69-32

GEOLOGICAL SURVEY OF CANADA

DEPARTMENT OF ENERGY, MINES AND RESOURCES

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PALYNOLOGICAL STUDIES IN CENTRAL SASKATCHEWAN

Contemporary pollen spectra from surface samples.

(Report, 2 figures and 2 tables)

R. J. Mott

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Illustrations

ABSTRACT

Saskatchewan lies within two vegetational zones: the grasslands or prairie, and the boreal forest. Surface samples collected as part of a study of the late-glacial and postglacial geochronology and vegetational and climatic history of central Saskatchewan, yielded contemporary pollen spectra characteristic of both zones. Pollen spectra typical of the grasslands contained 60 to 70 per cent herbs, 25 to 35 per cent trees, and 5 per cent or less shrubs. Spectra from the forested areas showed varying amounts of tree pollen, typically in excess of 50 per cent, with herb pollen usually less than 35 per cent. Although not as readily distinguishable by their pollen spectra, some sections of the Boreal Forest Region, as defined by Rowe (1959), were found to have discernible pollen assemblages. In addition to the general relative proportions of tree, shrub and herb pollen, data on the abundance of individual genera are needed in order to differentiate these forest sections.

PALYNOLOGICAL STUDIES IN CENTRAL SASKATCHEWAN

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INTRODUCTION

The main objective of this palynological study was to determine the late-glacial and postglacial geochronology and vegetational and climatic history of central Saskatchewan, an area that, in the past, has received scant attention. Of special interest from the point of view of vegetational history were the fluctuations of the prairie-forest boundary.

As part of this research, nine central Saskatchewan lakes, located in various vegetational zones, were sampled. To aid in interpreting the results of the pollen analysis of the lake-sediment cores obtained, additional surface samples were collected along a transect across the main vegetational zones in Saskatchewan. Sample types and site locations are listed in Table 1. The present paper attempts to determine the relationship between the pollen spectra of these surface samples and the contemporary vegetation.

In recent years, the intuitive approach of interpreting pollen diagrams has been giving way to a more scientific approach based on the use of pollen spectra from known vegetative zones as a base of comparison. Wright (1967) pointed out the value of using surface samples and has reviewed methods used to compare their pollen spectra with contemporary vegetation.

Studies of pollen spectra and vegetation along the prairie-forest boundary have been carried out in Minnesota by McAndrews (1966, 1967), and Janssen (1966, 1967a and b); and in Manitoba by Ritchie and Lichti-Federovich (1963), Lichti-Federovich and Ritchie (1965), and Ritchie (1967).

McAndrews (1966, 1967) compared pollen spectra in short cores from ponds along a transect across the prairie-forest boundary with those of the existing general vegetational zones. By using witness-tree records from early land surveys, he also compared the pollen spectra of the cores with the earlier or pre-agriculture vegetation. Janssen (1966, 1967a and b) working in the same area, made more detailed surveys of the vegetation and compared them with the pollen content of surface samples.

Because of the difficulties involved in determining the areal extent of the vegetation contributing to the pollen spectra of any particular site, Lichti-Federovich and Ritchie (1965) characterized distinct landform-vegetation regions in terms of pollen spectra. This approach has been particularly successful in Manitoba.

In the present study, pollen spectra from surface samples are compared with the broad vegetational zones of the grassland and forest-regions of Saskatchewan. This approach is similar to that adopted by Lichti-Federovich and Ritchie in that detailed studies of the surrounding vegetation were not made for every site. However, in the central Saskatchewan survey discussed here, not even all the various landform-vegetation zones were sampled. Rather,

