Vegetation and Flora of the Caribou Mountains, Alberta

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The mire complex and forests of the Caribou Mountains contain three forest community types dominated by Black Spruce: *Picea mariana*/ feather moss, *Picea mariana*-feather moss-*Cladina*, and *Picea mariana*/ *Sphagnum-Cladina*. These widespread forest types have strong affinities with vegetation types described from more northerly areas. Two other forest community types are recognized: *Populus tremuloides-Picea glauca* and *Picea glauca-Betula papyrifera*. Community types of the mire complex include: two flark community types, *Menyanthes trifoliata* and *Carex limosa*; two string community types, *Betula glandulosa* and *Picea mariana*/ *Rubus chamaemorus*: three peat plateau community types; two very widespread *Carex aquatilis* community types; and a rare *Eleocharis pauciflora* community type. The known vascular flora presently consists of 195 species and the non-vascular flora consists of 22 lichen, 85 moss, and 4 liverwort species. Two vascular flora species are not known to occur elsewhere in Alberta. The vegetation and flora have northern boreal woodland affinities, suggesting a reclassification of the Caribou Mountains from an outlier of the Lower Foothills to Subarctic or Northern Transition.

Key Words: Caribou Mountains, Alberta, vegetation, flora, peat plateaus, patterned fens, boreal forest, peatlands.

The Caribou Mountains of north central Alberta (Figure 1) are isolated and little work has been done on their vegetation and flora. Raup (1933) visited the easternmost portion in the early 1930's and, stressing the importance of *Pinus contorta*, referred to the area as an outlier of the Cordilleran forest. He also described large areas as being densely covered with Black Spruce forests. Moss (1953 a, b) visited the southern part of the area in the early 1950's and described the large areas covered by muskegs and underlain by discontinuous permafrost. Rowe (1972) classified the Caribou Mountains as a northern outlier of the Lower Foothills Section of the Boreal Forest, presumably because of the reputedly widespread occurrence of *Pinus contorta*. In 1976 Horton et al. (1979) visited the plateau and reported on the habitats of the fourteen species of *Sphagnum* found there. As well, they described three wetland plant community types: treed-tundra, sedge thaw pockets, and shrub-bordered streams.

The present study is based on fieldwork conducted by the Alberta Ecological Survey on 19-21 August 1976 in the southern part of the plateau near Semo Lake and Foggy Tower and by the Natural Areas Program on 19-22 July 1979 in the northern part of the plateau around Horseshoe Lake and on the northern slope (Figure 1). The study was done to assist in the selection of candidate Ecological Reserves for the Alberta Government Natural Areas Program.

Study Area

The Caribou Mountains area in northern Alberta is a low saucer-shaped plateau that rises 600-700 m (1970-2300 ft.) above the surrounding lowlands. The highest elevations in northern Alberta are within the Caribou Mountains and reach a maximum of 1030 m (3380 ft.), in the western part of the plateau. The topography is gently rolling to rolling with some large areas of undulating to depressional relief (Lindsay et al. 1960). The plateau, including those areas above 770 m (2526 ft.), has a total area of about 1M ha with 87 000 ha within Wood Buffalo National Park. 160 000 ha or about 16% of the plateau are above 920 m (3020 ft.). Drainage is generally poor and numerous lakes occur. The four largest lakes, Margaret, Wentzel, Eva and Pitchimi cover about 16 000 ha. Drainage is to the Peace and Mackenzie Rivers. The slopes of the plateau are generally very gentle, with the steepest slopes occurring in a large area on the southern part and small sections on the northwestern and western part. The steepest slopes, on the northwest side, rise 310 m in 2 km. The area was glaciated by Laurentide Ice during the Wisconsin, but became ice-free around 9500BP (Ritchie 1976). The glacier advanced into the area from the Keewatin centre of glaciation to the northeast (Gravenor and Ellwood 1957). The Caribous formed an obstacle to the general flow of ice and this resulted in flutings on the northeastern slopes.

The bedrock geology consists of Cretaceous shales and sandstones, with some Tertiary gravels capping the high hills. These gravels protect the upland from erosion (Lindsay et al. 1960). Organic soils are widespread and often contain permafrost starting at

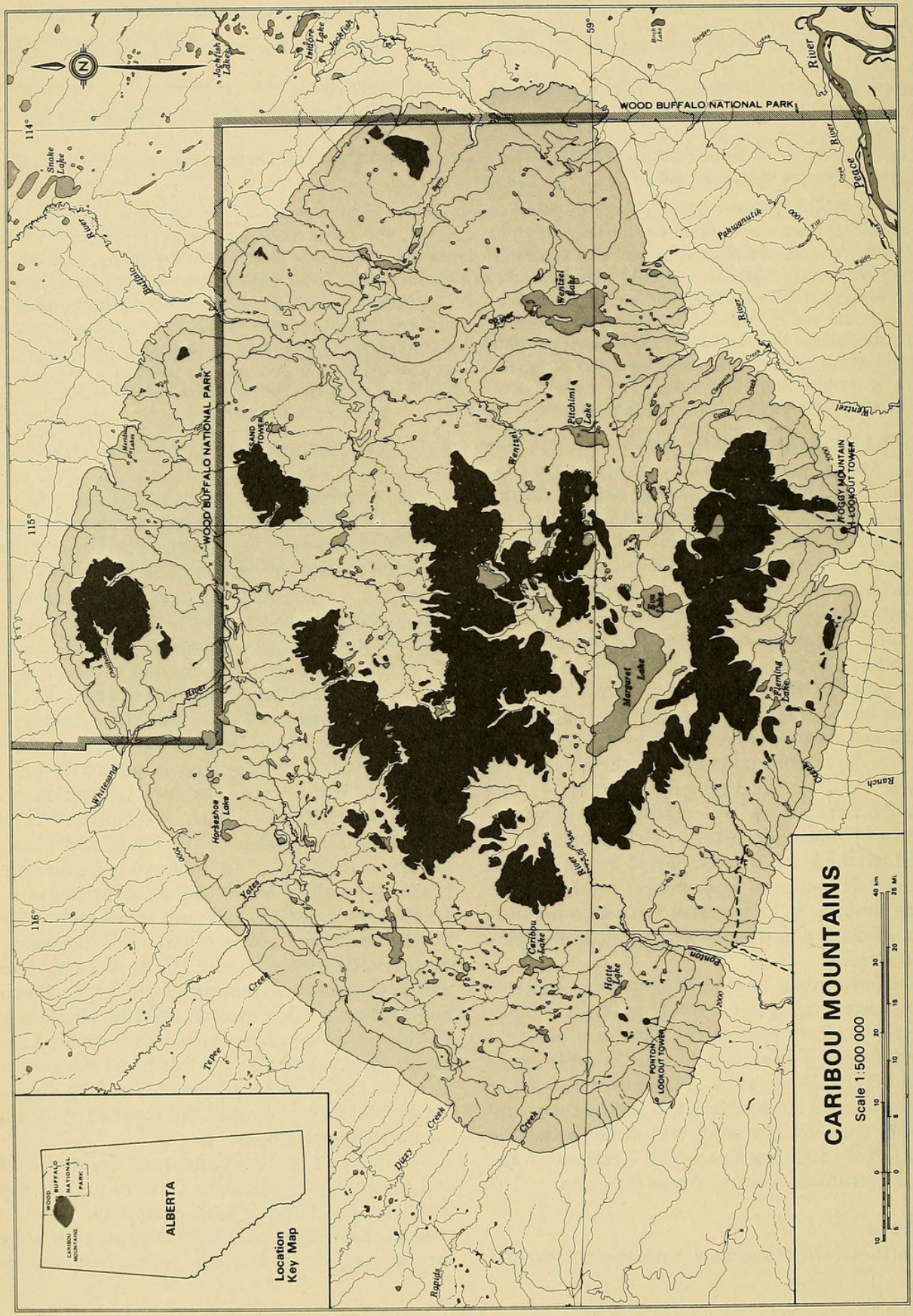

FIGURE 1. Caribou Moutains: Location of study area in Alberta (inset) and map of study area.

depths of 30 to 75 cm from the surface (Lindsay and Odynsky 1965). Where mineral soils occur, they are principally Gray Luvisols, Dystric Brunisols and Cumulic Regosols developed on glacial till. There is no evidence of permafrost in the mineral soils.

The climate of the area is boreal, cold-temperate, continental with cold winters and short, cool summers. Meteorological data are scanty and incomplete for the area. There are two May to September meteorological stations on the plateau but these have data gaps. Ft. Vermilion is the closest year-round station, but being 50 km south of and 500 m below the plateau, is drier and warmer. Based on 30-year normals (1941-1970) Ft. Vermilion has a mean daily temperature of -1.4°C and a total annual precipitation of 360 mm with snowfall averaging 136 cm. For the four months growing season (May-August), the 1975 to 1977 means for Ft. Vermilion were 259 mm for total precipitation and 14.4°C for mean monthly temperature. Over the same period, Foggy Tower on the plateau recorded means of 318 mm for precipitation and 11.2°C for temperature.

