Mtns. (M. Lenz, personal communication, Kosovich-Anderson 2018).

* ** **Kiaeria starkei** (F.Weber & D.Mohr) I.Hagen

First record: 2008. Rare, single collection from alpine zone; montane and arctic-alpine.

Deep Lake: unnamed small alpine lake immediately S of Hwy 212, edge of lake, on peaty soil over acid rock, 2008, 10,000 ft, 2671.

Note: An infrequently collected species, rare in Wyoming, known in the state from a single station on the Beartooth Plateau (Kosovich-Anderson unpublished data).

Leptobryum pyriforme (Hedw.) Wilson

First record: 1953. Common; on clayey, sandy, gravelly, and peaty soil of creek banks and lake

shores, on decaying wood in forested areas, on disturbed substrates: near animals' burrows, dens and nests, on animal trails, and in different anthropogenic habitats, from foothills through the alpine. Sporophytes common.

Jim Smith Peak: Crazy Creek CG Swamp, 2008, 6950 ft, 3190, S+. **Muddy Creek:** W of Beartooth Butte, along the Clarks Fork, 1953, 6940 ft, *Lawton 2011* (WTU); Mud Lake Fen, 2008, 7750 ft, 3130, S+; Rd 801: swampy mixed forest, 2009, 7000 ft, 6165, S+; tributary of Beartooth Creek, 2010, 8450 ft, 7090; tributary of Gilbert Creek, 2010, 7800 ft, 7567, S+; "Beaver Lake", 2010, 7300 ft, 8336, S+. **Beartooth Butte:** Clay Butte Fen, 2008, 8950 ft, 2992, S+. **Deep Lake:** summits: unnamed alpine lake, 2008, 10,500 ft, 3502; Wyoming Creek-2, 2009, 10,600 ft, 5049; Top Lake Fen-2, 2010, 9450 ft, 7742, S+; tributary of Canyon Creek, 2010, 9400 ft, 7778.

Leptodietyum riparium (Hedw.) Warnst.

First record: 1953. Rare, from montane through the upper subalpine.

Muddy Creek: W of Beartooth, [Hwy 296], at Lake Creek, 1953, *Lawton 2042* (WTU). **Black Pyramid Mountain:** WY-MT state line: unnamed lake, in swale, 2010, ! 9750 ft (2970 m), 8089.

Note: Altitudinal update – 2970 m vs. "low to moderate elevations [0–1599 m]" (FNA 2014, p. 291).

* ** **Meesia longiseta** Hedw.

First record: 2002. Rare, in montane zone.

Jim Smith Peak: Little Moose Fen, 2002, 7960 ft, *Jackson s.n.* (RM), det. YKA. **Muddy Creek:** Ghost Creek Fen, *Drosera anglica* Huds./*Sphagnum warnstorffii* community, on soaked peaty soil, forms admixture with *Straminergon stramineum* (Dicks. ex Brid.) Hedenäs, 2008, 7900 ft, 3706.

Note: Regionally rare species of boreal, alpine, and arctic habitats, occurring in rich fens. Species of conservation concern in Montana (Elliott and Pipp 2019).

* ** **Meesia triquetra** (L. ex Jolycl.) Ångstr.

First record: 2008. Rare, single collection from montane zone.

Muddy Creek: Ghost Creek Fen, on soaked boggy soil, assoc.: *Scorpidium cossonii* (Schimp.) Hedenäs and *Aulacomnium palustre*, 2008, 7900 ft, 3711.

Note: A rich fen indicator species of basically arctic and boreal habitats. Disjunct in Wyoming, known from very few locations in the high mountains - on the Beartooth Plateau, Bighorn Mtns., and Wind River Range (Kosovich-Anderson unpublished data). Species of conservation concern in Montana (Elliott and Pipp 2019).

Meesia uliginosa Hedw.

First record: 2008. Sporadic; in rich subalpine and alpine fens and moist calcareous soil banks.

Deep Lake: Littlerock Creek Fen, 2008, 10,650 ft, 3636; head of Wyoming Creek, 2009, 10,600 ft, 4975.

Black Pyramid Mountain: WY-MT state line: unnamed lake, 2010, 9750 ft, 8091.

Meiotrichum lyallii (Mitt.) G.L.Merr.

[*Polytrichadelphus lyallii* Mitt., *Polytrichum lyallii* (Mitt.) Kindb.].

First record: 1953. Frequent; on soil and duff in old-growth subalpine spruce-fir forests, on soil of banks of lakes inlets and outlets in subalpine and alpine zones. E.

Beartooth Butte: Island Lake CG: spruce forest, 2008, 9500 ft, 2216; Beartooth Lake CG: coniferous forest, 2009, 8950 ft, 6230; 4WD Rd 149-1A: forested SW slope, 2010, 9650 ft, 7006. **Deep Lake:** [Hwy 212], near summit, 1953, ! 10,940 ft (3330 m), *Lawton 1983* (WTU); boggy area between two small alpine lakes along Hwy 212, 2008, 10,000 ft, 2678.1; Sawtooth Lake, 2009, 9300 ft, 6053; Top Lakes: old-growth spruce-fir forest, 2010, 9600 ft, 7694.

Note: Altitudinal update – 3330 m vs. "moderate to high elevations (900–3300 m)" (FNA 2007, p. 142).

Mnium arizonicum J.J.Amarn

First record: 1953. Common; in the alpine and subalpine zones on soil over granite outcrops and in deeply shaded niches between granite debris in forested areas up to alpine tundra. E.

Muddy Creek: Lake Creek Waterfalls, 2009, 7500 ft, 5820; Beartooth Creek-3, 2010, 7550 ft, 7415; "Beaver Lake", 2010, 7250 ft, 8331. **Beartooth Butte:** granite ridge, W slope: coniferous forest, 2010, 9500 ft, 6932. **Deep Lake:** [Hwy 212], near summit, 1953, 10,950 ft, *Lawton 1977* (WTU); summits: alpine fen-1, 2008, 10,500 ft, 2292; ski-lift scenic point, alpine tundra, 2008, 10,900 ft, 2347; summits: granite outcrops in alpine tundra, 2008, 10,900 ft, 2532 (H, MO), det. T. Koponen; summits: alpine fen-4, 2008, 10,400 ft, 3278; summits: Overlook Roadside Park, alpine tundra, 2008, 10,950 ft, 3534; W summit and vicinity, 2010, 11,150 ft, 6685; summits: Stockade area, alpine tundra, 2010, 11,100 ft, 6699; Gravel Pit vicinity, alpine tundra, 2010, 10,400 ft, 7328. **Black Pyramid Mountain:** summits: alpine tundra-1, 2008, 10,200–10,300 ft, 2287.

Mnium blyttii Bruch & Schimp.

First record: 2008. Frequent; on wet soil in forested areas, preferring calcareous soil; along creeks and lakes, from montane through the subalpine; essentially arctic-alpine.

Jim Smith Peak: Crazy Creek CG Swamp, 2008, 6950 ft, 3187. **Muddy Creek:** Lake Creek Waterfalls, 2009, 7500 ft, 5808; tributary of Beartooth Creek, 2010, 8450 ft, 7056 (H, MO), det. T. Koponen.

Beartooth Butte: pine forest along Hwy 212, 2008, 9000 ft, 3903; Clay Butte foothills: subalpine forest, 2009, 9000 ft, 5392; Beartooth Lake: W shore, 2010, 8900 ft, 6578.

Mnium lycopodioides Schwägr.

[*Mnium ambiguum* H.Müll.]

First record: 2009. Rare, at montane elevations; essentially arctic-alpine.

Jim Smith Peak: Crazy Creek-2, on soil over rocks, 2010, 6900 ft, 7956. **Muddy Creek:** Lake Creek

Waterfalls, on soil over granite boulders, in splash zone of waterfalls, 2009, 7500 ft, 5817.1 (H, MO), det. T. Koponen.

Mnium marginatum (Dicks.) P. Beauv.

First record: 1953. Frequent; on rotten logs, humus soil and duff in springy areas of old-growth subalpine spruce-fir forests, from montane through the subalpine; essentially arctic-alpine.

Jim Smith Peak: Crazy Creek, bank of creek, 1953, *Welch 16700* (WTU). **Muddy Creek:** Lake Creek Waterfalls, 2009, 7500 ft, 5817; tributary of Beartooth Creek-1, 2010, 8450 ft, 7058; Beartooth Creek-3, 2010, 7550 ft, 7411. **Beartooth Butte:** Little Bear Creek-4, 2009, ! 8950 ft (2730 m), 6224; tributary of Beartooth Creek-2, 2010, 7750 ft, 7396.

Note: Altitudinal update – 2730 m vs. “low to moderate elevations [0–1599 m]” (FNA 2014, p. 226).

* **Mnium spinulosum** Bruch & Schimp.

First record: 2010. Rare, single collection from montane zone.

Muddy Creek: outlet of Lily Lake, wet *Picea glauca*/*Alnus incana* forest, on forest floor, in partial shade, 2010, ! 7750 ft (2360 m), 7490, S+.

Note: Altitudinal update – 2360 m vs. “low to moderate elevations [0–1599 m]” (FNA 2014, p. 228) and 2200 m (Lawton 1971).

Mnium thomsonii Schimp.

First record: 1953. Common; on calcareous rock and soil along streams in forested areas from foothills through the subalpine, sometimes in alpine fens; arctic-alpine.

Jim Smith Peak: W of Beartooth Butte, Crazy Creek CG, 1953, *Lawton 2022* (WTU). **Muddy Creek:** W of Beartooth Butte, [Hwy 296], at Lake Creek, 1953, *Lawton 2089* (WTU); Lake Creek-1, 2010, 7700 ft, 7114; Rd 188: sparsely forested slope, 2010, 7600 ft, 7196; Beartooth Creek-3, 2010, 7550 ft, 7423; Gilbert Creek-2, 2010, 6900 ft, 8012. **Beartooth Butte:** Little Bear Creek-1, 2008, 9700 ft, 2686; Clay Butte Fen, 2008, 8950 ft, 2935; Beartooth Falls, 2009, 8900 ft, 5460; Beartooth Lake CG: coniferous forest, 2010, 8950 ft, 8261. **Deep Lake:** summits: alpine fen-4, 2008, 10,400 ft, 3278; Sawtooth Lake, 2009, 9300 ft, 6038.

* ** **Molendoa sendtneriana** (Bruch & Schimp.) Limpr.

First record: 2009. Rare, single collection from montane zone.

Muddy Creek: Lake Creek Waterfalls, splash zone of the waterfall, on a thick layer of humus-sandy soil over log, in shade under *Picea* sp., 2009, ! 7500 ft (2280 m), 5845.

Note: *Molendoa* Lindb. is a genus of mountain and arctic habitats, rarely collected in Wyoming. *Molendoa sendtneriana* is a regionally rare calciphilous montane species, known in Wyoming from very few stations (Kosovich-Anderson unpublished data), rare in Colorado (Weber and Wittmann 2007) and absent in a moss state list of Montana (Elliott and Pipp 2019). Altitudinal update – 2280 m vs. “low to high elevations (100–2000 m)” (FNA 2007, p. 564).

Myurella julacea (Schwägr.) Schimp.

First record: 2008. Sporadic; in alpine fen, tundra and drying bed of creek, as an admixture to other mosses.

Deep Lake: summits: dry creek in alpine tundra, 2008, 10,350 ft, 2440. **Black Pyramid Mountain:** summits: alpine tundra-4, 2008, 10,200–10,300 ft, 2459; summits: alpine fen-3, 2008, 10,100 ft, 2525.

Niphotrichum canescens (Hedw.) Bedn.-Ochyra & Ochyra

[*Racomitrium canescens* (Hedw.) Brid.]

First record: 1953. Sporadic; on wet ground in alpine tundra and in open subalpine sites.

Beartooth Butte: off Beauty Lake, on granite, 1953, *Welch 16833* (WTU). **Deep Lake:** ski-lift scenic point, alpine tundra, 2008, 10,900 ft, 2357 (½). **Unclear location:** Beartooth Plateau, 1973, 2900 m.s.m., *Weber B-44286* (COLO, RM).

Oncophorus virens (Hedw.) Brid.

First record: 1953. Common; on boggy soil in fens across subalpine and alpine zones, near streams, on moist rocks, rotten logs, more rare at lower elevations; arctic-alpine.

Muddy Creek: Beartooth Creek-3, 2010, 7550 ft, 7429 (US), det. R. Ireland, S+; Lake Creek-2, 2010, 6900 ft, 8408, S+. **Beartooth Butte:** up the Beartooth Butte, creek bank, 1953, *Welch 16670* (WTU); S slope of Beartooth Butte, 1953, *Lawton 2060* (WTU); Beartooth Lake: W shore, 2010, 8900 ft, 6603; boggy valley: small subalpine lake, 2010, 9500 ft, 6905; Chain Lake: S shore, 2010, 9480 ft, 6992, S+. **Deep Lake:** [Hwy 212], alpine bogs, head of Wyoming Creek, 3250 m.s.m., 1973, *Weber B-44223* & *B-44264* (COLO, RM); summits: alpine fen-1, along pools, 2008, 10,500 ft, 2305; summits: alpine fen-5, 2008, 10,750 ft, 3433 (COLO); Littlerock Creek Fen, 2008, 10,650 ft, 3560; Sawtooth Lake, 2009, 9200 ft, 6003; inlet of Sawtooth Lake, 2009, 9400 ft, 6067; Long Lake, NW slope: willow wetlands, 2010, 9750 ft, 8297, S+. **Black Pyramid Mountain:** WY-MT state line: unnamed lake, 2010, 9800 ft, 8094 (CAS, COLO, DUKE, MONTU, US), ver. R. Ireland.

Oncophorus wahlenbergii Brid.

First record: 1973. Sporadic; on rotten logs along streams or in flooded areas, on soil, humus, rock or bark at the base of coniferous trees, from montane through the subalpine.

Muddy Creek: Rd 801: swampy mixed forest, 2009, 7050 ft, 6161. **Beartooth Butte:** [Hwy 212], subalpine zone between Long Lake and lower Shepherdder Lakes, 1973, 2900 m.s.m., *Weber B-44288* (COLO, RM); Little Bear Lake Fen, 2008, 9600 ft, 2834 (US), ver. R. Ireland, S+.

Orthotrichum alpestre Hornsch. ex Bruch & Schimp.

First record: 2008. Sporadic; on rock debris in alpine tundra, on bases of trees and rocks in subalpine coniferous forests.

Beartooth Butte: Island Lake CG: spruce forest, 2008, 9550 ft, 2221, S+. **Deep Lake:** summits: dry

creek in alpine tundra, 2008, 10,350 ft, 2447; summits: alpine tundra-6, 2008, ! 10,850 ft (3310 m), 3381 S+.
Note: Altitudinal update – 3310 m vs. “high elevations (2100–3000 m)” (FNA 2014, p. 50).

Orthotrichum laevigatum J.E.Zetterst.

[*Lewinskya laevigata* (J.E.Zetterst.) F.Lara, Garilleti & Goffinet]

First record: 1953. Common; on granite boulders, outcrops and debris in dry, mesic, wet and swampy forests, in meadows, fens, and tundra; from foothills through the alpine. Sporophytes common.

Jim Smith Peak: Crazy Creek, on granite, 1953, *Welch 16695* (WTU); W of Beartooth Butte, Crazy Creek CG, 1953, *Lawton 2031* (WTU); Crazy Creek-1, 2009, 6950 ft, 5612, S+. **Muddy Creek:** W of Beartooth Butte, at Falls of Lake Creek, 1953, *Lawton 2086* (WTU); Lake Creek CG: wet coniferous forest, 2009, 6950 ft, 5933, S+. **Beartooth Butte:** W end of Beartooth Lake, 1953, *Lawton 1954* (WTU); NW side of Beartooth Lake, 1953, *Lawton 2076* (WTU); [Hwy 212], granite ridges with *Picea* and *Pinus flexilis*, vicinity of Long Lake and lower Shepherd Lakes, 1973, 2900 m.s.m., *Weber B-44240 & B-44283* (COLO, RM); Island Lake CG: spruce forest, 2008, 9550 ft, 2222, S+. **Deep Lake:** [Hwy 212], near summit, 1953, ! 10,950 ft (3340 m), *Lawton 2139* (WTU); summits: alpine tundra-3, 2008, 10,350 ft, 2397, det. D. Vitt, S+; dry creek in alpine tundra, 2008, 10,350 ft, 2437, S+; summits: alpine tundra-5, 2008, 10,700 ft, 3334, S+. **Black Pyramid Mountain:** summits: alpine tundra-1, 2008, 10,200 ft, 2282, S+; summits: alpine fen-3, 2008, 10,100 ft, 2516; summits: alpine tundra-4, 2008, 10,200–10,300 ft, 2476, det. D. Vitt.

Note: Altitudinal update – 3340 m vs. “moderate to high elevations (500–3000 m)” (FNA 2014, p. 58).

Orthotrichum rupestre Schleich. ex Schwägr.

[*Lewinskya rupestris* (Schleich. ex Schwägr.) F.Lara, Garilleti & Goffinet]

First record: 1953. Frequent; on granite rock overhang in mesic forested areas, rarely at the base of trees, from foothills through the alpine.

Jim Smith Peak: W of Beartooth [Butte], Crazy Creek CG, 1953, *Lawton 2017 & 2030* (WTU); Crazy Creek-2, 2010, 6900 ft, 7968, S+. **Muddy Creek:** [Hwy 296], at Lake Creek, 1953, *Welch 16741* (WTU); Lewis and Clark Trail: Douglas-fir forest, 2009, 6800 ft, 6178, ver. D. Vitt, S+. **Black Pyramid Mountain:** summits: alpine tundra-4, 2008, 10,200–10,300 ft, 2476; summits: alpine fen-3, 2008, 10,100 ft, 2501, S+.

Orthotrichum speciosum Nees

[*Lewinskya speciosa* (Nees) F.Lara, Garilleti & Goffinet]

First record: 2008. Rare, two collections from montane and alpine elevations.

