PROVINCE OF ALBERTA

RESEARCH COUNCIL OF ALBERTA

BULLETIN 25

MICROFLORAL DIAGNOSIS OF THE CRETACEOUS-TERTIARY BOUNDARY, CENTRAL ALBERTA

by

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Edmonton
October, 1969

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Microfloral Diagnosis of the Cretaceous-Tertiary Boundary, Central Alberta

ABSTRACT

Four stratigraphic sections in central Alberta adjacent to the contact between the Edmonton and Paskapoo Formations of Late Cretaceous and Tertiary ages were sampled for palynological study. A total of 36 genera and 58 species of microspores and pollen, and 2 genera and 14 species of megaspores useful for evaluating the position of the Cretaceous-Tertiary boundary in central Alberta are described and figured. A new approach to classification, based mainly on details of wall stratification, is used in discriminating among eight new species of *Azolla*.

Three microfloral "zones" defined mainly by the distribution of vertically restricted species have been established in the studied sections. Many of these species have been described previously from equivalent strata in South Dakota, Montana, and New Mexico. The lower microfloral "zone" encompasses beds a short distance above and below the "mauve shale" and Kneehills Member of the Edmonton Formation and contains a microflora of Maestrichtian age. The middle microfloral "zone" coincides with the uppermost beds of the Edmonton Formation (upper coaly interval), containing predominantly elements of the lower flora together with a few index species of Paleocene age. The upper microfloral "zone" spans the lower part of Paskapoo Formation and contains numerous index species of Paleocene or younger age. The distribution of index species in the three microfloral "zones" and the transitional nature of the flora in the middle "zone" suggest that the Cretaceous-Tertiary boundary probably lies within the uppermost beds of the Edmonton Formation (upper coaly interval).

INTRODUCTION

Nonmarine sedimentary rocks of late Cretaceous and early Tertiary ages underlie a large portion of southern and central Alberta. The greatest thickness of these beds is found along the axis of the Alberta Syncline, adjacent to the eastern margin of the Rocky Mountain Foothills (Fig. 1), where it is estimated to be in the order of 10,000 feet. The presence of thick coal beds in these strata has generated various stratigraphic and economic investigations over the years, although attempts to subdivide and correlate this succession of predominantly nonmarine rocks on a regional basis have been made difficult by the lack of widespread marker beds and reliable index fossils.

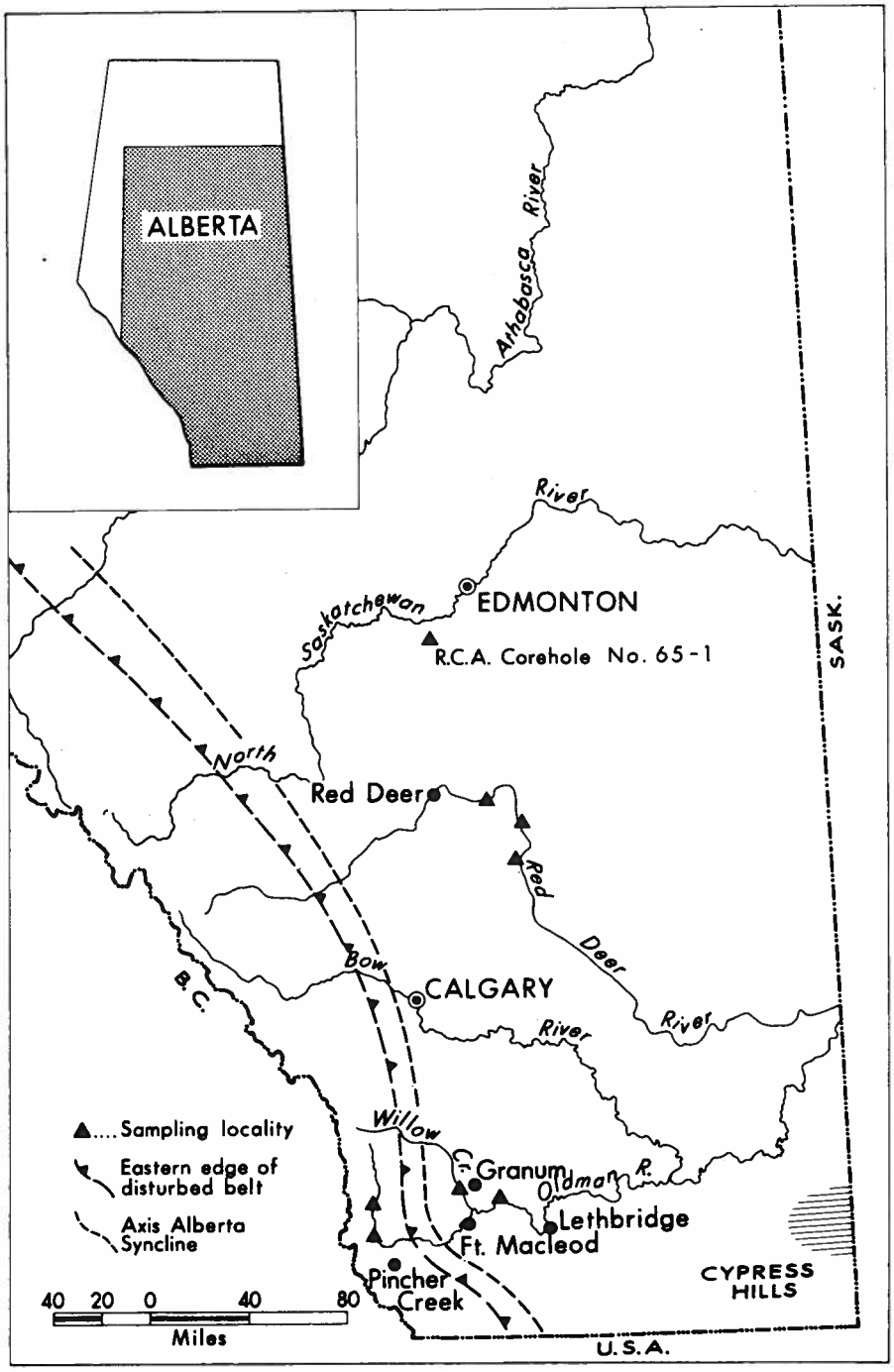

FIGURE 1. Map of sampling localities.

In this connection, criteria for defining the Cretaceous-Tertiary boundary in the Western Canada sedimentary basin have been sought over the past half-century. Because the rocks lack marine fossils, the criteria have rested largely on the distribution of dinosaur remains. However, although the presence of dinosaur bones identifies Cretaceous beds, their absence does not necessarily imply a Tertiary age for the rocks. Other criteria, based mainly on mammal and invertebrate remains and leaf impressions, also present difficulties in interpreting the exact ages of the succession, in part due to the scarcity of material and to the relatively long stratigraphic ranges of the forms involved.

This study is concerned with the microfloral succession in strata adjacent to the inferred position of the Cretaceous-Tertiary boundary in the central Alberta Plains: the uppermost beds of the late Cretaceous Edmonton Formation and the basal beds of the Paleocene Paskapoo Formation. Subsurface and outcrop samples from both formations have been examined for their microfloral content, and an evolutionary succession of genera and higher taxa of spores and pollen has been worked out for the interval extending from below beds containing the highest observed ceratopsian dinosaurs to those containing mammals of Paleocene age. Also, a small amount of material was obtained from partly correlative strata in southwestern Alberta which is included for comparative purposes.

The objectives of the investigation are:

(1) to define the contact between Cretaceous and Tertiary strata in central Alberta; and

(2) to correlate by means of microfloral assemblages the classic outcrop sections of upper Edmonton and lower Paskapoo strata along the Red Deer River with subsurface and outcrop sections of partly correlative strata in north-central and southwestern Alberta (Fig. 1).

The first part of the report describes the stratigraphy and lithology of the sections studied in central Alberta. Correlation with equivalent beds in southwestern Alberta and adjacent parts of Saskatchewan and the northern United States also is discussed. The subsequent portion deals with the age and correlation of the microfloras, followed by a section containing systematic descriptions of species.

Previous Work

The nonmarine uppermost Cretaceous and lower Tertiary strata of the Alberta Plains have been described by a number of geologists, including

Selwyn (1874), Dawson (1883), Tyrrell (1887), and Brown (1907, 1914), who outlined the broad stratigraphic features of the rocks, basing their correlations largely on lithologic criteria. Subsequently, during the period 1917-1925, Allan and Sanderson (1945) investigated the excellent exposures of the Edmonton and Paskapoo Formations along the Red Deer River valley in east-central Alberta, giving special attention to the distribution and correlation of coal seams in the Edmonton Formation.

More recently, the search for oil in Alberta has made available a large amount of subsurface data, permitting more detailed studies of the uppermost Cretaceous and Tertiary strata of the Plains. Ower (1960), for example, attempted to correlate the type section of the Edmonton Formation on the Red Deer River with scattered exposures on the North Saskatchewan River by tracing intervening subsurface sections with the aid of electric logs. Elliott (1960) also published a stratigraphic study of the Edmonton Formation in central Alberta based on electric log correlations, making use of a widespread tuffaceous bed (Kneehills Member) in the upper part of the formation which had been described previously by Allan and Sanderson (*op. cit.*). This unit provides the only reliable stratigraphic marker bed in an otherwise lithologically similar succession and, consequently, has received considerable attention (Russell, 1932; Fraser *et al.*, 1935; Stewart, 1943; Furnival, 1946; Rutherford, 1947; Douglas, 1950; Tozer, 1952; Ritchie, 1960; Folinsbee *et al.*, 1961).

Beds spanning the Cretaceous-Tertiary boundary in central and southern Alberta have yielded a variety of fossil remains, not all of equal value in dating the rocks. The invertebrate fauna, mainly molluscs, of the Edmonton Formation in the Red Deer River valley was described by Sanderson (*in* Allan and Sanderson, *op. cit.*), and that of the overlying Paskapoo Formation by Russell (1926a). Tozer (1956) subsequently described the molluscan fauna and Germundson (1965) the charophytes and ostracodes from correlative beds in southwestern Alberta. The Edmonton Formation of the Red Deer River valley is renowned for its reptilian fauna, which ranges into the upper part of the formation (Sternberg, 1947, 1949). More recently, mammalian remains have been discovered in the uppermost beds of the Edmonton Formation, as documented by Clemens and Russell (1965) and by Srivastava (1966).

The megaflora of the Edmonton-Paskapoo succession and correlative beds in western Alberta has been summarized in a comprehensive work by Bell (1949). The microflora from a composite section of the upper part of the Edmonton Formation in the Red Deer River valley has been described by Srivastava (*op. cit.*); this study helped to provide the foundation for the present investigation.

Acknowledgments

This report is based on a Ph.D. thesis prepared under the supervision of Dr. C. R. Stelck, Department of Geology, University of Alberta. Special

thanks are extended to Dr. G. B. Mellon, Research Council of Alberta, for generous assistance in helping to organize the field and laboratory phases of the investigation, and to Dr. C. Singh, Research Council of Alberta, for editing the taxonomic portion and offering much constructive criticism. Dr. L. V. Hills, Department of Geology, University of Calgary, originally suggested the problem and gave much critical advice concerning the *Azolla* megaspores. Mr. M. A. Carrigy and Dr. J. D. Campbell, Research Council of Alberta, offered many helpful suggestions during the course of the investigation. Dr. L. A. Bayrock, Research Council of Alberta, kindly translated pertinent portions from Russian papers.

Mrs. J. Rauh spent many hours of assistance in proofreading, and Mr. G. B. Tanne aided in preparing the plates. The writer is grateful to his wife not only for typing and helping in preparing the illustrations but also for her encouragement throughout the investigation.

Financial assistance was provided by the University of Alberta in the form of a Dissertation Fellowship, by the Department of Geology, University of Alberta, in the form of a teaching assistantship, and by the Research Council of Alberta, during the summers of 1965, 1966, and 1967. Laboratory space and equipment, and drafting services also were provided by the Research Council of Alberta.

LOCATION OF SAMPLES AND LABORATORY TECHNIQUES

Distribution of Sampling Localities

Nonmarine strata of latest Cretaceous and Paleocene ages form a thick monoclinal wedge of detrital rocks that is preserved in western Alberta in the so-called "Alberta Syncline" to the east of the Rocky Mountains and Foothills (Fig. 1). The width of these beds across strike narrows from 175 miles west of Edmonton to 30 miles west of Lethbridge, near the International Boundary.

Figure 1 shows the location of sampled outcrop and subsurface sections. R.C.A. Corehole 65-1 was drilled and sampled in 1965. Because 500 feet of continuous core were recovered from this well, through beds presumably adjacent to the Cretaceous-Tertiary boundary, and the recovery of microflora was high, it is used as a standard section with which the outcrop sections are compared. Outcrop sections exposing the upper part of the Edmonton and basal part of the Paskapoo Formations along the Red Deer River also were sampled and measured in 1965 (Fig. 2). These sections together with that in R.C.A. Corehole 65-1 constitute the sections on which the bulk of the study is based. Correlative beds in southwestern Alberta (Willow Creek Formation) were measured and sampled along the Oldman River and Willow Creek in 1966 (Fig. 1). The microfloral content of the samples was very low, and detailed palynological analysis and comparison with the sections in central Alberta was not possible.

In all, 99 samples were collected and processed for microfloral content: 41 from R.C.A. Corehole No. 65-1, 45 from sections along the Red Deer River, and the remainder from outcrops in southwestern Alberta. Forty-four of these yielded identifiable microfloral material: 23 from R.C.A. Corehole No. 65-1, 17 from sections along the Red Deer River, and 4 from southwestern Alberta. The stratigraphic positions of individual samples together with a general indication of their microfloral content are shown in figure 2 for R.C.A. Corehole No. 65-1 and for sections along the Red Deer River.

Sampling Procedure

The general lithology of the sampled sections consists of complexly interbedded claystones, siltstones and sandstones, but only the claystones and dark-colored siltstones were sampled. Channels three to five feet long and one to two feet deep were excavated to acquire a series of samples from outcrops. Composite samples were taken over continuous five-foot intervals from core material. Spot samples were taken only from isolated claystone or siltstone partings in predominantly sandy intervals.

Sample Preparation

The technique used in macerating the samples follows closely that used by Anderson (1960) and Singh (1964). Briefly, each sample was demineralized with hydrofluoric acid (the more calcareous samples were first treated with dilute hydrochloric acid), oxidized with Schultze's solution, suspended in potassium carbonate, and wet-sieved through a 100-mesh screen to collect megaspores. The material passing through the sieve was suspended in zinc bromide to separate the organic residue containing the microflora and then stained with safranin-0. Three slides were prepared for each sample; two with polyvinyl alcohol and Canada balsam as a permanent mounting medium, and one with corn syrup.

The recovery of megaspores, mainly *Azolla,* was poor using the above procedure, probably because of the small sample size (20 grams). Recovery was improved considerably in all samples, including those which had failed to yield any megaspores by the above technique, by using the following procedure:

(1) Forty to fifty grams of the uncrushed sample were washed and placed in a 1000 ml glass beaker partially filled with distilled water.

(2) About 30 grams of Quaternary-0 detergent were added to the beaker and the liquid was brought to a low boil. The boiling was continued till the sample was completely disaggregated.

(3) The sample was wet-sieved through a 100-mesh screen. Material remaining on the sieve was searched for megaspores.

(4) The megaspores were treated with hydrofluoric acid from 8 to 12 hours to remove any mineralization.

All of the claystones, regardless of the apparent degree of lithification, broke down readily within thirty minutes. This also was true of siltstones and sandstones which contained a matrix of argillaceous material. After recovery, each megaspore was oxidized if necessary, washed in distilled water, dehydrated in ethyl alcohol and xylene for ten minutes, and then mounted in Canada balsam.

Counting Procedure

Two-hundred and fifty grains per sample were counted for most of the samples from the No. 65-1 corehole and Red Deer River sections. In samples containing abundant microflora, only one slide per sample was necessary to count 250 grains. With other samples, two or more slides were

necessary for a complete count. Where microflora was scarce, counts of 100 grains per sample or less were made. After a complete count had been made and the grains recorded, the remaining slides were scanned for rarer specimens.

A Carl Zeiss Polarizing Photomicroscope was used for scanning the slides and for taking the photomicrographs.

Codification and Taxonomic Approach

The microspores and pollen grains were initially classified using a coded system similar to that described by Fournier and Newman (1964). This system is based entirely on morphological features, the most important being the nature and position of the aperture, colpi, and pores. On this basis 17 artificial groups were established which were then subdivided on the basis of the sculpture of the grain. Each group as well as each subdivision was coded. Finally, the specific characteristics defining the morphologic entity, such as size, exine thickness, labrum, outline, etc., were incorporated in the description. The coded morphologic entities pertinent to age determination and correlation subsequently have been reclassified formally according to the taxonomic approach proposed by Rouse (1957).

Slide Repository

The microfloral slides are stored in the palynological collection of the Research Council of Alberta. The coding on each slide contains the following information: geologic section number, sample number, and slide number or numbers. The code on all megaspore slides is followed by the letter M.

STRATIGRAPHY AND CORRELATION

The Late Cretaceous seas of the Interior Plains were characterized by numerous fluctuations in sea level which are reflected in the rocks from northern Alberta to those of the Texas-Louisiana Gulf Coast. The first marine transgression into southern and central Alberta during Late Cretaceous time resulted in deposition of the marine shales of the Colorado and Alberta Groups. Subsequent uplift of the source of sediment in the west and regression of this sea led to deposition of the coarse clastic sediments of the Belly River Formation throughout central and southern Alberta, and southwestern Saskatchewan. In the Foothills area between the Bow and Athabasca Rivers, the Belly River Formation is followed by an uninterrupted succession of similar continental sediments of latest Cretaceous and early Tertiary ages. South of this area, the Late Cretaceous sea once again transgressed from the southeast after deposition of the Belly River succession, resulting in the deposition of the marine sandstones and shales of the Bearpaw Formation (Table 1). After the withdrawal of the Bearpaw sea, continental conditions of deposition returned to the entire area, persisting into the Paleocene.

In the narrow portion of the Alberta Syncline, halfway between the Bow and Oldman Rivers, the marine Bearpaw shales are overlain respectively by the Blood Reserve, St. Mary River, Willow Creek, and Porcupine Hills Formations (Table 1). These units are correlative in part to the Eastend, Whitemud, Battle, Frenchman, and Ravenscrag Formations of southeastern Alberta and adjacent Saskatchewan (Cypress Hills region) and to the Edmonton and Paskapoo Formations of central Alberta.

Age designations for the stratigraphic units adjacent to the inferred position of the Cretaceous-Tertiary boundary have been assigned by numerous workers who have attempted to correlate with equivalent strata in the northern United States on the basis of plant megafossils, vertebrate remains, and marine and nonmarine invertebrate fossils. The general description, distribution, and assigned ages of these units are given in table 2.

Descriptions of Formations

Edmonton Formation

"Edmonton series" was the name used by Selwyn (1874) to describe exposures along the North Saskatchewan River in the vicinity of what is now the City of Edmonton. Tyrrell (1887) subsequently defined all the beds lying between the contact with the underlying marine Bearpaw shales and the thick coal seam mined on the Red Deer River at Ardley, Alberta,

as part of the Edmonton series. The unit was given formational status by Allan and Sanderson (1945), who redefined the upper boundary along the Red Deer River to include about 100 feet of beds between the Ardley coal interval and the base of a thick buff-weathering sandstone which they mapped as Paskapoo Formation. They considered the base of this sandstone to mark an erosional disconformity in the succession in this area which presumably coincided with the Cretaceous-Tertiary boundary.

More recent work on the Edmonton Formation has taken into account the large amount of subsurface data made available by drilling for oil in Alberta (Ower, 1960; Elliott, 1960). Ower (*ibid.*) divided the formation in central Alberta into five members, which together with their thicknesses and lithologies are described briefly in descending order below:

Member	*Lithology*	*Thickness (ft)*
E	Grey to green bentonitic shale; fine- to coarse grained "salt-and-pepper" sandstone; coal beds; *Triceratops* fauna.	185-400
D	Kneehills Tuff Member: brown to black bentonitic shale with purplish tuffaceous shale and thin tuff beds near top; white clay and bentonitic sand at base in places.	20-50
C	Grey bentonitic shale and "salt-and-pepper" sandstone; several coal beds.	70-180
B	Pale green bentonitic shale with lenses and beds of "salt-and-pepper" sandstone; on Red Deer River contains in mid portion thin beds of marine fossiliferous limestone known as the Drumheller marine tongue; lower portion carries *Arrhinoceratops* fauna.	200-300
A	Grey and brown, bentonitic, carbonaceous shale; white and grey, feldspathic, "salt-and-pepper" sandstone; ironstone beds and concretions common; numerous beds of coal and coaly shale; transitional contact with underlying Bearpaw Formation.	420-900

The most reliable stratigraphic marker interval in the succession is the Kneehills Member (Ower's Member D) recognized and named by Allan and Sanderson (*op. cit*) and used subsequently by Elliott (*op. cit.*) in correlating subsurface sections of the Edmonton Formation in central Alberta. From 20 to 50 feet thick, the unit is composed mainly of black to dark brown, highly bentonitic shale with a characteristic purplish-grey weathering surface ("mauve shale"). In most places, the upper part of the unit contains a pale grey, hard, siliceous bed from 1 inch to 1 foot thick, the Kneehills Tuff proper.

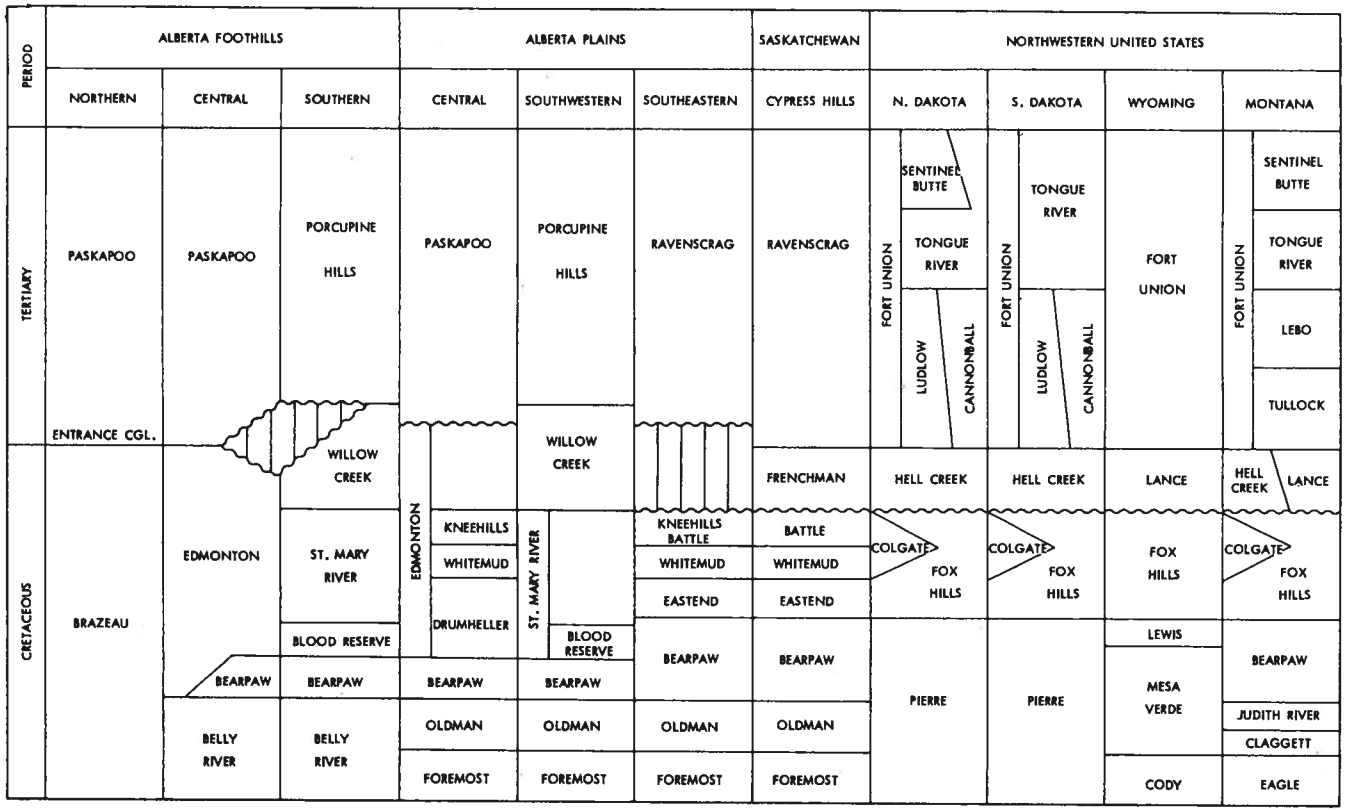

Table 1. A Correlation of Late Cretaceous and Tertiary Strata of Central and Southwestern Alberta with those of Southwestern Saskatchewan and Northwestern United States

Figure 2 shows the lithologies of the sections sampled for palynological study in central Alberta (see Appendix for detailed descriptions of sections). In R.C.A. Corehole No. 65-1 the lower 375 feet of section is correlative with the upper part of the Edmonton Formation, equivalent to Ower's members C (upper part), D, and E. Member C, about 150 feet thick, is represented by a lower coaly interval overlain by a thick white bentonitic sandstone. Member D contains 45 feet of soft, bentonitic shale with a well-developed silicified tuff layer (Kneehills Tuff) in the upper part. Member E passes from 45 feet of pale grey claystone and thin sandstone beds in the lower part to 135 feet of well-developed coal beds interbedded with carbonaceous claystone, siltstone, and sandstone.

Three sections on the Red Deer River were measured and sampled from the Kneehills Member upwards (Fig. 2). With the exceptions of the uppermost buff-weathering sandstones, sections 2 and 4 above the tuff were described by Ower as characteristic of member E. Section 3 also is mainly within member E but lacks abundant coal. It is lithologically similar to the lower 45 feet of member E in section 1 and the lower 120 feet in section 4.

Paskapoo Formation

The name "Paskapoo" was first applied by Tyrrell (1887) to a series of nonmarine sandstones and shales exposed along the canyon of Red Deer River a few miles east of the present City of Red Deer (Fig. 2). In this general area the term Paskapoo Formation has since become synonymous with any thick-bedded, buff-weathering sandstone overlying the uppermost coaly interval (Ower's member E = Ardley coal interval) of the Edmonton Formation. Allan and Sanderson (1945) interpreted the contact between the Paskapoo and underlying Edmonton Formations as a regional disconformity, but later work (*cf.* Ower, 1960) has thrown considerable doubt on this interpretation. The fact is that exposure of beds adjacent to the inferred position of the Edmonton-Paskapoo contact along the Red Deer River and its tributaries are too discontinuous and the lithologies of the two formations too variable to detect the presence of a regional disconformity in the section on the basis of gross lithology alone.

A portion of the Paskapoo Formation was measured and sampled in three sections in central Alberta. In R.C.A. Corehole No. 65-1 (Section 1, Fig. 2) the lower boundary was placed at the top of the uppermost coal bed. This is approximately 60 feet lower than the elevation (2,620 feet) at which Rutherford (1939) mapped the contact in the general area. However, the 35-foot thick, pale grey, medium-grained sandstone just above the uppermost coal seam in Corehole No. 65-1 is megascopically indistinguishable from Paskapoo Formation sandstones in the type area and thus provides a logical

datum for distinguishing between Edmonton and Paskapoo beds in this well. Above this sandstone, the section consists of 90 feet of interbedded grey to yellowish-grey carbonaceous siltstone, claystone, and silty claystone.

Along the Red Deer River, the basal beds of the Paskapoo Formation were recognized in sections 2 and 4, consisting of 10 to 40 feet of fine- to coarse-grained buff-weathering sandstone.

Willow Creek Formation

The Willow Creek Formation was defined originally by Dawson (1883) as a succession of nonmarine varicolored shales and sandstones between the St. Mary River and Porcupine Hills Formations in southwestern Alberta. Composite sections of the formation were measured and sampled in three areas of southern Alberta (Fig. 1) for palynological study, but the microfloral yield of the samples was insufficient for correlation with the sections in central Alberta.

On the west side of the Alberta Syncline, scattered samples from the entire Willow Creek Formation were taken along the Oldman River north of the Crowsnest Pass. In this area Douglas (1950) divided the formation into five "zones" on the basis of gross lithology. They are, in ascending order: "zone" A, 540 feet varicolored silty claystone and soft grey sandstone; "zone" B, 250 feet soft grey sandstone and mottled red and green claystone; "zone" C, 15 to 30 feet coarse-grained conglomeratic grey sandstone; "zones" D and E, together comprising 1900 feet, grading from soft grey sandstone and varicolored claystone of "zone" D to hard ledge-forming sandstone of "zone" E. Douglas suggested that the upper boundary of the formation was an erosional unconformity and consequently is post-Edmonton but pre-Paskapoo in age.

On the east side of the Alberta Syncline, two partial sections of the Willow Creek Formation were measured and sampled. The first, along the Oldman River north of Fort Macleod, contains 195 feet of interbedded varicolored silty claystones and thin grey sandstones. A well-developed silicified tuff within a mauve-weathering claystone, underlain by white fine-grained sandstone, is found at the base of the section. Tozer (1952) originally correlated this interval, on the basis of lithologic similarities, with the Kneehills Member along the Red Deer River, and with the Battle and Whitemud Formations in the Cypress Hills. Tozer assumed that the tuff unit marked the top of the St. Mary River Formation on the eastern limb of the Alberta Syncline.

The second section is west of Granum on Willow Creek, where the upper beds of the formation are exposed. Here, a conglomeratic sandstone is present which Bell (1949) correlated with the conglomerate that supposedly marks the base of the Paskapoo Formation on the Little Bow River to the north. Tozer (1956) subsequently stated that this conglomerate probably marks the Cretaceous-Tertiary boundary in this area, for molluscs of Paleocene age have not been found below this unit.

STRATIGRAPHIC PALYNOLOGY

Introduction

Of the four stratigraphic sections in central Alberta sampled for palynological study, that in R.C.A. Corehole No. 65-1 (Section 1, Fig. 2) contains the thickest and most complete succession of both upper Edmonton and basal Paskapoo strata. For this reason the succession of microfloral entities from this section has been used to calibrate it as a standard section for correlation with the outcrop sections of the same formations along the Red Deer River (Sections 2, 3, 4; Fig. 2) and with scattered outcrops of the Willow Creek Formation in southwestern Alberta.

The samples from R.C.A. Corehole No. 65-1 yielded 305 microfloral entities, which were classified according to the system of code outlined by Fournier and Newman (1964). The percentage and the total number of these entities restricted to different intervals in this section are shown in figure 3. Out of 305 microfloral entities recorded, 131 entities (43 per cent) do not range above the base of the upper coaly interval of the Edmonton Formation. On the other hand, out of 174 microfloral entities present in the upper coaly interval of the Edmonton Formation and in the overlying Paskapoo Formation, 74 entities (42.5 per cent) make their first appearance in these beds. This clearly indicates that major floral changes took place at the base of the upper coaly interval of the Edmonton Formation (upper part of Ower's member E). Thirty-one new microfloral entities make their first appearance just above the basal sandstone of the Paskapoo Formation, which points to another significant change in the flora. The beds between these two levels contain microfloral entities which are mostly transitional. Many microfloral entities present in the core samples from R.C.A. Corehole No. 65-1 also are present in the outcrop samples from the Red Deer River sections.

Out of the total microflora recovered, 36 genera and 58 species of microspores and pollen, and 2 genera and 14 species of megaspores, useful for evaluating the Cretaceous-Tertiary boundary in central Alberta, are described and figured. The stratigraphic distributions and relative abundances of these species are shown in tables 5 to 8. The 58 species of microspores and pollen mentioned above are well represented, constituting one per cent or more of the total microfloral count in each sample. Of these, 26 species have restricted stratigraphic ranges and a worldwide distribution. The stratigraphic and geographic distribution of these 26 index species is summarized in table 3.

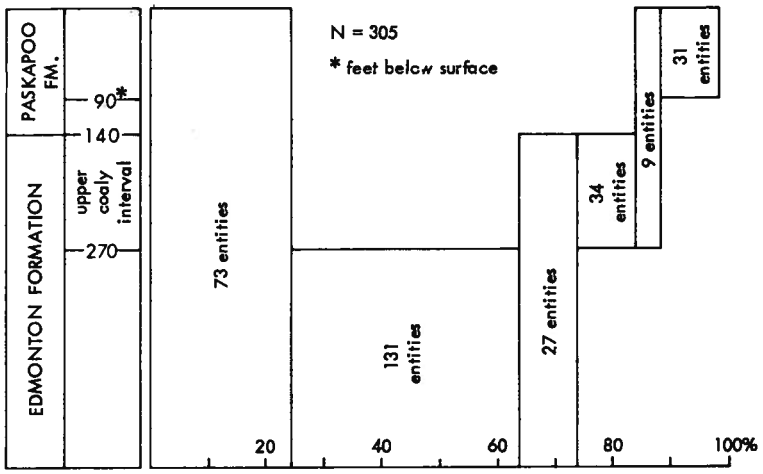

FIGURE 3. Percentages and total numbers of entities restricted to different intervals in R.C.A. Corehole 65-1.

Microfloral "Zones"

Three microfloral "zones", based mainly on the vertically restricted species, have been established in the studied sections. The lower microfloral "zone" (A) encompasses the beds from just below the Kneehills Member (Ower's member D), and extends up to the base of the upper coaly interval of the Edmonton Formation (Fig. 2). It contains 32 stratigraphically significant species which do not range above this "zone". The middle microfloral "zone" (B) coincides with the uppermost beds of the Edmonton Formation (upper coaly interval) and contains 8 stratigraphically significant species which are restricted to it. The upper microfloral "zone" (C) covers the lower part of the Paskapoo Formation and contains 10 stratigraphically significant species which make their entrance at this level. Microfloral "zones" A, B, and C are delineated in tables 3 to 8.

Species Restricted to Microfloral "Zone" A

Aquilapollenites polaris Funkhouser: Lance Formation (Maestrichtian), Wyoming (Funkhouser, 1961); Maestrichtian, Siberia, U.S.S.R. (Bratzeva, 1967)—1[1].

[1] Numbers indicate the section in which the entity is found (Fig. 2).

Aquilapollenites reticulatus Stanley: Hell Creek Formation (Maestrichtian), South Dakota (Stanley, 1961)—1, 3.

Leptolepidites tenuis Stanley: Hell Creek Formation (Maestrichtian), South Dakota (Stanley, 1965)—1, 3.

Erdtmanipollis pachysandroides Krutzsch: late Oligocene, Germany (Krutzsch, 1962); Hell Creek Formation (Maestrichtian) and Ludlow Member (Paleocene), Fort Union Formation, South Dakota (Stanley, 1965)—1, 3.

Schizosporis complexus Stanley: Hell Creek Formation (Maestrichtian), South Dakota (Stanley, 1965)—1.

Salixipollenites sp. cf. *Tricolpites bathyreticulatus* Stanley: Fort Union Formation, Ludlow and Cannonball Members (Paleocene), South Dakota (Stanley, 1965)—1, 3.

