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Palynology of the Kaiparowits Formation, Garfield County, Utah

C. FREDERICK LOHRENGEL II
Snow College, Ephraim, Utah

ABSTRACT.—The Kaiparowits Formation constitutes the youngest Cretaceous Age rocks in central southern Utah. One section of the formation 2,750 feet thick was measured, described, and collected in the type locality (The Blues, Garfield County, Utah). A total of 375 samples were collected; 63 of them were macerated for palynomorphs. Ultimately 15 samples were used to palynologically document the section. Palynomorphs assignable to 80 species in 41 genera were described. One genus and 36 species are probably new but not named at this time.

Evidence is presented to show that the age of the Kaiparowits Formation is Upper Lancian to Hell Creekian.

The Kaiparowits Formation is tentatively divided into three assemblage zones. Zone 1 is defined by the presence of an assemblage of 23 species. Zone 2 is defined by the presence of 6 palynomorphs and absence of the 23 that define Zone 1. Four palynomorphs are employed in defining Zone 3.

The lower 2,200 feet of the Kaiparowits Formation was probably deposited as a delta in a rapidly subsiding basin. The sediments indicate a western provenance, probably central or western Nevada. The Blues was in the fluvial portion of the delta. Topography was probably low and marshy to swampy. Within the drainage basin uplands and semiarid to arid areas were also present. Sedimentation of the upper 550 feet of the formation was probably similar but unfortunately is incompletely understood at this time. Considerable volcanic activity in the region is indicated by the presence of large volumes of bentonitic material. No evidence was observed to indicate that any of the Kaiparowits Formation was deposited under marine conditions.

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INTRODUCTION

Upper Cretaceous rocks of the Western Interior of the United States have posed some vexing stratigraphic problems for many years. Isolation of these rocks into numerous intermontane basins by late phases of the Laramide orogeny and subsequent erosion has made correlation extremely difficult. Correlations of Upper Cretaceous rocks along the western edge of the outcrop belt are more difficult because the sediments are either intertonguing marine and nonmarine or totally nonmarine, and biostratigraphers are left without the normal marine guide fossils. The present study of palynomorphs of the Kaiparowits Formation was undertaken in hopes of providing a zoned reference section for the uppermost Cretaceous rocks in central southern Utah.

Objectives and Scope.—The Kaiparowits Formation was sampled in its type locality where exposures are excellent and the complete section can be studied in a single unbroken sequence. Palynomorphs were extracted with the following broad objectives in mind: (1) systematic paleontological study of palynomorphs present within the formation, (2) establishment of stratigraphic sequence and ranges of the contained palynomorphs, (3) biostratigraphic zonation of the formation based upon the contained palynomorphs, (4) correlation of the Kaiparowits Formation with other Upper Cretaceous formations in the Western Interior, and (5) determination of the paleoecology and paleoclimatology of the drainage and depositional basins.

Only one section of this widespread formation has been studied. As a consequence our understanding is still incomplete and much remains to be done with the palynology of the Kaiparowits Formation.

ACKNOWLEDGMENTS

The writer expresses his most sincere appreciation to Dr. Jess R. Bushman (Department of Geology) who originally suggested this problem and who has served as chairman of the dissertation committee. He also thanks Dr. J. Keith Rigby (Department of Geology) and Dr. William D. Tidwell (Department of Botany) who served as the other two dissertation committee members. They gave much encouragement and many helpful suggestions throughout the duration of this study. Drs. Harold J. Bissell and W. Kenneth Hamblin gave many valuable suggestions. To the remainder of the faculty, to the staff of the science library, and to his several colleagues, the writer expresses his appreciation.

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To Mr. John Browning and the staff of the Palynology Laboratory of Shell Oil Company in Los Angeles, California, the writer expresses sincere appreciation for invaluable aid in the solution of the problem of maceration of samples. He also thanks Dr. Richard A. Robison, Department of Geology, University of Utah, and Dr. H. D. "Whity" Zeller, the United States Geological Survey, Denver, Colorado, for suggestions concerning sampling localities for this study. Appreciation is expressed to Miss Marilyn Thompson for typing part of this manuscript.

The writer expresses his most sincere thanks to his family for their undying faith in him, for their endless encouragement throughout the length of this study, and also for financial support during several critical periods.

Finally, Miss Darnell Zollinger deserves special recognition. She typed most of the manuscript several times and aided immeasurably with photographic work. He especially thanks her for her endless encouragement and unquestioning faith in him during the last, and hardest, year of this study.

DESCRIPTION OF FIELD INVESTIGATION AND SAMPLING PROCEDURE

During the summer and fall of 1965 several days were spent in the field making a reconnaissance survey of the area and collecting samples from several parts of the Kaiparowits Formation. During the winter of 1965-66 those samples were macerated to determine the palynomorph content. The present, more detailed study was initiated after a fairly abundant, diverse microflora was found. The month of June 1966 was spent measuring, describing, and collecting the type section of the Kaiparowits Formation in The Blues, Garfield County, Utah (Text-fig. 1). A total of 375 samples were collected in the 2,756 foot-thick measured section.

The measured section (Appendix A) is a composite of numerous short increments measured in areas of excellent exposure (Text-fig. 1). Type of sedimentation, topography, and slight regional dip of the rocks of approximately five degrees northeast controlled the traverse position through The Blues.

Samples were collected every ten feet or at each change of lithology. Megafossils were noted and collected.

Samples were processed for palynomorphs during the remainder of the summer of 1966. A total of 63 samples were macerated. A suite of 15 processed samples ultimately were used to document stratigraphic distribution of palynomorphs within the formation.

PREVIOUS STUDIES

Palynology of Utah sediments has been a rather neglected area of geological research. Presently there are only two published and two unpublished studies concerning Utah palynology. The earliest study was by Wodehouse (1932, 1933). Nine thin section of the oil shales of the Eocene Green River Formation of Utah and Colorado were studied. The purpose of this study was to see what plants are represented in the Green River Formation microflora. An investigation of the Mancos Group in the Book Cliffs is the only other publication on Utah palynology. Sarmiento (1957) published the results of an attempt to zone two sections of the Mancos Group at two locations—one at Woodside, Emery County, and the other at the Green River. These two sections of the Mancos Group zoned relatively well.

Wheelwright (1958) made an inconclusive reconnaissance study of several Upper Cretaceous-Lower Tertiary coals from northeastern Utah-southwestern Wyoming ". . . to determine the possible value of palynology in locating the Cretaceous-Tertiary boundary." (Wheelwright, 1958, p. 40). Orlansky (1967) studied one section of the Straight Cliffs Sandstone along Utah Highway 54 in Garfield County. This is the most extensive palynology study in the state of Utah to date.

Upper Cretaceous palynology of the world is excellently summarized in a recent paper by Srivastava (1967). Therefore, no further discussion of other previous palynological publications will be made except as they are specifically referred to in other parts of this report.

DESCRIPTION OF PREPARATION METHODS AND ANALYTICAL PROCEDURES

Maceration.—Several published maceration processes were tried during the early stages of this project; none gave satisfactory results. The process which gave most satisfactory results is a modified one of that used by Shell Oil Company. In this process 10 to 20 grams of sediment are initially digested. Carbonates are removed with HCl. Silicates are then removed with HF. Some organic materials are dissolved using HNO_3, KOH, and then HCl. The material is next treated with calgon to remove fine mineral matter by suspension and decanting. Finally samples are run through an aqueous solution of $ZnBr_2$ (sp. gr. 1.95-2.05) to remove any remaining mineral matter. The residue is organic material, largely palynomorphs. Samples are then stained with basic fuchsin. Samples are stored in a glycerine-alcohol solution in 1 dram vials with screw tops.

Slide Preparation.—Glycerine-jelly (from the W. H. Curtin Company) was used as the mounting medium on all slides used in this study. This type of mounting medium has the distinct advantage that specimens can be relocated with relative ease. Specimens cannot be reoriented on a slide, but since most are flattened and transparent, this is no handicap. This particular brand of gylcerine-jelly is stable at normal temperatures. The slides used were 25 mm by 75 mm with no. 1 cover glasses 22 mm by 35 mm.

Analytical Procedures.—One-hundred palynomorphs were identified in a traverse, or series of traverses if need be, on each slide and the frequency of each form recorded. The remainder of the slide was scanned after the one-hundred grains were counted. Any palynomorphs encountered during scanning that did not occur in the one-hundred count were recorded. For most samples three slides were counted but five slides were counted for those samples with diverse floras. Percentages of abundance were converted to the following terms:

Frequency Terms	Percentage	Symbol
Rare	less than 1%	R
Frequent	1%-10%	F
Common	10%-25%	C

This investigation was carried out using a Leitz SM-POL microscope equipped with a centered rotating stage no. 35 with 360 degree rotation (this feature was extremely useful for orientating palynomorphs for measurements) and a mechanical stage No. 42. The optical equipment included paired Periplan 8X occulars plus 3.5X, 10X, 45X, and 100X (oil immersion) achromatic objectives.

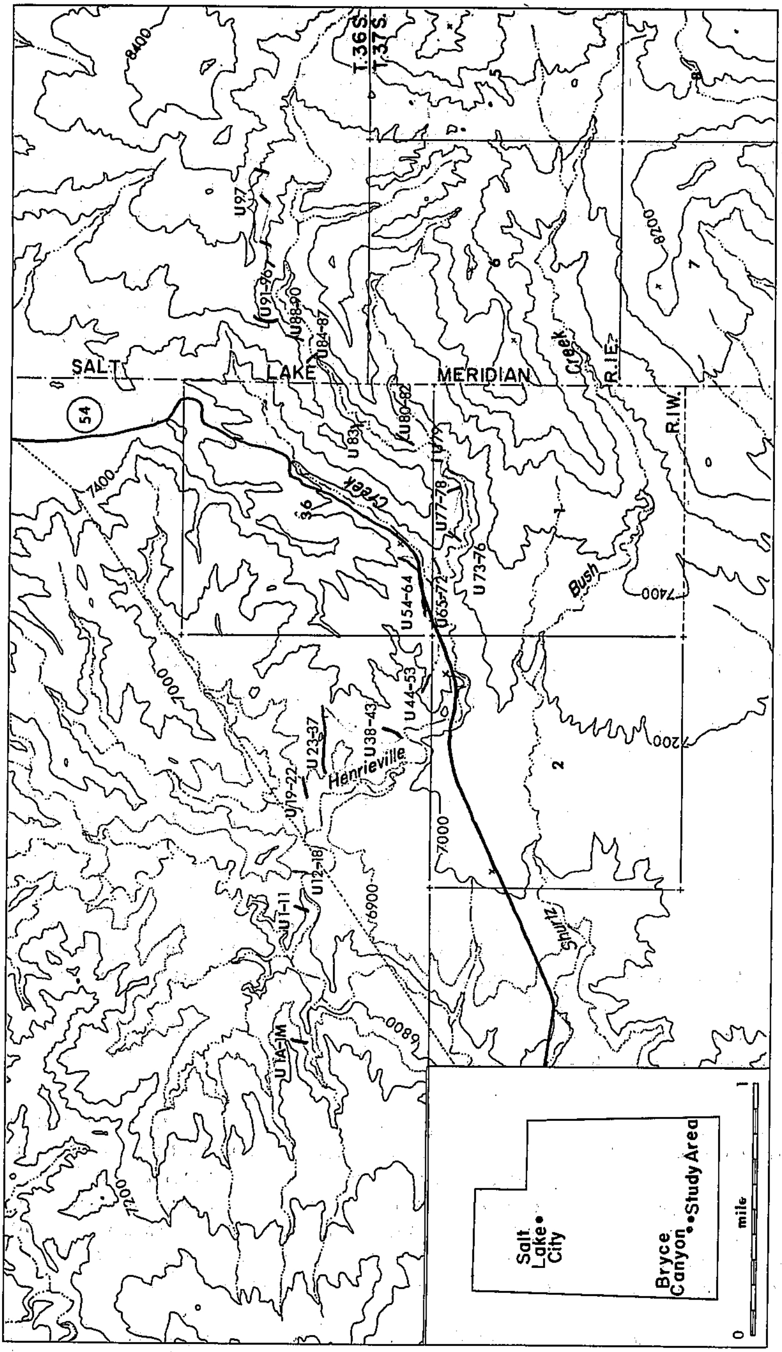
Scanning was done using the 45X objective rather than the normal 10X because of a tendency for motion sickness. The 100X objective was used for counting purposes because of the small size of most of the palynomorphs encountered during this study.

