

Rare mosses from siliceous regions in the Northern Rockies, Alberta, Canada: additions and significance

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Abstract

This study documents the occurrence of 62 rare mosses from siliceous regions within the northern Canadian Rocky Mountains. Ten species are reported as new to Alberta, and an additional three species are confirmed for the province. Additional records are documented for 49 mosses. The high diversity of rare silicolous species emphasizes the importance of this siliceous flora in the province. In addition, the large numbers of new occurrences significantly add to the knowledge of rare moss distribution in Alberta and diminishes the support for a rare species “hot spot” centred in the northern Rockies. The numerous additional records underscore the importance of inventory work for use in monitoring and environmental assessment.

Introduction

In 1966, Howard Crum (Crum 1966) stated that the Canadian Rockies moss flora was, “... a fairly rich assemblage of widespread calciphiles ...”, implying the dominance of limestone or other calcareous rock in the region. The Rockies are, however, known to possess major siliceous rock formations (Charlesworth et al 1967; Yorath and Gadd 1995), and the moss flora has reflected the presence of siliceous lithology. Several published lists of taxa for the region include numerous species belonging to a flora that are essentially restricted to siliceous substrata. For instance, in his catalogue of bryophytes for the Canadian Prairie Provinces, Bird (1973) listed several alpine or montane mosses occurring in the Rockies that are usually restricted to siliceous substrates, including *Andreaea nivalis*, *Cnestrum schisti*, *Dicranoweisia crispula*, *Grimmia torquata*, *Kiaeria blytii*, *K. falcata*, *K. starkei*, and *Oligotrichum aligerum*. Vitt (1973a, 1973b) also reported several species that are invariably associated with siliceous rock, from the Mt. Edith Cavell area in Jasper National Park (*Oligotrichum hercynicum*, *O. parallelum*, *Pogonatum urnigerum*, *Racomitrium heterostichum*, *Ulota curvifolia*). At that time, the species were considered rare in the province and restricted to the Mt. Edith Cavell area. Vitt & Belland (1997) later showed this area to be an important centre of rare provincial moss diversity.

Encouraged by the possibility of discovering more rare species in areas dominated by siliceous bedrock, the author conducted a short reconnaissance field trip to Jasper in 1986. This brief foray resulted in the discovery of several mosses previously unreported for Alberta

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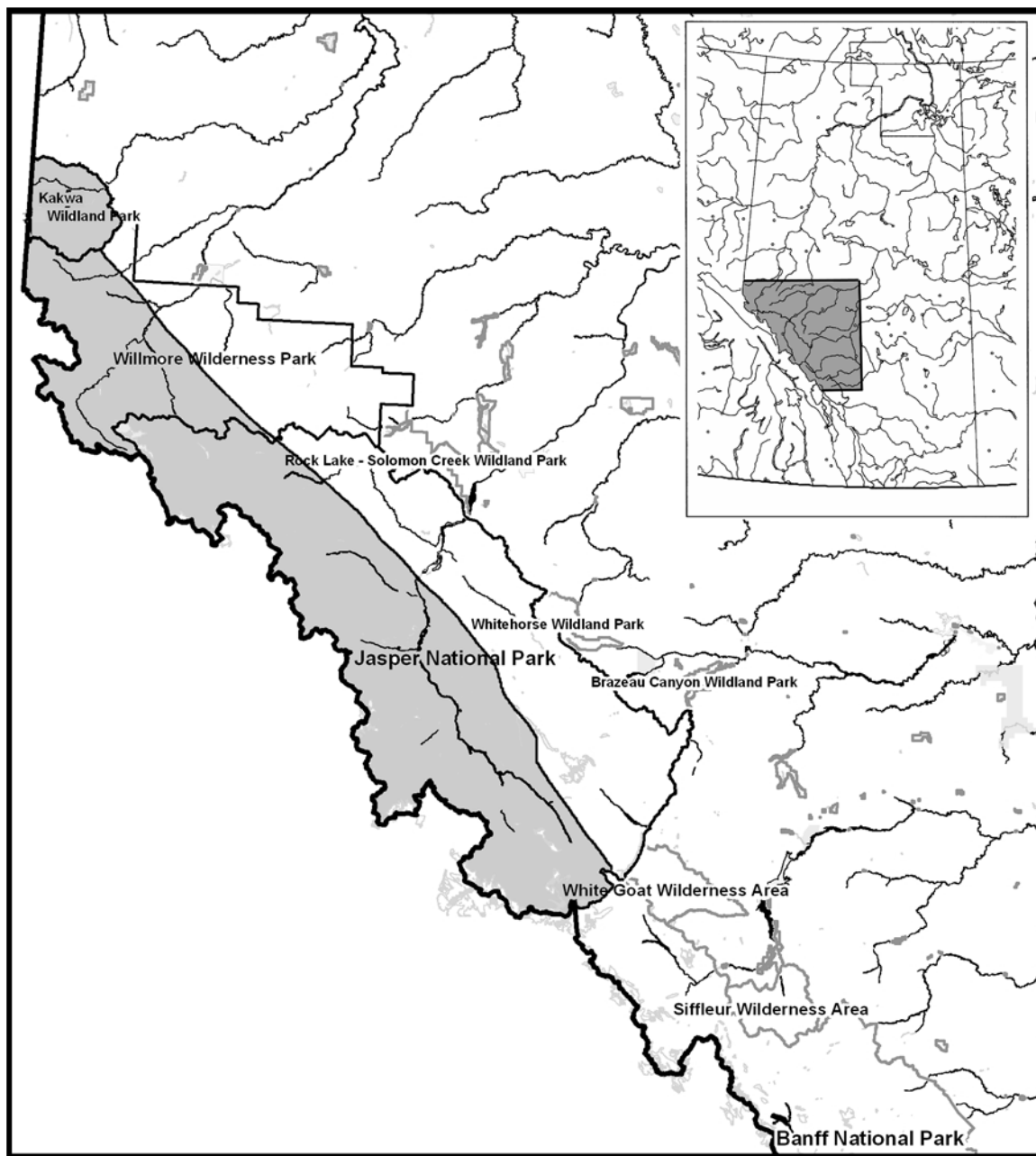


Figure 1. The study area comprised of Jasper National Park, Willmore Wilderness Park and Kakwa Wilderness Park is shown (shaded area). Inset shows map area within Alberta.

and added new sites for numerous species that were originally known from only 1-2 localities. These finds initiated a fieldwork program in 1995 that focused on determining the distribution of rare mosses relative to siliceous rock in the northern Rocky Mountains. The purpose of this paper is to document these rare mosses and to discuss their significance in the flora of Alberta.

Location of the study area and ecological description

The study encompasses the western portions of Jasper National Park and Willmore Wilderness Park (Figure 1) as well as Kakwa Wildlands Park. In Jasper, the study area includes the mountain ranges west of the Maligne Valley south of Highway 16, and areas west of the Snaring River north of this highway. In Willmore, the study area includes all locations west of Sulfur River and Wolverine Creek.

