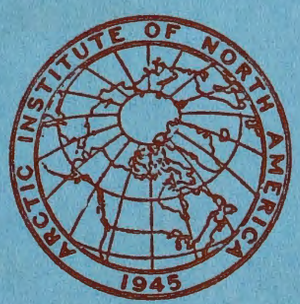
ARCTIC INSTITUTE OF NORTH AMERICA

TECHNICAL PAPER NO. 9

A GEOBOTANICAL SURVEY OF NORTHERN MANITOBA

By

J. C. RITCHIE



PUBLISHED MARCH 1962

William Barr

THE ARCTIC INSTITUTE OF NORTH AMERICA

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A GEOBOTANICAL SURVEY OF NORTHERN MANITOBA[1]

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Introduction

Geobotanical investigation has proceeded, generally, from the descriptive stage which sets out the basic data of vegetation and flora, to the search for those causal factors which facilitate interpretation and explanation. The first step is the recognition and description of a regional pattern of vegetation and flora, following which the full exploration of historical, ecological, and dynamic aspects is possible. For example, the appearance of Tansley's conspectus of British vegetation (1939) marked the culmination of a phase of descriptive study and made possible a balanced enquiry into particular problems of vegetation succession, ecology, and history. Similarly, the compilation of geographical inventories of the British flora (Matthews, 1937) and the accumulation of accurate species distribution maps (Walters, 1954) have provided part of the factual background for such interpretive treatments of fossil data as that of Godwin (1956).

For reasons of geography and history, geobotany in North America has not achieved fully this desideratum, and while there are available general accounts of vegetation and flora of large regions, the treatment, especially of vegetation, varies widely across the continent. In northern Canada particularly there are big areas where the vegetation, and to a lesser extent the flora are known in only the most superficial detail. In fact the most accurate sources of information on regional vegetation in many parts of Canada are not primarily botanical studies. The general account of forests by Rowe (1959) and the useful survey of vegetation by Munroe (1956) are perhaps the most comprehensive available. Also, it is widely recognized that the observations of such early Canadian explorers as Bell, Low, and Tyrrell still contain the only information on natural vegetation and flora in some areas.

Thus the present work is based on the notion that until a comprehensive, balanced account of the vegetation and flora of northern Canada is available, progress will be hampered in such fields of enquiry as the history of vegetation and flora (especially late-Pleistocene) and the ecology of vegetation in all its aspects. The aim has been to depict with as much accuracy as possible the spatial arrangements of the vegetational and floristic units of one area. The present account, the final in this descriptive series, attempts this by a detailed, uniformly compiled map of the vegetation of northern Manitoba, together with a summary of the main features of the floristic geography. Only field studies can establish accurately the information needed for maps of species distribution,

[1]A report submitted to the Arctic Institute of North America on investigations supported by a grant from the Banting Fund in 1960.

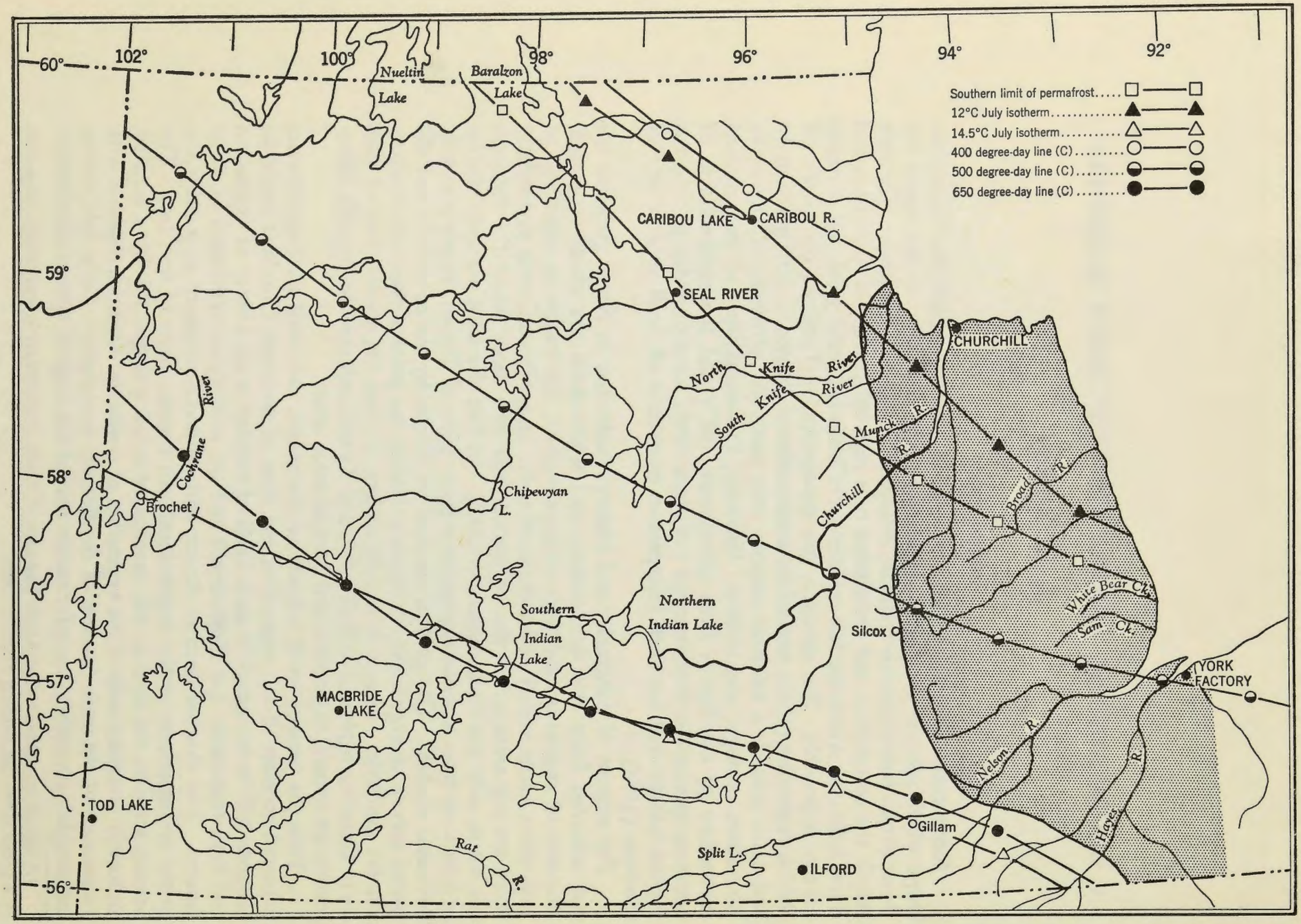

Fig. 1. The study area. The centres of intensive study are given in capitals. The line between the unshaded and faintly shaded areas separates approximately the Precambrian Shield physiographic region from the Hudson Bay Lowlands (the latter shaded).

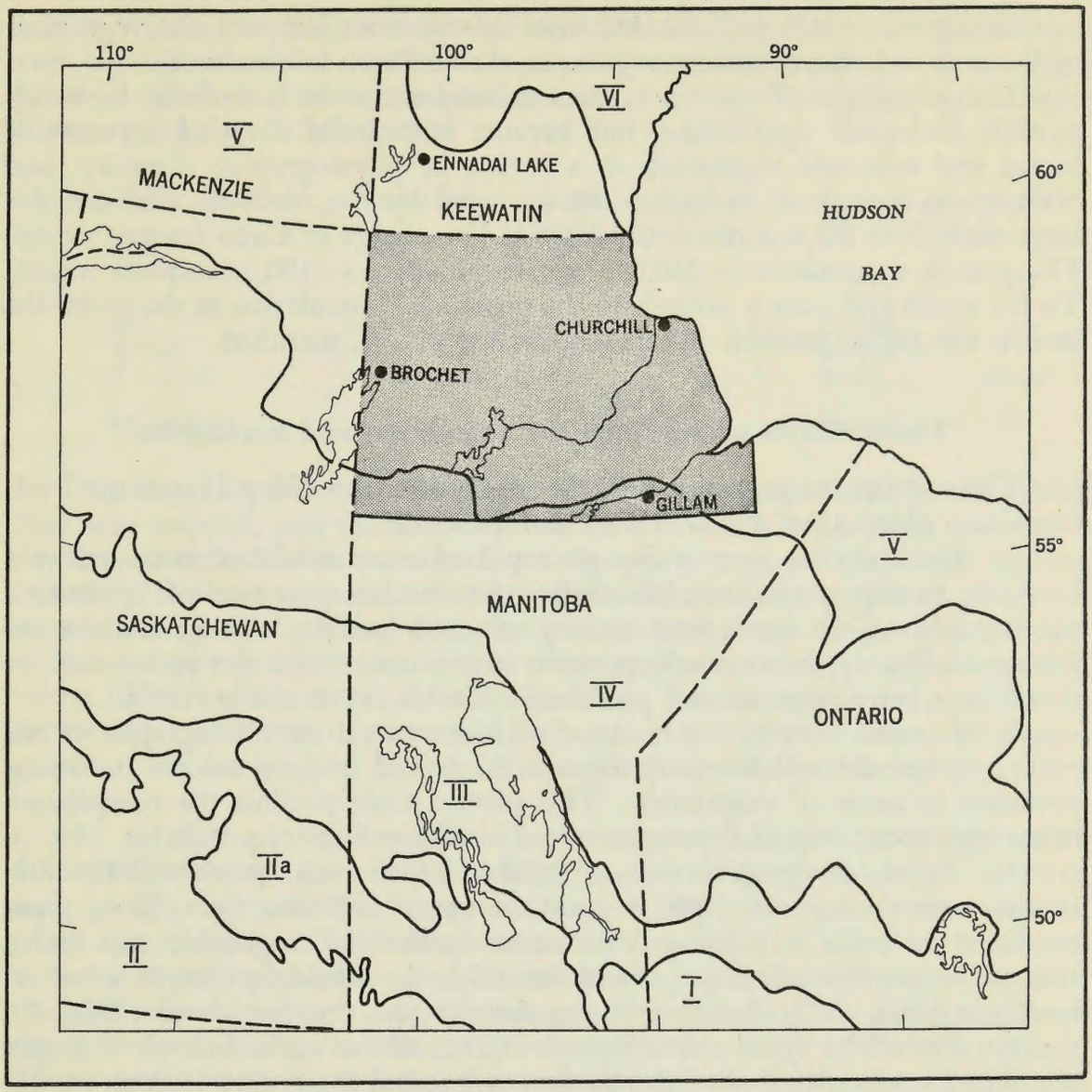

Fig. 2. The general position of the study area (faintly shaded) in relation to the main vegetation regions (modified version of Rowe, 1959). I, The Great Lakes-St. Lawrence; II, Grasslands; IIa, Aspen Parkland; III, Mixed Forest; IV, Northern Coniferous Forest; V, Northern Transition; VI, Tundra. The positions of the meteorological stations: Churchill, Brochet, Gillam, and Ennadai Lake are also shown.

but the use of aerial photography has made possible rapid progress in compiling precise vegetation maps of large, relatively inaccessible areas. An excellent example of such work is the photo-reconnaissance survey of Labrador-Ungava by Hare (1959), and the present mapping work owes much to the contribution of Hare and his colleagues for methods and procedures. The facts presented here complete the work of an extensive kind, and any future investigations will almost certainly deal with more specific problems. Descriptive accounts of the plant communities of particular localities have been published and the present paper adds nothing to these. Rather it is designed to provide in the form of a map an objective assessment of the distribution of the vegetation. The text is little more than the comments necessary for full understanding.

By way of setting out the broad features of the physical environment, some attention is paid to the climate and the landforms of the region. In the

concluding comments are included brief comparisons between the vegetation of the area and that of similar regions in the northern hemisphere.

The study area (Fig. 1) was chosen, not because its boundaries have any possible biological significance, but because it includes a varied segment of boreal and subarctic vegetation in a region of physiographic diversity, and occupies an area small enough to be surveyed by the methods used and yet large enough to fill in a perceptible gap in knowledge of Canadian geobotany. The area is approximately 260,000 square kilometres (100,000 square miles). To the north and west it extends to the provincial boundaries; in the south the limit is the 56°N. parallel, and in the east the 92°W. meridian.

The methods of mapping the vegetation and landforms

The steps in the preparation of the vegetation map (Map 2) and the landform map (Map 1) of the area were as follows:

1. Field studies over a five-year period were made at seven selected localities, to secure adequate information for the interpretation of vertical air photographs of the immediate vicinity of each locality. These stations are shown on Fig. 1. For some, vegetation maps at various scales and in various detail have been prepared and published (Ritchie, 1958, 1960a, 1960b).

2. A rapid survey was made of all the vertical air photographs of the region to test the adequacy of the control gained in local studies for interpretation in terms of vegetation. This survey made possible the compilation of a rough zonal map of the vegetation of northern Manitoba (Ritchie, 1960c).

3. Types of vegetation were established which could be identified readily on the vertical air photographs without the use of a stereoscope. These types are listed in Table 1, together with notes on their photographic appearance and physiographic affinities. Simultaneously, the establishment of a set of landform types, easily identified on the photographs, was completed (Table 2).

4. Both these types were mapped on each of the vertical air photographs required for complete non-stereoscopic coverage of the region—approximately 4,500 photographs. Apart from the coastal area near Churchill, between the 58th and 59th lines of latitude and east of the 96th line of longitude, the photographs used were at about a scale of 1:60,000. The Churchill area has been photographed at about 1:35,000. For convenience, the area of 1:60,000 cover was divided into 68 equal sections, each 30 minutes of latitude wide and one degree of longitude in depth (that is, about 3,300 sq. km.). The Churchill area was divided into 5 approximately equal sections, each about 4,000 sq. km. The 60 (approximately) photographs required for each section could be set out as a temporary mosaic on a convenient working surface, after their bottom and right-hand margins had been trimmed off. Thus a general scrutiny of the range of vegetation and landform types present was possible. Then the photographs of each flight-line were mapped consecutively, using a soft black wax-graphite pencil.[1] On the photographs, no category was outlined whose greatest linear dimension was less than 2.5 cm. Each outlined area was given a designation for vegetation and for landform, according to the letters and numbers in Tables 1 and 2. Thus vegetation and landforms were mapped simultaneously.

[1]Swan-Stabilo No. 8046, which has the advantages that it provides a clear black line which can be erased and leaves no mark on the photographs.

In many areas, the smallest mappable unit (about 1.5 sq. km.) shows more than one vegetation and/or landform type. A system of designations was used based on visual estimates of the relative areas occupied. The following examples illustrate the use of this system.

Example of designation	*Approximate % area occupied by categories*			*Approximate % area occupied by*	
	6	*5*	*7*	*d'*	*p*
6d'	90–100	–	–	90–100	–
6(5)d'	60–90	10–40	–	90–100	–
6–5 d'–p	40–60	40–60	–	40–60	40–60
		total			
6(5–7)d'	60–90	10–40		90–100	–

In general it was found that greater detail of vegetation could be recognized than was mapped, and the above system of combining types is an attempt to derive as much data as possible from the photographs. There are regions, especially in the southeastern section of the area, where complexes of several communities prevail, making difficult the decision as to the designation. Before the final mapping was begun, several photographs were mapped and empirical values of cover percentage were determined. In this way it was possible to improve the accuracy of the visual estimates. A section of about 60 photographs could be mapped completely (vegetation and landforms) in about 4 hours.