Photography.—Specimens illustrated on Plates 1 through 12 were photographed using Kodak Panatomic-X, 35 mm film and were printed on Kodak Polycontrast F paper. All specimens, except where noted, are enlarged 1,000 times. Photographs have not been retouched.

Original photomicrographs were taken with a Nikon Microflex Model AFM automatic photomicrographic attachment. This was mounted on the monocular tube of a Leitz SM-POL microscope.

Specimen Location.—Locations of specimens are given using standard rectangular Cartesian coordinates. Slides are all oriented with the label to the left. Point of origin (0.00, 0.00) for all measurements is the lower left-hand corner of the cover glass or projection to this point. All distances are therefore measured upward and to the right from the origin. Following standard mathematical convention the "X" coordinate is given first followed by the "Y" coordinate. Distances are in millimeters.

Explanation of Sample and Slide Numbers.—The Kaiparowits Formation was measured, described, and sampled during three different periods. Consequently



TEXT-FIGURE 1.—Index map showing location of individual segments of the measured section.

there are three different sets of code numbers for samples and therefore also for the slides.

Units 1A through 1M were measured on August 13, 1965, by the author and Dr. Jess R. Bushman. These units were sampled in the series FL-P. Example: FL-P-166+91.5 ft. is from the FL-P series of samples. It is sample number 166 and was collected 91.5 feet above the base of the Kaiparowits Formation.

Units 1 through 97 were measured, described, and sampled during June 1966. These units were sampled in the CFL-K series. Example: CFL-K-256+1250 ft. is from the CFL-K series of samples. It is sample number 256 and was collected 1,250 feet above the base of the Kaiparowits Formation.

The lateral equivalents of Units 1A through 1L were measured by Dr. Jess R. Bushman and Mr. Gary J. Newman on May 31, 1967, approximately one-half mile to the southwest of the base of the Kaiparowits Formation as described in Appendix A. This is part of a measured section of the Wahweap Formation which will be published by Dr. Bushman at a later date. These samples are designated as the series JRB-Ka. Example: JRB-Ka-1+5 ft. is from the JRB-Ka series of samples. It is sample number 1 from the Kaiparowits Formation, and it was collected five feet above the base of the formation. These samples were used in this study because the outcrops and contact between Wahweap and Kaiparowits Formations are better exposed in this collection area than where the basal portion of the Kaiparowits Formation was originally measured.

Individual slides are distinguished by letters of the alphabet. Example: CFL-K-256+1250 ft. A is slide "A" from sample number CFL-K-256+1250 ft.

Repository of Slides.—All slides used in this study are in the repository of the Palynology Laboratory of the Department of Geology, Brigham Young University, Provo, Utah.

GEOLOGY AND STRATIGRAPHY

Regional Physiography.—The Kaiparowits Plateau is located in central southern Utah and lies mostly within Garfield County. It is in the central western part of the Colorado Plateau's physiographic province. The Kaiparowits region is characterized by essentially horizontal Mesozoic and Cenozoic rocks; with a few sharp, linear, monoclinal flexures, high elevations, terraced plateaus, cliff-bounded mesas, and straight-sided canyons (Gregory and Moore, 1931, p. 4, 12-13). The Blues, the specific area of this report, is a strip approximately six miles long by three miles wide, extending from the Table Cliffs on the northwest to Canaan Peak on the southeast. "The Blues" derives its name from the drab gray-blue color of these outcrops of the Kaiparowits Formation which is noticeable when the formation is seen from a distance.

Local Geology.—Sedimentary rocks ranging in age from the Upper Permian Kaibab Limestone and Coconino Sandstone to the Paleocene (or Eocene) Wasatch (Claron of some authors) Formation are exposed in the Kaiparowits region. Most of the exposed rocks are Mesozoic clastic sedimentary units.

Unconformities separate many of the formations in the Kaiparowits region, but only two of them are of particular concern in this paper. Gregory (1950, p. 108-109, and 1951, p. 40) and Fisher, *et al.* (1960, p. 40), indicate a disconformable relationship between the Kaiparowits and underlying Wahweap Sandstone. No conclusive evidence for this was observed in The Blues during the present field work; but, in the Paunsaugunt and Zion Park regions to the west, these two formations are clearly disconformable.

The Kaiparowits Formation and the overlying Wasatch Formation are separated by an angular unconformity in the region surrounding The Blues. During Late Cretaceous and/or Early Tertiary times the Kaiparowits region was deformed into several broad folds. The Table Cliff Syncline (Gregory and Moore, 1931, p. 122) is the only one that affects the study area. The axis of this syncline trends northwest-southeast and reaches maximum downwarping near Canaan Peak. Erosion and development of a fairly well-defined surface followed folding and preceded Wasatch sedimentation. The old erosion surface has cut across progressively older rocks in all directions from Canaan Peak. The thickest remaining section of the Kaiparowits Formation underlies Canaan Peak where it is 2,756 feet thick. The Wasatch Formation was deposited over this bowl-shaped remnant of Kaiparowits rocks.

DESCRIPTION OF THE KAIPAROWITS FORMATION

Kaiparowits Formation is the name given by Gregory and Moore (1931, p. 106-108) to the youngest Cretaceous rocks in the Kaiparowits region of central southern Utah. The formation name was derived from Kaiparowits Peak which lies immediately southeast of The Blues, the type locality of the formation Current U. S. Geological Survey topographic maps do not carry the name "Kaiparowits Peak," but the name "Canaan Peak" or "Canaan Mountain" is used for this feature. These two names were applied to two peaks of an outlier of Tertiary Wasatch Formation about six miles southeast of the Table Cliffs. Originally "Canaan Peak" was the designation for the northwesterly peak and "Kaiparowits Peak" the designation for the more southeasterly peak. These two peaks lie mostly within SW¼, Sec. 4, and NW¼, Sec. 9, T. 37 S., R. 1 E. respectively.

The Kaiparowits Formation is strikingly different in appearance from the underlying and overlying formations. The underlying Wahweap Sandstone is a light buff-colored, cliff-forming unit. The overlying Wasatch Formation is a bright pink and white, cliff-forming unit with a dark brown basal conglomerate. The Kaiparowits Formation is a mostly drab, dark gray, badlands-forming unit in contrast to these lighter-colored cliff-forming units. When viewed from a distance the gross appearance of the Kaiparowits Formation is that it is dominantly shale or mudstone. Close examination, however, shows it to contain a large proportion of friable, lithic sandstone with calcareous cement. The Kaiparowits Formation is composed mainly of friable, poorly cemented rocks. The infrequent rains have left the outcrop belt of the formation carved into intricate badlands topography.

Deposition of Kaiparowits sediments in The Blues occurred under shallow, fluvial, deltaic conditions. The lower 80 percent or approximately 2,100 feet of the formation is composed of interlensing sandstone and mudstone. Compositionally the Kaiparowits Formation is approximately 52 percent mudstone, 41 percent sandstone, 3 percent bentonite, and 4 percent miscellaneous (siltstone, limestone, lignitic shale). Lens thickness ranges from a few inches to several tens of feet. Few units can be traced laterally for more than two to three hundred feet. Such diagnostic deltaic sedimentary features as point bars, natural levees, channel sandstone, and back-swamp deposits are common within this lower part of the formation. A western provenance is suggested by abundant cross-beds throughout, indicating eastward transport. Petrographic study of thin sections of some of the sandstone lenses shows up to 46 percent of the volume to be rock fragments. Of this, up to 20 percent of the total volume is volcanic and basaltic rock fragments. These volcanic and basaltic rock fragments are only slightly altered and highly angular indicating rapid erosion and transport from a not too distant source. The most probable source appears to be central or western Nevada.

Thickness and magnitude of individual lenses within the lower part increase upward through the stratigraphic section. This appears to be a reflection of an increasing rate of erosion in the Mesocordilleran Highland to the west. The rate of uplift apparently did not change because sediment coarseness does not increase with thickening of lenses. The middle part, Unit 96, comprising approximately 4 percent, from approximately 2,100 feet to 2,200 feet above the base, appears to represent culmination of this increase in rate of erosion. This unit is composed mainly of fine- to coarse-grained, well-cemented, cliff-forming sandstone. Another possibility is that provenance changed; but, similar, nearly constant lithology argues against this possibility. The upper 16 percent of the Kaiparowits Formation, from approximately 2,200 feet above the base to the top of the formation, which is 2,756 feet above the base, is dominantly bentonitic mudstone, clean quartz sandstone, and bentonite. Considerable volcanic activity in the vicinity is indicated by the bentonitic sediments. Due to cover by considerable slumping within the formation, depositional environment of this upper part is not as well understood as that of the remainder of the formation.

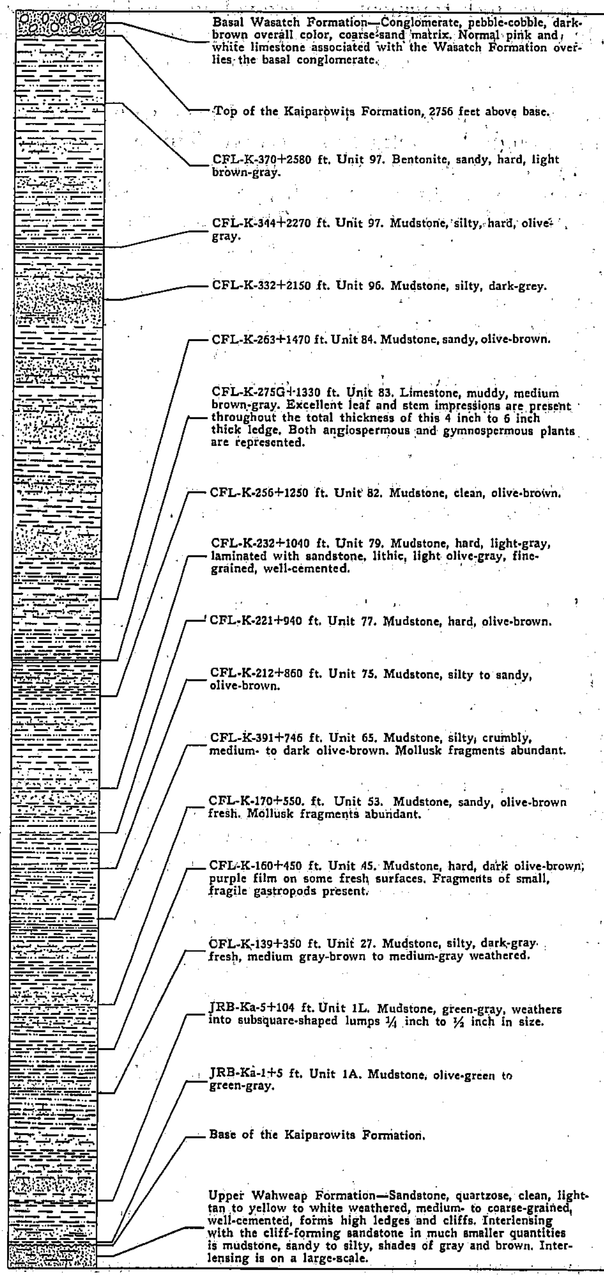
CLASSIFICATION AND NOMENCLATURE

Since the inception of the study of fossil spores and pollen, classification and nomenclature have been of paramount significance. These problems arise from differing philosophies of individual workers and matters of practicality in working with palynomorphs.

A palynologist is usually placed into one of three broad schools of thought depending upon his philosophy. The age of the material he is working with will largely limit the philosophical approach he is able to take. The first of these philosophical schools classifies palynomorphs solely upon objective morphological characteristics and gives them descriptive names reflective of this, i.e., *Triletes* for trilete spores. No attempt is made to relate forms described using this method to extant genera; in fact effort is made to avoid this. The descriptive method is most widely used by workers in the older (pre-Tertiary) sediments. Some proponents of this method are Couper (1958), Erdtman (1947, 1952), Pierce (1961), Potonié (1956, 1958, 1960, 1962), and others.

The second and opposing school of thought attempts to place as many forms as possible into extant genera. A suffix may be added to indicate it is a fossil form. This method is considerably more subjective than the first but has the advantage of giving some indication of botanical affinities which are so necessary for solution of evolutionary and paleoecological problems. Some proponents of this method are Traverse (1955, 1957), Stanley (1965), Couper (1953, 1960), and others. This method is most commonly used by Tertiary and Quaternary palynologists.