The Alberta northern Rocky Mountains consist of two sets of mountain ranges, the Front and Main ranges, each with its own distinct geology (Yorath and Gadd 1995). The Front Ranges include the eastern mountain ranges bordering the foothills and prairies, and consist almost entirely of calcareous rock such as limestone and dolomite. The study area falls wholly within the Main Ranges. These extend westward to the Continental Divide from their junction with the Front Ranges. The lithology of the Main Ranges is more heterogeneous than that of the Front Ranges and comprises of both calcareous and siliceous rock. Large sections are mainly of the Precambrian Miette Group and Lower Cambrian Gog Group (Charlesworth et al. 1967). The former consist primarily of 1200 m of conglomerates, sandstones, siltstones, and slates belonging to the Wynd Formation. The Gog Group, consisting of about 900 m of highly siliceous quartzite, conglomerates and sandstones, overlies the Miette Group. Massive Gog quartzites (300 m thick) form many of the well known peaks in Jasper National Park, including Mt. Edith Cavell, Mt. Fryatt, Gong Peak, Mt. Hardisty, the Endless Chain Ridge, Pyramid Mtn., and the many peaks of the Victoria Cross Ranges. In Willmore Wilderness, Gog quartzites shape the peaks in the western part of an unnamed mountain range southwest of the Persimmon Range in addition to the mountains in the unnamed range centered on Mt. Deheber.

Methods

Fieldwork was conducted from 1995 to 2008. The nature of the bedrock geology determined the choice of sites, and only those that were distinctly siliceous in nature were included in this study. Transportation to the sites varied depending on remoteness of the areas, but included hiking, horseback, automobile and helicopter. Numerous hiking trails enabled access to areas that could be reached within a day's walk, for instance in the Mt. Edith Cavell or Geraldine Lakes areas. Helicopter or horseback gave access to remote areas, including all of the sites in northern Jasper National Park (north of Hwy 16) and in Willmore Wilderness and Kakwa Wildlands parks. The sites visited are listed in Table 1.

The rare mosses treated here include taxa with ranks of S1 or S2 (1-5 occurrences and 6-20 occurrences, respectively) on the tracking list of the Alberta Conservation Information Management System (formerly known as Alberta Natural Heritage Information Centre, Gould 2006).

Taxonomy and nomenclature follows Anderson et al. (1990).

Table 1. List of locations in the northern Canadian Rockies. Site numbers correspond to site numbers preceding locations in annotated list.

Site	Jasper National Park
1	along upper Maligne Valley road, 52°46'N, 117°41'W
2	Amethyst Lake/Tonquin Valley area, 52° 43'N, 118°17'W
3	Athabasca Pass area, 52°23'N, 118°11'W
4	Bald Hills, 52°43'N, 17°41'W
5	Calumet Ridge, 53°14'N, 119°06'W
6	Campus Pass area, 52°38'N, 118°08'W
7	Cavell Lake area, 52°42'N, 118°04'W
8	Curator Lake area, 52°47'N, 117°53'W
9	Geraldine Lakes area, 52°36'N, 117°57'W
10	Horseshoe Lake area, 52°42'N, 117°52'W
11	Hwy 16 area at Alberta/BC border, 52°52'N , 118°26'W
12	Jonas Creek rockslide area, 52°26'N, 117°24'W
13	Maligne Lake area, Moose Lake trail 52°52'N, 118°15'W
14	Maligne Pass area, 52°30'N, 117°28'W
15	Meadow Creek area, 52°52'N, 118°15'W
16	Miette Valley, west of Jasper town 52°52'N, 118°12'W
17	Moat Lake area, 52°43'N, 118°18'W
18	Mount Edith Cavell area, 52°41'N, 118°03'W
19	Mount Griesbach area, 53°03'N, 118°29'W
20	Mount Kerr, 52°56'N, 118°13'W
21	NE slopes of Curator Mountain, 52°47'N, 117°54'W
22	Near headwaters of Simon Creek, 52°37'N, 118°15'W
23	Portal Creek, 52°47'N, 118°05'W
24	Pyramid Mtn area, 52°57'N, 118°08'W
25	Shovel Pass area, 52°46'N, 117°50'W
26	Twintree Lake area, 53°21'N, 119°08'W
27	Upper Geraldine Valley, 52°33'N, 117°59'W
28	Upper Maligne Valley, 52°33'N, 117°30'W
29	Verdant Pass area, 52° 39'N, 118°05'W
30	Wabasso Lake area, 52° 46'N, 117°57'W
31	Whistler Mountain area, 52°49'N, 118°08'W
32	Wilcox Pass, 52°14'N, 117°13'W
33	Mount Tekarra, 52°50'N, 117°56'W
34	Upper Miette River valley, 52°56'N, 118°33'W
35	Whistler Mountain, 53°50'N, 118°08'W
36	Middle Whirlpool River area, 52°34'N, 118°04'W
37	Upper Snaring River, 53°06'N, 118°36'W
38	Jonas Pass area, 52°20'N, 117°11'W
39	Miette Valley, 9.5 km NW of Hwy 16, 52°53'N, 118°27'W
40	Athabasca Falls, 52°34'N, 117°53'W
41	Maligne Lake road, 52°46'N, 117°41'W
Site	Wilmore Wilderness Park
42	Casket Creek area, 53°49'N, 119°53'W

43	Copton Mountain area, 53°58'N, 119°35'W
44	Desolation Creek area, 53°31'N, 119°26'W
45	Desolation Peak area, 53°30'N, 119°25'W
46	Draco Peak area, 53°29'N, 119°38'W
47	Headwaters of Monoghan Creek, 53°31'N, 119°01'W
48	Intersection Mountain area, 53°48'N, 119°58'W
49	Jackpine River valley, 53°23'N, 119°33'W
50	Meadowland Creek area, 53°31'N, 119°47'W
51	Mount Coté area, 53°53'N, 119°57'W
52	Mount Deveber area, 53°41'N, 119°38'W
53	Mt Pauline area, 53°30'N, 119°52'W
54	Pauline Creek area, 53°34'N, 119°48'W
55	Range east of HardScrabble Creek, 53°35'N, 119°11'W
56	South Hardscrabble Pass area, 53°30'N, 119°00'W
57	Sunset Peak area, 53°28'N, 118°57'W
58	Upper Beaverdam Creek, 53°35'N, 119°50'W
59	Beaverdam Pass area, 53°35'N, 119°53'W
60	Upper Hardscrabble Creek, 53°30'N, 119°01'W
61	West Sulfur River, vicinity of Glacier Pass, 53°31'N, 118°52'W
62	Castor Creek area 53°24'N, 119°39'W
63	No Luck Creek area, 53°31'N, 119°23'W
64	Mt Deveber Range, 53°38'N, 119°37'W
65	Beaverdam Creek area, 53°34'N, 119°42'W
66	Upper Fetherstonhaugh Creek Valley, 53°44'N, 119°51'W
67	Smoky River area, 53°30'N, 119°14'W
68	Casket Mountain area, 53°48'N, 119°59'W
69	Headwaters of Muddywater River, 53°37'N, 119°42'W
70	Shale Pass-Pauline Creek area, 52°40'N, 118°02'W
71	Mount Deveber area, 53°39'N, 119°37'W
72	Hardscrabble Pass area, 53°34'N, 119°09'W
73	Unnamed valley, near junction of Famm and Sheep Creeks, 53°54'N, 119°36'W
74	Unnamed valley 9.5 km WNW of Ptarmigan Lake, 53°33'N, 119°28'W
75	Along Sheep Creek trail, ca 5 km west of Clark's Landing, 53°46'N, 119°25'W
76	Unnamed mountain range between Mt Coté and Fetherstonhaugh Creeks, 53°48'N, 119°48'W
Site	Kakwa Wildlands Park
77	Kakwa Falls, 54°07'N, 119°56'W
78	Dead Horse Meadows area, 54°07'N, 119°59'W
79	Lower Kakwa Falls, 54°05'N, 119°42'W
Site	Others
80	Mt Hammel, Grande Cache area, 53°59'N, 119°12'W
81	Grande Cache area, east end of Caw Ridge, 54°04'N, 119°24'W