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TABLE 1

Sample Type and Location of Sampling Sites

Site No.	Site Name	Sample Type	Latitude (N)	Longitude (W)	'Pie' Diagram
*1	Clearwater Lake	core	50°52'25"	107°56'	A
2	Imperial	dredge	51°18'40"	105°23'	B
*3	Cut Knife Hill	core	52°50'30"	108°53'	C
*4	Wakaw Lake	core	52°41'45"	105°33'45"	D
5	Yellow Creek	fen	52°43'	105°13'	
6	Midnight Lake Area	dredge	53°35'	108°22'	
*7	Midnight Lake Area	core	53°35'	108°22'	E
8	Midnight Lake Area	fen	53°36'	108°22'	
9	Turtle Lake Area	fen	53°47'	108°29'	
*10	Prince Albert	core	53°14'15"	105°43'30"	
11	Sand Lake Slough	fen	53°20'45"	105°48'30"	
12	Mertock Lake	fen	53°29'25"	105°46'	F
13	Weirdale	bog	53°28'45"	105°15'20"	
14	Emma Lake Area	dredge	53°33'30"	105°52'	
*15	Tweedsmuir	core	53°34'	105°56'	
16	Waskesiu	moss	53°50'	106°04'	
*17	Prince Albert National Park	core	53°48'	106°04'	
18	Mile 0 Lac la Rouge Highway	moss	53°56'	106°00'	G
19	Mile 10 Lac la Rouge Highway	moss	54°01'	105°48'	
*20	Mile 12 Lac la Rouge Highway	core	54°02'	105°49'	
21	Mile 18 Lac la Rouge Highway	dredge	54°03'	105°43'	
22	Mile 19 Lac la Rouge Highway	moss	54°04'	105°42'	H
23	Mile 38 Lac la Rouge Highway	moss	54°17'	105°31'	
24	Mile 49 Lac la Rouge Highway	moss	54°26'	105°32'	
25	Mile 58 Lac la Rouge Highway	bog	54°33'	105°33'	
26	Mile 60 Lac la Rouge Highway	moss	54°34'30"	105°32'	
27	Mile 74 Lac la Rouge Highway	moss	54°44'	105°26'	I
28	Mile 88 Lac la Rouge Highway	moss	54°55'	105°21'	
29	Mile 98 Lac la Rouge Highway	moss	55°03'	105°19'	
*30	Cycloid Lake	core	55°15'	105°16'	J
31	Cree Lake Area	dredge	57°48'	105°41'	K
32	Cree Lake Area	moss	57°48'	105°41'	
33	Stony Rapids Area	moss	59°30'	105°45'	L
34	Stony Rapids Area	dredge	59°30'	105°45'	
35	Selwyn Lake Area NWT	dredge	60°12'	105°23'	M
36	Small Tree Lake Area NWT	dredge	61°06'	104°53'	N

* lake site – sample taken at mud/water interface used as surface sample

as already indicated, samples were collected in a transect across major vegetation zones. Because these zones (the forested regions as classified by Rowe, 1959, and the grassland regions as classified by Coupland, 1961) are, in effect, landform-vegetation zones, the approach in this report is very close to that developed by Lichti-Federovich and Ritchie. The characteristic spectra that emerge from the various vegetation zones can be used to interpret the spectra obtained from detailed study of cores of postglacial limnic sediments.

PHYSIOGRAPHY

Saskatchewan lies within two main physiographic divisions: the Canadian Shield (Churchill Province) and the Interior Plains (Central Lowlands and Great Plains provinces). These are shown on Figure 1 as described and mapped by Acton *et al.* (1960).

Subdivisions of the Churchill Province (Churchill River Plains and Athabasca Plains) represent an ancient peneplained surface of Precambrian rocks with a discontinuous cover of till, lacustrine sediments, outwash and other glacial deposits. Drainage has been disrupted by glacial deposits, resulting in the formation of myriad lakes and extensive muskeg. Elevations range between 950 and 1,760 feet asl in the Churchill River Plains and between 600 and 1,600 feet asl in the Athabasca Plains region.

Bordering the Shield and stretching south from it is the Central Lowland Province of the Interior Plains which includes the Manitoba Lowlands and the Manitoba-Saskatchewan Lowlands. In these regions, abundant glacial, glaciolacustrine and alluvial deposits form a gently rolling cover to the underlying, nearly-flat Paleozoic and Mesozoic sedimentary bedrock. Elevations range between 850 and 1,500 feet asl.

The Great Plains Province, which covers the remainder of Saskatchewan, includes the Saskatchewan Plains and the Alberta High Plains regions, in both of which plains and upland sections occur. In the plains section of the Saskatchewan Plains, elevations range between 1,500 and 2,100 feet asl and the characteristic landforms are gently rolling plains of till, glaciofluvial or glaciolacustrine deposits. In the uplands sections elevations range between 1,700 and 2,650 feet asl, and the characteristic landforms are gently to strongly rolling plains of till or morainic deposits, glaciated plateaus with a thin cover of surficial deposits, and dissected escarpments. The underlying sedimentary rocks, of Mesozoic and Cenozoic age, rarely outcrop except in the dissected escarpments.

The Alberta High Plains show similar landforms but the exposures of bedrock are more extensive and aeolian plains occur in the west and southwest. Elevations range between 2,200 and 3,500 feet asl. In the southwest, the Cypress Hills, which rise to 4,800 feet asl, form an upland underlain by Tertiary sediments. Their top is unglaciated.

As evidenced by the number of sloughs, bogs and muskeg, most of the drainage of Saskatchewan is local and internal, with little of the precipitation lost through runoff. The two main rivers, the North Saskatchewan and the South Saskatchewan, follow the northeasterly slope of the land. They rise in the Rocky Mountains and gain little water in their passage across Saskatchewan.

VEGETATION

In Saskatchewan, the major vegetation zones (Fig. 2) correspond closely to the physiographic regions (Fig. 1). The coniferous forests of the Canadian Shield, and the grasslands of the Interior Plains are separated by transitional zones in which components of both vegetation types occur.