5. After mapping, the outlined areas and designations were transferred to 1:506,880 base maps on which had been located the positions of the centre of each photograph. A "Seelyscope" (Spears, 1949) instrument was used to effect the transfer. This instrument makes it possible to view the base map with the superimposed image of one air photograph, reduced to the scale of the base map. In most cases, the topographical detail of the 1:506,880 sheets could be used to align as accurately as possible the image of the photograph. This method involves a margin of error, since it includes the distortion of the photographs and any inaccuracies of the Topographical Sheets.

By this procedure, the preliminary vegetation-landform maps were compiled at the 1:506,880 scale, and are reproduced here on a scale of 1:1M as Maps 1 and 2.

The accuracy of the maps depends upon the validity of the system of grouping and recognizing landforms and vegetation on photographs. All the interpretation and mapping was done by the writer, and it is likely that the vegetation mapping is less inaccurate than that of landforms. However, it was decided to include landforms since the existing maps of physiography for the area ('Economic Atlas of Manitoba', 1960; 'Atlas of Canada', 1958) show only the broadest separations. While there are errors of detail in Map 1, the regional divisions which can be made from it (Fig. 4) will probably retain validity. The landforms are separated solely on the grounds of their distinctness on vertical air photographs, and in this some attempt is made to follow the system of Hare (1959), which deliberately avoids considerations of genesis. Likewise, with one or two noted exceptions, the categories of vegetation are distinguished only on the basis of their photographic appearance—based on physiognomy—and considerations of status and ecology are disregarded.

Table 1. A summary of the photographic, physiographic, and structural characteristics of the vegetation cover types shown in Map 2

Cover type	*Symbol*	*Photographic appearance*	*Physiographic affinities*	*Community structure*
Heath	1	Flat, featureless, smooth texture; light gray to gray	Common on the upper slopes and summits of drift ridges, eskers, drumlins, and bedrock in the north. Occasionally on deep northern peats with permafrost	Treeless vegetation, dominated by microphanerophytes, especially ericoid and ericaceous shrubs
Lichen heath	1[1]	Flat, smooth, often with polygonal patterns; white to light gray with patches of gray	Appears to be confined to deep peat mantles with permafrost in the northeast. Well developed in the northern region of the Lowlands	Identical with 1, with in addition a conspicuous element of fruticose lichens
Sedge meadow	3	Flat, featureless; white to light gray	Common on wet coastal flats and occasionally inland in the northeast on shallow poorly drained peat	Along the coasts this is a salt marsh vegetation dominated by sedges and grasses. Inland on wet peat, sedges and *Scirpus* prevail
Shrub and scrub forest	5	Smooth and featureless, or locally with coarse dark dots on a flat background. Dark gray or gray	Found in all topographic positions, as a stable type in the northeast, along rivers and coastal flats; a seral type on upland sites elsewhere	Communities of shrubs or stunted trees or young trees between 1 and 3 metres tall. Willows and dwarf birch on fens; willow on alluvium; small tree birch and conifers with willows, alder, and dwarf birch on uplands
Open spruce forest with lichen-shrub	6	A coarse pattern of dark dots (trees) on a smooth, light gray background	Common on well-drained ridges in all subarctic parts of the Shield except the northeast corner; also on the Hudson Bay Lowlands where it occupies deep peats	An open stand of poorly grown, often "candelabrum" black spruce in the lowlands and northern parts of the forested Shield region; better growth elsewhere on the Shield; on drift plains and drumlins black spruce is prevalent; on eskers and sand plains white spruce. Dwarf birch, prostrate willows, ericoid shrubs, and fruticose lichens dominate ground vegetation
Open spruce forest with moss-shrub	7	A coarse pattern of dark dots (trees) on a smooth gray background	Always in low-lying areas with impeded drainage and peat accumulation	An open (variable) stand of black spruce with a ground cover of shrubs (willow, dwarf birch, *Ledum*, *Vaccinium uliginosum*) and hummock-forming mosses (*Sphagnum*, *Aulacomnium*). This is moss muskeg, as described in Ritchie (1960c)

Table 1. (*continued*)

Cover type	*Symbol*	*Photographic appearance*	*Physiographic affinities*	*Community structure*
Closed spruce forest (*Picea mariana*)	8	Continuous fine to medium stippling; dark gray to gray. Individual trees often visible	Mainly on mid-slope and summits of glacial ridges, especially patternless drift. Common only in the southeast	A continuous cover of spruce with a well-developed ground cover of mosses (*Pleurozium*, *Hylocomium*, *Ptilium*), poor in herbs and shrubs
Closed spruce forest (*Picea glauca*)	9	Indistinguishable from 8 by photographic characteristics alone	Confined to recent alluvium; the only mapped areas are near the coast where large stands occur on river deposits (elsewhere stands are fragmentary)	A continuous cover of spruce with a ground cover of shrubs (prostrate willows and ericoid shrubs) a few herbs and a well-developed *Hylocomium* moss layer
Mixed closed conifer and broad-leaved forests	10	Usually a pattern of fine to coarse stippling interrupted by diffuse light patches. The former are dark gray or black, the latter light gray	Occuring on drift ridges as large mappable tracts in the southeast; fragmentary patches, seldom mappable, occur on alluvial deposits	The type includes a variety of communities; most commonly the conifer component is black spruce, associated with white birch and aspen poplar. Jackpine occurs frequently. In lowland sites white spruce occurs
Closed broad-leaved forest	11	Smooth surface with diffuse pattern. Gray with light gray spots	Rarely occurs in mappable stands. Chiefly found in the southwest region where it occupies drift ridges	The dominants are either white birch or aspen poplar
Closed pine forest	12	Finely stippled surface, gray to dark gray tone. Tree outline diffuse	Occurs throughout the closed forest region of the Shield, where it develops chiefly on sand plains and eskers	A continuous cover of jackpine with a sparse ground cover of prostrate ericoids: *Arctostaphylos*, *Vaccinium vitis-idaea*, and lichens
Open pine forest	13	As above with a coarser pattern and usually a light gray to white background	Characteristic of ridges of outcropping bedrock throughout the closed forest region of the Shield	An open discontinuous canopy of jackpine with sparse ground vegetation on outcrop surfaces
Larch forest	14	Diffuse tree cover forming a faint stippling on a light gray background. Not always readily distinguished on photographic characteristics alone	Continuous stands confined to flat poorly drained areas with peat. Best development in the southern parts of the Hudson Bay Lowlands; rare elsewhere	Usually a larch fen community with an open stand of stunted larch associated with dwarf birch, willow, and rich herb and moss layers

Table 2. Landform types shown in Map 1

	Landform and Symbol	*Features*
I.	Terrain with bedrock-controlled relief	
	Outcropping bedrock (r)	Angular ridges and cliffs with evident structure, jointing, faulting, etc. Outcrops prevalent
	Bedrock-controlled with extensive drift mantle (d)	Areas of strong relief, often rolling, with the drainage patterns and ridge orientation indicating bedrock control. Outcrops common
II.	Terrain controlled by glacial drift	
	Patternless drift plains (d′)	Areas of moderately undulating relief with neither glacial nor bedrock pattern
	Drumlinized drift plains (f)	Areas of orientated ridges; the ridges are oval or tapered in outline, with their axes in parallel
	Hummocky disintegration moraine (d″)	Areas of rolling terrain with numerous rounded depressions and somewhat irregular ridges and mounds
	Ribbed minor moraines (m)	Areas of numerous sinuous, roughly parallel ridges, often with one side steeper than the other. Their long axes trend at right angles to the directions of adjacent eskers and drumlin fields
	Major moraines (t)	Large tracts of terrain with strong relief, forming ridges with an undulating or pitted surface; patternless
	Eskers and sand plains (e)	Ridges or plains of sand and gravel, locally with dunes. The ridges are steep-sided, sinuous, and long
III.	Terrain with neither glacial nor bedrock control	
	Recent alluvium (a)	Flat terrain associated with rivers (islands, deltas, flats)
	Raised beaches, spits, and bars (b) (inland and coastal)	Rounded ridges, often crescentic with parallel ridges. Other features are sometimes combined here; for example in the north eskers which have been re-worked by marine inundation
	Marine clay flats (c)	Flat, lacking relief; locally ponded and with dendritic drainage; distinguished by the prevalence of open and closed meadow vegetation with local shrubs
	Continuous peat mantles (o, p, p′)	Flat, lacking relief, with immature drainage patterns and a well-developed vegetation cover. Distinguished into deep (p) and shallow (o) peats by the nature of the vegetation cover; deep peats with surface polygonal patterns are separated (p′)

Climate

In the last two years two atlases have appeared ('Atlas of Canada', 'Economic Atlas of Manitoba'), where generalized information on regional climate can be found and the monograph by Kendrew and Currie (1955) provides more detailed consideration. This account presents no new data, but stresses certain aspects of climate which might be important in vegetation ecology. Three stations recording meteorological data lie within the study area, at Brochet, Gillam, and Churchill; a fourth lies just outside the area, at Ennadai Lake in Keewatin (Fig. 2). As it happens, these stations are fairly evenly spaced across the study area, and they probably give a representative picture of the prevailing climate.

Based in part on the system of Walter and Lieth (1960), climate diagrams for these four stations have been prepared (Fig. 3). They show the yearly cycle of mean monthly temperatures and precipitation for the station, as well as indicating the periods when the mean temperature is always less than 0°C and when only the absolute minimum falls below 0°C. In Table 3, further

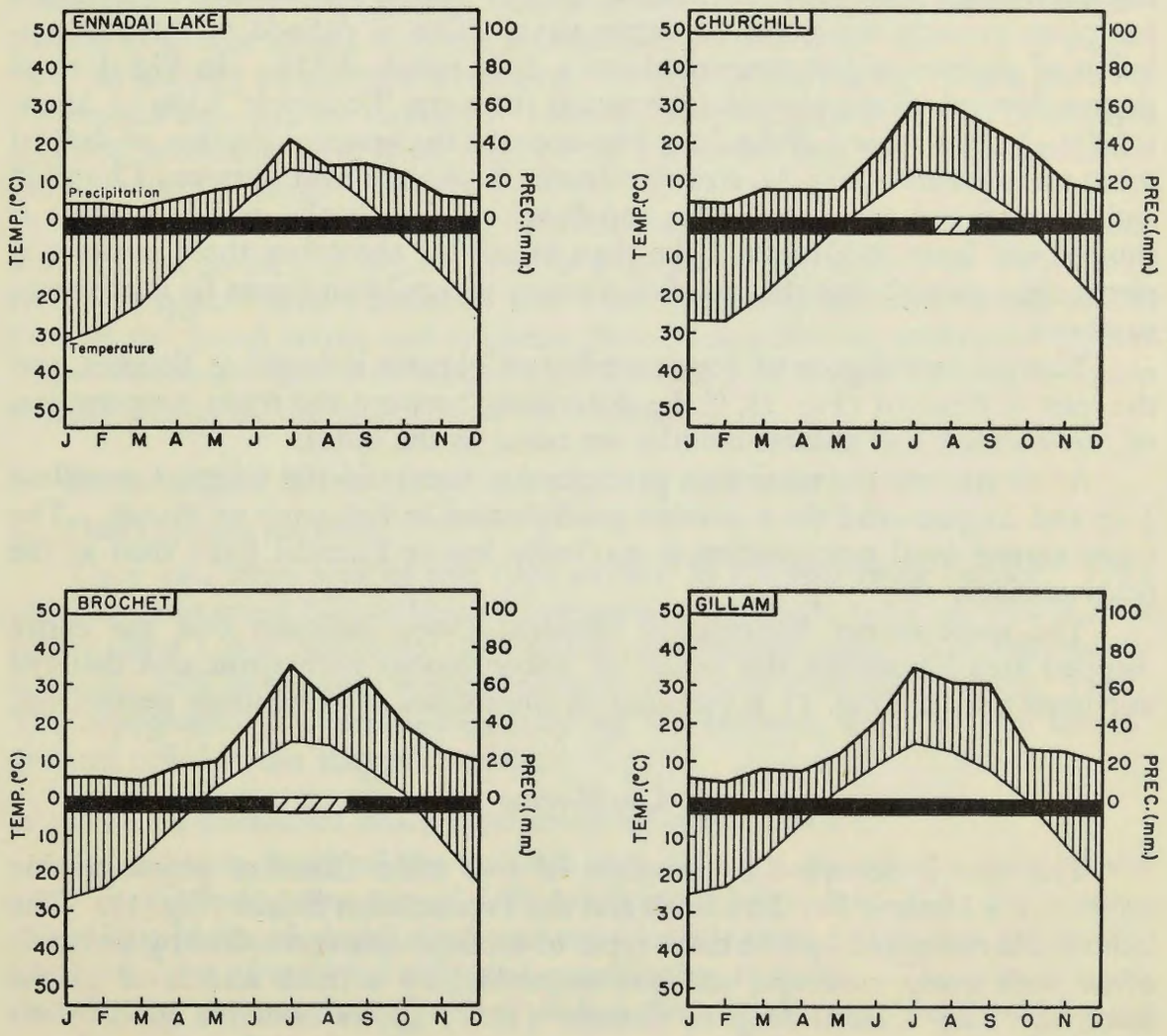

Fig. 3. Climate diagrams of the four meteorological stations in the region. The black band indicates months when the mean minimum temperature is always less than 0°C, and the diagonal hatching months when only the absolute minimum is below 0°C.

Table 3. Climatic data (all temperatures in ° Centigrade)

Station and altitude	*Ennadai* (319 m.)	*Churchill* (33 m.)	*Gillam* (136 m.)	*Brochet* (345 m.)
Period for which records are available	1949–59	1932–59	1943–59	1948–59
Annual average daily temperature	−9.3°	−4.7°	−4.9°	−7.4°
Mean annual total precipitation	217 mm.	353 mm.	400 mm.	389 mm.
Mean minimum of coldest month	−29.3°	−27°	−24.4°	−33°
Mean range of temperature	20.2°	21°	25°	29.3°

data are provided, and Fig. 1 includes certain temperature information, referred to below.

In considerations of thermal conditions in relation to plants it is useful, and has become customary, to calculate for any station the effective temperature for plant growth, expressed as degree-days. This is defined as the accumulation of degrees of temperature above a daily mean of 5°C. In Fig. 1 these degree-day values are plotted (abstracted from the 'Economic Atlas of Manitoba'). In this regard, and taking into account the seasonal rhythm of diurnal mean temperatures (Fig. 3), strong climatic similarities exist between Churchill and Ennadai and between Gillam and Brochet. While the growing season is shorter and later at Ennadai Lake than at any of the other three stations, it seems clear enough that the zones of summer thermal conditions lie northwest–southeast.

The greatest degree of continentality of climate is found at Brochet, and the least at Ennadai (Fig. 3), if the differences between the mean temperatures of the warmest and coldest months are taken as the index.

At all stations the maximum precipitation occurs in the warmest months—July and August—and the minimum precipitation in February or March. The mean annual total precipitation is markedly less at Ennadai Lake than at the other stations.

The most recent information (Brown, 1960) indicates that the entire mapped area lies within the region of discontinuous permafrost and that the northeast corner (Fig. 1) is included in the region of continuous permafrost.

Landforms

The area is occupied by portions of two main Canadian physiographic regions—the Hudson Bay Lowlands and the Precambrian Shield (Fig. 1). The latter is characterized by two main types of surface—one controlled by bedrock, often with many outcrops, and one controlled by a thick mantle of glacial material. The 'Glacial Map of Canada' (1958) shows tentative subdivisions of the Shield region in these terms, and the data offered in Map 1 extend this. The Hudson Bay Lowlands have been described in physiographic terms by Coombs (1954). This is an area underlain by horizontally bedded Ordovician

and Silurian limestone, with thick mantles of glacial and marine clays. The latter have resulted from a period of postglacial submergence (Lee, 1959). The poor relief and extensive areas of heavy clay result in immature drainage patterns and vast tracts of wet land occupied by various peat-forming vegetation types.