Results

The results of this work have added many new rare moss records for Alberta. Sixty-two rare mosses are documented from siliceous areas in the northern Rocky Mountains. Ten species are reported new to the flora of Alberta since the most recent Canadian moss checklist (Ireland et al. 1987): *Andreaea alpestris*, *A. blyttii*, *A. heinemanni*, *Anoetangium aestivum*, *Arctoa fulvella*, *Ditrichum pusillum*, *Grimmia mollis*, *Hygrohypnum cochlearifolium*, *Orthotrichum rivulare*, *Poblia crudoides*. The occurrence of three species is confirmed for the province: *Andreaea nivalis*, *Racomitrium aciculare*, *Rhytidiadelphus loreus*. Additional records are documented for 49 taxa that were previously known from only 1-2 locations in the province.

Several species that appeared on the tracking list in 1996 (Gould 1996) are no longer listed. Excluded are *Andreaea rupestris*, *Paraleucobryum longifolium* and *Polytrichastrum sexangulare*. Their removal from the list is due directly to the fieldwork efforts of this study.

Discussion

This work represents the first systematic attempt to document a segment of the Canadian Rockies moss flora and provides detailed records for rare Alberta mosses that are essentially restricted to areas dominated by siliceous rock. The large number of rare species documented on this rock type underscores the importance of this rare moss component in the provincial flora. These results also diminish Crum's (1966) assertion that a predominantly widespread calcareous flora dominates the Canadian Rocky Mountain flora.

Substrate preference is an important factor determining small and large-scale moss distributions. The basis for this restriction is generally complex and related to the base content (calcium or magnesium) of the substrate (Bates 1982, 2000). Bates (2000) and many others note that most mosses generally fall into one of two categories depending on the species' association with calcium (Ca⁺⁺): calcicole and calcifuge. Calcicoles are usually restricted to rocks and soil containing calcium carbonate, while calcifuges grow on substrates that are typically acidic. The distinction between the two categories does not necessarily reflect a physiological requirement for or inhibition of calcium but instead may result from other factors that include not only environmental, but also biotic factors such as competition (Bates 2000). Other categories of substrate preference are recognized, including acidophiles (avoiding soils/rock with high base, Ca⁺⁺ or Mg⁺⁺, status) and silicoles (restricted to soils/rock that are siliceous).

Most of the species in this study are consistent in their association with siliceous rock and generally do not grow on highly calcareous or otherwise basic substrates. By far, quartzite rock or siliceous conglomerate bedrock provided the substratum for most species considered here. The species are therefore calcifuges or silicoles and their inclusion into these categories is supported in several floras (Crum & Anderson 1981; Nyholm 1954-1969; Lawton 1971; Ireland 1982; Smith 1978). Examples of strong calcifuges include all the species in the genus *Andreaea*, and most species of the family Polytrichaceae (i.e., *Atrichum*, *Oligotrichum*, *Polytrichum*, *Pogonatum*).

Only a handful of the rare mosses included in this study are not silicoles or acidophiles. These species, while found on siliceous rock in this study, are frequently associated with calcareous rock elsewhere in the province. They are *Cirriphyllum cirrosum* (Nyholm 1959-1969), *Fissidens grandifrons*, *Hygrohypnum styriacum*, *Plagiobryum zierii* and *Tayloria lingulata*. Crum and

Anderson (1981) and Nyholm (1954-1969) consider *C. cirrosum*, *F. grandifrons* and *P. demissum*, especially, to be either calciphiles or found on mainly calcareous soils. Their association with siliceous substrate in this study suggests that their substrate requirements are perhaps more complex than initially assumed.

Many of the mosses in this study are associated with the centres of rare moss diversity documented by Vitt & Belland (1997). The most important northern Rockies “hotspot” was centered on Mt. Edith Cavell, 23 km south of Jasper town, and extended eastward to include also the eastern slopes of the mountains as far as Mountain Park. The following 29 rare mosses listed by Vitt & Belland (1997) are associated with this northern Rockies “hot-