The third school follows a sort of middle-of-the-road approach. This group utilizes parts of the other two schools of thought in an attempt to get the best parts of each. Palynologists in this group lean toward one of the other two groups to varying degrees. Proponents of this school include Brenner (1963), Singh (1964), and others. Excellent discussions of these problems are presented by Traverse (1955, p. 81-90; 1957, p. 255-258), Stanley (1965, p. 190-193), and Pocock (1962, p. 29-31).



TEXT-FIGURE 2.—Generalized Stratigraphic Column of the Kaiparowits Formation and Position of Studied Samples.

These problems are becoming constantly more acute as the number of palynologists increases, and chaos is a constant threat as the welter of names in the literature increases. Great care must be exercised in naming palynomorphs in order to avoid utter chaos.

A middle-of-the-road method of classification is followed in this report with an attempt to relate these fossils to extant genera where a reasonable degree of surety of relationship seems evident. Only one extant generic name, *Azolla,* is used. It is felt that this philosophy of classification is necessary in order to carry out paleoecological interpretations.

Botanical affinities mentioned under systematic descriptions are based upon work of previous authors, usually the author of the name or the last reference in the synonymy.

Nomenclature is mostly after Erdtman (1943, 1952), Faegri and Iversen (1950, 1964), Iverson and Troels-Smith (1950), Kuyl, Muller, and Waterbolk (1955), and minor additions from various other authors. An indispensable aid in this area is the recent encyclopedia by Kremp (1965). See Glossary (Appendix B).

PALYNOLOGICAL ZONATION OF THE KAIPAROWITS FORMATION

The Kaiparowits Formation in its type locality is divided into three assemblage zones (American Commission on Stratigraphic Nomenclature, 1961, Article 21). Zone 1 is characterized by the presence of 23 species of palynomorphs that are exclusive to this zone. The 23 species of palynomorphs are listed in Table 1. Zone 1 includes the interval from the base of the formation through sample CFL-K-256+1250 ft., or Units 1A through 82.

Zone 2 is characterized by the presence of six species of palynomorphs which are listed in Table 2 and by the absence of the 23 species listed in Table 1. Zone 2 includes the interval between CFL-K-257G+1330 ft. and CFL-K-332+2150 ft. Units 83 through 96 are included in this zone.

Zone 3 is characterized by the presence of four species of palynomorphs which are listed in Table 3. The first three of these are exclusive to Zone 3.

TABLE 1
Palynomorphs Indicative of Assemblage Zone 1

Triplanosporites species A	*I.* species E
Laevigatosporites ovatus	*Aquilapollenites* cf. *A. delicatus*
Azolla cretacea	*A. pyriformis*
Foveotriletes species A	*A.* species A
Intertriletes cf. *I. scrobiculatus*	*A.* species B
Lycopodiumsporites cf. *L. fastingioides*	*Tetracolporopollenites abditus*
(?) *Cingulatisporites* species A	*Monosulcites* cf. *M. carpentieri*
Schizosporis cf. *S. parvus*	*M.* cf. *M. perspinosus*
Cycadopites cf. *C. giganteous*	*Tricolpites* species A
Phyllocladidites mawsonii	*Tricolporopollenites* species A
Inaperturopollenites species C	*T.* species C
I. species D	

TABLE 2
Palynomorphs Indicative of Assemblage Zone 2

Reticulatasporites species A	*Porocolpopollenites miikensis*
Schizosporis species A	*Tricolporites prolata*
Monocolpopollenites minor	*Tricolporopollenites microreticulatus*

TABLE 3
Palynomorphs Indicative of Assemblage Zone 3

Lycopodiumsporites cf. *L. austoclavatidites*	*Reticulatasporites* species B
Cingulatisporites cf. *C. scabratus*	*Ericaceoipollenites rallus*

The fourth, *Ericaceoipollenites rallus* Stanley, 1965, is used to define Zone 3 on the basis of abundance. In Zone 3 it is common, as opposed to Zones 1 and 2 where it isonly rare to frequent. Zone 3 is composed of Unit 97, approximately 2190 feet above the base to the top of the formation.

This zonation is tentative and subject to alteration upon receipt of more complete data concerning stratigraphic distribution patterns both within the section in The Blues and sections from other geographic localities. Until at least one other section of the Kaiparowits Formation is studied in detail there is no way to corroborate the validity of the zonation as here proposed.

PALEOECOLOGY-PALEOCLIMATOLOGY OF THE KAIPAROWITS FORMATION

The probable ecological and climatological conditions existing in the study area, and to a lesser degree the entire drainage basin, during Kaiparowits times are postulated from a study of extant plants to which the Kaiparowits palynomorphs flora is related (see Table 5) and also from the sediments and depositional patterns. Fossil palynomorphs have been compared to extant taxa based solely upon morphological similarities. It is assumed that this described palynomorph flora represents most of the taxa growing in the area during Kaiparowits times and that the plants contributing these palynomorphs occupied the same ecological niches as the extant taxa to which they have been equated. (For some other considerations see Brookes and Thomas, 1967, p. 621, 622).

Palynomorph taxa from the Kaiparowits flora that have been equated to extant taxa are arranged in Table 5. Unfortunately most taxa can be assigned to extant taxa only at the family level which gives a much broader, more generalized discussion than the several taxa that are discussed at the generic level.

It is postulated that the Kaiparowits flora grew in a subtropical to warm temperate climate. Precipitation over most of the basin was considerably greater than at present in the study area. The amount was probably nearer to that received by the Gulf Coast of the United States. Temperatures were much milder, probably similar to the Central America-Gulf Coast Region of North America.

The drainage basin that fed material into the Kaiparowits Delta had a low marshy or swampy topography near the depositional site but uplands further west. Such forms as *Azolla* and *Sphagnum,* that grow only in quiet, fresh-water ponds, and Taxodiaceae, that are common to swamps and flood plains, particularly suggest a low-relief, marshy or swampy, topography. Many of the other taxa described are native to warm, moist, forest-floor areas.

Warm, moist, upland areas further away are indicated by Cyatheaceae, Dicksoniaceae, *Araucaria, Picea,* and Podocarpaceae. Warm arid to semiarid conditions in part of the drainage basin, for at least part of the year, are indicated by the Families Proteaceae, Cycadaceae, and possibly Palmae. The conditions for growth of these arid to semiarid families could possibly reflect an area of rain shadow or annual wet and dry seasonal changes.

TABLE 4
Stratigraphic Distribution of Palynomorphs within the Kaiparowits Formation

	JRB-Ka-1+5 ft.	JRB-Ka-5+104 ft.	CFL-K-139+350 ft.	CFL-K-160+450 ft.	CFL-K-170+550 ft.	CFL-K-391+746 ft.	CFL-K-212+860 ft.	CFL-K-221+940 ft.	CFL-K-232+1040 ft.	CFL-K-256+1250 ft.	CFL-K-257G+1330 ft.	CFL-K-263+1470 ft.	CFL-K-332+2150 ft.	CFL-K-344+2270 ft.	CFL-K-370+2580 ft.
Sphagnumsporites species A	F			F						R				R	
Cyathidites minor	R	F		F	F	F	F	F	F	R				F	F
Cicatricosisporites dorogensis	R		F							R		F			
Triplanosporites species A	R						F			R					
Laevigatosporites haardti		F	F		F	F	C			F	F	F	R	R	
L. ovatus		F	F		F	F	F		F	R					
Leiotriletes pseudmaximus	F	F		F		F	F	F	F	F	F	F		F	F
L. species A	R					F								F	F
Azolla cretacea	R									R					
Balmeisporites species A	F					F				R				R	
Concavisporites species A	R					F		F						F	
C. species B	R		F				F					F		F	F
Deltoidospora psilostoma			F			F	F			R		F		R	
Foveotriletes species A		F								R					
Hymenozonotriletes species A	R											F		R	
Intertriletes cf. I. scrobiculatus	R									R					
Lycopodiumsporites cf. L. austoclavatidites														R	F
L. cf. L. fastigioides										R					
Acanthotriletes species A		R				F								R	
Ceratosporites species A	F	F						F		R		F			
Cingulatisporites cf. C. scabratus														F	
(?)Cingulatisporites species A	R					F									
Reticulatasporites species A			F							R			R		
R. species B														R	
R. species C	R														
R. species D	R	F									F				
Schizosporis cf. S. parvus										R					
S. species A										R			F		
Cycadopites cf. C. giganteous				F						R					
C. species A	R	F	F		F	F		F		F			F	F	F
Entylissa cf. E. nitidus	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F
E. species A	F	F	F	F	F	F	F	F	F	F	F	C	F	F	F
Araucariacites australis	F				F	F	F	F	C		F		F	F	F
Larcoidites magnus										R	F				
Piceaepollenites species A	R		F	F	F			F	F	R	F	F	R	R	
Phyllocladidites mawsonii	F				F	F		F	F		F				
Podocarpidites species A	F		F		F			F	F				F	F	F
Pityosporites constrictus	F						F	F	C		F	F	F	F	
Inaperturopollenites dubius	F	F	F	F	F	F	F	F	F	R	F	F	F	F	F
I. rugosa	F	F	F	F	F	F	F	F	F	F	C	C	F	F	C

TABLE 4 (Continued)

	JRB-Ka-1+5ft.	JRB-Ka-5+104ft.	CFL-K-139+350ft.	CFL-K-160+450ft.	CFL-K-170+550ft.	CFL-K-391+746ft.	CFL-K-212+860ft.	CFL-K-221+940ft.	CFL-K-232+1040ft.	CFL-K-256+1250ft.	CFL-K-257G+1330ft.	CFL-K-263+1470ft.	CFL-K-332+2150ft.	CFL-K-344+2270ft.	CFL-K-370+2580ft.
Inaperturopollenites cf. I. incertus	R	F	F							R				R	
I. cf. I. limbatus	R									R		F	R		
I. minor	C	C	F	F	F	C	F	F	C	F	C	C	C	C	C
I. species A	C	C	C	C	F	F	F	F	F	F	F	F	F	F	F
I. species B	R				F										R
I. species C	R		F		F				F	R					
I. species D	R			F	F		F	F	F						
I. species E	R		F												
Ericaceoipollenites rallus	F	F	F	F	F	F		F	F	F	F	F	F	C	C
Liliacidites variegatus	R					F			F	R			F	R	F
L. species A	F	F	F	F	F	F	F	F	F	R	F	F	F	F	F
Monocolpopollenites minor	R	F		F	F	F		F		F			F		
M. verrucatus	F	F	F	F	F		F	F	F	F	F		F	F	F
M. species A	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F
M. species B	F	F	F		F	F		F		F	F		F	F	F
Proteacidites retusus	F	F		F	F	F	C			R			R	R	F
P. subpalisadus	R	F	F		F		F			R			R		F
P. thalmanni	F	F	F	F	F	F	C		F	F	F	F			F
P. species A	F				F	F	F	F	F	R	F				F
Aquilapollenites cf. A. delicatus				F			R			R					
A. pyriformis							R			R					
A. species A	R														
A. species B							F								
Tetracolporopollenites abditus										R					
Porocolpopollenites miikensis	R					F				F			F		
Monosulcites cf. M. carpentieri										R					
M. cf. M. perspinosus						F									
Extratriporopollenites pompeckji	R							F		F	F			R	
Tricolpites erugatus	R					F		F		F		F	R		F
T. membranus	R										F				
T. reticulata		F	F		F			F		R	F	F	R		F
T. cf. T. thomasii	F		F							R	F				
T. species A	R		F	F	F		F			F					
Tricolpopollenites parvulus	F	F		F	F	F	F	F	F	C	F	C	F	F	F
T. species A	F	F	F	F			F	F	F	F	F	F	F	R	F
Tricolporites prolata			F							F	F		F		
Tricolporopollenites microreticulatus	R				F					R	F		R		
T. species A	F		F	F		F	F	F		F					
T. species B	F		F	F	F					F	F	F	R	R	
T. species C	F		F	F		F		F		F					

TABLE 5
Geographical, Ecological, and Geological Distribution of Modern Equivalents of the Kaiparowits Palynomorph Flora