Methods

A rapid reconnaissance technique was used to describe vegetation types in 1976. Investigators selected homogeneous stands, 0.5 ha or larger, from airphotos and ground examination. All species present in the stand were recorded and a cover class value assigned to each using an eight-point scale: R, rare; +, < 1%; 1, 1-5%; 2, 6-25%; 3, 26-50%; 4, 51-75%; 5, 76-95%; 6, 96-100% (Daubenmire 1959).

In 1979, this method was used for most stands. A systematic quantitative sampling technique was used on strings and flarks, where more detailed information was desired. A 50 m baseline was established along the centre of the long axis of the string or flark. The vegetation was sampled every 5 m along the baseline, using a 1 m^2 quadrat frame, for a total of 10 quadrats. Two transects were placed on each fen, one each on a string and a flark. A similar systematic sampling technique was used to characterize the transition between string and flark. A transect of continuous 1 m^2 quadrats, perpendicular to the long axis of a string, was started in a flark and placed across the string to the next flark. Transect length depended on the particular string-flark transition. Tree cores for stand age determination were obtained where possible at 20-30 cm heights. On peat plateau 3, temperatures at 10 and 50 cm depths were measured along a transect using a microvoltmeter.

Plant voucher specimens were collected and are deposited in the herbarium of the University of Alberta (ALTA). Nomenclature for vasculars follows Moss (1959) except for *Boschniakia rossica, Pinguicula villosa, Pedicularis sudetica* (Hulten 1968); lichens follow Hale and Culberson (1970); liverworts follow Stotler and Crandall-Stotler (1977); and bryophytes follow Crum (1976). Soil nomenclature and concepts follow those of the Canada Soil Survey Committee (1978).

Results and Discussion

MIRE COMPLEX

Patterned Fens

In the northwestern part of the Caribou Plateau are extensive peatlands of the patterned fen or stringmire type (Moore and Bellamy 1974) which cover approximately 960 ha in an area of 9300 ha. The largest of the fens is 175 ha. They occur on nearly level topography with long, simple slopes, and consist of alternating peat ridges or strings (from German "strang", Heinselman 1965) and water-filled depressions or flarks (from Swedish, Sjors 1963). The patterning is usually somewhat concentric. These mire complexes contain both rich and poor fen sections as indicated by species richness and indicator species (Slack et al. 1980). This type of patterned peatland is a general feature of the subarctic and is also common in the main boreal zone (Sjors 1963).

The width and relative relief of the strings and flarks varies both within and between fens. The average width of eight flarks measured in one fen was 20.6 m (range 4-30.4 m) and the width of eight strings was 4.9 m (range 2-9 m). Strings containing trees averaged 30 cm above water level while those without trees were generally not as high, but with a minimum height of 15 cm. Tree ages varied considerably (41-182 years) on the same and adjacent strings (Table 1) and no age-related patterns are discernible.

In the flarks of fen one, "rises" less than 15 cm above mean water level and of various lengths were frequent. These are not considered strings although they were usually parallel to the strings. Their vegetation resembles the flarks more than the strings, with *Andromeda polifolia* and *Sphagnum* spp. dominant. In fen one there were also hummocks with *Salix pedicellaris, Andromeda polifolia, Oxycoccus microcarpus, Cladina rangiferina* and *Sphagnum* spp. which did not have a frozen layer (i.e. are not incipient peat plateaus). The developmental processes of these rises and mounds are unknown, but their possible relation to strings and peat plateaus is intriguing. In fen two, several strings had a frozen layer within 50 cm of the surface on July 20, 1979. Fen two also had the highest density of peat plateaus.

Flark Vegetation

Menyanthes trifoliata Community Type

Menyanthes trifoliata has high cover in all quadrats

TABLE 1. Tree ages on strings and peat plateaus within patterned fens

	Species	Tree hght (m)	DBH (cm)	Age (yrs)	Origin
Fen 1					
String A	*Picea mariana*	6	12.4	73	1906
	Picea mariana	4.5	5.8	60	1919
	Picea mariana	3	4.6	123	1856
String B	*Larix laricina*	2.6	2.7	41	1938
	Larix laricina	5	10.6	182	1797
	Picea mariana	4	7	78	1901
	Picea mariana	5.5	11.9	111	1868
Fern 2					
String A	*Picea mariana*	2.5	3	73	1906
String B	*Picea mariana*	3	5.4	122	1857
String C	*Picea mariana*	2.7	4	62	1917
Fen 3					
String A	*Picea mariana*	5.5	7.0	86	1893
String B	*Larix laricina*	6	10.1	66	1913
Peat Plateau 3	*Larix laricina*	2.0	4	119	1867
	Picea mariana	1.7	5	102	1877

of this community type, averaging 20% (Table 2). *Scorpidium scorpioides* is the dominant bryophyte, forming continuous carpets with *Drepanocladus revolvens* and *Meesia triquetra. Carex limosa* and *Juncus stygius* also occur with high frequency. Eight vascular and three bryophyte species occur in the community type. It is very similar to the *Scropidium scorpioides-Drepanocladus revolvens-Carex limosa* community type in rich fens of western Alberta (Slack et al. 1980).

Carex limosa Community Type

Carex limosa is the dominant vascular plant in this community type (Table 2). *Sphagnum jensenii* is the dominant bryophyte with lesser amounts of *Cladopodiella fluitans. Drosera anglica* occurs with high freqency but low cover. A total of four vascular and five bryophyte species occur in this community type. It is very similar to the *Carex limosa* association described from Swan Hills in central Alberta (Vitt et al. 1975).

String Vegetation

Betula glandulosa Community Type

A dense cover of *Betula glandulosa* (Table 2) characterizes this community type. *Larix laricina, Menyanthes trifoliata, Picea mariana* and *Salix pedicellaris* are also important. Dominant bryophytes include *Sphagnum angustifolium, S. warnstorfii* and *Scorpidium scorpioides. Tomenthypnum nitens*, a rich-fen indicator (Vitt et al. 1975), is also present. Eighteen vascular and 13 bryophyte species occur in the community type. It is similar to the *Tomenthypnum nitens-Betula glandulifera-Larix laricina* community type of western Alberta rich fens (Slack et al. 1980).

Picea mariana/ Rubus chamaemorus Community Type

Strings of this community type appear to be raised higher above mean water level than those of the *Betula glandulosa* community type. *Rubus chamaemorus* and *Chamaedaphne calyculata* are dominant understory plants. These two species are also significant components of the similar *Picea mariana-Ledum groenlandicum-Sphagnum magellanicum* association in Swan Hills (Vitt et al. 1975). Important bryophytes include *Sphagnum angustifolium, S. fuscum, S. warnstorfii* and *Pleurozium schreberi*. Ten vascular and 19 bryophyte species occur in this community type.

Direct Gradient Analysis of Ecotones

In both strings and flarks, moisture is an influential factor in species presence and performance. A direct gradient analysis of flark-string-flark sequences from two fens (Figure 2 and 3) illustrates this influence.

In fen 1 (Figure 2), *Picea mariana* is restricted to the middle of the string. Three shrubs, *Betula glandulosa, Andromeda polifolia* and *Salix pedicellaris* occur in the transition between string and flark. *Menyanthes trifoliata* is the most abundant vascular plant in the flarks, but its cover decreases on the strings. *Carex limosa* is most abundant in the flarks. *Sphagnum angustifolium* is the dominant string bryophte, but is replaced by *S. warnstorfii* and *Aulacomnium palustre* in the transition zone and by *Scorpidium scorpioides, Drepanocladus revolvens* and *Meesia triquetra* in the flarks.