Muddy Creek: Lake Creek CG: wet coniferous forest, on boulder, 2009, 6950 ft, 5933, det. D. Vitt. **Deep**

Lake: summits: alpine tundra-3, in crevice of granite rock, 2008, ! 10,350 ft (3150 m), 2399, S+.
Note: Altitudinal update – 3150 m vs. “low to high elevations (10–2000 m)” (FNA 2014, p. 67).

* **Paludella squarrosa** (Hedw.) Brid.

First record: 2002. Sporadic; in shallow water of montane and subalpine fens fed by spring water and snowmelt, semi-submerged above the late summer water table; boreal to arctic-alpine or montane-alpine.

Jim Smith Peak: Little Moose Peatland, 2002, 7960 ft, *Jackson s.n.* (RM), det. J. Harpel. **Beartooth Butte:** boggy valley of unnamed lake (“Paludella Lake”), 2010, 9500 ft, 6921 (COLO); Chain Lake: S shore, 2010, 9500 ft, 6989. **Deep Lake:** Sawtooth Palsa Fen (Heidel et al. 2008). **Black Pyramid Mountain:** WY-MT state line: unnamed lake, 2010, 9750 ft, 8064.

Palustriella falcata (Brid.) Hedenäs

[*Cratoneuron commutatum* var. *falcatum* (Brid.) Mönk.]

First record: 1953. Common in Beartooth Butte Quadrangle; in calcium-rich habitats, in springs, boggy streams, on wet rocks and creek banks in forested areas, from montane to subalpine elevations.

Beartooth Butte: W end of Beartooth Lake, 1953, *Lawton 1956* (WTU); S slope of Beartooth Butte, 1953, *Lawton 2048* (WTU), S+, det. as *Palustriella decipiens* (DeNot.) Ochyra; Beartooth Butte, 1953, *Welch 16807* (WTU); Beartooth Butte, S slope, lower altitude, 1953, *Lawton s.n.* (MO); Beartooth Butte, 1953, 8000–9000 ft, *Conard s.n.* (NY); near Beartooth Lake, 1953, *Welch 16604* (FLAS); Clay Butte Fen, 2008, 8950 ft, 2990; Little Bear Creek-2, 2008, 9500 ft, 3235; creek SW of Beartooth Butte, 2008, 9500 ft, 3856; Clay Butte foothills: subalpine forest, 2009, 9000 ft, 5396; Beartooth Lake: W shore, 2010, 8900 ft, 6562.

Paraleucobryum enerve (Thed.) Loeske

First record: 1973. Sporadic; on soil over granite boulders, outcrops and cliffs, on stream banks, in upper subalpine and alpine zones; essentially arctic-alpine.

Beartooth Butte: Little Bear Creek-1, steep rocky terrace along the creek, N-facing granite cliff, 2008, 9700 ft, 2712 (½) (CAS, COLO, MO, US), ver. R. Ireland. **Deep Lake:** [Hwy 212], alpine bogs of E summit, head of Wyoming Creek, 1973, 3250 m.s.m., *Weber B-44256* (COLO, RM, WTU), annot. P. Eckel; ski-lift scenic point, alpine tundra, 2008, 10,900 ft, 2357 (½) (COLO).

* **Philonotis caespitosa** Jur.

First record: 2008. Sporadic; on wet soil of streams banks and ditches, from montane through the alpine.

Jim Smith Peak: Crazy Creek-2, 2010, 6900 ft, 7959. **Beartooth Butte:** Little Bear Lake Fen, 2008, 9600 ft, 2901. **Deep Lake:** inlet of Frozen Lake, 2008, 10,350–10,550 ft, 2540.

Philonotis fontana (Hedw.) Brid.

- var. fontana

First record: 1953. Common; in seepy habitats, on rocks and clayey, sandy, gravelly and peaty soil along lake shores and stream banks, in willow communities at all elevations.

Jim Smith Peak: Little Moose Lake Fen (Heidel et al. 2008). **Muddy Creek:** Gilbert Creek-2, 2010, 6900 ft, 8005. **Beartooth Butte:** S slope of Beartooth Butte, 1953, *Lawton 2057* (WTU); NW side of Beartooth Lake, 1953, *Lawton 2080* (WTU); Beauty Lake Trail, 2009, 8900 ft, 5244; Beartooth Falls, 2009, 8900 ft, 5434; creek connecting Fort and Chain Lakes, 2010, 9500 ft, 7792. **Deep Lake:** below Beartooth Pass, 38 mi NW of Cody, tundra, 1965, 10,000 ft, *Hermann 20074* (NY, WTU), det. W.M. Zales; S of Sawtooth Mt., wet boggy area, 2007, 9800 ft, *E.Elliott, Heidel & B.Elliott 3588* (RM), det. YKA; summits: alpine fen-2, 2008, 10,600 ft, 2326 (H, MO), det. T. Koponen; inlet of Frozen Lake, 2008, 10,550 ft, 2562; summits: wet alpine meadow, 2008, 10,750 ft, 3395; Wyoming Creek-1, 2008, 10,300 ft, 3463; Sawtooth Palsa Fen, 2009, 9650 ft, 5694; summits: snow-melt rill, 2010, 10,600 ft, 6724 (H, MO), det. T. Koponen; Dollar Lake: SW shore, 2010, 9400 ft, 7755.

*** - var. americana** (Dism.) Flowers ex H.A.Crum

[*Philonotis americana* Dism.]

First record: 2009. Rare, single collection from subalpine zone.

Beartooth Butte: Little Bear Creek-3, moss-lined bank of creek, in shade, on wet humus, 2009, 9400 ft, 5382 (H, MO), det. T. Koponen.

- var. pumila (Turner) Brid.

[*Philonotis tomentella* Molendo]

First record: 1953. Frequent; in springs, flushes, wet clayey and gravelly soil, seepage zones on fens at montane through the alpine, especially at late snow-melt areas; essentially arctic-alpine.

Muddy Creek: Hwy 212 and Rd 188 intersection: boggy valley, 2010, 7550 ft, 7217. **Beartooth Butte:** Beartooth Butte, 1953, 9000 ft, *Lawton 2053* (WTU); boggy shore of Island Lake, 2008, 9500 ft, 2367; Little Bear Lake Fen, 2008, 9600 ft, 2757; Island Lake CG: subalpine meadow, 2008, 9500 ft, 2924. **Deep Lake:** [Hwy 212], alpine bogs, head of Wyoming Creek, 1973, 3250 m.s.m., *Weber 44262* (COLO, RM); Littlerock Creek Fen (Heidel et al. 2008); inlet of Frozen Lake, 2008, 10,350–10,550 ft, 2606; two alpine lakes along Hwy 212, 2008, 10,000 ft, 2657.

*** * * Philonotis yezoana** Besch. & Cardot

First record: 2009. Rare, two collections from Lake Creek, in montane zone.

Muddy Creek: Lake Creek Waterfalls, splash zone, sheltered granite outcrops lining the creek, under the steep creek bank, forested by *Picea* sp., *Pseudotsuga menziesii*, and *Pinus contorta*, 2009, 7500 ft, 5849 (COLO, DUKE); Lake Creek-2, on steep rocky bank

forested with *Picea* sp., over rock on a patch of soil, in shade, 2010, 6900 ft, 8397.

Note: A rare species of temperate habitats with primarily oceanic distribution; global conservation rank – G3. Wyoming population was discovered in the interior mountains of the state, approximately 500 km south-southeast of Montana's and east-southeast of Idaho's nearest known locations. The plants on Lake Creek grow in typical conditions for the species – on shaded granite rocks in spray-moist zone of rapids of creek (Kosovich-Anderson and Weber 2011) (Fig. 4B).

**** Plagiobryum zierii** (Dicks. ex Hedw.) Lindb.

First record: 2010. Rare, single collection from montane zone; arctic-alpine or montane-alpine.

Jim Smith Peak: Crazy Creek-2, cataracts, on shady seeping granite cliffs lining the creek, 2010, 6900 ft, 7972 (ASC, COLO), det. J. Spence.

Note: A rare species with disjunct worldwide distribution in Eurasia, Africa and North and Central America, typically growing on wet dripping rocks. In Colorado, it is an "extremely rare species of subalpine seeping cliffs and moist tundra" (Weber and Wittmann 2007, p. 55). The only known occurrence of species in Wyoming is at Crazy Creek on the Beartooth Plateau (Kosovich-Anderson unpublished data).

Plagiomnium ellipticum (Brid.) T.J.Kop.

[*Mnium ellipticum* Brid., *Plagiomnium rugicum* (Laurer) T.J.Kop.]

First record: 1973. Common; minerotrophic fens, willow carrs, along rills and snowbeds at high elevations, in seepage areas and on wet soil, decaying wood and duff in shady coniferous forests, from foothills through the alpine.

Jim Smith Peak: Crazy Creek CG Swamp, 2008, 6950 ft, 3166. **Muddy Creek:** Ghost Creek Fen, 2008, 7900 ft, 3731; Lewis and Clark Trail: swampy mixed forest, 2009, 6600 ft, 6186 (H, MO), det. T. Koponen.

Beartooth Butte: Fantan North Fen (Heidel et al. 2008); Clay Butte Fen, 2008, 8950 ft, 2955, S+; Meadow Lake Fen, 2008, 9850 ft, 3772; Beartooth Falls, 2009, 8900 ft, 5463. **Deep Lake:** [Hwy 212], alpine bogs, head of Wyoming Creek, 1973, 3250 m.s.m., *Weber B-44255 & B-44258* (COLO, RM); W side of Beartooth Pass, under late snow patch, 1973, 3200 m.s.m., *Weber B-44304* (COLO, RM); summits: alpine fen-1, 2008, 10,500 ft, 2322; Littlerock Creek Fen, 2008, ! 10,650 ft (3240 m), 3606; Wyoming Creek-2, 2009, 10,600 ft, 4973; Sawtooth Palsa Fen, 2009, 9700 ft, 5711; Dollar Lake: SW shore, 2010, 9400 ft, 7753. **Black Pyramid Mountain:** WY-MT state line: unnamed lake, 2010, 9750 ft, 8081.

Note: Altitudinal update – 3240 m vs. "low elevations [0–199 m]" (FNA 2014, p. 233).

*** Plagiomnium rostratum** (Schrad.) T.J.Kop.

[*Mnium rostratum* Schrad.]

First record: 2009. Sporadic; mainly on calcareous rocks and soil in woods, willow thickets, in montane and subalpine zones.

Muddy Creek: tributary of Beartooth Creek, 2010, 8400 ft, 7057. **Beartooth Butte:** Clay Butte foothills: subalpine forest, 2009, ! 9000 ft (2740 m), 5414; Beartooth Lake: W shore, 2010, 8900 ft, 6566. Note: Altitudinal update – 2740 m vs. “low to moderate elevations [0–1599 m]” (FNA 2014, p. 234).

Plagiothecium denticulatum (Hedw.) Schimp.

First record: 2008. Common; in shady, wet and swampy woods (spruce, spruce-fir, pine, and Douglas-fir): on soil, rotten logs, trunks, overturned stumps, duff, bare roots, bases of trees and shrubs, humus soil overlying granite boulders, especially at streamsides; also on soil in deeply shaded niches between granite rocks in alpine tundra and subalpine/alpine fens.

Muddy Creek: Lake Creek-1, 2010, 7700 ft, 7116. **Beartooth Butte:** Little Bear Creek-1, 2008, 9700 ft, 2685; Meadow Lake Fen, 2008, 9850 ft, 3764; Beauty Lake Trail, 2009, 8950 ft, 5222; Fantan Lake: E shore, 2010, 9500 ft, 6892; Little Bear Lake: SE shore, 2010, 9650 ft, 8317. **Deep Lake:** Sawtooth Palsa Fen, 2009, 9700 ft, 5735; Lake WGN Fen, 2009, 9600 ft, 6073; W summit and vicinity, 2010, ! 11,100 ft (3380 m), 6668; Lower Top Lake Fen, 2010, 9450 ft, 7685; Long Lake, NW slope: willow wetlands, 2010, 9750 ft, 8293.

Note: Altitudinal update – 3380 m vs. “low to high elevations (50–2700 m)” (FNA 2014, p. 487).

Platydictya jungermannioides (Brid.) H.A.Crum

[*Amblystegiella sprucei* (Spruce) Loeske]

First record: 2010. Rare, in montane and subalpine zones.

Jim Smith Peak: Crazy Creek-2, on wet shade rocks along stream, 2010, 6900 ft, 7979, propagula. **Beartooth Butte:** Beartooth Lake: W and SW shore, along stream, on wet granite outcrops and boulders covered with a layer of humus, assoc.: *Cratoneuron filicinum*, 2010, 8900 ft, 6575, propagula.

Pleurozium schreberi (Willd. ex Brid.) Mitt.

First record: 2007. Sporadic; on humus, soil and duff in wet coniferous forests, at foothills and montane elevations.

Jim Smith Peak: between Reed Lake and Rock Creek, 2007, 7550–7750 ft, *E.Elliott*, *B.Elliott* & *Heidel 3819* (RM), det. YKA; Crazy Creek CG Swamp, 2008, 6950 ft, 3212 (CAS, COLO); Crazy Creek-2, 2010, 6900 ft, 7998 (CAS, COLO, DUKE, MO). **Muddy Creek:** Lily Lake Swamp Forest, 2008, 7750 ft, 3025.

* **Pogonatum urnigerum** (Hedw.) P.Beauv.

First record: 2008. Rare, single collection from upper subalpine elevation.

Beartooth Butte: Little Bear Creek-1, steep rocky terrace, forested with *Picea engelmannii*, on N-facing ledge of granite cliff, inside the tightly compacted tufts of *Paraleucobryum enerve*, 2008, 9700 ft, 2712 (½) (COLO, MO) (Kosovich-Anderson 2011c).

* **Pohlia annotina** (Hedw.) Lindb.

First record: 2009. Rare, from montane through the subalpine.

Jim Smith Peak: Crazy Creek-2, on clayey soil over rock, 2010, 6900 ft, 7943, gemm. **Beartooth Butte:** unnamed creek/“Dichelyma Creek-1”, on sandy bank, 2009, 9500 ft, 6095, gemm.

Pohlia bolanderi (Lesq.) Broth.

First record: 1953. Frequent; in soil-filled rock crevices in different plant communities, and on dry alpine soil, mainly at subalpine and alpine elevations.

Muddy Creek: W of Beartooth Butte, [Hwy 296], at Lake Creek, 1953, *Lawton 2090* (WTU). **Beartooth Butte:** Little Bear Lake Fen, 2008, 9600 ft, 2807; Little Bear Creek-2, 2008, 9500 ft, 3255. **Deep Lake:** summits: alpine fen-4, 2008, 10,400 ft, 3304 (DUKE), det. J. Shaw; summits: alpine fen-5, 2008, 10,750 ft, 3461 (DUKE), det. J. Shaw, S+; Sawtooth Lake, 2009, 9250 ft, 5992; Hwy 212: roadside granite debris, 2010, 10,200 ft, 6733; Gravel Pit vicinity, alpine tundra, 2010, 10,400 ft, 7270; Long Lake, NW slope: willow wetlands, 2010, 9750 ft, 8292. **Black Pyramid Mountain:** summits: alpine tundra-4, 2008, 10,200–10,300 ft, 2458.

Note: Global conservation rank – G3 (vulnerable); however, the species is not infrequent in Wyoming where it occurs in high mountains (Kosovich-Anderson unpublished data).

Pohlia cruda (Hedw.) Lindb.

First record: 1953. Common; on soil banks, crevices in rocks and under tree roots in forested areas, decorticated downed wood, tundra soil and paths, from foothills through the alpine.

Jim Smith Peak: Crazy Creek-2, 2010, 6900 ft, 7936. **Muddy Creek:** Lily Lake Swamp Forest, 2008, 7750 ft, 3035; Ghost Creek Fen, 2008, 7900 ft, 3747; Lake Creek-1, 2010, 7700 ft, 7120. **Beartooth Butte:** near Beartooth Lodge, beside stream, 1953, 9000 ft, *Lawton 1937* (WTU); Island Lake: boggy shore, 2008, 9500 ft, 2385; Little Bear Creek-1, 2008, 9700 ft, 2693; Beartooth Falls, 2009, 8900 ft, 5460; granite ridge: coniferous forest, 2010, 9550 ft, 6930. **Deep Lake:** Littlerock Creek Fen, 2008, 10,650 ft, 3609; Sawtooth Lake, 2009, 9300 ft, 5992; Gravel Pit vicinity, alpine tundra, 2010, 10,400 ft, 7256; summits: alpine tundra-13, 2010, 10,900 ft, 8201. **Black Pyramid Mountain:** summits: alpine fen-3, 2008, 10,100 ft, 2492; WY-MT state line: unnamed lake, 2010, 9800 ft, 8077.

Pohlia drummondii (Müll.Hal.) A.L.Andrews

First record: 1953. Frequent; on acidic soils, in shaded crevices of granite outcrops, on wet loamy soil and burned wood in subalpine spruce-fir forests, in snowbeds and on stream banks in alpine tundra; arctic-alpine. Gemmae common.

Beartooth Butte: along stream near Beartooth Lodge, 1953, 2750 m, *Lawton 1933* (WTU), S+; [Hwy 212], subalpine zone between Long Lake and lower Shepherder Lakes, 1973, 2900 m.s.m., *Weber B-44273* (COLO), det. J. Shaw; Island Lake CG: spruce

forest, 2008, 9500 ft, 2216 (DUKE), det. J. Shaw, gemm.; Island Lake, boggy shore, 2008, 9500 ft, 2388, gemm. **Deep Lake**: summits: alpine fen-2, 2008, 10,850 ft, 2337 (DUKE), det. J. Shaw, gemm.; summits: granite outcrops in alpine tundra, 2008, 10,900 ft, 3492 (DUKE), det. J. Shaw, gemm. **Black Pyramid Mountain**: summits: alpine tundra-1, 2008, 10,200–10,300 ft, 2270, gemm.