Taxon	Geographic Range	Habitat	Geologic Range	Fossil Genera as Considered in This Study
Genus *Sphagnum*	Cosmopolitan; generally in higher altitudes and/or higher latitudes.	Quiet ponds, bogs, and swamps; often around the shores of ponds and lakes; acid conditions.	Jurassic to Recent	*Sphagnumsporites*
Family Cyatheaceae or Dicksoniaceae	Tropical rain forests, ranging into moist subtropical or moist, warm temperate regions, particularly in southern hemisphere.	Mild, moist areas; high, moist mountainous areas seem to be optimum.	Jurassic to Recent	*Cyathidites*
Family Schizaeaceae	Cosmopolitan in tropical areas, but ranging northward to the Pine Barrens of New Jersey and southward into Australia and New Zealand.	Warm, humid areas.	Carboniferous to Recent	*Cicatricosisporites* *Triplanosporites*
Family Polypodiaceae	Cosmopolitan in tropical to warm temperate regions; particularly Eastern Asia.	Moist, humid woodlands.	Triassic to Recent	*Laevigatosporites* *Leiotriletes*
Genus *Azolla*	Widespread in tropical and warm temperate regions.	Floating on the surface of quiet bodies of fresh water.	Upper Cretaceous to Recent	*Azolla*
Genus *Balmeisporites*	Extinct.	Tschudy (1961, p. 55) suggests a habitat for this genus similar to that of *Azolla*.	Upper Cretaceous and Lower Tertiary	*Balmeisporites*
Genus *Lycopodium*	Cosmopolitan; most abundant in tropical to temperate regions.	On forest floor commonly, most species require abundant moisture and shade, but a few species grow under open, dry conditions.	Carboniferous to Recent	*Lycopodiumsporites*

TABLE 5 (continued)

Taxon	Geographic Range	Habitat	Geologic Range	Fossil Genera as Considered in This Study
Genus *Selaginella*	Mostly in wet tropical to subtropical regions, but a few in temperate or more harsh regions.	Most species require abundant moisture and shade, but a few grow under open, dry conditions.	Lower Carboniferous to Recent	*Acanthotriletes* *Ceratosporites* *Cingulatisporites*
Family Cycadaceae	Central America, South Africa, and Eastern Asia with Australia; tropical to subtropical regions.	Rocky, arid conditions.	Basal Triassic to Recent	*Cycadopites*
Genus *Araucaria*	Chile-Argentina-Brazil and the Philippines-Australasia-New Zealand regions.	Moist, warm conditions, boggy to well-drained; sea level to a few thousand feet.	Triassic to Recent	*Araucariacites*
Family Cupressaceae	Cosmopolitan; more abundant in northern hemisphere.	Cosmopolitan.	Triassic to Recent	*Inaperturopollenites* (in part)
Genus *Larix*	Cool temperate portions of the northern hemisphere.	Frequently in wet woodlands, marshes, and bogs; mostly on poorer soils.	Upper Cretaceous to Recent	*Laricodites*
Genus *Picea*	North America and Eurasia, mostly restricted to the cooler regions.	Cool, moist areas; typically in swampy areas and along the margins of streams and lakes in uplands.	Upper Cretaceous to Recent	*Piceaepollenites*
Family Podocarpaceae	Tropical to subtropical regions; mainly in southern hemisphere, but extending into Central America, eastern Asia, and northern Africa.	Warm, moist woodlands; mostly mountainous uplands.	Jurassic to Recent	*Phyllocladidites* *Podocarpidites* *Pityosporites*
Family Taxodiaceae	Subtemperate to subtropical regions; mainly in northern hemisphere (only one genus extends into southern hemisphere).	Moist areas, particularly swamps and flood plains.	Jurassic to Recent	*Inaperturopollenites* (in part)

TABLE 5 (continued)

Taxon	Geographic Range	Habitat	Geologic Range	Fossil Genera as Considered in This Study
Family Ericaceae	Cosmopolitan.	Moist conditions, commonly in forested areas with wet, acid soils.	Cretaceous to Recent	*Ericaceoipollenites*
Family Liliaceae	Cosmopolitan; particularly abundant in temperate and subtropical regions.	Cosmopolitan.	Cretaceous to Recent	*Liliacidites*
Family Palmae	Cosmopolitan in tropical to subtropical regions.	Swamps and flood plains to mountainous and steepe regions; considerable amounts of water must be available either on the surface or in the subsurface for their survival.	Cretaceous to Resent	*Monocolpopollenites*
Family Proteaceae	Mainly in southern hemisphere.	Chiefly in arid regions or regions with a dry season.	Cretaceous to Recent	*Proteacidites*
Family Salicaceae	Cosmopolitan; except the Australasia-Malay Archipelago region.	Moist soils, commonly along streams and on unshaded slopes.	Lower (?) Cretaceous to Recent	*Inaperturopollenites* (in part)
Family Santalaceae	Cosmopolitan in tropical to temperate areas.	Moist areas.	Cretaceous to Recent	*Aquilapollenites*
Family Dipsacaceae	Eastern hemisphere; Mediterranean-Russian Steepe-Indian region.	Moist areas.	Cretaceous to Recent	*Aquilapollenites*
Family Sapotaceae	Cosmopolitan in tropical and warm climates.	Moist to swampy conditions.	Cretaceous to Recent	*Tetracolporopollenites*
Family Symplocaceae	Tropics of Asia and the Americas, extending into subtropics of North America.	Swamps, bottomlands, and moist woodlands.	Cretaceous to Recent	*Porocolpopollenites*

After: Arnold, 1947; Benson, 1965; Bold, 1967; Cain, 1944; Dallimore and Jackson, 1948; Haupt, 1953; and Scagel, *et al.*, 1965.

Correlation values derived from Index (2) in Table 7 suggest a closer relationship between the Kaiparowits microflora and those microfloras to the north and east than to the San Juan Basin to the southeast. This lack of correlation is probably due to ecological factors such as precipitation or topography as opposed to temperature.

AGE OF THE KAIPAROWITS FORMATION

Paleozoological Evidence.—Invertebrate and vertebrate fossils are not uncommon within the Kaiparowits Formation. Both are found at numerous stratigraphic levels and geographic locations, especially in the lower part of the formation. Based upon several suites of mollusks, J. B. Reeside, Jr. equated the Kaiparowits Formation to the Fruitland and younger Cretaceous formations of the San Juan Basin in northwestern New Mexico (Gregory, 1950, p. 109, 110; Gregory, 1951, p. 42, 43; Gregory and Moore, 1931, p. 107, 108; Reeside, 1924, p. 24). It has also been equated (in part) to the lower one third of the North Horn Formation on the Wasatch Plateau (Fisher, *et al.,* 1960, p. 40; Gregory, 1951, p. 43; Spieker, 1931, p. 42, 43). These local ages correspond to upper Montanan, or Lancian age in the Western Interior of North America, or Maestrichtian of Europe.

Following is a list of invertebrate remains from the Kaiparowits Formation that have been identified by J. B. Reeside, Jr. (Gregory, 1950, p. 110; Gregory, 1951, p. 42; Gregory and Moore, 1931, p. 107). All of these are fresh-water mollusks.

Bullinus subelongatus Meek and Hayden
Campeloma species
Goniobasis subtortuosa Meek and Hayden
Goniobasis species
Helix species
Physa cf. *P. pleromatis* White
Physa cf. *P. reesidei* Stanton
Planorbis (?) species
Unio aff. *U. amarillensis* Stanton
Unio species "suggesting *U. brachyopisthus* White"
Unio cf. *U. danae* Meek and Hayden
Unio cf. *U. haydeni* Meek
Unio cf. *U. neomexicanus* Stanton
Unio sp.
Viviparus cf. *V. Leai* (Meek and Hayden)
Viviparus cf. *V. Leidyi* Meek and Hayden
Viviparus panguitchensis White

Vertebrate remains collected from the Canaan Peak area led R. S. Lull to assign a probable Lancian age to the Kaiparowits Formation (Gregory and Moore, 1931, p. 108). C. W. Gilmore (in Gregory, 1950, p. 110), also using vertebrate remains, stated: "This collection of fragmentary specimens clearly indicates their Upper Cretaceous origin. This assemblage as a whole and especially the presence of *Baena nodosa* strongly suggests that the Kaiparowits Formation is the equivalent of the Fruitland of New Mexico."

Following is a list of vertebrate remains that have been identified from the Kaiparowits Formation (Gregory, 1950, p. 110; Gregory, 1951, p. 42; Gregory and Moore, 1931, p. 108).

Chelonia:
- *Adocus* sp.
- *Baena* cf. *B. nodosa* Gilmore
- *Basilemys* sp.
- Trionychid turtle

Crocidilia
Hadrosauridea (duck-billed dinosaur)
Nodosauridea (armored dinosaur)
Theropoda (carnivorous dinosaur)
Trachodonoid species
cf. *Triceratops* sp.

Paleobotanical Evidence.—Plant megafossils are not uncommon within the Kaiparowits Formation. Unfortunately they have been studied to only a limited extent and this was only of a reconnaissance nature. F. H. Knowlton (in Richardson, 1927, p. 470) tentatively identified the following plant megafossils. These plant megafossils indicate an uplands gymnospermous and dicotyledonous flora. They were collected from the lower part of the Kaiparowits Formation, 60 to 80 miles west of the study area, ". . . on the west fork of Virgin River. . ." (Gregory, 1950, p. 110).

Dammarites (=*Araucaria*) *caudatus* (?) Lesquereux
Podozamites oblongus (?) Lesquereux
Podozamites angustifolius (?) (Eichwald) Schimper
Platanus newberryana (?) Heer
Platanus sp. cf. *P. primaeva* Lesquereux
Betula cf. *B. beatriciana* Lesquereux
Menispermites ovalis (?) Lesquereux
Cinnamomum sp.
Viburnum robustum Lesquereux

Only one of these megaplant genera was co-identified in the palynomorph flora; this is *Dammarites* (= *Araucaria*) which equates to the fossil palynomorph genus *Arancariacites*. Other co-identifications were not made, possibly due to peculiarities of, or lack of, preservation, incompleteness of the known megaflora, misassignment of fossil palynomorphs to modern and fossil plant genera, or most plausibly, simply the lack of knowledge of which plants produced which palynomorphs.

Palynomorphs, or acid-insoluble plant microfossils, are both abundant and diverse within the Kaiparowits Formation. In this report on the palynology of the Kaiparowits Formation 41 genera and 80 species are described and identified to at least the generic level. One new genus and 36 probably new species are described but not formally named at this time. It is felt that these unnamed palynomorphs flora as complete as possible for stratigraphic, correlation, and paleoecologic purposes.

Table 6 compares the known Kaiparowits flora with 30 palynomorph floras. The 30 microfloras are of varying degrees of completeness and therefore of varying sizes. These palynomorph floras are of both Upper Cretaceous and Lower Tertiary age and from various sections of North America. Particular emphasis has been placed upon assemblages from the western part (Text-fig. 5).

The simple statistical correlation tests proposed by Simpson (1960) are applied to the results obtained from Table 6. These results are shown in Table

TABLE 6
Distribution of Kaiparowits Flora in Strata from Other Regions of North America

	NW Colorado (Newman, 1961)	Utah-Wyoming (Wheelwright, 1958)	NW New Mexico (Anderson, 1960)	Cent. Colorado (Clarke, 1963)	NW South Dakota (Stanley, 1965)	S. Alberta (Srivastava, 1966)	W. Alberta (Radforth & Rouse, 1954)	Delaware-Maryland (Gray & Groot, 1966)	S. Utah (Orlansky, 1967)	N. Arizona (Agasie, 1967)	SW Wyoming (Griesbach, 1956)	Cent. Colorado (Pannella, 1966)	W. Wyoming (Upshaw, 1959)	S. Cent. Oklahoma (Hedlund, 1966)	SW British Columbia (Rouse, 1957)	S. Alberta (Rouse, 1957)	S. Alberta (Norris, 1967)	S. Alberta (Singh, 1964)	W. Alabama (Leopold & Pakiser, 1964)	E. Maryland (Brenner, 1963)	Maryland-Delaware (Groot & Penny, 1960)	New Jersey (Groot, Penny & Groot, 1961)	E. Utah-W. Colorado (Wodehouse, 1933)	Cent. California (Drugg, 1967)	S. Cent. Montana (Wilson & Webster, 1946)	NW South Dakota (Gerhard, 1958)	SW B.C.-NW Wash. (Hopkins, 1966)	SW British Columbia (Rouse, 1962)	SE Texas (Elsik, 1965)	Maryland (Groot & Groot, 1962)
Proteacidites	G		G	G	G	G		G	G															G			G	G		
P. retusus			S		S																			S						
P. subpalisadus																														
P. thalmanni			S			S		S																S			S			
P. species A																														
Aquilapollenites	G	G		G	G	G										G												G		
A. cf. A. delicatus					S																									
A. pyriformis																														
A. species A																														
A. species B																														
Tetracolporopollenites																														
T. abditus																														
Porocolpopollenites																			G										G	
P. miikensis																														
Monosulcites	G		G	G		G			G			G	G	G					G	G	G	G						G	G	
M. cf. M. carpentieri				S										S																
M. cf. M. perspinosus			S																											
Extratriporopollenites	G		G																								G			G
E. pompeckji																														
Tricolpites		G	G	G	G	G			G	G				G			G		G					G		G	G		G	
T. rugatus														S																
T. membranus																														
T. reticulata																														
T. cf. T. thomasii																														
T. species A																														
Tricolpopollenites	G							G				G			G	G				G	G	G		G				G		
T. parvulus																					S	S		S						
T. species A																														