In fen 2 (Figure 3) a similar pattern prevails. *Picea mariana* is restricted to the middle of the string. *Betula*

TABLE 2. Association table of species present in the mire complexes in the Caribou Mountains

	Menyanthes trifoliata Community Type (fen 1)	*Carex limosa* Community Type (fen 2)	*Betula glandulosa* Community Type (fen 1)	*Picea mariana* Community Type (fen 2)	Peat plateaus			*Carex aquatilis* community		*Eleocharis pauciflora* Community Type	Shrub transition zone
					#1	#2	#3	Type 1	Type 2		
VASCULARS											
Andromeda polifolia	+	.	.	+	1	3	1	+	1	1	+
Arctostaphylos rubra	.	.	.	.	.	.	.	.	.	.	2
Betula glandulosa	.	.	4	1	.	.	1	+	.	1	3
Calamagrostis canadensis	.	.	.	.	.	.	.	1	.	.	3
Carex aquatilis	.	.	+	.	.	.	+	3	4	R	.
Carex diandra	+	.	.	.	.	.	+	.	.	.	.
Carex gynocrates	.	.	+	.	.	.	.	.	.	+	.
Carex interior	.	.	+	.	.	+	.	.	.	.	.
Carex limosa	2	2	+	+	3	3	1	+	.	1	.
Carex paupercula	.	.	.	.	.	.	.	.	5	.	+
Carex rostrata	.	.	.	.	.	.	.	3	.	.	.
Carex tenuiflora	.	.	.	.	.	.	.	.	.	.	+
Chamaedaphne calyculata	.	.	.	2	.	.	.	+	.	.	.
Chrysosplenium iowense	.	.	.	.	.	.	.	+	.	.	.
Drosera anglica	+	+	.	.	+	.	.	+	.	.	.
Eleocharis pauciflora	.	.	.	.	.	.	.	.	.	2	.
Empetrum nigrum	.	.	.	.	.	.	.	.	.	+	+
Epilobium palustre	.	.	+	.	.	.	.	+	.	.	.
Equisetum scirpoides	.	.	.	.	.	.	.	.	.	.	+
Equisetum sylvaticum	.	.	.	.	.	.	.	+	.	.	.
Eriophorum gracile	+	.	.	.	.	.	.	.	.	+	.
Eriophorum vaginatum var. *spissum*	.	+	.	.	.	.	.	+	2	.	.
Galium trifidum	.	.	.	.	.	.	.	.	.	+	.
Galium triflorum	.	.	.	.	.	.	.	+	.	.	.
Geum allepicum	.	.	.	.	.	.	.	+	.	.	.
Habenaria hyperborea	.	.	+	.	.	.	.	.	.	+	.
Hippurus vulgaris	.	.	.	.	.	.	.	+	.	.	.
Juncus stygius	+	.	.	.	.	.	.	.	+	+	.
Larix laricina	.	.	3	.	.	.	1	.	.	+	1
Ledum groenlandicum	.	.	+	+	.	.	2	+	+	.	.
Menyanthes trifoliata	3	+	3	.	.	+	1	.	.	+	.
Myriophyllum exalbescens	.	.	.	.	.	.	.	+	.	.	.
Oxycoccus microcarpus	.	.	+	+	.	1	+	+	+	.	.
Pedicularis labradorica	.	.	+	.	.	.	.	.	.	+	+
Pedicularis sudetica	.	.	.	.	.	.	.	.	.	+	.

continued

TABLE 2. Association table of species present in the mire complexes in the Caribou Mountains *(concluded)*

	Menyanthes trifoliata Community Type (fen 1)	*Carex limosa* Community Type (fen 2)	*Betula glandulosa* Community Type (fen 1)	*Picea mariana* Community Type (fen 2)	Peat plateaus			*Carex aquatilis* community		*Eleocharis pauciflora* Community Type	Shrub transition zone
					#1	#2	#3	Type 1	Type 2		
VASCULARS											
Petasites sagittatus	.	.	.	.	.	.	.	+	.	.	.
Picea mariana	.	.	1	3	.	.	3	+	+	+	+
Pinguicula villosa	.	.	.	.	.	.	+	.	.	+	.
Potamogeton alpinus	.	.	.	.	.	..	.	+	.	.	.
Polygonum viviparum	.	.	.	.	.	.	.	.	.	.	+
Potentilla palustris	.	.	+	.	.	.	+	1	+	+	+
Ranunculus gmelinii	.	.	.	.	.	.	.	+	.	.	.
Rubus acaulis	.	.	+	.	.	.	.	.	.	.	+
Rubus chamaemorus	.	.	+	3	.	.	2	+	.	+	+
Rumuex occidentalis	.	.	.	.	.	.	.	+	.	.	.
Salix pedicellaris	.	.	1	.	.	2	1	1	.	+	2
Scheuchzeria palustris	.	.	.	.	.	.	.	.	+	.	.
Senecio indecorus	.	.	.	.	.	.	.	.	.	.	+
Smilacina trifolia	.	.	+	.	.	.	1	+	.	.	+
Sparganium minimum	.	.	.	.	.	.	.	.	.	+	.
Spiranthes romanzoffiana	R	.	.	.	.	.	.	.	.	+	.
Tofieldia glutinosa	.	.	.	.	.	.	.	.	.	+	.
Triglochin maritima	.	.	.	.	.	.	+	.	.	+	.
Vaccinium uliginosum	.	.	.	.	.	.	.	.	.	.	+
Vaccinium vitis-idaea	.	.	.	.	.	.	.	.	.	.	+
NON-VASCULARS											
Aulocomnium palustre	.	.	+	+	.	.	+	+	.	*	
Calliergon stramineum	.	.	+	.	.	.	.	+	+	.	
Cephalozia sp.	.	.	.	+	.	.	.	.	.	.	
Cetraria nivalis	.	.	.	+	.	..	.	+	.	.	
Cladina mitis	.	.	.	+	.	.	.	+	.	.	
Cladina rangiferina	.	.	.	+	.	1	.	.	.	.	
Cladonia coccifera	.	.	.	+	.	.	.	.	.	.	
Cladonia gracilis	.	.	.	+	.	.	.	.	.	.	
Cladopodiella fluitans	.	3	.	.	.	.	.	.	.	.	
Dicranum elogatum	.	.	.	.	.	.	.	.	.	+	
Dicranum undulatum	.	.	+	+	.	.	+	.	.	+	
Drepanocladus revolvens	5	.	.	.	6	+	.	.	.	.	
Drepanocladus uncinatus	.	.	.	.	.	.	+	.	.	1	
Hylocomium splendens	.	.	+	.	.	.	.	.	.	.	
Icmadophila ericetorum	.	.	.	+	.	.	.	.	.	.	
Lophozia sp.	.	.	.	+	.	.	1	.	.	.	
Marchantia polymorpha	.	.	.	.	.	.	.	+	.	.	

Meesia triquetra	·	·	·	·	·	1	·	+	·	2
Paludella squarrosa	+	·	·	·	·	·	·	+	·	·
Pleurozium shreberi	·	·	·	·	·	·	2	·	·	·
Pohlia nutans	+	·	·	·	·	·	+	+	·	·
Polytrichum juniperinum	·	·	·	·	·	·	+	·	·	·
Polytrichum strictum	·	·	+	·	·	·	·	·	·	·
Rhizomnium gracile	·	·	·	·	·	·	·	+	·	·
Scapania sp.	·	·	·	·	·	·	·	·	+	·
Scapania paludosa	·	+	·	·	·	·	·	·	·	·
Scorpidium scorpioides	+	·	·	·	2	1	·	3	·	6
Sphagnum angustifolium	·	·	·	5	·	·	4	4	·	·
Sphagnum fuscum	·	3	·	+	·	·	1	+	·	·
Sphagnum jensenii	·	2	·	·	·	·	+	·	5	·
Sphagnum lindbergii	·	·	·	·	·	·	·	·	+	·
Sphagnum magellanicum	·	·	·	·	·	·	+	·	·	·
Sphagnum obtusum	·	·	+	·	·	·	·	·	·	·
Sphagnum riparium	·	·	3	·	·	·	·	·	·	·
Sphagnum russowii	·	·	·	+	·	·	+	·	·	·
Sphagnum squarrosum	·	·	1	·	·	·	·	·	·	·
Sphagnum warnstorfii	5	·	·	1	5	·	1	1	·	·
Tomenthypnum falcifolium	·	·	·	+	·	·	·	·	·	·
Tomenthypnum nitens	+	·	·	+	·	·	·	+	·	·

*not studied.

glandulosa is restricted to the transition zone, while *Ledum groenlandicum* and *Chamaedaphne calyculata* are more widely distributed. *Carex limosa* is restricted to the flarks. *Cladina rangiferna*, a lichen, has a narrow distribution on the string top. *Sphagnum magellanicum* and *S. angustifolium* have a wide distribution on the string. Vitt et al. (1975) found that *Sphagnum angustifolium* occurred on the string edges, while *S. magellanicum* occurred more in the center. *Sphagnum jensenii* and *Cladopodiella fluitans* occurred only in the flarks.

Peat Plateaus

The peat plateaus reported here are found in patterned fens in the northwest part of the Caribou Mountains. They have been previously reported from both the southern (Moss 1953) and northern parts (Lindsay et al. 1960) of the plateau. Peat plateau refers to a hummock of variable size with a frozen core rising out of a peatland (Brown 1968a). Peat plateaus vary in size from a few to hundreds of meters in diameter in the discontinuous permafrost zone (Zoltai and Tarnocai 1975) and are about 1 m high. Frozen peat landforms generally occur in the discontinuous permafrost zone of the Northern Hemisphere and the southern limit of permafrost is usually in raised peat landforms such as palsas and peat plateaus (Brown 1968a). In Alberta, permafrost peat landforms occur generally north of a line from Cold lake to Peace River (Lindsay and Odynsky 1965) and are common in northern Alberta (Reid 1977). The location of the Caribou Mountains peat plateaus in patterned fens is very similar to that described by Reid (1977).