The landform information in this report is offered solely to augment the available data on the physical setting of the vegetation and flora. There is an acute need for detailed studies of the surficial geology of the area, and only when such work has been completed will a balanced and reliable account of landforms be available. The present division of the area into landform regions (Fig. 4) is valid neither from the point of view of geomorphology nor glacial geology. The zonal map has been derived from the detailed map (Map 1), the categories of which were devised primarily for convenience.

The papers of Gravenor *et al.* (1960), Hare (1959), and Powers (1951) were helpful in the recognition of landform types on air photographs, although they were used mainly to confirm or adjust after interpretation. Useful information, much of which corroborates Map 1, was found in the published accounts of Milligan (1960), Russell (1953), Taylor (1958), and Tyrrell (1897) and in Maps 10 (1956), and 2 and 45 (1959) of the Preliminary Map Series of the Geological Survey of Canada. Likewise, the data presented here are compatible to a large extent with the information presented by Lee (1959) on the surficial geology of adjacent Keewatin. In spite of the fair agreement between the present data and the findings of professional geologists, it should be stressed that the landforms have been mapped by a botanist and are considered from the botanist's point of view.

If reference is made to Fig. 4, it will be seen that the area has been divided into regions, in each of which there is a rough preponderance of a particular landform type. Map 1 indicates that there is actually much variation within each of the broad zones, and in places their boundaries are arbitrarily chosen. The divisions are used here because they provide a workable framework within which to describe the information on landforms.

I. Precambrian Shield

a. *Outcropping bedrock*

Only one large area of this type occurs, in the southwest corner. Here there are numerous high ridges of outcropping bedrock, with occasional fault ridges rising 150 m. above the level of the surrounding lakes. The thin mantle of glacial drift in this area is predominantly of sandy material (Milligan, 1960). The topography is controlled entirely by the bedrock, and this area has the greatest relief in the mapped region.

b. *Bedrock-controlled relief with extensive drift mantle*

Immediately north of the bedrock area (Fig. 4), the relief is reduced and there are increasing amounts of drift overlying the bedrock. There are extensive rolling plains of glacial clays, and considerable areas of outwash sands, with scattered areas of rounded ridges of outcropping bedrock. The area is separated on Fig. 4 from the regions of deeper drift to the north and east by the apparent control of the drainage patterns and relief by underlying bedrock. In the southern part, immediately south of Southern Indian Lake, glacial lake deposits are prevalent (Milligan, 1960).

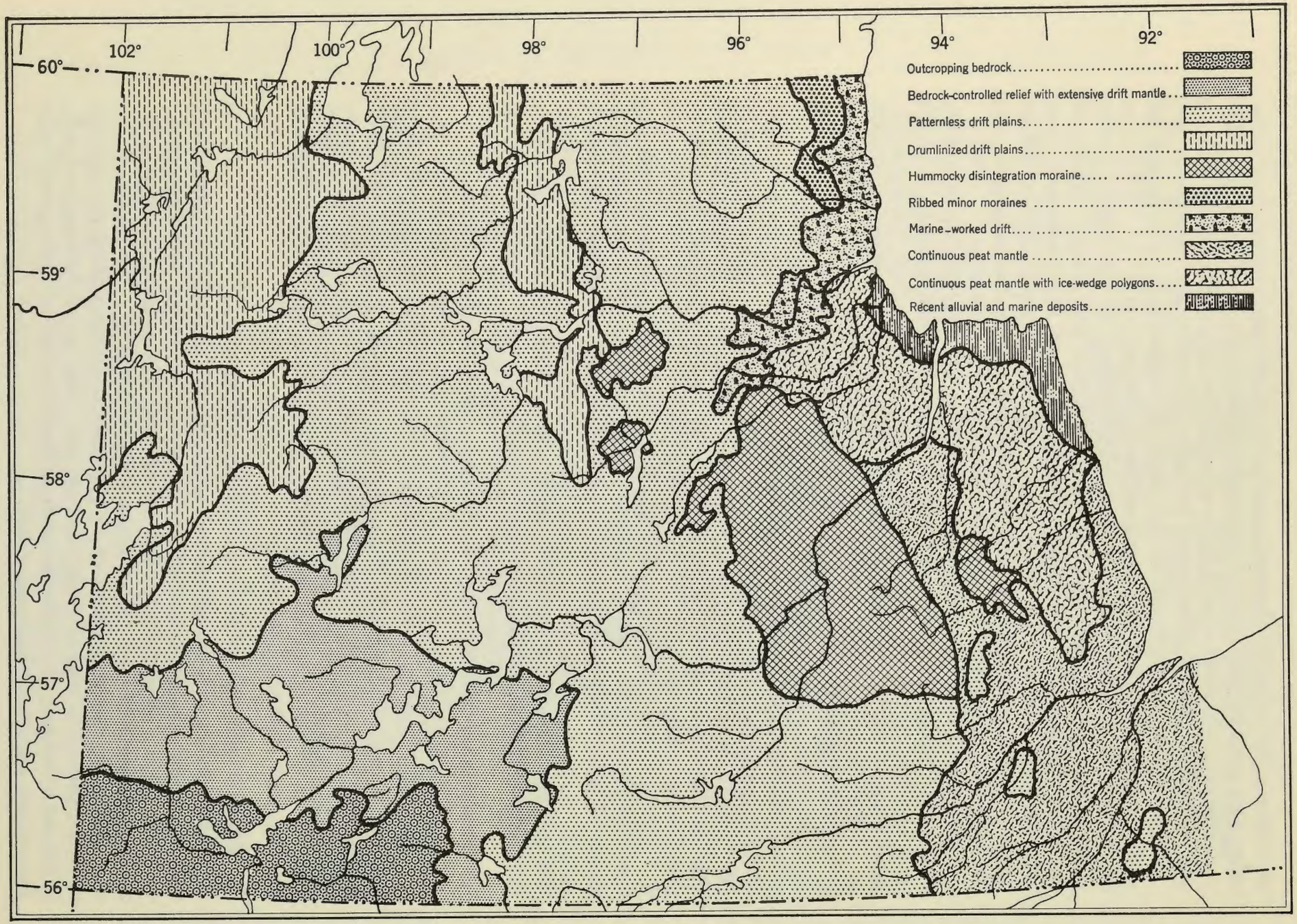

Fig. 4. A general or zonal map of landforms, based on the detail of Map 1.

c. *Patternless drift plains*

The largest portion of the Shield is occupied by thick deposits of glacial drift, overlying and obscuring the bedrock features. The relief is low and rolling with extensive bogs (*sensu stricto*) occupying the poorly drained depressions. In the northern parts of this region there are well-developed esker systems. In the northeast corner a small area has been influenced by postglacial marine submergence (Lee, 1959), and numerous spits and raised beaches were recorded. There is little or no evidence of orientation of the ridges or lakes, either glacially or under the control of bedrock. As Map 1 illustrates, there are small patches of disintegration hummocky moraine, drumlins, outcropping bedrock, and major moraines scattered throughout the area.

d. *Drumlinized drift plains*

This includes all forms of glacially molded drift, and two large regions of this type are recognized in the zonal map (Fig. 4). These occupy the northwest corner of the map area, and a narrow strip in the central northern region running south from just west of Baralzon Lake. In the former, the general direction of trend of the ridges is north–northeast, and in the latter slightly west of north. In these areas there are extensive esker systems, usually trending in the same direction as the drumlin ridges. In the northwest portion, immediately to the west of Nueltin Lake, there are well-developed drumlin fields associated with extensive areas of ribbed minor moraines.

The relief of these areas is moderately good, with extensive elongated bogs and occasionally fens in the depressions between the ridges. The ridges are usually of coarse gravelly material.

Two small fragments of drumlinized till are shown on Map 1, and they are mentioned here although they lie outside the Precambrian physiographic region. One is southeast of Split Lake, where the drumlin trend is east–west, and the other in the southeast corner of the mapped area (at 56°N. and 92°W.) where the trend is approximately north–south.

e. *Hummocky disintegration moraine*

Following Gravenor *et al.* (1960, p. 11), this term "is used to describe knob and kettle topography which was deposited from stagnant ice", and appears to be synonymous with the terms "dead-ice moraine" and "hummocky ground moraine". Its recognition here depended solely upon the hummocky nature of the topography, and took no account of possible origin. One large and several smaller areas of this type have been mapped, none forming extensive continuous patches. The large area abuts directly to the east on the largest inland beach which marks the limit of postglacial marine transgression. Generally the drainage is poor, with many bog and pond-filled kettle depressions, and much of the glacial material is a heavy clay till.

f. *Ribbed minor moraines*

These are found in discrete fields or continuous belts, confined here to two regions—in the northeast corner of the area, and to the immediate west of Nueltin Lake (Map 1). The latter area has not been distinguished on Fig. 4. This type consists of a series of ridges which lie in parallel east–west, or perhaps more accurately, at right angles to the trend of local eskers and drumlins. The ridges are sinuous rather than linear and vary in size. Usually they are about 30 m. high, 100–800 m. long, 70–100 m. in breadth, and separated

from each other by 50–100 m. Both the ridges and the intervening areas are covered with coarse material, and the area shown on Fig. 4 has particularly coarse material from which the fines have been washed by marine inundation.

g. *Major moraines*

These are not mapped in Fig. 4 but appear on Map 1. They are large, prominent ridges of glacial debris, with irregular surface topography, marked by numerous small pond-filled depressions. The largest of these moraines has a northeast arm extending 40 km. from Baldock Lake (56° 30N., 98°W.), a southern arm extending out of the mapped area and terminating just north of the mining town of Thompson, and an arm extending east to Limestone Lake (56° 30N., 96°W.). Smaller ridges are found near Christie Lake (56° 55N., 97°W.), Settee Lake (57° 05N., 96° 55W.), and immediately south of Northern Indian Lake (57° 20N., 97° 20W.). A ridge about 75 km. long, trending north–south, with a small northeast arm, extends from northeast of Etawney Lake (57° 50N., 96° 50W.) to Solmundsson Lake (57° 20N., 96° 50W.). Several large glacial lakes—for example, Limestone Lake and Waskaiowaka Lake (56° 35N., 96° 20W.)—are associated with these major moraines and show the typical moraine-impounded southern shores, with large, regular, and rounded bays.

h. *Marine-worked drift*

A narrow strip, widening to the south, extends from the Keewatin boundary to the vicinity of the North Knife River, and is characterized by thin glacial drift with marine deposits of silt and clay. The west boundary of this zone is abrupt and can be detected readily on air photographs by the marked change in drainage patterns and topography. This zone in Manitoba is continuous with an identical region in Keewatin, described by Lee (1959), and ascribed by him to the deepwater facies of the areas of marine submergence. Relief is low with ridges of coarse bouldery material forming a shallow reworked mantle over the bedrock. The low intervening areas are poorly drained, being occupied by deep clay and silt deposits. Much of the mineral material is obscured by peat deposits which form continuous mantles over large tracts.

II. Hudson Bay Lowlands

Only two large, continuous landform types are outlined in the zonal map (Fig. 4), since the other landform types on the Lowlands are fragmentary and scattered; these others are raised beaches, outcropping bedrock (only at Churchill), alluvial deposits, patternless drift, and those small areas of drumlinized drift referred to above.

a. *Recent alluvial and marine deposits*

In the vicinity of Churchill, extending up the coast of Hudson Bay to the mouth of Knife Rivers and south to about 58°N., a narrow strip of lowland is characterized by extensive clay flats, alluvial deposits, glacio-fluvial deposits, and relatively thin layers of peat.

b. *Continuous peat mantles*

The remaining portion of the Lowlands is occupied by large expanses of peat. The drainage patterns are immature, sometimes hardly existing at all. A northern area of this peat mantle has been separated, both on Map 1 and

Fig. 4, on the basis of the presence of extensive polygonal patterns, easily detected on the air photographs. Ground studies indicate that these are ice-wedge polygons, in the sense of Washburn (1956). Exposures along rivers show that the underlying material is clay, usually marine.

Vegetation

Zonal divisions of the vegetation of a large geographical region can be made in at least two main ways. If it is accepted that climate is the master factor of the regional environment, zones can be defined by the prevalence of particular communities on approximately comparable topographical sites. Such divisions are usually made in terms of the stable vegetation developed on "mesic" sites—a term with no more precise definition than that it includes all sites which lack extremes of either dryness or wetness. This approach tends to disregard the relative amounts of a particular type in any zone, and is concerned primarily with the expression by vegetation of regional climate. The other approach is to designate regions primarily in terms of the prevalent categories of vegetation, whether they be defined in floristic or physiognomic terms. That is, to use an approximately quantitative basis for the subdivisions. The latter approach is used here, mainly because it involves no ecological assumptions.

The subdivisions shown in Fig. 5 have been determined by outlining on a copy of Map 2 (the detailed vegetation map) those areas in which one or more categories are in preponderance. A comparison of Fig. 5 with Map 2 reveals that some of the lines are drawn rather arbitrarily, since there are areas, especially in the southwest, where the vegetation types form a complex mosaic. Eighteen sections have been recognized, of which all but two have different combinations of vegetation types. For convenience, they have been named geographically. There follow below annotations on each section, mainly to indicate the *types* of vegetation prevailing, without giving any detailed descriptions. Occasionally information is included which is not shown on the detailed vegetation map. For example, small stands of deciduous trees, chiefly aspen and white birch (*Populus tremuloides* and *Betula papyrifera*), could be recognized on the photographs, but seldom occurred in sufficient quantity to map at 1:506,880.

Hayes River Section. The dominant cover type is lichen muskeg, distinguished in this investigation as an open stand of *Picea mariana* with the ground cover of pure patches of *Cladonia* (*C. alpestris, C. rangiferina, C. mitis*) and *Ledum groenlandicum.* Wet peat situations are occupied by *Larix* fen[1] and palsa bog. Small areas of alluvium are occupied by closed stands of *Picea glauca,* of *Populus balsamifera,* and of tall shrubs. Recent marine and alluvial flats are covered by salt marsh types.

Gillam Section. There are three cover types found here, occupying large tracts, especially in the region south of the Nelson River. These are moss muskeg,[1] *Larix* fen, and shrub. Much of the last is secondary vegetation of shrubs and young trees developing after forest fire. Occasionally, on the few upland ridges in the section, *Picea mariana, Pinus banksiana,* and *Betula papyrifera* form fragmentary mixed stands, too small to be mapped.

[1]As defined by Ritchie (1960c).