TABLE 6 (Continued)

	NW Colorado (Newman, 1961)	Utah-Wyoming (Wheelwright, 1958)	NW New Mexico (Anderson, 1960)	Cent. Colorado (Clarke, 1963)	NW South Dakota (Stanley, 1965)	S. Alberta (Srivastava, 1966)	W. Alberta (Radforth & Rouse, 1954)	Delaware-Maryland (Gray & Groot, 1966)	S. Utah (Orlansky, 1967)	N. Arizona (Agasie, 1967)	SW Wyoming (Griesbach, 1956)	Cent. Colorado (Pannella, 1966)	W. Wyoming (Upshaw, 1959)	S. Cent. Oklahoma (Hedlund, 1966)	SW British Columbia (Rouse, 1957)	S. Alberta (Rouse, 1957)	S. Alberta (Norris, 1967)	S. Alberta (Singh, 1964)	W. Alabama (Leopold & Pakiser, 1964)	E. Maryland (Brenner, 1963)	Maryland-Delaware (Groot & Penny, 1960)	New Jersey (Groot, Penny & Groot, 1961)	E. Utah-W. Colorado (Wodehouse, 1933)	Cent. California (Drugg, 1967)	S. Cent. Montana (Wilson & Webster, 1946)	NW South Dakota (Gerhard, 1958)	SW B.C.-NW Wash. (Hopkins, 1966)	SW British Columbia (Rouse, 1962)	SE Texas (Elsik, 1965)	Maryland (Groot & Groot, 1962)
Sphagnumsporites	G	G	G	G	G	G	G	G	G	G		G	G	G	G	G	G	G		G		G		G	G	G		G		
S. species A																														
Cyathidites				G		G		G	G	G		G		G			G	G	G	G		G		G		G				
C. minor				S		S		S	S	S		S		S			S	S		S		S								
Cicatricosisporites	G			G				G	G	G		G	G	G		G	G	G	G	G	G	G		G			G	G		
C. dorogensis	S			S						S		S	S			S		S	S		S	S		S						
Triplanosporites					G				G				G						G											
T. species A																														
Laevigatosporites	G	G	G	G	G	G		G	G	G		G	G	G	G	G	G	G	G					G	G		G	G	G	
L. haardti					S			S											S											
L. ovatus				S	S	S			S	S		S		S	S	S	S	S						S	S		S	S		
Leiotriletes					G								G						G											
L. pseudmaximus					S																									
L. species A																														
Azolla					G	G																					G	G		
A. cretacea					S	S																								
Balmeisporites										G		G	G	G																
B. species A																														
Concavisporites	G		G						G			G	G	G					G			G				G				
C. species A																														
C. species B																														
Deltoidospora		G	G			G			G		G	G		G	G	G	G	G	G	G				G	G		G	G	G	G
D. psilostoma																	S	S												
Foveotriletes			G							G			G				G			G				G		G				
F. species A																														

TABLE 6 (Continued)

	NW Colorado (Newman, 1961)	Utah-Wyoming (Wheelwright, 1958)	NW New Mexico (Anderson, 1960)	Cent. Colorado (Clarke, 1963)	NW South Dakota (Stanley, 1965)	S. Alberta (Srivastava, 1966)	W. Alberta (Radforth & Rouse, 1954)	Delaware-Maryland (Gray & Groot, 1966)	S. Utah (Orlansky, 1967)	N. Arizona (Agasie, 1967)	SW Wyoming (Griesbach, 1956)	Cent. Colorado (Pannella, 1966)	W. Wyoming (Upshaw, 1959)	S. Cent. Oklahoma (Hedlund, 1966)	SW British Columbia (Rouse, 1957)	S. Alberta (Rouse, 1957)	S. Alberta (Norris, 1967)	S. Alberta (Singh, 1964)	W. Alabama (Leopold & Pakiser, 1964)	E. Maryland (Brenner, 1963)	Maryland-Delaware (Groot & Penny, 1960)	New Jersey (Groot, Penny & Groot, 1961)	E. Utah-W. Colorado (Wodehouse, 1933)	Cent. California (Drugg, 1967)	S. Cent. Montana (Wilson & Webster, 1946)	NW South Dakota (Gerhard, 1958)	SW B.C.-NW Wash. (Hopkins, 1966)	SW British Columbia (Rouse, 1962)	SE Texas (Elsik, 1965)	Maryland (Groot & Groot, 1962)
Hymenozonotriletes	G																	G	G											
H. species A																														
Intertriletes			G																											
I. cf. I. scrobiculatus			S																											
Lycopodiumsporites	G	G	G	G	G		G		G	G	G	G	G	G	G	G	G	G	G	G	G	G		G		G	G			
L. cf. L. austoclavatidites				S													S	S		S				S						
L. cf. L. fastigioides																														
Acanthotriletes				G		G						G	G	G	G		G	G												
A. species A																														
Ceratosporites						G																		G						
C. species A																														
Cingulatisporites	G		G	G	G				G				G	G					G	G	G									
C. cf. C. scabratus																			S											
(?)C. species A																														
Reticulatasporites					G															G										
R. species A																														
R. species B																														
R. species C																														
R. species D																														
Schizosporis				G	G	G			G	G		G		G			G	G		G				G						
S. cf. S. parvus				S						S				S				S						S						
S. species A																														
Cycadopites				G	G	G	G		G			G				G	G	G	G				G							
C. cf. C. giganteous					S																									
C. species A																														

TABLE 6 (Continued)

	NW Colorado (Newman, 1961)	Utah-Wyoming (Wheelwright, 1958)	NW New Mexico (Anderson, 1960)	Cent. Colorado (Clarke, 1963)	NW South Dakota (Stanley, 1965)	S. Alberta (Srivastava, 1966)	W. Alberta (Radforth & Rouse, 1954)	Delaware-Maryland (Gray & Groot, 1966)	S. Utah (Orlansky, 1967)	N. Arizona (Agasie, 1967)	SW Wyoming (Griesbach, 1956)	Cent. Colorado (Pannella, 1966)	W. Wyoming (Upshaw, 1959)	S. Cent. Oklahoma (Hedlund, 1966)	SW British Columbia (Rouse, 1957)	S. Alberta (Rouse, 1957)	S. Alberta (Norris, 1967)	S. Alberta (Singh, 1964)	W. Alabama (Leopold & Pakiser, 1964)	E. Maryland (Brenner, 1963)	Maryland-Delaware (Groot & Penny, 1960)	New Jersey (Groot, Penny & Groot, 1961)	E. Utah-W. Colorado (Wodehouse, 1933)	Cent. California (Drugg, 1967)	S. Cent. Montana (Wilson & Webster, 1946)	NW South Dakota (Gerhard, 1958)	SW B.C.-NW Wash. (Hopkins, 1966)	SW British Columbia (Rouse, 1962)	SE Texas (Elsik, 1965)	Maryland (Groot & Groot, 1962)
Entylissa																				G										
E. cf. E. nitidus																				S										
E. species A																														
Araucariacites				G		G		G	G			G					G		G	G										
A. australis						S		S	S			S					S		S	S										
Dammarites																														
D. caudatus?																														
Laricoidites				G		G	G		G					G					G	G						G				
L. magnus				S			S							S					S	S										
Piceaepollenites				G	G				G					G				G					G		G	G	G	G		
P. species A																														
Phyllocladidites																	G	G		G		G								
P. mawsonii																		S												
Podocarpidites				G		G	G		G	G		G				G	G	G	G	G				G			G	G		
P. species A																														
Podozamites																														
P. oblongus?																														
P. angustifolius?																														
Pityosporites	G					G												G	G											
P. constrictus																		S												
Inaperturopollenites	G	G	G	G		G			G		G	G					G		G	G	G	G						G		
I. dubius						S			S			S					S		S	S	S	S								
I. cf. I. incertus																														
I. cf. I. limbatus			S																											
I. minor																														
I. rugosa																						S								

TABLE 6 (Continued)

	NW Colorado (Newman, 1961)	Utah-Wyoming (Wheelwright, 1958)	NW New Mexico (Anderson, 1960)	Cent. Colorado (Clarke, 1963)	NW South Dakota (Stanley, 1965)	S. Alberta (Srivastava, 1966)	W. Alberta (Radforth & Rouse, 1954)	Delaware-Maryland (Gray & Groot, 1966)	S. Utah (Orlansky, 1967)	N. Arizona (Agasie, 1967)	SW Wyoming (Griesbach, 1956)	Cent. Colorado (Pannella, 1966)	W. Wyoming (Upshaw, 1959)	S. Cent. Oklahoma (Hedlund, 1966)	SW British Columbia (Rouse, 1957)	S. Alberta (Rouse, 1957)	S. Alberta (Norris, 1967)	S. Alberta (Singh, 1964)	W. Alabama (Leopold & Pakiser, 1964)	E. Maryland (Brenner, 1963)	Maryland-Delaware (Groot & Penny, 1960)	New Jersey (Groot, Penny & Groot, 1961)	E. Utah-W. Colorado (Wodehouse, 1933)	Cent. California (Drugg, 1967)	S. Cent. Montana (Wilson & Webster, 1946)	NW South Dakota (Gerhard, 1958)	SW B.C.-NW Wash. (Hopkins, 1966)	SW British Columbia (Rouse, 1962)	SE Texas (Elsik, 1965)	Maryland (Groot & Groot, 1962)
Inaperturopollenites																														
I. species A																														
I. species B																														
I. species C																														
I. species D																														
I. species E																														
Betula					G		G																G		G		G		G	
B. cf. B. beatriciana																														
Viburnum																														
V. robustum																														
Cinnamomum																														
C. species																														
Ericaceoipollenites					G														G							G				
E. rallus					S																									
Liliacidites			G	G		G			G	G	G	G		G		G	G		G	G	G			G			G		G	
L. variegatus						S				S				S							S			S						
L. species A																														
Menisermites																														
M. ovalis?																														
Monocolpopollenites																								G						
M. minor																														
M. verrucatus																														
M. species A																														
M. species B																														
Platanus																														
P. newberryana?																														
P. cf. P. primaeva																														

TABLE 6 (Continued)

	1 NW Colorado (Newman, 1961)	2 Utah-Wyoming (Wheelwright, 1958)	3 NW New Mexico (Anderson, 1960)	4 Cent. Colorado (Clarke, 1963)	5 NW South Dakota (Stanley, 1965)	6 S. Alberta (Srivastava, 1966)	7 W. Alberta (Radforth & Rouse, 1954)	8 Delaware-Maryland (Gray & Groot, 1966)	9 S. Utah (Orlansky, 1967)	10 N. Arizona (Agasie, 1967)	11 SW Wyoming (Griesbach, 1956)	12 Cent. Colorado (Pannella, 1966)	13 W. Wyoming (Upshaw, 1959)	14 S. Cent. Oklahoma (Hedlund, 1966)	15 SW British Columbia (Rouse, 1957)	16 S. Alberta (Rouse, 1957)	17 S. Alberta (Norris, 1967)	18 S. Alberta (Singh, 1964)	19 W. Alabama (Leopold & Pakiser, 1964)	20 E. Maryland (Brenner, 1963)	21 Maryland-Delaware (Groot & Penny, 1960)	22 New Jersey (Groot, Penny & Groot, 1961)	23 E. Utah-W. Colorado (Wodehouse, 1933)	24 Cent. California (Drugg, 1967)	25 S. Cent. Montana (Wilson & Webster, 1946)	26 NW South Dakota (Gerhard, 1958)	27 SW B.C.-NW Wash. (Hopkins, 1966)	28 SW British Columbia (Rouse, 1962)	29 SE Texas (Elsik, 1965)	30 Maryland (Groot & Groot, 1962)
Tricolporites		G	G						G		G	G															G			
T. prolata																														
Tricolporopollenites	G			G				G		G				G					G		G	G		G				G		G
T. microreticulatus																								S						
T. species A																														
T. species B																														
T. species C																														