Three peat plateaus which occur as islands in the flarks of stringmires were studied intensively. The plant cover of peat plateau 1 (Table 2) is dominated by *Drepanocladus revolvens* and *Carex limosa*. This community is very similar to the surrounding flark (*Menyanthes trifoliata* community type) except that *Menyanthes trifoliata* is absent on the peat plateau and *Scorpidium scorpioides* is greatly reduced in cover. *Scorpidium scorpioides* is less tolerant of the drier conditions of the peat plateau (Slack et al. 1980). This similarity to the flark may be because of the peat plateau's low relief, 15-20 cm higher than the surrounding flark. The peat plateau was 7 × 15 m; the maximum height was 20 cm; and a frozen layer on July 20, 1979 averaged 10 cm below ground surface. Although no depth to permafrost measurements were made later in the season at these specific sites, other researchers have found frozen layers in the fall (Lindsay et al. 1960 report frozen layers at 46 cm in September).

Peat plateau 2 (Table 2, Figure 4) is substantially different from the *Menyanthes trifoliata* community

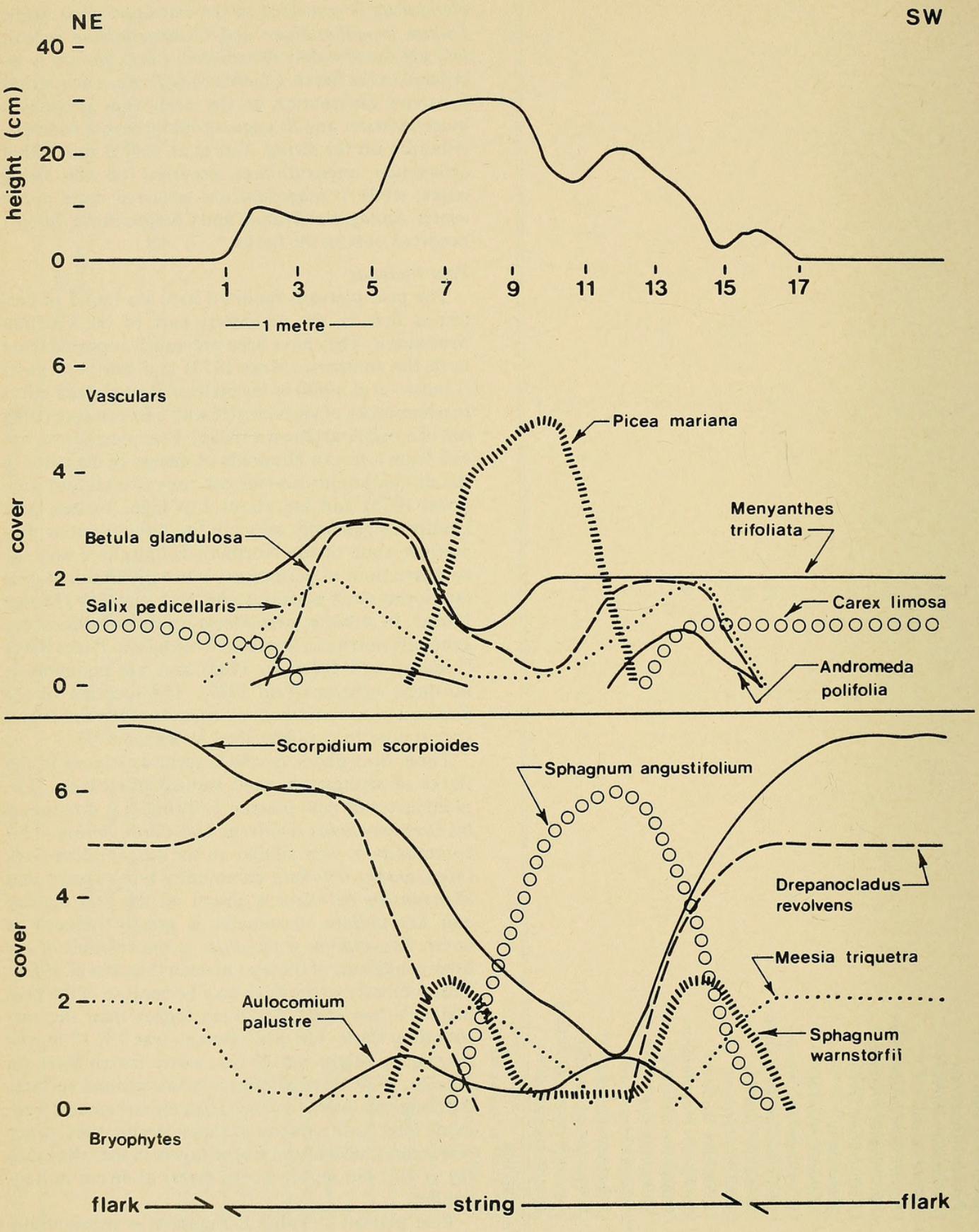

FIGURE 2. Smoothed curves of height above water table and cover of the major vascular and bryophyte plant species along a transect through a flark-string-flark complex in fen 1. Top = height, middle = vasculars, bottom = bryophytes.

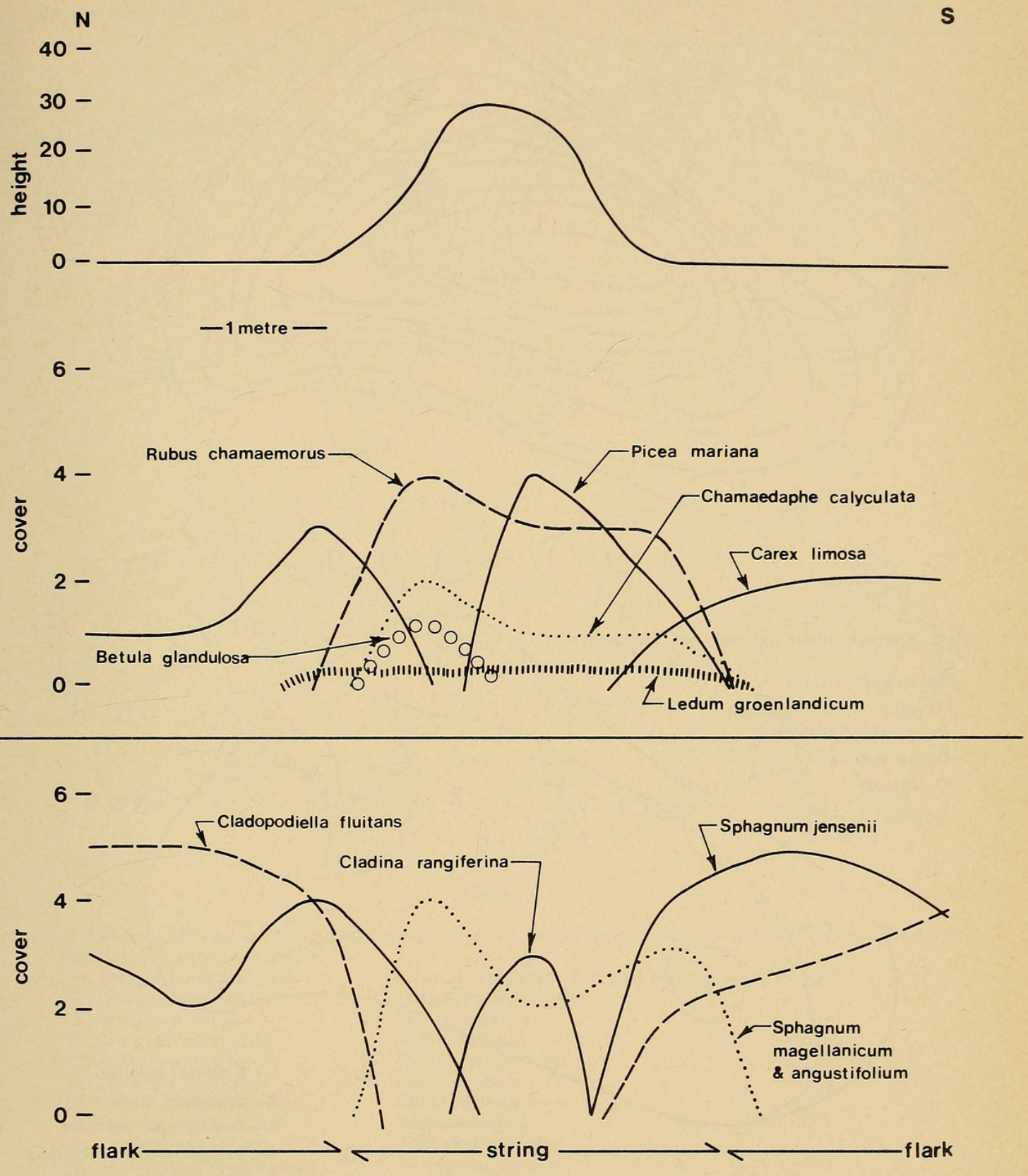

FIGURE 3. Smoothed curves of height above water table and cover of the major vascular and bryophyte plant species along a transect through a flark-string-flark complex in fen 2. Top = height, middle = vascular, bottom = bryophytes