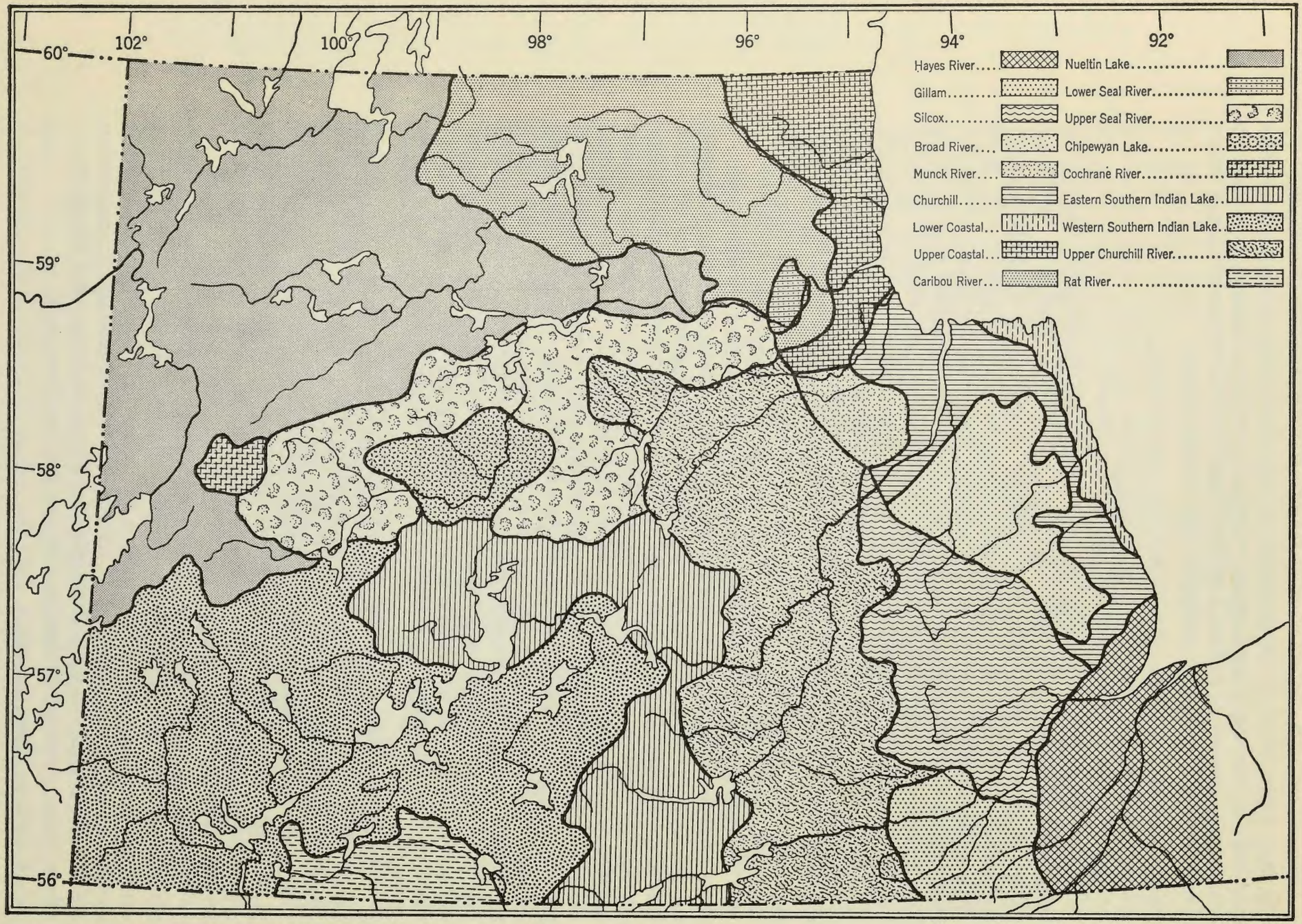

Fig. 5. A zonal map of vegetation, based on the detail of Map 2, showing the vegetation regions described in the text.

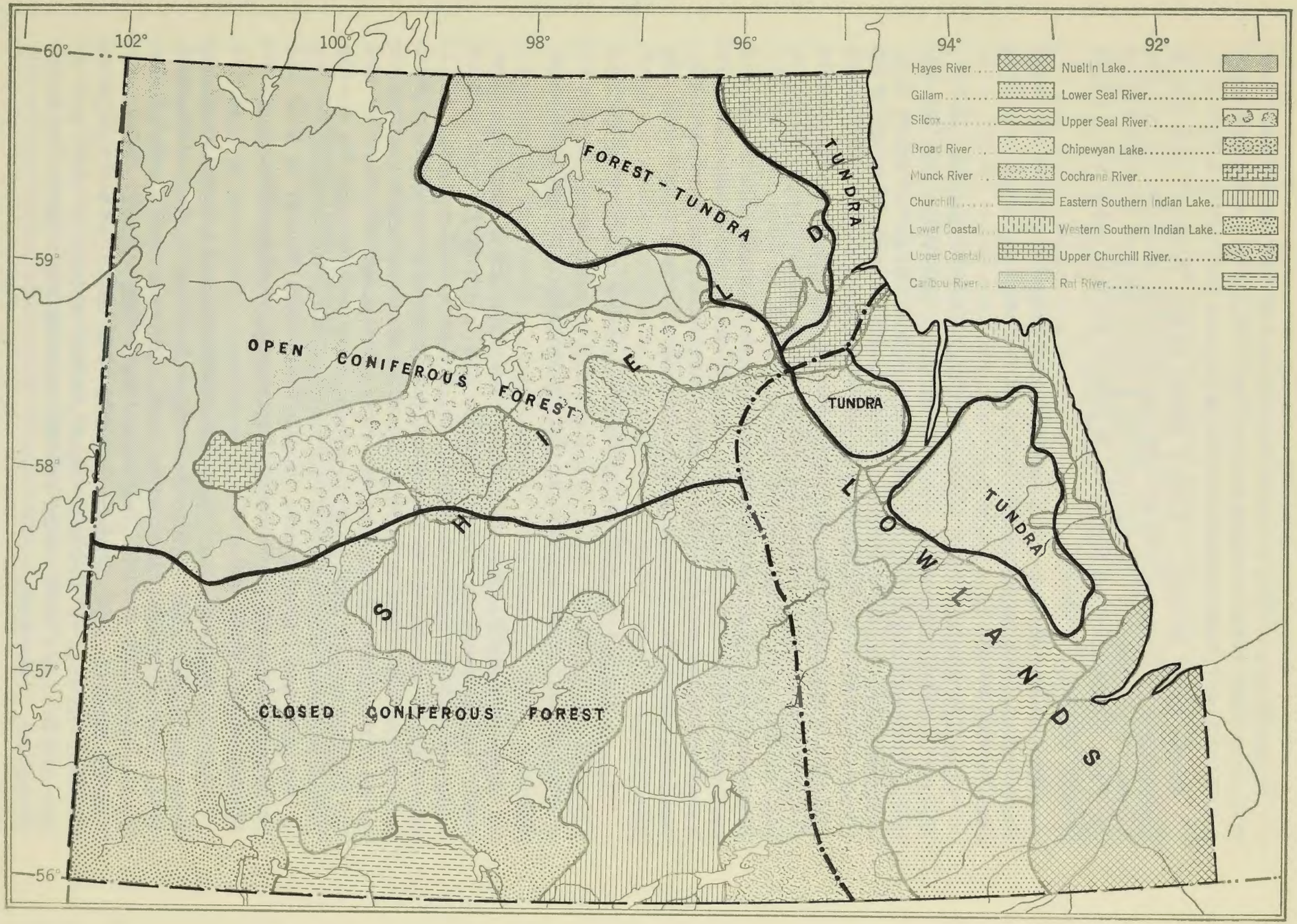

Fig. 6. Generalized scheme of the major vegetation zones and physiographic regions.

Silcox Section. This section is characterized by fairly continuous tracts of either shrubby communities or moss muskeg. Otherwise, only fragmentary patches of closed *Picea mariana* forest, *Larix* fen, and *Pinus* forest are found.

Broad River Section. Known locally as the "barrens", this area is characterized by the prevalence of heath-lichen tundra, developed on extensive continuous peat mantles. Along rivers and drainage channels continuous shrub and *Picea glauca* forest are found. Wet parts of the peat cover bear a *Carex-Eriophorum* bog community.

Munck River Section. The vegetation here is similar to that of the Broad River Section, being separated from it by a narrow neck of forested land along the Churchill River.

Churchill Section. This is one of the most varied zones, comprising a complex of diverse community types. In the south, near White Bear and Sam creeks, there are many large *Larix* fens on wet shallow peat and secondary shrub communities on deeper, drier peats. In the north, near the estuaries of the Churchill and Knife rivers, there are stands of *Picea glauca* on alluvium, associated with broad marsh, shrub, and *Larix* zones on younger sites. Inland, older sites bear peat deposits dominated by lichen muskeg, moss muskeg (both dominated, as always, by *Picea mariana*), and *Larix* fens. A large stand of open *Picea glauca* lichen forest covers a glacio-fluvial deposit called Twin Lake Hill, southwest of Churchill. Fragmentary communities of heath tundra are found on outcrop ridges and dune systems near Churchill, and salt marsh and sedge meadow communities dominate salt- and freshwater situations on recent clay flats.

Lower Coastal Section. This forms a narrow coastal zone between Churchill and latitude 57° 30N. It is dominated by extensive salt marshes and shrub communities, often occupying discrete zones lying parallel to the coastline.

Upper Coastal Section. The chief types of this belt of coastal terrain are tundra and treeless bog. In the northern part, north of 59° 30N., a heath tundra prevails on upland glacial and beach deposits. Along rivers and on recent marine deposits shrub vegetation, and occasionally scrub forest (*Picea mariana* and *Larix laricina*) occur. Local eskers, for example one near the mouth of the Caribou River, bear open *Picea glauca* stands. South of 59° 30N. the drainage is poor with extensive ponded areas over clay and silt deposits. Here a peat mantle bears treeless vegetation—a *Carex-Eriophorum-Scirpus* bog in wet parts and a heath tundra (locally lichen-heath tundra) on drier sites. Scrub forest and shrub vegetation are fragmentary, usually confined to mineral substrata along streams and rivers.

Caribou River Section. The characteristic feature here is a mixture of forest and tundra types. The former occupy slope and bottomland situations. Where peat accumulates the forest is a moss muskeg community. On alluvium there are fragments of *Picea glauca* closed forest (not mapped). The tundra —usually heath tundra—occupies the summits of till, esker, and beach ridges and scattered outcrops of bedrock. Local residual mantles of deep peat are common, bearing a heath tundra on drier situations and a *Carex-Eriophorum-Scirpus* bog in wet areas.

Nueltin Lake Section. The characteristic vegetation on slopes and summits of ridges and rolling till plains is an open spruce forest (*Picea mariana* on till, *P. glauca* on eskers and sand plains) with a ground cover dominated by lichens (chiefly *Cladonia* species), ericoid shrubs, and low shrubs of willow and dwarf birch (*Betula glandulosa*). In situations with heavier textured, often gleyed soils, closed spruce forests occur, with mosses (*Pleurozium, Hylocomium, Dicranum*) replacing the lichen component. In depressions bog vegetation develops, usually of the moss muskeg type. Many areas bear secondary communities developed after fire, but it was not possible to map them all at the 1:506,880 scale as they usually form a complex mosaic. *Pinus banksiana* is the chief tree of these secondary forests, often forming pure stands on better drained sites. Species of *Salix* and *Larix laricina* are often the earliest woody colonizers after fire, even on dry upland sites. The impression has been gained from the air photograph survey of this section that the open conifer-lichen-shrub communities are most prevalent on the better drained sites—the summits of drumlins, till ridges, sand plains, beaches, and eskers. Locally, usually on these apparently drier positions, heath tundra forms a continuous cover.

Lower Seal River Section. This is an island of essentially treeless vegetation, similar in all respects to the southern parts of the Upper Coastal Section.

Upper Seal River Section. This differs from the Nueltin Lake section only in the greater proportion of moss muskeg vegetation. Map 2 shows more or less equal areas of open spruce-lichen forest and moss muskeg. Many upland sites have *Pinus* rather than *Picea,* but it is rarely mapped because these seral stands are either too fragmentary or they cannot be distinguished with certainty on some photographs (usually those of poor quality).

Chipewyan Lake Section. This section is closely related to the previous two, in that the same types of vegetation occur. It has been separated from the others by its greater relative amount of moss muskeg. Only occasional esker, kame, and drift ridge summits bear open spruce lichen forest, but the greatest area is occupied by moss muskeg vegetation. The wettest situations are occupied by shrub vegetation. It has been noted above (section on landforms) that there is evidence that a glacial lake was present in this region, and in fact the limits of this section coincide approximately with the limits of the area with conspicuous beaches.

Cochrane River Section. The vegetation here is similar in all respects to that of the Chipewyan Lake section.

Eastern Southern Indian Lake Section. As Map 2 indicates, the vegetation of this section is represented by a complex mosaic of several types, even more complex than the generalized areas show. The main tree species is *Picea mariana,* and it occurs as the dominant of two main cover types—closed spruce forest and moss muskeg. Continuous secondary stands of tall shrubs are frequent, with a preponderance of species of *Salix* and *Alnus crispa.* Stands of young *Betula papyrifera* occur here as a secondary type, shown in Map 2 as shrub. *Pinus banksiana* is common in older seral communities, often forming pure stands on sand and gravel. Deciduous tree species are common here, although they seldom form large continuous tracts of forest. The main species

are *Betula papyrifera* and *Populus tremuloides*, with *P. balsamifera* in wetter, usually alluvial substrata.

Western Southern Indian Lake Section. Spruce forests form the main cover type of this section, with *Picea mariana* as the chief tree. In poorly drained areas where peat accumulates, the spruce forest is a moss muskeg type, and closed spruce forest occupies upland sites. On the latter sites fire has influenced the vegetation to a marked extent, and many younger seral types occur. Actually, tracts of mature closed spruce forest on moderately drained soils in this section are very rare, and the recent Manitoba Forest Inventory for the area illustrates this, showing an overwhelming preponderance of trees in the 4- to 9-inch (10–23 cm.) trunk diameter class. On well-drained ridges, *Betula papyrifera* and, less commonly, *Populus tremuloides* form local secondary stands. In lowland positions, especially alluvial deposits, *Picea glauca*, *Abies balsamea*, *Populus balsamifera*, and *P. tremuloides* form closed mixed forests. *Picea glauca* occurs also as fragmentary stands on steep, often south-facing slopes—for example, fault ridges, eskers, or moraines. *Pinus banksiana* is the dominant tree of communities developed on outcrop ridges and sand plains, situations where it appears to persist as a stable forest. Elsewhere, on substrata of a heavier texture, there is evidence that it is replaced by *Picea mariana*.

Upper Churchill River Section. The predominant cover type is moss muskeg—an open community of *Picea mariana* on acid peat, with low shrubs and mosses as the main subsidiary layers. The most poorly drained sites are occupied by bogs, rarely fens; upland sites, chiefly ridges of heavy texture glacial material, have pure black spruce cover in the absence of disturbance and mixed forest of *Pinus banksiana*, *Betula papyrifera*, and *Populus tremuloides* in situations with a recent fire history. Continuous shrub vegetation is common on recently burned areas and along watercourses.

Rat River Section. The main characteristic of this last section is the increasing participation of *Betula papyrifera* and *Populus tremuloides* in the secondary forest vegetation. On substrata of a heavy texture—glacial and lacustrine clays—older stands show a mixture of *Picea mariana*, *Populus tremuloides*, and *Betula papyrifera*, and only rarely are the forests mature enough to show the gradual replacement of the deciduous trees by a pure stand of *Picea mariana*. On outcrop ridges, which are very common in the western part of this section, and on sand and gravel deposits, *Pinus banksiana* forms continuous open and closed stands. Poorly drained areas, more common in the eastern than in the western part of the section, are occupied by moss muskeg. Alluvial deposits usually bear a mixed forest of *Picea glauca*, *Abies balsamea*, *Populus balsamifera*, and *P. tremuloides*.

General and comparative comments on the vegetation

It remains only to provide a general schematic summary of the findings on vegetation, to suggest briefly the ecological relationships which might prevail, and to mention other areas of the northern hemisphere where similar phenomena of vegetation chorology have been described.