Aquilapollenites amplus Stanley: Hell Creek Formation (Maestrichtian), South Dakota (Stanley, 1965)—1, 3.

Aquilapollenites reductus Norton: Hell Creek Formation (Maestrichtian), Montana (Norton, 1965)—1, 3.

Azolla conspicua n. sp.—1.

Balmeisporites striatellus Kondinskaya: Upper Cretaceous, Siberia (Kondinskaya, 1966)—1, 3.

Equisetosporites amabilis Srivastava: Edmonton Formation (Maestrichtian), central Alberta (Srivastava, 1968)—1, 3.

Sigmopollis hispidus Hedlund: Miocene, Nevada (Hedlund, 1965)—1, 3.

Symplocoipollenites vestibulum (Potonié) Potonié: Miocene, Germany (Potonié, 1931)—1, 3.

Aquilapollenites sp. cf. *A. attenuatus* Funkhouser: Lance Formation (Maestrichtian), Wyoming (Funkhouser, 1961)—1.

Aquilapollenites sp. C—1, 3.

Hamulatisporis hamulatis Krutzsch: Eocene, Germany (Krutzsch, 1959); Hell Creek Formation (Maestrichtian), South Dakota (Stanley, 1965)—1, 3.

Aquilapollenites sp. A—1.

Aquilapollenites sp. B—1.

Balmeisporites sp. A—1.

Balmeisporites sp. B—1.

Balmeisporites sp. C—1.

Balmeisporites sp. D—1, 3.

Dictyophyllidites sp.—1, 3.

Aquilapollenites conatus Norton: Hell Creek Formation (Maestrichtian), Montana (Norton, 1965)—1, 3.

Aquilapollenites delicatus Stanley: Hell Creek Formation (Maestrichtian), South Dakota (Stanley, 1961)—1.

Azolla barbata n. sp.—1, 3.

Kurtzipites trispissatus Anderson: Kirtland Shale (latest Cretaceous), San Juan Basin, New Mexico (Anderson, 1960)—1, 3.

Momipites sanjuanenis Anderson: Lewis Shale (latest Cretaceous), San Juan Basin, New Mexico (Anderson, 1960)—1, 3.

Wodehouseia spinata Stanley: Hell Creek Formation (Maestrichtian), South Dakota (Stanley, 1961); Hell Creek Formation (Maestrichtian), Montana (Norton and Hall, 1967); Maestrichtian, Siberia, U.S.S.R. (Bratzeva, 1967)—1, 3.

Aquilapollenites sp. cf. *A. quadricretaceus* Chlonova: Maestrichtian to Danian, Vakh River Basin, U.S.S.R. (Chlonova, 1961)—1, 3.

Azolla filosa n. sp.—1, 3.

Azolla pilata n. sp.—1.

Species Ranging Through Microfloral "Zones" A and B

Cingulatisporites dakotaensis Stanley: Hell Creek Formation (Maestrichtian) and Fort Union Formation, Ludlow Member (Paleocene), South Dakota (Stanley, 1965)—1, 2, 3, 4.

Cranwellia rumseyensis Srivastava: Edmonton Formation (Maestrichtian), central Alberta (Srivastava, 1966)—1, 2, 3, 4.

Cupuliferoipollenites pusillus (Potonié) Potonié: Paleocene to Miocene of Europe (Potonié, 1960)—1, 2, 3, 4.

Polypodiisporites sp.—1, 2, 3, 4.

Scollardia steevesi Srivastava: Edmonton Formation (Maestrichtian), central Alberta (Srivastava, 1966)—1, 2, 3, 4.

Sphagnum regium Drozhastichich: Maestrichtian and Paleocene of western Siberia, Drozhastichich (*in* Samoilovitch *et al.*, 1961); Fort Union Formation, Ludlow Member (Paleocene), South Dakota (Stanley, 1965)—1, 2, 3, 4.

Reticuloidosporites sp.—1, 2, 3, 4.

Tricolpites sp. A—1, 2, 3, 4.

Tricolpites sp. B—1, 2, 3, 4.

Azolla lauta n. sp.—1, 2, 3.

Kurtzipites sp.—1, 2, 4.

Species Restricted to Microfloral "Zone" B

Myrtaceidites sp. C—1, 2.

Rhoipites sp. cf. *R. pisinnus* Stanley: Hell Creek Formation (Maestrichtian) and Fort Union Formation, Ludlow Member (Paleocene), South Dakota (Stanley, 1965)—1, 2.

Betulaceoipollenites sp.—1, 2, 4.

Myrtaceidites sp. A—1, 2.

Liliacidites sp.—1, 2, 4.

Myrtaceidites sp. B—1, 2, 4.

Salixipollenites sp. B—1, 2, 4.

Azolla fistulosa n. sp.—2, 4.

Species Ranging Through Microfloral "Zones" B and C

Salixipollenites sp. A—1, 2, 4.

Ulmoideipites tricostatus Anderson: Ojo Alamo Sandstone and Nacimiento Formation (latest Cretaceous (?) to early Paleocene), San Juan Basin, New Mexico (Anderson, 1960); Paleocene, northwestern Colorado (Newman, 1964); Danian, Siberia, U.S.S.R. (Samoilovitch, 1967)—1, 2.

Alnus trina Stanley: Fort Union Formation, Ludlow Member (Paleocene), South Dakota (Stanley, 1965)—1.

Momipites tenuipolus Anderson: Nacimiento Formation (early Paleocene), San Juan Basin, New Mexico (Anderson, 1960)—1, 2.

Momipites inaequalis Anderson: Ojo Alamo Sandstone and Nacimiento Formation (earliest Paleocene), San Juan Basin, New Mexico (Anderson, 1960); Paleocene, northwestern Colorado (Newman, 1964)—1, 2, 4.

Tilia danei Anderson: Nacimiento Formation (earliest Paleocene), San Juan Basin, New Mexico (Anderson, 1960)—1, 2.

Species Restricted to Microfloral "Zone" C

Alnus verus (Potonié) Rouse: Green River Formation (Eocene), Colorado (Wodehouse, 1933); Eocene and Miocene, Germany (Potonié, 1934; Potonié and Venitz, 1934); Upper Tertiary, Germany (Thomson and Pflug, 1953); Burrard Formation (Late Cretaceous to Eocene), British Columbia (Rouse, 1962)—1.

Aquilapollenites spinulosus Funkhouser: Fort Union Formation (Paleocene), Wyoming and Eocene of Rocky Mountain area (Funkhouser, 1961)—1.

Azolla bulbosa n. sp.—1.

Caryapollenites scabratus Groot and Groot: Brightseat Formation (Paleocene), Maryland (Groot and Groot, 1962); Fort Union Formation, Cannonball Member (Paleocene), South Dakota (Stanley, 1965)—1.

Tilia tetraforaminipites Wodehouse: Green River Formation (Eocene), Colorado (Wodehouse, 1933); Burrard Formation, Third Beach (Eocene), British Columbia (Rouse, 1962)—1.

Vitis sp. cf. *V*? *affluens* Stanley: Fort Union Formation, Ludlow Member (Paleocene), South Dakota (Stanley, 1965)—1.

Alnus rubriformis Simpson: Interbasaltic lignites (Early Tertiary), Mull district of Argyllshire, Scotland (Simpson, 1961)—1.

Carpinus subtriangula Stanley: Fort Union Formation, Cannonball Member (Paleocene), South Dakota (Stanley, 1965)—1.

Ovoidites ligneolus (Potonié) Potonié: Oligocene and Miocene, Germany (Potonié, 1931); Tertiary, Queensland, Australia (Harris, 1965); Fort Union Formation, Cannonball Member (Paleocene), South Dakota (Stanley, 1965)—1.

Pandanus sp. ? cf. *P.* ? *shiabensis* Simpson: Interbasaltic lignites (Tertiary), Mull district of Argyllshire, Scotland (Simpson, 1961)—1.

Dominant Species Recorded in Microfloral "Zones" A, B and C

Laevigatosporites gracilis Wilson and Webster—1, 2, 3, 4.

Sequoiapollenites paleocenicus Stanley—1, 2, 3, 4.

Taxodiaceaepollenites hiatus (Potonié) Kremp—1, 2, 3, 4.

Azolla distincta n. sp.—1, 2, 3, 4.

Azolla schopfi Dijkstra—1, 2, 3.

Age and Correlation of the Microfloral "Zones"

Microfloral "zone" A contains 12 species of microspores and pollen of latest Cretaceous age (Table 3). Ten of these species have not been

reported from strata younger than Maestrichtian to date, and the other two from strata probably not younger than Maestrichtian (Anderson, 1960). These 12 species are listed below:

Aquilapollenites polaris
Aquilapollenites reticulatus
Leptolepidites tenuis
Schizosporis complexus
Aquilapollenites amplus
Aquilapollenites reductus
Aquilapollenites sp. cf. *A. attenuatus*
Aquilapollenites conatus
Aquilapollenites delicatus
Kurtzipites trispissatus
Momipites sanjuanensis
Wodehouseia spinata

None of these species ranges above the boundary of "zone" A and their presence in this "zone" indicates a Maestrichtian age for the strata beneath the base of the upper coaly interval in R.C.A. Corehole No. 65-1 (Fig. 2).

Microfloral "zone" B contains 4 species of microspores and pollen, which are known to be present in strata of Maestrichtian and Paleocene ages elsewhere. These 4 species are listed below:

Cingulatisporites dakotaensis
Sphagnum regium
Rhoipites sp. cf. *R. pisinnus*
Ulmoideipites tricostatus

Besides these, 4 species of pollen which have not been reported from strata older than Paleocene also are found in "zone" B (Table 3):

Alnus trina
Momipites tenuipolus
Momipites inaequalis
Tilia danei

There are many stratigraphically less significant species which continue from microfloral "zone" A into "zone" B and from "zone" B into "zone" C. Thus "zone" B, which coincides with the uppermost part of Edmonton Formation (upper coaly interval, Fig. 2), appears to have a transitional flora. The presence of species of microspores and pollen listed above suggests that the Cretaceous-Tertiary boundary probably lies within the interval of strata spanned by "zone" B.

Microfloral "zone" C contains 8 species of pollen which have not been reported from the strata older than Paleocene (Table 3). These species are listed below:

Aquilapollenites spinulosus
Caryapollenites scabratus
Tilia tetraforaminipites
Vitis sp. cf. *V*? *affluens*
Alnus rubriformis
Carpinus subtriangula
Ovoidites ligneolus
Pandanus sp.? cf. *P. shiabensis*

Microfloral "zone" C spans beds just above the basal sandstone of the Paskapoo Formation (Fig. 2). Thirty-one new microfloral entities make their first appearance in this "zone" (Fig. 3). None of the older microfloral entities, except the long-ranging forms which are present throughout the studied sections, are present in "zone" C. The "zone" C microfloral assemblage is entirely different from that of "zone" A and indicates a Paleocene age for the basal Paskapoo succession.

The distribution of species restricted to different microfloral "zones" in R.C.A. Corehole No. 65-1 and three sections on the Red Deer River is shown in Table 4. Section 2 contains 11 species restricted to "zones" A and B, 8 species restricted to "zone" B, and 5 species restricted to "zones" B and C. The microflora is characteristic of microfloral "zone" B. Section 3 contains 21 species restricted to "zone" A and 10 species restricted to "zones" A and B. The microflora is characteristic of microfloral "zone" A. Section 4 contains 10 species restricted to "zones" A and B, 5 species restricted to "zone" B, and 2 species restricted to "zones" B and C. The microflora is characteristic of microfloral "zone" B. Correlation of the four sections based on microfloral "zones" is shown in figure 2.

Table 4. Distribution of Restricted Species in Microfloral "Zones" Adjacent to the Edmonton-Paskapoo Formations Contact in Central Alberta

	R.C.A. Corehole No. 65-1	Red Deer River Section 2	Red Deer River Section 3	Red Deer River Section 4
Species restricted to "zone" C	13			
Species restricted to "zones" B and C	3	5		2
Species restricted to "zone" B	7	8		5
Species restricted to "zones" A and B	11	11	10	10
Species restricted to "zone" A	32		21	

SUMMARY AND CONCLUSIONS

Four stratigraphic sections in central Alberta which span the contact between the Edmonton and Paskapoo Formations of latest Cretaceous and early Tertiary ages were sampled for palynological study. R.C.A. Corehole No. 65-1 was used as a standard section with which three outcrop sections on the Red Deer River were compared.

Analysis of the distribution of 305 coded microfloral entities from R.C.A. Corehole No. 65-1 shows that 43 per cent of the entities do not range above the base of the upper coaly interval of the Edmonton Formation and 42.5 per cent of the entities present above the base of the upper coaly interval make their first appearance in these beds. This signifies a major floral change at the base of the upper coaly interval of the Edmonton Formation.

Thirty-one new microfloral entities make their first appearance just above the base of the Paskapoo Formation. None of the older microfloral entities, except the long-ranging ones which continue throughout the entire succession, are present in the Paskapoo Formation. The Paskapoo microfloral assemblage is distinctly different from that of the lower beds and signifies a major change in the flora at this level. Thus, the base of the upper coaly interval of the Edmonton Formation and the base of the Paskapoo Formation, where significant changes in the flora seem to have occurred, were chosen to delineate the boundaries of three microfloral "zones".

The lower microfloral "zone" (A) encompasses beds below and above the Kneehills Tuff Member and extends to the base of the upper coaly interval of the Edmonton Formation. The middle microfloral "zone" (B) coincides with the uppermost beds of the Edmonton Formation (upper coaly interval). The upper microfloral "zone" (C) spans the lower part of the Paskapoo Formation.

Of the total microflora recovered, 36 genera and 58 species of microspores and pollen, and 2 genera and 14 species of megaspores useful for evaluating the position of the Cretaceous-Tertiary boundary in central Alberta are described and figured. The microfloral content of the beds underlying the upper coaly interval of the Edmonton Formation ("zone" A) indicates that they are of Maestrichtian age. The upper coaly interval of the Edmonton Formation ("zone" B) contains certain elements of the lower flora together with a few index species of Paleocene age. The transitional nature of the flora in "zone" B suggests that the Cretaceous-Tertiary boundary probably lies within this "zone", i.e. the uppermost beds of the Edmonton Formation. The lower part of Paskapoo Formation ("zone" C) contains numerous index species of Paleocene or younger age.

FORMAL DESCRIPTIONS

Family SPHAGNACEAE

Genus SPHAGNUM Ehrhart, 1780

SPHAGNUM REGIUM Drozhastichich, 1961

Plate 5, figure 10

1961 *Sphagnum regium* Drozhastichich, *in* Samoilovitch, *et al.*, Trudy Vses. Neft. Nauch.-Issled. Geol.-Razv. Inst., vol. 177, p. 18, pl. 2, figs. 1a-d, 2, 3.

Description: Trilete; equatorial diameter circular to subcircular; laesurae distinct and about ½ of spore radius; exine ornamentation granulate on both proximal and distal surfaces; granules 1 to 2 microns wide; exine approximately 1 micron thick; amb usually smooth.

Size range: Equatorial diameter 20 to 27 microns.

Distribution: Edmonton Formation in R.C.A. Corehole No. 65-1 (section 1, "zones" A and B), and outcrop sections 2, 3, and 4 on the Red Deer River.

Maestrichtian and Paleocene of western Siberia (Drozhastichich *in* Samoilovitch, *et al.*, 1961); Ludlow Member (Paleocene), Fort Union Formation, South Dakota (Stanley, 1965).

Locality of figured specimen: R.C.A. Corehole No. 65-1.

Pl. 5, fig. 10.	Depth 502 to 505 feet;	Edmonton Formation.
Pl. 5, fig. 10.	Slide No. 1-54-3;	co-ord. 11/74.4.

Family LYCOPODIACEAE

Genus HAMULATISPORIS Krutzsch, 1959

Type species HAMULATISPORIS HAMULATIS Krutzsch, 1959

HAMULATISPORIS HAMULATIS Krutzsch, 1959

Plate 3, figures 1, 2

1959 *Hamulatisporis hamulatis* Krutzsch, Geologie, Jahrg. 8, p. 157, pl. 29, figs. 326-328.

Description: Trilete; equatorial outline circular to subcircular; laesurae about ¾ of the length of spore radius; hamulate sculpture strongly developed on distal surface and weakly developed on the proximal surface; exine 1 to 2 microns thick.

Size range: Equatorial diameter 30 to 38 microns.

Distribution: Edmonton Formation in R.C.A. Corehole No. 65-1 (section 1, "zone" A), and in outcrop section 3 on the Red Deer River.

Hell Creek Formation (Maestrichtian), South Dakota (Stanley, 1965); Eocene, Germany (Krutzsch, 1959).

Locality of figured specimen: R.C.A. Corehole No. 65-1.

Pl. 3, figs. 1, 2.	Depth 454 to 459 feet;	Edmonton Formation.
Pl. 3, figs. 1, 2.	Slide No. 1-51-1;	co-ord. 11.1/112.6.

Family CHEIROPLEURIACEAE

Genus DICTYOPHYLLIDITES Couper, 1958

Type species DICTYOPHYLLIDITES HARRISII Couper, 1958

DICTYOPHYLLIDITES sp.

Plate 3, figure 6

Description: Trilete; equatorial outline triangular, sides convex; laesurae raised with thickened lips and about ¾ of the length of spore radius; exine 0.5 to 1 micron thick and faintly pitted.

Size range: Equatorial diameter 24 to 31 microns.

Distribution: Edmonton Formation in R.C.A. Corehole No. 65-1 (section 1, "zone" A), and in outcrop section 3 on the Red Deer River.

Locality of figured specimen: R.C.A. Corehole No. 65-1.

Pl. 3, fig. 6.	Depth 445 to 449 feet;	Edmonton Formation.
Pl. 3, fig. 6.	Slide 1-50-1;	co-ord. 15/115.

Family POLYPODIACEAE or DENNSTAEDTIACEAE

Genus LAEVIGATOSPORITES Ibrahim, 1933, emend.
Schopf, Wilson and Bentall, 1944

Type species LAEVIGATOSPORITES VULGARIS (Ibrahim)
Ibrahim, 1933

LAEVIGATOSPORITES GRACILIS Wilson and Webster, 1946
Plate 8, figures 1, 2

1946 *Laevigatosporites gracilis* Wilson and Webster, Am. Jour. Botany, vol. 33, p. 273, fig. 4.

Description: Monolete; monolete mark faint; equatorial outline kidney-shaped with laesura on the proximal concave side; ornamentation faintly scabrate to smooth; exine 1 to 1.5 microns thick.

Size range: Length 23 to 38 microns.
Breadth 13 to 23 microns.

Distribution: Edmonton and Paskapoo Formations in R.C.A. Corehole No. 65-1 (section 1, "zones" A, B and C), and in outcrop sections 2, 3, and 4 on the Red Deer River.

Fort Union Formation (Paleocene), Montana (Wilson and Webster, 1946). Potomac Group (Lower Cretaceous), Maryland (Brenner, 1963).

Remarks: *Laevigatosporites gracilis* Wilson and Webster can be distinguished from *Laevigatosporites haardti* (Potonié and Venitz) Thomson and Pflug, 1953, by the lack of a thicker exine in the proximal region and its more elongate outline; and from *Laevigatosporites albertensis* Rouse, 1957, by the lack of a distinctly punctate ornamentation.

Locality of figured specimens: R.C.A. Corehole No. 65-1.

Pl. 8, fig. 1.	Depth 229 to 232 feet;	Edmonton Formation.
Pl. 8, fig. 1.	Slide No. 1-26-1;	co-ord. 13.1/85.7.
Pl. 8, fig. 2.	Depth 229 to 232 feet;	Edmonton Formation.
Pl. 8, fig. 2.	Slide No. 1-26-1;	co-ord. 11.9/87.7.

Genus RETICULOIDOSPORITES Pflug, 1953

Type species RETICULOIDOSPORITES DENTATUS (Pflug) Pflug, 1953

RETICULOIDOSPORITES sp.

Plate 5, figures 11, 12

Description: Monolete; outline elliptical to bean-shaped; proximal surface straight to concave; monolete scar short and indistinct; exine ornamentation reticulate with lumina 1 to 1.5 microns wide; muri about 0.8 micron wide and 1 micron thick, very irregular, often discontinuous and forming an imperfect positive reticulate pattern; exine approximately 1.5 microns thick.

Size range: Length 24 to 33 microns.
Breadth 14 to 23 microns.

Distribution: Edmonton Formation in R.C.A. Corehole No. 65-1 (section 1, "zones" A and B), and outcrop sections 2, 3, and 4 on the Red Deer River.

Locality of figured specimens: R.C.A. Corehole No. 65-1.

Pl. 5, fig. 11.	Depth 221 to 227 feet;	Edmonton Formation.
Pl. 5, fig. 11.	Slide No. 1-25-1;	co-ord. 16.3/91.4.
Pl. 5, fig. 12.	Depth 313 to 319 feet;	Edmonton Formation.
Pl. 5, fig. 12.	Slide No. 1-40-3;	co-ord. 16.7/114.

Genus POLYPODIISPORITES Potonié, 1934

Type species POLYPODIISPORITES FAVUS (Potonié) Potonié, 1934

POLYPODIISPORITES sp.

Plate 5, figure 7

Description: Monolete; equatorial outline bean-shaped; proximal surface usually straight; monolete scar distinct; exine ornamented by flat to slightly arched verrucae; verrucae on distal surface large, 2 to 5 microns in diameter and 1 to 3 microns high, irregular in outline, with angular to rounded margins; verrucae on proximal surface absent or very weakly developed; exine 1 to 2 microns thick.

Size range: Length 36 to 55 microns.
Breadth 24 to 34 microns.

Distribution: Edmonton Formation in R.C.A. Corehole No. 65-1 (section 1, "zones" A and B), and outcrop sections 2, 3, and 4 on the Red Deer River.

Locality of figured specimen: R.C.A. Corehole No. 65-1.

Pl. 5, fig. 7.	Depth 221 to 227 feet;	Edmonton Formation.
Pl. 5, fig. 7.	Slide No. 1-25-1;	co-ord. 6.9/81.

SPORES-INCERTAE SEDIS

Genus CINGULATISPORITES Thomson, 1953, emend. Potonié, 1956

Type species CINGULATISPORITES LEVISPECIOSUS Pflug, 1953

CINGULATISPORITES DAKOTAENSIS Stanley, 1965

Plate 5, figures 1, 2

1965 *Cingulatisporites dakotaensis* Stanley, Bull. Am. Paleont., vol. 49, p. 243, pl. 30, figs. 1-8.

Description: Trilete; equatorial outline subcircular to subtriangular; laesurae gaping to closed, extending from to 1/2 to 2/3 radius of the spore; body with a distinct 2 to 4 microns wide cingulum; distal surface exhibiting a Y-shaped thickening rotated 60° in relation to the position of the tetrad mark; exine about 1 micron thick and smooth.

Size range: Equatorial diameter 25 to 29 microns.

Distribution: Edmonton Formation in R.C.A. Corehole No. 65-1 (section 1, "zones" A and B), and outcrop sections 2, 3, and 4 on the Red Deer River.

Hell Creek Formation (Maestrichtian) and Ludlow Member (Paleocene), Fort Union Formation, South Dakota (Stanley, 1965).

Locality of figured specimens: R.C.A. Corehole No. 65-1.

Pl. 5, fig. 1.	Depth 445 to 449 feet;	Edmonton Formation.
Pl. 5, fig. 1.	Slide No. 1-50-2;	co-ord. 19.9/77.9.
Pl. 5, fig. 2.	Depth 445 to 449 feet;	Edmonton Formation.
Pl. 5, fig. 2.	Slide No. 1-50-2;	co-ord. 10.7/115.

Genus LEPTOLEPIDITES Couper, 1953

Type species LEPTOLEPIDITES VERRUCATUS Couper, 1953

LEPTOLEPIDITES TENUIS Stanley, 1965

Plate 1, figure 4

1965 *Leptolepidites tenuis* Stanley, Bull. Am. Paleont., vol. 49, p. 255, pl. 32, figs. 7-11.

Description: Trilete; equatorial outline subcircular; laesurae distinct, about 3/4 of the length of spore radius; exine about 3 microns thick, ornamented distally with verrucae 3 to 5 microns in diameter and approximately 2 microns high; proximal surface smooth.

Size range: Equatorial diameter 24 to 40 microns.

Distribution: Edmonton Formation in R.C.A. Corehole No. 65-1 (section 1, "zone" A), and in outcrop section 3 on the Red Deer River.

Hell Creek Formation (Maestrichtian), South Dakota (Stanley, 1965).

Remarks: According to Dettmann (1963), the type species of *Leptolepidites* Couper is smooth proximally. The illustrations of the proximal surface of *Leptolepidites tenuis* by Stanley (pl. 32, figs. 7, 9) also appear to be smooth.

Locality of figured specimen: R.C.A. Corehole No. 65-1.

Pl. 1, fig. 4.	Depth 454 to 459 feet;	Edmonton Formation.
Pl. 1, fig. 4.	Slide No. 1-51-1;	co-ord. 11.2/92.

Family TAXODIACEAE

Genus SEQUOIAPOLLENITES Thiergart, 1938

Type species SEQUOIAPOLLENITES POLYFORMOSUS Thiergart, 1938

SEQUOIAPOLLENITES PALEOCENICUS Stanley, 1965

Plate 8, figures 3, 4

1965 *Sequoiapollenites paleocenicus* Stanley, Bull. Am. Paleont., vol. 49, p. 282, pl. 38, figs. 8-11.

Description: Inaperturate; outline circular; ligula distinct, 3 to 5 microns long and 3 microns wide, and usually slightly curved; exine 1 to 1.5 microns thick and granulate; granules approximately 1 micron in diameter; exine of ligula and surrounding area smooth to faintly scabrate.

Size range: Diameter 18 to 24 microns.

Distribution: Edmonton and Paskapoo Formations in R.C.A. Corehole No. 65-1 (section 1, "zones" A, B and C), and in outcrop sections 2, 3, and 4 on the Red Deer River.

Cannonball and Ludlow Members (Paleocene), Fort Union Formation, South Dakota (Stanley, 1965).

Locality of figured specimens: R.C.A. Corehole No. 65-1.

Pl. 8, fig. 3.	Depth 221 to 227 feet;	Edmonton Formation.
Pl. 8, fig. 3.	Slide No. 1-25-1;	co-ord. 10.1/102.
Pl. 8, fig. 4.	Depth 221 to 227 feet;	Edmonton Formation.
Pl. 8, fig. 4.	Slide No. 1-25-1;	co-ord. 10.3/108.1.

Genus TAXODIACEAEPOLLENITES Kremp, 1949

Type species TAXODIACEAEPOLLENITES HIATUS (Potonié) Kremp, 1949

TAXODIACEAEPOLLENITES HIATUS (Potonié) Kremp, 1949

Plate 8, figure 5

1931 *Pollenites hiatus* Potonié, Jahrb. Preuss. Geol. L. A. (Berlin) vol. 152, p. 5, fig. 27.
1933 *Taxodium hiatipites* Wodehouse, Bull. Torrey Botan. Club, vol. 60, p. 49, fig. 19.
1949 *Taxodiaceaepollenites hiatus* (Potonié) Kremp, Palaeontographica, Band 90, Abt. B, p. 59.

Description: Inaperturate(?); outline spherical to subspherical; distinct split usually occurring with a length 1/3 to 1/2 of the grain diameter; exine 0.5 to 1 micron thick and scabrate to distinctly granulate; granules 0.5 to 0.8 micron wide.

Size range: Diameter 17 to 31 microns.

Distribution: Edmonton and Paskapoo Formations in R.C.A. Corehole No. 65-1 (section 1, "zones" A, B and C), and sections 2, 3, and 4 on the Red Deer River.

Oligocene and Miocene, Germany (Kremp, 1949).

Locality of figured specimen: R.C.A. Corehole No. 65-1.

Pl. 8, fig. 5.	Depth 313 to 319 feet;	Edmonton Formation.
Pl. 8, fig. 5.	Slide No. 1-40-3;	co-ord. 16.8/91.7.

Family EPHEDRACEAE

Genus EQUISETOSPORITES Daugherty, 1941, emend. Singh, 1964

Type species EQUISETOSPORITES CHINLEANA Daugherty, 1941

EQUISETOSPORITES AMABILIS Srivastava, 1968

Plate 2, figure 2

1968 *Equisetosporites amabilis* Srivastava, Can. Jour. Earth Sciences, vol. 5, p. 216, pl. 1, figs. 7-9.

Description: Acolpate; outline ellipsoidal; ektexinous ridges 10 to 12 in number, running longitudinally, unbranched, straight, and approximately 4 to 5 microns wide; ridges gently tapering toward the ends and fusing just before reaching the longitudinal ends; furrows between the ridges about 1 micron wide, straight; margin narrow and smooth at both longitudinal ends; exine about 1 micron thick on body increasing to 1.5 to 2 microns at longitudinal ends.

Size range: Length 39 to 47 microns.
Breadth 16 to 21 microns.

Distribution: Edmonton Formation in R.C.A. Corehole No. 65-1 (section 1, "zone" A), and in outcrop section 3 on the Red Deer River.

Lowermost Edmonton Formation (Maestrichtian), Horseshoe Canyon, Alberta (Srivastava, 1968).

Locality of figured specimen: R.C.A. Corehole No. 65-1.

Pl. 2, fig. 2.	Depth 476 to 481 feet;	Edmonton Formation.
Pl. 2, fig. 2.	Slide No. 1-52-1;	co-ord. 16.2/98.

Family LILIACEAE

Genus LILIACIDITES Couper, 1953

Type species LILIACIDITES KAITANGATAENSIS Couper, 1953

LILIACIDITES sp.

Plate 6, figure 6

Description: Monosulcate; outline elliptical to subcircular; sulcus moderately long, open and bordered by a distinct thickening; exine ornamentation finely reticulate with lumina less than 0.5 micron in diameter; exine 0.8 to 1 micron in thickness.

Size range: Length 10 to 11 microns.
Breadth 8 to 9 microns.

Distribution: Edmonton Formation in R.C.A. Corehole No. 65-1 (section 1, "zone" B), and in outcrop sections 2 and 4 on the Red Deer River.

Remarks: The muri on *Liliacidites* sp. appear to be composed of bacula, however, an accurate determination was difficult because of the extremely small size of the bacula.

Locality of figured specimen: R.C.A. Corehole No. 65-1.

Pl. 6, fig. 6.	Depth 229 to 232 feet;	Edmonton Formation.
Pl. 6, fig. 6.	Slide No. 1-26-1;	co-ord. 13.1/85.7.

Family VITACEAE

Genus VITIS (Tournefort) Linnaeus, 1753

VITIS sp. cf. V? AFFLUENS Stanley, 1965

Plate 7, figures 8, 9

Description: Tricolporate; equatorial outline subcircular; colpi long, straight and open; pores circular, about 1.5 microns in diameter and with an indistinct annulus; exine less than 1 micron thick, thinner adjacent to the colpi and thicker in the vicinity of the pores; ornamentation very finely reticulate to scabrate.

Size range: Equatorial diameter 12 to 16 microns.

Distribution: Paskapoo Formation in R.C.A. Corehole No. 65-1 (section 1, "zone" C).

Ludlow Member (Paleocene), Fort Union Formation, South Dakota (Stanley, 1965).

Remarks: *Vitis* sp. cf. *V? affluens* Stanley, differs from Stanley's specimens in having a subcircular instead of a subtriangular outline, and a smaller size.

Locality of figured specimen: R.C.A. Corehole No. 65-1.

Pl. 7, figs. 8, 9.	Depth 63 to 66 feet;	Paskapoo Formation.
Pl. 7, figs. 8, 9.	Slide No. 1-6-2;	co-ord. 11.1/105.6.

Family BETULACEAE

Genus CARPINUS (Tournefort) Linnaeus, 1753

CARPINUS SUBTRIANGULA Stanley, 1965

Plate 7, figure 12

1965 *Carpinus subtriangula* Stanley, Bull. Am. Paleont., vol. 49, p. 291, pl. 43, figs. 12-16.

Description: Triporate; equatorial outline subtriangular to subcircular; pores circular, about 3 microns in diameter, and with slight labrums; exine 0.5 to 1 micron thick and scabrate.

Size range: Equatorial diameter 22 to 35 microns.

Distribution: Paskapoo Formation in R.C.A. Corehole No. 65-1 (section 1, "zone" C).

Cannonball Member (Paleocene), Fort Union Formation, South Dakota (Stanley, 1965).

Remarks: No tetraporate specimens were found. However, the triporate forms recorded have the scabrate ornamentation, thin exine, and simple pore structure characteristic of this species.

Locality of figured specimen: R.C.A. Corehole No. 65-1.

Pl. 7, fig. 12.	Depth 54 to 60 feet;	Paskapoo Formation.
Pl. 7, fig. 12.	Slide No. 1-5-3;	co-ord. 11.5/76.

Genus BETULACEOIPOLLENITES Potonié, 1951

Type species BETULACEOIPOLLENITES BITUITUS (Potonié) Potonié, 1951

BETULACEOIPOLLENITES sp.

Plate 6, figure 4

Description: Triporate; equatorial outline subcircular; pores large, 2 to 3 microns wide; annulus and vestibulum well developed; body usually with numerous exinal folds; exine 1 to 1.5 microns thick with a scabrate ornamentation.

Size range: Equatorial diameter 25 to 30 microns.

Distribution: Edmonton Formation in R.C.A. Corehole No. 65-1 (section 1, "zone" B), and in outcrop sections 2 and 4 on the Red Deer River.

Locality of figured specimen: R.C.A. Corehole No. 65-1.

Pl. 6, fig. 4.	Depth 264 to 268 feet;	Edmonton Formation.
Pl. 6, fig. 4.	Slide No. 1-30-2;	co-ord. 17.1/119.

Genus ALNUS Miller, 1754

ALNUS VERUS (Potonié) Martin and Rouse, 1966

Plate 7, figure 1

1931 *Pollenites verus* Potonié, Z. Braunkohle, Heft 16, p. 332, pl. 2, fig. 40.
1931 *Alni-pollenites verus* Potonié, Z. Braunkohle, Heft 16, p. 332.
1933 *Alnus speciipites* Wodehouse, Bull. Torrey Botan. Club, vol. 60, p. 508, fig. 40.
1934 *Alnipollenites verus* Potonié-Potonié, Arb. Inst. Palaobot. Petrogr. Brennsteine, vol. 4, p. 58, pl. 2, fig. 17, (type species).
1953 *Polyvestibulopollenites verus* (Potonié) Thompson and Pflug, Palaeontographica, Band 94, Abt. B, p. 90, pl. 10, figs. 62-76.
1962 *Alnus quinquepollenites* Rouse, Micropaleont., vol. 8, p. 202, pl. 2, figs. 7, 8.
1962 *Alnus quadrapollenites* Rouse, Micropaleont., vol. 8, p. 202, pl. 2, figs. 9, 36.
1966 *Alnus verus* (Potonié) Martin and Rouse, Can. Jour. Botany, vol. 44, p. 196, pl. 8, figs. 69-71.