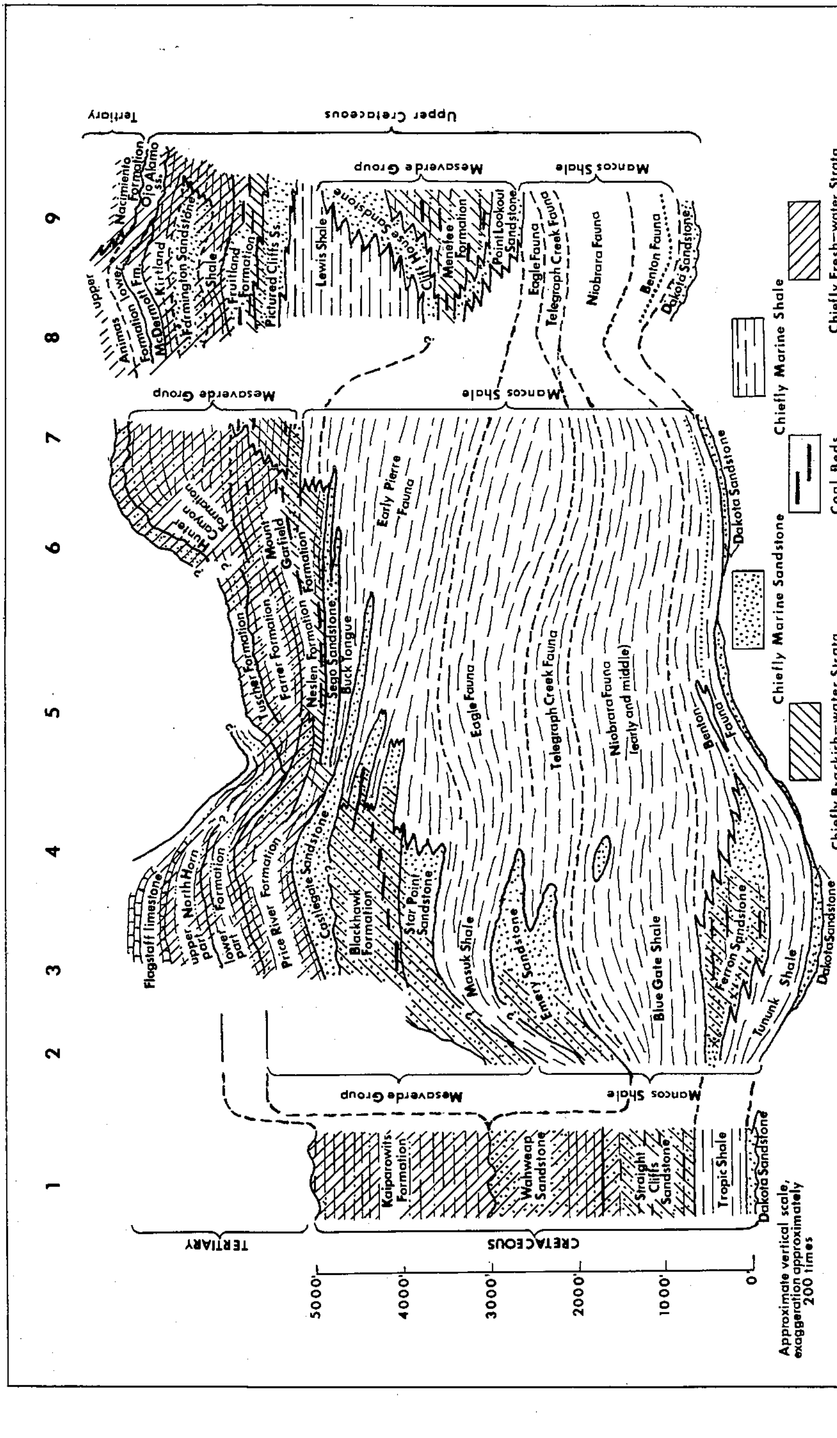
7. Simpson (1960) suggests that for correlation purposes the following symbols and tests, which also appear in Table 7, are sufficient for elucidation of the presence or absence of genera.

E_1—Number of genera present in the first, or numerically smaller of the two microfloras, but absent in the second microflora.
E_2—Number of genera present in the second, or numerically larger of the two microfloras, but absent in the first microflora.
C—Number of genera common to both microfloras.
$N_1 = E_1 + C$—Total number of genera present in the first, or numerically smaller microflora.
$N_2 = E_2 + C$—Total number of genera present in the second ,or numerically larger, microflora.

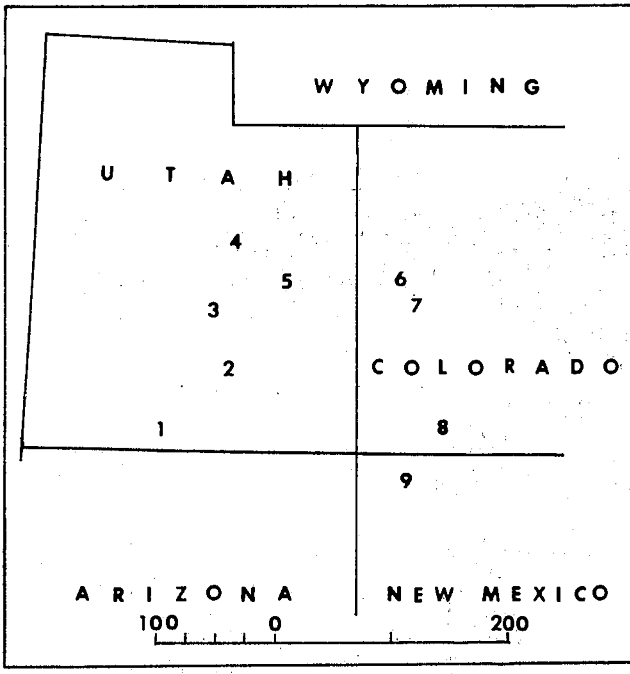
If the two microfloras being considered are both completely known and of approximately equal size, or if an equal portion of each is known and there is no bias concerning the portion of the original microfloras that is known, a simple percentage of genera common to both microfloras would give an acceptable measure of correlation. However, in all of the cases being dealt with in this study both microfloras are incompletely known, and in some cases they are quite incompletely known. It is therefore necessary to employ a test that tends to stress the most nearly similar elements of the two microfloras and which is generally less biased than a simple percentage test. Index (2): $C/N_1 X 100$, which is a comparison of the numerically smaller microflora to the numerically larger microflora, is therefore employed for this purpose. Index (2) may have values between 100 and zero—100 is complete identity of the smaller microflora to the larger microflora; zero is complete lack of identity. Therefore, the higher the numerical value of index (2) the better the correlation. Index (3): $C/N_2 X$ 100, is a test comparing the numerically larger microflora to the numerically smaller microflora. The nature of the numbers inserted into these two indices will always make index (3) a smaller numerical value than index (2). Therefore, the larger microflora always appears to be less similar to the smaller microflora than the smaller microflora to the larger. Index (3) was run and the results appear in Table 7. The results will not be discussed since they do not demonstrate the most nearly similar elements of each pair of microfloras which is the intent of these tests.

Several problems are outstanding in causing the results of these tests to be less desirable than could be hoped for. These problems are (1) lack of uniformity in classification systems, (2) incompleteness of described palynomorph floras, and (3) the necessity of comparing floras at the generic level, which is related to the preceding reason. The first of these problems is by far the greatest one facing palynology. Similarity or dissimilarity of classification systems has strongly affected the results of index (2), Table 7.

Another problem, closely related to reason 3 (above), is the long-ranging nature of several genera of palynomorphs; i.e., *Laevigatosporites, Deltoidospora, Inaperturopollenites, Monosulcites, Cyathidites, Lycopodiumsporites, Cycadopites,* and *Liliacidites* to mention only a few. These genera are separated and defined and given names that are morphologically descriptive or are descriptive of modern taxa. This classification system allows palynomorphs from many unrelated taxa to be placed together into these genera if they morphologically fit the definition. In the not-too-distant past most palynomorphs were placed into genera such as *Sporites, Triletes,* and *Pollenites.* Further study of modern taxa,



TEXT-FIGURE 3.—Regional Correlation of the Upper Cretaceous Formations—Utah, Colorado, New Mexico.

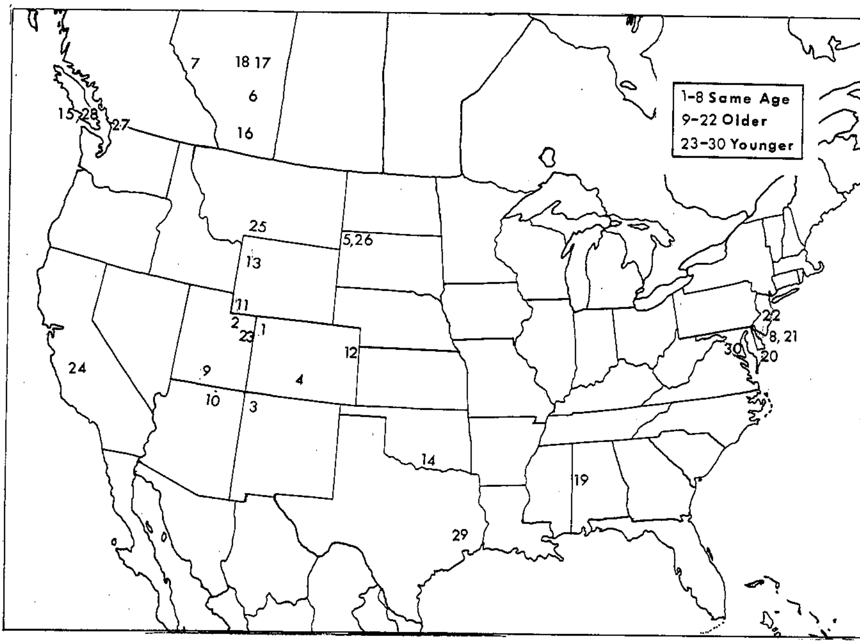


TEXT-FIGURE 4.—Index Map Showing Location of Numbers from Text-figure 3.

as well as of fossils, has allowed many species to be transferred into their more nearly correct phylogenetic relationship. It is hoped that future studies will further this research until all palynomorphs are placed into their proper phylogenetic relationship. Unfortunately this goal will probably never be reached. It is a frustrating but an all-too-real situation that many distantly related modern plants produce morphologically similar spores and pollen grains that are difficult or impossible to classify phylogenetically without knowing their source. This situation undoubtedly has existed in the geological past. Many palynomorphs are so simple morphologically that little if any reassignment of species will take place with future studies.

Results obtained from index (2) in Table 7 indicate, first of all, that the Kaiparowits Formation is Upper Cretaceous and not Lower Tertiary. Values for index (2) when the Kaiparowits microflora is N_1 are the only ones that will be considered for correlation purposes. Only when the Kaiparowits microflora is N_1 is the Kaiparowits microflora compared to an already known microflora. Columns 1-8 (same age) and columns 9-22 (older), Table 7, are all Upper Cretaceous. The values in these columns vary between 29 (Upshaw, 1959) and 54 (Leopold and Pakiser, 1964) and have a mean of 42. Values in columns 23-30, which are Lower Tertiary, vary between 22 (Gerhard, 1958) and 39 (Drugg, 1967) and have a mean of 31. The difference of mean values of 11, or more than 25 percent, is sufficient to show the Upper Cretaceous age for the Kaiparowits Formation.

Concerning individual correlations, the best correlation value, 54, is with the older Tuscaloosa Group in western Alabama (Leopold and Pakiser, 1964).



TEXT-FIGURE 5.—Index Map of Studies Referred to in Table 6.

The Tuscaloosa Group is Cenomanian and Lower Turonian in age. The principal reasons for this correlation are the large number of genera, 77, identified from the Tuscaloosa Group and the similarity in classification systems used in the two studies. Second best correlation, 51, is with the Straight Cliffs Sandstone (Orlansky, 1967) which crops out in the same general areas as the Kaiparowits Formation. The Straight Cliffs Sandstone is Coniacian in age. Geographic proximity and similarity of classification systems used in these two studies probably account for their close correlation.