**** Pohlia longicolla** (Hedw.) Lindb.

First record: 1953. Rare, single collection, elevation unknown.

Beartooth Butte: N side of Beartooth Lake, 1953, *Lawton 2081* (WTU), det. J. Shaw.

Note: A circumboreal mountain species; according to FNA (2014), relatively rare in North America. Distribution in Wyoming is poorly studied.

**** Pohlia ludwigii** (Spreng. ex Schwägr.) Broth.

First record: 2008. Sporadic; on soaked soil along fen and streams at subalpine and alpine elevations, alpine or arctic-alpine.

Beartooth Butte: Meadow Lake Fen, 2008, 9850 ft, 3811; creek SW of Beartooth Butte, 2008, 9500 ft, 3859. **Deep Lake**: inlet of Frozen Lake, 2008, 10,350–10,550 ft, 2572.

Note: A rare alpine species, characteristic for late snow-melt areas in alpine and subalpine zones (FNA 2014). According to Savich-Lyubitskaya and Smirnova (1970), the species has an arctic-alpine distribution.

Pohlia nutans (Hedw.) Lindb.

First record: 1953. Common; on soil banks, logs, tree bases in forested areas, in subalpine meadows shrublands, in various disturbed habitats in alpine tundra. Sporophytes common.

Muddy Creek: Ghost Creek Fen, 2008, 7900 ft, 3754, S+. **Beartooth Butte**: Beartooth Lake, near Lodge, 1953, *Lawton s.n.* (MO), det. E.Whitehouse; Little Bear Lake Fen, 2008, 9600 ft, 2755 (DUKE), det. J. Shaw; Beauty Lake Trail, 2009, 8950 ft, 5218; Beartooth Falls, 2009, 8900 ft, 5453; Fantan South Fen, 2010, 9500 ft, 6982, S+. **Deep Lake**: summits: alpine fen-5, 2008, 10,750 ft, 3451, S+; Wyoming Creek-1, 2008, 10,300 ft, 3472 (DUKE), det. J. Shaw; Sawtooth Palsa Fen, 2009, 9700 ft, 5734, S+; Lake WGN Fen, 2009, 9600 ft, 6073, S+; summits: Stockade area, alpine tundra, 2010, 11,150 ft, 6716; Top Lake, N slope: subalpine meadow, 2010, 9500 ft, 7749, S+; tributary of Canyon Creek, 2010, 9400 ft, 7776.

**** Pohlia obtusifolia** (Vill. ex Brid.) L.F.Koch

First record: 1973. Sporadic; on soil in late snow-melt areas, rills and snowbeds, in subalpine and alpine zone; arctic-alpine.

Beartooth Butte: Meadow Lake Fen, 2008, 9850 ft, 3770. **Deep Lake**: [Hwy 212], W side, under late snow patch, 1973, 3200 m.s.m., *Weber B-44319* (COLO), det. J. Shaw; summits: alpine fen-5, 2008, 10,750 ft, 3450 (DUKE), det. J. Shaw, S+; Wyoming Creek-2, 2009, 10,600 ft, 5011.

Note: A rare species with disjunctive distribution in arctic and, mainly, subarctic mountains; global conservation rank – G3; known in Wyoming from very few locations – all at upper subalpine and alpine elevations (Kosovich-Anderson unpublished data).

*** Pohlia prolifera** (Kindb. ex Breidl.) Lindb. ex Arnell

First record: 2008. Rare, single collection from subalpine zone.

Beartooth Butte: Little Bear Creek-2, sandy soil on stream bank, 2008, 9500 ft, 3255, gemm.

**** Pohlia tundrae** A.J.Shaw

First record: 1988. Rare, in subalpine zone; arctic-alpine.

Beartooth Butte: unnamed creek/“Dichelyma Creek-1”, on soil over granite rocks lining the creek, 2009, 9500 ft, 6085, gemm. **Deep Lake**: Morrison Jeep Trail, at S end of Plateau, meadow, on humus-rich soil over granite rock debris, 1988, 9300 ft, *Hartman* (with *Houston*) 23782 (RM), det. YKA, gemm.

Note: A rare species with global conservation rank G2 (imperiled). Occurs in Wyoming’s Rocky Mountains, where it is infrequent (Kosovich-Anderson unpublished data).

Pohlia wahlenbergii (F.Weber & D.Mohr) A.L.Andrews

First record: 2008. Common; in swales on fens, on moist clayey or sandy soil along streams, path banks, in riparian willow communities and willow carrs, in calcareous seeps, late snow-melt meadows and along muddy banks in alpine zone.

Muddy Creek: Muddy Creek-1, 2009, 8100 ft, 6146; tributary of Beartooth Creek-1, 2010, 8400 ft, 7070.

Beartooth Butte: Little Bear Creek-2, 2008, 9500 ft, 3261; Clay Butte: slope facing to E, 2008, 9700 ft, 3846 (DUKE), det. J. Shaw; Fantan Lake: N shore, 2010, 9500 ft, 7012. **Deep Lake**: summits: alpine fen-2, 2008, 10,800 ft, 2337 (DUKE), det. J. Shaw; summits: inlet of Frozen Lake, 2008, 10,350–10,550 ft, 2602 (COLO, DUKE), det. J. Shaw; alpine fen-5, 2008, 10,750 ft, 3414 (DUKE), det. J. Shaw, S+; Wyoming Creek-1, 2008, 10,300 ft, 3471 (DUKE), det. J. Shaw; summits: snow-melt rill, 2010, 10,600 ft, 6727; Top Lake Fen-2, 2010, 9450 ft, 7720; head of unnamed creek-2, 10,300 ft, 2010, 8240.

Polytrichastrum alpinum (Hedw.) G.L.Sm.

[*Polytrichum alpinum* Hedw.]

*** - var. alpinum**

First record: 2008. Rare, single collection from alpine zone.

Beartooth Butte: Meadow Lake Fen, on boggy soil, 2008, 9850 ft, 3771.

- var. septentrionale (Sw. ex Brid.) G.L.Sm.

First record: 1953. Common; on rocky ridgecrests and slopes, outcrops, stabilized talus, in subalpine forests, alpine meadows, tundra and fens, especially in late snow-melt areas and snowbeds; arctic-alpine.

Beartooth Butte: Little Bear Lake Fen, 2008, 9600 ft, 2799; Chain Lake: S shore, 2010, 9450 ft, 6990. **Deep Lake:** [Hwy 212], E of summit, near small glacial lake, 1953, 10,500 ft, *Lawton 1964* (WTU); near summit, 1953, 11,000 ft, *Lawton 2142* (WTU); [Hwy 212], 1973, 3200 m.s.m., *Weber, B-44315* (COLO, RM); ca 2 air mi ENE of Beartooth Pass, wet alpine meadows, 2008, approx. 10,600–10,800 ft, *Elliott 14628* (RM), det. YKA, S+; Sawtooth Palsa Fen (Heidel et al. 2008); ski-lift scenic point, alpine tundra, 2008, 10,900 ft, 2345; Littlerock Creek Fen, 2008, 10,650 ft, 3618; Lake WGN Fen, 2009, 9600 ft, 6073; W summit and vicinity, 2010, 11,100 ft, 6675; summits: Stockade area, alpine tundra, 2010, 11,050 ft, 6713; Lower Top Lake Fen, 2010, 9450 ft, 7685; tributary of Canyon Creek-2, 2010, 9400 ft, 7776.

Polytrichastrum longisetum (Sw. ex Brid.) G.L.Sm.
[*Polytrichum longisetum* Sw. ex Brid.]

First record: 1984. Frequent; on boggy soil in subalpine and alpine fens.

Jim Smith Peak: Ivy Lake: SE edge, 2010, 8000 ft, 7528. **Beartooth Butte:** Little Bear Lake Fen, 2008, 9600 ft, 2850 (½) (CAS, COLO, MO, VBG), S+. **Deep Lake:** S of Sawtooth Mt., palsa peatbeds, 2007, 9800 ft, *Elliott 3566.1* (RM), det. YKA, S+; Littlerock Creek Fen, 2008, 10,650 ft, 3619, S+; Canyon Creek, 2009, 9400 ft, 5669; Sawtooth Palsa Fen, 2009, 9700 ft, 5744; creek connecting Lower Top and Sawtooth Lakes, 2010, 9450 ft, 7620; Lower Top Lake Fen, 2010, 9450 ft, 7663. **Unclear location:** Beartooth Mts., 1984, 9700 ft, *Hartman 18542* (RM). Note: Morphological features in specimen 3619: capsules 2–3 mm long and seta 2–2.5 cm vs. capsules 3–5 mm long and seta 4–7 cm, as described in FNA (2007).

Polytrichastrum sexangulare (Flörke ex Brid.) G.L.Sm.

[*Polytrichum sexangulare* Flörke ex Brid.]

First record: 1953. Frequent; in snowbeds and on rocky banks of streamlets in late snow-melt areas, on moist soil on solifluction terraces in alpine zone; essentially arctic-alpine.

Beartooth Butte: Little Bear Lake Fen, 2008, 9600 ft, 2617. **Deep Lake:** [Hwy 212], E of summit, near small glacial lake, 1953, 10,500 ft, *Lawton 1973* (WTU); inlet of Frozen Lake, seepage slope, 2008, 10,400–10,500 ft, 2632 (MO), det. B. Allen; Littlerock Creek Fen, 2008, 10,650 ft, 3581; Wyoming Creek-2, 2009, 10,600 ft, 4990, S+; Gravel Pit vicinity, alpine tundra, 2010, 10,400 ft, 7276.

Polytrichum commune Hedw.

First record: 2009. Rare, in montane and subalpine zones.

Jim Smith Peak: Ivy Lake: SE edge, along lake shore, on soaked peaty soil, not abundant, 2010, 8000 ft, 7527. **Deep Lake:** Morrison Jeep Trail, Top Lake Fen-1, SW boggy shore of lake, on wet peaty soil, in low hummock, assoc.: *Sphagnum angustifolium*, 2009, ! 9450 ft (2880 m), 5773 (½).

Note: Altitudinal update – 2880 m vs.: “low to moderate elevations [0–1599 m]” (FNA 2007, p. 136), 2600 m (Hermann 1987), and 2650 m (Flowers 1973).

Polytrichum juniperinum Hedw.

First record: 1953. Common; a cosmopolitan and almost weedy moss, on a variety of substrates, including disturbed ones, in different communities, but tends to avoid excessively dry or exposed sites, from foothills through the alpine. Sporophytes common.

Jim Smith Peak: Ivy Lake: SE edge, 2010, 8000 ft, 7563, S+. **Muddy Creek:** Lily Lake Fen, 2008, 7750 ft, 3067, S+; SE slope: sagebrush thickets, 2010, 7750 ft, 7407. **Beartooth Butte:** Clay Butte Fen, 2008, 9000 ft, 2925, S+; Little Bear Creek-2, 2008, 9500 ft, 3239; Meadow Lake Fen, 2008, 9850 ft, 3768, S+; 4WD Rd 149: roadside tundra communities, 2009, 9700 ft, 6097; Fantan South Fen, 2010, 9500 ft, 6980. **Deep Lake:** summit, near glacial lake, 1953, 10,500 ft, *Lawton 1969* (WTU); S of Sawtooth Mt., palsa peatbeds, 2007, 9800 ft, *Elliott 3565* (RM), det. YKA, S+; ski-lift scenic point, alpine tundra, 2008, 10,900 ft, 2347; summits: wet alpine meadow, 2008, 10,750 ft, 3398; summits: Overlook Roadside Park, alpine tundra, 2008, 10,950 ft, 3535; Canyon Creek, 2009, 9400 ft, 5682; Sawtooth Lake, 2009, 9300 ft, 5992; Lake WGN Forest, 2009, 9600 ft, 6079, S+. **Black Pyramid Mountain:** summits: alpine tundra-1, 2008, 10,200–10,300 ft, 2280.

Polytrichum piliferum Hedw.

First record: 1953. Common; on rocky ridgecrests and slopes, stabilized talus, on shallow well-drained sandy or gravelly soils over granite rocks and boulders in forests and sagebrush thickets, on solifluction terraces in alpine tundra; often associated with lichens and *Selaginella* P.Beauv., spp., a dominant of poor soil cover on wind-swept summits.

Jim Smith Peak: Ivy Lake: SE edge, 2010, 8000 ft, 7564, S+. **Muddy Creek:** SE slope: sagebrush thickets, 2010, 7750 ft, 7406. **Beartooth Butte:** Beartooth Lodge, 1953, *Lawton 1938* (WTU); E of Beartooth Lake, Beartooth Pass, 1953, *Lawton s.n.* (MO); Island Lake CG: spruce forest, 2008, 9500 ft, 2220; 4WD Rd 120: roadside tundra communities, 2009, 9700 ft, 5642A, S+. **Deep Lake:** summit, rock crevice, 1953, 11,000 ft, *Welch 16648* (WTU); [Hwy 212], near summit, 1953, 10,940 ft, *Lawton 1988* (WTU); near summit, 1953, 11,000 ft, *Lawton 2140* (WTU); E of summit, 1953, 10,500 ft, *Lawton 1968* (WTU), S+; Beartooth Pass, 48 km E of Cooke City, alpine meadow, 1993, 3340 m, *Eversman 93192* (ISC), det. D.G. Horton; Sawtooth Palsa Fen (Heidel et al. 2008); ski-lift scenic point, alpine tundra, 2008, 10,900 ft, 2353; summits: Overlook Roadside Park, alpine tundra, 2008, 10,950 ft, 3536; W summit and vicinity, 2010, ! 11,100 ft (3380 m), 6664; Gardner Lake: head of USFS Trail, 2010, 10,600 ft, 8183. **Black Pyramid Mountain:** summits: alpine tundra-1, 2008, 10,200–10,300 ft, 2270 (CAS, COLO, MO);

summits: alpine tundra-4, 2008, 10,300 ft, 2467; WY-MT state line: unnamed lake, 2010, 9800 ft, 8100. Note: Altitudinal update – 3380 m vs. “low to moderate elevations [0–1599 m]” (FNA 2007, p. 140).

Polytrichum strictum Menzies ex Brid.

[*Polytrichum affine* Funck, *P. juniperinum* var. *affine* (Funck) Brid.].

First record: 1953. Common; in moist tundra, on rotten stumps in old-growth spruce-fir forests, on *Sphagnum* fens, in subalpine and alpine zones.

Beartooth Butte: Fantan Lake: E shore, 2010, 9500 ft, 6867. **Deep Lake:** [Hwy 212], Beartooth Lake, W end, 1953, *Lawton 1961* (WTU); summit near glacial lake, 1953, 10,500 ft, *Lawton 1965* (WTU); Sawtooth Palsa Fen (Heidel et al. 2008); Littlerock Creek Fen, 2008, 10,650 ft, 3588, S+; Lake WGN Fen, 2009, 9600 ft, 6071; Gravel Pit vicinity, alpine tundra, 2010, 10,400 ft, 7291; Top Lake Fen-2, 2010, 9450 ft, 7717. **Black Pyramid Mountain:** WY-MT state line: unnamed lake, 2010, 9800 ft, 8069. **Unclear locations:** [Hwy 212], 1973, 3250 m.s.m., *Weber B-44259* (COLO, RM); Beartooth Mtns., 1984, *Hartman 18541* (RM).

** **Pseudocalliergon angustifolium** Hedenäs

[*Drepanocladus angustifolius* (Hedenäs) Hedenäs & Rosborg]

First record: 2008. Sporadic; on soaked boggy soil and in shallow wet depressions of minerotrophic fens, in subalpine and alpine zone.

Deep Lake: summits: alpine moss fen, 2008, 10,500 ft, 2296; inlet of Frozen Lake, seepage slope, 2008, 10,550 ft, 2570 (MHA, MO, S), det. L. Hedenäs; head of Wyoming Creek, alpine Bryidae fen, 2009, 10,600 ft, 4968. **Black Pyramid Mountain:** summits: alpine fen, 2008, 10,100 ft, 2491; WY-MT state line: unnamed lake, *Salix* sp./*Carex* spp. (+ Bryidae mosses) fen, 2010, 9750 ft, 8051.

Note: A rare species of mountain and arctic fens, occurring in mineral-rich to strongly calcareous habitats. In North America, it is known from few locations, including those from Medicine Bow Mts. of south-eastern Wyoming, collected by F.J. Hermann in 1962 (L. Hedenäs, Swedish Museum of Natural History, Stockholm, personal communication).

** **Pseudocalliergon turgescens** (T.Jensen) Loeske

[*Scorpidium turgescens* (T.Jensen) Loeske]

First record: 1973. Sporadic; on moist boggy soil in calcareous fens at alpine elevations; arctic-alpine.

Deep Lake: [Hwy 212], alpine bogs of E summit, head of Wyoming Creek, 1973, 3250 m.s.m., *Weber B-44257* (COLO); summits: alpine fen-1, 2008, 10,500 ft, 2302, assoc.: *Scorpidium cossonii*; Wyoming Creek-2, 2009, 10,600 ft, 4951 (COLO). **Black Pyramid Mountain:** summits: alpine fen-3, on soaked peaty soil, assoc.: *Pseudocalliergon angustifolium*, 2008, 10,100 ft, 2491A.

Note: A species rare in North America (particularly, south of the Canadian border); listed as a species of

conservation concern in Montana (Elliott and Pipp 2019).

* **Pseudoleskea incurvata** (Hedw.) Loeske

[*Lescuraea incurvata* (Hedw.) E.Lawton]

First record: 1953. Sporadic; on granite boulders, especially in or near streamlets in upper subalpine and alpine.

Beartooth Butte: Little Bear Creek-1, 2008, 9700 ft, 2690. **Deep Lake:** summits: alpine tundra-6, 2008, 10,850 ft, 3376 (ASC), det. J. Spence. **Unclear location:** [Hwy 212], 1953, 10,000 ft, *Whitehouse 27477* (WTU).

Pseudoleskea radicata (Mitt.) Macoun & Kindb.

[*Lescuraea radicata* (Mitt.) Mönk.]