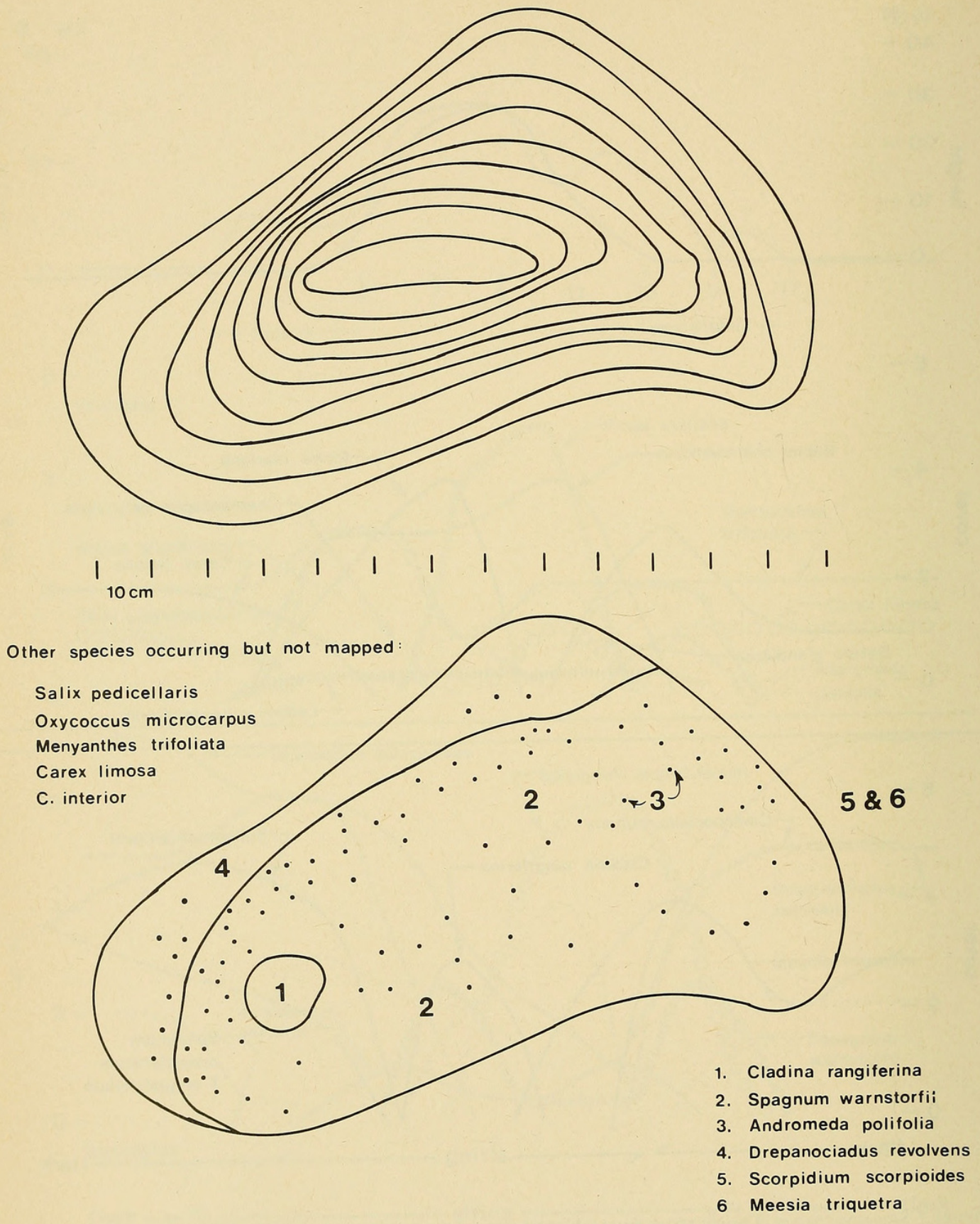

FIGURE 4. Species occurrence and contour map of peat plateau #2. Contour interval = 5 cm.

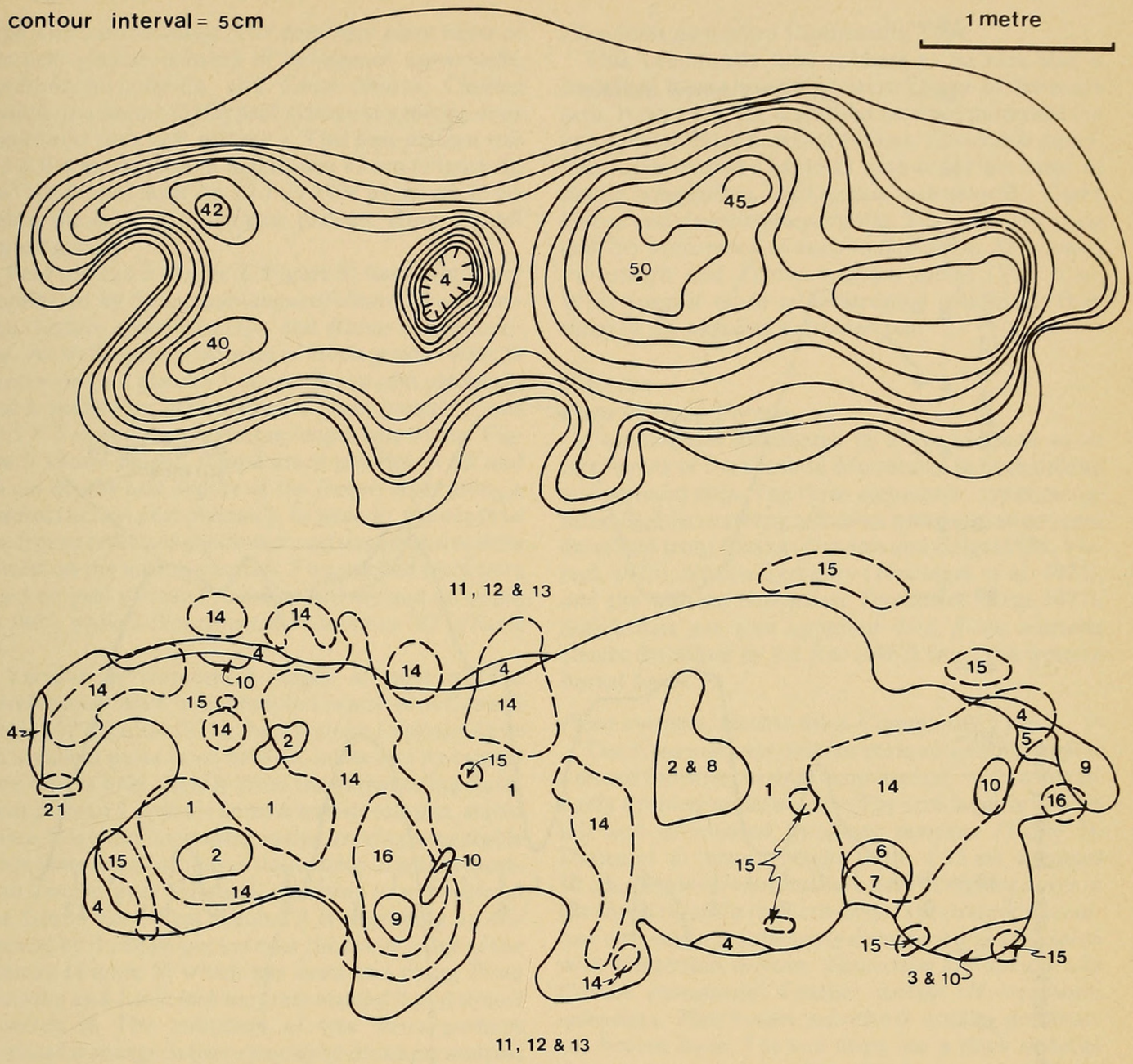

FIGURE 5. Species occurrence and contour map of peat plateau #3. Top = contours, bottom = species occurrence. Bryophytes solid lines; vasculars, broken lines

1. *Sphagnum angustifolium*
2. *Sphagnum fuscum*
3. *Sphagnum russowii*
4. *Sphagnum warnstorfii*
5. *Aulocomium palustre*
6. *Dicranum undulatum*
7. *Drepanocladus uncinatus*
8. *Icmadophila ericetorum*
9. *Tomenthypnum nitens*
10. *Tomenthypnum falcifolium*
11. *Scorpidium scorpioides*
12. *Drepanocladus revolvens*
13. *Meesia triquetra*
14. *Picea mariana*
15. *Betula glandulosa*
16. *Larix laricina*

Other species occurring on peat plateau but not mapped:
Ledum groenlandicum
Salix pedicellaris
Andromeda polifolia
Oxycoccus microcarpus
Carex aquatilis
Rubus chamaemorus
Smilacina trifolia
Triglochin maritima
Menyanthes trifoliata
Pinguicula villosa
Carex diandra
Potentilla palustris
Carex limosa