Correlation values of the assemblages that are approximately the same age (columns 1-8, Table 7) vary between 37 and 49 with a mean of 41. The best correlation, 49, is with the Vermejo Formation (Clarke, 1963) in central Colorado. Second best correlation, 46, is with the Upper Edmonton Formation (Srivastava, 1966) in southern Alberta. Third best, 39, is with the Hell Creek and Fort Union Formations (Stanley, 1965) in northwestern South Dakota. Poorest correlation, 37, is with the post-Mancos Upper Cretaceous and Paleocene formations in northwestern Colorado (Newman, 1961) and the uppermost Cretaceous and basal Tertiary in northwestern New Mexico (Anderson, 1960).

A good correlation, 39, is made with the upper Moreno Formation (Drugg, 1967) in the Fresno, California, area. The Cretaceous-Tertiary boundary is in the lower part of the stratigraphic section studied by Drugg.

Mean correlation values of the assemblages older than the Kaiparowits assemblage is 42. The lowest value, 29, (Upshaw, 1959) for the Frontier Formation in northwestern Wyoming appears to be quite out of place. It must be pointed out that only the spores were identified and studied to any considerable extent and the pollen grains studied only to a minor extent during this study of

TABLE 7
Comparison of Results Obtained in Table 6

Comparison	E_1=no. of genera peculiar to smaller microflora	E_2=no. of genera peculiar to larger microflora	C=no. of genera common to both microfloras	N_1= total no. of genera in smaller microflora	N_2= total no. of genera in larger microflora	$\frac{C}{N_1}$ X100 (2)	$\frac{C}{N_2}$ X100 (3)
Kaiparowits Fm.—Maryland (Groot & Groot, 1962)	14	38	3	17	41	18	7
Kaiparowits Fm.—SE Texas (Elsik, 1965)	29	34	7	36	41	19	17
Kaiparowits Fm.—SW British Columbia (Rouse, 1962)	28	33	13	41	46	32	28
Kaiparowits Fm.—SW B.C.—NW Wash. (Hopkins, 1966)	28	43	13	41	56	32	23
Kaiparowits Fm.—NW South Dakota (Gerhard, 1958)	32	36	9	41	45	22	20
Kaiparowits Fm.—S. Cent. Montana (Wilson & Webster, 1946)	8	36	5	13	41	38	12
Kaiparowits Fm.—Cent. California (Drugg, 1967)	25	44	16	41	60	39	27
Kaiparowits Fm.—E. Utah—W. Colorado (Wodehouse, 1933)	31	38	3	34	41	9	7
Kaiparowits Fm.—New Jersey (Groot, Penny & Groot, 1961)	18	31	10	28	41	36	24
Kaiparowits Fm.—Maryland—Delaware (Groot & Penny, 1960)	6	33	8	14	41	57	20
Kaiparowits Fm.—E. Maryland (Brenner, 1963)	23	46	18	41	64	44	28
Kaiparowits Fm.—W. Alabama (Leopold & Pakiser, 1964)	19	55	22	41	77	54	29
Kaiparowits Fm.—S. Alberta (Singh, 1964)	27	39	14	41	53	34	26
Kaiparowits Fm.—S. Alberta (Norris, 1967)	25	44	16	41	60	39	27
Kaiparowits Fm.—S. Alberta (Rouse, 1957)	17	31	10	27	41	37	24
Kaiparowits Fm.—SW British Columbia (Rouse, 1957)	12	35	6	18	41	33	15
Kaiparowits Fm.—S. Cent. Oklahoma (Hedlund, 1966)	24	28	17	41	45	41	38
Kaiparowits Fm.—W. Wyoming (Upshaw, 1959)	29	41	12	41	53	29	23
Kaiparowits Fm.—Cent. Colorado (Pannella, 1966)	23	47	18	41	65	44	28
Kaiparowits Fm.—SW Wyoming (Griesbach, 1956)	11	36	5	16	41	31	12
Kaiparowits Fm.—N. Arizona (Agasie, 1967)	27	29	12	39	41	31	29
Kaiparowits Fm.—S. Utah (Orlansky, 1967)	20	34	21	41	55	51	38
Kaiparowits Fm.—Delaware—Maryland (Groot & Groot, 1966)	11	32	9	20	41	45	22
Kaiparowits Fm.—W. Alberta (Radforth & Rouse, 1954)	9	35	6	15	41	40	15
Kaiparowits Fm.—S. Alberta (Srivastava, 1966)	22	40	19	41	59	46	32
Kaiparowits Fm.—NW South Dakota (Stanley, 1965)	25	38	16	41	54	39	30
Kaiparowits Fm.—Cent. Colorado (Clarke, 1963)	21	44	20	41	64	49	31
Kaiparowits Fm.—NW New Mexico (Anderson, 1960)	26	40	15	41	55	37	27
Kaiparowits Fm.—Utah—Wyoming (Wheelwright, 1958)	13	33	8	21	41	26	20
Kaiparowits Fm.—NW Colorado (Newman, 1961)	26	27	15	41	42	37	36

the Frontier microflora. Pollen grains form a substantial segment of the Kaiparowits microflora.

Distribution of correlation values, together with the geologic unit studied, geographic locality of the study, the geologic age of the unit(s), and the investigator and date are summarized in Table 8.

Several palynomorphs compared at the specific level give a stronger correlation with the same age assemblages.

Aquilapollenites ranges from Albian to Lower Eocene in western North America. This genus reaches its greatest diversity during Upper Cretaceous times (Srivastava, 1967, p. 265). *Aquilapollenites* cf. *A. delicatus* Stanley, 1961, and *Aquilapollenites pyriformis* Norton, 1965, are similar enough to, or conspecific with, the forms described from the Hell Creek Formation in northwestern South Dakota and central eastern Montana, and the Upper Edmonton Formation in southern Alberta suggest correlation of the Kaiparowits Formation with these formations.

Azolla cretacea Stanley, 1965, appears to be conspecific with the form described from the Hell Creek Formation by Stanley, 1965, and with the Upper Edmonton Formation in southern Alberta (Srivastava, 1966). The oldest known occurrence of the genus *Azolla* is uppermost Cretaceous.

Proteacidites retusus Anderson, 1960, and *Proteacidites thalmanni* Anderson, 1960, are restricted to the uppermost Cretaceous Lewis Shale and Kirtland Shale in the San Juan Basin of New Mexico (Anderson, 1960, p. 6, 7). North of where Anderson made his study the Fruitland Formation comes in as a tongue between the Lewis Shale and Kirtland Shale (Baltz, Ash, and Anderson, 1966, p. D19). *Proteacidites retusus* Anderson, 1960, is confined to the Hell Creek Formation in northwestern South Dakota (Stanley, 1965, p. 307, Table 4). *Proteacidites thalmanni* Anderson, 1960, is present in the Lancian age Upper Edmonton Formation of southern Alberta (Srivastava, 1966). *Proteacidites retusus* Anderson, 1960, and *Proteacidites thalmanni* Anderson, 1960, are abundant in the uppermost Maestrichtian but only rare in the Danian of the Fresno, California area (Drugg, 1967, p. 8, 9). See Table 6 for conspecific distribution of species of *Proteacidites*.

These five species strongly indicate a Lancian or Hell Creekian age for the Kaiparowits Formation. The information from Table 7 also indicates that the Kaiparowits Formation is Upper Cretaceous, and definitely not Lower Tertiary. These facts, plus the paleozoological evidence, to show that the Kaiparowits Formation is upper Lancian to Hell Creekian, or upper Maestrichtian, in age.

PROPOSED FUTURE RESEARCH

This initial palynological study of the Kaiparowits Formation has pointed out the richness and diversity of the contained microflora. It is urged that the middle and upper parts of the Kaiparowits Formation in the type locality be restudied for a more complete suite of palyniferous samples. These samples will be necessary in order to delimit the age and paleoecology of these units. The upper part should also be studied sedimentologically in order to gain a more full knowledge of paleoecology and sedimentary environments (which at present are incompletely understood).

A rich, diverse, well-preserved megaflora was observed during the course of the fieldwork for this study. The megaflora of the entire Kaiparowits Formation should be studied in detail and phylogenetic correlation between the mega-

TABLE 8
Distribution of Values of Index (2) from Table 7

Values of Index (2)	Geologic Unit(s)	Geographic Locality	Geologic Age	Author and Year
54	Tuscaloosa Group and Eutaw and McShan Formations	Central western Alabama	Cenomanian-Lower Turonian and Coniacian	Leopold and Pakiser, 1964
51	Straight Cliffs Sandstone	Central southern Utah	Coniacian	Orlansky, 1967
49	Vermejo Formation	Central Colorado	Hell Creekian (Maestrichtian)	Clarke, 1963
46	Upper Edmonton Formation	Southern Alberta	Lancian-Hell Creekian (Maestrichtian)	Srivastava, 1966
44	Dakota Group and Graneros Shale	Northeastern Colorado	Aptian (?)-Cenomanian	Pannella, 1963
44	Potomac Group	Eastern Maryland	Wealden-Albian	Brenner, 1963
41	Red Branch Member (Woodbine Formation)	Central southern Oklahoma	Cenomanian	Hedlund, 1966
39	Hell Creek and Fort Union Formations	Northwestern South Dakota	Hell Creekian-(Maestrichtian) Lower Paleocene	Stanley, 1965
39	Lower Colorado Group	Southern Alberta	Late Middle-Late Albian	Norris, 1967
39	Upper Moreno Formation	Fresno, California	Uppermost Maestrichtian-Danian	Drugg, 1967
37	Iles, Williams Fork, "Lewis," Lance, Mesaverde, Fort Union, and Lower Wasatch Formations	Northwestern Colorado	Lancian-Lower (Maestrichtian) Paleocene	Newman, 1961
37	Lewis Shale, Kirtland Shale, Ojo Alamo Sandstone, Nacimiento Formation	Northwestern New Mexico	Hell Creekian-(Maestrichtian) Lower Paleocene	Anderson, 1960

TABLE 8 (continued)

Values of Index (2)	Geologic Unit(s)	Geographic Locality	Geologic Age	Author and Year
34	Manville Group	Southern Alberta	Wealden	Singh, 1964
32	Brothers Creek Formation, Nanaimo Group, Burrard and Kitsilano Formations	SW B.C.-NW Washington	Upper Cretaceous Middle and Upper Eocene, Miocene	Hopkins, 1966
32	Burrard Formation	Southwestern British Columbia	Middle Eocene	Rouse, 1962
29	Frontier Formation	Western Wyoming	Cenomanian-Lower Coniacian	Upshaw, 1959
22	Fort Union Formation	Northwestern South Dakota	Paleocene	Gerhard, 1958

and microfloras undertaken. All geological aspects, including the flora of the Kaiparowits Formation, should be studied to the west of The Blues where the formation crops out in the Paunsaugunt Plateau and Zion Park regions.

The North Horn Formation, to the north of The Blues on the Wasatch Plateau, should be studied palynologically and sedimentologically. This project should be carried out in order to determine as exactly as possible how these two formations (Kaiparowits and North Horn) correlate and what their relationship is to their provenances. This study was initiated by Dr. Jess R. Bushman and the author during 1965 and is still in progress.

SUMMARY

The Kaiparowits Formation was measured, described, and collected in the type locality The Blues, Garfield County, Utah, during approximately one week of 1965 and one month of 1966. The measured section, which is a composite of a number of short increments, has a total thickness of 2,756 feet. A total of 375 samples were collected; 63 of them were macerated for palynomorphs. Ultimately 15 samples were used to palynologically document the section. Palynomorphs assignable to 80 species in 41 genera are described. One genus and 36 species are probably new but not formally named at this time.

The Kaiparowits Formation is tentatively divided into three assemblage zones. Zone 1, which includes Units 1A through 82, is defined by an assemblage of 23 palynomorphs. Zone 2, Units 83 through 96, is defined by the presence of six palynomorphs and absence of the 23 that define Zone 1. Zone 3, which is Unit 97, is defined by 3 species that are exclusive to the zone and by the presence of *Ericaceoipollenites rallus* Stanley, 1965, in abundance greater than 10 percent (in Zones 1 and 2 it constitutes less than 10 percent of the microflora).

Evidence is presented to show that the Kaiparowits Formation is Upper Cretaceous and not Lower Tertiary. An Upper Lancian to Hell Creekian age is indicated for this formation.