A generalized scheme of vegetation zones is shown in Fig. 6. These zones have been described and distinguished elsewhere (Ritchie, 1960c) and the

present treatment merely adjusts the boundaries in the light of more accurate information. The primary divisions are related to the two major physiographic regions, with a third zone of a transitional nature. This decision is based on the opinion that zonal types can be compared more effectively within an area of general physiographic uniformity than one which includes two or more major physiographic regions. On the Precambrian Shield a zonal division is made into four broad types: tundra, forest-tundra, open coniferous forest, and closed coniferous forest. The Precambrian Shield vegetation region is distinguished from the Lowlands vegetation region by the prevalence of bog or fen communities in the latter. Within the Lowlands, the zonal divisions are physiognomic. The alternative approach might as readily be used, and the first divisions made in terms of physiognomy, regardless of physiographic region. And it would be of great interest to be able to assess accurately the nature of the stable vegetation developed on equivalent sites throughout the whole area, regardless of physiographic regions. In this way one might be able to delineate major zones within which certain types of vegetation develop, presumably as the expression of particular climatic regimes. At present there is not enough information to do this for the study area.

On the basis of the vegetation map, landform map, and climatic data, it is suggested that the two main environmental factors governing the vegetation chorology are climate and topography. With regard to the former, one can establish (Fig. 5) on the Precambrian Shield region zonal categories whose boundaries are aligned roughly in parallel with such climatic factors as length of growing season and the mean daily temperature of the warmest month. Within each there is great variation in vegetation, apparently controlled by the influence of historical factors (largely unexplored), disturbance by fire, and local topography. On the Hudson Bay Lowlands on the other hand, the chief factor governing the nature of the vegetation appears to be topography, or more particularly drainage pattern, while climate, disturbance, and history are important as secondary, local factors.

However, in many areas it seems that the influence of one factor has been masked by that of others. It is not clear at present whether the open coniferous (spruce) forest zone is primarily a climatic type or whether its preponderance in an area is related to an abundance of well-drained, coarse mineral substrata. Elsewhere in northwestern Canada, Raup (1946) has suggested the latter correlation and Sochava (1956) makes a similar comment regarding the open lichen forests of Finno-Karelian S.S.R. and the Russian Plain. Also, there are parts of the Caribou River Section where it is evident that tundra vegetation is secondary, the result of fire. In the Churchill Section it is likely that the regional climate is favourable enough for fair tree growth, but the generally poorly drained substrata of the area seldom bear tree growth of more than stunted stature. Also, the prevalence of treeless vegetation on the peat substrata of the Broad River section might well be related to the presence of continuous permafrost (mapped in Fig. 1, after Brown, 1960). However, these are speculative comments, and it is clear that ecological (*sensu stricto*) investigations are needed.

The presence of apparently relict stands of mixed aspen and white spruce forest in the forest-tundra zone (Ritchie, 1960a), and the widespread occurrence in the subarctic zone of residual mantles of raised-bog peat, suggest that the

postglacial climate has varied and might have altered the disposition of vegetation boundaries. Such changes are reported elsewhere in the northern hemisphere (for example, Tikhomirov, 1941; Marr, 1948; and Griggs, 1946) and future studies of micro- and macro-fossils, bog stratigraphy, and surficial geology should elucidate these problems and indicate the extent and nature of historical changes in the present vegetation and flora.

One field of enquiry requiring careful study concerns the relationships between vegetation and Barren Ground Caribou. Some authors (Ahti, 1959; Hustich, 1951; Hanson *et al.*, 1958); have indicated the importance of open lichen forest as winter range for this mammal. The present study suggests that there are two main regions in northern Manitoba where such vegetation is found in large quantities—in the Nueltin Lake Section and the Hayes River Section (Fig. 5). Fire has removed the lichen carpet from places in both sections, but to a much greater extent in the former (Ritchie, 1959). There is an open field of research here, which might ultimately lead to some basis for management. As the extensive studies of a closely similar problem in the Soviet Union have shown (Andreev, 1954), detailed knowledge of all aspects of vegetation is required.

The task of comparing the vegetation of northern Manitoba with that of other parts of the northern hemisphere is hampered by the great variation in the amount of information available from different parts. At present only the broad zonations are compared, rather than the details of community structure and composition.

In the Old World, the area most closely resembling the present area in vegetation is that portion of the Soviet Union which lies between the Urals and Finno-Karelia. Here, between the latitudes of 60° and 67° N., the vegetation cover has been mapped (Lavrenko and Sochava, 1954) and described in a convenient summary form (Sochava, 1956). Three main zones or regions are described and mapped which resemble closely the zones described here for the Precambrian Shield portion of northern Manitoba. Further, it appears that this part of northwest Eurasia shows closer similarity with regard to climate and landforms than any other large area of the northern hemisphere (Berg, 1947). Sochava (1956) designates the three zones as: I. "Subarctic sparsely treed Siberian spruce vegetation, in combination with tundra and bogs (forest-tundra)", II. "European northern boreal spruce forests, locally combined with birch forests and sphagnum bogs", and III. "The European Middle Boreal Spruce Forests locally combined with birch-aspen forests, sphagnum bogs and meadows". West of Finno-Karelian S.S.R. in northern Finland and Scandinavia, spruce is replaced by birch (*Betula tortuosa*) in the forest-tundra zone, and east of the Yenisey River the spruce forest-tundra communities disappear altogether being replaced by *Larix sibirica* and *L. dahurica.* Sochava (1956) writes (p. 153) "The humid, relatively temperate (maritime type) climatic regime of more western areas of the European forest-tundra, as well as the abruptly continental climatic conditions of the Eastern Siberian forest-tundras, are not favourable to spruce. In the first place birch replaces it, in the second—larch".

Sochava (1956) describes typical Siberian spruce (*Picea sibirica*) forest-tundra as an open community of sparsely grown trees, 4 to 6 metres in height, ranging up to 7 to 10 metres. In composition and structure of the ground

cover, these communities are very similar to Manitoba types. In some cases the same species are involved, in others closely related, often vicarious taxa.

"The European Northern Boreal Spruce forests are distributed in the Russion plain mainly to the north of the 64th line of latitude . . . . in the herb-shrub layer, even on relatively well-drained soils outside the groups of Sphagnum-spruce, is found a series of plants characteristic of bogs in the south (*Empetrum nigrum, Ledum palustre, Vaccinium uliginosum, Rubus chamaemorus*, and others). In the cover are found, rarely, tundra plants (for example *Loiseleuria procumbens, Phyllodoce caerulea* and others). The more or less general characteristic of all northern boreal spruce forests is the reported participation of tree birch and in other areas pine". "The spruce forests with lichen cover, if not included in the subarctic sparsely wooded vegetation, are related only to the northern boreal forests. A large part of the northern spruce forests belong to the green-moss and sphagnum groups of association. After felling or fire in the northern boreal forests the position of birch is often strengthened and there spring up secondary northern boreal birch forests . . ." These direct translations from Sochava (1956, p. 151) are quoted in full because they would apply, with very few minor changes to the comparable zones of Manitoba vegetation. The northern European spruce forest zone is divided into an eastern section with *Picea excelsa* and a western with *P. obovata.* Sochava (1956) suggests a correlation in this zone between the open spruce-lichen-shrub forests and coarse, sandy, and gravelly substrata.

In the European Middle Boreal Spruce Forest, the same author describes features of structure and composition which bear close resemblance to the vegetation found in southwestern parts of our area. The characteristic association—the "green-moss group, in the cover of which there are few species of shrub and herb", has *Pleurozium schreberi* and *Hylocomium proliferum* as ground-cover dominants.

To a lesser extent perhaps, there are resemblances between the vegetation of parts of the Hudson Bay Lowlands and that large area of western Siberia lying between the Urals and the Yenisey River—the Siberian Lowlands—where bog vegetation, both treeless and with forest, prevails.

Farther east, in Siberia, mountain massifs and an increasingly continental climate are probably responsible for the contrasts in broad zonal patterns with our area, although similar communities, floristically and structurally, prevail, but with altered chorological relationships.

In Finland and northern Scandinavia (Kujala, 1952) resemblances at zonal levels are less clear. The mountainous topography, complex oceanic climatic regimes, and disturbance by man have produced a less simple zonation. Also the place of *Picea* in subarctic forest-tundra communities is taken by *Betula tortuosa.* However, many individual plant communities in the two regions are similar in all respects.

In North America, the zonal sequence of tundra, forest-tundra, open coniferous forest, and closed coniferous forest extends across the Labrador-Ungava Peninsula (Hare, 1959), and from the western shores of Hudson Bay to the northwest corner of the District of Mackenzie, Northwest Territories (Rowe, 1959). The pattern is not maintained in Alaska and the Yukon (Sigafoos, 1958) where it is obscured by mountainous topography and bears closer resemblances in broad zonation to adjacent portions of eastern Siberia (Lavrenko and

Sochava, 1956). The pattern is also interrupted in northern Ontario where the marine deposits of the Hudson Bay Lowlands and the lacustrine deposits of the Clay Belt region bear extensive areas of fen, bog, and *Picea mariana* forests (Baldwin, 1958; Hustich, 1957; Rowe, 1959; Sjörs, 1958). The vegetation of the Hudson Bay Lowlands in Manitoba to the south of the Nelson River appears to be very similar to that of the Lowlands in Ontario, but north of the Nelson River a more truly subarctic regime is expressed by a preponderance of treeless vegetation on deep peats with ice-wedge polygons, especially in the Broad River and Munck River sections (Map 2 and Fig. 5). Likewise, there are similarities of vegetation structure and composition between the Lowlands in Manitoba and those lowland areas in Alaska for which Drury (1956) has provided descriptions.

In Labrador-Ungava, the open forests have both a more continuous and a more luxuriant lichen mat than in the study area (Hare, 1959; Hustich, 1949; Rousseau, 1952). Presumably this is related to the greater summer precipitation of the eastern region ('Atlas of Canada', 1959), both as it restricts forest fires and stimulates lichen growth. Also, local over-grazing of lichen mats by Barren Ground Caribou in northern Manitoba (Ritchie, 1959) might be involved in this difference. On the Precambrian Shield areas, the structure and composition of the vegetation are otherwise very similar.

To the northwest of the study area vegetation zones are not well established and much survey work is required before a comparison can be made, although several valuable and detailed investigations have been published for specific localities (in particular those of Porsild, 1951 and Raup, 1934, 1935, 1946, 1947).

Floristic geography

This section summarizes the present knowledge of the vascular plant flora of the region. The information is presented in tabular form. In Table 5 the species which have been recorded have been listed, and some information appended about their general and local distribution. Four categories of information are offered as follows:

1. The general extent in the northern hemisphere. There are three types here: *circumpolar species,* whose areas are more or less continuous in the northern hemisphere, including those species represented in parts of the range by subspecies; *American species,* whose areas are confined to North America and Greenland; and *amphi-Atlantic* species, in the sense of Hultén (1958).

2. The general area in relation to latitude. There are four main categories, with several combinations:

a) *Arctic species*: species confined to the arctic region, in the strict sense of Polunin (1959, p. vi).

b) *Subarctic species*: species whose areas are centred about the northern limit of forested vegetation, extending for short distances (about 100 km.) into the arctic and the forested areas.

c) *Boreal species*: species whose areas are centred about the coniferous forest belt. Unquestionably, some species fit rather unconformably in this category. Many have their southern limits far to the south of this belt, and in

some cases a rigid distinction between boreal and boreal-temperate is not possible. However, those species included have their main areas in approximate coincidence with this belt.

d) *Temperate species*: species whose areas are confined to regions of grassland and broad-leaved forest.

In many cases species areas straddle two or more zones and combinations of these terms are necessary.

3. The known distribution in Manitoba in relation to subarctic, boreal, and temperate belts. This information has been abstracted from the distribution maps (dot type) which are maintained at the Herbarium of the University of Manitoba (records which were started in 1952 by Dr. Doris Löve, now at the Institute of Botany, University of Montreal). Only records for which there are voucher specimens are included. In some cases records from the 'Flora of Manitoba' (Scoggan, 1957) are included to supplement the information. The three zones are shown in Figs. 7a and 7b; they are defined as follows:

a) *Subarctic*: that area of Manitoba characterized by a climate whose growing season does not exceed 650 degree-days C and whose mean July temperature does not exceed 14°C; and by a vegetation which is primarily an open coniferous forest or a mixture of forest and tundra.

b) *Boreal*: characterized by a climate whose growing season is between 1,200 and 650 degree-days C and whose mean July temperature lies between 14°C and 20°C; and by a vegetation of closed coniferous forests or mixed coniferous-broad-leaved forests.

c) *Temperate*: those regions of the province with growing seasons exceeding 1,200 degree-days C and a mean July temperature greater than 20°C; and with either an exclusively broad-leaved forest, or with grassland.

This is an attempt, which applies only to Manitoba at present, to give some precision to those three terms. Further, it restores the term "boreal", which has disappeared from several recent Canadian treatments of floristic areas (Scoggan, 1957; Baldwin, 1958) which stretch the meaning of "subarctic" to include all regions between the arctic tundra and the temperate broad-leaved forests.

4. The distribution in Manitoba in relation to the two physiographic regions: the Hudson Bay Lowlands and the Precambrian Shield. Here it is indicated whether a species occurs on both the Lowlands and Shield, or on one or other of them. The data were taken from the Manitoba distribution maps.

The list includes recent additions to the flora of the area, either those by Schofield (1958) or by the present author (specimens in the Herbarium of the University of Manitoba). Eight examples of the main types of Manitoba distribution are given in Figs. 7a and 7b. However, it is clear that many more records are needed before any floristic patterns can be established with certainty.

The information for categories 1 and 2 was taken from the following sources: Hultén (1958), Polunin (1959), Porsild (1957), and Raup (1947 and 1959). In general the nomenclature of Scoggan's 'Flora of Manitoba' (1957) is followed, or is given in parentheses after a synonym.