First record: 1953. Common; on rocks outcrops and debris scattered across forests, meadows and tundra, from montane through the alpine.

Muddy Creek: Beartooth Creek-3, 2010, 7550 ft, 7414. **Beartooth Butte:** 2 mi W of Beartooth Lake, 1953, *Whitehouse s.n.* (WTU); Beartooth Butte, Beartooth Creek near Beartooth Lodge, 1953, *Lawton 1946* (WTU); near stream at Beartooth Lodge, 1953, *Lawton 1944* (WTU); Beartooth Lake, across the Lake from the Lodge, *Lawton 2075* (WTU); Meadow Lake Fen, 2008, 9850 ft, 3772; Beartooth Falls, 2009, 8900 ft, 5446; Little Bear Creek-4, 2009, 8950 ft, 6226; Beartooth Lake: SW shore, 2010, 8900 ft, 6633; Little Bear Lake: SE shore, 2010, 9650 ft, 8317. **Deep Lake:** Wyoming Creek-2, 2009, 10,500 ft, 5015; Sawtooth Lake, 2009, 9250 ft, 6025; Lower Top Lake Fen, 2010, 9450 ft, 7683.

Pseudoleskeella rupestris (Berggr.) Hedenäs & L.Söderstr.

[*Leskea rupestris* Berggr.]

First record: 2008. Rare, single collection from alpine elevation.

Black Pyramid Mountain: summits: alpine fen-3, on calcareous rocks, 2008, ! 10,100 ft (3080 m), 2508.

Note: Altitudinal update – 3080 m vs. “low to high elevations (0–3000 m)” (FNA 2014, p. 364).

Pterigynandrum filiforme Hedw.

First record: 2010. Rare, at montane elevations.

Jim Smith Peak: Crazy Creek-2, rocky bank, wet *Picea glauca* (+*Pinus contorta* var. *latifolia*)/*Alnus* sp. forest, on shaded granite outcrops in splash zone of creek, 2010, 6900 ft, 7968. **Muddy Creek:** Lake Creek-2, rocky bank, on wet surface of granite outcrop, in splash zone, shaded by spruce, 2016, 6900–6950 ft, 21036.

Ptilium crista-castrensis (Hedw.) DeNot.

First record: 1953. Rare, both collections from Crazy Creek, in montane zone.

Jim Smith Peak: W of Beartooth Butte, Crazy Creek CG, along Crazy Creek, 1953, *Lawton 2018* (WTU); Crazy Creek, swampy *Picea glauca* x *P. engelmannii* + *Pinus* spp. forest, at the base of spruce and pine, on shaded humus soil and litter, 2008, ! 7000 ft (2130 m), 3179.

Note: Altitudinal update – 2130 m vs. “low to high elevations (0–2000 m)” (FNA 2014, p. 563).

Ptychostomum creberrimum (Taylor) J.R.Spence & H.P.Ramsay

[*Bryum creberrimum* Taylor; *B. lisae* var. *cuspidatum* (Bruch & Schimp.) Margad.]

First record: 2008. Sporadic; on damp and dry soil and soil over rocks, from montane through the alpine.

Jim Smith Peak: Crazy Creek CG, 2008, 7000 ft, 3207; Crazy Creek-2, 2010, 6900 ft, 7988 (ASC), det. J. Spence. **Beartooth Butte:** Little Bear Creek-2, 2008, 9500 ft, 3259 (ASC), det. J. Spence. **Deep Lake:** dry creek in alpine tundra, 2008, 10,350 ft, 2432, S+; inlet of Frozen Lake, 2008, 10,500 ft, 2595 (ASC), det. J. Spence.

Ptychostomum cyclophyllum (Schwäger.) J.R.Spence

[*Bryum cyclophyllum* (Schwäger.) Bruch & Schimp.]

First record: 1965. Sporadic; on wet soil in subalpine and alpine wetlands, fens and moist tundra; essentially arctic-alpine.

Beartooth Butte: Beartooth Falls, 2009, 8900 ft, 5436. **Deep Lake:** alpine tundra, 1965, 10,000 ft, *Hermann 20070* (RM, WTU); summits: alpine fen-2, 2008, ! 10,800 ft (3290 m), 2336; inlet of Frozen Lake, 2008, 10,350 ft, 2601; summits: small alpine lake, 2008, 10,500 ft, 3499.

Note: Altitudinal update – 3290 m vs. “low to high elevations (0–3000 m)” (FNA 2014, p. 171).

Ptychostomum inclinatum (Sw. ex Brid.) J.R.Spence

[*Bryum amblyodon* Müll.Hal.]

First record: 1953. Sporadic; in subalpine wetlands and alpine tundra, on rocky ridgecrests and slopes, stabilized talus; arctic-alpine.

Deep Lake: [Hwy 212], along a stream just W of the summit, 1953, 2750–3050 m, *Lawton 1993* (WTU); dry creek in alpine tundra, 2008, 10,350 ft, 2436, S+; inlet of Frozen Lake, seepage slope, 2008, 10,350–10,550 ft, 2549 (ASC), det. J. Spence, S+; summits: alpine tundra-11, 2010, 10,750 ft, 8161 (ASC), det. J. Spence. **Black Pyramid Mountain:** summits: alpine tundra-4, 2008, 10,200–10,300 ft, 2479 (ASC), det. J. Spence.

** **Ptychostomum knowltonii** (Barnes) J.R.Spence

[*Bryum knowltonii* Barnes]

First record: 2008. Sporadic; on soil in moist alpine tundra, zone of late snow-melt; essentially arctic-alpine.

Deep Lake: summits: dry creek in alpine tundra, 2008, 10,350 ft, 2430 (ASC), det. J. Spence; Gravel Pit vicinity, alpine tundra, 2010, 10,400 ft, 7271. **Black Pyramid Mountain:** summits: alpine fen-3, 2008, 10,100 ft, 2489 (ASC), det. J. Spence.

Note: A rarely collected species, with very few known occurrences in Wyoming (Kosovich-Anderson unpublished data).

Ptychostomum pallescens (Schleich. ex Schwäger.) J.R.Spence

[*Bryum pallescens* Schleich. ex Schwäger.]

First record: 1953. Frequent; on wet soils of different origin, often along streams, also in crevices in rocks, on rotting logs, trunks and duff in forests, on loamy soil in *Artemisia tridentata* thickets, from montane through the alpine.

Jim Smith Peak: Ivy Lake: SE edge, 2010, 8000 ft, 7566. **Muddy Creek:** seepage slope along Hwy 212, 2009, 8700 ft, 6105, S+; SE slope: sagebrush thickets, 2010, 7750 ft, 7405; Rd 801: swampy mixed forest, 2009, 7000 ft, 6168; top of terrace: sagebrush thickets, 2010, 7650 ft, 7198. **Beartooth Butte:** Clay Butte foothills: subalpine forest, 2009, 9000 ft, 5390, S+; Fantan Lake: N shore, 2010, 9500 ft, 7042. **Deep Lake:** Hwy 212, 13 mi E of Beartooth Lake, 1953, 10,500 ft, *Conard s.n.* (NY), det. A.L. Andrews.

Ptychostomum pseudotriquetrum (Hedw.) J.R.Spence & H.P.Ramsay ex Holyoak & N.Pedersen

[*Bryum pseudotriquetrum* (Hedw.) P.Gaertn., B.Mey. & Scherb.]

First record: 1953. Common; on boggy soil in riparian willow communities and willow carrs, eutrophic fens, along streamlets, lakes and ponds (often on carbonate soils), in seepage areas in coniferous forests; from foothills through the alpine.

Jim Smith Peak: Little Moose Peatland, 2002, 7960 ft, *Jackson s.n.* (RM), det. YKA. **Muddy Creek:** [Hwy 296], along Lake Creek, near Beartooth Butte, 1953, *Lawton 2099* (WTU); drainage pipe beside Hwy 212, 2009, 8300 ft, 6110; Ghost Creek Fen, 2008, 7900 ft, 3748; Muddy Creek-1, 2009, 8100 ft, 6129, S+; Hwy 212 and Rd 188 intersection: boggy valley, 2010, 7550 ft, 7208. **Beartooth Butte:** W end of Beartooth Lake, 1953, *Lawton 1957* (WTU); Beartooth Butte-1, 2009, 8950 ft, 5297. **Deep Lake:** [Hwy 212], W side, under late snow patch, rills and snowbeds, 1973, 3200 m.s.m., *Weber B-44305* (COLO, RM); alpine bogs, head of Wyoming Creek, 1973, 3250 m.s.m., *Weber B-44224* (COLO, RM), det. J. Spence; summits: alpine fen-1, 2008, 10,500 ft, 2307; summits: alpine fen-2, 2008, 10,850 ft, 2323 (ASC), det. J. Spence; inlet of Frozen Lake, seepage slope, 2008, 10,350 ft, 2550 (ASC), ver. J. Spence; Wyoming Creek-2, head of creek, 2009, 10,600 ft, 4980; summits: snow-melt rill, 2010, 10,600 ft, 6726; Gravel Pit vicinity, zone of late snowmelt, 2010, 10,400 ft, 7272. **Black Pyramid Mountain:** summits: alpine tundra-4, 2008, 10,200–10,300 ft, 2477 (ASC), ver. J. Spence; summits: alpine fen-3, 2008, 10,100 ft, 2489; WY-MT state line: unnamed lake, 2010, 9750 ft, 8056.

* **Ptychostomum schleicheri** (DC.) J.R.Spence

[*Bryum schleicheri* DC.]

First record: 2008. Rare, at subalpine elevations; arctic-alpine.

Beartooth Butte: Island Lake CG: subalpine meadow, on shaded slope, between granite outcrops, 2008, 9500 ft, 2924 (DUKE), det. J. Shaw; Long Lake: E shore, on peaty banks of lake, 2010, 9600 ft, 6814.

Ptychostomum turbinatum (Hedw.) J.R.Spence[*Bryum turbinatum* (Hedw.) Turner]

First record: 1953. Frequent; on wet soil in forests, on peaty soil along lakes, on stream banks in tundra communities, at subalpine and alpine elevations.

Beartooth Butte: SE and E of Beartooth Lodge cabins, 1953, *Welch 15867* (WTU), S+; base of Beartooth Butte, 1953, *Lawton 2064* (WTU); S slope of Beartooth Butte, 1953, *Lawton 2055 & 2063* (WTU); Beartooth Butte-1, 2009, 8950–9250 ft, 5252 (ASC), det. J. Spence. **Deep Lake:** Beartooth Pass, 38 mi NW Cody, edge of streamlet, 1965, 10,000 ft, *Hermann 20070* (WTU). **Black Pyramid Mountain:** WY-MT state line: unnamed lake, 2010, 9800 ft, 8057 (ASC), det. J. Spence.

Ptychostomum weigeli (Biehler) J.R.Spence[*Bryum weigeli* Biehler]

First record: 2008. Frequent; on wet boggy soil in minerotrophic fens, snow-melt rills and seepage slopes, at all elevations.

Jim Smith Peak: Crazy Creek CG Swamp, 2008, 6950 ft, 3181. **Beartooth Butte:** Meadow Lake Fen, 2008, 9850 ft, 3823; boggy valley NE of Fantan Lake, 2010, 9500 ft, 6830; Fantan Lake: N shore, 2010, 9500 ft, 7029. **Deep Lake:** summits: alpine fen-2, seepage zone, 2008, 10,850 ft, 2325, det. J. Spence; ski-lift scenic point, wet alpine tundra, 2008, 10,900 ft, 2354; Canyon Creek, 2009, 9400 ft, 5671; head of unnamed creek-1, 2010, 10,250 ft, 6735; Dollar Lake: SW shore, 2010, 9400 ft, 7760. **Black Pyramid Mountain:** WY-MT state line: unnamed lake, 2010, 9800 ft, 8097.

* * * **Rhizomnium andrewsianum** (Steere) T.J.Kop.[*Mnium andrewsianum* Steere]

First record: 1973. Rare, single collection from upper subalpine zone; arctic or arctic-alpine.

Beartooth Butte: [Hwy 212], swales around small lakes, subalpine zone between Long Lake and lower Shepherder Lakes, 1973, ! 2900 m.s.m. (2900 m), *Weber B-44267* (RM -?, COLO), det. P. Eckel: “small leaves, subalpine”. Specimen not seen.

Note: A rare species of essentially high arctic distribution. The only known station in Wyoming is on the Beartooth Plateau. Altitudinal update – 2900 m vs. “low elevations [0–199 m]” (FNA 2014, p. 238).

Rhizomnium magnifolium (Horik.) T.J.Kop.[*Mnium magnifolium* Horik.]

First record: 2008. Frequent; on soaked soil and duff in seepage areas in coniferous forests and swamps, from montane through the alpine; essentially arctic-alpine.

Jim Smith Peak: Crazy Creek CG Swamp, 2008, 6950 ft, 3190 (H, MO), det. T. Koponen. **Muddy Creek:** tributary of Beartooth Creek-1, 2010, 8450 ft, 7102; Beartooth Creek-3, 2010, 7550 ft, 7439. **Beartooth Butte:** boggy shore of Island Lake, 2008, 9500 ft, 2390; Chain Lake: S shore, 2010, 9500 ft, 6990; Fantan Lake: N shore, 2010, 9550 ft, 7022 (H,

MO), det. T. Koponen; Little Bear Lake: SE shore, 2010, 9650 ft, 8316 (H, MO), det. T. Koponen. **Deep Lake:** Sawtooth Lake, 2009, 9250 ft, 6062; small alpine lake along Hwy 212, 2010, ! 10,000 ft (3050 m), 8256.

Note: Altitudinal update – 3050 m vs. “low to moderate elevations [0–1599 m]” (FNA 2014, p. 240).

Rhizomnium pseudopunctatum (Bruch & Schimp.) T.J.Kop.[*Mnium pseudopunctatum* Bruch & Schimp.]

First record: 1973. Common; on wet soil and duff in boggy forests and minerotrophic fens, from montane through the subalpine; arctic-alpine and subarctic.

Jim Smith Peak: Crazy Creek CG Swamp, 2008, 6950 ft, 3169. **Muddy Creek:** Lily Lake Swamp Forest, 2008, 7750 ft, 3024; Lily Lake Fen, 2008, 7750 ft, 3089; Ghost Creek Fen, 2008, 7900 ft, 3740.

Beartooth Butte: [Hwy 212], between Long Lake and lower Shepherd Lakes, subalpine zone, 1973, 2900 m.s.m., *Weber s. n.* (TENN); Little Bear Creek-1, 2008, ! 9700 ft (2960 m), 2697; Little Bear Lake Fen, 2008, 9600 ft, 2801; Beartooth Lake: E shore, 2009, 8900 ft, 4836; Little Bear Creek-3, 2009, 9400 ft, 5326; Beartooth Falls, 2009, 8900 ft, 5452. **Deep Lake:** creek connecting Dollar and Sawtooth Lakes, 2009, 9400 ft, 5786; Sawtooth Lake, 2009, 9300 ft, 6031.

Note: Altitudinal update – 2960 m vs. “low to moderate elevations [0–1599 m]” (FNA 2014, p. 242).

Rhizomnium punctatum (Hedw.) T.J.Kop.[*Mnium punctatum* Hedw.]

First record: 2008. Rare, single collection from subalpine elevations.

Beartooth Butte: *Pinus contorta* var. *latifolia* forest along Hwy 212, brook bank, moist clayey soil, assoc.: *Chiloscyphus pallescens*, 2008, ! 8950 ft (2730 m), 3905.

Note: Altitudinal update – 2730 m vs. “low to moderate elevations [0–1599 m]” (FNA 2014, p. 242).

Rhytidium rugosum (Hedw.) Kindb.

First record: 1953. Frequent; on soil in alpine tundra.

Beartooth Butte: between Beartooth Lake and summit, on soil below rock, 1954 [?], 10,600 ft, *Welch 16629* (WTU). **Deep Lake:** [Hwy 212], near summit, 1953, 10,940 ft, *Lawton 1981* (WTU); summits: alpine fen-1, 2008, 10,500 ft, 2301; summits: alpine tundra-3, 2008, 10,350 ft, 2405; summits: dry creek in alpine tundra, 2008, 10,350 ft, 2447; summits: alpine tundra-7, 2010, 10,800 ft, 6719; Gravel Pit vicinity, alpine tundra, 2010, 10,400 ft, 7320; summits: alpine tundra-9, 2010, 10,400 ft, 8119. **Black Pyramid Mountain:** summits: alpine tundra-4, 2008, 10,200–10,300 ft, 2464.

Rosulabryum capillare (Hedw.) J.R.Spence[*Bryum capillare* Hedw.]

First record: 1953. Sporadic; on soil banks and rotten wood, from montane through the alpine.

Jim Smith Peak: Crazy Creek-2, 2010, 6900 ft, 7972. **Deep Lake:** 9 mi E of Beartooth Lake, 1953, 10,450

ft, *Conard s.n.* (NY); inlet of Frozen Lake, 2008, ! 10,350 ft (3150 m), 2592.

Note: Altitudinal update – 3150 m vs. “low to high elevations (0–2500 m)” (FNA 2014, p. 182).

* **Rosulabryum elegans** (Nees ex Brid.) Ochyra

[*Bryum elegans* Nees ex Brid.]

First record: 2008. Frequent: mostly calciphile moss, on wet soil of creek banks, in alpine fens and tundra, from subalpine through alpine elevations.

Beartooth Butte: Little Bear Creek-3, 2009, 9400 ft, 5346, det. J. Spence. **Deep Lake:** summits: alpine tundra-3, 2008, 10,350 ft, 2398; dry creek in alpine tundra, 2008, 10,350 ft, 2429; summits: alpine tundra-6, 2008, 10,850 ft, 3338 (ASC), det. J. Spence.

Black Pyramid Mountain: summits: alpine tundra-4, 2008, 10,200–10,300 ft, 2472; summits: alpine fen-3, 2008, 10,100 ft, 2504 (ASC), det. J. Spence.