The Grassland Region comprises two grassland associations: the Mixed Prairie Association which occupies the Alberta High Plains and part of the

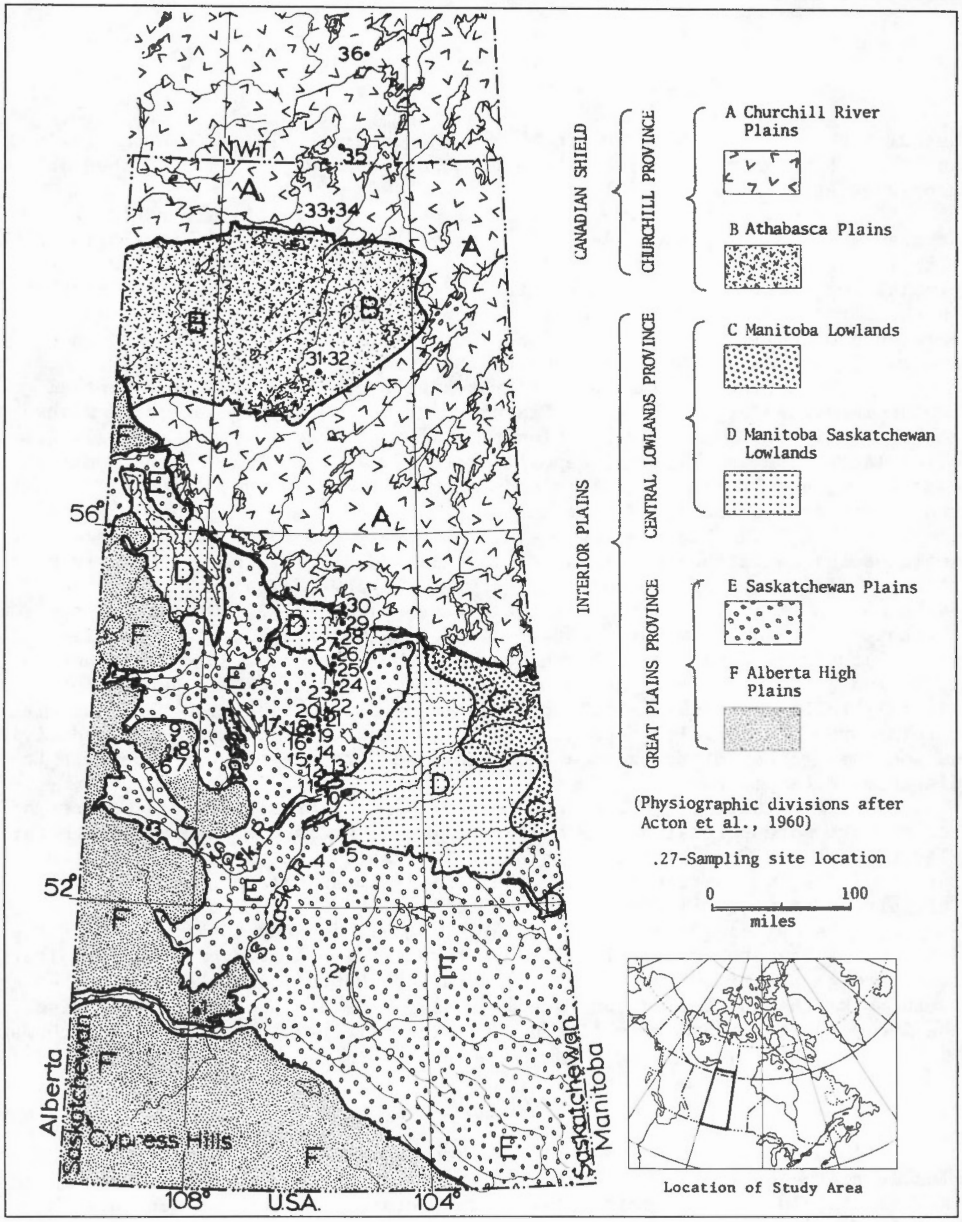

Figure 1. Physiographic divisions of Saskatchewan and location of sampling sites.