The floristic data are summarized in Table 4. It is evident that any interpretive treatment would be premature. The factual basis for such discussions is either the circumstantial evidence of a thoroughly investigated flora, or the

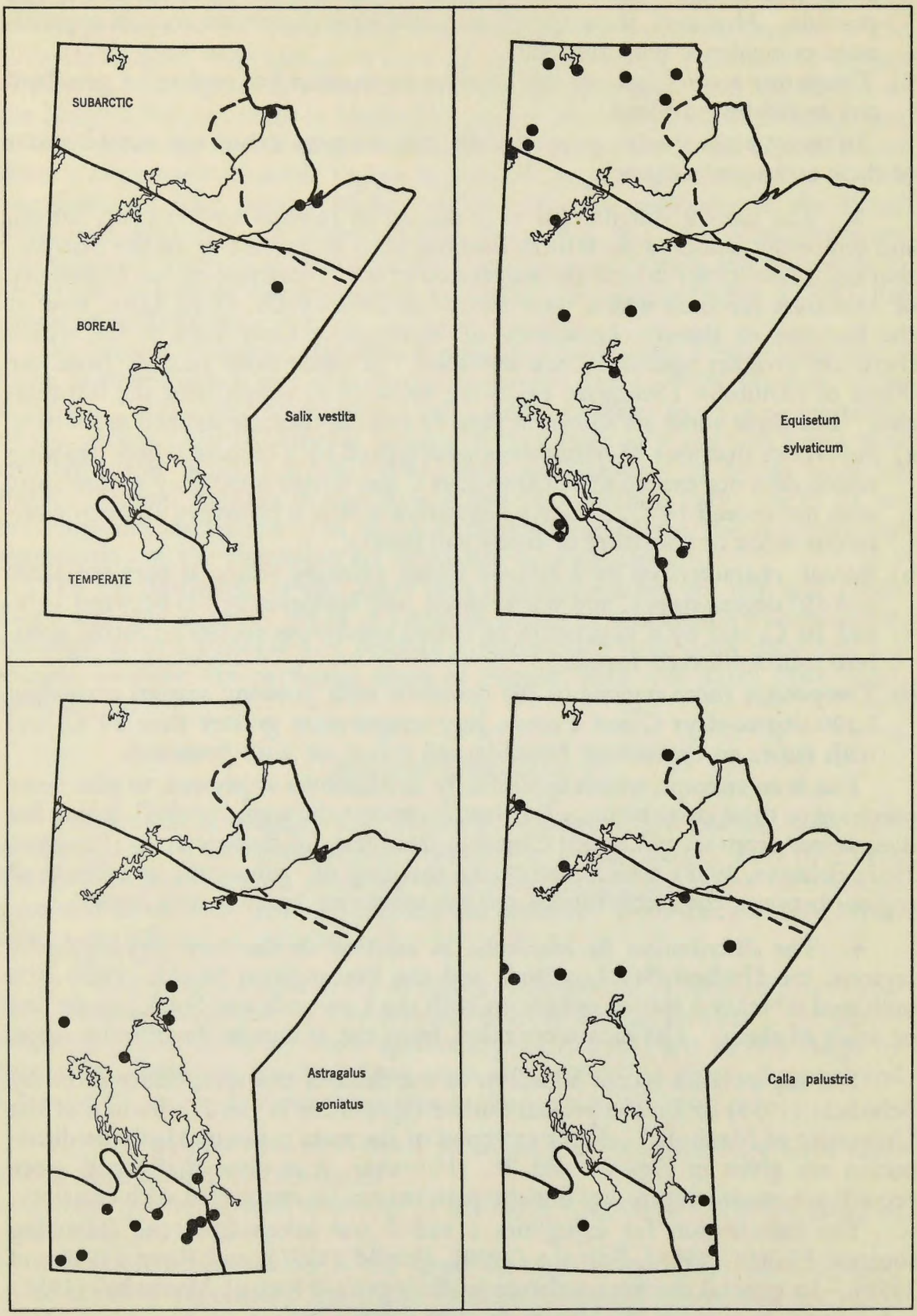

Fig. 7a. Distribution maps of four species illustrating types of occurrence in Manitoba. The discontinuous line delimits the Hudson Bay Lowlands (east) from the Shield. The continuous lines mark the southern limit of the subarctic and the southern limit of the boreal area as defined on p. 29.

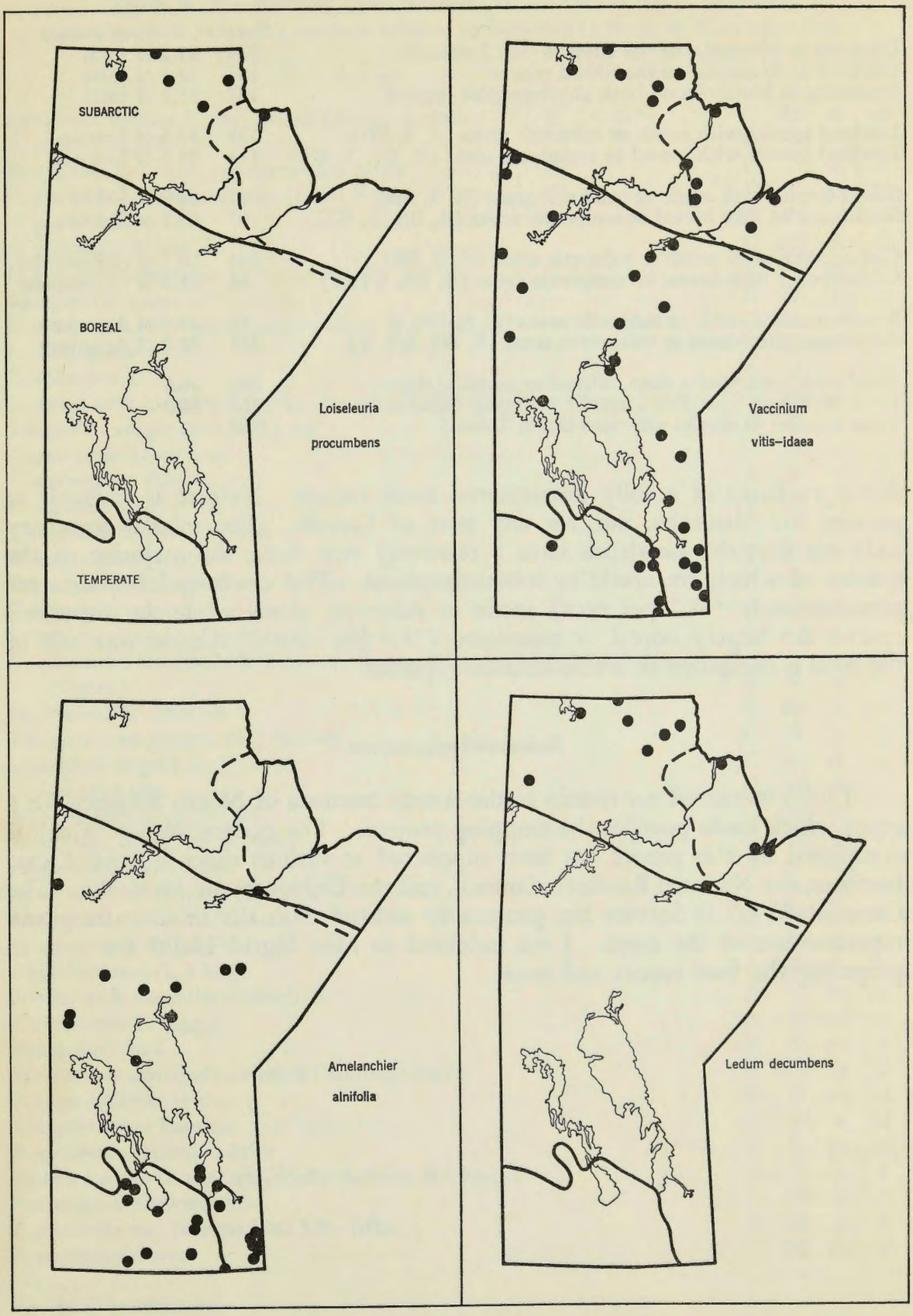

Fig. 7b. Distribution maps of four species illustrating types of occurrence in Manitoba. The discontinuous line delimits the Hudson Bay Lowlands (east) from the Shield. The continuous lines mark the southern limit of the subarctic and the southern limit of the boreal area as defined on p. 29.

Table 4. A summary of the floristic data

	Totals	*% of species*
Confined in Manitoba to the Hudson Bay Lowlands	239	41.2 of total
Confined in Manitoba to the Shield region	134	23.1 of total
Occurring in Manitoba on both physiographic regions	207	35.7 of total
Lowland species with arctic or subarctic areas (A, S, SB)	128	53.6 of Lowland
Lowland species with boreal or temperate areas (B, BS, T, BT)	111	46.4 of Lowland
Shield species with arctic or subarctic areas (A, S, SB)	47	34.9 of Shield
Shield species with boreal or temperate areas (B, BS, T, BT)	87	65.1 of Shield
Circumpolar, with arctic or subarctic areas (A, S, SB)	184	68.7 of circumpolar
Circumpolar, with boreal or temperate areas (B, BS, BT, T)	84	31.3 of circumpolar
American, with arctic or subarctic areas (A, S, SB)	81	26.0 of American
American, with boreal or temperate areas (B, BS, BT, T)	231	74.0 of American
Total with circumpolar distr., including amphi-Atlantic	268	46.0
Total with American distr., usually including Greenland	312	54.0
Total number of species and varieties in Table 5	580	

direct evidence of a fully documented fossil record. Neither is available at present for Manitoba, nor for any part of Canada. The tabular summary indicates that the Lowlands have a relatively rich flora, the majority of the species of which are arctic or subarctic plants. The circumpolar species are predominantly (68.7 per cent) arctic or subarctic plants while the American species are largely boreal or temperate (74.0 per cent). Almost one-half of the total is composed of arctic-subarctic species.

Acknowledgments

I wish to record my thanks to the Arctic Institute of North America for a grant which made possible the mapping project. The general survey which is completed by this report has been supported at various times by the Arctic Institute, the National Research Council, and the University of Manitoba. The Canadian Wildlife Service has generously assisted with the final drafting and reproduction of the maps. I am indebted to Miss Sigrid Lichti for help in preparing the final report and maps.

Table 5. The vascular plants recorded for the area of study, indicating their general range (1), range in relation to latitude (2), range in Manitoba (3,4)

Species	*1*	*2*	*3*	*4*
Equisetum arvense L. var. *boreale* (Bong.) Ledeb.	C	AB	sb	cl
E. pratense Ehrh.	C	B	s–t	c
E. sylvaticum L. var. *pauciramosum* Milde	C	B	sb	c
E. fluviatile L. f. *linnaeanum* (Döll) Broun	C	B	sb	cl
E. palustre L.	C	BS	sb	cl
E. scirpoides Michx.	C	AB	sb	cl
E. variegatum Schleich.	C	AB	sb	cl
Lycopodium selago L.	C	AS	s	c
L. clavatum L. var. *monostachyon* Grev. & Hook.	C	SB	s	c
L. complanatum L.	C	BS	sb	c
L. obscurum L.	A	B	sb	c
L. annotinum L. (including var. *pungens* (LaPylaie) Desv.)	C	SB	sb	c
Selaginella selaginoides (L.) Link	C	S	s	l
Isoëtes echinospora Dur.	C	AS	s	c
I. macrospora Dur.	A	B	s	c
I. muricata Dur.	A	BS	sb	c
Botrychium lunaria (L.) Sw.	C	S	sb	c
B. virginianum (L.) Sw.	C	B	b	cl
Cryptogramma crispa (L.) R.Br. var. *acrostichoides* (R.Br.) Clarke	A	B	sb	c
Polypodium virginianum L.	A	B	sb	c
Dryopteris disjuncta (Ledeb.) C. V. Mort.	C	AS	sb	c
D. robertiana (Hoffm.) Christens. (*Gymnocarpium robertianum* (Hoffm.) Newm.)	C	S	b	c
D. fragrans (L.) Schott	C	SB	s	c
Thelypteris phegopteris (L.) Slosson	C	B	b	c
Cystopteris fragilis (L.) Bernh.	C	AB	sb	c
C. dickieana Sim.	C	AB	sb	c
Woodsia ilvensis (L.) R.Br.	C	SB	sb	c
W. alpina (Bolton) S. F. Gray	C	AS	b	c
Pinus banksiana Lamb.	A	B	sb	c
Larix laricina (DuRoi) K. Koch	A	B	sb	cl
Picea glauca (Moench) Voss	A	B	sb	cl
P. mariana (Mill.) BSP.	A	B	sb	cl
Abies balsamea (L.) Mill.	A	B	b	c
Juniperus horizontalis Moench	A	B	bt	c
J. communis L. (agg.)	A	B	s–t	cl
Typha latifolia L.	A	B	s–t	c
Sparganium multipedunculatum (Morong) Rydb.	A	SB	sb	cl
S. angustifolium Michx.	M	B	s–t	cl
S. hyperboreum Laestad.	C	S	s	cl
S. minimum (Hartm.) Fries	C	S	sb	cl
Zostera marina L. var. *stenophylla* Aschers. & Graebn.	A	A	s	l
Potamogeton filiformis Pers.	C	SB	s	l
P. filiformis var. *borealis* (Raf.) St. John	A	SB	s	l
P. vaginatus Turcz.	C	BS	sb	cl

Key to abbreviations:
Column 1: C = circumpolar, A = American, M = amphi-Atlantic
Column 2: A = arctic, S = subarctic, B = boreal, T = temperate
Column 3: s = subarctic, b = boreal, t = temperate (all in Manitoba)
Column 4: c = on the Precambrian Shield, l = on the Hudson Bay Lowlands (in Manitoba)

Table 5 — continued

Species	*1*	*2*	*3*	*4*
Potamogeton friesii Rupr.	C	S	b	c
P. strictifolius Benn. var. *rutiloides* Fern.	A	S	sb	l
P. pusillus L.	C	B	b	c
P. alpinus Balbis var. *tenuifolius* (Raf.) Ogden	C	S	sb	cl
P. gramineus L.	C	SB	sb	c
P. richardsonii (Benn.) Rydb.	A	SB	s–t	cl
Triglochin maritima L.	C	SB	s–t	cl
T. palustris L.	C	SB	s–t	cl
Scheuchzeria palustris L. var. *americana* Fern.	A	B	b	c
Sagittaria cuneata Sheldon	A	BT	sb	cl
Elodea canadensis Michx.	A	BT	bt	c
Bromus ciliatus L.	C	B	s–t	cl
B. pumpellianus Scribn.	A	AS	s–t	cl
Schizachne purpurascens (Torr.) Swallen	C	BT	bt	c
Festuca rubra L. (including var. *arenaria* (Osbeck) Fries)	C	AS	sb	cl
F. brachyphylla Schultes	C	A	s	cl
Puccinellia phryganodes (Trin.) Scribn. & Merr.	C	A	s	l
P. vaginata (Lange) Fern. & Weath.	A	A	s	l
P. vaginata var. *paradoxa* Sørensen	A	A	s	l
P. langeana Th. Sør.	C	A	s	l
P. nuttalliana (Schultes) Hitchc.	A	BT	s–t	cl
P. lucida Fern. & Weath.	A	S	s	l
Glyceria borealis (Nash) Batchelder	A	B	sb	c
G. striata (Lam.) Hitchc.	A	B	sb	cl
G. grandis Wats.	A	B	sb	cl
Poa pratensis L.	C	A–T	s–t	cl
P. alpigena (Fries) Lindm. f.	C	A	sb	cl
P. arctica R. Br.	C	A	s	cl
P. palustris L.	C	SB	sb	c
P. nemoralis L.	C	BT	s–t	cl
P. alpina L.	C	A	sb	cl
P. glauca Vahl	C	AB	sb	c
Arctophila fulva (Trin.) Rupr.	C	A	s	cl
Dupontia fisheri R. Br.	C	A	s	l
Catabrosa aquatica (L.) Beauv.	C	B	s	l
Roegneria pauciflora (Schw.) Hyl. (*Agropyron trachycaulum* (Link) Malte)	A	S	sb	cl
R. violacea (Hornem.) Meld.	A	S	s	cl
Agropyron trachycaulon (Link) Malte var. *glaucum* (Pease & Moore) Malte	A	T	s–t	cl
Hordeum jubatum L.	A	B	s–t	cl
Elymus arenarius L. ssp. *mollis* (Trin.) Hult.	A	A	s	l
E. innovatus Beal	A	SB	sb	cl
E. macounii Vasey	A	SB	s–t	c
Koeleria cristata (L.) Pers.	C	BT	s–t	l
Sphenopholis intermedia Rydb.	A	T	b	lc
Trisetum spicatum (L.) Richter	C	A–T	sb	lc
Deschampsia atropurpurea (Wahl.) Scheele	C	S	s	c
D. caespitosa (L.) Beauv.	C	S	sb	cl
Oryzopsis pungens (Torr.) Hitchc.	A	B	sb	c
O. asperifolia Michx.	A	T	bt	c
Alopecurus alpinus L.	C	A	s	l
A. aequalis Sobol.	C	S	sb	cl
Agrostis scabra Willd.	A	B	sb	cl