Note: Collections from the Beartooth Plateau are represented by “*stirtonii*” expression (J. Spence personal communication).

Rosulabryum laevifilum (Syed) Ochyra

[*Bryum laevifilum* Syed]

First record: 2008. Rare, at montane through alpine elevations.

Muddy Creek: Lake Creek CG: spruce forest, on granite boulder, 2009, 6950 ft, 5918. **Deep Lake:** summits: granite outcrop in alpine tundra, on rock, 2008, ! 10,900 ft (3320 m), 2538, gemm.

Note: Altitudinal update – 3320 m vs. “low to high elevations (0–2500 m)” (FNA 2014, p. 183).

* **Saelania glaucescens** (Hedw.) Broth.

First record: 1953. Rare, at foothills and montane elevations, both collections from Crazy Creek.

Jim Smith Peak: W of Beartooth Butte, Crazy Creek CG, 1953, *Lawton 2020* (WTU); Crazy Creek-2, on soil at base of granite rocks, 2010, 6900 ft, 7945.

* * **Sanionia nivalis** Hedenäs

First record: 2008. Frequent; on soil at late snow-melt areas, alpine and upper subalpine fens and meadows; arctic-alpine.

Deep Lake: summits: alpine fen-1, 2008, 10,500 ft, 2313, S+; inlet of Frozen Lake, 2008, 10,550 ft, 2557; summits: alpine fen-4, 2008, 10,400 ft, 3268; summits: wet alpine meadow, 2008, 10,750 ft, 3397; summits: alpine fen-5, 2008, 10,750 ft, 3430 (COLO, MO, S), S+; Littlerock Creek Fen, 2008, 10,650 ft, 3558, S+; Wyoming Creek-2, 2009, 10,450–10,600 ft, 4964; Sawtooth Palsa Fen, 2009, 9700 ft, 5752, S+. **Black Pyramid Mountain:** summits: alpine fen-3, 2008, 10,100 ft, 2500.

Note: A recently described rare arctic-alpine species, found in mountains in the high- and middle-alpine regions, and in the arctic, in late snowbeds and on the shores of glacier-fed brooks. In the author’s experience, reliable identification of species is possible only if mature capsules present. So far, the Beartooth occurrences of the species are the only known in Wyoming (Kosovich-Anderson and Weber 2011, Kosovich-Anderson unpublished data).

Sanionia uncinata (Hedw.) Loeske

[*Drepanocladus uncinatus* (Hedw.) Warnst.]

First record: 1953. Common; on tree and shrub bases and along stream banks in forests, swamps and meadows, riparian willow communities, on soil over rocks, logs, stumps, decorticated downed wood, from foothills to the alpine.

Muddy Creek: Lily Lake Fen, 2008, 7750 ft, 3093; Ghost Creek Fen, 2008, 7900 ft, 3685; Lake Creek Waterfalls, 2009, 7500 ft, 5824; Muddy Creek-2, 2010, 7750 ft, 7226. **Beartooth Butte:** Beartooth Lodge, near stream, 1953, *Lawton 1930* (WTU); [Hwy 212], swales around small lakes, subalpine zone between Long Lake and lower Sheepherder Lakes, 1973, 2900 m.s.m., *Weber B-44276* (COLO, RM); Fantan North Fen (Heidel et al. 2008); Little Bear Lake Fen, 2008, 9600 ft, 2791, S+; Clay Butte Fen, 2008, 9000 ft, 2946; Meadow Lake Fen, 2008, 9850 ft, 3784; Beartooth Falls, 2009, 8900 ft, 5436; Chain Lake: S shore, 2010, 9500 ft, 7003. **Deep Lake:** Littlerock Creek Fen and Sawtooth Palsa Fen (Heidel et al. 2008); summits: alpine fen-1, 2008, 10,500 ft, 2294; Canyon Creek, 2009, 9400 ft, 5682; W summit and vicinity, 2010, 11,050 ft, 6678; Long Lake, NW slope: willow wetlands, 2010, 9750 ft, 8294. **Black Pyramid Mountain:** WY-MT state line: unnamed lake, 2010, 9800 ft, 8092.

Sarmentypnum exannulatum (Schimp.) Hedenäs

[*Drepanocladus exannulatus* (Schimp.) Warnst., *Warnstorfia exannulata* (Schimp.) Loeske]

First record: 1953. Common; in swales of fens, bog pools, ponds and along edges of lakes, around springs or snowbeds, in mossy wet gravelly tundra; from foothills through the alpine.

Jim Smith Peak: Rock Creek Fen (Heidel et al. 2008). **Muddy Creek:** East Lily Peatland, 2002, 8100 ft, *Jackson s.n.*, det. YKA; Mud Lake Fen, 2008, 7750 ft, 3113; Ghost Creek Fen, 2008, 7900 ft, 3702.

Beartooth Butte: Near Beartooth Lake cabins, in water in coniferous forest, 1953, *Welch 16577* (WTU); [Hwy 212], swales around small lakes, subalpine zone between Long Lake and lower Sheepherder Lakes, 1973, 2900 m.s.m., *Weber B-44252* (COLO, RM), det. J. Janssens as *Drepanocladus exannulatus* var. *rotae* (DeNot.) Loeske; Lower Sheepherder Fen and Meadow Lake Fen (Heidel et al. 2008); Little Bear Lake Fen, 2008, 9600 ft, 2846; Little Bear Creek-2, 2008, 9500 ft, 3233; Beauty Lake Trail, 2009, 8900 ft, 5319. **Deep Lake:** [Hwy 212], E of the summit, near small glacial lake, 1953, 10,500 ft, *Lawton 1971* (WTU); [Hwy 212], along a stream W of the summit, 1953, *Lawton 1992* (WTU); W side of Beartooth Pass, rills and snowbeds, 1973, 3200 m.s.m., *Weber B-44310* (COLO, RM); S of Sawtooth Mt., wet boggy area surrounding palsa peatbed, 2007, 9800 ft, *E.Elliott, Heidel & B.Elliott 3587* (RM), det. YKA; ca. 2 air mi ENE of Beartooth Pass, wet alpine meadows, 2008, approx. 10,600–10,800 ft, *Elliott 14629a* (RM), det. YKA, S+; 3 mi E of Beartooth Pass, dry alpine meadow, 2008, approx.

10,600–10,800 ft, *Elliott 14660* (RM), det. YKA; Wyoming Creek and upstream, 2008, 10,300–10,550 ft, *Hartman 87943* (RM), det. YKA; Lake WGN Fen and Sawtooth Palsa Fen (Heidel et al. 2008); summits: alpine fen-1, 2008, 10,500 ft, *2306* (S, MO), det. L. Hedenäs; summits: wet alpine meadow, 2008, 10,750 ft, *3397*; summits: alpine fen-5, 2008, 10,750 ft, *3405*; Littlerock Creek Fen, 2008, 10,650 ft, *3548*; summits: snow-melt rill, 2010, 10,600 ft, *6726*.

Black Pyramid Mountain: WY-MT state line: unnamed lake, 2010, 9750 ft, *8053*.

Note: Some submerged alpine forms have longly excurrent costa, with leaf morphology strongly suggesting Arctic *Sarmentypnum trichophyllum* (Warnst.) Hedenäs. Comparison of these collections with Swedish material of *S. trichophyllum* kindly provided by Lars Hedenäs shows that in the study area occur phenotypes of *S. exannulatum* with clearly excurrent costae.

Sarmentypnum sarmentosum (Wahlenb.) Tuom. & T.J.Kop.

[*Calliergon sarmentosum* (Wahlenb.) Kindb., *Warnstorfia sarmentosa* (Wahlenb.) Hedenäs]

First record: 1973. Common; in swales of mineral-rich alpine fens, in frost scar pools, often around springs in late snowbeds, at upper subalpine and alpine elevations; arctic-alpine.

Beartooth Butte: Little Bear Lake Fen, 2008, 9600 ft, *2845* (CAS, COLO); Meadow Lake Fen, 2008, 9850 ft, *3798*; Long Lake: E shore, 2010, 9650 ft, *6802*.

Deep Lake: [Hwy 212], alpine bogs, head of Wyoming Creek, 1973, 3250 m.s.m., *Weber B-44254* (COLO, RM); just off Hwy 212, alpine fen, 2007, 10,700 ft, *E.Elliott* (with *Houston* & *B. Elliott*) *3659* (RM), det. YKA; Littlerock Creek Fen (Heidel et al. 2008); summits: alpine fen-1, 2008, 10,500 ft, *2295*; inlet of Frozen Lake, 2008, 10,500 ft, *2548*; summits: alpine fen-5, 2008, 10,750 ft, *3427*; Wyoming Creek-2, 2009, 10,600 ft, *4962*; head of unnamed creek-1, 2010, 10,250 ft, *6746*; Gravel Pit vicinity, small alpine lake, 2010, 10,400 ft, *7301*; creek connecting Lower Top and Sawtooth Lakes, 2010, 9450 ft, *7625*. **Black Pyramid Mountain:** WY-MT state line: unnamed lake, 2010, 9750 ft, *8083A*.

Schistidium agassizii Sull. & Lesq.

First record: 1953. Sporadic; on wet rocks along streams, from foothills through the montane, essentially arctic-alpine.

Jim Smith Peak: W of Beartooth Butte, Crazy Creek CG, 1953, *Lawton 2028* (WTU); Crazy Creek-2, 2010, 6900 ft, *7941*. **Muddy Creek:** W of Beartooth, [Hwy 296], at Lake Creek, 1953, *Lawton 2046* (WTU); Gilbert Creek-2, 2010, 6900 ft, *8011*.

* **Schistidium apocarpum** (Hedw.) Bruch & Schimp.

First record: 1953. Sporadic; on wet granite cliffs and ledges, from montane through the alpine.

Jim Smith Peak: W of Beartooth Butte, Crazy Creek CG, 1953, *Lawton 2032* (WTU). **Muddy Creek:** Lake Creek CG, wet spruce forest, 2009, 6950 ft, *5912*.

Deep Lake: [Hwy 212], near summit, 1953, ! 11,000 ft (3350 m), *Lawton 1982* (WTU). **Unclear location:** granite bluff along [Hwy 212], 46 miles NW of Cody, 1965, 7550 ft, *Hermann 20063* (RM).

Note: Altitudinal update – 3350 m vs. “low to moderate elevations (0–1500 m)” (FNA 2007, p. 211).

* **Schistidium atrichum** (Müll.Hal. & Kindb.) W.A.Weber

First record: 2008. Rare, single collection from upper subalpine zone. E.

Beartooth Butte: Island Lake CG, *Picea engelmannii* forest, on rock debris in shade of spruce, 2008, 9500 ft, *2219*, det. M. Ignatov, S+.

Schistidium confertum (Funck) Bruch & Schimp.

First record: 2008. Rare, single collection from subalpine zone.

Beartooth Butte: Hwy 212, S-facing slope, *Pinus contorta* forest, on rock, 2008, 9000 ft, *3882*, S+.

Schistidium dupretii (Thér.) W.A.Weber

First record: 1953. Rare, single collection, elevation unknown.

Beartooth Butte: S slope of Beartooth Butte, 1953, *Lawton 2058* (WTU).

* **Schistidium papillosum** Culm.

First record: 1953. Sporadic; on shaded rocks and cliffs along streams in forested areas, from foothills through the subalpine.

Jim Smith Peak: Crazy Creek-2, 2010, 6900 ft, *7973*, S+. **Beartooth Butte:** Island Lake CG, spruce forest, 2008, ! 9500 ft (2900 m), *2224*, S+. **Unclear location:** W of Beartooth, Clarks Fork of Yellowstone River, 1953, *Lawton 1998a* (WTU), det. H.H. Blom.

Note: Altitudinal update – 2900 m vs. “low to high elevations (0–2000 m)” (FNA 2007, p. 221).

Schistidium rivulare (Brid.) Podp.

First record: 1953. Sporadic; on wet granite rocks along streams from foothills to alpine zone.

Jim Smith Peak: W of Beartooth Butte, Crazy Creek CG, 1953, *Lawton 2024* (WTU). **Muddy Creek:** Lake Creek Waterfalls, 2009, 7500 ft, *5856*; Lake Creek-1, 2010, 7700 ft, *7140*, S+; Muddy Creek-2, 2010, 7750 ft, *7248*. **Deep Lake:** Gravel Pit vicinity, alpine tundra, 2010, 10,400 ft, *7311*.

** **Sciuro-hypnum glaciale** (Schimp.) Ignatov & Huttunen

[*Brachythecium glaciale* Schimp.]

First record: 2008. Rare, at alpine elevations; arctic-alpine.

Deep Lake: Wyoming Creek-1, on wet silt along streams, 2008, 10,300 ft, *3469*; summits: small alpine lake, boggy shore, on wet clay, assoc.: *Polytrichastrum alpinum* s.l., 2008, 10,500 ft, *3508* (MHA, MO), det. M. Ignatov.

Note: A highly disjunct species, reported from the Wyoming's Beartooth Plateau as new to North American continent (Kosovich-Anderson and Ignatov 2010).

Sciuro-hypnum latifolium (Kindb.) Ignatov & Huttunen

[*Brachythecium nelsonii* Grout, *B. latifolium* Kindb.] First record: 1953. Common; seepage areas in coniferous forests, riparian willow communities, in subalpine and alpine fens and peaty and rocky banks of streams, in wet tundra, snow-melt rills.

Muddy Creek: Lily Lake Swamp Forest, 2008, 7750 ft, 3034; tributary of Beartooth Creek-1, 2010, 8450 ft, 7062; Beartooth Creek-3, 2010, 7550 ft, 7439; Ghost Creek, 2010, 7900 ft, 8428. **Beartooth Butte:** Beartooth Lodge, near stream, 1953, *Lawton 1925* (WTU); Island Lake CG: subalpine meadow, 2008, 9500 ft, 2913; Meadow Lake Fen, 2008, 9850 ft, 3817; Beauty Lake Trail, 2009, 8900 ft, 5223; Beartooth Falls, 2009, 8900 ft, 5463; Little Bear Creek-4, 2009, 8950 ft, 6222 (MHA, MO), det. M. Ignatov. **Deep Lake:** Sawtooth Palsa Fen (Heidel et al. 2008); inlet of Frozen Lake, 2008, 10,350 ft, 2571; Wyoming Creek-1, 2008, 10,300 ft, 3477; Canyon Creek, 2009, 9400 ft, 5645; summits: snow-melt rill, 2010, 10,600 ft, 6724.

Sciuro-hypnum oedipodium (Mitt.) Ignatov & Huttunen

[*Brachythecium oedipodium* (Mitt.) A.Jaeger] First record: 1973. Frequent; in forests on duff, rotten wood, humus, mineral soil, on rocks, from montane through the alpine.

Muddy Creek: Ghost Creek Fen, 2008, 7900 ft, 3759 (MHA, MO), det. M. Ignatov; Rd 188: sparsely forested slope, 2010, 7600 ft, 7186. **Beartooth Butte:** Island Lake CG, spruce forest, 2008, 9500 ft, 2217 (½) (MHA, MO), det. M. Ignatov; Beartooth Lake CG: spruce forest, 2009, 8950 ft, 6207; 4WD Rd 149-1A: forested SW slope, 2010, 9650 ft, 7006 (MHA, MO), det. M. Ignatov. **Deep Lake:** [Hwy 212], W side of Beartooth Pass, rills and snowbeds, 1973, 3200 m.s.m., *Weber B-44307* (COLO, RM, US).

Sciuro-hypnum plumosum (Hedw.) Ignatov & Huttunen

[*Brachythecium plumosum* (Hedw.) Schimp.] First record: 2009. Sporadic; on rocks and soil along streams, in montane zone.

Muddy Creek: Lake Creek Waterfalls, 2009, 7500 ft, 5832 (MHA, MO); Lake Creek CG: wet coniferous forest, 2009, 6950 ft, 5906 (MHA, MO); Muddy Creek-1, 2009, 8100 ft, 6129 (MHA, MO). All det. M. Ignatov.

* **Scorpidium cossonii** (Schimp.) Hedenäs

[*Drepanocladus intermedius* (Lindb.) Warnst., *Limprichtia cossonii* (Schimp.) L.E.Anderson, H.A.Crum & W.R.Buck]

First record: 2002. Frequent; in rich minerotrophic fens, in springs, periodically water-filled depressions, from montane through the alpine; essentially arctic-alpine.

Jim Smith Peak: Little Moose Peatland, 2002, 7960 ft, *Jackson s.n.* (RM), det. YKA. **Muddy Creek:** ca. 1 air mi W of Lily Lake, floating bog, 2007, 7750 ft,

E.Elliott & B.Elliott 574 (RM); Ghost Creek Fen and Lily Lake East Fen (Heidel et al. 2008); Mud Lake Fen, 2008, 7750 ft, 3102 (CAS). **Beartooth Butte:** Clay Butte Fen (Heidel et al. 2008); Little Bear Lake Fen, 2008, 9600 ft, 2778. **Deep Lake:** summits: alpine fen-1, 2008, 10,500 ft, 2302. **Black Pyramid Mountain:** summits: alpine fen-3, 2008, 10,100 ft, 2491 (½).

Scorpidium revolvens (Sw.) Rubers

[*Drepanocladus revolvens* (Sw.) Warnst., *Limprichtia revolvens* (Sw.) Loeske]

First record: 2008. Rare, at upper subalpine and alpine elevations; essentially arctic-alpine.

Beartooth Butte: Little Bear Lake Fen, in shallow swales, 2009, 9600 ft, 5638. **Deep Lake:** summits: alpine fen-4, on soaked peat around the pool, 2008, ! 10,400 ft (3170 m), 3271.

Note: This species, like the following one, is widespread in tundra pools across North America and Eurasia; disjunct in Wyoming's Rocky Mountains (Kosovich-Anderson unpublished data). Altitudinal update – 3170 m vs. “low to high elevations (0–3100 m)” (FNA 2014, p. 388).

Scorpidium scorpioides (Hedw.) Limpr.

First record: 2008. Rare, single collection from alpine zone.