Description: Stephanoporate; four to six pored; equatorial outline four to six-sided; pores situated at the angles, elliptical to slit-shaped and normal to the equator; pores protruding with thickened annulus, 5 to 7 microns in diameter; distinct arci about 2 microns wide, looped from pore to pore; ornamentation faintly granulate to scabrate; exine 0.5 to 1 micron thick, increasing to about 1.5 to 2 microns in thickness in pore areas.

Size range: Equatorial diameter 22 to 24 microns.

Distribution: Paskapoo Formation in R.C.A. Corehole No. 65-1 (section 1, "zone" C).

Green River Formation (Eocene), Colorado (Wodehouse, 1933); Eocene and Miocene, Germany (Potonié, 1934; Potonié and Venitz, 1934); Upper Tertiary, Germany (Thomson and Pflug, 1953); Burrard Formation (Late Cretaceous to Eocene), British Columbia (Rouse, 1962).

Locality of figured specimen: R.C.A. Corehole No. 65-1.

Pl. 7, fig. 1.	Depth 16 to 21 feet;	Paskapoo Formation.
Pl. 7, fig. 1.	Slide No. 1-1-1;	co-ord. 13.6/116.

ALNUS TRINA Stanley, 1965

Plate 6, figure 13

1965 *Alnus trina* Stanley, Bull. Am. Paleont., vol. 49, p. 289, pl. 43, figs. 4-6.

Description: Triporate; equatorial outline triangular; sides straight to slightly convex; pores protruding, with definite annulus and labrum; arci well defined about 2 microns in width and paralleling the sides of the grain; exine about 0.5 micron thick increasing to about 2 microns towards the pore regions; exine scabrate.

Size range: Equatorial diameter 12 to 18 microns.

Distribution: Paskapoo and Edmonton Formations in R.C.A. Corehole No. 65-1 (section 1, "zones" B and C).

Ludlow Member (Paleocene), Fort Union Formation, South Dakota (Stanley, 1965).

Locality of figured specimen: R.C.A. Corehole No. 65-1.

Pl. 6, fig. 13.	Depth 16 to 21 feet;	Paskapoo Formation.
Pl. 6, fig. 13.	Slide No. 1-1-1;	co-ord. 9/107.5.

ALNUS RUBRIFORMIS Simpson, 1961

Plate 7, figures 10, 11

1961 *Alnus rubriformis* Simpson, Trans. Roy. Soc. Edinburgh, vol. 64, p. 442, pl. 13, figs. 7, 8.

Description: Stephanoporate; five to six pored; equatorial outline five to six-sided; sides usually straight; pores small and elliptical, strongly aspidate, with annulus and well formed vestibulum and labrum; pores, including annulus, 5 to 6 microns in diameter; arci indistinct to distinct and about 2 microns wide; exine about 1 to 1.5 microns thick increasing in thickness in the pore region; ornamentation infragranulate.

Size range: Equatorial diameter 20 to 22 microns.

Distribution: Paskapoo Formation in R.C.A. Corehole No. 65-1 (section 1, "zone" C).

Interbasaltic lignites (Early Tertiary), Mull district of Argyllshire, Scotland (Simpson, 1961).

Remarks: The specimens described in the present study are slightly smaller than the upper size limit of 30 microns of the Scottish specimens.

Locality of figured specimen: R.C.A. Corehole No. 65-1.

Pl. 7, figs. 10, 11.	Depth 54 to 60 feet;	Paskapoo Formation.
Pl. 7, figs. 10, 11.	Slide No. 1-5-3;	co-ord. 12.2/103.

Family TILIACEAE

Genus TILIA Linnaeus, 1753

TILIA TETRAFORAMINIPITES Wodehouse, 1933

Plate 7, figure 7

1933 *Tilia tetraforaminipites* Wodehouse, Bull. Torrey Botan. Club, vol. 60, p. 516, fig. 50.

Description: Tetraporate; equatorial outline rectangular; sides convex; pores small, about 1.5 microns wide and 1.5 microns deep, elliptical and not protruding; exine 0.8 to 1 micron thick, increasing slightly in thickness in pore areas; exine very finely pitted.

Size range: Equatorial diameter 24 to 28 microns.

Distribution: Paskapoo Formation in R.C.A. Corehole No. 65-1 (section 1, "zone" C).

Green River Formation (Eocene), Colorado (Wodehouse, 1933); Burrard Formation, Third Beach (Eocene), British Columbia (Rouse, 1962).

Locality of figured specimen: R.C.A. Corehole No. 65-1.

Pl. 7, fig. 7.	Depth 80 to 87 feet;	Paskapoo Formation.
Pl. 7, fig. 7.	Slide No. 1-8-2;	co-ord. 13.9/77.9.

TILIA DANEI Anderson, 1960

Plate 6, figure 16

1960 *Tilia danei* Anderson, N. Mex. Bur. Mines and Mineral Resources, Mem. 6, p. 23, pl. 7, figs. 10, 11.

Description: Triporate; equatorial outline circular; pores longitudinally elongate with thickened margin; endexine curving inwards at pores and slightly thickened; exine thin, about 0.5 micron in thickness and increasing to about 1 micron at the pores; ornamentation finely reticulate.

Size range: Equatorial diameter 19 to 25 microns.

Distribution: Paskapoo Formation in R.C.A. Corehole No. 65-1 (section 1, "zone" C), and the Edmonton Formation in outcrop section 2 on the Red Deer River.

Nacimiento Formation (earliest Paleocene), San Juan Basin, New Mexico (Anderson, 1960).

Locality of figured specimen: R.C.A. Corehole No. 65-1.

Pl. 6, fig. 16.	Depth 16 to 21 feet;	Paskapoo Formation.
Pl. 6, fig. 16.	Slide No. 1-1-1;	co-ord. 11.5/96.6.

Family LORANTHACEAE

Genus CRANWELLIA Srivastava, 1966

Type species CRANWELLIA STRIATA (Couper) Srivastava, 1966

CRANWELLIA RUMSEYENSIS Srivastava, 1966

Plate 5, figures 8, 9

1966 *Cranwellia rumseyensis* Srivastava, Pollen et Spores, vol. 8, p. 538, pl. 11, figs. 3, 7.

Description: Isopolar; tricolpate or possibly tricolporate; equatorial outline triangular with straight to slightly convex sides; apices bluntly rounded; colpi located at apices, about ½ of the length of spore radius, narrow, and indistinct; exine 0.5 to 1 micron thick and ornamented with fine striations; striations indistinct in vicinity of poles.

Size range: Equatorial diameter 15 to 24 microns.

Distribution: Edmonton Formation in R.C.A. Corehole No. 65-1 (section 1, "zones" A and B), and in outcrop sections 2, 3, and 4 on the Red Deer River.

Edmonton Formation (Maestrichtian), Scollard area, Alberta (Srivastava, 1966).

Remarks: The specimens described in the present study differ from Srivastava's specimens of *C. rumseyensis* in having a smaller size. All other characteristics seem to be identical.

Locality of figured specimens: R.C.A. Corehole No. 65-1.

Pl. 5, fig. 8.	Depth 476 to 481 feet;	Edmonton Formation.
Pl. 5, fig. 8.	Slide No. 1-52-1;	co-ord. 7.9/98.
Pl. 5, fig. 9.	Depth 431 to 435 feet;	Edmonton Formation.
Pl. 5, fig. 9.	Slide No. 1-49-1;	co-ord. 11.7/85.

Family SALICACEAE

Genus SALIXIPOLLENITES Srivastava, 1966

Type species SALIXIPOLLENITES DISCOLORIPITES (Wodehouse) Srivastava, 1966

Remarks: In the present study, forms included in the genus *Salixipollenites* consist of only reticulate to broadly-reticulate tricolpate pollen.

SALIXIPOLLENITES sp. cf. TRICOLPITES BATHYRETICULATUS Stanley, 1965

Plate 1, figure 8

1965 *Tricolpites bathyreticulatus* Stanley, Bull. Am. Paleont., vol. 49, p. 320, pl. 47, figs. 18-23.

Description: Tricolpate; equatorial outline subcircular; colpi straight, gaping; apocolpium small; ornamentation reticulate, muri moderately high; lumina 1 to 3.5 microns wide; exine thick, endexine less than 1 micron, and ektexine 1 to 1.5 microns thick.

Size range: Equatorial diameter 20 to 23 microns.

Distribution: Edmonton Formation in R.C.A. Corehole No. 65-1 (section 1, "zone" A), and in outcrop section 3 on the Red Deer River.

Ludlow and Cannonball Members (Paleocene), South Dakota (Stanley, 1965).

Remarks: *Salixipollenites* sp. cf. *T. bathyreticulatus* Stanley, has a smaller apocolpium than the specimens described by Stanley (1965). All other characteristics are closely similar.

Locality of figured specimen: R.C.A. Corehole No. 65-1.

Pl. 1, fig. 8.	Depth 476 to 481 feet;	Edmonton Formation.
Pl. 1, fig. 8.	Slide No. 1-52-1;	co-ord. 23.4/89.

SALIXIPOLLENITES sp. A

Plate 6, figures 10, 11

Description: Tricolpate; equatorial outline subtriangular; colpi long, apocolpium small; exine ornamentation coarsely reticulate, lumina 0.5 to 1.5 microns wide becoming finer near the margins of the colpi and at the poles.

Size range: Equatorial diameter 20 to 23 microns.

Distribution: Edmonton and Paskapoo Formations in R.C.A. Corehole No. 65-1 (section 1, "zones" B and C) and the Edmonton Formation in outcrop sections 2 and 4 on the Red Deer River.

Locality of figured specimen: R.C.A. Corehole No. 65-1.

Pl. 6, figs. 10, 11.	Depth 264 to 268 feet;	Edmonton Formation.
Pl. 6, figs. 10, 11.	Slide No. 1-30-2;	co-ord. 17.2/74.

SALIXIPOLLENITES sp. B

Plate 6, figures 8, 9

Description: Tricolpate; prolate; outline ellipsoidal; colpi about ¾ of length of polar axis with exinous thickenings along borders; ornamentation distinctly reticulate with angular lumina, 1 to 1.5 microns wide, and muri less than 0.5 micron wide and about 1 micron high; exine approximately 1.8 to 2 microns thick.

Size range: Polar diameter 15 to 17 microns.
Equatorial diameter 9 to 13 microns.

Distribution: Edmonton Formation in R.C.A. Corehole No. 65-1 (section 1, "zone" B), and in outcrop sections 2 and 4 on the Red Deer River.

Locality of figured specimen: R.C.A. Corehole No. 65-1.

Pl. 6, figs. 8, 9.	Depth 150 to 156 feet;	Paskapoo Formation.
Pl. 6, figs. 8, 9.	Slide No. 1-15-3;	co-ord. 7.8/9.8.

Family MYRTACEAE

Genus MYRTACEIDITES Cookson and Pike, 1954, emend. Potonié, 1960

Type species MYRTACEIDITES MESONESUS Cookson and Pike, 1954

MYRTACEIDITES sp. A

Plate 6, figure 5

Description: Tricolporate; equatorial outline triangular; sides convex; angulaperturate; arci indistinct and enclosing a polar island; exine less than 1 micron thick, increasing in thickness near poles; ornamentation granulate with granules about 0.8 micron in diameter.

Size range: Equatorial diameter 16 to 21 microns.

Distribution: Edmonton Formation in R.C.A. Corehole No. 65-1 (section 1, "zone" B), and in outcrop section 2 on the Red Deer River.

Remarks: The species described above does not contain distinct arci as originally diagnosed for the genus *Myrtaceidites* by Cookson and Pike (1954). In all other respects, however, *Myrtaceidites* sp. A conforms with their generic diagnosis.

Locality of figured specimen: R.C.A. Corehole No. 65-1.

Pl. 6, fig. 5.	Depth 198 to 202 feet;	Edmonton Formation.
Pl. 6, fig. 5.	Slide No. 1-22-3;	co-ord. 13.7/82.3.

MYRTACEIDITES sp. B

Plate 6, figure 7

Description: Tricolporate; equatorial outline triangular; sides straight to slightly convex; angulaperturate, pores about 2 microns in diameter; arci distinct, making a wide bend near pole and not enclosing a polar island;

exine less than 1 micron thick, slightly increasing in thickness near pore areas; ornamentation indistinct to finely granulate.

Size range: Equatorial diameter 12 to 13 microns.

Distribution: Edmonton Formation in R.C.A. Corehole No. 65-1 (section 1, "zone" B), and in outcrop sections 2 and 4 on the Red Deer River.

Locality of figured specimen: R.C.A. Corehole No. 65-1.

Pl. 6, fig. 7.	Depth 175 to 181 feet;	Edmonton Formation.
Pl. 6, fig. 7.	Slide No. 1-19-2;	co-ord. 14.6/79.6.

Myrtaceidites sp. C

Plate 6, figure 1

Description: Tricolporate; equatorial outline triangular; sides straight; angulaperturate; pores large and with an annulus about 1 to 2 microns in diameter; arci very distinct, about 2 microns wide, making a moderately gentle bend at the pole and not enclosing a polar island; exine thinning in interaperturate areas, varying from 0.5 to 1.5 microns in thickness; ornamentation granulate, granules about 0.5 micron in diameter.

Size range: Equatorial diameter 16 to 19 microns.

Distribution: Edmonton Formation in R.C.A. Corehole No. 65-1 (section 1, "zone" B), and in outcrop section 2 on the Red Deer River.

Remarks: *Myrtaceidites* sp. C differs from *Myrtaceidites* sp. B in having a larger size, thicker exine, and a coarser ornamentation.

Locality of figured specimen: R.C.A. Corehole No. 65-1.

Pl. 6, fig. 1.	Depth 276 to 280 feet;	Edmonton Formation.
Pl. 6, fig. 1.	Slide No. 1-32-3;	co-ord. 15.5/114.

Family Symplocaceae

Genus Symplocoipollenites Potonié, 1951

Type species Symplocoipollenites vestibulum (Potonié) Potonié, 1951

Symplocoipollenites vestibulum (Potonié) Potonié, 1951

Plate 2, figure 5

1931 *Pollenites vestibulum* Potonié, Z. Braunkohle, Heft 16, p. 329, pl. 2, fig. 23.
1951 *Symplocoipollenites vestibulum* (Potonié) Potonié, Palaeontographica, Band 91, Abt. B, p. 147, pl. 21, figs. 158, 159.

Description: Tricolporate; equatorial outline triangular; sides convex; apertures situated at apices; endexine parting from ektexine in vicinity of each pore forming a very distinct and large vestibulum; depth of vestibulum about $\frac{1}{3}$ of the radius of grain; exopore small; colpi narrow extending slightly beyond vestibulum; apocolpium moderate; exine 1 to 1.5 microns thick, ornamentation granulate; granules approximately 0.5 micron wide.

Size range: Equatorial diameter 22 to 25 microns.

Distribution: Edmonton Formation in R.C.A. Corehole No. 65-1 (section 1, "zone" A), and in outcrop section 3 on the Red Deer River.

Miocene, Germany (Potonié, 1931).

Locality of figured specimen: R.C.A. Corehole No. 65-1.

Pl. 2, fig. 5.	Depth 445 to 449 feet;	Edmonton Formation.
Pl. 2, fig. 5.	Slide No. 1-50-2;	co-ord. 2.5/75.

Family FAGACEAE

Genus CUPULIFEROIPOLLENITES Potonié, 1951

Type species CUPULIFEROIPOLLENITES PUSILLUS (Potonié) Potonié, 1951

CUPULIFEROIPOLLENITES PUSILLUS (Potonié) Potonié, 1951

Plate 5, figures 5, 6

1934 *Pollenites quisqualis* forma *pusillus* Potonié, Art. Inst. Palaobot. Petrogr. Brennsteine, vol. 4, p. 71, pl. 3, fig. 21.

1951 *Cupuliferoipollenites pusillus* (Potonié) Potonié, Palaeontographica, Band 91, Abt. B, p. 150, pl. 20, fig. 69.

Description: Prolate; tricolporate; outline elliptical; furrows long and bordered by a distinct thickening; pores distinct; exine about 1 micron thick, smooth to scabrate.

Size range: Polar diameter 12 to 18 microns.
Equatorial diameter 8 to 12 microns.

Distribution: Edmonton Formation in R.C.A. Corehole No. 65-1 (section 1, "zones" A and B), and outcrop sections 2, 3, and 4 on the Red Deer River.

Paleocene to Miocene of Europe (Potonié, 1960).

Remarks: *Cupuliferoipollenites pusillus* (Potonié) Potonié, differs from *Tricolporites traversei* Anderson, 1960, in having a larger size and distinct pores.

Locality of figured specimens: R.C.A. Corehole No. 65-1.

Pl. 5, fig. 5.	Depth 142 to 146 feet;	Edmonton Formation.
Pl. 5, fig. 5.	Slide No. 1-14-3;	co-ord. 12.8/104.
Pl. 5, fig. 6.	Depth 175 to 181 feet;	Edmonton Formation.
Pl. 5, fig. 6.	Slide No. 1-19-2;	co-ord. 17.7/91.5.

Family ANACARDIACEAE

Genus RHOIPITES Wodehouse, 1933

Type species RHOIPITES BRADLEYI Wodehouse, 1933

RHOIPITES sp. cf. R. PISINNUS Stanley, 1965

Plate 6, figures 2, 3

1965 *Rhoipites pisinnus* Stanley, Bull. Am. Paleont., vol. 49, p. 286, pl. 42, figs. 14-23.

Description: Tricolporate; equatorial outline elliptical; pores 1 to 1.5 microns long, about 0.5 micron wide, and paralleling equator; colpi long, straight, slightly open and possibly bearing caverna; apocolpium moderate; exine 1 to 1.5 microns thick with a microreticulate ornamentation.

Size range: Polar diameter 16 to 17 microns.
Equatorial diameter about 14 microns.

Distribution: Edmonton Formation in R.C.A. Corehole No. 65-1 (section 1, "zone" B), and in outcrop section 2 on the Red Deer River.

Hell Creek Formation (Maestrichtian) and Ludlow Member (Paleocene), Fort Union Formation, South Dakota (Stanley, 1965).

Remarks: *Rhoipites* sp. cf. *R. pisinnus* Stanley, 1965 differs from Stanley's specimens in having a pore of smaller size and an indistinct caverna. All other characteristics are similar.

Locality of figured specimens: R.C.A. Corehole No. 65-1.

Pl. 6, figs. 2, 3.	Depth 276 to 280 feet;	Edmonton Formation.
Pl. 6, figs. 2, 3.	Slide No. 1-32-3;	co-ord. 22.1/92.

Family ULMACEAE

Genus MOMIPITES Wodehouse, 1933

Type species MOMIPITES CORYLOIDES Wodehouse, 1933

MOMIPITES SANJUANENSIS Anderson, 1960

Plate 4, figure 2

1960 *Momipites sanjuanensis* Anderson, N. Mex. Bur. Mines and Mineral Resources, Mem. 6, p. 25, pl. 11, figs. 1-3.

Description: Triporate; equatorial outline subtriangular; sides convex; pores 1 to 2 microns in diameter with a distinct annulus; pores interconnected by either arci or small folds; exine aboue 0.5 micron thick with a distinct irregularly scabrate surface ornamentation.

Size range: Equatorial diameter 15 to 17 microns.

Distribution: Edmonton Formation in R.C.A. Corehole No. 65-1 (section 1, "zone" A), and outcrop section 3 on the Red Deer River.

Lewis Shale (latest Cretaceous), San Juan Basin, New Mexico (Anderson, 1960).

Locality of figured specimen: R.C.A. Corehole No. 65-1.

Pl. 4, fig. 2.	Depth 286 to 291 feet;	Edmonton Formation.
Pl. 4, fig. 2.	Slide No. 1-34-2;	co-ord. 14/74.1.

MOMIPITES INAEQUALIS Anderson, 1960

Plate 6, figure 15

1960 *Momipites inaequalis* Anderson, N. Mex. Bur. Mines and Mineral Resources, Mem. 6, p. 25, pl. 6, figs. 7-10, pl. 7, fig. 13.

1964 *Momipites* sp. Newman, Soc. Eco. Paleont. and Mineral., Special Publ. 11, p. 78, pl. 1, fig. 15.

Description: Triporate; equatorial outline triangular; sides slightly convex; pores longitudinally elongate with slightly thickened margins, and not or only slightly protruding; pores about 1.5 to 2 microns in diameter; exine about 0.5 micron thick increasing to about 1 micron around pores; surface scabrate.

Size range: Equatorial diameter 20 to 28 microns.

Distribution: Paskapoo and Edmonton Formations in R.C.A. Corehole No. 65-1 (section 1, "zones" B and C), and the Edmonton Formation in outcrop section 2 and 4 on the Red Deer River.

Ojo Alamo Sandstone and Nacimiento Formation (earliest Paleocene), San Juan Basin, New Mexico (Anderson, 1960); Paleocene of northwestern Colorado (Newman, 1964).

Locality of figured specimen: R.C.A. Corehole No. 65-1.

Pl. 6, fig. 15.	Depth 54 to 60 feet;	Paskapoo Formation.
Pl. 6, fig. 15.	Slide No. 1-5-3;	co-ord. 17.5/98.

MOMIPITES TENUIPOLUS Anderson, 1960

Plate 6, figure 14

1960 *Momipites tenuipolus* Anderson, N. Mex. Bur. Mines and Mineral Resources, Mem. 6, p. 25, pl. 7, fig. 14, pl. 8, figs. 14, 15.

Description: Triporate; equatorial outline triangular to subtriangular; sides slightly convex or straight; apices rounded; pores small, longitudinally elongate, not protruding, and diameters about 1.5 microns; exine 1 to 1.5 microns thick, slightly thickened in the pore regions and thinning noticeably in the polar regions; ornamentation scabrate to infragranulate.

Size range: Equatorial diameter 14 to 20 microns.

Distribution: Paskapoo Formation in R.C.A. Corehole No. 65-1 (section 1, "zone" C), and the Edmonton Formation in section 2 on the Red Deer River.

Nacimiento Formation, (early Paleocene), San Juan Basin, New Mexico (Anderson, 1960).

Locality of figured specimen: R.C.A. Corehole No. 65-1.

Pl. 6, fig. 14.	Depth 54 to 60 feet;	Paskapoo Formation.
Pl. 6, fig. 14.	Slide No. 1-5-3;	co-ord. 16.5/113.8.

Genus ULMOIDEIPITES Anderson, 1960

Type species ULMOIDEIPITES KREMPI Anderson, 1960

ULMOIDEIPITES TRICOSTATUS Anderson, 1960

Plate 6, figure 12

1958 *Triporopollenites undulatus* Pflug (part), Wayland, Pflug and Jähnichen, Palaeontographica, Band 105, Abt. B, pl. 12, fig. 22.

1960 *Ulmoideipites tricostatus* Anderson, N. Mex. Bur. Mines and Mineral Resources, Mem. 6, p. 20, pl. 4, figs. 9-11, pl. 6, figs. 4, 5, pl. 7, fig. 8, pl. 8, figs. 8, 9.

Description: Triporate; equatorial outline triangular; sides slightly convex; pores subcircular to meridionally elongate, about 1.5 microns in

diameter; irregularly verrucate; arci paralleling the sides; surface ornamentation consisting of distinct to indistinct low verrucae; exine 0.5 to 1 micron thick, increasing in thickness in the pore regions and forming a slight annulus.

Size range: Equatorial diameter 20 to 24 microns.

Distribution: Paskapoo and Edmonton Formations in R.C.A. Corehole No. 65-1 (section 1, "zones" B and C), and the Edmonton Formation in outcrop section 2 on the Red Deer River.

Ojo Alamo Sandstone and Nacimiento Formation (latest Cretaceous (?) to early Paleocene), San Juan Basin, New Mexico (Anderson, 1960); Paleocene of northwestern Colorado (Newman, 1964); Danian, Siberia, U.S.S.R. (Samoilovitch, 1967).

Locality of figured specimen: R.C.A. Corehole No. 65-1.

Pl. 6, fig. 12.	Depth 54 to 60 feet;	Paskapoo Formation.
Pl. 6, fig. 12.	Slide No. 1-5-3;	co-ord. 7.2/81.

Family Pandanaceae

Genus Pandanus (Tournefort) Linnaeus, 1753

Pandanus sp? cf. P? shiabensis Simpson, 1961

Plate 7, figure 13

1961 ?*Pandanus shiqbensis* Simpson, Trans. Roy. Soc. Edinburgh, vol. 64, p. 430, pl. 9, fig. 7.

Description: Monoporate; shape spherical; exine covered with 1- to 2-micron long spinules spaced about 2 microns apart and approximately 1 micron wide at bases; pore 1 to 2 microns wide and circular to slightly elliptical in shape; exine 0.5 micron thick, increasing to 1 micron in thickness near the pore; pore region without spinules.

Size range: Diameter 24 to 26 microns.

Distribution: Paskapoo Formation in R.C.A. Corehole No. 65-1 (section 1, "zone" C).

Interbasaltic lignites (Tertiary), Mull district of Argyllshire, Scotland (Simpson, 1961).

Locality of figured specimen: R.C.A. Corehole No. 65-1.

Pl. 7, fig. 13.	Depth 45 to 50 feet;	Paskapoo Formation.
Pl. 7, fig. 13.	Slide No. 1-4-2;	co-ord. 8.2/90.

Family Buxaceae

Genus Erdtmanipollis Krutzsch, 1962

Type species Erdtmanipollis pachysandroides Krutzsch, 1962

Remarks: The present specimens have been assigned to the organ-genus *Erdtmanipollis* Krutzsch, 1962 because it is very difficult to distinguish between the pollen of *Pachysandra* and *Sarcococca* (Gray and Sohma, 1968).

ERDTMANIPOLLIS PACHYSANDROIDES Krutzsch, 1962
Plate 1, figure 5

1962 *Erdtmanipollis pachysandroides* Krutzsch, Geologie, Jahrg. 11, p. 281, pl. 8, figs. 1-8.
1965 *Pachysandra cretacea* Stanley, Bull. Am. Paleont., vol. 49, p. 294, pl. 44, figs. 1-9.

Description: Polyporate; equatorial outline spherical; exine ornamented with plate-like structures arranged next to but not touching one another to form a reticulate pattern; triangular structures present at the junctions of the walls of the reticulum; lumina 3 to 6 microns in diameter; circular pores about 1.5 microns in diameter present in about 1/3 of the lumina; exine about 3 microns thick.

Size range: Diameter 26 to 32 microns.

Distribution: Edmonton Formation in R.C.A. Corehole No. 65-1 (section 1, "zone" A), and outcrop section 3 on the Red Deer River.

Hell Creek Formation (Maestrichtian), Ludlow Member (Paleocene), Fort Union Formation, South Dakota (Stanley, 1965); late Oligocene, Germany (Krutzsch, 1962).

Remarks: *Pachysandra cretacea* is distinguished by Stanley (1965) from *Erdtmanipollis pachysandroides* merely on the basis of its slightly wider size range, and is probably a junior synonym.

Locality of figured specimen: R.C.A. Corehole No. 65-1.

Pl. 1, fig. 5.	Depth 431 to 435 feet;	Edmonton Formation.
Pl. 1, fig. 5.	Slide No. 1-49-1;	co-ord. 9.2/90.

Family JUGLANDACEAE
Genus CARYAPOLLENITES Raatz, 1937
Type species CARYAPOLLENITES SIMPLEX (Potonié) Raatz, 1937

CARYAPOLLENITES SCABRATUS Groot and Groot, 1962
Plate 7, figures 4-6

1962 *Caryapollenties scabratus* Groot and Groot, Palaeontographica, Band 111, Abt. B., p. 166, pl. 30, figs. 13, 14.
1965 *Carya paleocenica* Stanley, Bull. Am. Paleont., vol. 49, p. 299, pl. 45, figs. 3-7.

Description: Triporate; equatorial outline subcircular to circular; pores subequatorial, large and circular, about 2 to 3 microns in diameter; ornamentation scabrate to weakly granulate; exine about 1.5 microns thick, slightly thicker in the pore region.

Size range: Equatorial diameter 24 to 28 microns.

Distribution: Paskapoo Formation in R.C.A. Corehole No. 65-1 (section 1, "zone" C).

Cannonball Member (Paleocene), Fort Union Formation, South Dakota (Stanley, 1965); Brightseat Formation (Paleocene), Maryland (Groot and Groot, 1962).

Locality of figured specimens: R.C.A. Corehole No. 65-1.

Pl. 7, fig. 4.	Depth 16 to 21 feet;	Paskapoo Formation.
Pl. 7, fig. 4.	Slide No. 1-1-1;	co-ord. 15/96.8.
Pl. 7, fig. 5.	Depth 16 to 21 feet;	Paskapoo Formation.
Pl. 7, fig. 5.	Slide No. 1-1-1;	co-ord. 15/112.7.
Pl. 7, fig. 6.	Depth 16 to 21 feet;	Paskapoo Formation.
Pl. 7, fig. 6.	Slide No. 1-1-1;	co-ord. 15.2/111.1.

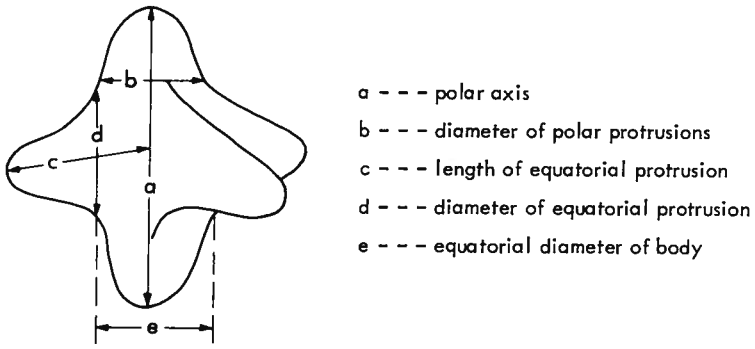

FIGURE 4. Measurements of Aquilapollenites *grain.*

ANGIOSPERMAE-INCERTAE SEDIS

Genus AQUILAPOLLENITES Rouse, 1957, emend. Funkhouser, 1961

Type species AQUILAPOLLENITES QUADRILOBUS Rouse, 1957

AQUILAPOLLENITES RETICULATUS Stanley, 1961

Plate 1, figures 2, 3

1961 *Aquilapollenites reticulatus* Stanley, Pollen et Spores, vol. 3, p. 348, pl. 8, figs. 1-12.

Description: Isopolar; tridemicolpate; body with three equatorial and two polar protrusions; diameter of polar protrusions approximately equal to the diameter of the body; equatorial protrusions short, tube-like; colpi distinct, extending from near distal ends and along the polar edges of the equatorial protrusions onto the body; exine of body reticulate with lumina 0.5 to 1 micron wide and 1 micron high muri; lumina reduced near the base of each equatorial protrusion to a very fine reticulate pattern which continues onto the equatorial protrusions.

Size range: Polar axis 30 to 32 microns.
Diameter of polar protrusions 12 to 15 microns.
Length of equatorial protrusions 17 to 20 microns.
Diameter of equatorial protrusions 12 to 15 microns.
Equatorial diameter of body 18 to 22 microns.

Distribution: Edmonton Formation in R.C.A. Corehole No. 65-1 (section 1, "zone" A), and outcrop section 3 on the Red Deer River.

Hell Creek Formation (Maestrichtian), South Dakota (Stanley, 1961).

Remarks: The specimens of *Aquilapollenites reticulatus* Stanley, 1961, described in this study, differ from Stanley's specimens in having a microreticulate instead of a concentrically arranged striate pattern on the equatorial protrusions.

Locality of figured specimens: R.C.A. Corehole No. 65-1, section 3 on the Red Deer River.

Pl. 1, fig. 2.	58 to 60 feet above Kneehills Member;	Edmonton Formation.
Pl. 1, fig. 2.	Slide No. 3-9-1;	co-ord. 21.8/77.4.
Pl. 1, fig. 3.	Depth 476 to 481 feet;	Edmonton Formation.
Pl. 1, fig. 3.	Slide No. 1-52-1;	co-ord. 6/96.

AQUILAPOLLENITES CONATUS Norton, 1965

Plate 3, figures 7, 8

1965 *Aquilapollenites conatus* Norton, Pollen et Spores, vol. 7, p. 142, pl. 3, figs. 10, 11, pl. 4, figs. 12-16.

Description: Isopolar; tricolpate; body with three equatorial and two polar protrusions; body rectangular in equatorial view; colpi distinct, extending from distal end of equatorial protrusions to the grain body; ornamentation on body and polar protrusions consisting of ridges giving a fingerprint-like sculpture; ridges concentrically arranged around the two slightly projecting corners at the distal end of each polar protrusion; ornamentation on equatorial protrusions reduced to small ridges subparallel to the polar axis; exine of body 1.5 to 2 microns thick; exine of equatorial protrusions approximately 1 micron thick.

Size range: Polar axis 56 to 60 microns.
Diameter of polar protrusions 18 to 20 microns.
Length of equatorial protrusions about 27 microns.
Diameter of equatorial protrusions 12 to 14 microns.
Equatorial diameter of body about 20 microns.

Distribution: Edmonton Formation in R.C.A. Corehole No. 65-1 (section 1, "zone" A), and in outcrop section 3 on the Red Deer River.

Hell Creek Formation (Maestrichtian), Montana (Norton, 1965).

Locality of figured specimens: R.C.A. Corehole No. 65-1.

Pl. 3, figs. 7, 8.	Depth 286 to 291 feet;	Edmonton Formation.
Pl. 3, figs. 7, 8.	Slide No. 1-34-2;	co-ord. 12.3/82.

AQUILAPOLLENITES SPINULOSUS Funkhouser, 1961

Plate 7, figures 2, 3

1961 *Aquilapollenites spinulosus* Funkhouser, Micropaleont., vol. 7, p. 194, pl. 1, figs. 4-6.

Description: Isopolar; tridemicolpate; body with three equatorial and two polar protrusions; diameter of equatorial protrusions approximately equal to the diameter of polar portrusions; demicolpi located within the concavities formed between the equatorial and the polar protrusions; smooth, narrow, thickened bands paralleling each demicolpi; remainder of the body covered by randomly spaced spinules about 0.5 to 1 micron long and 1 to 2 microns apart; spinules on the equatorial protrusions curving back toward the poles.

Size range: Polar axis 32 to 36 microns.

Diameter of polar protrusions 10 to 12 microns.
Length of equatorial protrusions 15 to 18 microns.
Diameter of equatorial protrusions 10 to 12 microns.
Equatorial diameter of body 12 to 15 microns.

Distribution: Paskapoo Formation in R.C.A. Corehole No. 65-1 (section 1, "zone" C).

Fort Union Formation (Paleocene), Wyoming, and Eocene of the Rocky Mountain area (Funkhouser, 1961).

Locality of figured specimens: R.C.A. Corehole No. 65-1.

Pl. 7, fig. 2.	Depth 80 to 87 feet;	Paskapoo Formation.
Pl. 7, fig. 2.	Slide No. 1-8-2;	co-ord. 13.5/114.
Pl. 7, fig. 3.	Depth 16 to 21 feet;	Paskapoo Formation.
Pl. 7, fig. 3.	Slide No. 1-1-1;	co-ord. 13.6/110.