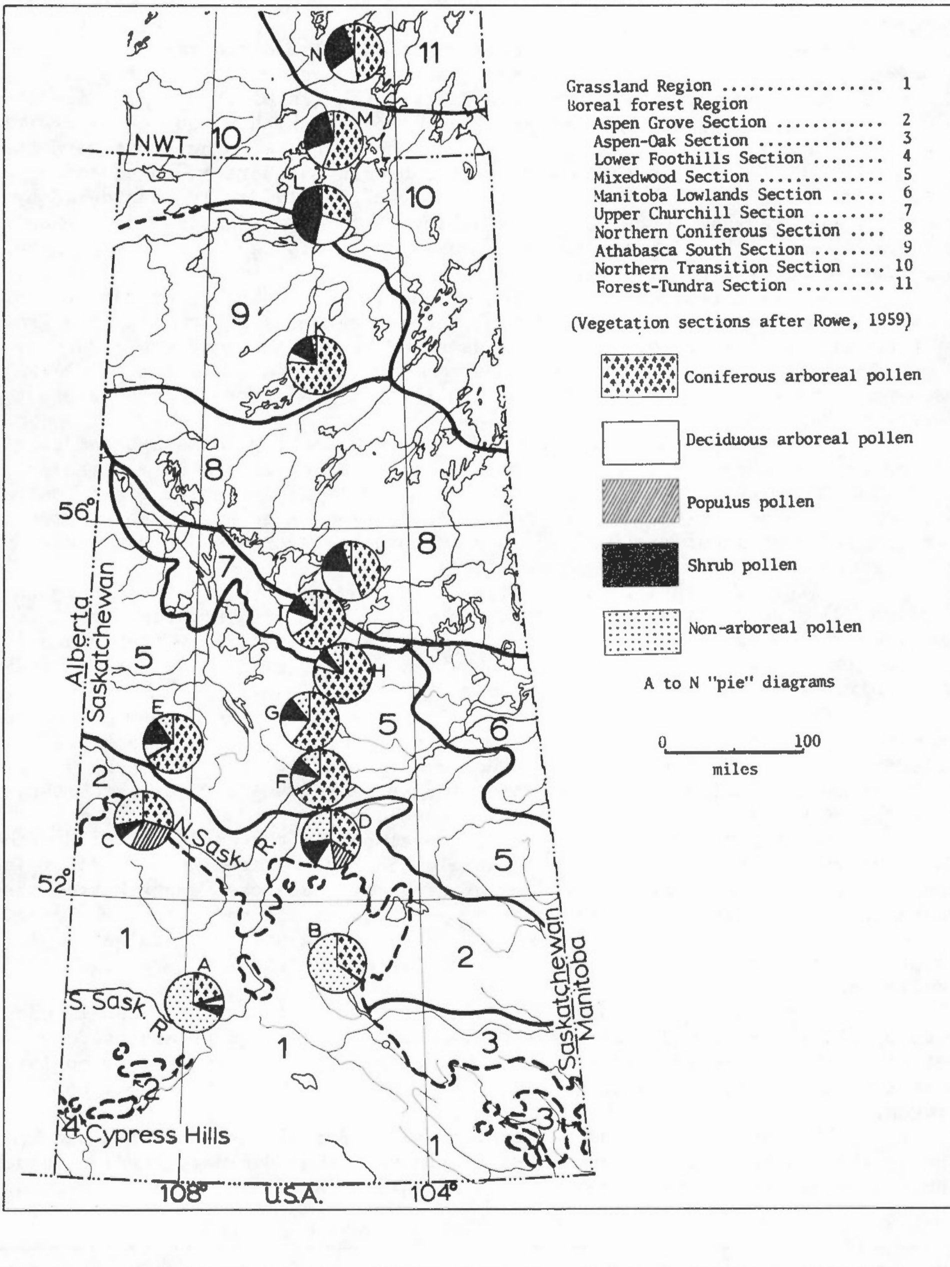

Figure 2. Vegetation zones of Saskatchewan and 'pie' diagrams of pollen types in samples.

Saskatchewan Plains, and the Fescue Prairie Association which is limited to part of the Saskatchewan Plains north of the mixed prairie (Coupland, 1961). Several species of grass (Graminaea) dominate the mixed prairie but communities and species vary depending on topography, aridity, exposure and soils. Although grasses dominate these communities, sedges (Cyperaceae) especially *Carex*, are important, as well as several forbs, notably *Artemisia frigida* and *Phlox hoodii*. Coupland (1950, 1961) discusses the vegetation and ecology of the mixed prairie in detail

The vegetation of the Fescue Prairie is also dominanted by several species of grass, with either grasses or sedges secondary in importance. Numerous forbs and shrubs are also abundant. Details of this vegetation and ecology are given in Coupland and Brayshaw (1953). Within the Fescue Prairie, groves of aspen (*Populus tremuloides*) occur and increase in number toward the north. This aspen grove region, described by many authors as an ecotone between the northern coniferous forests and the grasslands, is considered by Coupland and Brayshaw to be an intermingling of forest and grassland communities with an ecotone occurring around each grove. The ecology of this region has been described by Bird (1961).

In his forest classification of Canada, Rowe (1959) includes the aspen grove region as a section of the Boreal Forest Region (*see* Fig. 2). The groves of *Populus tremuloides* become continuous stands along the northern border of the Aspen Grove Section* thus defined. Balsam poplar (*Populus balsamifera*) is present in moist lowlands and white birch (*Betula papyrifera*) may be present on rough, broken ground.

In southeast Saskatchewan the Aspen Oak Section forms a broad transition zone between forest and prairie. This section is similar to the Aspen Grove Section except that bur oak (*Quercus macrocarpa*) and white elm (*Ulmus americana*) may be present on favourable sites, as well as green ash (*Fraxinus pennsylvanica* var. *subintegerrima*), Manitoba maple (*Acer negundo* var. *interius*) and eastern cottonwood (*Populus deltoides*).

A small vegetational outlier of the Lower Foothills Section in the Cypress Hills contains abundant lodgepole pine (*Pinus contorta* var. *latifolia*) together with aspen and balsam poplar. Older stands contain white spruce (*Picea glauca*) and black spruce (*Picea mariana*). Poor sites support scattered white birch and tamarack (*Larix laricina*).