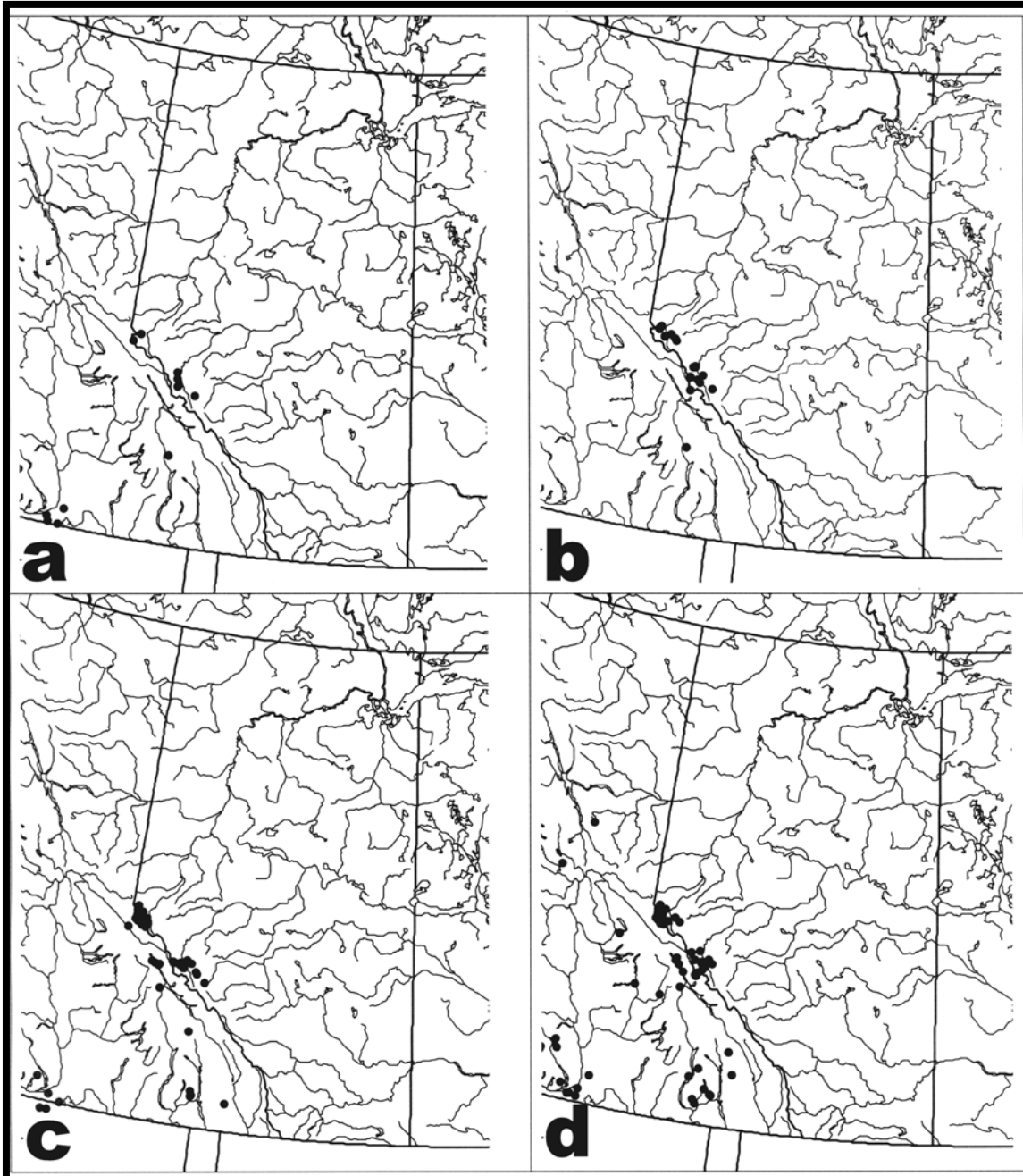


Figure 2. Distribution in Alberta: a) *Andreaea blyttii*, b) *Grimmia mollis*, c) *Oligotrichum berynicum*, d) *Racomitrium fasciculare*.

spot” (asterisks indicate taxa included in this study): **Andreaea blyttii*, **A. nivalis*, **A. rupestris* (no longer listed as rare), **Bartramia halleriana*, *Bryum porsildii*, *Cynodontium schisti*, *Desmatodon laureri*, **Dichelyma falcatum*, *Didymodon nigrescens*, *Encalypta brevipes*, *Hygrohypnum smithii*, *Loesky-pnum badium*, *Paraleucobryum longifolium* (no longer listed as rare), *Pohlia andalusica*, *P. annotina*, **P. drummondii*, **P. filum*, **P. obtusifolia*, *Polytrichum sexangulare* (no longer listed as rare), **Oligotrichum hercynicum*, **O. aligerum*, **O. parallelum*, **Racomitrium fasciculare*, **R. heterostichum*, **Rhytidiadelphus squarrosus*, *Schistidium agassizii*, **S. tenerum*, *Tayloria froelichiana*, *T. hornschurchii*, and **Ulota curvifolia*.

The results of this study show that this northern Rockies “hotspot” is no longer supported by the distributions of the species involved. The increased search effort into areas where siliceous rocks predominate has significantly expanded the ranges of many of the species. Many species with previously restricted ranges now show more or less continuous distributions northward from the centre to northern Willmore Wilderness park—(e.g., *Andreaea nivalis*, *A. blyttii* (Figure 2a), *Bryum porsildii*, *Grimmia mollis* (Figure 2b), *Oligotrichum aligerum*, *O. hercynicum* (Figure 2c), *O. parallelum*, *Pohlia drummondii*, *R. fasciculare* (Figure 2d), *R. heterostichum*). In addition, some species (e.g., *Andreaea rupestris*, *Polytrichum sexangulare*, *Racomitrium heterostichum*) are much more frequent than previously thought and are no longer included on the Alberta Conservation Information Management System (Gould 2006) tracking list.

These results emphasize the importance of continuous inventory work in plant biodiversity and conservation studies. Such inventory is important not only for determining the presence of species in areas, but also for long-term monitoring and environmental assessment. Further exploration in the siliceous mountain ranges along the Continental Divide will no doubt continue to add species to an already diverse flora.

Annotated list of taxa

The annotated list that follows, documents additional records for the Alberta flora. The Alberta status (Gould 2006) is given after the species authority. Citations for each species include site numbers, each referring to a location (see Table 1). Unless otherwise indicated, all the collecting numbers are the authors’ and are italicized. The following abbreviations are used to group sites by park: **JNP**, Jasper National Park; **WWP**, Willmore Wilderness Park; **Kakwa**, Kakwa Wildlands Park; **Others**, specimens collected outside of parks. Species collected by others that until now have remained unreported in the literature are also included in the list. The most recent Alberta Conservation Information Management System status rank (Gould 2006) follows each specimen citation.

With some exceptions (indicated), all vouchers are deposited at the herbarium of the Devonian Botanic Garden, University of Alberta.

Aulacomnium acuminatum (Lindb. & H. Arn.) Kindb. S1.

JNP: 25. 29865; **Others:** 81. 19446.

The Jasper record extends the range of *A. acuminatum* southward in Alberta, where the species was previously known only from the Grande Cache area (Vitt and Koponen 1976) and from a collection on Childear Mountain, in Willmore Wilderness Park (*Bel-land* 37435). *A. acuminatum* is an arctic-alpine moss with a wide range throughout Arctic Canada.

Andreaea alpestris (Thed.) Schimp. S1.

JNP: 9. 23149, Priddle 1194 (verified by Barbara Murray); 18. 21132; 24. 21209; 25. 27517.

New to Alberta. This species is sometimes regarded as a variety of *A. rupestris* Hedw. (e.g., Nyholm 1954-1969) and the recent Flora of North America revision (Zander 2007) considers *A. alpestris* to be a high elevation form of *A. rupestris*. However, Murray (1987) considered this taxon to merit species status, and that conclusion is followed here. The Alberta locations are isolated from others in western Canada, where the nearest sites are restricted to coastal British Columbia. In the study area, *A. alpestris* grows on mineral soil.

Andreaea blyttii Schimp. S1.

JNP: 14. 26741; 18. 21299; 24. 23496, 28069; 31. 27971; **WWP:** 52. 29433; 53. 33611.

New to Alberta. Belland (1987) mapped two locations for this species in Alberta (both in Jasper) but record citations were not provided. The species has since been found at several additional locations, all at high elevation. *A. blyttii* is infrequent, and seldom occurs in great abundance where it grows on the upper surfaces of siliceous boulders in extreme late snow beds.

Andreaea heinemannii Hampe & C. Mull. S1.

JNP: 33. *Lee & Peterson s.n.* (ALTA, verified by Barbara Murray).