AQUILAPOLLENITES DELICATUS Stanley, 1961

Plate 3, figures 9, 10

1961 *Aquilapollenites delicatus* Stanley, Pollen et Spores, vol. 3, p. 346, pl. 4, figs. 1-12.

Description: Heteropolar; tricolpate; body with three equatorial and two markedly unequal polar protrusions; one polar protrusion extremely reduced; diameter of larger polar protrusion about equal to diameter of equatorial protrusions; colpi indistinct and restricted to the distal end of each equatorial protrusion; body reticulate, with largest lumina up to 2 microns wide near the base of the larger polar protrusion; reticulate pattern formed by clavae 1 to 2 microns high; spinules up to 3 microns long and 1 to 2 microns wide present on the body and the basal portion of the polar protrusions; ektexine of equatorial protrusions scabrate with a few widely separated clavae; exinous thickenings present along the concave junctions between the polar and equatorial protrusions and extending for a short distance onto the equatorial protrusions.

Size range: Polar axis 40 to 45 microns.

Diameter of polar protrusion about 14 microns.
Length of equatorial protrusions 26 to 32 microns.
Diameter of equatorial protrusions about 12 microns.
Equatorial diameter of body 14 to 16 microns.

Distribution: Edmonton Formation in R.C.A. Corehole No. 65-1 (section 1, "zone" A).

Hell Creek Formation (Maestrichtian), South Dakota (Stanley, 1961).

Remarks: The specimens of *Aquilapollenites delicatus* Stanley, 1961, described in this study are slightly larger than those described by Stanley (1961).

Locality of figured specimen: R.C.A. Corehole No. 65-1.

Pl. 3, figs. 9, 10.	Depth 286 to 291 feet;	Edmonton Formation.
Pl. 3, figs. 9, 10.	Slide No. 1-34-2;	co-ord. 15.4/87.5.

AQUILAPOLLENITES POLARIS Funkhouser, 1961

Plate 1, figure 1

1961 *Aquilapollenites polaris* Funkhouser, Micropaleont., vol. 7, p. 198, pl. 1, figs. 1, 2.

Description: Heteropolar; tridemicolpate; body with three equatorial and two unequal polar protrusions; one polar protrusion extremely reduced; diameter of the larger polar protrusion less than 1/2 of the length of the polar axis and slightly more or equal to the width of the equatorial protrusions; equatorial protrusions about 2/3 of the length of polar axis; demicolpi extending from the base of the larger polar protrusion to about halfway up the equatorial protrusions; exine thickened along the margins of the demicolpi; body covered with spinules and coarse punctae; spinules up to 1 micron long in polar regions and missing along the thickened margins of demicolpi.

Size range: Polar axis 32 to 34 microns.
Diameter of polar protrusions 13 to 18 microns.
Length of equatorial protrusions about 20 microns.
Diameter of equatorial protrusions 12 to 19 microns.
Equatorial diameter of body 20 to 22 microns.

Distribution: Edmonton Formation in R.C.A. Corehole No. 65-1 (section 1, "zone" A).

Lance Formation (Maestrichtian), Wyoming (Funkhouser, 1961); Maestrichtian, Siberia, U.S.S.R. (Bratzeva, 1967).

Remarks: The specimens of *Aquilapollenites polaris* Funkhouser, 1961, described in this study differ from Funkhouser's specimens in having a polar protrusion which is wider or equal in width to the equatorial protrusions, instead of being narrower. This effect is probably created by the grain orientation.

Locality of figured specimen: R.C.A. Corehole No. 65-1.

Pl. 1, fig. 1.	Depth 445 to 449 feet;	Edmonton Formation.
Pl. 1, fig. 1.	Slide No. 1-50-1;	co-ord. 14.2/104.

AQUILAPOLLENITES sp. cf. A. ATTENUATUS Funkhouser, 1961

Plate 2, figures 6, 7

1961 *Aquilapollenites attenuatus* Funkhouser, Micropaleont., vol. 7, p. 194, pl. 2, figs. 1 a-c.

Description: Isopolar; tridemicolpate; body with three equatorial and two polar protrusions; diameter of equatorial protrusions about 1/3 length of polar axis; demicolpi located within the concavities formed between the equatorial and polar protrustions; ornamentation finely reticulate with lumina varying from 0.5 micron in diameter on the polar and equatorial protrusions to approximately 1 micron on the body; muri up to 1 micron thick on the body; spinules 1 to 3 microns long restricted to the polar protrusions, distal portions of the equatorial protrusions, and narrow strips along the equatorial sides of each equatorial protrusion.

Size range: Polar axis 39 to 67 microns.
Diameter of polar protrusions 16 to 25 microns.
Length of equatorial protrusions 28 to 50 microns.
Diameter of equatorial protrusions 12 to 19 microns.
Equatorial diameter of body about 18 to 26 microns.

Distribution: Edmonton Formation in R.C.A. Corehole No. 65-1 (section 1, "zone" A).

Lance Formation (Maestrichtian), Wyoming (Funkhouser, 1961).

Remarks: Funkhouser (1961) described *Aquilapollenites attenuatus* as coarsely punctate. The specimens examined in the present study are finely reticulate and include forms which are slightly smaller to larger than Funkhouser's specimens.

Locality of figured specimens: R.C.A. Corehole No. 65-1.

Pl. 2, fig. 6.	Depth 454 to 459 feet;	Edmonton Formation.
Pl. 2, fig. 6.	Slide No. 1-51-1;	co-ord. 15.2/100.
Pl. 2, fig. 7.	Depth 454 to 459 feet;	Edmonton Formation.
Pl. 2, fig. 7.	Slide No. 1-51-1;	co-ord. 14/117.9.

AQUILAPOLLENITES REDUCTUS Norton, 1965

Plate 1, figures 9, 10; plate 2, figure 1

1965 *Aquilapollenites reductus* Norton, Pollen et Spores, vol. 7, p. 140, pl. 2, figs. 5-7, pl. 3, figs. 8, 9.

Description: Isopolar; tricolpate; body with three equatorial protrusions and two broad polar protrusions; diameter of the polar protrusions approximately equal to the diameter of the body; colpi located on the distal end of each equatorial protrusion; ornamentation on body reticulate; with lumina 2 microns wide near equator and about 0.5 micron wide near poles; distal portion of each equatorial protrusion reticulate and the proximal portion smooth; lumina on equatorial protrusions 0.5 to 1 micron in width; exine approximately 1 micron thick at the poles to about 2.5 microns at the equator.

Size range: Polar axis 40 to 48 microns.
Diameter of polar protrusions 15 to 18 microns.
Length of equatorial protrusions 15 to 20 microns.
Diameter of equatorial protrusions 7 to 10 microns.
Equatorial diameter of body 20 to 25 microns.

Distribution: Edmonton Formation in R.C.A. Corehole No. 65-1 (section 1, "zone" A), and in outcrop section 3 on the Red Deer River.

Hell Creek Formation (Maestrichtian), Montana (Norton, 1965).

Locality of figured specimens: R.C.A. Corehole No. 65-1.

Pl. 1, figs. 9, 10.	Depth 445 to 449 feet;	Edmonton Formation.
Pl. 1, figs. 9, 10.	Slide No. 1-50-2;	co-ord. 11.1/89.2.
Pl. 2, fig. 1.	Depth 476 to 481 feet;	Edmonton Formation.
Pl. 2, fig. 1.	Slide No. 1-52-1;	co-ord. 20.3/78.

AQUILAPOLLENITES AMPLUS Stanley, 1961

Plate 1, figure 6

1961 *Aquilapollenites amplus* Stanley, Pollen et Spores, vol. 3, p. 342, pl. 1, figs. 1-6, pl. 2, figs. 1-4, pl. 3, figs. 1-5.

Description: Isopolar; tricolpate; body with three equatorial and two polar protrusions; colpi distinct and located on the distal portions of the equatorial protrusions; ornamentation on body and protrusions reticulate with lumina about 0.5 micron wide on equatorial protrusions increasing in size on the body and enlarging to about 1 micron near the poles; clavae forming muri on the body and polar protrusions 1.5 to 2 microns high; moderate amount of randomly spaced spinules over entire surface; spinules on body about 4 microns long and on equatorial protrusions approximately 2 microns long and directed back toward the body; boomerang-shaped thickenings along the polar edges of the equatorial protrusions and extending a short distance onto the body.

Size range: Polar axis 42 to 55 microns.
Diameter of polar protrusions 14 to 19 microns.
Length of equatorial protrusions 20 to 30 microns.
Diameter of equatorial protrusions 14 to 18 microns.
Equatorial diameter of body 14 to 24 microns.

Distribution: Edmonton Formation in R.C.A. Corehole No. 65-1 (section 1, "zone" A), and in outcrop section 3 on the Red Deer River.

Hell Creek Formation (Maestrichtian), South Dakota (Stanley, 1965).

Locality of figured specimen: R.C.A. Corehole No. 65-1.

Pl. 1, fig. 6.	Depth 313 to 319 feet;	Edmonton Formation.
Pl. 1, fig. 6.	Slide No. 1-40-3;	co-ord. 12.5/116.1.

AQUILAPOLLENITES sp. cf. A. QUADRICRETACEUS Chlonova, 1961

Plate 4, figures 6-8

1961 *Aquilapollenites quadricretaceus* Chlonova, Trudy Inst. Geol. Geophys., Sib. Otdel., Akad. Nauk SSSR, Novosibirsk, no. 7, p. 84, pl. 14, fig. 108a-b.

Description: Isopolar; tricolpate; body with three equatorial protrusions with axes normal to the polar axis; diameter of equatorial protrusions approximately equal to the diameter of the polar protrusions; colpi located at the distal end of each equatorial protrusion; ektexine consisting of clavae

about 1 to 1.5 microns long and about 1 micron in width; clavae distinctly separated over most of the body and passing to a reticulate pattern near the poles; lumina approximately 1 micron in diameter.

Size range: Polar axis 45 to 55 microns.

Diameter of polar protrusions 11 to 14 microns.
Length of equatorial protrusions 21 to 28 microns.
Diameter of equatorial protrusions 11 to 14 microns.
Equatorial diameter of body about 14 microns.

Distribution: Edmonton Formation in R.C.A. Corehole No. 65-1 (section 1, "zone" A), and in outcrop section 3 on the Red Deer River.

Vakh River Basin (Maestrichtian to Danian), U.S.S.R. (Chlonova, 1961).

Remarks: *Aquilapollenites* sp. cf. *A. quadricretaceus* differs from *Aquilapollenites quadricretaceus* Chlonova, 1961, in having an intectate ektexine with clavae completely separated over most of the grain surface. A few specimens do, however, exhibit an ektexine which becomes more tectate in areas other than the tips of the polar protrusions. In other respects, these specimens compare closely to *Aquilapollenites quadricretaceus* Chlonova, 1961.

Locality of figured specimens: R.C.A. Corehole No. 65-1.

Pl. 4, figs. 6, 7.	Depth 286 to 291 feet;	Edmonton Formation.
Pl. 4, figs. 6, 7.	Slide No. 1-34-2;	co-ord. 14.2/97.7.
Pl. 4, fig. 8.	Depth 286 to 291 feet;	Edmonton Formation.
Pl. 4, fig. 8.	Slide No. 1-34-2;	co-ord. 7.5/97.1.

AQUILAPOLLENITES sp. A

Plate 2, figure 10

Description: Isopolar; tridemicolpate; body with three equatorial and two polar protrusions; diameter of polar protrusions about equal to diameter of equatorial protrusions; demicolpi located within the concavities formed between the equatorial and the polar protrusions; smooth, narrow, thickened bands paralleling each demicolpi; remainder of the body covered by a fine bertillon (fingerprint) pattern; spinules approximately 4 microns high at tips of all protrusions and sparsely distributed over the remaining surface.

Size range: Polar axis 34 to 36 microns.

Diameter of polar protrusions 15 to 18 microns.
Length of equatorial protrusions 20 to 22 microns.
Diameter of equatorial protrusions 12 to 14 microns.
Equatorial diameter of body about 18 microns.

Distribution: Edmonton Formation in R.C.A. Corehole No. 65-1 (section 1, "zone" A).

Remarks: The nature and the position of the colpi could not be ascertained precisely because the relatively few specimens were poorly orientated. Although they appear to exhibit a tridemicolpate condition, it seems possible that the specimens may be tricolpate with colpi restricted to the distal portions of each equatorial protrusion.

Locality of figured specimen: R.C.A. Corehole No. 65-1.

Pl. 2, fig. 10.	Depth 445 to 449 feet;	Edmonton Formation.
Pl. 2, fig. 10.	Slide No. 1-50-1;	co-ord. 6/96.

AQUILAPOLLENITES sp. B

Plate 3, figures 3-5

Description: Isopolar; tridemicolpate; body with three equatorial and two polar protrusions; diameter of polar and equatorial protrusions approximately ½ the polar axis; demicolpi short, located within the concavities formed between the equatorial and polar protrusions; smooth, short, thickened bands paralleling each demicolpi; spinules 0.5 to 1 micron long covering entire surface of body and densely packed near distal ends of equatorial protrusions; some specimens showing only a few very small spinules in the vicinity of the poles.

Size range: Polar axis 19 to 22 microns.
Diameter of polar protrusions 8 to 10 microns.
Length of equatorial protrusions 8 to 12 microns.
Diameter of equatorial protrusions 8 to 10 microns.
Equatorial diameter of body about 10 microns.

Distribution: Edmonton Formation in R.C.A. Corehole No. 65-1 (section 1, "zone" A).

Locality of figured specimens: R.C.A. Corehole No. 65-1.

Pl. 3, figs. 3, 4.	Depth 313 to 319 feet;	Edmonton Formation.
Pl. 3, figs. 3, 4.	Slide No. 1-40-3;	co-ord. 16.7/100.5.
Pl. 3, fig. 5.	Depth 313 to 319 feet;	Edmonton Formation.
Pl. 3, fig. 5.	Slide No. 1-40-3;	co-ord. 14.9/91.5.

AQUILAPOLLENITES sp. C

Plate 2, figures 8, 9

Description: Isopolar; tridemicolpate; body with three equatorial and two polar protrusions; diameter of polar protrusions approximately 1/3 of polar axis; equatorial protrusions constricted near their bases; demicolpi located within the concavities formed between the equatorial and polar protrusions and extending from the constricted bases of the equatorial protrusions to 2/3 the distance to the poles; reticulate ornamentation with lumina approximately 1 micron in diameter and muri 1 to 1.5 microns high

occurring on body, polar protrusions, and near bases of equatorial protrusions; ornamentation on the distal portions of the equatorial protrusions consisting of a very fine striatoreticulate pattern with lumina less than 0.5 micron in diameter.

Size range: Polar axis 33 to 36 microns.
Length of equatorial protrusions 15 to 18 microns.
Diameter of equatorial protrusions 12 to 13 microns.
Equatorial diameter of body about 25 microns.

Distribution: Edmonton Formation in R.C.A. Corehole No. 65-1 (section 1, "zone" A), and in outcrop section 3 on the Red Deer River.

Locality of figured specimen: R.C.A. Corehole No. 65-1.

Pl. 2, figs. 8, 9.	Depth 445 to 449 feet;	Edmonton Formation.
Pl. 2, figs. 8, 9.	Slide No. 1-50-3;	co-ord. 5.4/93.

GENUS SCOLLARDIA Srivastava, 1966
Type species SCOLLARDIA TRAPAFORMIS Srivastava, 1966
SCOLLARDIA STEEVESI Srivastava, 1966
Plate 5, figures 3, 4

1966 *Scollardia steevesi* Srivastava, Pollen et Spores, vol. 8, p. 545, pl. 10, figs. 4, 5, 7.

Description: Isopolar; tricolpate; equatorial outline triangular with three equatorial protrusions at the apices; sides straight to slightly concave or convex; colpi long extending from the tips of equatorial protrusions to the polar area, usually with a distinct to indistinct thickened margin; tips of equatorial protrusions often crumpled or bent; exine striate with striations running parallel to each other and roughly normal to the axes of the equatorial protrusions; exine about 1 micron thick.

Size range: Equatorial diameter 30 to 45 microns.

Distribution: Edmonton Formation in R.C.A. Corehole No. 65-1 (section 1, "zones" A and B), and outcrop sections 2, 3, and 4 on the Red Deer River.

Edmonton Formation (Maestrichtian), Scollard area, Alberta (Srivastava, 1966).

Locality of figured specimens: R.C.A. Corehole No. 65-1.

Pl. 5, fig. 3.	Depth 476 to 481 feet;	Edmonton Formation.
Pl. 5, fig. 3.	Slide No. 1-52-1;	co-ord. 7.9/98.
Pl. 5, fig. 4.	Depth 431 to 435 feet;	Edmonton Formation.
Pl. 5, fig. 4.	Slide No. 1-49-1;	co-ord. 11.7/85.

Genus TRICOLPITES Cookson, 1947 ex Couper, 1953, emend. Potonié, 1960
Type species TRICOLPITES RETICULATUS Cookson, 1947

Remarks: Forms included in genus *Tricolpites* in the present study are restricted to only finely reticulate to microreticulate tricolpate pollen.

TRICOLPITES sp. A

Plate 5, figure 14

Description: Tricolpate; prolate; outline elliptical; colpi long and narrow; apocolpium small; endexine less than 0.5 micron thick, ektexine with pila about 1 micron thick; pila arranged to produce a fine striatoreticulate ornamentation.

Size range: Polar diameter 16 to 25 microns.

Distribution: Edmonton Formation in R.C.A. Corehole No. 65-1 (section 1, "zones" A and B), and outcrop sections 2, 3 and 4 on the Red Deer River.

Remarks: *Tricolpites* sp. A differs from *Tricolpites striatus* Couper, 1954 in being considerably smaller and having a finer striatoreticulate sculpture.

Locality of figured specimen: R.C.A. Corehole No. 65-1.

Pl. 5, fig. 14.	Depth 286 to 291 feet;	Edmonton Formation.
Pl. 5, fig. 14.	Slide No. 1-34-2;	co-ord. 4.8/82.

TRICOLPITES sp. B

Plate 5, figure 13

Description: Tricolpate; equatorial outline subtriangular; sides strongly convex; intercolpate margins arching into apices; apocolpium small to moderate; colpi straight and narrow; exine ornamentation microreticulate, lumina 0.5 micron or less in diameter; exine about 1 micron thick.

Size range: Equatorial diameter 24 to 27 microns.

Distribution: Edmonton Formation in R.C.A. Corehole No. 65-1 (section 1, "zones" A and B), and outcrop sections 2, 3 and 4 on the Red Deer River.

Remarks: *Tricolpites* sp. B is similar to *Tricolpites microreticulatus* Belsky *et al.*, 1965, in size and ornamentation. However, the equatorial outline of *Tricolpites* sp. B is more triangular than circular.

Locality of figured specimen: R.C.A. Corehole No. 65-1.

Pl. 5, fig. 13.	Depth 313 to 319 feet;	Edmonton Formation.
Pl. 5, fig. 13.	Slide No. 1-40-3;	co-ord. 20.3/80.

Genus KURTZIPITES Anderson, 1960

Type species KURTZIPITES TRISPISSATUS Anderson, 1960

KURTZIPITES TRISPISSATUS Anderson, 1960

Plate 4, figure 1

1960 *Kurtzipites trispissatus* Anderson, N. Mex. Bur. Mines and Mineral Resources, Mem. 6, p. 25, pl. 2, figs. 15-17.

Description: Triporate; equatorial outline hexagonal; interpore areas sharply convex at midpoints; pores slit-like with a distinctive, crescentic to triangular, opaque thickening behind each pore; thickened patches 3 to 4 microns in diameter; pores showing very little thickening elsewhere; overall thickness of exine about 0.5 micron; ornamentation indistinct, possibly microreticulate.

Size range: Equatorial diameter about 22 microns.

Distribution: Edmonton Formation in R.C.A. Corehole No. 65-1 (section 1, "zone" A), and outcrop section 3 on the Red Deer River.

Kirtland Shale (latest Cretaceous), San Juan Basin, New Mexico (Anderson, 1960).

Locality of figured specimen: R.C.A. Corehole No. 65-1.

Pl. 4, fig. 1.	Depth 313 to 319 feet;	Edmonton Formation.
Pl. 4, fig. 1.	Slide No. 1-40-3;	co-ord. 18.8/110.8.

KURTZIPITES sp.

Plate 5, figures 15, 16

Description: Triporate; equatorial outline subcircular to subtriangular; triangular or crescent-shaped thickenings surrounding the pores, with the apices of the triangles or crescents pointing toward the poles; pores longitudinally elongate with slightly thickened margins and 0.5 to 1 micron in diameter; exine less than 1 micron thick; ornamentation indistinct to scabrate.

Size range: Equatorial diameter 16 to 24 microns.

Distribution: Edmonton Formation in R.C.A. Corehole No. 65-1 (section 1, "zones" A and B), and in outcrop sections 2 and 4 on the Red Deer River.

Remarks: *Kurtzipites* sp. differs from *Kurtzipites trispissatus* Anderson, 1960, in having sides which are not sharply convex at the midpoint between the pores.

Locality of figured specimens: R.C.A. Corehole No. 65-1.

Pl. 5, fig. 15.	Depth 276 to 280 feet;	Edmonton Formation.
Pl. 5, fig. 15.	Slide No. 1-32-3;	co-ord. 21.1/105.
Pl. 5, fig. 16.	Depth 313 to 319 feet;	Edmonton Formation.
Pl. 5, fig. 16.	Slide No. 1-40-3;	co-ord. 12.6/104.7.

INCERTAE SEDIS

Genus SCHIZOSPORIS Cookson and Dettmann, 1959

Type species SCHIZOSPORIS RETICULATUS, Cookson and Dettmann, 1959

SCHIZOSPORIS COMPLEXUS Stanley, 1965

Plate 1, figure 7

1965 *Schizosporis complexus* Stanley, Bull. Am. Paleont., vol. 49, p. 267, pl. 36, figs. 7-17.

Description: Inaperturate(?); outline circular to subcircular; exine ornamentation reticulate; lumina 1 to 3 microns wide; muri composed of two rows of 1- to 2-micron high baculae; a fissure or tear paralleling the long axis of the grain almost always present.

Size range: Diameter 38 to 50 microns.

Distribution: Edmonton Formation in R.C.A. Corehole No. 65-1 (section 1, "zone" A).

Hell Creek Formation (Maestrichtian), South Dakota (Stanley, 1965).

Locality of figured specimen: R.C.A. Corehole No. 65-1.

Pl. 1, fig. 7.	Depth 445 to 449 feet;	Edmonton Formation.
Pl. 1, fig. 7.	Slide No. 1-50-1;	co-ord. 13.7/106.

Genus OVOIDITES Potonié, 1951, emend. Potonié, 1966

Type species OVOIDITES LIGNEOLUS (Potonié) Potonié, 1951

OVOIDITES LIGNEOLUS (Potonié) Potonié, 1951

Plate 7, figure 14

1931 *Pollenites*(?) *ligneolus* Potonié, Sitzber. Ges. Naturf. Freunde (Berlin), no. 1-3, p. 28, pl. 2, fig. V25a.

1951 *Ovoidites ligneolus* (Potonié) Potonié, Palaeontographica, Band 91, Abt. B, p. 150, pl. 21, fig. 185.

1965 ?*Schizosporis* sp. or *Ovoidites* sp. Harris, Geol. Surv. Queensland, Rept. 10, fig. 10.

Description: Inaperturate; body fusiform to elongate-elliptical in shape, usually splitting approximately in half by an elongate fissure; exine 2 to 2.5 microns thick, surface irregularly reticulate with 1- to 1.5-micron wide muri.

Size range: Length 65 to 90 microns.
Breadth 28 to 36 microns.

Distribution: Paskapoo Formation in R.C.A. Corehole No. 65-1 (section 1, "zone" C).

Tertiary strata of Brisbane, Queensland (Harris, 1965); Cannonball Member (Paleocene), Fort Union Formation, South Dakota (Stanley, 1965); Oligocene and Miocene of Germany (Potonié, 1931).

Locality of figured specimen: R.C.A. Corehole No. 65-1.

Pl. 7, fig. 14.	Depth 54 to 60 feet;	Paskapoo Formation.
Pl. 7, fig. 14.	Slide No. 1-5-3;	co-ord. 16/78.3.

Genus SIGMOPOLLIS Hedlund, 1965

Type species SIGMOPOLLIS HISPIDUS Hedlund, 1965

SIGMOPOLLIS HISPIDUS Hedlund, 1965

Plate 2, figures 3, 4

1965 *Sigmopollis hispidus* Hedlund, Pollen et Spores, vol. 7, p. 92, pl. 1, figs. 1-12.

Description: Aperture single; body spherical, outline circular to subcircular; aperture doubly recurved, sigmoidal; exine less than 1 micron thick, ornamented with spinules about 0.5 micron long, densely distributed.

Size range: Diameter 15 to 24 microns.

Distribution: Edmonton Formation in R.C.A. Corehole No. 65-1 (section 1, "zone" A), and outcrop section 3 on the Red Deer River.

Miocene, Elko County, Nevada (Hedlund, 1965).

Locality of figured specimens: R.C.A. Corehole No. 65-1.

Pl. 2, fig. 3.	Depth 286 to 291 feet;	Edmonton Formation.
Pl. 2, fig. 3.	Slide No. 1-34-1;	co-ord. 10.4/115.9.
Pl. 2, fig. 4.	Depth 476 to 481 feet;	Edmonton Formation.
Pl. 2, fig. 4.	Slide No. 1-52-1;	co-ord. 4.6/77.9.

Genus WODEHOUSEIA Stanley, 1961

Type species WODEHOUSEIA SPINATA Stanley, 1961

WODEHOUSEIA SPINATA Stanley, 1961

Plate 4, figures 3-5

1961 *Wodehouseia spinata* Stanley, Pollen et Spores, vol. 3, p. 157, pl. 1, figs. 1-12.

Description: Tetraporate; dorso-ventral outline of body elliptical with a well-developed flange; flange 2 to 4 microns wide along longitudinal ends and 5 to 7 microns wide along lateral edges; membrane of the flange pitted and supported by 6 to 12 microns long knobby spines; spines numbering 10 or 11 on each surface; two pores on each surface, pores elliptical to slit-like, and elongated parallel to the minor axis of central body; exine very finely granulate.

Size range: Length of body including flange 34 to 48 microns.
Breadth of body including flange 15 to 35 microns.

Distribution: Edmonton Formation in R.C.A. Corehole No. 65-1 (section 1, "zone" A), and outcrop section 3 on the Red Deer River.

Hell Creek Formation (Maestrichtian) South Dakota (Stanley, 1961); Hell Creek Formation (Maestrichtian) Montana (Norton and Hall, 1967); Maestrichtian, Siberia, U.S.S.R. (Bratzeva, 1967).

Locality of figured specimens: R.C.A. Corehole No. 65-1, section 3 on the Red Deer River.

Pl. 4, fig. 3.	101 to 103 feet above Kneehills Member;	Edmonton Formation.
Pl. 4, fig. 3.	Slide No. 3-1-1;	co-ord. 9.9/114.8.
Pl. 4, fig. 4.	101 to 103 feet above Kneehills Member;	Edmonton Formation.
Pl. 4, fig. 4.	Slide No. 3-1-1;	co-ord. 16/101.9.
Pl. 4, fig. 5.	Depth 313 to 319 feet;	Edmonton Formation.
Pl. 4, fig. 5.	Slide No. 1-40-3;	co-ord. 11.2/90.1.

MEGASPORES

Genus BALMEISPORITES Cookson and Dettmann, 1958

Type species BALMEISPORITES HOLODICTYUS Cookson and Dettmann, 1958

BALMEISPORITES STRIATELLUS Kondinskaya, 1966

Plate 8, figures 6, 7

1966 *Balmeisporites striatellus* Kondinskaya, Palynology of Siberia, Trudy Inst. Geol. Geophys., Sib. Otdel., Akad. Nauk SSSR, Novosibirsk, p. 118, pl. 2, fig. 1.

Description: Trilete megaspore; spore body circular in outline, with ridged, rib-like outer surface; neck composed of three segments, finely granulate, approximately equal to the body diameter in length; exospore double-layered; inner layer smooth, 1 to 4 microns thick; outer layer finely granulate ornamented by thin subparallel ridges 2 to 3 microns wide; ridges interconnected by rib-like structures, rib-like structures 1 to 1.5 microns wide, very irregular, branching, discontinuous to continuous.

Size range: Total length of megaspore (5 specimens) 100 to 350 microns.
Diameter of megaspore body (10 specimens) 50 to 180 microns.

Distribution: Edmonton Formation in R.C.A. Corehole No. 65-1 (section 1, "zone" A), and in outcrop section 3 along the Red Deer River; uppermost St. Mary River Formation in outcrops along the Oldman River north of Fort Macleod (Fig. 1).

Upper Cretaceous, Siberia, U.S.S.R. (Kondinskaya, 1966).

Locality of figured specimen: R.C.A. Corehole No. 65-1.

Pl. 8, figs. 6, 7.	Depth 445 to 449 feet;	Edmonton Formation.
Pl. 8, figs. 6, 7.	Slide No. 1-50-17M;	co-ord. 11.6/94.5.

BALMEISPORITES sp. A

Plate 9, figures 1-3

Description: Trilete megaspore; spore body circular in outline, with a coarsely reticulate surface; neck composed of three segments, finely pitted, approximately equal to or less than the body diameter in length; exospore three layered; inner layer smooth about 4 microns thick; central layer finely pitted, 2 to 8 microns thick and with a reticulate pattern; lumina circular to subcircular, 5 to 15 microns wide; outer layer finely pitted, about 30 microns thick, ornamented by a broad reticulate pattern with lumina 30 to 55 microns in diameter and muri 2 to 8 microns wide; body with three equatorial extensions formed by the outer exospore layer, 40 to 50 microns wide.

Size range: Total length of megaspore (5 specimens) 200 to 320 microns.
Diameter of megaspore body (8 specimens) 150 to 240 microns.

Distribution: Edmonton Formation in R.C.A. Corehole No. 65-1 (section 1, "zone" A); uppermost St. Mary River Formation in outcrops along Oldman River north of Fort Macleod (Fig. 1).

Remarks: *Balmeisporites* sp. A differs from ***Balmeisporites dettmannii*** Srivastava and Binda, in press, in possessing larger lumina in both the central as well as the outer layer of exospore, and in the lack of gradation of the size of lumina in the outer exospore layer.

Locality of figured specimen: R.C.A. Corehole No. 65-1.

Pl. 9, figs. 1-3.	Depth 431 to 435 feet;	Edmonton Formation.
Pl. 9, figs. 1-3.	Slide No. 1-49-1M;	co-ord. 8.9/79.7.

BALMEISPORITES sp. B
Plate 10, figures 1-3

Description: Trilete megaspore; spore body circular in outline, with a coarsely reticulate surface; neck composed of three segments, with a faint rib-like ornamentation, and shorter than the body diameter; exospore double-layered; inner layer smooth, 3 to 4 microns thick; outer layer ornamented by a reticulate pattern, lumina triangular, about 30 microns in diameter; muri smooth, often double walled, 3 to 4 microns wide, and 10 to 20 microns high; muri junctions crenulated and usually raised.

Size range: Total length of megaspore (3 specimens) 230 to 250 microns.

Diameter of megaspore body (4 specimens) 160 to 180 microns.

Distribution: Edmonton Formation in R.C.A. Corehole No. 65-1 (section 1, "zone" A).

Locality of figured specimen: R.C.A. Corehole No. 65-1.

Pl. 10, figs. 1-3.	Depth 445 to 449 feet;	Edmonton Formation.
Pl. 10, figs. 1-3.	Slide No. 1-50-3M;	co-ord. 5.5/86.9.

BALMEISPORITES sp. C
Plate 11, figure 3; plate 12, figures 1, 2

Description: Trilete megaspore; spore body circular in outline, with a coarsely reticulate surface; neck composed of three segments and shorter than body diameter; exospore three layered; inner layer smooth to faintly scabrate and 2 to 4 microns thick; central layer with a reticulate pattern, muri smooth, contorted, curved, about 12 microns thick and 2 to 3 microns wide forming irregular-shaped lumina; lumina 5 to 15 microns wide; outer layer ornamented by a broad reticulate pattern with larger lumina 20 to 50 microns in diameter, and about 30 microns high, formed by similarly contorted muri; body with three wing-like equatorial outgrowths formed by the outer exospore layer, 40 to 50 microns wide.

Size range: Total length of megaspore (2 specimens) 240 to 260 microns.
Diameter of megaspore body (4 specimens) 180 to 200 microns.

Distribution: Edmonton formation in R.C.A. Corehole No. 65-1 (section 1, "zone" A).

Locality of figured specimen: R.C.A. Corehole No. 65-1.

Pl. 11, fig. 3.	Depth 445 to 449 feet;	Edmonton Formation.
Pl. 11, fig. 3.	Slide No. 1-50-4M;	co-ord. 14.3/71.5.
Pl. 12, figs. 1, 2.	Depth 445 to 449 feet;	Edmonton Formation.
Pl. 12, figs. 1, 2.	Slide No. 1-50-4M;	co-ord. 14.3/71.5.

Balmeisporites sp. D

Plate 11, figures 1, 2

Description: Trilete megaspore; spore body circular in outline, with a ribbed surface; neck short with three segments; exospore double layered; inner layer smooth; outer layer ornamented by fine-meshed reticulate pattern with lumina 1 to 2 microns wide; surface with converging ribs forming peaks 30 to 40 microns high, ribs smooth, 2 to 4 microns wide.

Size range: Total length of megaspore (5 specimens) 120 to 210 microns.
Diameter of megaspore body (10 specimens) 80 to 180 microns.

Distribution: Edmonton Formation in R.C.A. Corehole No. 65-1 (section 1, "zone" A), and outcrop section 3 along the Red Deer River; uppermost St. Mary River Formation in outcrops along the Oldman River north of Fort Macleod (Fig. 1).

Remarks: *Balmeisporites* sp. D is similar to *Balmeisporites bellus* Kondinskaya, 1966 and *Balmeisporites mollis* Kondinskaya, 1966 in possessing converging ribs which coalesce to form numerous peaks. Kondinskaya's species, however, have an outer exospore layer ornamented by fine granules instead of a fine-meshed reticulate pattern.

Locality of figured specimen: R.C.A. Corehole No. 65-1.

Pl. 11, figs. 1, 2.	Depth 445 to 449 feet;	Edmonton Formation.
Pl. 11, figs. 1, 2.	Slide No. 1-50-6M;	co-ord. 10.7/73.4.