The Aspen Grove Section gradually gives way to the Mixedwood Section in which aspen is still the dominant species, with varying proportions of balsam poplar, white birch, white spruce and balsam fir (*Abies balsamea*). Drier, sandy areas are dominanted by jack pine (*Pinus banksiana*) and, on wet sites, communities of black spruce and tamarack develop.

The Upper Churchill Section is developed in that part of the Manitoba-Saskatchewan Lowlands bordering the Canadian Shield. Extensive stands of jack pine growing on plains and low ridges of sand, separate the tamarack from the black spruce forests of the wetter areas. White spruce and aspen, while not as important as in the Mixedwood Section, are still abundant. Balsam poplar is present on well drained sites. Balsam fir and white birch are present in small numbers.

In the Manitoba Lowlands Section, flat, poorly drained land is covered by black spruce and tamarack forests with abundant swamps and meadows. Better drained areas support stands of white spruce, aspen and balsam poplar with some balsam fir and white birch. Jack pine is abundant locally on ridges.

The northern Coniferous Section of the Boreal Forest Region occupies the southern part of the Churchill River Plains. The dominant species, black spruce, is associated with jack pine on the higher areas and with tamarack on

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*The classification referred to throughout the following discussion are those of Rowe (1959).

the poorly drained areas. White spruce, balsam fir, aspen and balsam poplar form mixed stands where local climate and soils are favourable.

In the Athabasca South Section of the Athabasca Plains, the rigorous climate and frequent fires favour a park-like forest of jack pine on the extensive sandy soils. Moister areas support black spruce and tamarack. Poplars and white spruce are uncommon except along river valleys and lake shores. Balsam fir may be associated with the latter species only in the south.

North and east, the forests give way to large areas of bog and muskeg intermixed with open stands of dwarf trees. In this Northwest Transition Section, black spruce is the most abundant tree and grows in association with white spruce on favourable sites. White birch and tamarack are present, with the latter more prominent toward the north. Stunted aspen and balsam poplar occur over most of the area while jack pine is confined to the southern parts. This Section extends into the Northwest Territories where it merges gradually into the Forest-Tundra Section which is characterized by black and white spruce with tamarack. These species are accompanied by shrubs of alder (*Alnus* sp.) and willow (*Salix sp.*).

SAMPLING METHODS

Surface samples were collected from moss polsters, lake or pond surface sediments, bog and fen surface peat, and lake sediment cores. Table 1 lists the sites by number, indicates the type of sample collected from each, and gives the specific locations, each of which is shown on Figure 1.

Collection of moss polster samples was made by hand from wet, growing moss, usually *Sphagnum*, and each was placed in a plastic bag. The water and fine detritus that could be squeezed from the moss in the laboratory, provided the sample used for analysis. Where lakes were deep, an Eckman dredge was used to obtain lake bottom samples but, in the case of shallow lakes, the surface mud was scooped from the bottom by hand. Bog and fen surface peat was either collected from the surface by hand or taken from the top of a core or section of peat. In the case of lakes whose entire sediment sequence was cored, sediment form the mud/water interface was collected with a Brown sampler (Brown, 1956), and was used as the surface sample. Several samples collected from sloughs in the grassland region proved to be devoid of pollen and are not listed with the sampling sites.

RESULTS

The results of the pollen and spore analysis are shown in Table 2, and are also expressed as pie diagrams on Figure 2. In some cases, such as site 1, no other samples were collected nearby and the single sample was used in the construction of the pie diagram. In all other cases data from samples in the same physiographic area were averaged to give a single pie diagram. The individual sites included in each pie diagram are shown in Table 1.

Whether or not the total pollen should be included in the pollen sum has been discussed by Wright and Patten (1963). The taxa included in the present paper follow closely the example of Lichti-Federovich and Ritchie (1965). The pollen sum used in calculating percentages included all arboreal pollen, shrub pollen, non-arboreal pollen and spores from upland vegetation. Sedges (Cyperaceae), bog plants, aquatic plants, fern spores, *Sphagnum* spores and all unidentified grains were not included.