Deep Lake: summits: alpine fen-5, in seasonal pool, highly minerotrophic, 2008, 10,750 ft, 3433 (½), forms admixture with *Sarmentypnum sarmentosum*.

Scouleria aquatica Hook.

First record: 1953. Frequent; in aquatic habitats, banks or beds of streams, on irrigated granite rocks, from montane through the subalpine.

Jim Smith Peak: W of Beartooth Butte, along Crazy Creek, 1953, *Lawton 2026* (WTU), ver. S.P. Churchill; Crazy Creek, 1953, *Welch 16697* (WTU); Crazy Creek-2, 2010, 6900 ft, 7970 (CAS). **Muddy Creek:** Lake Creek Waterfalls, 2009, 7500 ft, 5816; Muddy Creek-2, 2010, 7750 ft, 7236; Lake Creek-2, 2010, 6900 ft, 8385. **Beartooth Butte:** Beartooth Creek-1, fully submerged (!), 2009, ! 8900 ft (2710 m), 5424.

Note: Altitudinal update – 2710 m vs. “low to high elevations (0–1900 m)” (FNA 2007, p. 313).

Sphagnum angustifolium (Russow) C.E.O.Jensen

First record: 1973. Sporadic; in fens, as carpets, floating mats, low hummocks, from montane through the alpine.

Muddy Creek: East Lily Peatland, 2002, 8100 ft, *Jackson s.n.*, det. YKA; Lily Lake East Fen (Booth and Zygmont 2005; Heidel et al. 2008). **Beartooth Butte:** [Hwy 212], swales around small lakes, subalpine zone between Long Lake and lower Shepherd Lakes, 1973, 2900 m.s.m., *Weber B-44268* (COLO, RM), det. R. Andrus. **Deep Lake:** Wyoming Creek and upstream, 2008, 10,550 ft, *Hartman 87944* (RM), det. YKA; Morrison Jeep Trail, Top Lake Fen-1, 2009, 9450 ft, 5773 (½).

* **Sphagnum fimbriatum** Wilson

First record: 1973. Sporadic; in minerotrophic fens and willow wetlands, at subalpine elevations.

Beartooth Butte: [Hwy 212], swales around small lakes, subalpine zone between Long Lake and lower Sheepherder Lakes, 1973, 2900 m.s.m., *Weber B-44287* (COLO, RM); boggy valley NE of Fantan Lake, 2010, 9500 ft, 6821. **Deep Lake:** creek connecting Dollar and Sawtooth Lakes, willow wetlands, 2009, 9400 ft, 5792.

Sphagnum fuscum (Schimp.) H.Klinggr.

First record: 2008. Rare; in alpine and subalpine fens, on peaty soil in dense hummock.

Beartooth Butte: Little Bear Lake Fen, 2008, 9600 ft, 2831. **Deep Lake:** Littlerock Creek Fen, 2008, 10,650 ft, 3631.

* ** **Sphagnum miyabeanum** Warnst.

First record: 2008. Rare to sporadic, at upper subalpine elevations.

Beartooth Butte: boggy shore of Island Lake, willow wetlands, in low hummocks, on vertical peaty banks of streamlet, also forms carpets in shallow swales, on soaked peaty soil, 2008, 9500–9600 ft, 2379, 2380, 2381, & 2392 (all in BING, DUKE); Little Bear Lake Fen, *Carex utriculata*/*Sphagnum miyabeanum* + *Sarmentypnum exannulatum* community, on soaked peaty soil, 2008, ! 9600 ft (2930 m), 2822 & 2824 (all in DUKE).

Note: A taxon of essentially oceanic habitats with Western North American – Eastern Asiatic distribution; was not included in FNA (2007). “The species has a Pacific Rim distribution that extends from California northward through British Columbia, southern Alaska, eastern Russia, southward to Japan and China” (Shaw et al. 2014, p. 19). The condition of the *S. miyabeanum* population on Little Bear Lake Fen may be characterized as vulnerable: periodic reconstruction of Hwy 212, which crosses Little Bear Lake Fen, is negatively affecting the fen ecosystem. Altitudinal update – 2930 m vs. “from sea level to moderate elevations” (Shaw et al. 2014, p. 19). Specimens 2379, 2380, 2381, 2392, 2822, and 2824 were included in genetic microsatellite analyses (Shaw et al. 2014, 2015).

Sphagnum platyphyllum (Lindb. ex Braithw.) Sull. ex Warnst.

First record: 1973. Common; in swales of fens, pools in lakeside swamps, in flooded sites, from montane through the lower alpine.

Jim Smith Peak: Rock Creek Fen (Heidel et al. 2008); Ivy Lake: SE edge, 2010, 8000 ft, 7527.

Beartooth Butte: [Hwy 212], swales around small lakes, subalpine zone between Long Lake and lower Sheepherder Lakes, 1973, 2900 m.s.m., *Weber B-44271* (COLO, RM); Lower Sheepherder Fen and Meadow Lake Fen (Heidel et al. 2008); boggy shore of Island Lake, 2008, 9500 ft, 2365; Little Bear Lake Fen, 2008, 9600 ft, 2747, 2820 & 2826 (all in DUKE), ver. J. Shaw; Meadow Lake Fen, 2008, 9800–9900 ft, 3763 (DUKE), ver. J. Shaw; Beartooth Lake: E

shore, 2009, 8900 ft, 4850 (DUKE), det. J. Shaw; boggy valley NE of Fantan Lake, 2010, 9500 ft, 6820; Fantan South Fen, 2010, 9500 ft, 6974; Long Lake: S edge, 2010, 9650 ft, 8308. **Deep Lake:** Lake WGN Fen and Sawtooth Palsa Fen (Heidel et al. 2008); Canyon Creek, 2009, 9400 ft, 5673 (DUKE), det. J. Shaw; Sawtooth Meadow, 2009, 9450 ft, 5762; Top Lake Fen-1, 2009, 9450 ft, 5779 (DUKE), det. J. Shaw; Sawtooth Lake, 2009, 9200 ft, 5968 (DUKE), det. J. Shaw; Lake WGN Fen, 2009, 9600 ft, 6076 (DUKE), det. J. Shaw; creek connecting Lower Top and Sawtooth Lakes, 2010, 9450 ft, 7597; Lower Top Lake Fen, 2010, 9450 ft, 7678; Dollar Lake: SW shore, 2010, 9400 ft, 7753.

Note: Specimens 2747, 2820, 2826, and 3763 were used in the microsatellite-based genetic analyses of the Pacific Rim clade of *Sphagnum* subgen. *Subsecunda* (Shaw et al. 2015).

* ** **Sphagnum riparium** Ångstr.

First record: 2009. Sporadic: all collections from Jeep Morrison Trail area; forms extensive carpets in weakly minerotrophic fens and on peaty banks of streams, at subalpine elevations.

Deep Lake: Canyon Creek valley, *Carex* spp./*Sphagnum riparium* + *S. russowii* + *S. squarrosum* fen, in low hummocks on soaked peaty soil, shaded by dense *Carex* stands, 2009, 9400 ft, 5657; creek connecting Lower Top and Sawtooth Lakes, all across peaty bank, 2010, 9400 ft, 7615; Lower Top Lake Fen, *Kalmia microphylla* (Hook.) A.Heller/*Carex* spp./*Sphagnum* spp. fen complex along W shore of lake, forms carpets, 2010, ! 9450 ft (2880 m), 7662.

Note: A species of arctic and boreal zones of Northern Hemisphere, distributed in northern portion of the conterminous United States; disjunct in the Wyoming mountains. Listed as a species of conservation concern in Montana (Elliott and Pipp 2019). Altitudinal update – 2880 m vs. “low to moderate elevations [0–1599 m]” (FNA 2007, p. 75).

Sphagnum russowii Warnst.

First record: 2005. Common; in willow carrs, fens and swampy forests, from montane through the alpine.

Jim Smith Peak: Rock Creek Fen (Heidel et al. 2008). **Muddy Creek:** East Lily Peatland (Booth and Zygmont 2005); Ghost Creek Fen (Heidel et al. 2008). **Beartooth Butte:** Meadow Lake Fen, Fantan North Fen, and Lower Sheepherder Fen (Heidel et al. 2008); Little Bear Lake Fen, 2008, 9600 ft, 2819.

Deep Lake: SW of Sawtooth Mt., wet meadow, 2007, approx. 9500 ft, *Elliott & Heidel 3652* (RM), det. YKA; Lake WGN Fen, Littlerock Creek Fen, and Sawtooth Palsa Fen (Heidel et al. 2008); unnamed lake S of Hwy 212, 2008, 10,000 ft, 2674 (BING, DUKE), ver. R. Andrus; Littlerock Creek Fen, 2008, 10,650 ft, 3656 (BING), det. R. Andrus; Wyoming Creek-2, 2009, 10,600 ft, 5073; Top Lake Fen-1, 2009, 9450 ft, 5778; creek connecting Dollar and Sawtooth Lakes, 2009, 9400 ft, 5786; Canyon Creek,

2009, 9400 ft, 5803; Lower Top Lake Fen, 2010, 9450 ft, 7661.

Sphagnum squarrosum Crome

First record: 2002. Frequent; on soaked boggy soil in riparian willow communities and minerotrophic fens, from montane through the subalpine.

Jim Smith Peak: Little Moose Peatland, 2002, 7960 ft, *Jackson s.n.* (RM), det. YKA. **Muddy Creek:** East Lily Peatland, 2002, 8100 ft, *Jackson s.n.* (RM), det. YKA; East Lily Peatland (Booth and Zygmont 2005); Ghost Creek Fen, 2008, 7900 ft, 3725. **Beartooth Butte:** Meadow Lake Fen, 2008, 9850 ft, 3788; boggy valley NE of Fantan Lake, 2010, 9500 ft, 6817. **Deep Lake:** Canyon Creek, 2009, 9400 ft, 5667; creek connecting Lower Top and Sawtooth Lakes, 2010, 9450 ft, 7597.

Sphagnum teres (Schimp.) Ångstr. ex Hartm.

First record: 2002. Sporadic; on wet and soaked boggy soil in riparian willow communities and minerotrophic fens, from montane through the alpine.

Jim Smith Peak: Rock Creek Fen (Heidel et al. 2008). **Muddy Creek:** East Lily Peatland, 2002, 8100 ft, *Jackson s.n.* (RM), det. YKA; Lily Lake East Fen (Heidel et al. 2008). **Deep Lake:** Lake WGN Fen (Heidel et al. 2008); Littlerock Creek Fen, 2008, 10,650 ft, 3632.

Sphagnum warnstorffii Russow

First record: 1953. Common; forms lawns and hummocks in rich, open and forested fens, also along streams in swampy forests, from montane through the alpine.

Jim Smith Peak: Little Moose Peatlands, 2002, 7960 ft, *Jackson s.n.* (RM), det. YKA; Little Moose Lake Fen (Booth and Zygmont 2005; Heidel et al. 2008); between Reed Lake and Rock Creek, floating bog and surrounding *Carex* mat, 2007, 7550–7800 ft, *E.Elliott, B.Elliott & Heidel 3845* (RM), det. YKA. **Muddy Creek:** East Lily Peatland, 2002, 8100 ft, *Jackson s.n.*, det. YKA; East Lily Peatland (Booth and Zygmont 2005); between Muddy and Ghost Creeks, fen with floating mat, 2007, 6950–8100 ft, *Elliott & Heidel 3244* (RM), det. YKA; area surrounding fen with spruce overstory and stream bed, 2007, 6950–8100 ft, *Elliott & Heidel 3288* (RM), det. YKA; Ghost Creek Fen, 2008, 7900 ft, 3758 (BING), det. R. Andrus. **Beartooth Butte:** stream near Beartooth Lodge, 1953, *Lawton 1951* (WTU); [Hwy 212], swales around small lakes, subalpine zone between Long Lake and lower Shepherder Lakes, 1973, 2900 m.s.m., *Weber B-44272* (COLO, RM, TENN); boggy shore of Island Lake, 2008, 9700 ft, 2391 (BING), det. R. Andrus; Meadow Lake Fen, 2008, 9850 ft, 3775.1 (BING), det. R. Andrus; Beauty Lake Trail, 2009, 8900 ft, 5309 (CAS, COLO). **Deep Lake:** S of Sawtooth Mt., wet boggy area surrounding palsa peatbed, 2007, 9800 ft, *E.Elliott, Heidel & B.Elliott 3586* (RM), det. YKA; Littlerock Creek Fen, 2008, ! 10,650 ft (3240 m), 3652; Wyoming

Creek-2, 2009, 10,550 ft, 5072; Canyon Creek, 2009, 9400 ft, 5802; Top Lake Fen-2, 2010, 9450 ft, 7706.

Black Pyramid Mountain: WY-MT state line: unnamed lake, 2010, 9800 ft, 8068 (DUKE).

Note: Alpine forms of the species from the Beartooth Plateau have stable morphological features: elliptic pore-like wall thinning and ruptures at the distal ends of the cells of stem hyalodermis and fibrillose hyaline cells in distal portion of stem leaves. Altitudinal update – 3240 m vs. “low to moderate elevations [0–1599 m]” (FNA 2007, p. 101).

Splachnum sphaericum Hedw.

First record: 2008. Rare, in upper subalpine and alpine zones, dung of animals on boggy soil.

Beartooth Butte: Little Bear Lake Fen, 2008, 9600 ft, 2774. **Deep Lake:** inlet of Frozen Lake, 2008, 10,350–10,550 ft, 2547.

Stegonia latifolia (Schwägr.) Venturi ex Broth.

* ** - **var. pilifera** (Brid.) Broth.

First record: 2010. Rare, single collection from alpine zone; arctic-alpine.

Deep Lake: W summit and vicinity, alpine tundra, at base of granite debris, on calcareous silt, locally abundant, 2010, ! 11,050 ft (3370 m), 6663, S+.

Note: The arctic-alpine species *Stegonia latifolia* is represented on the Beartooth Plateau with the rare variety *pilifera* with well-pronounced awn. Altitudinal update for the variety – 3370 m vs. “moderate to high elevations (600–2200 m)” (FNA 2007, p. 605).

Straminergon stramineum (Dicks. ex Brid.) Hedenäs [*Calliergon stramineum* (Dicks. ex Brid.) Kindb.]

First record: 1973. Common; in mineral-poor to mineral-rich fens, on irrigated rocks, in wet ground along the edges of tundra pools, from montane through the alpine.

Jim Smith Peak: Rock Creek Fen (Heidel et al. 2008). **Muddy Creek:** Ghost Creek Fen (Heidel et al. 2008); Mud Lake Fen, 2008, 7750 ft, 3138. **Beartooth Butte:** [Hwy 212], swales around small lakes, subalpine zone between Long Lake and lower Shepherder Lakes, 1973, 2900 m.s.m., *Weber B-44280* (COLO, RM); Little Bear Lake Fen, 2008, 9600 ft, 2860; Clay Butte Fen, 2008, 9000 ft, 3009; boggy valley NE of Fantan Lake, 2010, 9500 ft, 6817. **Deep Lake:** S of Sawtooth Mt., palsa peatbeds, 2007, 9800 ft, *E.Elliott, Heidel, & B.Elliott 3586* (RM), det. YKA; summits: alpine fen-1, 2008, 10,500 ft, 2310; Wyoming Creek-2, 2009, 10,550 ft, 4972; Lower Top Lake Fen, 2010, 9450 ft, 7662; Dollar Lake: SW shore, 2010, 9400 ft, 7762.

* ** **Syntrichia calcicola** J.J.Amann

[*Syntrichia ruralis* var. *calcicola* (J.J.Amann) Mönk.] First record: 2009. Rare, in subalpine zone.

Muddy Creek: Clay Butte: slope facing to W, grasslands, limestone debris, in crevices of limestone rock, on a layer of loamy soil, in partial shade, assoc.: *Bryum argenteum* and *Hypnum vaucheri*, 2009, 9500 ft, 4938. **Beartooth Butte:** Beartooth Butte-1,

scattered limestone debris on E slope, in shallow crevices of rock, assoc.: *Brachytheciastrum collinum*, *Bryum argenteum*, *Distichium capillaceum*, and *Tortula obtusifolia* (Schwagr.) Mathieu, 2009, 9200 ft, 5259.

Note: Specimens from the Beartooth Plateau are morphologically almost identical to those from the Wyoming's Medicine Bow Mtns., collected by the author in 2007 (870, 1281 and others) and identified by M.T. Gallego as *Syntrichia calcicola*. A predominantly calciphilous species, known from Europe, Caucasus, and Middle Asia (Savich-Lyubitskaya and Smirnova 1970; Gallego et al. 2006). In North America, the species distribution is unclear: it was not listed in FNA (2007). The species was previously reported from Colorado by Weber and Wittmann (2007).

***Syntrichia caninervis* Mitt.**

[*Tortula caninervis* (Mitt.) Broth.]

First record: 2016. Rare (undercollected?), in montane zone.

Jim Smith Peak: Hwy 212, roadside slope, xeric grassland, on gravelly soil, 2016, 7550 ft, 21061.

* ***Syntrichia montana* Nees**

[*S. intermedia* Brid.]

First record: 2008. Sporadic; on soil over rock outcrops, from montane through the alpine.

Jim Smith Peak: Crazy Creek-2, 2010, 6900 ft, 7999.

Beartooth Butte: Beartooth Butte-1, 2009, 8950 ft, 5262. **Deep Lake:** summits: granite outcrop in alpine tundra, 2008, 10,900 ft, 2532A.

Note: Medium size plants. In Wyoming, the plants of *S. montana* are at least twice as large than they are described in FNA (2007, p. 624): "stems 2–10 mm" (Kosovich-Anderson unpublished data).

* ***Syntrichia norvegica* F.Weber**

[*Tortula norvegica* (F.Weber) Lindb.]

First record: 1973. Frequent; in forests on soil over granite outcrops, on duff and litter, on saturated ground under willows in subalpine fens and willow carrs, in late snow-melt areas in alpine tundra, from montane through the alpine; arctic-alpine.