New to Alberta. *Andreaea heinemannii* is rare in Canada where it is known from only two stations, the Jasper park site and a site in Garibaldi Provincial Park, coastal British Columbia (*Schofield 81515*, UBC). The species is rare also in North America.

Andreaea nivalis Hook. S2.

JNP: 3. 30588; 5. 30033; 9. 23578; 14. 26751; 18. 29308; 19. 30170; 24. 21203; 25. 29865; **WWP:** 53. 33588; 46. 29179; 52. 29452.

Confirmed for Alberta. An old report in Brinkman (1915) from Banff National Park is the first documented occurrence from Alberta although the record is likely an error based on the location of the find (Sulfur Mountain). *A. nivalis* shows a wide distribution along the siliceous backbone of the Main Ranges.

Anoetangium aestivum (Hedw.) Mitt. S1.

JNP: 18. 21120.

A. aestivum is occasional in the mountains from Waterton Lakes as far north as Jasper (Mt. Edith Cavell). It grows on moist soil, on both calcareous and non-calcareous substrates (Zander 1977). In Mt. Edith Cavell, the species grew in a crevice on a siliceous rock face at treeline (~1900m).

Aongstroemia longipes (Somm.) B.S.G. S2.

JNP: 18. 28679, 28962.

A. longipes has a scattered distribution in Alberta where it is found mainly in the west-central part of the province as far east as Edmonton. It is a small species that, in the mountains, grows primarily on moist or damp soil.

Arctoa fulvella (Dicks.) B.S.G. S1.

JNP: 9. 23592.

A genus new for Alberta. This species is listed for Alberta in Nyholm (1971) but was not included in the later Canadian checklist (Ireland et al. 1987). Newmaster (2007) recently noted the species for the province, but no specimen citations were given, nor are we able to locate a specimen. *A. fulvella* is a frequent species in the mountains of coastal western North America, where it occurs from Washington northward to the Aleutian Islands. The species is rare at inland sites where it occurs mainly in northern regions of the Yukon and mountains of the Northwest Territories (Vitt & Horton 1979). The nearest location to the Alberta population is in the Columbia River region of eastern British Columbia. This, and the Alberta population, are isolated from other western North American populations.

Bartramia halleriana Hedw. S1.

JNP: 11. 36014; 16. 30977.

These citations document the species' occurrence in the province. *B. halleriana* is rare in Canada where it is designated as "Threatened" by Committee on the Status of Endangered Wildlife in Canada (COSEWIC) (Belland 2001) and protected under federal law (Species At Risk Act, 2002). The Canadian Rocky Mountain stations in Alberta and British Columbia are the only ones known for the species in North America.

Bartramia pomiformis Hedw. S2.

JNP: 11. 36008.

In Alberta, *B. pomiformis* is known also from the Genesee area, Cadomin, Waterton Lakes, and the Canadian Shield in northeastern Alberta.

Buxbaumia aphylla Hedw. S2.

JNP: 31. 30412.

B. aphylla was previously known in Alberta from Waterton Lakes and Banff National Parks, and from Swan Hills. These latter records date to the 1950's and 1960's; there appear to be no records of this species from Alberta in the intervening years between those records and the one reported here. The species was also recently collected from the Lac La Biche area in north central Alberta (*Pinches s/n*, May 13, 2009, Devonian Botanic Garden Herbarium).

In Jasper National Park, the species grew on coarse mineral soil at subalpine elevations with *Oligotrichum parallelum*.

Cirriphyllum cirrosium (Schwaegr. ex Schultes) Grout. S1/S2.

JNP: 18. 28807, 28843.

C. cirrosium is restricted to the mountains and foothills of Alberta where it has stations ranging from Waterton Lakes National Park to Jasper. This species often grows in loose mats on calcareous soil or in rock crevices of alpine areas (Nyholm 1954-69).

Dicbelyma falcatum (Hedw.) Myrin. S2.

JNP: 2. 26421; 7. 26424, 2784; **Kakwa:** 77. Vitt 30922 (ALTA).

Fay MacFadden collected *D. falcatum* for the first time in Alberta at Tonquin Valley (MacFadden (1927). The report here (Amethyst Lake) confirms that the species is still extant in this area. In addition, the species is known from scattered locations in the Banff and Kananaskis areas.

Dicranella palustris (Dicks.) Crundw. ex Warb. S1?

JNP: 18. 28739; 24. 21171; **WWP:** 50. 35341; 64. 34831.

In Alberta, *D. palustris* is infrequent, ranging from Castle Mountain in Banff National Park, northward to the Grande Cache area. *D. palustris* grows on wet mineral soil, where it is usually associated with stream edges or continuous seepage.

Dicranella subulata (Hedw.) Schimp. S2.

JNP: 18. 28738, 28759; 24. 21159.

The species also occurs at Whistler Mtn. (Jasper) in the Rockies. In Alberta *D. subulata* is infrequent, occurring sporadically from the Kananaskis area northward to Jasper, and has isolated stations in the Swan Hills.

Ditrichum montanum Leib. S1.

JNP: 18. 28650.

This record represents the most northerly report of *D. montanum* in Alberta; the species is known otherwise only from the southern Rockies where it occurs at Waterton Lakes and Banff National Parks.

Dryptodon patens (Hedw.) Brid. S2.

JNP: 3. 30602. **WWP:** 59. 34364; 62. 34757; 63. 36741; 64. 36735.

The first specimen of *D. patens* from Alberta was collected from Athabasca Pass in 1827 by Thomas Drummond (Bird 1967). The specimen cited here confirms the species' persistence in that area. The Willmore and Jasper locations are at the northern limit of the species' range in Alberta and disjunct from their nearest locations in southwestern Alberta where the species is most frequent in Waterton Lakes National Park. Vitt & Belland (1991) published a North America map for the species.

Grimmia alpestris (Weber & Mohr.) Schleich. S2.

JNP: 18. 21129; 24. 21172; 31. 21346.

These are the first reports of *G. alpestris* from Jasper National Park. The species is known also from several locations in Banff and Waterton Lakes National Parks (as *G. tenerima*), in addition to Kananaskis and Mt. Rae. However, many of these are older records dating from the 1960's.

Grimmia anomala Hampe. S2.

WWP: 48. 29347; 51. 28576; 62. 34760; 64. 36750.

These records represent significant northern range extensions for the species in Alberta where the previously known locations are from Waterton Lakes National Park.

G. anomala shows a similar distribution in Alberta as *Dryptodon patens*; the species is frequent in the mountains of southwestern Alberta but shows a large disjunction to the northern Rockies. In the latter area, the species grows only in upper subalpine habitats in northern Willmore Wilderness.

Grimmia donniana Sm. S2.

JNP: 18. 28773.

In Jasper National Park, the species is thus far known only from the Cavell area. C.D. Bird made an earlier collection of this species along the nearby Tonquin Valley (*Bird 5152*, PMA). *G. donniana* is restricted to the Rockies in Alberta where it ranges from Waterton Lakes National Park northward as far as Jasper. This small moss is typically found at higher elevations where it grows as small clumps on dry exposed siliceous rocks or cliffs.