TABLE 2. POLLEN PERCENTAGES IN DETAIL

Region	Section	SAMPLE NUMBER	Picea mariana	Picea glauca	Pinus	Abies	Larix	Betula	Populus	Quercus	Ulmus	Carpinus-Ostrya	ARBOREAL POLLEN TOTAL	Alnus	Corylus	Salix	Myrica	Elaeagnus	Sambucus	SHRUB POLLEN TOTAL.
Grassland Region		1	0.8	1.2	18.6	0.4		4.0	1.2				26.3	2.8		2.8				5.6
		2	5.0		33.7								38.7					1.0		1.0
Boreal Forest Region	Aspen Grove Section	3	3.0	0.9	25.5	0.6		7.0	27.1				64.1	4.9		2.7				7.6
		4	3.2	1.2	20.8			5.3	23.1				53.6	6.4		5.0				11.4
		5	8.6	3.6	33.6			18.6					64.4	9.3		5.0	0.7		0.7	15.7
		6	5.7	12.7	41.2	0.4		18.8					78.8	10.6		0.4				11.0
		7	4.1	1.4	32.4			9.7	2.4				50.0	12.8	0.3	7.6				20.7
		8	4.6	4.1	83.0			2.5					94.2	2.1		0.4				2.5
		9	7.2	4.8	60.2			2.8			0.4		75.4	5.2		9.2				14.4
	Mixedwood Section	10	4.7	1.7	40.4	0.2		22.3				0.2	69.5	10.4	0.2	3.0				13.6
		11	10.3	9.7	67.9			3.0					90.9	1.2		0.6				1.8
		12	6.9	3.9	43.6			11.8					66.2	9.3	0.5	2.9				12.7
		13	25.4	10.5	53.5			1.8					91.2	1.8		1.8				3.6
		14	9.1	10.6	53.4			9.6					82.7	3.4	0.5	1.9				5.8
		15	6.9	16.8	17.7	0.9		15.1	14.2				71.6	15.5	1.3	2.2				19.0
		16	8.9	7.2	43.6			11.4		0.4			71.5	14.8		1.3				16.1
		17	10.1	7.0	34.2			22.4					73.7	16.7		1.3				18.0
		18	23.2	8.1	47.1			5.0		0.4			83.8	4.6		4.6				9.2
		19	34.1	11.2	32.1	1.3		4.7			0.4		83.9	4.3		0.4				4.7
		20	6.6	9.8	15.6			34.0					66.0	19.9		0.8	0.4			21.2
		21	48.9	21.4	18.3	0.4		2.6					91.6	0.8		0.8				1.6
		22	12.2	16.6	56.0	0.9		2.7					88.4	0.9		1.8				2.7
		23	12.7	8.6	42.4			6.5					70.2	3.7		11.0				14.7
		24	11.1	21.6	46.5	1.5		9.1					89.9	6.5						6.5
	Upper Churchill Section	25	14.2	4.6	57.9	0.4		6.7					83.8	7.1		0.8				7.9
		26	8.0	3.6	40.4			17.3					69.3	11.1		2.7				13.8
		27	21.9	5.0	42.6			18.2					87.7	6.6		0.8				7.4
		28	20.3	17.4	22.4	0.4	0.4	19.9				0.4	81.2	7.9		0.8				8.7
		29	16.1	2.4	48.3	0.9		12.3					80.0	15.2			0.4			15.6
	Northern Coniferous Section	30	8.4	4.2	30.6			32.4					75.6	17.8		1.8				19.6
	Athabasca South Section	31	10.6	1.1	68.7			4.8	0.3				85.5	12.5						12.5
		32	5.6		68.3			6.2	0.3				80.4	16.2		0.3				16.5
	Northwestern Transition Section	33	14.9	0.4	11.9			36.4					63.6	34.2	0.4					34.6
		34	12.0	1.0	18.3			11.6					42.9	56.0		0.2	0.2			56.4
		35	17.8	5.2	32.7	0.3		14.6					70.6	24.6			1.3			25.9
	Forest-Tundra	36	11.5	11.5	25.8			16.1					64.9	29.5						29.5

Table 2 (continued below)