Muddy Creek: aspen grove along Hwy 212, 2008, 7750 ft, 3919; tributary of Beartooth Creek-1, 2010, 8450 ft, 7081. **Beartooth Butte:** Island Lake CG, spruce forest, 2008, 9500 ft, 2225 (UC); pine forest along Hwy 212, 2008, 9000 ft, 3887; Little Bear Creek-3, 2009, 9400 ft, 5375; 4WD Rd 149: NE slope, subalpine meadow, 2010, 9650 ft, 7049 (MO); Beartooth Lake CG: coniferous forest, 2010, 8950 ft, 8021. **Deep Lake:** [Hwy 212], W side, rills and snowbeds, 1973, 3200 m.s.m., *Weber 44311* (COLO, RM), annot. P. Eckel; W summit and vicinity, 2010, 10,950 ft, 6665. **Black Pyramid Mountain:** WY-MT state line: unnamed lake, 2010, 9800 ft, 8097.

* ***Syntrichia papillosissima* (Copp.) Loeske**

[*Tortula ruralis* var. *hirsuta* (Venturi) Paris]

First record: 2016. Rare, in montane zone.

Jim Smith Peak: Hwy 212, roadside slope, xeric grassland, on gravelly soil, 2016, 7550 ft, 21062.

***Syntrichia ruralis* (Hedw.) F.Weber & D.Mohr**
[*Tortula ruralis* (Hedw.) P.Gaertn., B.Mey. & Scherb.]

First record: 1965. Common; on soil in sheltered areas around boulders and on ledges of rock debris and outcrops in *Festuca idahoensis* grasslands, *Artemisia tridentata* shrublands, and different types of forests – on soil, decaying wood, exposed roots of trees; on rocky ridgcrests and slopes, stabilized talus; from foothills through the alpine.

Jim Smith Peak: Crazy Creek-1, 2009, 6950 ft, 5611, S+; WY-MT state line: spruce forest, 2009, 7800 ft, 5480. **Muddy Creek:** aspen grove along Hwy 212, 2008, 7750 ft, 3918, S+; Index Lookout: roadside, 2009, 8750 ft, 6099; Lewis and Clark Trail: Douglas-fir forest, 2009, 6800 ft, 6177; top of terrace: sagebrush thickets, 2010, 7650 ft, 7202, S+; SE slope: sagebrush thickets, 2010, 7750 ft, 7407.

Beartooth Butte: Beartooth Falls, 2009, 8900 ft, 5462; granite ridge: coniferous forest, 2010, 9550 ft, 6950. **Deep Lake:** summits: alpine tundra-3, 2008, 10,350 ft, 2404; dry creek in alpine tundra, 2008, 10,350 ft, 2422 (UC); summits: granite outcrops in alpine tundra, 2008, 10,900 ft, 2539; summits: alpine tundra-6, 2008, 10,850 ft, 3342; Hwy 212: roadside granite debris, 2010, 10,200 ft, 6731; Gardner Lake: head of USFS Trail, 2010, 10,600 ft, 8189. **Black Pyramid Mountain:** summits: alpine tundra-1, 2008, 10,200–10,300 ft, 2277; summits: alpine fen-3, 2008, 10,100 ft, 2526 (CAS), ver. P. Eckel. **Unclear location:** along Rd ca. 11 mi SE of [Hwy 212], 33 mi NW of Cody, granite outcrop, 1965, *Hermann 20026* (WTU).

* * * ***Syntrichia virescens* (DeNot.) Ochyra**

First record: 2008. Rare, single collection from subalpine zone.

Beartooth Butte: Island Lake CG, *Picea engelmannii* forest, on soil in crevice of rock, 2008, 9500 ft, 2224, det. K. Kellman.

Note: The species ecology and distribution in North America are poorly known; this taxon was not included in FNA (2007).

* * * ***Tayloria lingulata* (Dicks.) Lindb.**

First record: 1973. Sporadic; on damp soil or humus in willow-sedge hummock of late snow-melt areas, from upper subalpine through the alpine; arctic-alpine.

Beartooth Butte: [Hwy 212], swales around small lakes, subalpine zone between Long Lake and lower Shepherder Lakes, 1973, 2900 m.s.m., *Weber B-44275* (COLO); Fantan North Fen (Heidel et al. 2008); Little Bear Lake Fen, 2008, 9600 ft, 2897, S+; Meadow Lake Fen, 2008, 9850 ft, 3799, S+. **Deep Lake:** unnamed alpine lake along Hwy 212, 2010, 10,000 ft, 8244, S+.

Note: A minerotrophic species with predominantly arctic distribution; disjunct on the Beartooth Plateau,

rare in Wyoming (Kosovich-Anderson unpublished data).

**** *Thuidium recognitum* (Hedw.) Lindb.**

First record: 2008. Rare, single collection from montane zone.

Muddy Creek: SE edge of Lily Lake Fen, swampy forest, *Picea glauca*/*Alnus* sp./*Linnaea borealis* L. (+ Bryidae mosses), in shade under recently fallen spruce, forms carpet on duff and humus, locally abundant, assoc.: *Marchantia polymorpha* subsp. *montivagans*, *Aulacomnium palustre*, *Climacium dendroides*, *Rhizomnium pseudopunctatum*, *Timmia austriaca* Hedw., 2008, 7750 ft, 3047 (COLO).

Note: A circumboreal species, disjunct in Wyoming, with the only known station – on the Beartooth Plateau (Kosovich-Anderson and Weber 2011, Kosovich-Anderson unpublished data).

***Timmia austriaca* Hedw.**

First record: 1953. Frequent; on shaded creek banks and humus-covered surface of rocks in wet and swamp montane and subalpine coniferous forests; arctic-alpine.

Jim Smith Peak: W of Beartooth Butte, Crazy Creek CG, 1953, *Lawton 2035* (WTU); Crazy Creek, W of Beartooth Lake, 1953, *Conard s.n.* (PH); Crazy Creek-2, 2010, 6900 ft, 7991, S+. **Muddy Creek:** Lake Creek Waterfalls, 2009, 7500 ft, 5812; Muddy Creek-1, 2009, 8100 ft, 6136; tributary of Beartooth Creek-1, 2010, 8450 ft, 7104; Ghost Creek, 2010, 7900 ft, 8437. **Beartooth Butte:** Clay Butte Fen, 2008, 9000 ft, 2928; Beartooth Lake: W shore, 2010, 8900 ft, 6640. **Deep Lake:** Sawtooth Lake, 2009, 9300 ft, 6048.

***Timmia megapolitana* Hedw.**

- **subsp. *bavarica* (Hessl.) Brassard**

First record: 2009. Rare, single collection from subalpine zone.

Beartooth Butte: SE slope of Beartooth Butte, limestone debris scattered across the slope, in rock crevice, assoc.: *Distichium capillaceum*, 2009, 9250 ft, 5275, S+.

Note: Capsules are smaller than in genus description provided in FNA (2007, p. 166): 2.5–3 × 1–1.5 mm vs. 2–2.2 × 0.9–1 mm in the Beartooth specimen.

***Tomentypnum nitens* (Hedw.) Loeske**

First record: 1953. Common; on boggy soil in minerotrophic (open or forested) fens and willow cars, from foothills through the upper subalpine.

Jim Smith Peak: Little Moose Peatlands, 2002, 7960 ft, *Jackson s.n.* (RM), det. J. Harpel; Crazy Creek CG Swamp, 2008, 7000 ft, 3183. **Muddy Creek:** East Lily Peatland, 2002, 8100 ft, *Jackson s.n.* (RM), det. J. Harpel; Ghost Creek Fen (Heidel et al. 2008); Lily Lake Swamp Forest, 2008, 7750 ft, 3019; Ghost Creek Fen, 2008, 7900 ft, 3734; outlet of Lily Lake, 2010, 7750 ft, 7514. **Beartooth Butte:** Beartooth Lodge, near stream, 1953, *Lawton 1934* (WTU); [Hwy 212], swales around small lakes, subalpine zone between Long Lake and lower Shepherd Lakes, 1973, 2900 m.s.m., *Weber B-44285* (COLO,

RM); Clay Butte Fen (Heidel et al. 2008); Meadow Lake Fen, 2008, 9850 ft, 3793. **Deep Lake:** Sawtooth Lake, 2009, 9250 ft, 5978; Top Lake Fen-2, 2010, 9500 ft, 7721. **Black Pyramid Mountain:** WY-MT state line: unnamed lake, 2010, 9650 ft, 8063 (MONTU).

***Tortella fragilis* (Drumm.) Limpr.**

First record: 1953. Frequent; on loamy soil in alpine tundra, on rocky ridgelines and margins of solifluction lobes, in late snow-melt areas; arctic-alpine.

Jim Smith Peak: W of Beartooth Butte, Crazy Creek CG, 1953, *Lawton 2027* (WTU). **Deep Lake:** [Hwy 212], alpine bogs of E summit, head of Wyoming Creek, 1973, 3250 m.s.m., *Weber B-44263* (COLO, RM), det. R. Zander; summits: alpine tundra-3, 2008, 10,350 ft, 2409; dry creek in alpine tundra, 2008, 10,350 ft, 2420 (CAS); summits: Overlook Roadside Park, alpine tundra, 2008, 10,950 ft, 3547; summits: alpine tundra-7, 2010, 10,800 ft, 6718 (US), det. R. Ireland; summits: alpine tundra-9, 2010, 10,400 ft, 8112. **Black Pyramid Mountain:** summits: alpine tundra-4, 2008, 10,300 ft, 2470; summits: alpine fen-3, 2008, 10,100 ft, 2524.

***Tortella tortuosa* (Schrad. ex Hedw.) Limpr.**

First record: 2008. Rare, single collection from alpine zone; arctic-alpine.

Deep Lake: summits: alpine fen-1, at base of granite rock, in shade, assoc.: *Tortella fragilis*, 2008, 10,500 ft, 2298.

***Tortula hoppeana* (Schultz) Ochyra**

[*Desmatodon latifolius* (Hedw.) Brid.]

First record: 1939. Common; on loamy and rocky soil in subalpine and alpine meadows and tundra, on bare soil on trailsides; arctic-alpine. Sporophytes common.

Beartooth Butte: near Beartooth Lodge, 1939, *unknown s.n.* (WTU); near Beartooth Lodge, along stream, 1953, *Lawton 1933* (WTU); E of Beartooth Lake, Beartooth Pass, 1953, *Lawton s.n.* (MO). **Deep Lake:** [Hwy 212], E of summit near small glacial lake, 1953, 10,500 ft, *Lawton 1967* (WTU); near Frozen Lake at curve of Rd, 1953, 10,264 ft, *Lawton 2135* (WTU); [Hwy 212], W summit of Beartooth, tundra above Black Stone Lake, 1973, 3300 m.s.m., *Weber B-44251* (COLO, RM); Sawtooth Palsa Fen (Heidel et al. 2008); dry creek in alpine tundra, 2008, 10,350 ft, 2429 (MO), S+; inlet of Frozen Lake, 2008, 10,500 ft, 2586, S+; Littlerock Creek Fen, 2008, 10,650 ft, 3666; Sawtooth Palsa Fen, 2009, 9700 ft, 5761, S+; W summit and vicinity, 2010, 11,050 ft, 6695; Hwy 212, roadside granite debris, 2010, 10,200 ft, 6732, S+; summits: alpine tundra-11, 2010, 10,750 ft, 8157, S+; Gardner Lake: head of USFS Trail, 2010, 10,600 ft, 8189.

***Tortula inermis* (Brid.) Mont.**

First record: 2008. Rare, single collection from subalpine zone.

Beartooth Butte: Beartooth Butte, on limestone rock along creek bank, 2008, ! 9500 ft (2900 m), 3839.

Note: Altitudinal update – 2900 m vs. “low to high elevations (0–2000 m)” (FNA 2007, p. 600).

* **Tortula leucostoma** (R.Br.) Hook. & Grev.

[*Desmatodon leucostoma* (R.Br.) Berggr.]

First record: 2008. Rare, single collection from alpine zone; arctic-alpine.

Deep Lake: Littlerock Creek Fen, ecotone zone of alpine *Salix planifolia*/Bryidae fen and alpine tundra, on frost boils, locally abundant, 2008, 10,650 ft, 3610, S+.

Tortula mucronifolia Schwägr.

First record: 2008. Rare, from montane through the alpine; arctic-alpine.

Beartooth Butte: tributary of Beartooth Creek-2, on soil over granite outcrop, 2010, 7750 ft, 7397, S+.

Deep Lake: summits: alpine tundra-6, on loamy soil, 2008, ! 10,850 ft (3310 m), 3343, S+.

Note: Altitudinal update – 3310 m vs. “low to high elevations (0–2700 m)” (FNA 2007, p. 601).

Tortula obtusifolia (Schwägr.) Mathieu

[*Desmatodon obtusifolius* (Schwägr.) Schimp.]

First record: 2009. Sporadic; on soil and rock (granite, limestone) in fens, meadows and tundra, in zone of late snowmelt at subalpine and alpine elevations.

Muddy Creek: seepage slope along Hwy 212, 2009, 8700 ft, 6104. **Beartooth Butte:** Beartooth Lake CG: wet subalpine meadow, 2009, 8950 ft, 4889; Beartooth Butte-1, 2009, 9250 ft, 5266; boggy valley NE of Fantan Lake, 2010, 9500 ft, 6831. **Deep Lake:** Gravel Pit vicinity, alpine tundra, 2010, 10,400 ft, 7265.

* **Trichostomum tenuirostre** (Hook. & Taylor) Lindb.

[*Oxystegus tenuirostris* (Hook. & Taylor) A.J.E.-Smith]

First record: 2009. Rare, in foothills and montane zone.

Jim Smith Peak: Crazy Creek-2, on granite outcrops in splash zone of creek, 2010, 6900 ft, 7976. **Muddy Creek:** Lake Creek Waterfalls, on inundated rocks, in shade of spruce, 2009, 7500 ft, 5828 (MHA, MO), ver. M. Ignatov.

* **Warnstorfia fluitans** (Hedw.) Loeske

[*Drepanocladus fluitans* (Hedw.) Warnst.].

First record: 1953. Frequent; in swales of fens, pools, stagnant water of streams, from montane through the alpine.

Muddy Creek: Mud Lake Fen, 2008, 7750 ft, 3117.

Beartooth Butte: between summit and Beartooth Lake, along Hwy, 1953, *Welch 16652* (WTU); E of Beartooth Lake, Beartooth Pass, *Lawton s. n.* (MO).

Deep Lake: 13 mi E of Beartooth Lake, 1953, 10,500 ft, *Conard, s.n.* (WTU); [Hwy 212], head of Wyoming Creek, alpine bogs of E summit, 1973, 3240 m.s.m., *Weber B-44265* (COLO); inlet of Frozen Lake, 2008,

10,400 ft, 2612; summits: alpine fen-4, 2008, 10,400 ft, 3281; Wyoming Creek-2, 2009, 10,500 ft, 5079 (MHA, MO), det. M. Ignatov.

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APPENDIX 1

TAXONOMIC DIVERSITY OF BRYOPHYTE FLORA OF THE WYOMING'S BEARTOOTH PLATEAU

Family	Genus (# of species in genus)	# of species in family
Hepaticae / Marchantiophyta		
Anastrophyllaceae	<i>Barbilophozia</i> (3), <i>Gymnocolea</i> (1), <i>Schljakovia</i> (1)	5
Aneuraceae	<i>Riccardia</i> (2)	2
Antheliaceae	<i>Anthelia</i> (1)	1
Blepharostomataceae	<i>Blepharostoma</i> (1)	1
Calypogeiaceae	<i>Calypogeia</i> (1)	1
Cephaloziaceae	<i>Cephalozia</i> (1), <i>Fuscocephaloziopsis</i> (2)	3
Cephaloziellaceae	<i>Cephaloziella</i> (2)	2
Cleveaceae	<i>Clevea</i> (1)	1
Conocephalaceae	<i>Conocephalum</i> (1)	1
Gymnomitriaceae	<i>Nardia</i> (1)	1
Harpanthaceae	<i>Harpanthus</i> (1)	1
Jungermanniaceae	<i>Jungermannia</i> (2)	2
Lepidoziaceae	<i>Lepidozia</i> (1)	1
Lophocoleaceae	<i>Chiloscyphus</i> (2), <i>Lophocolea</i> (2)	4
Marchantiaceae	<i>Marchantia</i> (1)	1
Pelliaceae	<i>Apopellia</i> (1), <i>Pellia</i> (1)	2
Plagiochilaceae	<i>Plagiochila</i> (1)	1
Radulaceae	<i>Radula</i> (1)	1
Scapaniaceae	<i>Lophozia</i> (3), <i>Saccobasis</i> (1), <i>Scapania</i> (7), <i>Schistochilopsis</i> (1), <i>Tritomaria</i> (1)	13
Solenostomataceae	<i>Solenostoma</i> (1)	1
Total (Hepaticae): 20	29	45
Musci / Bryophyta		
Amblystegiaceae	<i>Amblystegium</i> (1), <i>Calliergonella</i> (1), <i>Campyliadelphus</i> (1), <i>Campyllum</i> (2), <i>Campylophyllum</i> (1), <i>Cratoneuron</i> (1), <i>Drepanocladus</i> (3), <i>Hygroamblystegium</i> (1), <i>Hygrohypnum</i> (7), <i>Leptodictyum</i> (1), <i>Palustriella</i> (1), <i>Platydictya</i> (1), <i>Pseudocalliergon</i> (2), <i>Sanionia</i> (2), <i>Tomentypnum</i> (1)	26
Aulacomniaceae	<i>Aulacomnium</i> (1)	1
Bartramiaceae	<i>Bartramia</i> (1), <i>Philonotis</i> (3)	4
Brachytheciaceae	<i>Brachythecium</i> (11), <i>Eurhynchiastrum</i> (1), <i>Homalothecium</i> (1), <i>Sciuro-hypnum</i> (4)	19