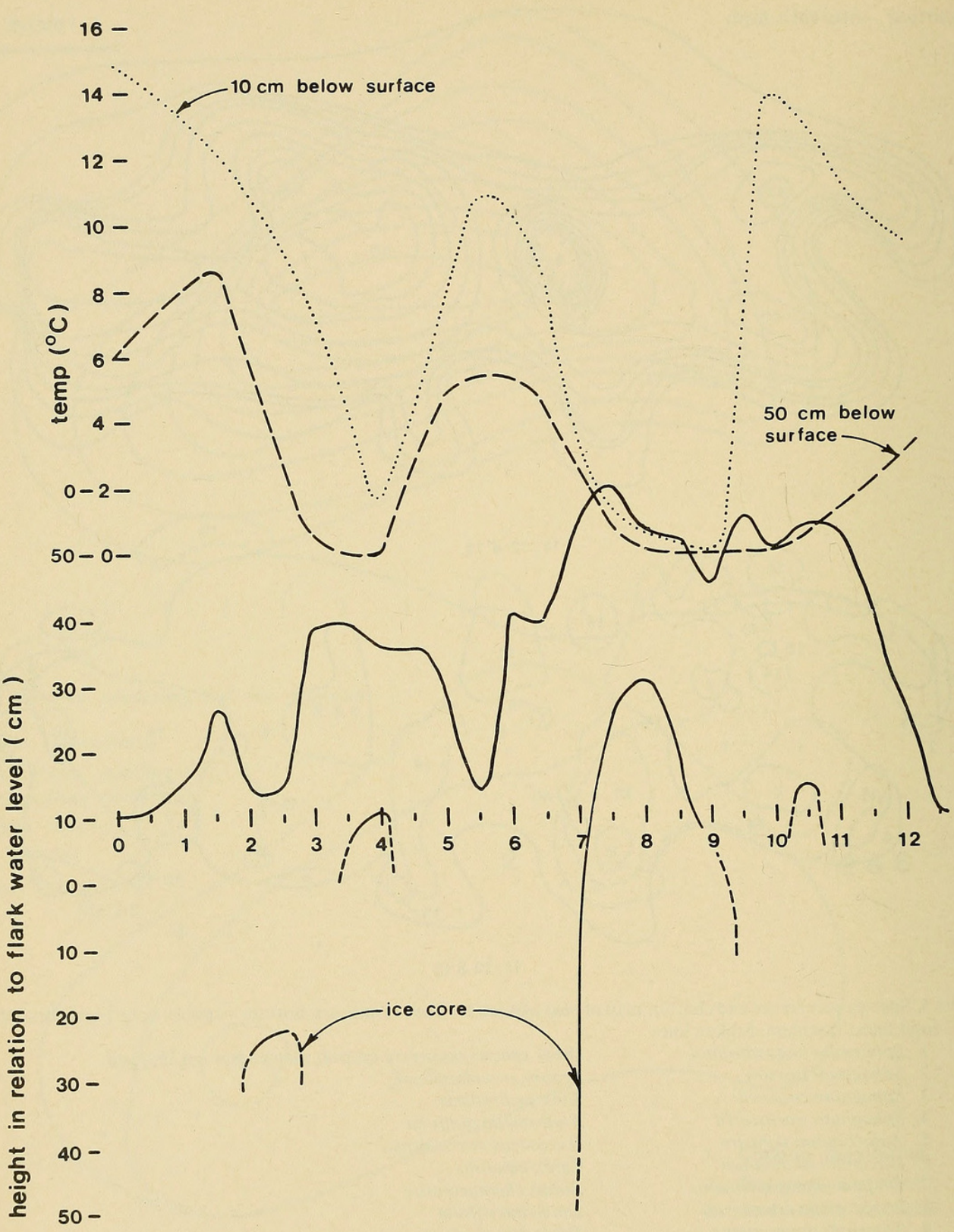

FIGURE 6. Height, temperature profiles and frozen layer depths of peat plateau #3 (measured 20 July 1979). Solid line is surface height above the water. Ice core refers to frozen core.

type which surrounds it. The dominant plant cover of the peat plateau consists of *Sphagnum warnstorfii, Andromeda polifolia,* and *Carex limosa. Cladina rangiferina* occurs in this peat plateau suggesting drier conditions than peat plateau 1. This peat plateau was 1.3 × 0.6 m; maximum height was 45 cm (Figure 4); and the frozen layer on 20 July 1979 averaged 20 cm below the summit of the peat plateau, although this varied greatly.

Peat plateau 3 (Table 2, Figure 5) has plant cover dominated by *Sphagnum angustifolium, Picea mariana, Ledum groenlandicum* and *Rubus chamaemorus*. As well, species richness is much greater with 26 species on peat plateau 3, 10 species on peat plateau 2, and 6 species on peat plateau 1. Peat plateau 3 was 10.5 × 5 m and the maximum height was 50 cm. Figure 6 shows height, temperature profiles at 10 and 50 cm depths and depths of the frozen layer along a transect across peat plateau 3. In general, the depth to the frozen layer was shallowest and temperatures were lowest on the highest portion. Two stunted trees were aged on peat plateau 3: a *Larix laricina* had an origin in 1867, while a *Picea mariana* started in 1877 (Table 1).

Various developmental stages of peat plateau development have been observed in northern Canada (Reid 1977; Zoltai 1972). Peat plateau 1 appears to be an incipient palsa since its relief is low and its vegetation differs only slightly from the surrounding flark. Peat plateau 2 appears to be a well-developed, stable palsa. It is either increasing in size or remaining stable since there were no signs of desiccation cracks, vegetation demise, peat deflation, slumping or exposure of the frozen core. Peat plateau 3 is degrading as evidenced by the thaw pocket near the center-edge of the plateau (Figure 5) which has dead and dying *Picea mariana* and *Larix laricina* trees around it and tipped towards it. The reduction of tree cover perhaps initiated a change in the topography of the permafrost table (Brown 1968b) eventually forming the thaw-pocket.

Carex aquatilis fens

Fens dominated by *Carex aquatilis* occur commonly on the plateau usually adjacent to sluggish streams or shallow lakes. Two community types are distinguished: *Carex aquatilis-C. rostrata,* and *Carex aquatilis-C. paupercula*. In the first, *Carex rostrata* is important along with *Salix pedicellaris* and *Potentilla palustris*. In the second. *Carex rostrata* is absent and *C. paupercula, Eriphorum vaginatum* and *Andromeda polifolia* are important (Table 2). Similar communities dominated by *Carex aquatilis* are common across boreal (Viereck and Dyrness 1980, Moss 1953b, Jeglum et al. 1973) and Rocky Mountain (Achuff and Corns 1981) regions.

Eleocharis pauciflora Community Type

This community type appears to be rare and is described from the northwestern corner of the study area. It occurs in the transition between patterned fen and upland *Picea mariana* forests. *Eleocharis pauciflora* is dominant (Table 2) with lesser amounts of *Betula glandulosa, Sphagnum warnstorfii, Carex limosa* and *Andromeda polifolia*. The species richness and the occurrence of such indicators as *Sphagnum warnstorfii* and *Tomenthypnum nitens* (Vitt et al. 1975) suggest more minerotrophic conditions than those in the adjacent patterned fen.

FORESTS

Picea mariana Forests

Communities dominated by *Picea mariana* cover large areas of the Caribou Mountains in both upland and wetland sites. The three community types recognized here have strong affinities with vegetation types described from Alaska (Dyrness and Grigal 1979, Viereck 1975), Yukon Territory (Hettinger et al. 1973), and the western Northwest Territories (Reid 1977). Similarities are also apparent with *Picea mariana* stands described by La Roi (1967) from the western boreal forest.

Picea mariana/feather moss Community Type

The *Picea mariana*/feather moss community type is a closed forest occurring on moderately well to imperfectly drained mineral soils. The tree layer is 7-10 m tall and dominated by *Picea mariana* (Table 3). Diameter at breast height (dbh, 1.35 m) averages 10 cm. *Ledum groenlandicum* has the highest cover in the shrub layer. In the herb-dwarf shrub layer *Vaccinium vitis-idaea* is commonly dominant and associated with *Empetrum nigrum, Equisetum sylvaticum* and *Cornus canadensis*. Feather mosses (*Hylocomium splendens, Pleurozium schreberi*) usually dominate the bryoid layer. The soil often has a thick surficial organic layer but it is seldom thick enough to constitute an Organic soil.

This community type is very similar to the Black Spruce/feather moss vegetation unit of Viereck (1975) and Dyrness and Grigal (1979) in Alaskan boreal forests. In northern Alberta, a similar upland Black Spruce-feather moss forest has been described by Moss (1953a).