SAMPLE NUMBER	Gramineae	Chenopodiineae	Sarcobatus	Ambrosia type	Artemisia	Compositae	Thalictrum	Leguminosae	Carypchyllaceae	Epilobium	Rosaceae	Ranunculaceae	Urticaceae	Equisetum	Lycopodium	NON-ARBOREAL POLLEN TOTAL	POLLEN SUM	Cyperaceae*	Ericaceae*	Rubus chamaemorus*	Menyanthes*	Nuphar*	Typha*	Sparganium*	Mynophyllum*	Unidentified non-arboreal pollen*	Polypodiaceae*	Ferns (trilete)*	Osmunda*	Unidentified Fern spores*	Sphagnum*
1	6.1	28.3	0.4	1.6	28.3	2.0	0.8		0.4							67.9	247	2.8								7.3		0.4		13.8	
2	1.0	43.6			12.9	3.0										60.5	101	14.9								3.0	7.0			1.0	
3	5.5	4.3		0.3	17.6	0.6										28.3	329	2.7								3.0				3.3	
4	9.1	10.5	0.9	1.2	12.3	0.9			0.3							35.2	342	0.9					0.6			4.1		0.3		1.5	
5	4.3	8.6			6.4						0.7					20.0	140	5.7					0.7			5.7		1.4			0.7
6	1.6	0.8			6.5	0.4	0.4		0.4							10.1	245	0.4				0.4	0.4			1.2		0.4			0.4
7	11.7	4.1		0.3	6.2	5.5	0.3				0.3		0.3	0.3		29.0	290	2.1				0.3	0.6		3.4	1.7	0.3				
8	0.8	0.4			1.2				0.4		0.4					3.2	241	7.9					0.4			0.8					
9	3.2	3.2		1.6	0.8	0.4			0.4						0.4	10.0	249	1.6	0.4						0.4	1.6					0.4
10	1.2	4.2			10.7	0.2	0.2									16.5	403	1.0				0.2	0.2	0.2		2.2				0.2	
11		3.0		0.6	2.4	0.6			0.6							7.2	165	3.0					9.7			1.8		0.6			
12	2.5	6.9		0.5	9.3	2.0										21.2	204	39.2				3.4	7.8	0.5	3.9	5.4				0.5	
13				1.8	2.6	0.9										5.3	114	0.9			0.9										7.0
14	1.0	2.4			3.8	1.9				1.9					0.5	11.5	208	5.8				0.5	2.9		1.4	0.5					0.5
15	2.2	2.6			4.7											9.5	232	1.7					1.3			2.2				0.9	
16	2.5	4.7			3.0	0.8					0.4	0.4			0.4	12.2	236	78.8	1.3							1.7					39.4
17	2.6	2.2			3.5											8.3	228	0.4				0.4				0.9					
18	3.1	1.2			1.2	0.4									1.2	7.1	259	1.5	4.6							0.8					52.1
19	2.1	2.1	0.4		6.0	0.4									0.4	11.4	234	0.4	0.4									1.3			
20	0.8	2.0		0.8	8.2	0.8	0.4			0.4						13.4	256	0.4	0.8			1.2				2.0					4.3
21	2.6	0.4			3.5											6.5	229	3.5	0.8				7.4			3.5					0.4
22	0.9			0.9	1.3	3.2		0.4	1.8						1.3	8.9	225									1.3		0.4			
23	5.3	0.4			7.8	1.2					0.4					15.1	245									3.3	0.8				0.8
24		1.0			1.5		0.5							0.5		3.5	199		9.5							1.0					**
25	2.9	2.5		1.7	0.8									0.4		8.3	239	0.4	4.2						1.3						151.5
26	3.6	4.9		0.4	6.2						1.3				0.4	16.9	225	0.9	0.9							0.4		0.9	0.4		0.9
27		0.4		2.1	1.6						0.8					4.9	242	20.7													0.4
28	0.8	2.9		0.4	4.1	0.4				0.4					0.4	9.4	241	0.8	0.4		0.4					1.7		0.4			44.8
29		2.4		0.4	0.4	0.4	0.4									4.0	211	0.4	3.8	0.4						0.4					3.8
30	0.3	0.9		0.6	2.7	0.3										4.8	233	0.3	0.3							0.3				0.3	2.7
31		0.8			1.3											2.1	377	4.5	1.3												10.1
32		0.3			1.9						0.3		0.3		0.3	3.1	322	1.5	7.4	0.3						0.3					40.2
33	0.4	0.7			0.7											1.8	269		4.1							1.9					**
34		0.2			0.2	0.2									0.2	0.8	501	0.6	0.2							0.2					2.6
35	0.6				2.3		0.3				0.3					3.5	309		0.3			0.3				0.9					4.9
36	0.9				3.2	0.5				0.5	0.5					5.4	217	0.9	1.4	0.9						0.5					18.0

* Percentages calculated on pollen sum but not included in it　　** Very abundant

DISCUSSION

The pie diagrams (Fig. 2) illustrate the relative increase in arboreal and shrub pollen and the decrease in non-arboreal pollen along a transect from the grasslands across the boreal forests. Arboreal pollen totals increase from a minimum in the grasslands to a general dominance in the forested areas and decrease again in the transition zone between forest and tundra. The shrub pollen total, although somewhat erratic, shows a low value in the grasslands, a higher value in the forested areas and reaches a maximum in the northern transition zone. This maximum would be enhanced if the shrub birch fraction of the total birch pollen in this zone could be ascertained. The reverse of the shrub trend is true of total non-arboreal pollen.

Pollen of individual genera show relative percentages that vary widely over the range of samples. Spruce pollen reaches a maximum near the centre of the Mixedwood Section and, as would be expected, is abundant throughout this section and the Upper Churchill Section. It is understandably poorly represented in the grasslands and Aspen Grove Section. Why it is less plentiful in the Northern Coniferous, Athabasca South and Northwest Transition sections where it is a dominant genus, is not readily explainable. Possibly, local overabundance of pollen and spores of other genera mask the spruce.

Pine pollen is found in great quantities in all samples, even those from the grasslands, although the nearest pine tree may be hundreds of miles away. Abundance of pine pollen beyond the range of pine has been encountered elsewhere (Terasmae and Mott, 1965). In Saskatchewan the highest relative percentages for pine pollen are obtained along the northern and southern limits of its range where it covers large areas or is locally abundant. Fir and tamarack pollen do not reach significant values in any sample.