APPENDIX 1
CONTINUED

Family	Genus (# of species in genus)	# of species in family
Bryaceae	<i>Anomobryum</i> (1), <i>Bryum</i> (1), <i>Gemmabryum</i> (1), <i>Imbriobryum</i> (1), <i>Plagiobryum</i> (1), <i>Ptychostomum</i> (9), <i>Rosulabryum</i> (3)	17
Calliergonaceae	<i>Calliergon</i> (3), <i>Sarmentypnum</i> (2), <i>Scorpidium</i> (3), <i>Srtramingeron</i> (1), <i>Warnstorfia</i> (1)	10
Climaciaceae	<i>Climacium</i> (2)	2
Dicranaceae	<i>Campylopus</i> (1), <i>Cynodontium</i> (1), <i>Dichodontium</i> (1), <i>Dicranella</i> (3), <i>Dicranoweisia</i> (2), <i>Dicranum</i> (6), <i>Kiaeria</i> (2), <i>Oncophorus</i> (2), <i>Paraleucobryum</i> (1)	19
Ditrichaceae	<i>Ceratodon</i> (1), <i>Distichium</i> (2), <i>Ditrichum</i> (2), <i>Saelania</i> (1)	6
Encalyptaceae	<i>Encalypta</i> (3)	3
Fissidentaceae	<i>Fissidens</i> (2)	2
Fontinalaceae	<i>Dichelyma</i> (1), <i>Fontinalis</i> (3)	4
Funariaceae	<i>Funaria</i> (1)	1
Grimmiaceae	<i>Bucklandiella</i> (1), <i>Coscinodon</i> (1), <i>Grimmia</i> (12), <i>Niphotrichum</i> (1), <i>Schistidium</i> (7)	22
Helodiaceae	<i>Elodium</i> (1)	1
Hylocomiaceae	<i>Hylocomium</i> (1), <i>Pleurozium</i> (1)	2
Hypnaceae	<i>Hypnum</i> (5), <i>Isopterygiopsis</i> (1), <i>Ptilium</i> (1)	7
Leskeaceae	<i>Pseudoleskea</i> (2), <i>Pseudoleskeella</i> (1)	3
Meesiaceae	<i>Amblyodon</i> (1), <i>Leptobryum</i> (1), <i>Meesia</i> (3), <i>Paludella</i> (1)	6
Mielichhoferiaceae	<i>Pohlia</i> (11)	11
Mniaceae	<i>Mnium</i> (6), <i>Plagiomnium</i> (2), <i>Rhizomnium</i> (4)	12
Orthotrichaceae	<i>Amphidium</i> (1), <i>Orthotrichum</i> (4)	5
Plagiotheciaceae	<i>Plagiothecium</i> (1)	1
Polytrichaceae	<i>Meiotrichum</i> (1), <i>Pogonatum</i> (1), <i>Polytrichastrum</i> (3), <i>Polytrichum</i> (4)	9
Pottiaceae	<i>Barbula</i> (1), <i>Bryoerythrophyllum</i> (1), <i>Didymodon</i> (4), <i>Molendoa</i> (1), <i>Syntrichia</i> (7), <i>Stegonia</i> (1), <i>Tortella</i> (2), <i>Tortula</i> (5), <i>Trichostomum</i> (1)	23
Pterigynandraceae	<i>Myurella</i> (1), <i>Pterigynandrum</i> (1)	2
Rhytidiaceae	<i>Rhytidium</i> (1)	1
Scouleriaceae	<i>Scouleria</i> (1)	1
Seligeriaceae	<i>Blindia</i> (1)	1
Sphagnaceae	<i>Sphagnum</i> (10)	10
Splachnaceae	<i>Tayloria</i> (1), <i>Splachnum</i> (1)	2
Thuidiaceae	<i>Abietinella</i> (1), <i>Thuidium</i> (1)	2
Timmiaceae	<i>Timmia</i> (2)	2
Total (Musci): 33	102	237
Total: 53	131	282

APPENDIX 2

EXCLUDED TAXA

The following 10 unaccepted taxa were present in the original lists (Kosovich-Anderson 2011a, 2015). These taxa have been designated unconfirmed, or unrecognized as separate taxa, or recently excluded from the *Flora of North America North of Mexico* (FNA 2014) and Synopsis of Liverwort Flora of North America North of Mexico (Stotler and Crandall-Stotler 2017).

HEPATICAE

Jungermannia exsertifolia Steph. subsp. *exsertifolia*. This subspecies is restricted to Japan, Korea, and China (Stotler and Crandall-Stotler 2017). The original report was based on erroneous identification.

Marchantia polymorpha L. subsp. *polymorpha*. Temporarily (?) excluded. Taxon with unclear distribution in North America; electrophoretically confirmed only from Europe (Stotler and Crandall-Stotler 2017).

Plectocolea subelliptica (Lindb. ex Heeg) A.Evans. The taxon was synonymized with *Solenostoma obovatum* (Nees) C.Massal. (Stotler and Crandall-Stotler 2017).

MUSCI

Amblystegium juratzkanum Schimp. [*A. serpens* (Hedw.) Bruch & Schimp. var. *juratzkanum* (Schimp.) Rau & Hervey]. The taxon was synonymized with *A. serpens* in *Flora of North America North of Mexico* (FNA 2014).

Aulacomnium androgynum (Hedw.) Schwägr. Specimens YKA 2655, 2671, 6052 & 7034 were redetermined by the author in 2020 as a stunted form of *A. palustre*.

Aulacomnium palustre var. *imbricatum* Bruch & Schimp. Excluded from *Flora of North America North of Mexico* (FNA 2014); taxonomic position of the variety is still controversial.

Hypnum cupressiforme Hedw. Specimens have been misidentification of *H. vaucheri*. The most reliable distinguishing feature of these species is the blunt foliose pseudoparaphyllia of *H. vaucheri*, filamentous to lanceolate in *H. cupressiforme*.

Palustriella decipiens (DeNot.) Ochyra [Cratoneuron *decipiens* (DeNot.) Loeske]. Excluded from *Flora of North America North of Mexico* (FNA 2014).

Sarmentypnum tundrae (Arnell) Hedenäs. Previous report from Wyoming Creek (Kosovich-Anderson 2015) was based on incorrect identification of the specimen YKA 5087. Reevaluated by the author in 2020 as a short-leaved alpine form of *S. exannulatum*.

Sphagnum subsecundum Nees. Temporarily (?) excluded. According to Shaw et al. (2014), the geographic range of 'real' *S. subsecundum* is restricted to eastern North America and western Europe. However, some specimens from the Beartooth Plateau (e.g., 5311, 5312, 5313, 5618) morphologically strongly suggest typical *S. subsecundum*. These specimens need additional genetic investigations. I cannot rule out that *S. subsecundum* has wider distribution.

APPENDIX 3

COMMON BRYOPHYTES BY HABITAT

This research revealed a core set of bryophytes which are most commonly found in the following habitats on Wyoming's Beartooth Plateau:

alpine tundra (on soil, rock debris, stabilized talus, solifluction lobes, frost boils, snowbeds, glacial till): *Abietinella abietina*, *Barbilophozia hatcheri*, *Brachytheciastrum collinum*, *Bryum argenteum*, *Cephaloziella divaricata*, *Ceratodon purpureus*, *Dicranum muehlenbeckii*, *D. spadiceum*, *Didymodon asperifolius*, *Ditrichum flexicaule*, *Encalypta raptocarpa*, *Gemabryum caespiticium*, *Grimmia montana*, *Hypnum revolutum* s. l., *H. vaucheri*, *Mnium arizonicum*, *Orthotrichum laevigatum*, *Pohlia bolanderi*, *P. cruda*, *P. drummondii*, *Polytrichastrum alpinum* var. *septentrionale*, *P. sexangulare*, *Polytrichum juniperinum*, *P. piliferum*, *Ptychostomum inclinatum*, *Rhytidium rugosum*, *Rosulabryum elegans*, *Syntrichia norvegica*, *S. ruralis*, *Tortella fragilis*, *Tortula hoppeana*.

cliffs and ridgecrests: *Barbilophozia hatcheri*, *Bartramia ithyphylla*, *Blepharostoma trichophyllum*, *Brachytheciastrum collinum*, *Cephaloziella divaricata*, *Distichium capillaceum*, *Encalypta raptocarpa*, *Grimmia elatior*, *G. longirostris*, *G. montana*, *Hypnum revolutum* s. s., *H. vaucheri*, *Orthotrichum laevigatum*, *Polytrichastrum alpinum* var. *septentrionale*, *Polytrichum piliferum*, *Pseudoleskea radicata*, *Syntrichia ruralis*.

snow-melt rills and seepage slopes: *Brachythecium erythrorhizon* s. s., *Campylium stellatum*, *Dicranum muehlenbeckii*, *Distichium capillaceum*, *Drepanocladus aduncus*, *Gymnocolea inflata*, *Hygrohypnum duriusculum*, *H. ochraceum*, *Hypnum lindbergii*, *H. pratense*, *Marchantia polymorpha* subsp. *montivagans*, *Philonotis fontana* var. *pumila*, *Plagiomnium ellipticum*, *Pohlia wahlenbergii*, *Polytrichastrum alpinum* var. *septentrionale*, *P. sexangulare*, *Ptychostomum pseudotriquetrum*, *P. turbinatum*, *P. weigelii*, *Rhizomnium magnifolium*, *Sarmentypnum exannulatum*, *Scapania irrigua*, *Sciuro-hypnum latifolium*, *Syntrichia norvegica*.

alpine and subalpine fens and peaty banks of lakes: *Aulacomnium palustre*, *Barbilophozia hatcheri*, *Blepharostoma trichophyllum*, *Calliergon cordifolium*, *C. giganteum*, *Campylium stellatum*, *Cephaloziella bicuspidata*, *Cephaloziella divaricata*, *Ceratodon purpureus*, *Cratoneuron filicinum*, *Drepanocladus aduncus*, *Fuscocephaloziopsis pleniceps*, *Gymnocolea inflata*, *Hypnum lindbergii*, *H. pratense*, *Lophozia ventricosa* s. s., *Marchantia polymorpha* subsp. *montivagans*, *Oncophorus virens*, *Palustriella falcata*, *Philonotis fontana* s.

l., *Plagiomnium ellipticum*, *Pohlia cruda*, *P. wahlenbergii*, *Polytrichastrum alpinum* s. l., *P. longisetum*, *Polytrichum strictum*, *Ptychostomum pseudotriquetrum*, *P. weigelii*, *Rhizomnium magnifolium*, *R. pseudopunctatum*, *Rosulabryum elegans*, *Sanionia nivalis*, *S. uncinata*, *Sarmentypnum exannulatum*, *S. sarmentosum*, *Scapania irrigua*, *S. subalpina*, *Sciuro-hypnum latifolium*, *Scorpidium cossonii*, *Sphagnum platyphyllum*, *S. russowii*, *S. squarrosum*, *S. warnstorffii*, *Straminergon stramineum*, *Tomentypnum nitens*.

alpine and subalpine meadows: *Abietinella abietina*, *Aulacomnium palustre*, *Bryoerythrophyllum recurvirostrum*, *Calliergon cordifolium*, *Dicranum spadicum*, *Hypnum lindbergii*, *Pohlia nutans*, *Polytrichastrum alpinum* s. l., *Polytrichum juniperinum*, *Pseudoleskea radicata*, *Ptychostomum* spp., *Sanionia uncinata*, *Schljakovia kunzeana*, *Syntrichia norvegica*, *S. ruralis*, *Tortula hoppeana*.

ponds, lakes, swales and pools in fens (submerged): *Calliergon giganteum*, *Drepanocladus aduncus*, *D. polygamus*, *Jungermannia exsertifolia* subsp. *cordifolia*, *Pohlia wahlenbergii*, *Sarmentypnum exannulatum*, *S. sarmentosum*, *Scorpidium cossonii*, *Sphagnum platyphyllum*, *Warnstorffia fluitans*.

creeks and streams: a) inundated /seasonally inundated rocks: *Brachythecium rivulare*, *Chiloscyphus pallescens*, *Cratoneuron filicinum*, *Dichelyma falcatum*, *Fontinalis antipyretica*, *Hygrohypnum duriusculum*, *H. ochraceum*, *Jungermannia exsertifolia* subsp. *cordifolia*, *Philonotis fontana* s. l., *Pseudoleskea radicata*, *Scapania irrigua*, *S. undulata*, *Schistidium* spp., *Scouleria aquatica*; **b) soil banks:** *Bartramia ithyphylla*, *Bryoerythrophyllum recurvirostrum*, *Conocephalum salebrosum*, *Cratoneuron filicinum*, *Ditrichum flexicaule*, *Fissidens bryoides*, *F. osmundioides*, *Leptobryum pyriforme*, *Meiotrichum lyallii*, *Mnium blyttii*, *M. thomsonii*, *Palustriella falcata*, *Pellia neesiana*, *Philonotis fontana* s. l., *Ptychostomum pallescens*, *P. pseudotriquetrum*, *P. weigelii*.

riparian willow communities and willow carrs: *Amblystegium serpens*, *Aulacomnium palustre*, *Campyliadelphus chrysophyllus*, *Climacium dendroides*, *Conocephalum salebrosum*, *Cratoneuron filicinum*, *Drepanocladus aduncus*, *D. polygamus*, *Eloidium blandowii*, *Fissidens bryoides*, *F. osmundioides*, *Hygrohypnum ochraceum*, *Hypnum lindbergii*, *H. pratense*, *Marchantia polymorpha* subsp. *montivagans*, *Philonotis fontana* s. l., *Plagiomnium ellipticum*, *Pohlia bolanderi*, *P. wahlenbergii*, *Ptychostomum pseudotriquetrum*, *Sanionia uncinata*, *Sciuro-hypnum latifolium*, *Sphagnum russowii*, *S. squarrosum*, *Syntrichia norvegica*, *Timmia austriaca*.

mesic to wet forests (old-growth spruce-fir and pine-spruce-fir forests): a) forest floor (soil, duff): *Amblystegium serpens*, *Barbilophozia lycopodioides*, *Blepharostoma trichophyllum*, *Brachytheciastrum collinum*, *Brachythecium erythrorrhizon* s. s., *Climacium dendroides*, *Dicranum scoparium*, *Eurhynchiastrum pulchellum*, *Meiotrichum lyallii*, *Mnium arizonicum*, *M. marginatum*, *Pohlia cruda*, *Polytrichastrum alpinum* var. *septentrionale*, *Polytrichum juniperinum*, *Sanionia uncinata*, *Sciuro-hypnum oedipodium*, *Syntrichia norvegica*, *S. ruralis*; **b) decaying bark, wood and on tree bases:** *Amblystegium serpens*, *Barbilophozia hatcheri*, *Blepharostoma trichophyllum*, *Brachytheciastrum collinum*, *Ceratodon purpureus*, *Dicranoweisia crispula*, *Dicranum muehlenbeckii*, *D. scoparium*, *Hypnum revolutum* s. s., *Lophozia ventricosa* s. s., *Mnium arizonicum*, *Plagiogonum denticulatum*, *Ptychostomum pallescens*, *Syntrichia ruralis*; **c) seepage areas:** *Aulacomnium palustre*, *Marchantia polymorpha* subsp. *montivagans*, *Mnium blyttii*, *M. marginatum*, *M. thomsonii*, *Philonotis fontana*, *Plagiomnium ellipticum*, *Ptychostomum pseudotriquetrum*, *Rhizomnium magnifolium*, *Scapania irri-*

gua, *S. subalpina*, *Sciuro-hypnum latifolium*, *Scouleria aquatica*, *Timmia austriaca*; **d) rocks under the canopy of trees:** *Brachytheciastrum collinum*, *Dicranoweisia crispula*, *Grimmia elatior*, *G. longirostris*, *G. montana*, *Hypnum revolutum* s. s., *Orthotrichum laevigatum*, *O. rupestre*, *Pohlia drummondii*, *P. nutans*, *Pseudoleskea radicata*, *Sciuro-hypnum oedipodium*, *Syntrichia norvegica*, *S. ruralis*.

dry forests (open pine and aspen-pine woods, aspen groves and stands; mostly on rock outcrops and debris or in sheltered areas around rocks): *Brachytheciastrum collinum*, *Brachythecium erythrorrhizon* s. s., *Bryum argenteum*, *Ceratodon purpureus*, *Dicranoweisia cirrata*, *D. crispula*, *Encalypta rhabdocarpa*, *Grimmia elatior*, *G. montana*, *Hypnum revolutum* s. s., *Orthotrichum laevigatum*, *O. rupestre*, *Pohlia cruda*, *P. nutans*, *Polytrichum juniperinum*, *P. piliferum*, *Pseudoleskea radicata*, *Syntrichia norvegica*, *S. ruralis*.

xeric grasslands and shrublands (mostly beside or in crevices of rock outcrops and debris, and on soil under shrubs or on

sides of grass tussocks): *Bryum argenteum*, *Ceratodon purpureus*, *Gemmabryum caespiticium*, *Grimmia montana*, *Hypnum revolutum* s. s., *Pohlia nutans*, *Polytrichum piliferum*, *Pseudoleskea radicata*, *Ptychostomum pallescens*, *Syntrichia ruralis*.

dry and open limestone rocks (mainly in crevices and on partially shaded ledges): *Brachytheciastrum collinum*, *Bryoerythrophyllum recurvirostrum*, *Distichium capillaceum*, *Grimmia anodon*, *Hypnum vaucheri*, *Syntrichia* spp., *Tortula* spp.

dry and open granite rocks (mainly in crevices and on partially shaded ledges): *Bryum argenteum*, *Dicranoweisia crispula*, *Grimmia alpestris*, *G. montana*, *Orthotrichum laeviganum*, *Hypnum revolutum* s. l., *Syntrichia ruralis*.

disturbed habitats (by human, animals or natural events): *Bryum argenteum*, *Ceratodon purpureus*, *Gemmabryum caespiticium*, *Leptobryum pyriforme*, *Marchantia polymorpha* s. l., *Pohlia nutans*, *Polytrichum juniperinum*.