Picea mariana/feather moss — *Cladina* Community Type

The *Picea mariana*/feather moss - *Cladina* community type is an open forest occurring on well drained mineral soils. The sites are generally drier than the *Picea mariana*/feather moss community type. Only one stand was sampled (Table 3) although our field notes indicate a more widespread occurrence of this

TABLE 3. Association table of species present in the forests of the Caribou Mountains

	Picea mariana/ feathermoss Community Type	*Picea mariana*/ feathermoss - *Cladina* Community Type	*Picea mariana*/ *Sphagnum* - Cladina Community Type	1961 Burn		*Populus tremuloides*-*Picea glauca*-- Community Type	*Picea glauca*-*Betula papyrifera* Community Type
				Lowland	Upland		
VASCULARS							
Achillea millefolium	+	.	.	+	.	+	.
Achillea sibirica	.	.	.	.	.	+	.
Actaea rubra	.	.	.	.	.	.	+
Adoxa moschatellina	.	.	R	.	.	.	.
Agrostis scabra	.	.	.	+	+	+	.
Alnus crispa	+	.	.	.	1	.	2
Amelanchier alnifolia	.	.	.	.	.	+	.
Andromeda polifolia	.	.	+	+	.	.	.
Arctostaphylos rubra	+	.	+	+	.	.	.
Arctostaphylos uva-ursi	.	.	.	+	.	+	.
Arnica fulgens	.	.	.	.	.	+	.
Aster conspicuus	.	.	.	.	.	+	.
Betula glandulosa	.	+	1	+	2	+	.
Betula occidentalis	.	.	.	.	+	.	.
Betula papyrifera	.	.	.	.	.	.	1
Bidens cernua	.	.	.	.	.	.	R
Boschniakia rossica	.	.	.	.	.	.	R
Calamagrostis canadensis	+	+	+	+	+	.	+
Carex aquatilis	.	.	+	R	.	.	.
Carex limosa	+	.	.	.	.	.	.
Castilleja raupii	.	.	.	R	.	+	.
Chamaedaphne calyculata	.	.	+	.	.	.	.
Circaea alpina	.	.	.	.	.	.	R
Cornus canadensis	1	1	+	+	1	1	1
Delphinium glaucum	.	.	.	.	R	.	+
Elymus innovatus	+	.	.	+	1	1	+
Empetrum nigrum	+	+	+	+	.	+	.
Epilobium angustifolium	.	.	.	1	1	2	+
Equisetum arvense	1	.	.	.	.	+	+
Equisetum fluviatile	.	.	.	.	+	.	.
Equisetum pratense	.	.	.	.	.	+	+
Equisetum scirpoides	1	.	+	+	.	.	.
Equisetum sylvaticum	1	+	+	+	+	+	+
Galium boreale	.	.	.	.	.	.	+
Galium triflorum	+	.	.	.	.	.	.
Gentianella amaralla	.	.	.	.	+	.	.
Geocaulon lividum	.	+	R	.	.	+	+
Goodyera repens	.	.	.	.	.	.	+
Gymnocarpium dryopteris	R	.	.	.	.	.	.

Habenaria hyperborea	.	.	.	+	.	.	.
Hieracium umbellatum	.	.	.	.	.	R	.
Juniperus communis	+	.	.	.	2	+	.
Larix laricina	.	.	+	.	.	.	.
Lathyrus ochroleucus	.	.	.	.	.	.	+
Ledum groenlandicum	1	2	2	3	2	+	+
Ledum palustre	.	.	1	1	.	.	.
Linnaea borealis	+	.	+	.	+	.	+
Luzula parviflora	.	.	.	.	.	+	.
Lycopodium annotinum	+	.	+	.	+	1	+
Lycopodium tristachyum	.	+	+	.	.	1	.
Maianthemum canadense	.	.	.	.	.	.	+
Mertensia paniculata	+	.	.	+	+	+	+
Mitella nuda	+	.	+	.	.	.	+
Moneses uniflora	+	.	.	.	.	.	.
Oxycoccus microcarpus	+	.	+	+	.	.	.
Oxytropis splendens	.	.	.	.	.	.	+
Parnassia palustris	.	.	.	R	.	.	.
Pedicularis labradorica	+	.	+	+	.	+	.
Petasites palmatus	+	.	+	+	.	+	+
Picea glauca	.	.	.	.	.	1	3
Picea mariana	3	3	2	1	+	2	+
Pinus contorta	.	.	R	+	1	.	.
Poa pratensis	.	.	.	.	.	+	.
Populus balsamifera	.	.	.	.	+	.	+
Populus tremuloides	.	.	R	+	+	2	+
Potentilla norvegica	.	.	.	.	.	R	.
Potentilla palustris	.	.	+	.	.	.	.
Pyrola asarifolia	.	.	.	.	.	+	+
Pyrola secunda	+	.	+	.	+	+	+
Pyrola virens	.	.	.	.	.	.	+
Ribes glandulosum	.	.	.	+	.	.	.
Ribes triste	.	.	+	.	+	.	+
Rosa acicularis	+	.	+	+	+	+	1
Rubus acaulis	+	.	+	.	.	+	+
Rubus chamaemorus	.	.	1	1	.	.	.
Rubus pubescens	+	.	.	.	.	.	+
Rubus strigosus	.	.	.	+	+	.	.
Salix glauca	.	.	+	.	1	.	.
Salix myrtillifolia	.	.	.	1	.	.	.
Salix pseudomonticola	.	+	.	.	.	.	.
Salix scouleriana	.	.	.	.	.	+	.
Senecio indecorus	R	.	.	R	.	+	.
Shepherdia canadensis	.	.	.	R	+	.	+
Smilacina trifolia	.	.	+	+	.	.	.
Symphoricarpos albus	.	.	.	.	.	.	+

(continued)

TABLE 3. Association table of species present in the forests of the Caribou Mountains *(continued)*

	Picea mariana/ feathermoss Community Type	*Picea mariana*/ feathermoss - *Cladina* Community Type	*Picea mariana*/ *Sphagnum* - Cladina Community Type	1961 Burn		*Populus tremuloides*- *Picea glauca*-- Community Type	*Picea glauca*- *Betula papyrifera* Community Type
				Lowland	Upland		
VASCULARS							
Vaccinium myrtilloides	.	.	.	.	.	.	.
Vaccinium uliginosum	.	1	+	+	+	.	.
Vaccinium vitis-idaea	1	1	1	+	1	+	+
Viburnum edule	+	.	.	.	1	+	1
Viola orbiculata	.	.	.	.	.	.	+
NON-VASCULARS							
Alectoria sp.	.	.	+	.	.	.	.
Aulocomnium palustre	.	.	+	+	.	.	.
Brachythecium salebrosum	.	.	.	.	.	.	+
Campylium chrysophyllum	.	.	.	.	.	.	+
Ceratodon atrosquama	.	.	.	.	.	+	.
Ceratodon purpureus	.	.	.	.	+	.	.
Cetraria nivalis	R	+	+	+	.	+	.
Cetraria pinastre	.	.	+	.	.	.	.
Cladina mitis	R	+	3	+	.	+	.
Cladina rangiferina	.	1	1	+	.	+	.
Cladina stellaris	.	1	1	.	.	.	.
Cladonia coccifera	.	+	+	+	.	+	.
Cladonia gracilis	.	+	1	.	.	+	.
Cladonia uncialis	.	+	+	.	.	.	.
Climacium dendroides	+	.	.	.	.	.	+
Dicranum flagellare	.	.	.	.	.	.	+
Dicranum fuscescens	.	.	+	.	.	.	.
Dicranum polysetum	.	.	.	+	.	.	.
Dicranum undulatum	+	+	+	+	.	+	+
Distichium capillaceum	.	.	.	.	.	.	+
Evernia mesomorpha	+	.	.	.	.	.	.
Hylocomium splendens	2	1	+	.	2	2	3
Hypnum pratense	.	.	.	.	.	.	+
Hypogymnia physodes	.	.	+	.	.	.	.
Icmadophila ericetorum	.	.	.	+	.	.	.
Marchantia polymorpha	.	.	+	.	.	.	.
Mylia anomala	.	.	+	.	.	.	.
Parmelia sulcata	+	.	+	.	.	+	.
Peltigera aphthosa	+	+	+	+	+	+	+
Peltigera canina	+	.	+	+	.	+	.
Pleurozium schreberi	2	2	+	.	.	.	2
Pohlia cruda	.	.	.	.	.	.	+

Pohlia nutans	·	·	·	·	·	+	·
Polytrichum juniperinum	+	+	+	1	+	+	+
Polytrichum strictum	·	·	+	·	·	+	·
Ptilidium ciliare	·	·	·	·	·	·	R
Ptilium crista-castrensis	+	·	·	·	·	·	2
Sphagnum fuscum	·	·	3	3	·	·	·
Sphagnum nemoreum	·	·	+	·	·	·	·
Sphagnum warnstorfii	·	·	+	·	·	·	·
Tomenthypnum nitens	·	·	+	·	·	·	·
Usnea sp.	·	·	·	·	·	+	·

type in the Caribou Mountains. *Picea mariana*, with a height of about 8 m and an average dbh of 8 cm, dominates the scattered tree layer. *Ledum groenlandicum* is dominant in the shrub layer and *Vaccinium vitis-idaea* is most important in the herb-dwarf shrub layer. *Cladina* spp., especially *Cladina mitis*, have the highest cover in the bryoid layer with lesser amounts of feather moss (*Pleurozium schreberi*) and *Cetraria nivalis* occuring.