Table 5 — continued

Species	*1*	*2*	*3*	*4*
Agrostis borealis Hartm.	C	S	s	c
Calamagrostis deschampsioides Trin.	C	S	s	l
C. purpurascens R. Br.	A	AS	s	c
C. canadensis (Michx.) Nutt. aggr.	C	AB	sb	cl
C. inexpansa Gray var. *brevior* (Vasey) Stebbins	A	BS	sb	cl
C. neglecta (Ehrh.) Gaertn., Mey. & Scherb.	C	AS	sb	cl
C. lapponica (Wahl.) Hartm. var. *nearctica* Porsild	A	S	s	c
Arctagrostis latifolia (R. Br.) Griseb.	C	A	s	l
Beckmannia syzigachne (Steud.) Fern.	A	BT	s–t	l
Hierochloë alpina (Sw.) R. & S.	C	A	s	c
H. pauciflora R. Br.	C	A	s	l
H. odorata (L.) Beauv.	C	S	s–t	cl
Eleocharis pauciflora (Lightf.) Link	C	S	sb	l
E. palustris (L.) R. & S.	C	S	sb	cl
E. smallii Britt.	A	T	sb	cl
E. acicularis (L.) R. & S.	C	SB	sb	cl
Scirpus caespitosus L. ssp. *austriacus* (Palla) Asch. & Graebn.	C	SA	sb	cl
S. hudsonianus (Michx.) Fern.	C	S	sb	cl
S. validus Vahl	A	B	b	l
S. rubrotinctus (Fern.) Jones	A	BT	sb	l
S. atrocinctus Fern.	A	BT	sb	c
Eriophorum gracile Koch	C	B	bs	cl
E. angustifolium Honckeny	C	AB	s–t	cl
E. viridi-carinatum (Engelm.) Fern.	A	BS	sb	l
E. scheuchzeri Hoppe	C	A	s	cl
E. chamissonis Mey.	C	AS	s	cl
E. medium Anders.	A	BS	sb	c
E. spissum Fern.	A	AS	sb	cl
E. brachyantherum Trautv. & Meyer	C	S	sb	cl
E. callitrix Cham.	A	A	s	l
Kobresia simpliciuscula (Wahl.) Mack.	C	A	s	l
K. myosuroides (Vill.) Fiori & Paol.	C	A	s	l
Carex arctogena H. Smith	M	A	s	cl
C. maritima Gunn.	C	A	s	l
C. dutillyi O'Neill & Duman	A	S	s	l
C. chordorrhiza L. f.	C	SB	sb	cl
C. diandra Schrank	C	B	s–t	cl
C. disperma Dew.	C	BS	sb	c
C. tenuiflora Wahl.	C	BS	sb	c
C. loliacea L.	C	S	s	c
C. bipartita Bellardi var. *amphigena* (Fern.) Polunin	C	A	s	l
C. amblyorhyncha Krecz.	C	A	s	l
C. heleonastes Ehrh.	C	SB	sb	c
C. mackenziei Krecz.	C	S	s	l
C. brunnescens (Pers.) Poir.	C	BS	sb	c
C. canescens L.	C	BS	sb	c
C. arcta Boott	A	BS	sb	c
C. gynocrates Wormskj.	C	BS	sb	cl
C. praticola Rydb.	A	B	sb	c
C. aenea Fern.	A	BS	b	c
C. leptalea Wahl.	A	BS	sb	cl
C. backii Boott	A	BT	b	l

Table 5 — continued

Species	*1*	*2*	*3*	*4*
Carex supina Wahl. ssp. *spaniocarpa* (Steud.) Hult.	A	AS	sb	c
C. deflexa Hornem.	A	BS	sb	c
C. rossii Boott	A	BT	b	l
C. scirpoidea Michx.	M	A	sb	l
C. concinna R. Br.	A	BS	sb	cl
C. rupestris All.	C	A	s	l
C. glacialis Mack.	C	A	s	cl
C. eburnea Boott	A	BT	b	l
C. rufina Drej.	M	A	s	c
C. bicolor All.	C	A	s	l
C. garberi Fern.	A	S	s	l
C. aurea Nutt.	A	BS	bs	l
C. livida (Wahl.) Willd. var. *grayana* (Dew.) Fern.	A	B	sb	l
C. vaginata Tausch	C	BS	sb	cl
C. capillaris L.	C	AB	sb	cl
C. williamsii Britt.	A	S	s	c
C. atrofusca Schk.	C	A	s	l
C. houghtonii Torr.	A	BT	b	l
C. lanuginosa Michx.	A	BT	b	cl
C. lasiocarpa Ehrh. var. *americana* Fern.	A	B	b	c
C. rariflora (Wahl.) Sm.	C	A	s	cl
C. limosa L.	C	BS	sb	cl
C. paupercula Michx.	C	B	sb	cl
C. media R. Br.	A	BS	sb	c
C. norvegica Retz.	M	A	s	l
C. raymondii Calder	A	BS	s	l
C. adelostoma V. Krecz.	M	A	s	cl
C. bigelowii Torr.	C	A	s	c
C. aquatilis Wahl.	C	AB	s–t	cl
C. stans Drej.	A	AS	s	l
C. paleacea Wahl.	C	SB	s	l
C. salina Wahl. var. *subspathacea* (Wormskj.) Tuckerm.	C	A	s	l
C. microglochin Wahl.	C	A	s	l
C. ursina Dew.	C	A	s	l
C. pauciflora Lightf.	C	SB	s	c
C. atherodes Spreng.	C	B	b	l
C. saxatilis L. var. *miliaris* (Michx.) Bailey	A	S	s	cl
C. rotundata Wahl.	C	S	s	cl
C. rostrata Stokes	C	SB	sb	cl
C. oligosperma Michx.	A	SB	sb	cl
Acorus calamus L.	A	BT	b	c
Calla palustris L.	C	BS	bs	c
Lemna trisulca L.	C	BS	bs	cl
L. minor L.	C	B	bs	cl
Juncus balticus Willd. var. *littoralis* Engelm.	A	B	bs	cl
J. filiformis L.	C	BS	sb	c
J. arcticus Willd.	C	A	s	cl
J. bufonius L.	C	BS	sb	cl
J. vaseyi Engelm.	A	BT	b	c
J. biglumis L.	C	A	s	l
J. albescens (Lange) Fern.	A	A	s	cl
J. castaneus Sm.	C	AS	s	cl

Table 5 — continued

Species	*1*	*2*	*3*	*4*
Juncus nodosus L.	A	B	bs	l
J. brevicaudatus (Engelm.) Fern.	A	BS	sb	c
J. alpinus Vill. var. *rariflorus* Hartm.	C	BS	sb	cl
Luzula parviflora (Ehrh.) Desv.	C	BS	s	cl
L. wahlenbergii Rupr.	C	SA	s	c
L. spicata (L.) DC.	C	AS	s	c
L. confusa Lindb.	C	A	s	c
L. multiflora (Retz.) Lejeune	C	S	s	cl
L. groenlandica Böcher	A	S	s	l
Allium schoenoprasum L. var. *sibiricum* (L.) Hartm.	C	B	bs	l
Tofieldia pusilla (Michx.) Pers.	C	AS	s	cl
T. glutinosa (Michx.) Pers.	A	B	bs	l
Lilium philadelphicum L.	A	B	bs	l
Maianthemum canadense Desf. var. *interius* Fern.	A	B	b	c
Smilacina stellata (L.) Desf.	A	B	b	l
S. trifolia (L.) Desf.	A	B	sb	cl
Sisyrinchium montanum Greene	A	B	bs	l
Cypripedium parviflorum (Salisb.) Fern.	A	B	b	l
C. passerinum Richards.	A	B	sb	l
Orchis rotundifolia Banks	A	BS	sb	cl
Platanthera obtusata (Pursh) Lindl.	A	BS	sb	l
P. hyperborea (L.) Lindl.	A	BS	sb	cl
Corallorhiza trifida Chat.	C	BS	sb	cl
Spiranthes romanzoffiana Cham.	M	B	sb	l
Goodyera repens (L.) R. Br. var. *ophioides* Fern.	A	B	sb	c
Listera cordata (L.) R. Br.	C	B	bs	l
L. borealis Morong	A	B	bs	l
L. auriculata Wieg.	A	B	s	l
Populus tremuloides Michx.	A	B	bs	cl
P. balsamifera L.	A	B	bs	cl
Salix serissima (Bailey) Fern.	A	BT	bs	cl
S. lucida Muhl.	A	BT	bs	cl
S. interior Rowlee	A	BT	bs	l
S. vestita Pursh	A	A	sb	l
S. reticulata L.	C	AS	s	l
S. herbacea L.	M	A	s	c
S. arctophila Cockerell	A	A	s	c
S. cordifolia Pursh var. *callicarpaea* (Trautv.) Fern.	A	S	s	cl
S. brachycarpa Nutt.	A	S	s	l
S. maccalliana Rowlee	A	B	bs	l
S. lutea Nutt.	A	B	bs	l
S. myrtillifolia Anderss.	A	BS	bs	cl
S. pseudomonticola Ball	A	B	bs	l
S. uva-ursi Pursh	A	A	s	c
S. pyrifolia Anderss.	A	B	sb	c
S. calcicola Fern. & Wieg.	A	AS	s	l
S. alaxensis (Anderss.) Cov.	A	A	s	l
S. candida Flügge	A	B	bs	l
S. bebbiana Sarg.	A	B	t–s	cl
S. pedicellaris Pursh var. *hypoglauca* Fern.	A	B	bs	cl
S. athabascensis Raup	A	BS	sb	c
S. gracilis Anderss. (*S. petiolaris* Sm.)	A	BT	bs	c

Table 5 — continued

Species	*1*	*2*	*3*	*4*
Salix discolor Muhl.	A	BT	bs	c
S. scouleriana Barratt	A	BT	bs	c
S. planifolia Pursh	A	BT	bs	c
S. pellita Anderss.	A	BT	bs	l
S. arbusculoides Anderss.	A	BS	s	cl
Myrica gale L.	C	B	sb	cl
Alnus crispa (Ait.) Pursh	A	BS	sb	cl
A. rugosa (Du Roi) Spreng. var. *americana* (Regel) Fern.	A	B	sb	cl
Betula glandulosa Michx. (including var. *glandulifera*)	A	S	sb	cl
B. papyrifera Marsh. (including var. *neoalaskana*)	A	B	sb	c
B. occidentalis Hook.	A	BT	sb	c
Urtica gracilis Ait.	A	B	b	cl
Geocaulon lividum (Richards.) Fern.	A	B	sb	c
Comandra richardsiana Fern.	A	TB	b	c
R. mexicanus Meisn.	A	B	sb	cl
Rumex occidentalis Wats.	A	B	s	l
R. maritimus L. var. *fueginus* (Phillippi) Dusén.	A	B	b	l
Bistorta vivipara (L.) S. F. Gray	C	A	s	cl
Polygonum amphibium L. var. *stipulaceum* (Coleman) Fern.	A	B	sb	c
P. lapathifolium L.	C	BT	sb	l
P. boreale (Lange) Small	A	S	s	l
P. achoreum Blake	A	B	sb	l
Koenigia islandica L.	C	AS	s	l
Salicornia europaea L.	A	B	s	l
Atriplex patula L.	C	BT	sb	l
Chenopodium capitatum (L.) Asch.	C	BT	sb	l
Montia lamprosperma Cham.	C	S	s	l
Spergularia marina (L.) Griseb.	C	BT	sb	l
Sagina caespitosa (J. Vahl) Lange	M	A	s	c
S. nodosa (L.) Fenzl	C	S	sb	l
Arenaria peploides L.	C	A	s	l
A. rossii R. Br.	M	A	s	l
A. humifusa Wahl.	C	AS	s	l
A. lateriflora L.	C	SB	sb	cl
A. rubella (Wahl.) Sm.	C	A	s	l
A. uliginosa Schleich.	C	S	b	l
A. dawsonensis Britt.	A	B	sb	cl
Stellaria longipes Goldie	C	B	sb	cl
S. monantha Hult.	A	A	s	c
S. ciliatosepala Trautv.	C	A	s	cl
S. humifusa Rottb.	C	A	s	l
S. crassifolia Ehrh.	C	SB	sb	l
S. calycantha (Ledeb.) Bongard	C	B	sb	cl
S. alsine Grimm	C	S	s	l
S. longifolia Muhl.	C	SB	sb	cl
Cerastium nutans Raf.	A	BT	b	l
C. arcticum Lange var. *vestitum* Hult.	C	A	s	l
C. alpinum L. (including var. *strigosum* Hult.)	M	A	s	l
Melandrium apetalum (L.) Fenzl (= *Lychnis*)	C	A	s	l
M. furcatum (Walp.) Hadac	C	A	s	l
Nuphar variegatum Engelm.	A	B	sb	cl
Aquilegia brevistyla Hook.	A	BT	b	cl

Table 5 — continued

Species	*1*	*2*	*3*	*4*
Actaea rubra (Ait.) Willd.	A	BT	sb	cl
Coptis groenlandica (Oeder) Hult.	A	SB	sb	c
Caltha palustris L.	C	SB	b	cl
C. natans Pall.	C	B	sb	c
Anemone richardsonii Hook.	A	S	sb	l
A. canadensis L.	A	BT	sb	l
A. parviflora Michx.	A	S	sb	l
A. multifida Poir.	A	B	sb	l
Thalictrum venulosum Trel.	A	B	b	l
Ranunculus trichophyllus Chaix.	C	B	sb	c
R. circinatus Sibth. var. *subrigidus* (Drew) Benson	A	S	sb	l
R. purshii Richards. (*R. gmelini* DC.)	A	BS	sb	cl
R. pallasii Schlecht.	C	S	sb	l
R. hyperboreus Rottb.	C	A	s	l
R. reptans L.	M	B	sb	c
R. lapponicus L.	C	SB	sb	cl
R. cymbalaria Pursh	C	BS	sb	l
R. sceleratus L.	C	B	sb	l
R. abortivus L.	A	BT	b	c
R. pedatifidus Sm. var. *leiocarpus* (Trautv.) Fern.	C	A	sb	l
R. pensylvanicus L. f.	A	BT	b	l
R. macounii Britt.	A	B	b	l
Corydalis sempervirens (L.) Pers.	A	SB	sb	c
C. aurea Willd.	A	SB	b	c
Eutrema edwardsii R. Br.	C	A	s	cl
Draba alpina L.	C	A	s	l
D. fladnizensis Wulf. var. *heterotricha* (Lindbl.) Ball	C	A	s	l
D. nivalis Liljebl.	C	A	s	l
D. minganensis (Vict.) Fern.	A	S	s	l
D. incana L. var. *confusa* (Ehrh.) Liljebl.	M	A	s	l
D. glabella Pursh	C	A	s	l
D. lanceolata Royle	C	S	s	l
D. luteola Greene	A	S	s	l
D. cinerea Adams	C	A	s	l
D. aurea M. Vahl	A	A	s	l
D. nemorosa L. var. *lejocarpa* Lindbl.	C	BS	sb	cl
Lesquerella arctica (Wormskj.) Wats.	A	A	s	l
Lepidium ramosissimum Nels.	A	BT	sb	cl
L. densiflorum Schrad.	A	BT	sb	cl
Subularia aquatica L.	C	BS	sb	c
Cochlearia officinalis L. (*sensu lato*)	C	A	s	l
Hutchinsia procumbens (L.) Desv.	C	B	s	l
Descurainia sophioides (Fisch.) O.E. Schultz	A	S	s	l
D. richardsonii (Sweet) O.E. Schultz	A	BT	sb	l
Braya humilis (C. A. Meyer) Robinson	C	A	s	l
Rorippa islandica (Oeder) Borbas var. *fernaldiana* Butt. & Abbe	A	B	sb	cl
R. islandica var. *hispida* (Desv.) Butt. & Abbe	A	BT	sb	cl
Barbarea orthoceras Ledeb.	A	BT	sb	cl
Cardamine pratensis L. (*sensu lato*)	C	AS	sb	cl
C. pensylvanica Muhl.	A	BT	sb	c
Arabis alpina L.	M	A	s	l
A. arenicola (Richards.) Gelert var. *pubescens* (Wats.) Gelert	A	A	s	cl