Although somewhat erratic in its occurrences, birch pollen is present in all but one sample. Percentages increase gradually northward and reach a maximum in the Northwest Transition Section. More than one species is involved and shrub birch pollen may be locally very plentiful in the north. *Populus* is usually poorly represented because of the poor preservation of the pollen as shown by the low percentages or complete absence of *Populus* pollen in most samples. At only three sites, two in the Aspen Grove Section and one in the Mixedwood Section, was *Populus* pollen abundant. The better preservation at these sites cannot be explained by a similarity in the type of environment. At site 3, where 27.1 per cent *Populus* pollen was obtained, the greatest depth of this small lake is 30 feet and the sediment is marl. At site 4, a large lake in a former glacial spillway, samples of marl collected from a water depth of 40 feet yielded 23.1 per cent *Populus* pollen. The third site, site 8, is a small pond with a maximum water depth of 13.5 feet. Algal gyttja from this lake gave 14.2 per cent *Populus* pollen. It remains to be seen whether or not *Populus* pollen is preserved throughout the cores obtained from these three sites. Pollen of other genera of deciduous trees were represented in quantities too minute to be significant.

Among the shrub pollen represented, alder is the most plentiful but its percentages are erratic. Sites in the Northwest Transition Section of the boreal forest have the highest percentages of alder pollen, probably reflecting local abundance of alder shrubs in wet areas. Willow is usually the only other shrub represented in the pollen spectra. It occurs locally in great quantities around lakes and on wet sites in the forested areas.

Among those included in the non-arboreal pollen sum, only three types - grass, chenopodiineae and *Artemisia* - occur in significant amounts. Grass pollen, even in the Grassland Region, rarely exceeds 10 per cent, and in forested areas the percentage is much lower. Of the other non-arboreal pollen representatives, Chenopodiinaea and *Artemisia* appear to be even more characteristic than grass pollen of a grassland environment. Both are abundantly represented by pollen at grassland sites but decrease abruptly in the forested areas. The prominent role played by *Artemisia*, and especially *A. frigida* in the grass communities explains the high percentages of this pollen in grassland sites. Chenopodiinaea are at their present abundance on salt flats, disturbed areas and waste spaces. The high abundance of Chenopodiinaea pollen thus may simply reflect the increase in disturbed and waste areas with the advent of agriculture, but this should become evident when longer cores are studied.

Of the taxa not included in the pollen sum, the sedges, although varying greatly in percentage, are the most consistently present. The argument for their exclusion, based on the assumption that they are only present in wet areas, may be valid for forested areas but carries little weight in the grasslands. Although secondary to some grasses, sedges are, nevertheless, prominent members of grassland communities. Pollen of other taxa are much more erratic in occurrence, indicating only local concentrations.

CONCLUSIONS

The following conclusions emerge from the results of this study:

The major vegetation zones can be distinguished by their pollen spectra.

Grasslands are characterized by:
60 to 70 per cent herb pollen, chiefly *Artemisia*, members of the Chenopodiinaea, and grasses,
25 to 35 per cent tree pollen that is predominantly pine,
5 to 6 per cent or less shrub pollen of alder and willow.

Spectra from forested landscapes show a preponderance of tree pollen (between 50 and 95 per cent) with 5 to 20 per cent shrub pollen and less than 20 per cent herb pollen. The herb pollen content, however, varies, and in forest zones close to the grassland region is as high as 35 per cent.

Some sections within the Boreal Forest Region are distinguishable if the abundance of pollen from representative individual genera is considered in conjunction with the above percentages.

Populus pollen, although usually somewhat unreliable, may be a good indicator of aspen grove forest if present in large amounts (>20 per cent). Other taxa should also be considered for this type of forest. For example, spruce pollen would be consistently low while pine pollen may be abundant. Pollen of characteristic grassland herb taxa may also be abundant, indicating open areas among the groves of aspen.

Pollen spectra for the other forested sections are not as diagnostic and are therefore more difficult to recognize Also, in the more northerly sections, the percentages are based on too few sampling sites to be reliable. Characteristically, however, the forested sections have relatively more tree pollen, 65 to 95 per cent, with a better representation of spruce than is found farther south. Pine pollen is abundant and toward the southern and northern edges of the region may account for 65 to 70 per cent of the sample. If there is abundance of grassland herb pollen, between 5 and 20 per cent, in conjunction with considerable amounts of pine pollen a more southerly section is usually indicated. However, a low herb pollen percentage does not necessarily indicate a northerly section.

Within the Northwestern Transition Section alder and, to some extent, birch pollen are more abundant. Therefore, tree pollen percentages between 40 and 70 per cent accompanied by higher shrub pollen percentages (between 20 and 50 per cent) and low herb pollen percentages (less than 6 per cent) appear to be indicative of the northern transition between forest and tundra. More complete study may reveal that these criteria are not reliable indicators of a transition zone but are merely reflections of local vegetation. The presence of small amounts of pollen of characteristic tundra vegetation might prove to be a more useful criterion.

Detailed study of several long cores already obtained from Saskatchewan may determine the extent to which the present conclusions will be useful in outlining past vegetation zones. Preliminary results suggest that at least some of the pollen spectra discussed here are of diagnostic value.

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