Similar Alaskan types are Black Spruce/feather-moss/*Cladonia* (Viereck 1975) and open Black Spruce/feather moss/*Cladonia* (Dyrness and Grigal 1979). This community type also falls within Moss's (1953a) broader "black spruce- feather moss association".

Picea mariana/*Sphagnum* - *Cladina*
Community Type

This is an open forest community type occurring on poorly drained, Organic and Organic Cryosol soils. Scattered *Picea mariana*, 4-6 m tall, dominate the tree layer (Table 3). *Ledum groenlandicum* and *L. palustre* have the highest cover in the shrub layer. *Rubus chamaemorus* and *Vaccinium vitis-idaea* are characteristic of the herb-dwarf shrub layer. The ground surface has a hummock and hollow pattern with *Sphagnum* spp. in the hollows and sides of the hummocks, and *Cladina* spp., especially *Cladina mitis* and *C. rangiferina*, on the drier hummock tops. Permafrost often occurs in this type at a depth of 35-45 cm.

This community type is very similar to the Black Spruce/*Sphagnum-Cladonia* type of Viereck (1975) and the open Black Spruce/*Sphagnum* type of Dyrness and Grigal (1979). Moss (1953a) described a somewhat broader "black spruce - peat moss association" from a number of sites in northern Alberta. Reid (1977) described a similar type as widespread in the Cameron Hills of extreme northwestern Alberta and also in the southwestern Northwest Territories. Horton et al. (1979) include this community type in "treed-tundra".

Two stands of this community type were in an area which burned 15 years previously. The regenerating *Picea mariana* are about 2 m tall and of very low cover. *Ledum groenlandicum* dominates the shrub layer. The herb-dwarf shrub layer has a greater species richness than in the unburned stands with species such as *Epilobium angustifolium* and *Rubus strigosus* entering the community following disturbance by fire. *Sphagnum* spp. dominate the bryoid layer as in the unburned stands.

Nearly all the species present in the unburned stands are also present in the burned stands. The main effect of this apparently moderate intensity fire was not the elimination of the entire community. Rather,

the tree canopy was eliminated temporarily, new species entered the community, especially where the peat was burned, and the relative importances of the species were changed. Thus, postfire succession appears to involve re-establishment of a tree canopy, the introduction and later elimination of some species (e.g., *Epilobium angustifolium*), and a general shifting of relative species importances as time since fire increases. Most of the species of this community type appear to remain throughout the successional stages.

Populus tremuloides - Picea glauca Community Type

Populus tremuloides-Picea glauca closed forests, with *Picea mariana* frequently present, occur on the lower to upper slopes around the perimeter of the plateau. Important understory plants include *Elymus innovatus, Epilobium angustifolium, Cornus canadensis, Lycopodium* spp. and *Hylocomium splendens* (Table 3). This community type is similar to the *Viburnum edule/Hylocomium splendens* community type of other highland plateaus in northern Alberta (Achuff and La Roi 1977).

Picea glauca - Betula papyrifera Community Type

This community type occurs within forests of *Populus tremuloides - Picea glauca* or pure *Picea glauca* and is usually 1 ha in size. *Betula papyrifera* may reach heights of 10 m with 25 cm dbh and the one tree that was cored was 57 years old. *Picea glauca* may be quite large, up to 25 m tall and 40-50 cm dbh. *Alnus crispa* is prevalent in the understory. Other important understory plants are *Cornus canadensis, Viburnum edule, Hylocomium splendens, Pleurozium schreberi* and *Ptilium crista-castrensis* (Table 3). Moss (1953a) describes a similar type within his broader "white spruce" association from Lesser Slave Lake in central Alberta. In its mixedwood physiognomy, this community type is similar to the *Viburnum edule/Hylocomium splendens* community type which Achuff and La Roi (1977) described from northern Alberta.

Other Vegetation

There are numerous lakes and ponds in the Caribou Mountains, most of which are fairly shallow and rimmed by peatland. *Carex aquatilis* and *Carex rostrata* are common shoreline species. *Calamagrostis canadensis, Betula glandulosa, Potentilla palustris* and *Chamaedaphne calyculata* are also frequently found along the shoreline. *Potamogeton gramineus* and *Nuphar variegatum* are the most prevalent aquatic species.

Mesophytic shrub transition communities generally occur between the Black Spruce communities and the fens, or they occupy the area between upland sites and more aquatic habitats, such as lakes and streams. Important shrubs are *Salix pedicellaris, S. planifolia*, and *Betula glandulosa. Sphagnum teres, S. warnstorfii, S. squarrosum* and *Aulacomnium palustre* are the major bryophytes. *Rubus chamaemorus* and *Calamagrostic neglecta* frequently occur. (Table 2).

Flora

The vascular flora of the Caribou Mountains presently consists of 48 families comprising 107 genera and 195 species. Species-rich families include Cyperaceae with 26 species, Compositae (16), Ericaceae (12), Gramineae (11), Rosaceae (11), Salicaceae (11) and Saxifragaceae (10). Species-rich genera include *Carex* with 21 species, *Salix* (9), *Equisetum* (4), *Potamogeton* (4), *Juncus* (4), *Ribes* (4), *Vaccinium* (4) and *Galium* (4).

The non-vascular flora presently consists of 109 species of which there are 21 lichens, 84 bryophytes and 4 hepatics. Species rich genera include *Sphagnum* with 15 species, *Cladonia* (9), *Dicranum* (7), *Drepanocladus* (4), *Pohlia* (4) and *Polytrichum* (4). Collections to date have only found this number of plant species. In comparison to other similar areas the Caribou Mountains have probably not been well collected (Bird et al. 1977, Bird et al. 1980 and 1981).

Two vascular species collected in the Caribous are not known to occur elsewhere in Alberta. *Boschniakia rossica*, a vascular plant parasitic on the roots of *Alnus crispa* and *Picea* spp. was found on the north slope of the Caribou Mountains (59°33'N, 115'45'W: Lee 1980). It frequently occurs in low and high subarctic regions in western North America, especially Alaska (Scoggan 1979). *Pinguicula villosa* occurs mainly in high arctic and both high and low subarctic regions (Scoggan 1979). In the Caribou Mountains it was found growing in *Sphagnum warnstorfii* on the sides of a degrading peat plateau in the flark of a patterned fen at about 59°29'N and 115°47'W.

Pedicularis sudetica was growing in a rich fen located at about 59°29'N and 115°47'W. It and two bryophyte species collected - *Pohlia bulbifera* and *Polytrichum gracile* have been reported only in one other location each in Alberta. (A list of the flora is available at a nominal charge, from the Depository of Unpublished Data, CISTI, National Research Council of Canada, Ottawa, Canada K1A 0S2).

Ecological Classification

Rowe (1972) classified the Caribou Mountains as an outlier of the Lower Foothills (B19a) Section of the Boreal Forest Region. This was presumably based largely on the occurrence of *Pinus contorta* (Moss 1953a, Raup 1935) and Raup's comment that the Caribou Mountains are "an outlier of northern Rocky Mountain or foothill forest" (Raup 1946).

However, while the Caribou Mountains do contain

Pinus contorta, the area differs from the rest of the Lower Foothills Section, including outliers such as Swan Hills, in several significant ways. The overall vegetation composition is different in that *Picea mariana* is the predominant tree and *Picea mariana* forests are the most prevalent vegetation type. *Pinus contorta* usually occurs in mixed forests with *Picea mariana*, a situation quite different from the rest of the Lower Foothills. The general landscape pattern, with much of the area occupied by peatland with discontinuous permafrost and the presence of peat plateaus also differentiates the area. The absence of *Abies balsamea* and the presence of plants such as *Boschniakia rossica, Pedicularis sudetica* and *Pinguicula villosa* indicate affinities with more northern areas. The presence of birds such as Red-throated Loon, Gray-cheeked Thrush and Northern Phalarope and the absence of other birds typical of the Lower Foothills (e.g. Marsh Hawk, Black Capped Chickadee, Common Flicker) (Hohn and Burns 1975, 1976; Hohn and Marklevitz 1974; Hohn and Mussel 1980) further distinguish the Caribou Mountains from other portions of the Lower Foothills and indicate more northern affinities.

In view of these differences the Caribou Mountains are better classified as Subarctic or, in Rowe's (1972) classification, as an outlier of the Northern Transition (B27) Section. Preliminary information indicates that the Cameron Hills in northwestern Alberta also should be included with the Caribou Mountains as Subarctic or Northwest Transition (Achuff and Wallis 1977).

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