Family Salviniaceae

Genus Azolla Lamarck, 1783

Remarks: Figure 5 shows the general morphological components of the *Azolla* megaspores described in the present study. The megaspore body is circular in outline and covered with a dense perispore composed of two

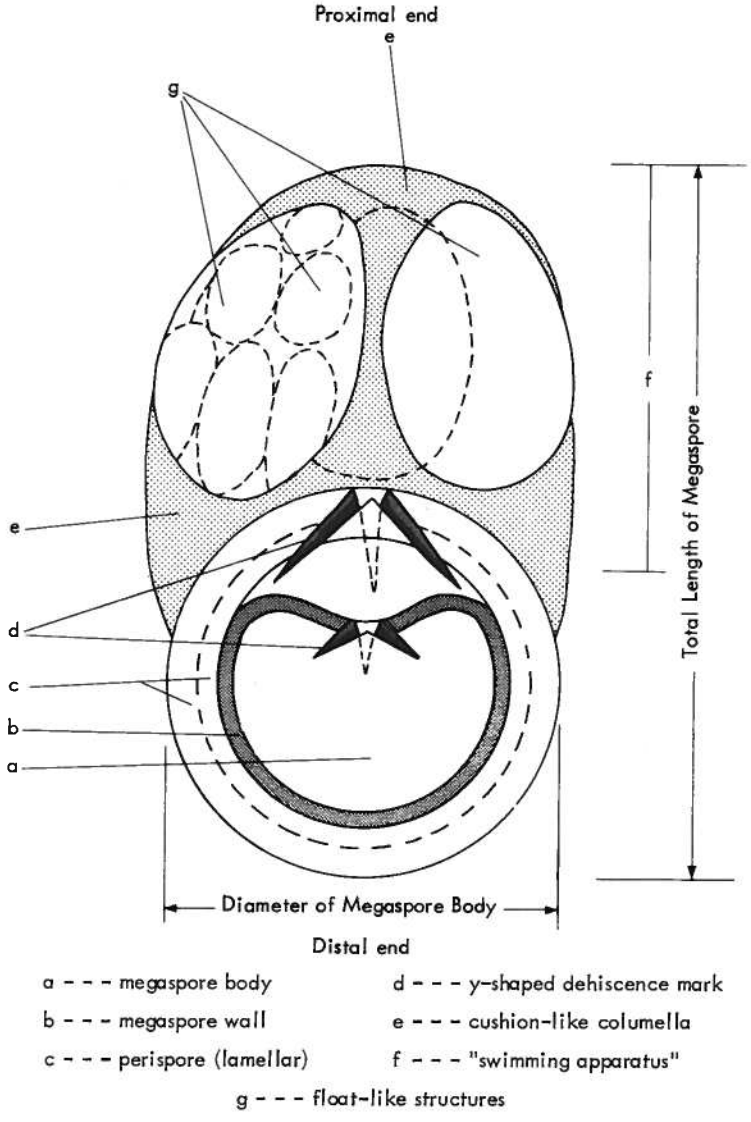

FIGURE 5. Azolla. *Diagrammatic representation of the general morphology.*

or more lamellae. A Y-shaped dehiscence mark is always visible on the megaspore wall and usually seen on the perispore. Above the Y-shaped mark a spongy mound provides a cushion-like columella which carries the three upper massulae or the "swimming apparatus" (Eames, 1936). According to Hills (personal communication), this cushion-like mass extends upward, parallel to the Y-shaped dehiscence mark, and along three planes of original separation within the "swimming apparatus". A detailed discussion of the subdivision of the "swimming appartus" into multifloated conditions is given by Hills and Gopal (1966). In this study, the end nearest the Y-shaped dehiscence mark is referred to as the proximal end, and the one away from it as the distal end.

To date, in almost every palynological study, the nature of the "swimming apparatus" has been the primary basis for classification of *Azolla* megaspores species. In the following descriptions a new approach is taken which lays more stress on the nature and structure of the megaspore wall and perispore lamellae. The "swimming apparatus" is not always well defined on every specimen, which limits the application of a classification based on it. Although it is recognized that the division of the "swimming apparatus" is genetically very significant, it is necessary to supplement this approach through the study of the wall structure.

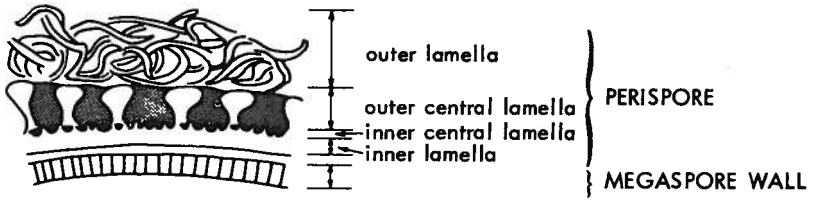

FIGURE 6. Azolla distincta *n. sp. Cross section of perispore and megaspore wall.*

AZOLLA DISTINCTA n. sp.

Plate 13, figures 1-4; plate 14, figures 1-3

Description: Outline of megaspore conical; "swimming apparatus" with numerous float-like structures; Y-shaped dehiscence mark distinct on megaspore wall and perispore; perispore composed of four lamellae; outer lamella 5 to 15 microns thick, consisting of filaments 1 to 2 microns in diameter; outer central lamella 7 to 10 microns thick, composed of a regular

reticulate structure with 8- to 10-micron wide lumina; muri widen from 1 to 2 microns at the base to 2 to 5 microns at the top; outer central lamella supported by the inner central lamella consisting of a fine reticulate structure 1 to 2 microns thick; inner lamella smooth, about 3 microns thick; megaspore wall faintly scabrate, 3 to 4 microns thick.

Size range: Total length of megaspore (50 specimens) 470 to 630 microns.
Diameter of megaspore body (75 specimens) 350 to 440 microns.

Distribution: Paskapoo and Edmonton Formations in R.C.A. Corehole No. 65-1 (section 1, "zones" A, B, and C), and in outcrop sections 2, 3 and 4 on the Red Deer River; throughout Willow Creek Formation in southwestern Alberta (Fig. 1).

Remarks: The specific name is derived from "*distinctus*" (distinct).

The float-like structures were visible only when the "swimming apparatus" had been crushed or separated. No attempt was made to investigate the "swimming apparatus" in detail.

Locality of figured specimens: R.C.A. Corehole No. 65-1, section 2 on the Red Deer River.

Holotype:		
Pl. 13, figs. 1, 4.	Depth 313 to 319 feet;	Edmonton Formation.
Holotype:		
Pl. 13, figs. 1, 4.	Slide No. 1-40-8M;	co-ord. 4.4/77.7.
Pl. 13, fig. 2.	145 to 147 feet above Kneehills Member;	Edmonton Formation.
Pl. 13, fig. 2.	Slide No. 2-14-6M;	co-ord. 14/81.
Pl. 13, fig. 3.	Depth 142 to 146 feet;	Edmonton Formation.
Pl. 13, fig. 3.	Slide No. 1-14-4M;	co-ord. 11.2/80.4.
Pl. 14, figs. 1-3.	145 to 147 feet above Kneehills Member;	Edmonton Formation.
Pl. 14, figs. 1-3.	Slide No. 2-14-6M;	co-ord. 14/81.

AZOLLA FILOSA n. sp.

Plate 15, figures 1-4

Description: Outline of megaspore oval to ellipsoidal; "swimming apparatus" with numerous float-like structures; Y-shaped dehiscence mark distinct on megaspore wall and indistinct on perispore; perispore composed of two lamellae; outer lamella 16 to 20 microns thick, consisting of fine filaments about 1 micron in width; outer lamella, grading gradually into dense, smooth inner lamella, 6 to 8 microns thick; megaspore wall very finely granulate and 4 to 6 microns thick.

Size range: Total length of megaspore (10 specimens) 500 to 525 microns.
Diameter of megaspore body (10 specimens) 270 to 300 microns.

Distribution: Edmonton Formation in R.C.A. Corehole No. 65-1 (subsurface section 1, "zone" A), and outcrop section 3 on the Red Deer River.

Remarks: The specific name is derived from *"filosus"* (full of threads). The number of float-like structures could not be determined accurately.

Locality of figured specimens: R.C.A. Corehole No. 65-1.

Holotype:		
Pl. 15, fig. 1.	Depth 286 to 291 feet;	Edmonton Formation.
Holotype:		
Pl. 15, fig. 1.	Slide No. 1-34-11-2M;	co-ord. 12.5/81.2.
Pl. 15, fig. 2.	Depth 286 to 291 feet;	Edmonton Formation.
Pl. 15, fig. 2.	Slide No. 1-34-6M;	co-ord. 11.3/107.
Pl. 15, figs. 3, 4.	Depth 286 to 291 feet;	Edmonton Formation.
Pl. 15, figs. 3, 4.	Slide No. 1-34-6M;	co-ord. 11.7/94.2.

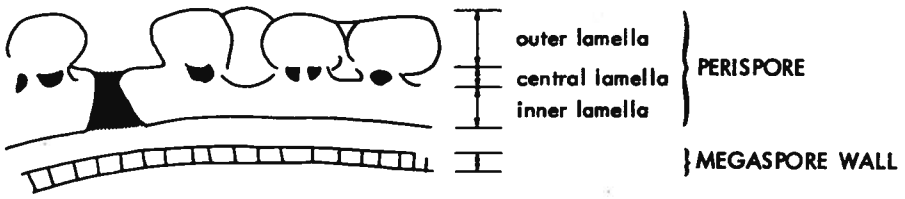

FIGURE 7. Azolla barbata *n. sp. Cross section of perispore and megaspore wall.*

AZOLLA BARBATA n. sp.

Plate 16, figures 1-3; plate 17, figures 1, 2

Description: Outline of megaspore elongate-ellipsoidal; "swimming apparatus" with numerous indistinct float-like structures; Y-shaped dehiscence mark distinct on megaspore wall and perispore; perispore composed of three lamellae; outer lamella 10 to 15 microns thick consisting of a foveolate structure; foveae 8 to 10 microns wide and may or may not be occupied by a pore; areas between foveae 10 to 15 microns wide; outer lamella supported by a central lamella consisting of columellae 3 to 4 microns high and 1 to 2 microns in diameter; columellae fused in the area around the fovea; inner lamella about 5 microns thick and smooth; megaspore wall 3 to 4 microns thick, scabrate or possibly infragranulate.

Size range: Total length of megaspore (5 specimens) 450 to 500 microns.
Diameter of megaspore body (10 specimens) 270 to 350 microns.

Distribution: Edmonton Formation in R.C.A. Corehole No. 65-1 (section 1, "zone" A), and in outcrop section 3 on the Red Deer River; upper Willow Creek Formation in outcrop sections along Willow Creek, west of Granum, and along Oldman River north of Pincher Creek.

Remarks: The specific name is derived from *"barbatus"* (bearded). The number of float-like structures was not determined.

Locality of figured specimens: R.C.A. Corehole No. 65-1.

Holotype:		
Pl. 16, fig. 1.	Depth 286 to 291 feet;	Edmonton Formation.
Holotype:		
Pl. 16, fig. 1.	Slide No. 1-34-14M;	co-ord. 12.6/93.3.
Pl. 16, figs. 2, 3.	Depth 286 to 291 feet;	Edmonton Formation.
Pl. 16, figs. 2, 3.	Slide No. 1-34-11-1M;	co-ord. 8.2/79.4.
Pl. 17, figs. 1, 2.	Depth 286 to 291 feet;	Edmonton Formation.
Pl. 17, figs. 1, 2.	Slide No. 1-34-14M;	co-ord. 12.6/93.3.

AZOLLA PILATA n. sp.

Plate 17, figures 3, 4; plate 18, figures 1-4

Description: Outline of megaspore oval to circular; columella well developed, three lobed, cushion like and situated above a distinct Y-shaped dehiscence mark on megaspore wall; perispore composed of two lamellae; outer lamella up to 90 microns thick and consisting of very fine densely packed filaments less than 1 micron in diameter; inner lamella 40 to 50 microns thick, dense, fibrous to cellular; megaspore wall smooth, 4 to 5 microns thick.

Size range: Total length of megaspore (7 specimens) 400 to 450 microns.
Diameter of megaspore body (7 specimens) 300 to 360 microns.

Distribution: Edmonton Formation in R.C.A. Corehole No. 65-1 (section 1, "zone" A).

Remarks: The specific name is derived from *"pilatus"* (dense, thick, hairy). According to Hills (personal communication), the float-like structures have been removed from these specimens leaving numerous concave surfaces of attachments along the sides and proximal end of the megaspore (Pl. 17, Fig. 1).

Locality of figured specimens: R.C.A. Corehole No. 65-1.

Holotype:		
Pl. 17, fig. 1.	Depth 286 to 291 feet;	Edmonton Formation.
Holotype:		
Pl. 17, fig. 1.	Slide No. 1-34-10-3M;	co-ord. 12/80.6.
Pl. 17, fig. 2.	Depth 286 to 291 feet;	Edmonton Formation.
Pl. 17, fig. 2.	Slide No. 1-34-4M;	co-ord. 11.5/84.3.
Pl. 18, fig. 1.	Depth 286 to 291 feet;	Edmonton Formation.
Pl. 18, fig. 1.	Slide No. 1-34-10-2M;	co-ord. 12.3/83.8.
Pl. 18, fig. 2.	Depth 286 to 291 feet;	Edmonton Formation.
Pl. 18, fig. 2.	Slide No. 1-34-10-3M;	co-ord. 12/80.6.
Pl. 18, figs. 3, 4.	Depth 286 to 291 feet;	Edmonton Formation.
Pl. 18, figs. 3, 4.	Slide No. 1-34-10-1M;	co-ord. 11/77.

AZOLLA CONSPICUA n. sp.

Plate 19, figures 1, 2; plate 20, figures 1, 2

Description: Outline of megaspore ellipsoidal; "swimming apparatus" with numerous float-like structures; Y-shaped dehiscence mark distinct on megaspore wall and indistinct on perispore; perispore composed of two lamellae; outer lamella 20 to 40 microns thick, consisting of coarse densely packed filaments 1 to 2 microns in diameter; outer lamella supported by a smooth to finely granulate inner lamella, 3 to 5 microns thick; megaspore wall 10 to 12 microns thick, very finely punctate or possibly infragranulate.

Size range: Total length of megaspore (5 specimens) 800 to 1000 microns.
Diameter of megaspore body (5 specimens) 460 to 520 microns.

Distribution: Edmonton Formation in R.C.A. Corehole No. 65-1 (section 1, "zone" A), and uppermost St. Mary River Formation on Oldman River, Fort Macleod area.

Remarks: The specific name is derived from *"conspicuus"* (conspicuous).

Azolla conspicua n. sp. differs from similar species described in this study by having a much larger body diameter and thicker megaspore wall.

Locality of figured specimens: R.C.A. Corehole No. 65-1.

Holotype:		
Pl. 19, fig. 1.	Depth 476 to 481 feet;	Edmonton Formation.
Holotype:		
Pl. 19, fig. 1.	Slide No. 1-52-2M;	co-ord. 12.5/72.5.
Pl. 19, fig. 2.	Depth 476 to 481 feet;	Edmonton Formation.
Pl. 19, fig. 2.	Slide No. 1-52-2M;	co-ord. 20.3/76.
Pl. 20, figs. 1, 2.	Depth 476 to 481 feet;	Edmonton Formation.
Pl. 20, figs. 1, 2.	Slide No. 1-52-2M;	co-ord. 20.3/76.

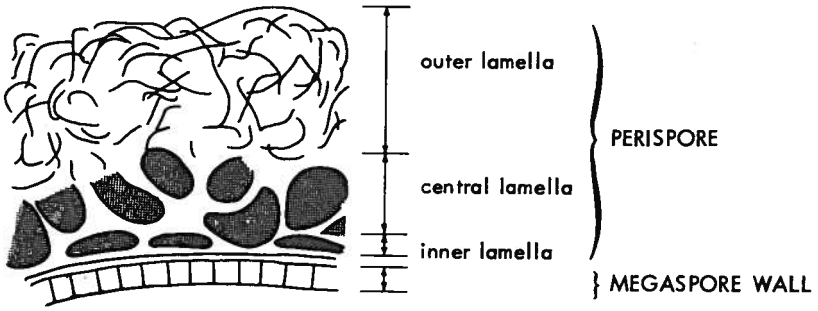

FIGURE 8. Azolla fistulosa *n. sp. Cross section of perispore and megaspore wall.*

AZOLLA FISTULOSA n. sp.

Plate 20, figures 3, 4; plate 21, figures 1-3

Description: Outline of megaspore oval to ellipsoidal; "swimming apparatus" dense with indistinct float-like structures; Y-shaped dehiscence mark distinct on megaspore wall and indistinct on perispore; perispore composed of three lamellae; outer lamella 20 to 30 microns thick, consisting of closely packed fine filaments about 0.5 micron in diameter; outer lamella grading into a spongy central lamella 15 to 20 microns thick; pores of spongy lamella 2 to 15 microns in diameter; central lamella supported by a very thin, smooth inner lamella 1 to 2 microns thick; megaspore wall 3 to 4 microns thick and faintly scabrate.

Size range: Total length of megaspore (10 specimens) 450 to 480 microns.
Diameter of megaspore body (10 specimens) 250 to 290 microns.

Distribution: Edmonton Formation in outcrop sections 2 and 4, "zone" B, on the Red Deer River.

Remarks: The specific name is derived from *"fistulosus"* (spongy).

Locality of figured specimens: Red Deer River outcrop section 4.

Holotype:		
Pl. 20, fig. 3.	150 to 155 feet above Kneehills Member;	Edmonton Formation.
Holotype:		
Pl. 20, fig. 3.	Slide No. 4-4-9M;	co-ord. 11/79.9.

Pl. 20, fig. 4.	150 to 155 feet above Kneehills Member;	Edmonton Formation.
Pl. 20, fig. 4.	Slide No. 4-4-5M;	co-ord. 8.4/80.1.
Pl. 21, figs. 1-3.	150 to 155 feet above Kneehills Member;	Edmonton Formation.
Pl. 21, figs. 1-3.	Slide No. 4-4-5M;	co-ord. 21.6/75.1.

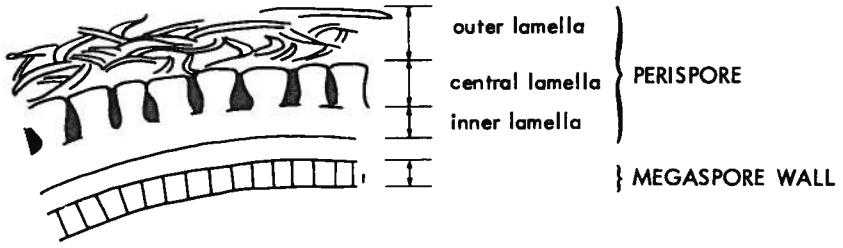

FIGURE 9. Azolla lauta *n. sp. Cross section of perispore and megaspore wall.*

AZOLLA LAUTA n. sp.

Plate 22, figures 1-4

Description: Outline of megaspore elongate-ellipsoidal; "swimming apparatus" with numerous float-like structures; Y-shaped dehiscence mark distinct on megaspore wall and perispore; perispore composed of three lamellae; outer lamella 10 to 20 microns thick, consisting of filaments approximately 1 micron in diameter; central lamella 6 to 8 microns thick consisting of fossulae-like grooves widening near their bases; grooves about 1 micron wide and 2 to 5 microns long; inner lamella 5 to 6 microns thick, smooth and dense; megaspore wall finely granular, 4 to 5 microns thick.

Size range: Total length of megaspore (25 specimens) 560 to 640 microns.
Diameter of megaspore body (50 specimens) 275 to 360 microns.

Distribution: Edmonton Formation in R.C.A. Corehole No. 65-1 (section 1, "zones" A and B), and in outcrop sections 2 and 3 on the Red Deer River; upper Willow Creek Formation in outcrop sections along Willow Creek west of Granum and along Oldman River north of Pincher Creek.

Remarks: The specific name is derived from *"lautus"* (neat, elegant).

The nature of the "swimming apparatus" and number of float-like structures were not investigated in detail.

Locality of figured specimens: R.C.A. Corehole No. 65-1.

Holotype:		
Pl. 22, fig. 1.	Depth 286 to 291 feet;	Edmonton Formation.
Holotype:		
Pl. 22, fig. 1.	Slide No. 1-34-2M;	co-ord. 7.7/91.3.
Pl. 22, figs. 2, 3.	Depth 286 to 291 feet;	Edmonton Formation.
Pl. 22, figs. 2, 3.	Slide No. 1-34-1-1M;	co-ord. 9.3/80.2.
Pl. 22, fig. 4.	Depth 286 to 291 feet;	Edmonton Formation.
Pl. 22, fig. 4.	Slide No. 1-34-4M;	co-ord. 11.7/81.3.

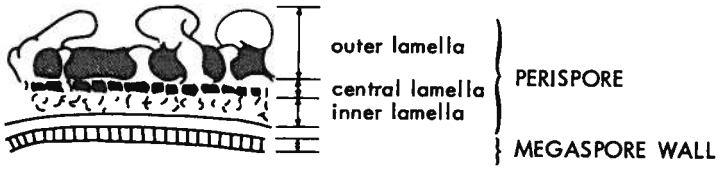

FIGURE 10. Azolla bulbosa *n. sp. Cross section of perispore and megaspore wall.*

AZOLLA BULBOSA n. sp.

Plate 23, figures 1-4; plate 24, figures 1-3

Description: Outline of megaspore oval to ellipsoidal; "swimming apparatus" three tiered with approximately 18 float-like structures; Y-shaped dehiscence mark distinct on megaspore wall and perispore; perispore composed of three lamellae; outer lamella 6 to 12 microns thick and consisting of an irregular reticulate structure with 5- to 15-micron wide lumina; muri 3 to 5 microns in width, expanding at junctions to form bulbous protrusions 8 to 12 microns in diameter; outer lamella supported by a central lamella composed of columellae approximately 1 micron in diameter and 1 to 2 microns high; inner lamella faintly granular, 3 to 5 microns thick; megaspore wall faintly scabrate or possibly smooth, 3 to 4 microns thick.

Size range: Total length of megaspore (15 specimens) 430 to 540 microns.
Diameter of megaspore body (15 specimens) 290 to 350 microns.

Distribution: Paskapoo Formation in R.C.A. Corehole No. 65-1 (section 1, "zone" C).

Remarks: The specific name is derived from "*bulbosus*" (bulbous) and refers to the bulbous protrusions on the perispore. The nature of the "swimming apparatus" and number of float-like structures were not investigated in detail. The size range and wall morphology of *Azolla bulbosa* are very similar to those of *Azolla teschiana* Florschütz, 1949. For comparison, plates 25 and 26 were prepared from specimens of *A. teschiana* loaned by L. V. Hills, University of Calgary. Both *A. bulbosa* and *A. teschiana* show an irregular discontinuous reticulate structure with distinct protrusions on the perispore surface. A detailed analysis of the wall structure shows the protrusions in *A. teschiana* to be composed of outer lamella material surrounding a pore which arises from the inner lamella. This differs markedly from the simple bulbous muri which form the protrusions in *A. bulbosa* n. sp.

Locality of figured specimens: R.C.A. Corehole No. 65-1.

Holotype:		
Pl. 23, fig. 1.	Depth 80 to 87 feet;	Paskapoo Formation.
Holotype:		
Pl. 23, fig. 1.	Slide No. 1-8-1M;	co-ord. 14/76.
Pl. 23, fig. 2.	Depth 80 to 87 feet;	Paskapoo Formation.
Pl. 23, fig. 2.	Slide No. 1-8-6M;	co-ord. 7.6/85.
Pl. 23, figs. 3, 4.	Depth 80 to 87 feet;	Paskapoo Formation.
Pl. 23, figs. 3, 4.	Slide No. 1-8-21M;	co-ord. 16/84.
Pl. 24, figs. 1-3.	Depth 80 to 87 feet;	Paskapoo Formation.
Pl. 24, figs. 1-3.	Slide No. 1-8-21M;	co-ord. 16/84.

AZOLLA SCHOPFI Dijkstra, 1961

Plate 27, figures 1-3; plate 28, figures 1-3

1961 *Azolla schopfi* Dijkstra, Mededel. Geol. Sticht., n.s., no. 13, p. 9, pl. 2, figs. 42-49.

Description: Outline in longitudinal view oval; "swimming apparatus" three tiered with approximately 18 float-like structures; long axis of float-like structures in basal tier 80 to 100 microns and in central tier 50 to 60 microns; Y-shaped dehiscence mark distinct on the megaspore wall and perispore; perispore composed of three lamellae; outer lamella 5 to 9 microns thick, consisting of granules, verrucae and verrucae-rugulae; granules and verrucae densely packed, 3 to 6 microns in diameter and often coalescing to form a verrucate-rugulate structure; pore spaces 4 to 5 microns wide, randomly distributed through outer lamella; outer lamella supported by a central lamella composed of columellae about 1 micron in diameter and 1 to 2 microns high; inner lamella 6 to 12 microns thick, smooth, with distinct pore structures 2 to 3 microns in diameter; megaspore wall finely granulate, 3 to 4 microns thick.

Size range: Total length of megaspore (50 specimens) 475 to 525 microns.
Diameter of megaspore body (100 specimens) 290 to 350 microns.

Distribution: Paskapoo and Edmonton Formations in R.C.A. Corehole No. 65-1 (section 1, "zones" A, B, and C), and Edmonton Formation in outcrop sections 2 and 3 on the Red Deer River; uppermost Willow Creek Formation on Willow Creek west of Granum.

Fort Union Formation, Ludlow Member (Paleocene), South Dakota (Dijkstra, 1961).

Remarks: Plate 29 was prepared for *Azolla schopfi* Dijkstra, 1961, from specimens on loan from L. V. Hills, University of Calgary, Calgary, Alberta. *A. schopfi* was described by Dijkstra as having at least 15 floats which compares very closely to the number of floats present on the specimens in this study. By comparing plates 27, 28 and 29, it can be seen that the wall structures are almost identical.

Locality of figured specimens: R.C.A. Corehole No. 65-1.

Pl. 27, fig. 1.	Depth 229 to 232 feet;	Edmonton Formation.
Pl. 27, fig. 1.	Slide No. 1-26-12M;	co-ord. 13.9/82.6.
Pl. 27, figs. 2, 3.	Depth 142 to 146 feet;	Edmonton Formation.
Pl. 27, figs. 2, 3.	Slide No. 1-14-1M;	co-ord. 13.6/83.2.
Pl. 28, figs. 1-3.	Depth 142 to 146 feet;	Edmonton Formation.
Pl. 28, figs. 1-3.	Slide No. 1-14-1M;	co-ord. 13.6/83.2.

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APPENDIX. MEASURED SECTIONS

Section: Cored section of lowermost Paskapoo Formation and uppermost Edmonton Formation (section 1).

Location: R.C.A. Corehole No. 65-1, about 25 miles southwest of Edmonton, Lsd. 4, Sec. 8, Tp. 48, R. 27, W. 4th Mer. (Figs. 1, 2).

Thickness of bed (feet)	Total depth (feet)	Lithology
2.00	15.20	siltstone, yellowish to buff, blocky fracture, yellowish-brown coating along fractures.
1.00	16.20	siltstone, light grey, blocky fracture, yellowish-brown coating along fractures.
5.00	21.20	interbedded sandstone and siltstone, yellowish-grey, friable, carbonaceous laminations, yellowish-brown coating along fractures.
1.70	22.90	claystone grading to siltstone near bottom, grey, blocky fractures, yellowish-brown coating along fractures.
13.50	36.40	claystone, grey, homogeneous, moderately consolidated, blocky fracture.
1.60	38.00	claystone, light grey to grey, hard.
2.45	40.45	siltstone, yellowish-grey to grey, blocky fracture, yellowish-brown coating along fractures.
4.00	44.45	sandstone, medium-grained, grey.
6.30	50.75	siltstone, grey to black, blocky fracture, carbonaceous and sandy near bottom.
0.40	51.15	sandstone, fine- to medium-grained, grey, yellowish-brown coating along fractures, hard to friable.
2.50	53.65	siltstone, argillaceous, bluish-grey, blocky fracture.
0.50	54.15	sandstone, medium-grained, grey.
6.10	60.25	siltstone, shaly, bluish-grey, blocky fracture.
5.97	66.22	claystone, alternating layers of grey, greenish-grey, brownish-grey and yellowish-green, slightly fissile, carbonaceous near top.
1.00	67.22	sandstone, light grey, thin-bedded.
6.40	73.62	claystone, sandy, mottled greenish-grey, less sandy and more consolidated near bottom.
1.00	74.62	sandstone, shaly, greenish-grey.
5.40	80.02	sandstone, fine- to medium-grained, laminated carbonaceous.
15.00	95.02	claystone, greenish-grey, carbonaceous, varved and somewhat silty near center.

5.80	100.82	siltstone, grey to light grey, cross-laminated near bottom.
4.50	105.32	siltstone, argillaceous, mottled grey and light brown, increasingly argillaceous near bottom.
4.50	109.82	sandstone, silty, grey, finely-laminated, less silty and mottled grey and yellowish-brown near bottom.
2.10	111.92	sandstone, medium-grained, grey, even textured.
1.60	113.52	sandstone, medium-grained, grey, laminated, carbonaceous, soft.
6.45	119.97	sandstone, silty, grey, homogeneous, moderately consolidated.
0.35	120.32	sandstone, medium-grained, finely laminated, hard.
5.00	125.32	sandstone, medium- to coarse-grained, grey, some orangish-brown coatings along fractures (poor core recovery).
2.50	127.82	sandstone, medium- to coarse-grained, very carbonaceous, few shale stringers, two bands of claystone fragments along with several large megafossils.
0.70	128.52	sandstone, medium- to coarse-grained, homogeneous.
5.33	133.85	sandstone, medium- to coarse-grained, grey to bluish-grey, abundant light brown to bluish-green claystone pebbles, carbonaceous, some Unio type megafossils near top.
1.20	135.05	siltstone, grey to yellowish-grey, finely laminated, some carbonaceous material.
0.80	135.85	sandstone, fine- to medium-grained, grey, carbonaceous, some cross-bedding.
1.70	137.55	siltstone, grey, hard, some cross-laminations, grading from sandy near top to argillaceous, near bottom.
3.30	140.85	claystone, yellowish-grey to buff, blocky fracture.

EDMONTON FORMATION

0.80	141.65	claystone, silty, grey to light purple, fractures at all angles, very hard.
0.50	142.15	claystone, dark brown, bituminous, hard.
0.80	142.95	lignite, with few claystone and siltstone stringers.
0.60	143.55	claystone, purplish-brown, with some coal.
2.30	145.85	coal.
1.50	147.35	siltstone, sandy, bluish-brown, very carbonaceous.

1.40	148.75	claystone, dark grey to black, bituminous.
0.50	149.25	siltstone and coal intermixed.
0.50	149.75	claystone, light grey.
0.30	150.05	bituminous lignite.
0.65	150.70	claystone, purplish-brown, very hard, carbonaceous.
0.30	151.00	claystone, greenish-grey.
2.00	153.00	lignite, coal and black colored claystone.
4.00	157.00	claystone, dark greenish-grey, interbedded with carbonaceous material, few coal stringers.
4.50	161.50	coal.
1.00	162.50	silty claystone, light grey, hard, carbonaceous.
2.50	165.00	coal.
0.90	165.90	claystone, greenish-grey, blocky fracture, hard, carbonaceous.
0.20	166.10	claystone, very light grey, blocky fracture, soft.
1.00	167.10	claystone, greenish-grey, blocky fracture, hard, carbonaceous.
5.50	172.60	shale, grey to dark grey, fissile, shaly partings.
4.00	176.60	sandstone, silty, fine-grained light grey to buff, finely laminated.
5.50	182.10	coal, argillaceous.
1.30	183.40	siltstone, sandy, grey, coal stringers throughout.
0.60	184.00	siltstone, grey, hard.
0.30	184.30	sandstone, fine-grained, grey.
2.30	186.60	siltstone, sandy, grey, cross-laminated.
0.80	187.40	sandstone, fine-grained, grey, laminated.
1.50	188.90	siltstone, grey, friable.
1.00	189.90	sandstone, grey, hard, laminated, some yellowish-brown coatings along fractures.
4.20	194.10	siltstone, sandy to argillaceous, grey, carbonaceous stringers parallel to bedding, yellowish-red at bottom.
0.60	194.70	siltstone, argillaceous, hard, few carbonaceous stringers.
1.50	196.20	sandstone, silty, grey, laminated.
3.40	199.60	sandstone, medium-grained, grey, yellowish-brown mottled, laminated at base and top.
2.00	201.60	siltstone, grey to greenish-grey, finely laminated, blocky fracture, scattered carbonaceous fragments.
0.30	201.90	siltstone, buff, calcareous, very hard, carbonaceous.
0.40	202.30	claystone, dark grey, carbonaceous, coal stringers near base.
0.40	202.70	sandstone, medium- to fine-grained, light grey.

0.60	203.30	siltstone, interlaminated with fine-grained sandstone, grey, abundant plant remains, coal stringer near bottom.
1.70	205.00	siltstone, sandy, laminated, soft, last few inches yellowish-brown, calcareous.
1.40	206.40	siltstone, sandy, buff to grey, hard, local concentrations of reddish-brown.
0.90	207.30	sandstone, fine- to medium-grained, green to grey, finely laminated.
0.60	207.90	sandstone, silty, mottled grey to yellowish-brown, laminated, some carbonaceous material.
0.80	208.70	sandstone, medium-grained, grey, moderately consolidated, homogeneous.
1.00	209.70	siltstone, orangish-brown, hard.
1.00	210.70	sandstone, silty, grey, laminated.
2.25	212.95	siltstone, dark grey, laminated, argillaceous near bottom.
4.55	217.50	sandstone, fine- to medium-grained, light grey, crossbedded near top, coarser-grained near bottom.
0.75	218.25	siltstone, light buff to grey.
0.55	218.80	sandstone, medium-grained, light grey to dark grey, laminated.
0.66	219.46	siltstone and silty sandstone, light tan to grey, hard.
4.00	223.46	claystone, silty, grey.
5.50	228.96	claystone, grey, orangish-brown stringers.
0.80	229.76	siltstone, argillaceous, dark grey, carbonaceous.
0.75	230.51	claystone, dark grey to black, carbonaceous.
1.00	231.51	claystone, light grey, some carbonaceous material, few calcareous orangish-brown nodules.
0.59	232.10	coal.
2.50	234.60	siltstone, light grey to dark grey, slightly carbonaceous.
1.20	235.80	sandstone, fine-grained, abundant carbonaceous material.
4.50	241.30	sandstone, grey, laminated, some crossbedding, moderately consolidated.
3.00	244.30	siltstone, buff to grey, blocky fracture, hard, slightly carbonaceous.
1.50	245.80	sandstone, silty, light grey to dark grey, laminated.
2.70	248.50	siltstone, buff to grey, hard, few leaf imprints.
2.00	250.50	sandstone, medium- to coarse-grained, light grey, homogeneous.
0.20	250.70	siltstone, sandy, grey, carbonaceous.
0.90	251.60	sandstone, dark grey to brown, crossbedded, soft.