Grimmia incurva Schwaegr. S1.

JNP: 9. Priddle 1199, 1205, 1214; 33. Lee & Peterson 16 Aug 1974 (ALTA).

These reports document the presence of the species in Alberta. *G. incurva* was listed for Alberta in the Canadian checklist (Ireland et al. 1987), without citing a specimen. The species appears to be rare in western Canada.

Grimmia montana B.S.G. S2.

JNP: 18. 28116, 28690.

G. montana has scattered locations along the mountains of southern Alberta; this is the first report of the species in the northern Rockies. *G. montana* grows on cliffs and boulders at mid to high elevations, usually on siliceous rock.

Grimmia mollis B.S.G. S2.

JNP: 2. 26205; 3. 30640; 9. 23575; 14. 26753; 18. 26491; 20. 30252; 24. 2348, 28055; 25. 29822; **WWP:** 47. 29655; 55. 28390; 52. 29465; 57. 29141; 63. 36814.

New to Alberta. *G. mollis* was first collected in Alberta in 1995 and is now known to occur widely in the Main Ranges of the northern Rockies of Jasper and Willmore parks. The species occurs at high elevation, usually on rocks irrigated by snowmelt or in cold snowmelt fed creeks. The species is not abundant at any site where it occurs.

G. mollis is a rare species in western North America. It has a scattered distribution ranging from British Columbia and Yukon Territory, with disjunctions to northern Labrador, Gaspé, and Greenland (Hedderson & Brassard 1986). The species was recently collected from a location in nearby British Columbia (Canoe Mountain, *Belland 20790*). Although this latter site is not in the Rockies, it is on a mountain range adjacent to the Rocky Mountain Trench (Monashee Mountains) that separates the Rockies from other Cordilleran ranges.

Grimmia torquata. Grev. S2.

JNP: 10. 27648; 11. 23297; 18. 29344; 21. 29774; 29. 27192; 31. 28027; 34. 36123; 35. 28027; 36. 36043; 37. 36189; 40. 36025; **WWP:** 44. 33418; 49. 33465; 54. 32675; 58. 33501; 50. *Belland 32705*; 60. 33359; 62. 34725; 65. 33501; 66. 34623; 67. 34236; **Kakwa:** 78. 32515.

Grimmia torquata was known from only six sites in 1995, but is now shown to be frequent in siliceous area at upper montane and subalpine elevations. The species is widely distributed, occurring from Waterton Lakes northward as far northern Willmore Wilderness.

Hygrohypnum alpestre (Swartz ex Hedw.) Loeske S1.

JNP: 7. 27863; 13. 27019; 23. 27842.

The specimens cited here confirm the species' presence in the province. Ireland et al. (1987) listed the species for Alberta, but did not cite a specimen. The nearest locations to the Jasper sites are in southwestern British Columbia.

Hygrohypnum cochlearifolium (Vent. ex De Not.) Broth. S1.

JNP: 14. 26760; 24. 28071; 25. 27387; **WWP:** 47. 29646; 68. 35523; 69. 34874.

New to Alberta. *H. cochlearifolium* occurs at only a handful of sites from southern Jasper National Park northward to central Willmore Wilderness Park. This species is restricted to high alpine sites where it occurs in cold alpine streams, usually associated with waterfalls.

H. cochlearifolium is a rare northern montane species, otherwise restricted in western North America to a few stations in the Yukon and Alaska. Elsewhere on the continent, this species occurs only in northern Labrador and Greenland (Hedderson & Brassard 1986).

Hygrohypnum molle (Hedw.) Loeske. S1/S2.

JNP: 24. 21174.

Confirmed for Alberta. The species was first collected for the province by Thomas Drummond in 1827 at Athabasca Pass (Bird 1967), and by Fay MacFadden at Tonquin Valley in 1926. The Jasper reports are the northernmost for the province where the species shows a bi-centric distribution, with a second, southern, centre in southwestern Alberta; Doubt (2001) recorded numerous sites for the species in Waterton Lakes National Park.

Hygrohypnum ochraceum (Hedw.) Loeske. S1/S2.

JNP: 3. 30593; 8. 29738; 24. 21168.

The earliest record of *H. ochraceum* for Alberta is an early historic specimen collected by Fay MacFadden in 1926 at Tonquin Valley (MacFadden 1927), followed by one collected by C.D. Bird from Waterton (Bird 17302, PMA). Subsequently, Doubt (2001) made numerous collections of the species in Waterton Lakes National Park. As with *H. molle*, the species presently shows a wide gap in its provincial distribution with two centres, one each in the northern Rockies (Jasper National Park) and the southern Rockies (Waterton Lakes National Parks). The species occurs at mid to high elevations and may potentially be found in suitable sites in Banff National Park. *H. ochraceum* is widely distributed in adjacent British Columbia.

Hygrohypnum styriacum (Limpr.) Broth. S2.

JNP: 9. *Belland* 21685.

H. styriacum occurs at a few scattered localities in the Kananaskis and Banff (Jamieson 1976).

Kiaeria blyttii (B.S.G.) Broth. S2.

JNP: 9. 23572; 18. 21287; 19. 30228. **WWP:** 70. 37011.

These records represent northern range extensions in the Rockies for this species where old collections document the species from Banff and Waterton Lake National Parks. *Kiaeria blyttii* grows on thin soil over siliceous rock at mid to alpine elevations. The species grows in exposed habitats (moraines, cliffs) as well as forested cliffs and talus.

Kiaeria falcata (Hedw.) I. Hagen. S1.

JNP: 24. 23530; **WWP:** 70. 37017.

Confirmed for Alberta. The species is listed for the province in Ireland et al. (1987) based on a specimen collected from Jasper National Park by Fay MacFadden in 1926 (*MacFadden s/n*, UBC Accession #69971).

Kiaeria starkei (Web. & D. Mohr) I. Hagen. S2.

JNP: 9. 21684; 18. 21684; 24. 21186; 25. 29901. **WWP:** 63. 36816; 64. 36735.

These represent additional records for a rare species that occurs at Waterton Lakes and Jasper parks, but is absent from Banff National Park. The species is expected to be in Banff park in areas along the Continental Divide where quartzite and other siliceous lithologies are known to exist. *Kiaeria starkei* grows in similar habitats as *K. blyttii*, on siliceous rocks at subalpine to alpine elevations.

Myurella tenerrima (Brid.) Lindb. S2.

JNP: 34. 36154; **WWP:** 42. 32431; 44. 33438; 49. 33480; 50. 33239; 54. 32685; 58. 33504.

These are the first records of this species for Willmore Wilderness. The species is documented from only a handful of localities whose distribution ranges from the Coleman area and Banff National Park northward to Kakwa Wildlands Park. Bird (1968) and Holland & Coen (1982) have previously reported the species from Jasper National Park.

Oligotrichum aligerum Mitt. S1/S2.

JNP: 3. 30585; 9. 30324; 18. 29313; 19. 30195; **WWP:** 50. 32730; 52. 29448.