Table 5 — continued

Species	*1*	*2*	*3*	*4*
Arabis holboellii Hornem. var. *retrofracta* (Graham) Rydb.	A	TB	b	c
A. glabra (L.) Bernh.	C	TB	sb	cl
A. hirsuta (L.) Scop. var. *pycnocarpa* (Hopkins) Rollins	A	B	bs	l
A. divaricarpa Nels.	A	BT	bs	cl
Drosera rotundifolia L.	C	B	bs	c
Chrysosplenium tetrandrum (Lund) Fries	C	AB	sb	l
Parnassia palustris L. var. *neogaea* Fern.	C	SB	sb	cl
P. kotzebuei Cham.	A	S	sb	cl
Saxifraga oppositifolia L.	C	A	s	l
S. hirculus L.	C	A	s	l
S. aizoides L.	M	A	s	l
S. tricuspidata Rottb.	A	AB	sb	cl
S. caespitosa L.	C	A	s	l
S. rivularis L.	C	A	s	l
Mitella nuda L.	A	B	sb	cl
Ribes hudsonianum Richards.	A	B	sb	cl
R. lacustre (Pers.) Poir.	A	B	sb	l
R. glandulosum Grauer	A	B	sb	c
R. triste Pall.	A	B	sb	cl
R. oxyacanthoides L.	A	B	sb	cl
Rosa acicularis Lindl.	A	B	bs	c
Fragaria virginiana Duchesne	A	B	bs	cl
F. virginiana var. *terrae-novae* (Rydb.) Fern. & Wieg.	A	B	bs	cl
Dryas integrifolia Vahl	A	A	s	l
Geum strictum Ait.	A	BT	bs	l
G. macrophyllum Willd.	A	BT	bs	cl
Potentilla tridentata Ait.	A	BS	bs	c
P. palustris (L.) Scop.	C	SB	bs	cl
P. arguta Pursh	A	BT	b	cl
P. fruticosa L.	C	BT	sb	cl
P. anserina L.	C	BT	sb	l
P. egedii Wormskj. var. *groenlandica* (Tratt.) Polunin	A	A	s	l
P. norvegica L.	C	BT	sb	cl
P. nivea L.	C	A	s	cl
P. pectinata Raf.	A	SB	s	l
P. pulchella R. Br.	M	A	s	l
P. multifida L.	C	B	bs	lc
Rubus chamaemorus L.	C	BS	sb	cl
R. idaeus L. var. *strigosus* (Michx.) Maxim.	A	B	b	cl
R. idaeus L. var. *canadensis* Richards.	A	B	sb	cl
R. acaulis Michx.	A	BS	sb	cl
R. pubescens Raf.	A	B	b	lc
R. arcticus L.	A	B	s	c
Prunus pensylvanica L. f.	A	TB	b	c
Amelanchier alnifolia Nutt.	A	BT	b	c
Oxytropis splendens Dougl.	A	T	b	c
O. deflexa (Pall.) DC.	A	BT	bt	c
O. johannensis Fern.	A	S	s	l
O. terrae-novae Fern.	A	A	s	l
O. campestris (L.) DC. var. *varians* (Rydb.) Barneby	A	S	s	cl
O. gracilis (A. Nels.) K. Schum.	A	S	b	l
Astragalus striatus Nutt.	A	TB	bt	l

Table 5 — continued

Species	*1*	*2*	*3*	*4*
Astragalus goniatus Nutt.	A	TB	bt	l
A. tenellus Pursh	A	TB	bt	l
A. yukonis M. E. Jones	A	TB	b	c
A. americanus (Hook.) M. E. Jones	A	B	b	l
A. eucosmus Robins.	A	S	sb	l
A. alpinus L.	C	AS	sb	cl
Hedysarum alpinum L. var. *americanum* Michx.	A	BT	sb	l
H. mackenzii Richardson	A	AS	s	l
Vicia americana Muhl.	A	BT	b	cl
Lathyrus japonicus Willd. var. *glaber* (Ser.) Fern.	C	BT	sb	l
L. japonicus var. *aleuticus* (Greene) Fern.	C	S	s	l
L. palustris L.	C	BT	sb	l
L. ochroleucus Hook.	A	BT	b	l
Linum lewisii Pursh	A	S	bt	l
Geranium bicknellii Britt.	A	B	b	c
Callitriche palustris L.	C	B	b	cl
C. hermaphroditica L.	C	B	sb	l
Empetrum hermaphroditum (Lge.) Hagerup	C	AB	sb	cl
Rhamnus alnifolia L'Hér.	A	TB	sb	l
Viola nephrophylla Greene	A	B	bt	c
V. palustris L.	M	B	sb	cl
V. pallens (Banks) Brainerd	A	SB	sb	l
V. renifolia Gray	A	BT	b	l
V. labradorica Schrank (*V. adunca* var. *minor*)	A	S	sb	c
Elaeagnus commutata Bernh.	A	BT	bt	l
Shepherdia canadensis (L.) Nutt.	A	B	bs	cl
Chamaenerion angustifolium (L.) Scop. (*Epilobium*)	C	AT	sb	cl
C. latifolium (L.) Sweet	C	A	s	l
Epilobium davuricum Fisch.	C	S	s	cl
E. adenocaulon Haussk. (*E. glandulosum* Lehm. var. *adenocaulon* (Haussk.) Fern.)	A	B	bs	cl
E. palustre L.	C	B	bs	cl
Myriophyllum alterniflorum DC.	C	BS	s	c
M. exalbescens Fern.	A	B	bs	cl
Hippuris vulgaris L.	C	AB	bs	cl
H. tetraphylla L. f.	C	AS	s	l
Aralia nudicaulis L.	A	BT	bt	c
Cicuta bulbifera L.	A	BT	bs	cl
C. mackenzieana Raup	A	S	sb	cl
C. maculata L.	A	BT	bt	l
Sium suave Walt.	A	B	s–t	cl
Heracleum maximum Bartr.	A	BT	sb	l
Cornus canadensis L. (*Chamaepericlymenum*)	A	B	bs	c
C. stolonifera Michx.	A	B	b	cl
Moneses uniflora (L.) Gray	C	B	b	l
Pyrola secunda L.	C	S	bs	cl
P. minor L.	C	AS	bs	c
P. virens Schweigg.	C	B	b	c
P. grandiflora Radius (including var. *canadensis*)	M	B	bs	cl
P. asarifolia Michx. (including var. *purpurea*)	A	BT	bs	cl
Ledum groenlandicum Oeder	A	BS	bs	cl
L. decumbens (Ait.) Lodd.	A	S	s	cl

Table 5 — continued

Species	*1*	*2*	*3*	*4*
Kalmia polifolia Wang.	A	SB	sb	c
Chamaedaphne calyculata (L.) Moench	C	SB	sb	cl
Andromeda glaucophylla Link	A	SB	b	l
A. polifolia L.	C	SB	sb	cl
Phyllodoce caerulea (L.) Bab.	C	AS	s	c
Arctostaphylos uva-ursi (L.) Spreng.	C	BS	sb	c
A. uva-ursi var. *adenotricha* Fern. & Macbr.	A	B	b	cl
A. uva-ursi var. *coactilis* Fern. & Macbr.	A	B	sb	cl
A. alpina (L.) Spreng.	C	S	sb	cl
A. rubra (Rehd. & Wils.) Fern.	C	S	sb	cl
Rhododendron lapponicum (L.) Wahl.	M	A	s	cl
Loiseleuria procumbens (L.) Desv.	M	A	s	c
Oxycoccus microcarpus Turcz.	C	B	sb	cl
Vaccinium uliginosum L.	C	AB	sb	cl
V. vitis-idaea L. var. *minus* Lodd.	A	AB	sb	cl
V. myrtilloides Michx.	A	B	sb	c
Diapensia lapponica L.	C	SA	s	c
Primula egaliksensis Wormskj.	A	S	s	l
P. mistassinica Michx.	A	B	sb	cl
P. stricta Hornem.	M	A	s	l
P. incana Jones	A	BS	sb	l
Androsace septentrionalis L.	C	AS	sb	l
Trientalis borealis Raf.	A	B	b	c
Naumburgia thyrsiflora (L.) Duby	C	B	b	c
Menyanthes trifoliata L.	C	B	bs	cl
Lomatogonium rotatum (L.) Fries	C	A	s	l
Gentiana propinqua (Richards.)	A	S	s	l
G. amarella L.	A	B	b	l
Collomia linearis Nutt.	A	TB	b	l
Apocynum androsaemifolium L.	A	B	b	l
Phacelia franklinii (R.Br.) Gray	A	B	b	l
Mertensia paniculata (Ait.) G. Don	A	B	b	cl
M. maritima (L.) S.F. Gray	C	A	s	l
Scutellaria epilobiifolia A. Hamilton	A	BT	b	c
Moldavica parviflora (Nutt.) Britt.	A	BT	b	cl
Stachys palustris L. var. *pilosa* (Nutt.) Fern.	A	BT	b	c
Lycopus uniflorus Michx.	A	BT	b	c
L. americanus Muhl.	A	BT	b	cl
Limosella aquatica L.	C	B	b	l
Veronica peregrina L. var. *xalapensis* (HBK.) St. John & Warren	A	B	bt	l
V. scutellata L.	C	B	bt	cl
Castilleja raupii Pennell	A	S	sb	l
Euphrasia hudsoniana Fern. & Wieg.	A	B	sb	l
E. arctica Lange	C	A	sb	l
Bartsia alpina L.	M	A	s	l
Rhinanthus crista-galli L.	C	B	sb	l
R. borealis (Sterneck) Chabert	C	S	s	l
Pedicularis groenlandica Retz.	A	S	sb	l
P. parviflora Sm.	A	S	b	l
P. sudetica Willd.	C	AS	s	l
P. lapponica L.	C	S	s	l
P. labradorica Wirsing	C	S	s	cl

Table 5 — continued

Species	*1*	*2*	*3*	*4*
Pedicularis flammea L.	M	A	s	l
Pinguicula villosa L.	C	SB	s	cl
P. vulgaris L.	C	SB	s	cl
Utricularia vulgaris L.	C	B	bt	cl
U. minor L.	C	B	bt	l
U. intermedia Hayne	C	B	sb	cl
Plantago maritima L.	C	SB	sb	l
Galium septentrionale R. & S.	A	B	s–t	cl
G. labradoricum Wieg.	A	B	b	l
G. palustre L.	C	B	b	l
G. trifidum L. (including var. *halophilum*)	C	B	sb	cl
G. brandegei Gray	A	B	s	l
Linnaea borealis L. var. *americana* (Forbes) Rehd.	A	B	sb	c
Lonicera involucrata (Richards.) Banks	A	BT	b	l
L. villosa (Michx.) R. & S. var. *solonis* (Eat.) Fern.	A	BT	b	l
Viburnum edule (Michx.) Raf.	A	B	sb	cl
Campanula uniflora L.	M	A	s	l
C. rotundifolia L.	C	BS	b	l
Valeriana septentrionalis Rydb.	A	B	b	l
Lobelia kalmii L.	A	B	b	l
Solidago hispida Muhl.	A	TB	b	l
S. multiradiata Ait.	A	S	s	cl
S. decumbens Greene var. *oreophila* (Rydb.) Fern.	A	BT	b	l
S. canadensis L. var. *gilvocanescens* Rydb.	A	BT	b	l
S. graminifolia (L.) Salisb. var. *major* (Michx.) Fern.	A	B	b	l
Aster ciliolatus Lindl.	A	B	b	c
A. puniceus L.	A	BT	b	l
A. junciformis Rydb.	A	B	b	l
A. praealtus Poir.	A	TB	sb	c
A. simplex Willd.	A	TB	b	l
Erigeron angulosus Gaud. var. *kamtschaticus* (DC.) Hara (*E. acris*)	C	S	sb	c
E. elatus Greene (*E. acris*)	A	B	sb	cl
E. lonchophyllus Hook.	A	B	b	l
E. humilis Graham	M	A	s	l
E. philadelphicus L.	A	BT	b	l
E. hyssopifolius Michx.	A	BT	b	l
Antennaria pulcherrima (Hook.) Greene	A	BT	b	l
A. isolepis Greene	A	BS	s	c
A. campestris Rydb.	A	BT	bt	l
A. rosea (D. C. Eat.) Greene	A	B	sb	cl
A. parvifolia Nutt.	A	BT	bt	l
A. neodioica Greene	A	BT	bt	l
Achillea sibirica Ledeb.	A	B	b	c
A. borealis Bong.	C	BS	sb	cl
A. lanulosa Nutt.	A	B	bt	l
Matricaria matricarioides (Less.) Porter	A	BT	b	cl
M. ambigua (Ledeb.) Krylof	C	A	s	l
Chrysanthemum arcticum L.	C	S	s	l
Tanacetum huronense Nutt.	A	S	b	l
Artemisia canadensis Michx.	A	B	sb	cl
A. biennis Willd.	A	BT	bt	l
A. tilesii Ledeb.	A	S	s	l

Table 5 — continued

Species	*1*	*2*	*3*	*4*
Artemisia ludoviciana Nutt. var. *latifolia* (Bess.) T. & G.	A	TB	b	l
Petasites sagittatus (Pursh) Gray	A	SB	sb	cl
P. palmatus (Ait.) Gray	A	B	sb	c
P. vitifolius Greene	A	B	b	l
Arnica chamissonis Less. ssp. *foliosa* (Nutt.) Maguire	A	B	b	c
A. alpina (L.) Olin ssp. *attenuata* (Greene) Maguire	A	S	sb	l
A. lonchophylla Greene	A	S	sb	cl
Senecio congestus (R. Br.) DC.	C	A–T	bt	l
S. aureus L.	A	BT	bt	l
S. pauperculus Michx.	A	B	b	cl
Taraxacum ceratophorum (Ledeb.) DC.	A	SB	sb	l
T. lacerum Greene	A	A	s	l
T. lapponicum Kihlm.	C	AS	b	l
Lactuca pulchella (Pursh) DC.	A	B	bt	l
Prenanthes racemosa Michx.	A	BT	bt	l
Hieracium umbellatum L.	C	B	b	cl
H. canadense Michx.	A	B	b	l

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АВТОРЕФЕРАТ

Географические данные о растительности и формах рельефа Манитобы к северу от 56° с. ш. представлены в виде двух карт в масштабе 1 : 1 млн.

Карты были изготовлены на основе вертикальных аэросъемок при одновременном аэрофотодешифрировании растительности и ландшафта, после предварительного полевого обследования избранной местности.

Большая часть данного района расположена в До-Кембрийской физиографической области, разделенной на 8 зон, из которых каждая характеризуется преобладанием особенного рельефа, включая рельеф обусловленный коренными породами, наносами и переработанными морскими отложениями.

Низменность Гудсонового Залива занимает юго-восточную часть района, с преобладанием морских глин, перекрытых внутрь страны отложениями торфа различной толщины.

Растительный покров подразделен на зональной карте на 18 секций. В то время как на исследованном участке наблюдается широкая зональность в распределении растительности, типа сомкнутных и открытых хвойных лес, лесо-тундры и тундры, стоящая в связи, по-видимому, с климатом, характер расположения отдельных зон обусловен главным образом распределением форм рельефа местности.

В сводной таблице представлены суммарно фотографическое изображение, физиографические взаимоотношения и общие данные о структуре сообществ растительности.

Флористическая география исследованного участка представлена в таблице содержащей список 580 местных таксонов и выявляющей уже известные данные об их общем и местном распространении.

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MAP 1

MAP 2

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