1.20	252.80	alternating layers of light grey to grey sandstone and dark grey to brown siltstones.
0.50	253.30	siltstone, dark brownish-grey to yellowish-buff.
0.20	253.50	sandstone, finely laminated.
0.40	253.90	sandstone, medium- to coarse-grained, light grey, homogeneous.
0.40	254.30	siltstone, brown.
0.30	254.60	sandstone, silty, brownish-grey, laminated to crossbedded, abundant carbonaceous material.
1.40	256.00	sandstone, medium- to coarse-grained, light grey, finely bedded, soft.
0.60	256.60	sandstone, silty, brownish-grey to buff, crossbedded, hard.
1.00	257.60	siltstone, sandy, brownish-grey, crossbedded, soft.
0.40	258.00	sandstone, grey to dark grey, crossbedded.
6.00	264.00	claystone, silty, grey, shaly partings, scattered thin hard orangish-brown layers.
4.30	268.30	claystone, silty, black, very carbonaceous, hard.
4.30	272.60	coal, argillaceous.
0.80	273.40	claystone, white, very hard.
1.30	274.70	coal.
0.50	275.20	siltstone, brown to purple.
1.10	276.30	coal.
3.30	279.60	siltstone, mottled greenish-grey to grey, blocky fracture, very hard.
0.70	280.30	sandstone, fine- to medium-grained, light grey.
2.10	282.40	siltstone, grey to greenish-grey, numerous stringers of orangish-brown material, hard.
0.90	283.30	sandstone, silty, greenish-grey, some orangish-brown concentrations.
0.50	283.80	siltstone, argillaceous, laminated, grey to dark grey, shaly partings.
0.50	284.30	sandstone, silty to argillaceous, light green, friable.
1.50	285.80	sandstone, medium-grained, greyish-green, carbonaceous.
0.20	286.00	lignite.
2.50	288.50	siltstone, argillaceous, greenish-grey.
2.40	290.90	claystone, silty, dark grey, blocky fracture.
2.60	293.50	siltstone, buff to green, very finely laminated, some carbonaceous material.
0.50	294.00	sandstone, silty, light green, some argillaceous inclusions.
0.40	294.40	siltstone, light green.
0.60	295.00	sandstone, silty, light green, some argillaceous inclusions.
0.25	295.25	sandstone, medium- to fine-grained, grey.

0.75	296.00	siltstone, green, argillaceous stringers.
2.20	298.20	sandstone, fine- to medium-grained, grey to greenish-grey, finely laminated near top.
2.30	300.50	siltstone, greenish-grey, carbonaceous, hard.
2.50	303.00	siltstone, light green, small green subrounded claystone inclusions.
4.00	307.00	siltstone, sandy, light brownish-grey, very hard.
5.00	312.00	siltstone, light green, laminated, blocky fracturing.
1.33	313.33	sandstone, medium-grained, grey, containing rounded clay granules.
0.80	314.13	shale, green, shaly partings.
0.40	314.53	shale, brownish-grey, silty toward bottom with distinct shaly partings.
4.47	319.00	sandstone, silty to argillaceous.
1.30	320.30	sandstone, medium-grained, light grey.
1.10	321.40	siltstone, greenish-grey, hard.
14.10	335.50	alternating layers of light grey and dark brown bentonitic claystone, numerous spherical inclusions of bentonite.
0.60	336.10	tuff, silicified, grey.
21.90	358.00	claystone, bentonitic, alternating intervals of light grey and dark brown, prominent shaly partings.
4.00	362.00	siltstone, light brown to grey, hard bentonitic stringers.
4.40	366.40	siltstone, buff colored, laminated.
2.60	369.00	sandstone, medium-grained, grey, with inclusions of large yellowish-green claystone pebbles.
29.80	398.80	sandstone, medium- to coarse-grained, greenish-grey, homogeneous, lack of distinct bedding, moderately consolidated.
12.70	411.50	sandstone, coarse-grained, grey, friable.
2.00	413.50	sandstone, medium-grained, hard, calcareous.
16.00	429.50	sandstone, coarse-grained, grey, friable, homogeneous.
0.50	430.00	shale, dark brownish-grey, carbonaceous.
1.00	431.00	siltstone, argillaceous, light green, hard, some carbonaceous stringers.
3.00	434.00	siltstone, sandy to argillaceous, light green, orange speckled, hard, calcareous.
1.50	435.50	siltstone, argillaceous, light green, hard, some carbonaceous material.
2.50	438.00	sandstone, silty, fine- to medium-grained, brownish-grey, laminated, soft.
0.60	438.60	claystone, dark brown to dark grey, carbonaceous.

2.40	441.00	sandstone, silty, grey mottled, laminated.
0.30	441.30	claystone, greenish-grey, dense, blocky fracture.
3.30	444.60	sandstone, fine- to medium-grained, grey, laminated near top.
2.40	447.00	siltstone, argillaceous, dark brown, carbonaceous, few light green claystone pebbles near base.
2.20	449.20	siltstone, sandy, greenish-grey, laminated.
2.30	451.50	sandstone, fine- to medium-grained, grey.
2.00	453.50	coal, argillaceous and silty.
0.20	453.70	siltstone, very light grey, calcareous.
1.00	454.70	claystone, silty, light green.
1.10	455.80	siltstone, argillaceous, greenish-grey, blocky fracture, hard, abundant carbonaceous material.
1.20	457.00	sandstone, medium-grained, grey, laminated and crossbedded.
2.50	459.50	sandstone, grey, few orange claystone inclusions.
2.50	462.00	sandstone, medium-grained, grey, cross-laminated.
4.50	466.50	sandstone, silty, grey, cross-laminated, few orange claystone inclusions.
2.50	469.00	sandstone, medium-grained, grey, cross-laminated.
2.00	471.00	sandstone, coarse-grained, soft, numerous carbonaceous stringers parallel to bedding.
2.60	473.60	coal.
0.40	474.00	claystone, white, mica flaked.
2.00	476.00	sandstone, fine- to medium-grained, grey.
5.00	481.00	claystone, greenish-grey, shaly partings, hard.
7.00	488.00	sandstone, light grey, few laminations, soft.
4.50	492.50	sandstone, medium- to coarse-grained, light grey, hard, carbonate cement.
4.10	496.60	siltstone, greenish-grey, carbonaceous, becoming sandy near bottom.
5.90	502.50	sandstone, medium-grained, laminated to cross-laminated, numerous lenses of orangish-brown calcareous siltstone.
2.50	505.00	siltstone, sandy, grey to dark grey.
1.00	506.00	coal.

Section: Composite outcrop section of the lowermost Paskapoo Formation and the uppermost Edmonton Formation (Section 2).

Location: Red Deer River, Ardley region, in Tp. 38, R. 23, W. 4th Mer.

Thickness of bed (feet)	Total depth (feet)	Lithology
		Sec. 17, Tp. 38, R. 23, W. 4th Mer.
		PASKAPOO FORMATION
10.00	10.00	sandstone, medium- to coarse-grained, grey, small yellowish-brown concentrations make up approximately 10% of the matrix, yellowish-brown weathering surface.
		EDMONTON FORMATION
1.00	11.00	siltstone, orangish-red, very hard.
1.00	12.00	siltstone, light grey.
1.00	13.00	coal.
5.00	18.00	claystone, silty, dark grey, laminated.
2.00	20.00	interbedded dark lignitic shale and dark green to grey claystone.
7.50	27.50	siltstone, light green to grey, blocky fracturing, dark orangish-brown coating along fractures near bottom.
7.00	34.50	sandstone, medium-grained, grey orangish-brown coating along fractures and parallel to bedding, laminated in part.
2.50	37.00	siltstone, grey, orangish-brown concentrations along fractures, laminated.
2.00	39.00	claystone, grey.
2.00	41.00	siltstone, brown, blocky-fracture.
0.50	41.50	sandstone, fine-grained, grey.
4.00	45.50	claystone, silty, greenish-grey.
1.00	46.50	claystone, silty, purple to green.
0.25	46.75	coal.
0.25	47.00	claystone, green.
3.00	50.00	siltstone, greenish-grey, orangish-brown concentrations along fractures.
4.00	54.00	sandstone, medium-grained, yellowish-grey.
0.50	54.50	claystone, dark grey.
0.50	55.00	sandstone, grey, orangish-brown coatings along fractures.
1.00	56.00	coal.
0.50	56.50	claystone, dark grey.
0.50	57.00	lignite.
1.00	58.00	claystone, dark grey, carbonaceous.

3.50	61.50	sandstone, fine- to medium-grained, grey, orangish-brown coatings along fractures.
0.50	62.00	siltstone, grey to orangish-brown, hard.
1.00	63.00	claystone, silty, grey.
5.50	68.50	sandstone, fine- to medium-grained, grey, laminated, orangish-brown concentrations throughout.
1.00	69.50	siltstone, sandy, grey, finely laminated.
1.00	70.50	coal.
2.50	73.00	claystone, silty, dark grey.
1.00	74.00	siltstone, brown, blocky fracture.
0.50	74.50	siltstone, orangish-red, hard.
1.00	75.50	sandstone, grey, soft.
6.50	82.00	claystone, mottled dark grey to yellowish-green, carbonaceous near bottom.
2.50	84.50	siltstone, sandy, yellowish-green.
1.00	85.50	sandstone, grey, orangish-brown concentrations.
8.50	94.00	(covered interval)
2.50	96.50	claystone, green.
1.00	97.50	siltstone, yellow-red, hard.
4.00	101.50	claystone, dark grey, blocky fracture, orangish-brown coatings along fractures.
3.50	105.00	claystone, light green.
13.00	118.00	coal (Ardley seam).

Sec. 35, Tp. 38, R. 23, W. 4th Mer.

EDMONTON FORMATION

5.00	5.00	claystone, grey.
3.00	8.00	sandstone, fine-grained, nodular.
2.50	10.50	sandstone, fine- to medium-grained, hard.
6.00	16.50	claystone, silty, buff to grey.
10.00	26.50	sandstone, fine-grained, buff to grey, nodular.
3.50	30.00	claystone, yellowish-grey, nodular.
28.00	58.00	claystone, silty, yellowish-grey.
12.00	70.00	claystone, dark purplish-grey, bentonitic (Mauve shale).
0.70	70.70	tuff, silicified, light grey (Kneehills Tuff).
15.00	85.70	claystone, dark purplish-grey, bentonitic (Mauve shale).
10.00	95.70	sandstone, fine- to medium-grained, white.

Section: Outcrop section of the uppermost Edmonton Formation (section 3).
Location: Red Deer River, Caprona region, in Sec. 17, Tp. 36, R. 21, W. 4th Mer., east side of river.

Thickness of bed (feet)	Total depth (feet)	Lithology
		EDMONTON FORMATION
3.0	3.0	coal.
4.0	7.0	sandstone, medium- to coarse-grained, grey, buff weathering surface.
5.0	12.0	claystone, silty, passing from dark grey to purple near top, light green near the base.
1.5	13.5	sandstone, fine- to medium-grained, very hard, buff weathering surface.
5.0	18.5	sandstone, fine- to medium-grained, grey, soft.
1.5	20.0	sandstone, fine-grained, dark brown to purple, finely laminated, very carbonaceous.
4.0	24.0	sandstone, medium-grained, grey.
1.0	25.0	claystone, silty, yellowish-grey.
1.0	26.0	claystone, silty, dark grey.
1.5	27.5	siltstone, light yellowish-green.
1.5	29.0	claystone, silty, dark grey to yellowish-grey.
3.0	32.0	siltstone, sandy, buff to yellowish-grey.
5.0	37.0	claystone, silty, greenish-grey.
3.0	40.0	siltstone, sandy, buff weathering surface.
1.0	41.0	sandstone, fine-grained, orangish-brown, very hard, crossbedded.
7.0	48.0	sandstone, medium-grained, grey, soft.
4.0	52.0	claystone, silty, light yellowish-green to grey.
3.0	55.0	sandstone, fine- to medium-grained, light yellowish-green.
4.0	59.0	claystone, silty, dark grey to purple.
1.5	60.5	siltstone, light yellowish to buff.
2.5	63.0	claystone, silty, dark grey.
3.0	66.0	sandstone, fine-grained, grey, buff weathering surface, very hard.
7.0	73.0	sandstone, medium-grained, grey, soft.
11.0	84.0	claystone, silty, yellowish to grey.
1.0	85.0	claystone, dark grey.
2.0	87.0	claystone, silty, light grey to yellow.
5.0	92.0	claystone, silty, purplish-grey.
7.0	99.0	sandstone, medium-grained moderately consolidated.
1.0	100.0	sandstone, fine- to medium-grained, yellowish-buff to brown, very hard, calcareous.
10.0	110.0	sandstone, medium-grained, grey, moderately consolidated.
9.0	119.0	claystone, silty, dark purplish-grey (Mauve shale).
1.0	120.0	tuff, siliceous, hard (Kneehills Tuff).

Section: Outcrop section of the lowermost Paskapoo Formation and the uppermost Edmonton Formation (section 4).

Location: Red Deer River, Huxley region, Sec. 13, Tp. 34, R. 22, W. 4th Mer.

Thickness of bed (feet)	Total depth (feet)	Lithology
		PASKAPOO FORMATION
17.0	17.0	sandstone, medium- to coarse-grained, grey, buff weathered surface, crossbedded.
4.0	21.0	claystone, silty, buff to grey.
13.0	34.0	sandstone, fine- to medium-grained, grey, buff weathered surface, some crossbedding, carbonaceous near base.
		EDMONTON FORMATION
5.0	39.0	claystone, silty, light grey to buff, carbonaceous.
6.0	45.0	claystone, light grey, homogeneous.
4.0	49.0	claystone, silty, light grey to buff, carbonaceous.
5.0	54.0	claystone, grey to dark grey, carbonaceous.
8.0	62.0	coal.
15.0	77.0	claystone, slightly silty, grey, carbonaceous, blocky fracture.
5.0	82.0	sandstone, fine- to medium-grained, grey, hard.
7.0	89.0	sandstone, fine-grained, light grey, argillaceous.
15.0	104.0	claystone, silty, grey to dark grey, slightly carbonaceous.
5.0	109.0	siltstone, buff to grey.
14.0	123.0	claystone interbedded with siltstones, carbonaceous.
1.0	124.0	lignite, very argillaceous, dark grey to black.
20.0	144.0	sandstone, medium-grained, grey, loosely consolidated.
50.0	194.0	(covered interval)
4.0	198.0	claystone, grey to purplish-grey.
10.0	208.0	sandstone, medium-grained, light grey, yellowish-brown weathering surface.
18.0	226.0	sandstone and siltstone interbedded, few nodules, numerous orangish-brown concentrations along bedding planes.
12.0	238.0	sandstone, medium-grained, light grey, yellow-brown weathering surface, hard.
2.0	240.0	claystone, silty, dark purplish-grey (Mauve shale).
0.5	240.5	tuff, siliceous, hard (Kneehills Tuff).
10.5	251.0	claystone, silty, dark purplish-grey (Mauve shale).
10.0	261.0	sandstone, fine-grained, white, argillaceous.

PLATES 1 - 29

Explanation of Plate 1

Edmonton Formation

"zone" A

Central Alberta

Magnification X1000

Figure 1: *Aquilapollenites polaris* Funkhouser; equatorial view, 1-50-1 ..... (p. 45)

Figures 2, 3: *Aquilapollenites reticulatus* Stanley; 2—equatorial view, body reticulation, 3-9-1; 3—equatorial view, mid-focus, 1-52-1 ..... (p. 42)

Figure 4: *Leptolepidites tenuis* Stanley; mid-focus, 1-51-1 ..... (p. 26)

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PLATE 1


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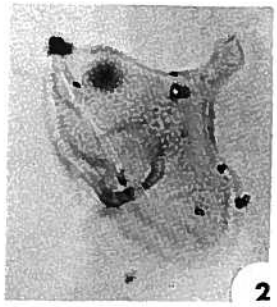
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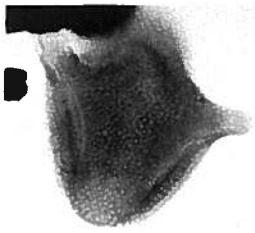
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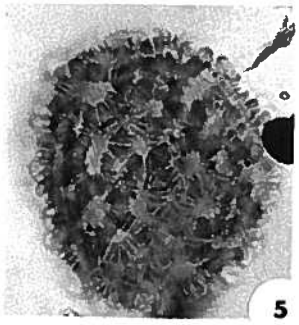
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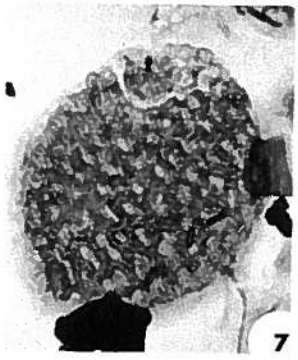
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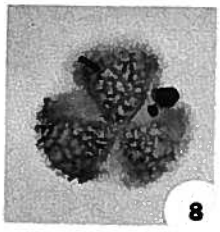
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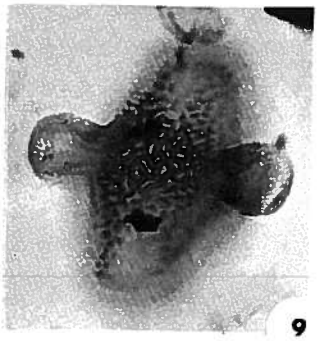
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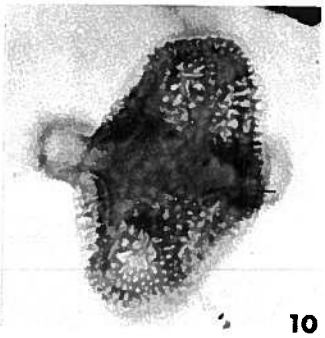
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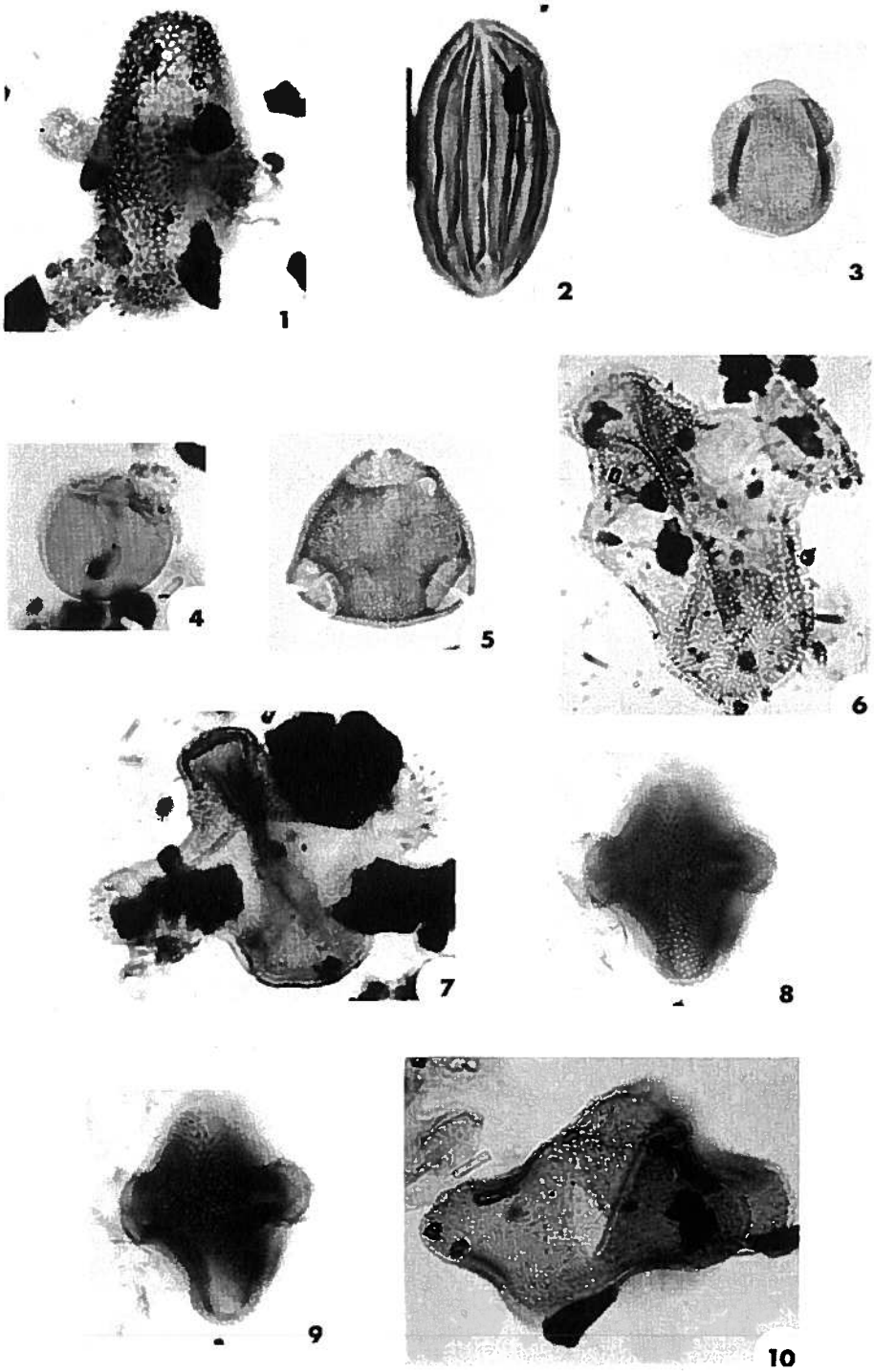
PLATE 2



Explanation of Plate 2

Edmonton Formation

"zone" A

Central Alberta

Magnification X1000

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Explanation of Plate 3

Edmonton Formation

"zone" A

Central Alberta

Magnification X1000

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PLATE 3


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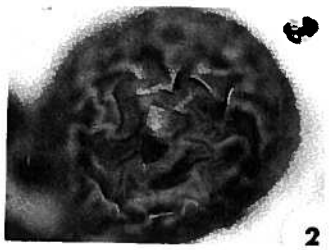
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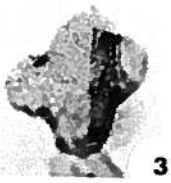
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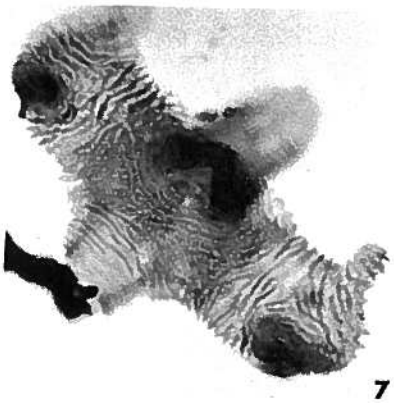
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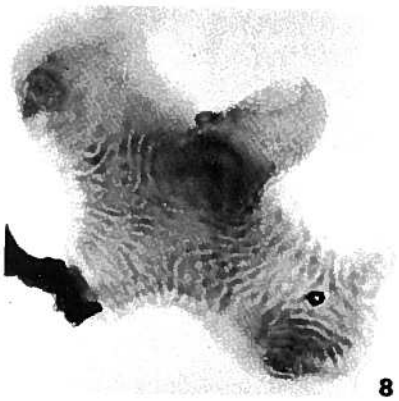
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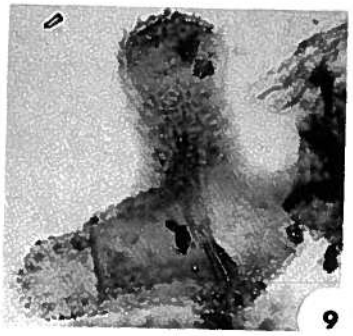
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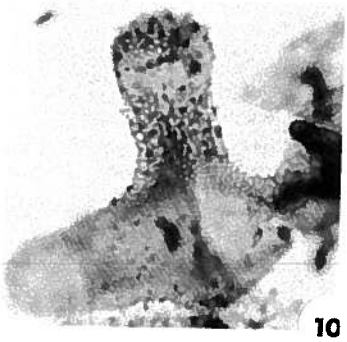
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PLATE 4


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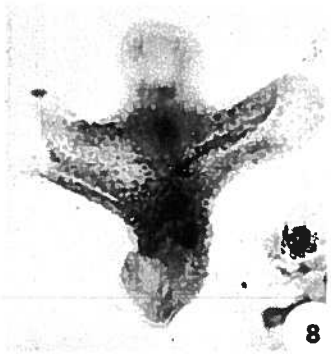
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Explanation of Plate 4

Edmonton Formation

"zone" A

Central Alberta

Magnification X1000

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Edmonton Formation
"zones" A and B
Central Alberta

Magnification X1000

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Figures 15, 16: *Kurtzipites* sp.; 15—polar view, mid-focus, 1-32-3; 16—polar view, mid-focus, 1-40-3 ..... (p. 52)

PLATE 5

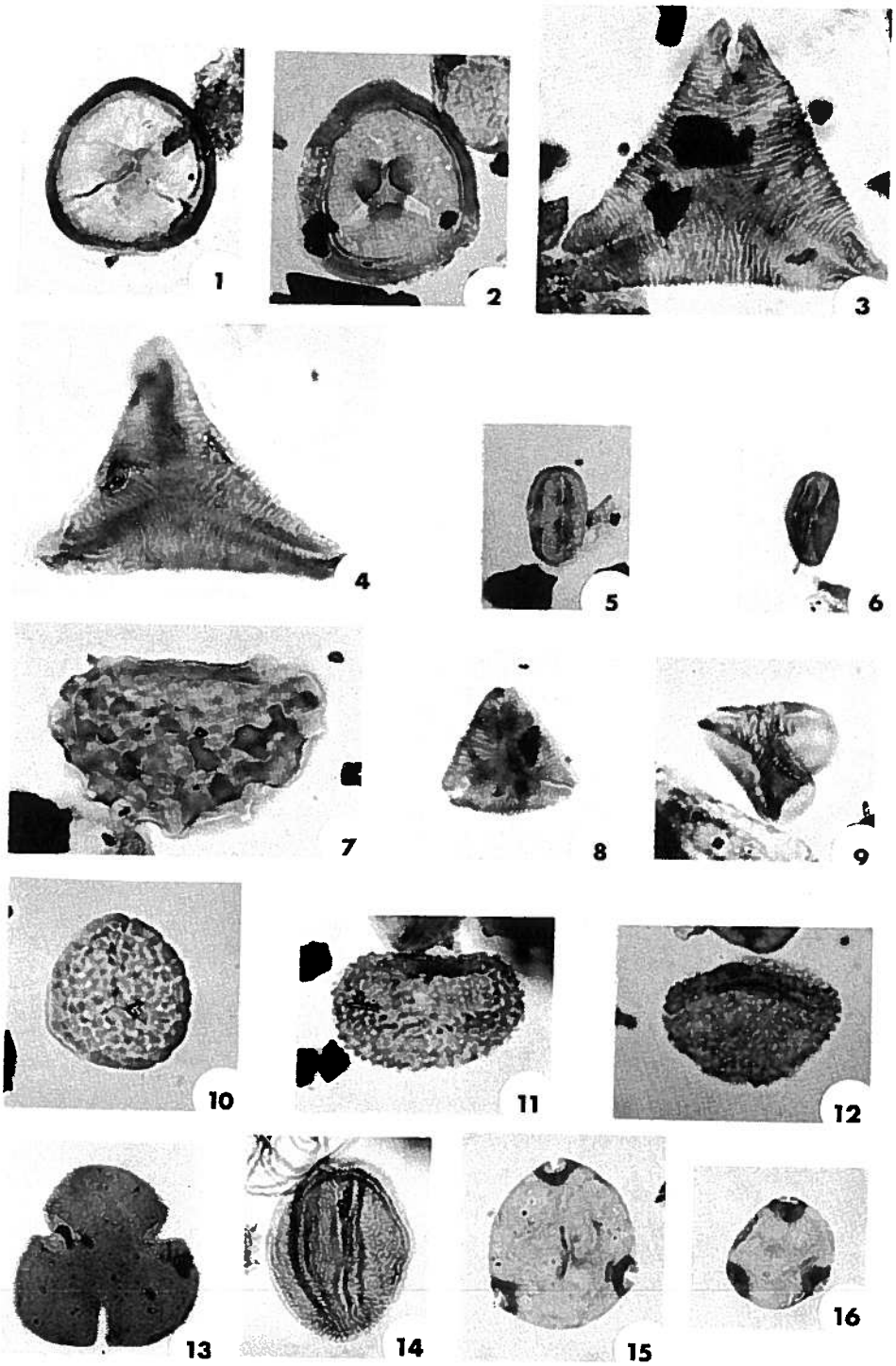
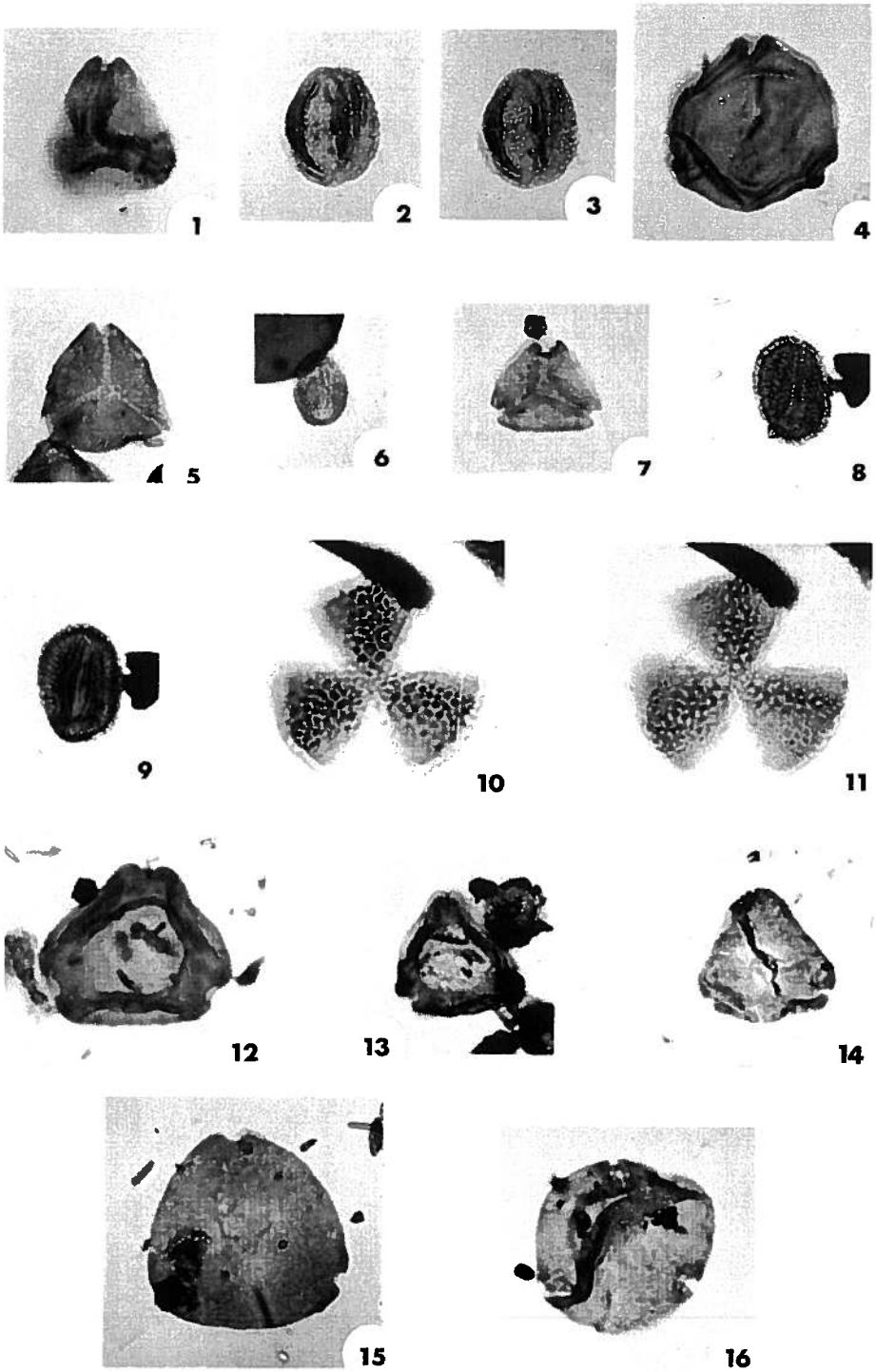


PLATE 6



Explanation of Plate 6

Edmonton Formation
"zone" B
Central Alberta

Magnification X1000

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Edmonton and Paskapoo Formations
"zones" B and C
Central Alberta

Magnification X1000

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Explanation of Plate 7

Paskapoo Formation

"zone" C

Central Alberta

Magnification X1000 unless otherwise stated

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Figure 14: *Ovoidites ligneolus* (Potonié) Potonié; mid-focus, X500 1-5-3 ..... (p. 53)

PLATE 7

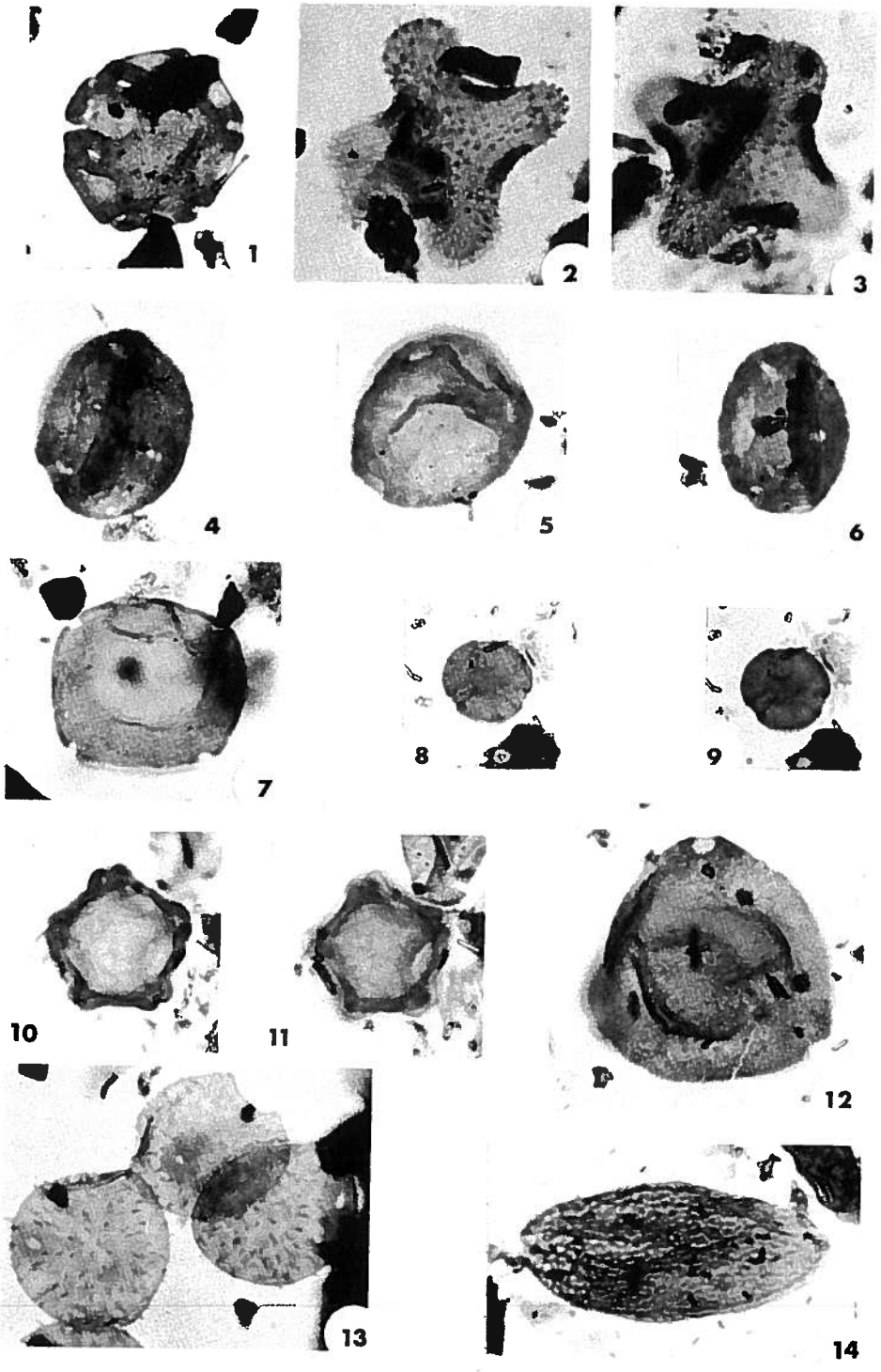

PLATE 8


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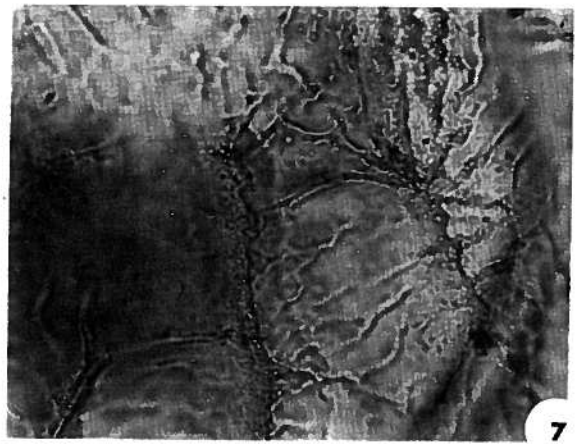
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Explanation of Plate 8