Fay MacFadden made the first collection of *O. aligerum* in the northern Rockies in 1926 from Tonquin Valley, Jasper National Park but its continued presence in this valley was not confirmed in this study.

Oligotrichum hercynicum (Hedw.) DC. S2.

JNP: 2. 26088; 4. 27718; 8. 29741; 9. 21712; 14. 26750; 17. 26359; 18. 29304; 28. 26535; 29. 27249; 38. *Belland s/n*; **WWP:** 49. 33284; 45. 29253; 46. 29209; 50. 33192; 52. 29438; 53. 33614.

Vitt (1973b) first reported this species for Alberta from Mt. Edith Cavell. *O. bercynicum* occurs at numerous sites in the northern Rockies, all at subalpine and alpine elevations within Jasper National Park and Willmore Wilderness. The species grows on mineral soil or soil banks from the subalpine forest to alpine elevations. Its habitats include the margins of late snow beds, morainal slopes, and on mineral soil along trail edges.

Oligotrichum parallelum (Mitt.) Kindb. S1.

JNP: 3. 30592; 4. *Kuchar B1340* (ALTA); 9. 23581; 17. 26369; 18. 21345; 19. 30212; 31. 30411; **WWP:** 50. 33191.

E.H. Moss first collected *O. parallelum* in Alberta in 1933 from the Mt. Edith Cavell area in Jasper park (*Moss 2749d*, ALTA). Vitt (1973b) erroneously reported the species as new to Alberta based on the record from Bald Hills collected by P. Kuchar in 1969. The current records extend the species' range northward to Willmore park.

Oreas martiana (Hoppe & Hornsch.) Brid. S1.

Others: 80. 19359.

This species is very rare in Alberta and rare in Canada with isolated stations in B.C. and Nunavut. Vitt and Koponen (1976) recorded the species for the first time in the province from Ambler Mtn., just north of Grande Cache. It occurs also at only two additional locations, all in the Grande Cache/Willmore area. The Mt. Hammel site is near the Amber Mtn. location; *O. martiana* was found also at Rocky Pass in Willmore Wilderness Park (*Belland 28428*).

Orthotrichum rivulare Turn. S1.

JNP: 18. 28769; **WWP:** 63. 36822.

New to Alberta. *O. rivulare* is rare in Canada, known elsewhere from only British Columbia where it is restricted to the south-westernmost portion of the province. Vitt (2009) mentions the species from Alberta but does not cite a specimen. The most recent Canadian checklist (Ireland et al. 1987) did not list the species for Alberta.

Philonotis marchica (Hedw.) Brid. S1.

JNP: 18. 21141.

This species has a widespread, but scattered distribution in the province, where it has been collected only seven times since 1955. All previous records are from the foothills and mountains. The species ranges from Banff National Park northward to Kakwa Wildlands Park. The Jasper site is a large, siliceous, east-facing cliff in the subalpine zone.

Plagiobrum demissum (Hook.) Lindb. S1.

Others: 80. 19269.

This is only the second record for the province. D.H. Vitt collected an earlier specimen of *P. demissum* from Mountain Park (*Vitt 10933*, ALTA).

Plagiobryum zierii (Dicks. ex Hedw.) Lindb. S2.

WWP: 49. 33471; 50. 33247; 54. 32659; 58. 33546; 60. 33371.

These are the first records of this arctic-alpine species from Willmore Wilderness. The species has been recorded at several sites from Banff National Park as far as north-western Jasper National Park where it apparently occurs on rocks of varied lithology, including both limestone and quartzite.

Pogonatum dentatum (Menzies ex Brid.) Brid. S2.

JNP: 9. 21711; 18. 28653; 13. 30797; **WWP:** 50. 33198; 66. 34628; 71. 35039; 72. 36756; 73. 35212; 74. 35627.

In Jasper National Park, the species also occurs on Mt. Tekarra and in the Astoria Valley near Mt. Edith Cavell. The species has a scattered distribution in the province ranging from the northern Rockies eastward to Lesser Slave Lake. The species is found at sub-alpine and alpine elevations where it grows on exposed mineral soil in open habitats.

Pogonatum urnigerum S2/S3.

JNP: 8. 29742; 18. 21140; 20. 30268; 21. 29820; 27. 30146; 31. 21366; 39. 36009. **WWP:** 50. 35295; 63. 35569; 64. 36735; 70. 37024; 75. 35463.

These are additional records for a species previously considered infrequent in Alberta. Although the species distribution is mainly at mountain sites associated with siliceous substrata, *P. urnigerum* occurs also as an outlier in the Swan Hills, northwest of Edmonton. This distribution pattern is also seen among numerous vascular plants, most notably *Oplopanax horridus* (Sm.) Miq. *P. urnigerum* grows on acidic mineral soil, in crevices of cliffs or boulders, or on soil among rocks.

Poblia andalusica (Hoehnel) Broth. S1.

JNP: 18. 28810.

This is only the second record of *P. andalusica* for Alberta. J. Shaw first collected *P. andalusica* from the Bald Hills, Jasper, in 1978 (*Shaw 2840*, ALTA)

Poblia bulbifera (Warnst.) Warnst. S1.

JNP: 18. 28782.

The Edith Cavell location is only the second report of this species for the province. *P. bulbifera* also has a station in north-eastern Alberta, at Lesser Slave Lake (*Vitt 7309*, ALTA).

Poblia crudoides (Sull. & Lesq.) Broth. S1.

JNP: 9. 21672; **WWP:** 52. 29485.

New to Alberta. *P. crudoides* is a montane species known from northern North America: Alaska and the Yukon Territory, Northwest Territory, and British Columbia. The species is disjunct to Greenland and occurs in northern Europe and Asia, including Japan (Shaw 1982). The Alberta sites thus represent a southern disjunction within the species range. S1.

Poblia drummondii (C. Müll.) Andr. S2.

JNP: 3. 36090; 8. 29747; 18. 21799; 24. 21202; 31. 21414; 39. 36163; **WWP:** 44. 33408. There is also a record from Bald Hills (Jasper) (*Shaw* 2847, ALTA).

These are additional northern records for *P. drummondii* in Alberta, where the species ranges farther south in the Banff National Park and Kananaskis areas. This species is a pioneer on mineral soil in open habitats, especially in non-calcareous areas. Lawton (1971) gives its microhabitat as damp soil, sometimes in or on the margins of bogs, from the lowlands to about 2400 m. The species also grows on road banks, stream banks and in gullies (*Shaw* 1982).

Poblia filum (Schimp.) Mart. S1.

JNP: 18. 28675.

This record reaffirms the presence of *P. filum* at Mt. Edith Cavell area, which is the only known location for the species in Alberta. D.H. Vitt collected the species from this area in 1971 (*Vitt* 4598, ALTA).

This species grows on mineral soils. According to *Shaw* (1982), *P. filum* is common on glacial outwash in northwestern North America.

Poblia obtusifolia (Brid.) L. Koch. S1.

JNP: 18. 21127; **WWP:** 57. 29134; 76. 34991.