Edmonton and Paskapoo Formations

"zones" A, B, C

Central Alberta

Magnification X1000

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Megaspores

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PLATE 9

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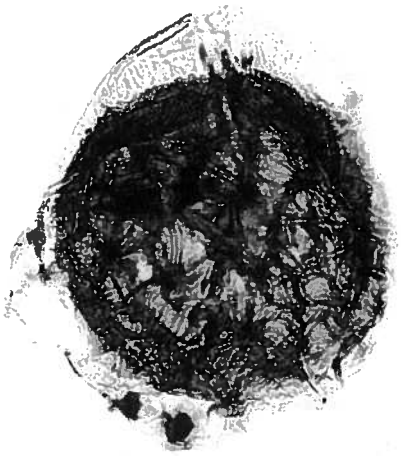
PLATE 10



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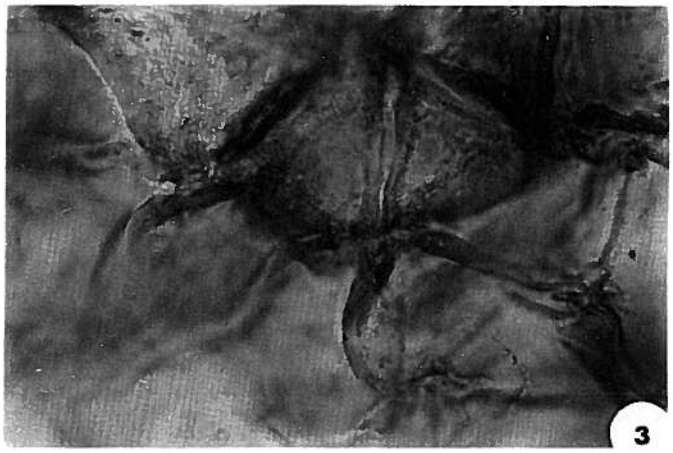

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Explanation of Plate 10

Figures 1-3: *Balmeisporites* sp. B; 1—equatorial view, mid-focus showing the megaspore body and neck, X250; 2—plan view of the outer layer showing the crenulated muri junctions, X1000; 3—plan view of the outer layer showing the triangular-shaped lumina, X1000, 1-50-3M: ("zone" A) Edmonton Formation, central Alberta ..... (p. 56)

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PLATE 11

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PLATE 12

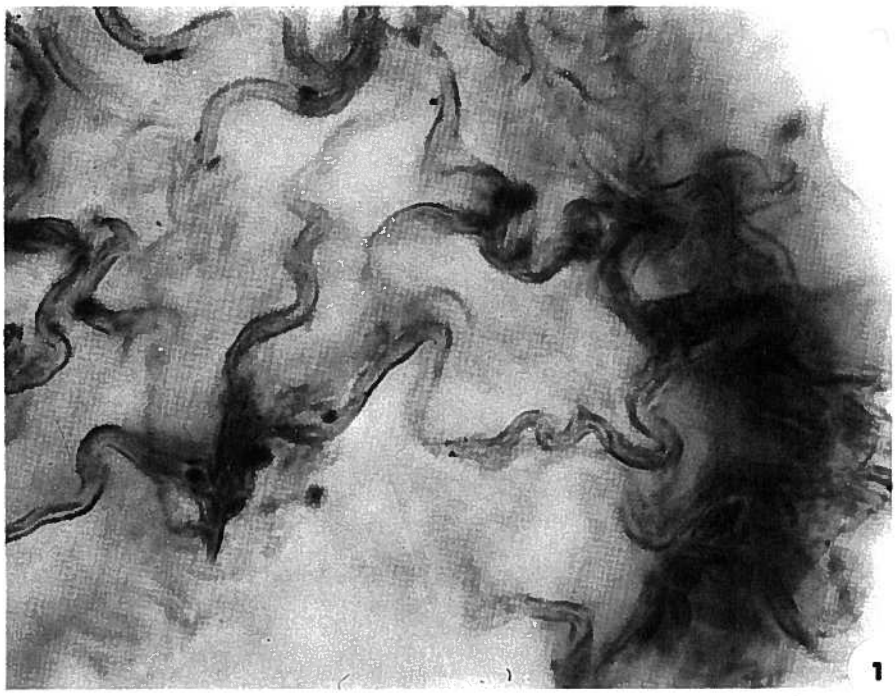

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PLATE 13

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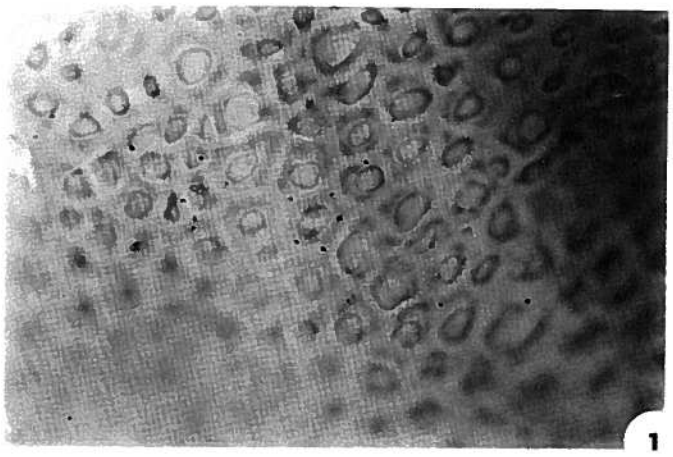
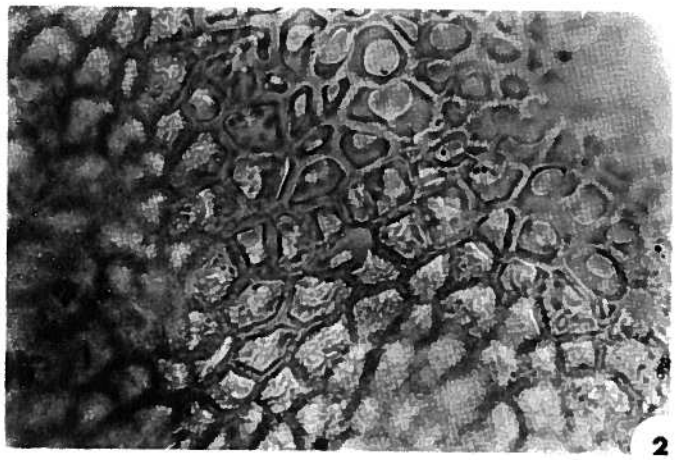
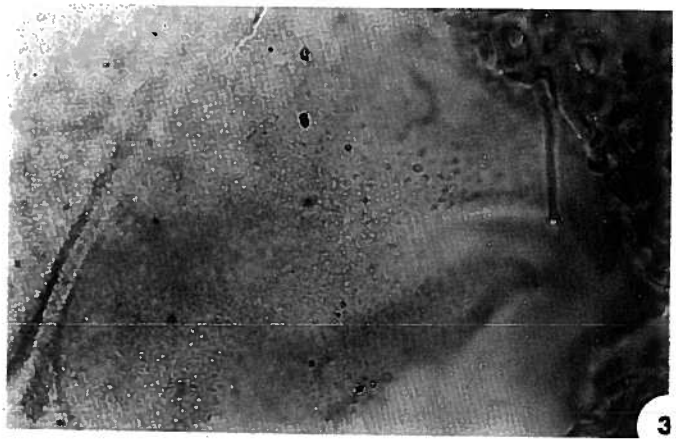
PLATE 14







Explanation of Plate 14

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PLATE 15

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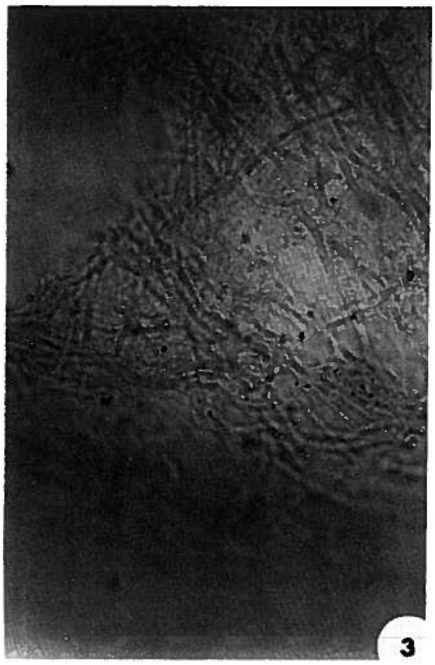

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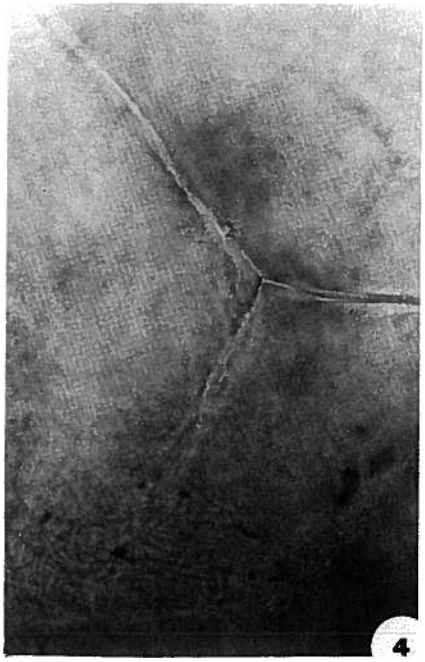

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PLATE 16

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Explanation of Plate 16

Figures 1-3: *Azolla barbata* n. sp.; 1—(holotype) mid-focus showing the megaspore body and "swimming apparatus", X125, 1-34-14M; 2—cross section view of megaspore wall and perispore lamellae, X1000, 1-34-11-1M; 3—plan view of the outer lamella showing the foveolate structure, X1000, 1-34-14M: ("zone" A) Edmonton Formation and Willow Creek Formation, central Alberta ..... (p. 61)

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PLATE 17


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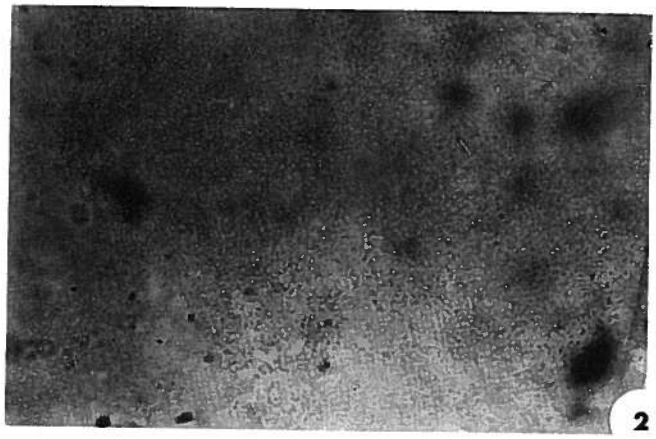
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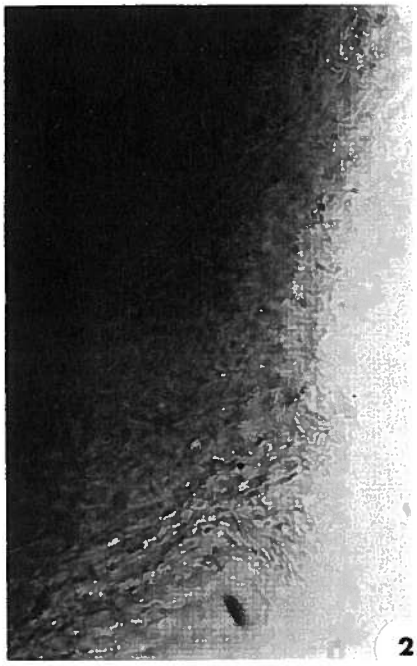
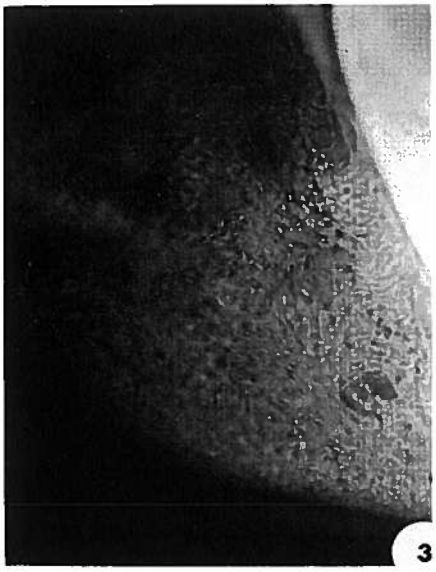
PLATE 18





Explanation of Plate 18

Figures 1-4: *Azolla pilata* n. sp.; 1—cross section view of megaspore wall and perispore lamellae, X1000, 1-34-10-2M; 2—plan view of filamentous outer lamella, X1000, 1-34-10-3M; 3—plan view of inner lamella, X1000, 1-34-10-1M; 4—plan view of the smooth megaspore wall, X1000, 1-34-10-1M: ("zone" B) Edmonton Formation, central Alberta (p. 62)

Explanation of Plate 19

Figures 1, 2: *Azolla conspicua* n. sp.; 1—(holotype) mid-focus showing the megaspore body, "swimming apparatus" and Y-shaped dehiscence marks on the megaspore wall and the perispore, X125, 1-52-2M; 2—cross section view of megaspore wall and perispore lamellae, X1000, 1-52-2M: ("zone" A) Edmonton Formation and St. Mary River Formation, central and southwestern Alberta (p. 63)

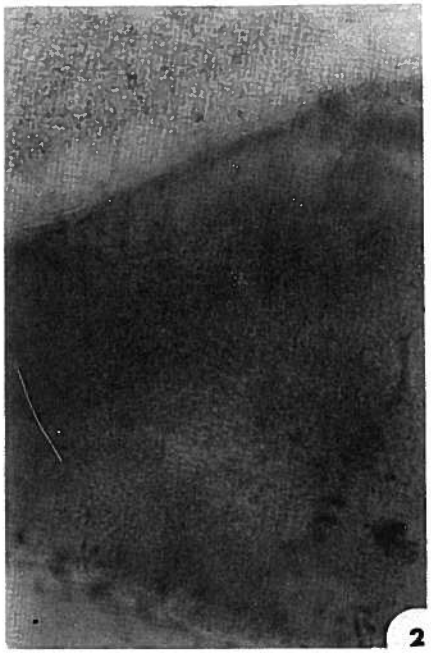
PLATE 19

1

2

PLATE 20


1


2


3


4

Explanation of Plate 20

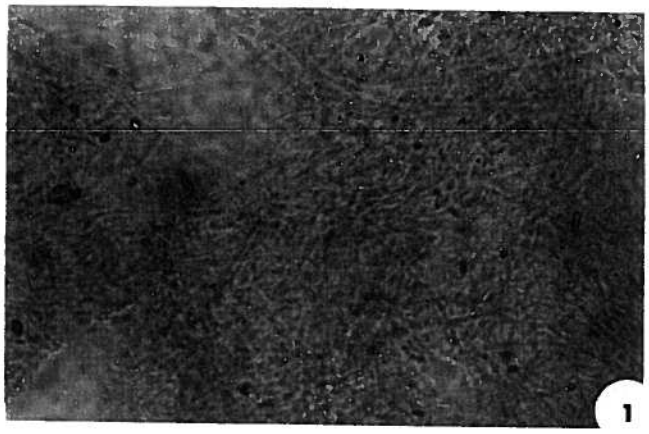
Figures 1, 2: *Azolla conspicua* n. sp.; 1—plan view of filamentous outer lamella, X1000, 1-52-2M; 2—plan view of megaspore wall, X1000, 1-52-2M: ("zone" A) Edmonton Formation and St. Mary River Formation, central and southwestern Alberta ..... (p. 63)

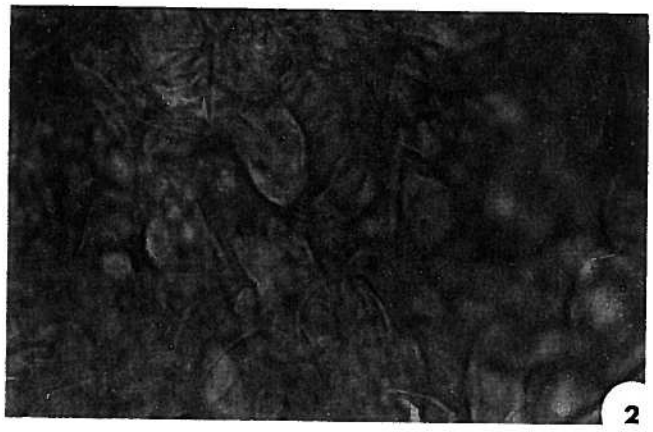
Figures 3, 4: *Azolla fistulosa* n. sp.; 3—(holotype) mid-focus showing the megaspore body and "swimming apparatus", X125, 4-4-9M; 4—cross section view of megaspore wall and perispore lamellae, X1000, 4-4-5M: ("zone" B) Edmonton Formation, central Alberta ..... (p. 64)

Explanation of Plate 21

Figures 1-3: *Azolla fistulosa* n. sp.; 1—plan view of filamentous outer lamella; 2—plan view of spongy central lamella showing the pores; 3—plan view of the megaspore wall, X1000, 4-4-5M: ("zone" B) Edmonton Formation, central Alberta (p. 64)

PLATE 21





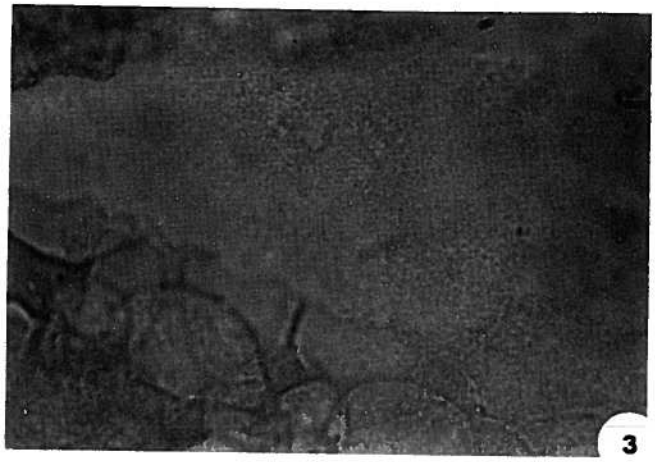
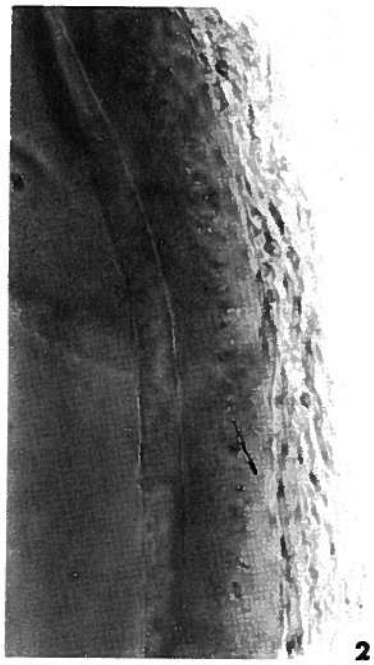


PLATE 22

1



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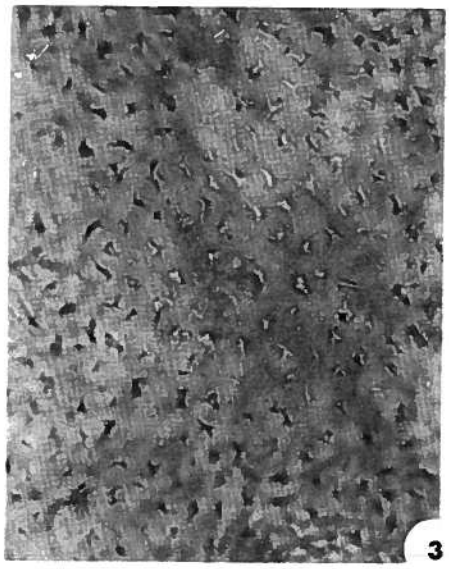

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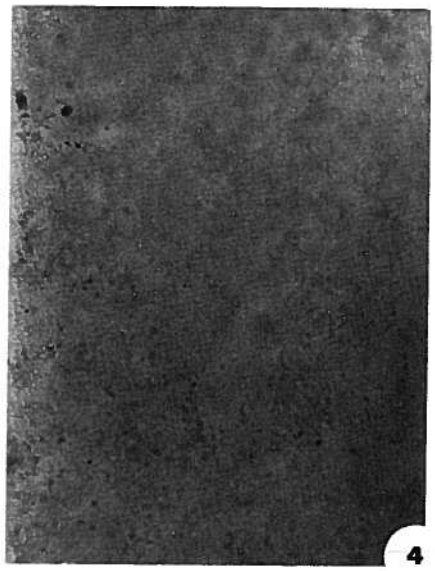


4

Explanation of Plate 22

Figures 1-4: *Azolla lauta* n. sp.; 1—(holotype) mid-focus showing the megaspore body, "swimming apparatus" and Y-shaped dehiscence mark on the megaspore wall, X125, 1-34-2M; 2—cross section of the megaspore well and the perispore lamellae, X1000, 1-34-1-1M; 3—plan view of the central lamella showing the fossulae-like grooves, X1000, 1-34-1-1M; 4—plan view of the megaspore wall, X1000, 1-34-4M: ("zones" A and B) Edmonton Formation and Willow Creek Formation, central and southwestern Alberta (p. 65)

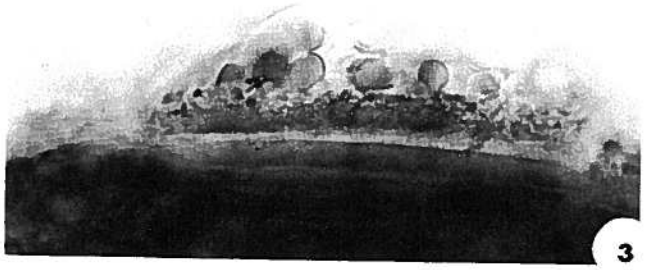
Explanation of Plate 23

Figures 1-4: *Azolla bulbosa* n. sp.; 1—(holotype) high-focus showing the megaspore body and "swimming apparatus", X125, 1-8-1M; 2—mid-focus showing the megaspore body and cushion-like columellae with the float-like structures removed, megaspore wall seen detached from the perispore and folded down toward the distal end of the megaspore, X125, 1-8-6M; 3—cross section of megaspore wall and perispore lamellae, X1000, 1-8-21M; 4—plan view of outer lamella showing bulbous protrusions, X1000, 1-8-21M: ("zone" C) Paskapoo Formation, central Alberta (p. 66)

PLATE 23

1

2



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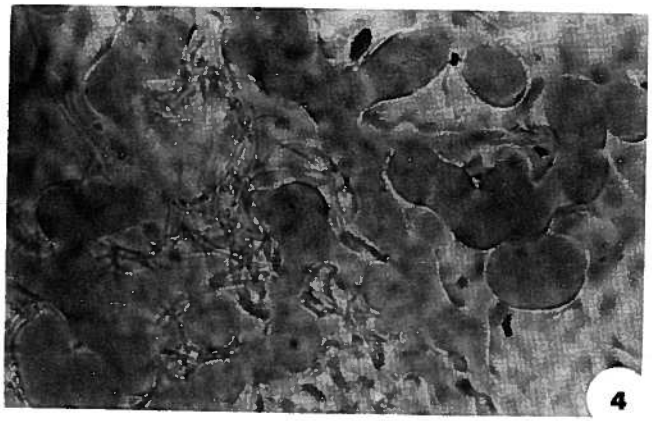
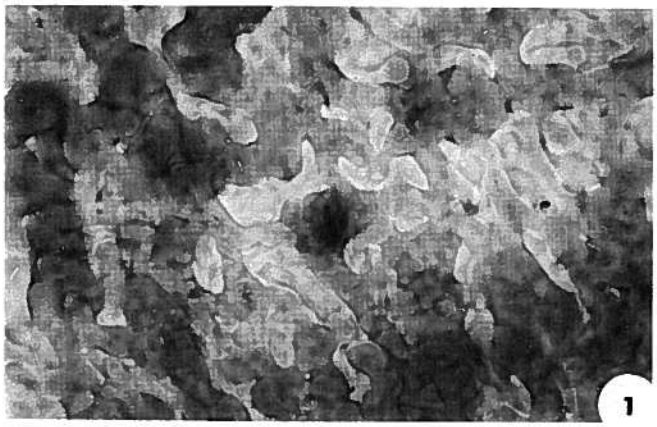
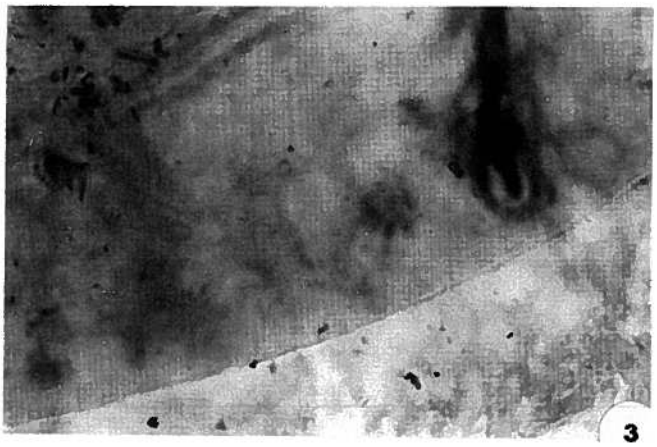


4

PLATE 24





Explanation of Plate 24

Figures 1-3: *Azolla bulbosa* n. sp.; 1—plan view of outer lamella showing irregular reticulation, X1000; 2—plan view of inner lamella showing faint granulate structure, X1000; 3—plan view of megaspore wall, X1000, 1-8-21M: ("zone" C) Paskapoo Formation, central Alberta .... (p. 66)

Explanation of Plate 25

Figures 1-3: *Azolla teschiana* Florschutz; 1—high-focus showing megaspore body, "swimming apparatus", and protrusions on outer perispore surface, X125, slide T-6, co-ord. 12.4/81.8; 2—mid-focus showing megaspore body, "swimming apparatus" and collapsed megaspore wall, X125, slide T-5, co-ord. 13.5/97.3; 3—cross section of megaspore wall and perispore lamellae, X1000, slide T-2, co-ord. 8.5/76.8 (p. 67)

(Figured specimen is from the Netherlands, kindly loaned by Dr. L. V. Hills, Dept. of Geology, University of Calgary, for comparison with Alberta material.)

PLATE 25

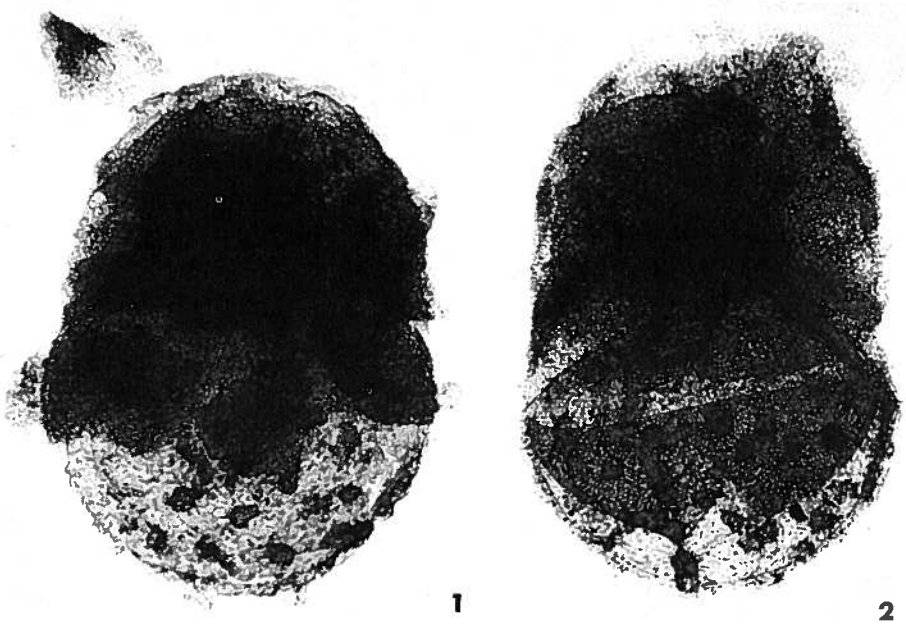
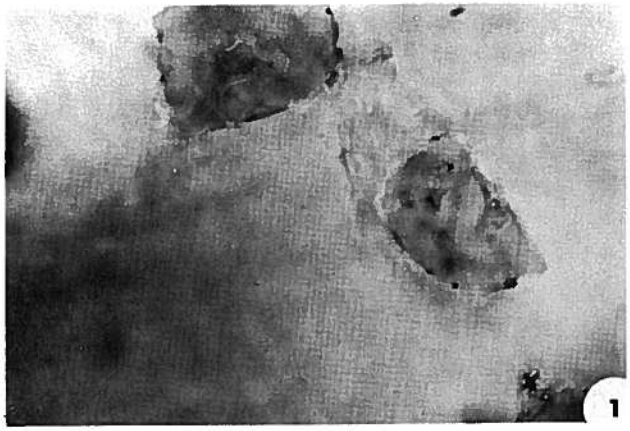
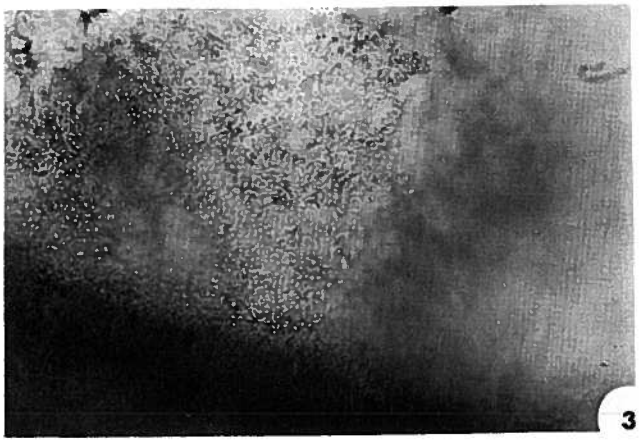


PLATE 26





Explanation of Plate 26

Figures 1-3: *Azolla teschiana* Florschutz; 1—plan view of outer lamella showing protrusions, X1000; 2—plan view of outer lamella showing irregular reticulation, X1000; 3—plan view of megaspore wall, X1000, slide no. T-5, co-ord. 13.5/97.3 ..... (p. 67)

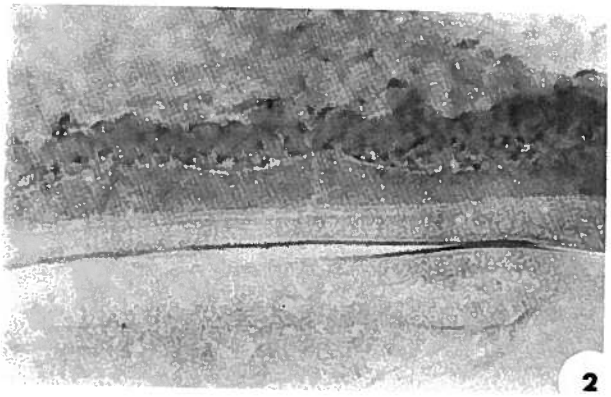
(Figured specimen is from the Netherlands, kindly loaned by Dr. L. V. Hills, Dept. of Geology, University of Calgary, for comparison with Alberta material.)

Explanation of Plate 27

Figures 1-3: *Azolla schopfi* Dijkstra; 1—mid-focus showing the megaspore body and "swimming apparatus", X125, 1-26-12M; 2—cross section view of megaspore wall and perispore lamellae showing a well-developed pore structure, X1000, 1-14-1M; 3—plan view of outer lamella showing randomly distributed pore spaces, X1000, 1-14-1M: ("zones" A, B and C) Edmonton and Paskapoo Formations and Willow Creek Formation, central and southwestern Alberta ..... (p. 67)

PLATE 27

1



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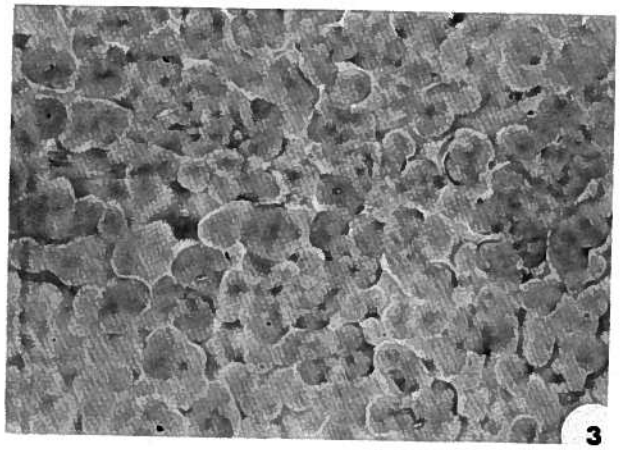
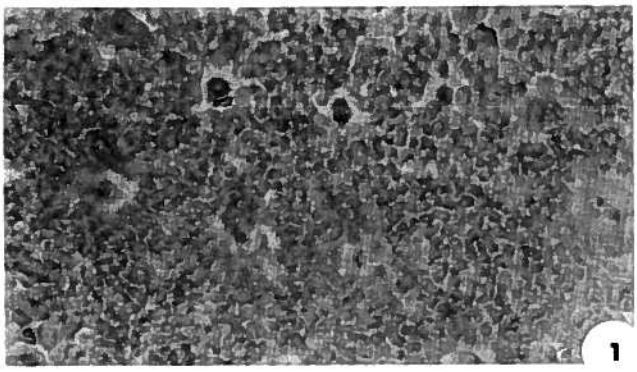
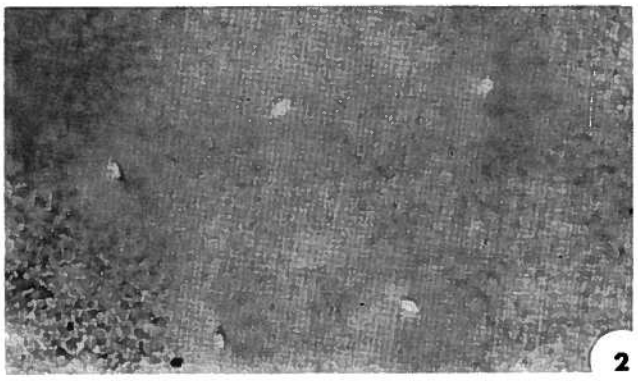
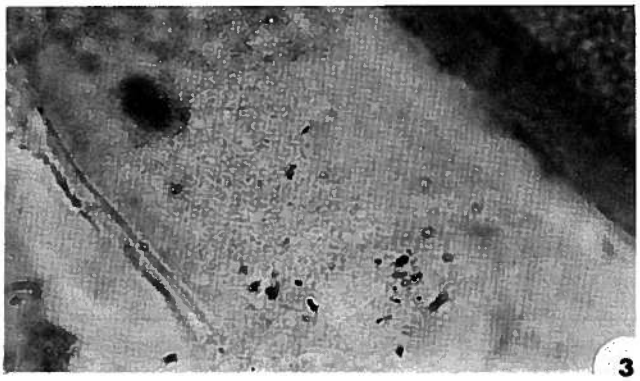


3

PLATE 28







Explanation of Plate 28

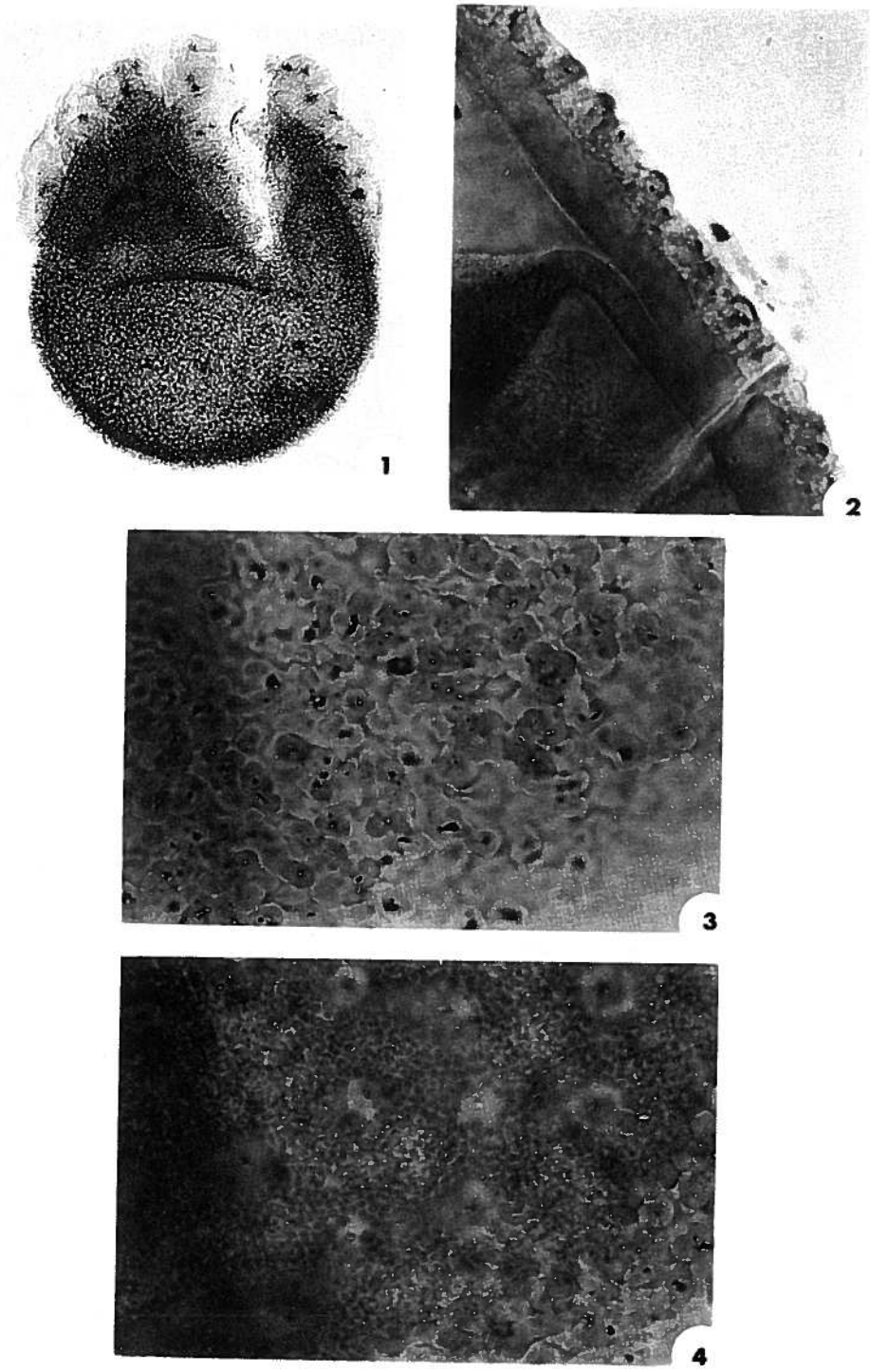
Figures 1-3: *Azolla schopfi* Dijkstra; 1—plan view of central lamella showing columellae and pore structures, X1000; 2—plan view of smooth inner lamella showing distinct pore structures, X1000; 3—plan view of megaspore wall, X1000, 1-14-1M: ("zones" A, B and C) Edmonton and Paskapoo Formations, and Willow Creek Formation, central and southwestern Alberta ..... (p. 67)

Explanation of Plate 29

Figures 1-4: *Azolla schopfi* Dijkstra; 1—mid-focus showing megaspore body and "swimming apparatus", X125, slide no. S-4, co-ord. 11.7/81.4; 2—cross section view of megaspore wall and perispore lamella, X1000, slide no. S-3, co-ord. 12.7/79; 3—plan view of outer lamella showing randomly distributed pore structures, X1000, slide no. S-3, co-ord. 12.7/79; 4—plan view of central lamella showing columellae and pore structures, X1000, slide no. S-3, co-ord. 12.7/79 ..... (p. 68)

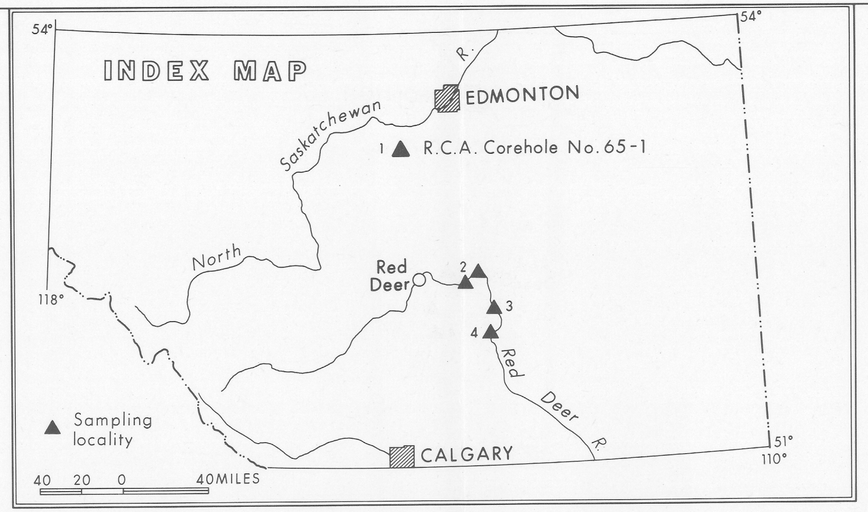
(Figured specimen is from the Netherlands, kindly loaned by Dr. L. V. Hills, Dept. of Geology, University of Calgary, for comparison with Alberta material.)

PLATE 29



INDEX

(**Bold** numbers indicate description)



SCALE (FEET)
0
100
200
300
400
500
600

MICROFLORAL "ZONES"
C
B
A

SECTION 1
RCA COREHOLE NO. 65-1
SEC 8, TP 48, R 27, W4

SECTION 2
ARDLEY AREA
COMPOSITE SECTION
(1) SEC 17, TP 38, R 23, W4
(2) SEC 35, TP 38, R 23, W4

SECTION 3
CAPRONA AREA
SEC 17, TP 36, R 21, W4

SECTION 4
HUXLEY AREA
SEC 13, TP 34, R 22, W4

F PASKAPOO FM.
EDMONTON FM.

upper coaly interval

Ardley seam

Kneehills Member

white bentonitic sst.

lower coaly interval

buff sst.

white bentonitic sst.

LEGEND

- SANDSTONE
- SILTSTONE
- CLAYSTONE
- SILTY OR SANDY CLAYSTONE
- COAL
- TUFF
- COVERED INTERVAL
- CARBONACEOUS
- IRONSTONE NODULES
- CLAYSTONE PEBBLES
- F INVERTEBRATE FOSSILS

PALYNOLOGICAL SAMPLE

- ▲ GOOD RECOVERY
- ▲ POOR RECOVERY
- △ NO RECOVERY

FIGURE 2. COLUMNAR SECTIONS SHOWING LITHOLOGIES, MICROFLORAL "ZONES" AND CORRELATION OF SAMPLED COREHOLE AND OUTCROP SECTIONS.

To accompany Research Council of Alberta
Bulletin 25, by Robert G. Snead

UNIT	EDMONTON FORMATION (Tyrrell, 1887)	PASKAPOO FORMATION (Tyrrell, 1887)	PORCUPINE HILLS FORMATION (Dawson, 1883)	WILLOW CREEK FORMATION (Dawson, 1883)	RAVENSCRAG FORMATION (Davis, 1918)	FRENCHMAN FORMATION (Furnival, 1946)	BATTLE FORMATION (Furnival, 1946)	WHITEMUD FORMATION (Davis, 1918)	FORT UNION GROUP (Meek and Hayden, 1862)	LANCE FORMATION (Hatcher, 1903)	HELL CREEK FORMATION (Brown, 1907)
LITHOLOGY	Thin beds of soft, grey, bentonitic sandstone, siltstone, carbonaceous shale, and coal; scattered red to brownish concretionary and nodular intervals; few hard, calcareous and sideritic sandstone intervals.	Hard, buff-weathered, light grey, fine- to coarse-grained, lenticular, crossbedded sandstones alternating with bluish- and greenish-grey silty claystones; interstratified with limestone concretions; numerous coal and lignite beds in basal part.	Thick, buff-weathered, grey, cross-bedded sandstones alternating with grey, silty claystones.	Soft, grey, sandstones interbedded with maroon to reddish-black claystones in lower half; buff-weathering, crossbedded sandstones and grey claystones in upper half.	Grey- to buff-weathered, greyish-brown claystones and silty claystones interbedded with soft, grey, buff-weathered sandstones; numerous lignite seams.	Greenish-brown to brown, fine- to coarse-grained, crossbedded, carbonaceous sandstone; scattered concretions, siltstone pebbles, and limonitic lenses.	Dark brown to black and greenish-grey, bentonitic claystones; silicified tuff interval commonly present.	White-weathering, kaolinitic sandstones, siltstones, and claystones.	Light grey to yellowish-grey claystones and sandstones; numerous beds of coal and carbonaceous shale.	Light grey to light yellowish-grey, fine- to medium-grained crossbedded sandstones; shaly towards base; lenticular stringers and partings of brown carbonaceous shale throughout (Mapel, 1959).	Dark brown to grey, fine- to medium-grained sandstones interbedded with brown to black lignitic shales; sandstones with calcareous to bentonitic matrix, and cross-bedded; few brown limonitic concretionary intervals.
DISTRIBUTION	Plains and Foothills of central and southwestern Alberta.	Plains and Foothills of central and southwestern Alberta.	Western margin of the Plains in southwestern Alberta.	Plains and Foothills of southwestern Alberta and adjacent Montana.	Cypress Hills of southeastern Alberta and southwestern Saskatchewan.	Cypress Hills of southeastern Alberta and southwestern Saskatchewan.	Cypress Hills of southeastern Alberta and southwestern Saskatchewan.	Cypress Hills of southeastern Alberta and southwestern Saskatchewan.	Wyoming, Montana, North and South Dakota.	Eastern Wyoming and Montana.	Montana, southwestern North Dakota, and northern South Dakota.
THICKNESS	400 feet on Little Bow River in southern Alberta to approximately 1,200 feet on North Saskatchewan River in central Alberta.	200 to 800 feet in the central Plains and up to 5,000 feet in the central Foothills.	Up to 4,000 feet in the Porcupine Hills of southwestern Alberta.	400 feet in the Plains thickening westward to 4,000 feet in the southern Foothills	227 feet (maximum).	Minimum of 10 feet, Ravenscrag Butte, Saskatchewan, thickening westward to a maximum of 225 feet, Elkwater, Alberta.	5 to 30 feet.	5 to 75 feet.	Approximately 2000 feet (average).	600 to 1200 feet.	100 to 425 feet.
BOUNDARIES	Upper contact: erosional disconformity with Paskapoo Formation although locally conformable with overlying channel sandstones. Lower Contact: transitional with Bearpaw Formation.	Upper contact: erosional. Lower contact: unconformable to locally conformable with Edmonton Formation.	Upper contact: erosional. Lower contact: transitional with Willow Creek Formation along southern limit and unconformable along northern limit.	Upper contact: transitional to unconformable with Porcupine Hills Formation. Lower contact: conformable to transitional with St. Mary River Formation.	Upper contact: unconformable with Cypress Hills Formation. Lower contact: transitional with the Frenchman Formation.	Upper contact: transitional with Ravenscrag Formation. Lower contact: unconformable with Battle Formation.	Upper contact: unconformable with Frenchman Formation. Lower contact: conformable with Whitemud Formation.	Upper contact: unconformable with Frenchman Formation; conformable with Battle Formation. Lower contact: transitional with Eastend Formation.	Upper contact: erosional. Lower contact, Ludlow Formation: conformable with Hell Creek and Lance Formations; Cannonball Formation: unconformable with Hell Creek Formation.	Upper contact: conformable with Fort Union Group. Lower contact: conformable with Fox Hills Formation.	Upper contact: conformable with Fort Union Group. Lower contact: conformable with Fox Hills Formation.
AGE — PLANT MEGAFOSSILS	Maestrichtian (Lance equivalent), (Bell, 1949).	Paleocene (Fort Union equivalent), (Bell, 1949).	Paleocene, (Bell, 1949).	Paleocene (upper half), (Bell, 1949).	Paleocene (Paskapoo equivalent), (Berry, 1935; Bell, 1949).				Paleocene, (Knowlton, 1919; Dorf, 1940; Brown, 1948, Bell, 1954).	Cretaceous, (Dorf, 1940).	
AGE — VERTEBRATES	Maestrichtian (Lance equivalent), (Sternberg, 1947).	Paleocene (Fort Union equivalent), (Simpson, 1927; Russell, 1926b).				Maestrichtian (Lance equivalent), (Rose, 1916; Sternberg, 1924).			Paleocene, (Jepsen, 1930; Simpson, 1937; Brown, 1948).	Cretaceous, (Hose, 1955; Sternberg, 1947).	Cretaceous, (Leonard, 1911; Thom and Dobbin, 1924).
AGE — MARINE INVERTEBRATES	Maestrichtian (Drumheller marine tongue), (Allan and Sanderson, 1945).								Paleocene (Cannonball Formation), (Stanton, 1920; Dorf, 1940; Schuchert and Dunbar, 1941; Fox and Ross, 1942).		
AGE — NONMARINE INVERTEBRATES	Cretaceous, (Tozer, 1956).	Paleocene, (Tozer, 1956).	Paleocene, (Tozer, 1956).	Paleocene (upper half; Fort Union equivalent), (Russell and Landes, 1940; Tozer, 1956).	Paleocene (Paskapoo equivalent), (Russell and Landes, 1940).				Paleocene, (Russell, 1932; Brown, 1948).	Cretaceous, (Henderson, 1935).	Cretaceous (Meek and Hayden, 1862; Whitefield, 1903, 1907; Henderson, 1935).

Table 2. Lithologies, Distributions and Ages of Formations Adjacent to the Cretaceous-Tertiary Boundary in Central and Southwestern Alberta, Southwestern Saskatchewan and Northwestern United States

SPECIES	ALBERTA			BRITISH COLUMBIA		MONTANA	WYOMING		NEW MEXICO		SOUTH DAKOTA		SIBERIA		COLORADO	MARYLAND	GERMANY	SCOTLAND	AUSTRALIA
	Microfloral "zones"			Latest Cretaceous	Tertiary	Maestrichtian	Maestrichtian	Paleocene	Latest Cretaceous	Paleocene	Maestrichtian	Paleocene	Maestrichtian	Paleocene	Tertiary	Paleocene	Tertiary	Tertiary	Tertiary
	A	B	C																
Aquilapollenites polaris	X						Funkhouser (1961)						Bratzeva (1967)						
Aquilapollenites reticulatus	X										Stanley (1961)								
Leptolepidites tenuis	X										Stanley (1961)								
Schizosporis complexus	X										Stanley (1961)								
Aquilapollenites amplus	X										Stanley (1961)								
Aquilapollenites reductus	X					Norton (1965)													
Aquilapollenites sp. cf. A. attenuatus	X						Funkhouser (1961)												
Aquilapollenites conatus	X					Norton (1965)													
Aquilapollenites delicatus	X										Stanley (1961)								
Kurtzipites trispissatus	X								Anderson (1960)										
Momipites sanjuanensis	X								Anderson (1960)										
Wodehouseia spinata	X					Norton and Hall (1967)					Stanley (1961)		Bratzeva (1967)						
Ulmoideipites tricostatus		X	X						Anderson (1960)	Anderson (1960)				Samoilovitch (1967)	Newman (1964)				
Alnus verus			X	Rouse (1962)	Rouse (1962)										Wodehouse (1933)		Potonié (1934) Thomson and Pflug (1953)		
Alnus trina		X	X									Stanley (1965)							
Momipites tenuipolus		X	X							Anderson (1960)									
Momipites inaequalis		X	X							Anderson (1960)					Newman (1964)				
Tilia danei		X	X							Anderson (1960)									
Aquilapollenites spinulosus			X					Funkhouser (1961)							Funkhouser (1961)				
Caryapollenites scabratus			X									Stanley (1965)				Groot and Groot (1962)			
Tilia tetraforaminipites			X		Rouse (1962)										Wodehouse (1933)				
Vitis sp. cf. V. affluens			X									Stanley (1965)							
Alnus rubriformis			X															Simpson (1961)	
Carpinus subtriangula			X									Stanley (1965)							
Ovoidites ligneolus			X									Stanley (1965)					Potonié (1931)		Harris (1965)
Pandanus? sp. cf. P? shiabensis			X															Simpson (1961)	

Table 3. Stratigraphically Significant Species at the Cretaceous-Tertiary Boundary and Their Distribution in Other Localities

Long-ranging species

Age	Formation	Member (Ower, 1960)	Floral "zones"	Sample No. (Fig. 2)	Depth in feet	Laevigatosporites gracilis	Sequoiapollenites paleocenicus	Taxodiaceaepollenites hiatus	Azolla distincta**	Azolla schopfi**
TERTIARY	PASKAPOO		C	1	16 - 21	☼		⌖		
				4	45 - 50	☼		⌖		
				5	54 - 60	☼		⌖	○	○
				6	63 - 66					
				8	80 - 87	☼	⌖	☼	○	
	EDMONTON	E	B	14	142 - 146	●	⌖	●	⌖	⌖
				15	150 - 156	☼	⌖	●		
				18	163 - 172	☼	⌖	●	☼	☼
				19	175 - 181	☼	○	●	⌖	☼
				22	198 - 202	☼	⌖	●	●	☼
				25	221 - 227	☼	⌖	●		
				26	229 - 232	☼	⌖	●	○	●
CRETACEOUS				30	264 - 268	⌖	⌖	●		
			A	32	276 - 280	⌖		⌖		
				34	286 - 291	⌖	⌖	☼		○
				38	304 - 308	⌖	⌖	☼	○	
				40	313 - 319	⌖	⌖	☼	⌖	
				42	327 - 335	⌖	○	☼		
		D								
		C		49	431 - 435	●	⌖	☼	⌖	☼
				50	445 - 449	●	⌖	☼		
				51	454 - 459	●	⌖	☼		
				52	476 - 481	●	⌖	☼		
				54	502 - 505	●	☼	●		

Species restricted to "zone" A

Sample No.	Depth in feet	Aquilapollenites polaris*	Aquilapollenites reticulatus*	Leptolepidites tenuis*	Erdtmanipollis pachysandroides	Schizosporis complexus*	Salixipollenites sp. cf. Tricolpites bathyreticulatus	Aquilapollenites amplus*	Aquilapollenites reductus*	Azolla conspicua**	Balmeisporites striatellus**	Equisetosporites amabilis	Sigmopollis hispidus	Symplocoipollenites vestibulum	Aquilapollenites sp. cf. A. attenuatus*	Aquilapollenites sp. C	Hamulatisporis hamulatis
1	16 - 21																
4	45 - 50																
5	54 - 60																
6	63 - 66																
8	80 - 87																
14	142 - 146																
15	150 - 156																
18	163 - 172																
19	175 - 181																
22	198 - 202																
25	221 - 227																
26	229 - 232																
30	264 - 268																
32	276 - 280				○												
34	286 - 291		○			○	○		⌖		⌖		⌖			○	
38	304 - 308				○											○	
40	313 - 319	○	○					⌖	⌖		⌖				⌖	○	
42	327 - 335		○														
49	431 - 435		○		○				⌖						○		⌖
50	445 - 449	○	○	○	⌖	⌖	○	⌖	⌖		○			⌖		○	⌖
51	454 - 459	○	○	○	⌖				○			○			⌖	○	○
52	476 - 481	○	○		○		○	○	○	⌖	⌖	⌖	○	⌖			
54	502 - 505	○	○	○	○	○	○										

Species restricted to "zone" A (continued)

Sample No.	Depth in feet	Aquilapollenites sp. A	Aquilapollenites sp. B	Balmeisporites sp. A**	Balmeisporites sp. B**	Balmeisporites sp. C**	Balmeisporites sp. D**	Dictyophyllidites sp.	Aquilapollenites conatus*	Aquilapollenites delicatus*	Azolla barbata**	Kurtzipites trispissatus*	Momipites sanjuanensis*	Wodehouseia spinata*	Aquilapollenites sp. cf. A. quadricretaceus	Azolla filosa**	Azolla pilata**
1	16 - 21																
4	45 - 50																
5	54 - 60																
6	63 - 66																
8	80 - 87																
14	142 - 146																
15	150 - 156																
18	163 - 172																
19	175 - 181																
22	198 - 202																
25	221 - 227																
26	229 - 232																
30	264 - 268																
32	276 - 280	○												○			
34	286 - 291		○				○		○	⌖	⌖		○	⌖	⌖	⌖	⌖
38	304 - 308							○	○			⌖	○				
40	313 - 319		⌖						○	○	○	⌖	○	⌖			
42	327 - 335																
49	431 - 435			○													
50	445 - 449	⌖	○	⌖	○	○	○	○									
51	454 - 459																
52	476 - 481																
54	502 - 505																

Species restricted to "zones" A and B

Sample No.	Depth in feet	Cingulatisporites dakotaensis	Cranwellia rumseyensis	Cupuliferoipollenites pusillus	Polypodiisporites sp.	Scollardia steevesi	Sphagnum regium	Reticuloidosporites sp.	Tricolpites sp. A	Tricolpites sp. B	Azolla lauta**	Kurtzipites sp.
1	16 - 21											
4	45 - 50											
5	54 - 60											
6	63 - 66											
8	80 - 87											
14	142 - 146	○		○								
15	150 - 156									○		
18	163 - 172											
19	175 - 181			○				⌖				
22	198 - 202						○				⌖	○
25	221 - 227	○	⌖		○	○		⌖			☼	
26	229 - 232		⌖			○						⌖
30	264 - 268	○			○				⌖	○		
32	276 - 280											⌖
34	286 - 291						○		⌖	⌖	●	
38	304 - 308											
40	313 - 319		⌖	○		⌖		⌖	⌖	☼	⌖	
42	327 - 335									○		
49	431 - 435	○	⌖		○	⌖	⌖				⌖	○
50	445 - 449		⌖	○	○	○	⌖		⌖	○		
51	454 - 459			○			⌖	⌖				
52	476 - 481							⌖	⌖			
54	502 - 505	○	⌖	○	○	○	⌖					

Species restricted to "zone" B; Species restricted to "zones" B and C

Sample No.	Depth in feet	Myrtaceidites sp. C	Rhoipites sp. cf. R. pisinnus	Betulaceoipollenites sp.	Myrtaceidites sp. A	Liliacidites sp.	Myrtaceidites sp. B	Salixipollenites sp. B	Salixipollenites sp. A	Ulmoideipites tricostatus*	Alnus trina*
1	16 - 21								○		○
4	45 - 50								⌖		
5	54 - 60										
6	63 - 66								⌖	⌖	
8	80 - 87								○	⌖	
14	142 - 146			○	○		○	○	⌖		
15	150 - 156	○						○			
18	163 - 172				○						
19	175 - 181		○	⌖			⌖				
22	198 - 202			⌖	⌖	⌖			⌖		
25	221 - 227		○	⌖							○
26	229 - 232	○		○		○					
30	264 - 268	○	○	○	○				⌖	○	
32	276 - 280										
34	286 - 291										
38	304 - 308										
40	313 - 319										
42	327 - 335										
49	431 - 435										
50	445 - 449										
51	454 - 459										
52	476 - 481										
54	502 - 505										

Species restricted to "zone" C

Sample No.	Depth in feet	Alnus verus*	Aquilapollenites spinulosus*	Azolla bulbosa**	Caryapollenites scabratus*	Momipites inaequalis*	Tilia tetraforaminipites*	Vitis sp. cf. V? affluens*	Alnus rubriformis*	Carpinus subtriangula*	Momipites tenuipolus*	Ovoidites ligneolus*	Pandanus ? sp. cf. P? shiabensis*	Tilia danei*
1	16 - 21	○	○		○	⌖			⌖		⌖	○		○
4	45 - 50	○	○		○							○	⌖	
5	54 - 60	○	○	⌖	○	⌖	○		○	⌖	⌖	⌖		
6	63 - 66		○		○			⌖						
8	80 - 87	○	☼	☼	○	⌖	○							
14	142 - 146													
15	150 - 156													
18	163 - 172													
19	175 - 181													
22	198 - 202													
25	221 - 227													
26	229 - 232													
30	264 - 268													
32	276 - 280													
34	286 - 291													
38	304 - 308													
40	313 - 319													
42	327 - 335													
49	431 - 435													
50	445 - 449													
51	454 - 459													
52	476 - 481													
54	502 - 505													

LEGEND

		POLLEN AND MICROSPORES	MEGASPORES
○	Rare	1 to 2 per cent	1 to 3 grains
⌖	Common	3 to 6 per cent	4 to 10 grains
☼	Abundant	7 to 20 per cent	10 to 30 grains
●	Dominant	greater than 20 per cent	greater than 30 grains

* Index species
** Megaspores

To accompany Research Council of Alberta Bulletin 25, by Robert G. Snead

TABLE 5. DISTRIBUTION AND RELATIVE ABUNDANCES OF MICROFLORAL SPECIES IN R.C.A. COREHOLE 65-1

KNEEHILLS MBR.	CRETACEOUS																TERTIARY		AGE
	EDMONTON																		FORMATION
	E																		MEMBER (OWER, 1960)
	no sample yield	1, 2		5	B 8		12	14	15	16									FLORAL "ZONES" Sample No. (Fig. 2)
		82 - 87		102 - 108	126 - 130		140 - 142	145 - 147	163 - 165	165 - 171									APPROXIMATE INTERVAL ABOVE KNEEHILLS MEMBER (feet)
	Long-ranging species	✲	✧	o	✲			✧		✧									Laevigatosporites gracilis
		✧	✧	✧	✧			✧		✧									Sequoiapollenites paleocenicus
		o		✧	●			●		●									Taxodiaceaepollenites hiatus
				✧	✧		✧	✧	✧										Azolla distincta**
				✧	✧		✧	✧	✧										Azolla schopfi**
	Species restricted to "zones" A and B						o												Cingulatisporites dakotaensis
		o		o															Cranwellia rumseyensis
				o	o														Cupuliferoipollenites pusillus
		o								o									Polypodiisporites sp.
		o		✧															Scollardia steevesi
		o																	Sphagnum regium
					o														Reticuloidosporites sp.
		o								o									Tricolpites sp. A
					o		o												Tricolpites sp. B
					o														Azolla lauta**
					✧		o												Kurtzipites sp.
	Species restricted to "zone" B	o		o			o												Myrtaceidites sp. C
		o		o															Rhoipites sp. cf. R. pisinnus
				o	o		o		o										Betulaceoipollenites sp.
		o		o															Myrtaceidites sp. A
		o			o														Liliacidites sp.
					o														Myrtaceidites sp. B
			✧							o									Salixipollenites sp. B
	Species restricted to "zones" B and C		o		o		o												Salixipollenites sp. A
					o		o												Ulmoideipites tricostatus*
	Species restricted to "zone" C		✧					o											Momipites inaequalis*
										o									Momipites tenuipolus
					o					✧									Tilia danei*

TABLE 6. DISTRIBUTION AND RELATIVE ABUNDANCES OF MICROFLORAL SPECIES IN OUTCROP SECTION 2, RED DEER RIVER

KNEEHILLS MBR.	CRETACEOUS																		AGE
	EDMONTON																		FORMATION
	E																		MEMBER (OWER, 1960)
		18			12		A 9		6	4	3	1, 2							FLORAL "ZONES" Sample No. (Fig. 2)
		1 - 2			30 - 32		58 - 60		83 - 88	94 - 96	101 - 103	112 - 115							INTERVAL ABOVE KNEEHILLS MEMBER (feet)
	Long-ranging species	✧			o		✧		o	✧	o	✲							Laevigatosporites gracilis
		✧			✧		✲		o	o	✧	✧							Sequoiapollenites paleocenicus
		✲			✲		✲		✲	✲	✲	✲							Taxodiaceaepollenites hiatus
							✧		o		o	o							Azolla distincta**
							✲					o							Azolla schopfi**
	Species restricted to "zone" A									o		o							Leptolepidites tenuis*
					o		✧												Erdtmanipollis pachysandroides
									o	✧		o							Salixipollenites sp. cf. Tricolpites bathyreticulatus
							o		o		o								Aquilapollenites amplus*
					o				✧	o									Aquilapollenites reductus*
					o		o												Balmeisporites striatellus**
										o	o								Equisetosporites amabilis
										o		o							Sigmopollis hispidus
					o		o												Symplocoipollenites vestibulum
					o		o		o		o	o							Aquilapollenites sp. C
										✧									Hamulatisporis hamulatis
					o														Balmeisporites sp. D**
					o														Dictyophyllidites sp.
					o		o				o	o							Aquilapollenites conatus*
							o												Azolla barbata**
												✧							Kurtzipites trispissatus*
										o		o							Momipites sanjuanensis*
					o		o		o		o	o							Wodehouseia spinata*
							o					o							Aquilapollenites sp. cf. A. quadricretaceus
							o												Azolla filosa*
	Species restricted to "zones" A and B				o		✧		o										Cingulatisporites dakotaensis
					o					o	o	o							Cranwellia rumseyensis
					o							o							Cupuliferoipollenites pusillus
							o			o		o							Polypodiisporites sp.
					o		o			o	o								Scollardia steevesi
							o				o								Sphagnum regium
							✧		✧		o								Reticuloidosporites sp.
					o		o		o	o	o	o							Tricolpites sp. A
					✧		✧		✧	o	o	o							Tricolpites sp. B
					✧		✧				✧	✧							Azolla lauta**

TABLE 7. DISTRIBUTION AND RELATIVE ABUNDANCES OF MICROFLORAL SPECIES IN OUTCROP SECTION 3, RED DEER RIVER

KNEEHILLS MEMBER	CRETACEOUS						TERTIARY		AGE
	EDMONTON						PASKAPOO		FORMATION
	E								MEMBER (OWER, 1960)
	no sample yield	4		B 3		2			FLORAL "ZONES" Sample No. (Fig. 2)
		150 - 155		170 - 175		200 - 205			INTERVAL ABOVE KNEEHILLS MEMBER (feet)
	Long-ranging species	✲		✧		o			Laevigatosporites gracilis
		✧		✧		✲			Sequoiapollenites paleocenicus
		●		●		●			Taxodiaceaepollenites hiatus
		✧							Azolla distincta**
	Species restricted to "zones" A and B			o					Cingulatisporites dakotaensis
		o							Cranwellia rumseyensis
		✧		✧		o			Cupuliferoipollenites pusillus
				o					Polypodiisporites sp.
		o		o		o			Scollardia steevesi
		o				o			Sphagnum regium
		✧							Reticuloidosporites sp.
		✧		✧		o			Tricolpites sp. A
		o		✧		o			Tricolpites sp. B
				o					Kurtzipites sp.
	Species restricted to "zone" B	✧		✧		o			Betulaceoipollenites sp.
		o		o		o			Liliacidites sp.
				o		o			Myrtaceidites sp. B
		✧		✧		✧			Salixipollenites sp. B
	Species restricted to "zone" B & C	o		✧		o			Salixipollenites sp. A
	Species restricted to "zone" C	o				o			Momipites inaequalis*

TABLE 8. DISTRIBUTION AND RELATIVE ABUNDANCES OF MICROFLORAL SPECIES IN OUTCROP SECTION 4, RED DEER RIVER

LEGEND

	POLLEN AND MICROSPORES	MEGASPORES
o Rare	1 to 2 per cent	1 to 3 grains
✧ Common	3 to 6 per cent	4 to 10 grains
✲ Abundant	7 to 20 per cent	10 to 30 grains
● Dominant	greater than 20 per cent	greater than 30 grains

* Index species
** Megaspores

To accompany Research Council of Alberta
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