This species is known from only five sites in Alberta. In addition to the three sites listed here, *P. obtusifolia* occurs also in Waterton Lakes National Park (along the Rowe Lake Trail, *Doubt* 3694, ALTA) and on Signal Mtn. in Jasper National Park (*Horton* 3457, ALTA). This species is generally associated with late-snowbeds, where it is most frequent in moist, rich snowmelt areas.

Pseudoleskea stenophylla Ren. & Card. in Röhl. S2.

JNP: 18. 21789.

The Mt. Edith Cavell location is the northernmost in Alberta where it represents an outlier to a wider range in the southern Canadian Rockies (the Kananaskis region southward to Waterton Lake).

Racomitrium aciculare (Hedw.) Brid. S1.

JNP: 3. 30641; 17. 26390; 18. 21133; 24. 21152; **WWP:** 50. 32008; 54. 32682; 60. 33353.

Confirmed for Alberta. Thomas Drummond first collected this species in Alberta in 1826, from "Committee's Punch Bowl, border of Alberta and B.C." at Athabasca Pass (*Bird* 1967). Drummond also collected *R. fasciculare* and *Dryptodon patens* from this site, both which are reported in this study. The species occurs also in Waterton Lakes National Park (*Doubt* 2001).

Racomitrium fasciculare (Hedw.) Brid. S2.

JNP: 3. 30635; 4. 27943; 7. 27881, *Bird* 5133 (ALTA); 9. 21649; 18. 29326; 19. 30171; 24. 21164; 25. 29867; 27. 30154; Tonquin Valley, *MacFadden* 4091 (CANM); **WWP:** 45. 29236; 47. 29683. 49. 33487; 50. 32010; 52. 29466; 53. 33599; 55. 28387.

In 1995 *R. fasciculare* was only known from the Mt. Edith Cavell and Pyramid Mtn. areas. These new records significantly expand the range of this species in the Rockies. The species is an acidophile that grows on rock, often in microhabitats that are periodically inundated or irrigated by intermittent seepage.

Racomitrium heterostichum (Hedw.) Brid. S2?

JNP: 3. 30610; 9. 21696; 18. 21795; 24. 21158; 25. 29840; **WWP:** 49. 33490; 53. 33617; 58. 33520; 60. 33348.

In Alberta, *R. heterostichum* also has stations in Waterton Lakes National Park. Of the *Racomitrium* species occurring within the province, this species is by far the most frequent. *R. heterostichum* grows in both exposed and shaded habitats, on siliceous or otherwise acidic rock.

Racomitrium heterostichum is a widely distributed boreal species that is taxonomically complex, and has recently been split into numerous taxa (Frisvoll 1988; Ochyra, 2007).

Racomitrium microcarpon (Hedw.) Brid. S1?

JNP: 5. 30047; 25. 29879. The species is also known from Trapper Creek, Maligne Range (*Kuchar B7796*, ALTA).

R. microcarpon occurs only in Jasper National Park in Alberta. The species has been treated as a variety of *R. heterostichum* (Crum and Anderson 1981). Vouchers of *R. heterostichum* collected in other regions of Alberta may turn out to be *R. microcarpon* upon careful examination. The species grow in similar habitats, on siliceous rock in exposed and shaded situations.

Racomitrium sudeticum (Funck) B.S.G. S1/S2.

JNP: 18. 28880, 28911.

R. sudeticum is found only in the Rockies within Alberta. In Jasper National Park, *R. sudeticum* also occurs at Tonquin Valley, Bald Hills, Evelyn Creek, and Signal Mountain. Farther south, the species has sites in Banff and Waterton Lakes National Park as well as Cadomin and Pincher Creek areas. *R. sudeticum* is a common species on siliceous boulders and cliffs. This species is sometimes considered a variety of *R. heterostichum* and can be difficult to distinguish in the field.

Rhizomnium nudum (Britt. & Williams) Kop. S2.

JNP: 18. 28742, 28937.

Rhizomnium nudum was recorded at four sites at Mt. Edith Cavell. It was first reported from Alberta from Bald Hills, near Maligne Lake in Jasper National Park (Vitt 1973b) and has sites also near Miette Hot Springs. Elsewhere in Alberta, *R. nudum* shows isolated stations in the Waterton Lakes National Park and Coleman areas in southern Alberta. *R. nudum* grows on moist soil in forests and along streams (Lawton 1971) and on wet peaty soil in seepage areas.

Rhytidiadelphus loreus (Hedw.) Warnst. S1.

JNP: 11. 36343.

New to the flora of Alberta. *Rhytidiadelphus loreus* was listed for Alberta based on a

report in the Canadian checklist (Ireland et al., 1987) but no citation was given. *R. loreus* is widely distributed at low elevations in the wet rainforests of British Columbia. Its presence in Alberta was expected.

Rhytidiadelphus squarrosus (Hedw.) Warnst. S1.

JNP: 18. 28993, 28992.

Bird (1962) was the first to report *Rhytidiadelphus squarrosus* for Alberta, based on a specimen from Mt. Edith Cavell (*Bird 5112a*, ALTA); the present citation reaffirms the presence of this species in this area. In Jasper National Park, the species occurs also at nearby Outpost Lake and South Pass (Caledonia Mtn.).

R. squarrosus is found only in Waterton and Jasper National Parks within Alberta. It often grows in wet areas, and is commonly associated with anthropogenic habitats (Crum & Anderson 1981).

Schistidium tenerum (J.E. Zett.) Nyh. S2.

JNP: 10. 27644; 11. 31355; **WWP:** 61. 32588.

Schistidium tenerum is infrequent in the Jasper/Willmore area where it has only five locations. This species was recently found at Marston Creek in the Kananaskis area (*Davis 440*, deposited at Devonian Botanic Garden).

Scouleria aquatica Hook. S2.

JNP: 7. 27845; 9. 21637; **Kakwa:** 79. 32315.

Scouleria aquatica is widely distributed in the Rockies, ranging from Waterton Lakes to Kakwa Falls in the Alberta mountains. There is an isolated station on the North Saskatchewan River near Edmonton (*Vitt 24254*, ALTA). The species grows attached to siliceous rock in creeks and rivers. *S. aquatica* is frequent throughout much of British Columbia.

Tayloria lingulata (Dicks.) Lindb. S2.

JNP: 8. 29727; 9. 21665; 18. 6281; 29. 27233; 31. 27988; **WWP:** 71. 35058.

In Alberta, *T. lingulata* occurs from Banff National Park northwards to Willmore Wilderness Park. *T. lingulata* is a subalpine-alpine species that grows on either humus or soil associated with seepage.

Ulota curvifolia (Wahl.) Lilj. S2/S3.

JNP: 9. 30361; 10. 27672; 15. 27074; 31. 27112; 37. 36190; 41. 36626.

Bird (1968) first reported *U. curvifolia* for Alberta from the Cavell area (*Crum 5093*, CANM) and the species was later recorded from the northeast corner of the province (*Vitt 1973b*). The locations cited here are significant additions to the species' range in Alberta.

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