It is suggested that the lower 2,200 feet of the Kaiparowits Formation was deposited as a delta in a rapidly subsiding basin. A western provenance is indicated for the sediments, probably central or western Nevada. The Blues was in the fluvian portion of the delta and had a low, marshy-to-swampy topography. Uplands, as well as semiarid to arid conditions were present within the drainage basin. Sedimentation in the upper part was probably similar but is incompletely understood at present. Considerable volcanic activity in the region is indicated by considerable amounts of bentonitic material throughout the upper part of the formation. No evidence was observed either in the field or in the laboratory to indicate that any of the sediments were deposited under marine conditions.

Division BRYOPHYTA
Class MUSCI
Family SPHAGNACEAE
Genus SPHAGNUMSPORITES Raatz, 1937

Sporites POTONIÉ AND VENITZ, 1934 (in part), Arb. Inst. Paläobot. u. Petrogr. Brennsteine, v. 5, p. 11.
Sphagnumsporites RAATZ, 1937, Abb. preuss. geol. L.-A.N.F., v. 183, p. 9.
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Triletes COOKSON, 1947 (in part), British, Australian, and New Zealand Antarctic Res. Expedition. 1929-31, Rept. Ser. A, v. 2, pt. 8, p. 136.

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Stereisporites PFLUG in THOMSON AND PFLUG, 1953, Palaeontographica, v. 94, pt. B, p. 53.
Sphagnum LINNAEUS, COUPER, 1953, New Zealand Geol. Survey Paleont. Bull. 22, p. 18.
Sphagnumsporites RAATZ 1937, POTONIÉ, 1956, Beih. Geol. Jb., v. 23, p. 17.
Stereisporites PFLUG in THOMSON AND PFLUG 1952, 1953, POTONIÉ, 1956, Beih. Geol. Jb., v. 23, p. 18.
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Sphagnum (DILLENIUS) EHRHART, POTONIÉ, 1956, Beih. Geol. Jb., v. 23, p. 18.
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Sphagnum (DILLENIUS) EHRHART, DROZHASTCHICH AND PURTOVA in SAMOILOVITCH AND MTCHEDLISHVILI, 1961, Pollen and Spores from Western Siberia, p. 13.
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Stereisporites PFLUG 1953, DETTMANN, 1963, Proc. Royal Soc. Victoria, New Ser. v. 77, pt. 1, p. 25.
Sphagnumsporites RAATZ, 1937, SINGH, 1964, Research Council of Alberta Bull. 15, p. 38.
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Sphagnumsporites RAATZ, 1937, HEDLUND, 1966, Okla. Geol. Survey Bull. 112, p. 11.
Stereisporites PFLUG 1953, DRUGG, 1967, Palaeontographica, v. 120, pt. B, p. 37.
Stereisporites PFLUG, NORRIS, 1967, Palaeontographica, v. 120, pt. B, p. 87.

Type Species.—Not designated.

Description.—Trilete spore. Circular to subcircular equatorial outline. Walls moderately thick and psilate to variously sculptured. Laesurae distinct, about ½ the radius. Size usually small.

Discussion.—*Sphagnum* (bog or peat moss) is represented, at present, by several hundred species and is of worldwide distribution. Ecologically it is known to grow only in moist areas.

SPAGNUMSPORITES n. sp. A

Plate 1, fig. 1

Description.—Trilete spore. Circular to subcircular in equatorial outline. Walls 1.25μ thick and uniformly scabrate; ektexine twice as thick as endexine. Laesurae extend ⅔ to ¾ radius; Commissure is simple, narrow straight line; Margo is thickened, psilate, approximately 0.75μ wide. Overall size 18μ to 22μ.

Differential Diagnosis.—*Sphagnumsporites* n. sp. A is distinguished from other trilete spores in this sequence by its small size and circular equatorial outline.

Occurrence.—*Sphagnumsporites* n. sp. A is poorly distributed through the lower and upper portions of the Kaiparowits Formation.

Frequency.—Rare to frequent.

Figured Specimen.—BYU-Py-1, CFL-K-256+1250 ft. Orig. (2.2, 20.4).

Division PTERIDOPHYTA
Class PTEROPSIDA
Order FILICALES
Family CYATHEACEAE or DICKSONIACEAE (provisional assignment)
Genus CYATHIDITES Couper, 1953

Cyathidites COUPER, 1953, New Zealand Geol. Survey Paleont. Bull. 22, p. 27.
Cyathidites COUPER 1953, POTONIÉ, 1956, Beih. Geol. Jb., v. 23, p. 13.
Cyathidites COUPER, COUPER, 1958, Palaeontographica, v. 103, pt. B, p. 138.
Cyathidites COUPER 1953, POTONIÉ, 1960, Beih. Geol. Jb., v. 39, p. 28.
Cyathidites COUPER 1953, GROOT, PENNY AND GROOT, 1961, Palaeontographica, v. 108, pt. B, p. 128.
Cyathidites COUPER, POCOCK, 1962, Palaeontographica, v. 111, pt. B, p. 43.
Cyathidites COUPER, 1953, BRENNER, 1963, Maryland Dept. Geol., Mines Water Res. Bull. 27, p. 53, 60.
Cyathidites COUPER 1953, DETTMANN, 1963, Proc. Royal Soc. Victoria, New Ser. v. 77, pt. 1, p. 22.
Cyathidites COUPER, 1953, ENGELHARDT, 1964, Mississippi Geol., Econ. and Topo. Survey Bull. 104, p. 68.
Cyathidites COUPER, 1953, HARRIS, 1965, Palaeontographica, v. 115, pt. B, p. 79.
Cyathidites COUPER, 1953, SRIVASTAVA, 1966, Pollen et Spores, v. 8, no. 3, p. 507.
Cyathidites COUPER, 1953, HEDLUND, 1966, Okla. Geol. Survey Bull. 112, p. 11.
Cyathidites COUPER 1953, DRUGG, 1967, Palaeontographica, v. 120, pt. B, p. 36.
Cyathidites COUPER, NORRIS, 1967, Palaeontographica, v. 120, pt. B, p. 86.

Type Species.—*Cyathidites australis* Couper, 1953.

Description.—"Free, anisopolar, trilete, laesurae clearly defined, long, always over two thirds of the radius of the spore. Spores triangular, apices broadly rounded, and sides concave between apices in polar view. Both proximal and distal surfaces convex, distal markedly so. Exine psilate." Couper (1953, p. 27).

Botanical Affinities.—Family Cyatheaceae or Dicksoniaceae.

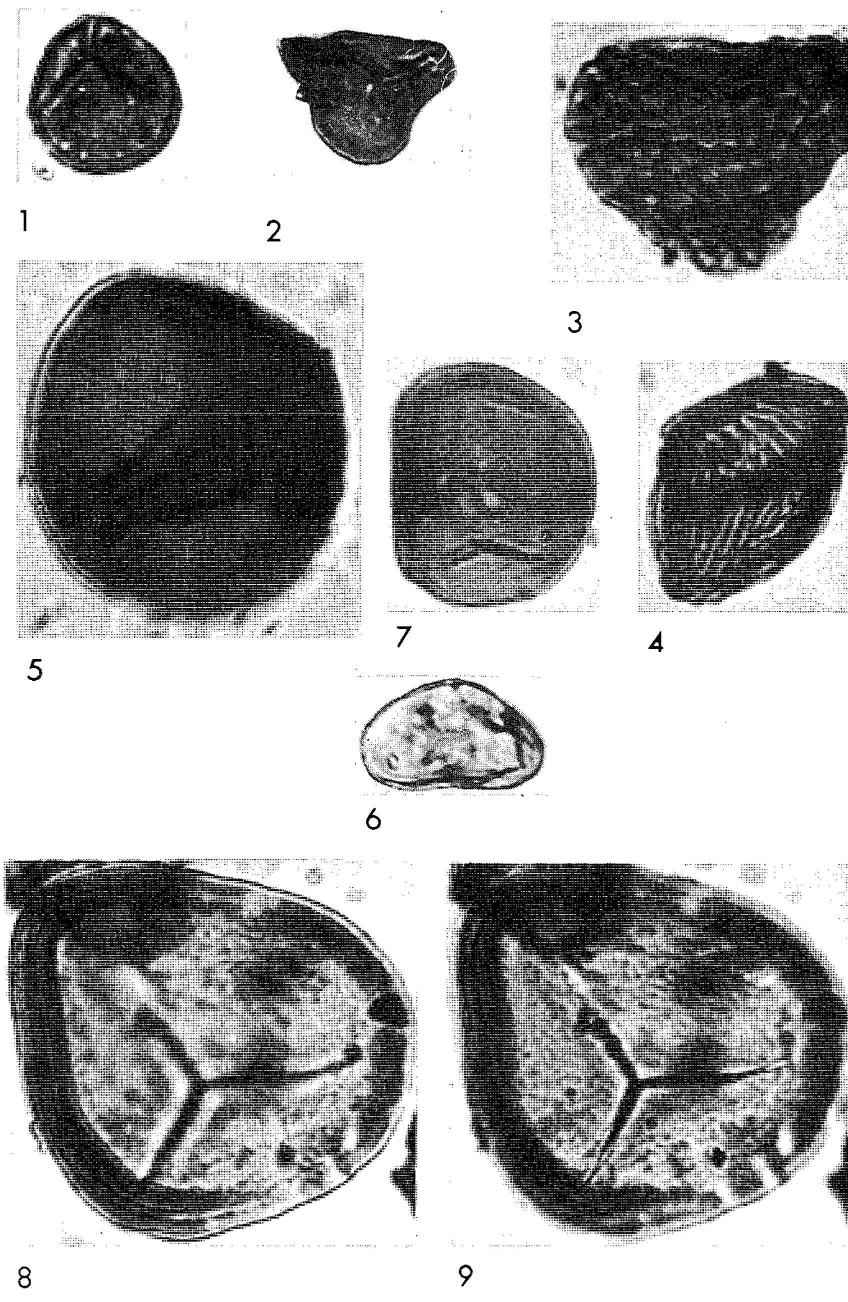
CYATHIDITES MINOR Couper, 1953
Plate 1, fig. 2

Cyathidites minor COUPER, 1953, New Zealand Geol. Survey Paleont. Bull. 22, p. 28, pl. 2, fig. 13.
Cyathidites minor COUPER (1953), KREMP, AMES AND GREBE, 1957, Catalog of Fossil Spores and Pollen, p. 120.
Cyathidites minor COUPER, COUPER, 1958, Palaeontographica, v. 103, pt. B, p. 139, pl. 20, figs. 9, 10.

EXPLANATION OF PLATE 1

FIG. 1.—*Sphagnumsporites* n. sp. A, X1000, polar view, BYU-Py-1, CFL-K-256+1250 ft. Orig. (2.2, 20.4).
FIG. 2.—*Cyathidites minor* Couper, 1953, X1000, polar view, BYU-Py-2, CFL-K-256 +1250 ft. Orig. (12.65, 6.75).
FIGS. 3, 4.—*Cicatricosisporites dorogensis* Potonié and Gelletich, 1933, X1000. *3.* polar view, BYU-Py-3, FL-P-166+91.5 ft. Orig. (20.6, 1.3). *4.* lateral view, BYU-Py-4, JRB-Ka-1+5 ft. Orig. (6.45, 13.8).
FIG. 5.—*Triplanosporites* n. sp. A, X1000, lateral view, BYU-Py-5, CFL-K-256+1250 ft. Orig. (4.6, 8.8).
FIG. 6.—*Laevigatosporites haardti* (Potonié and Venitz) Thomson and Pflug, 1953, X1000, lateral view, BYU-Py-6, CFL-K-256+1250 ft. Orig. (10.3, 9.75).
FIG. 7.—*Laevigatosporites ovatus* Wilson and Webster, 1946, X1000, lateral view, BYU-Py-7, CFL-K-256+1250 ft. D (30.0, 5.7).
FIGS. 8, 9.—*Leiotriletes* n. sp. A, X1000, polar view, BYU-Py18, JRB-Ka-1+5 ft. Orig. (1.15, 9.4).

PLATE 1



Cyathidites minor COUPER 1953, GROOT, PENNY AND GROOT, 1961, Palaeontographica, v. 108, pt. B, p. 128, 129, pl. 24, fig. 9.
Cyathidites minor COUPER, POCOCK, 1962, Palaeontographica, v. 111, pt. B, p. 43, pl. 4, figs. 57, 58.
Cyathidites minor COUPER, BRENNER, 1963, Maryland Dept. Geol., Mines Water Res. Bull. 27, p. 53, 54, pl. 11, fig. 7.
Cyathidites minor COUPER, 1953, DETTMANN, 1963, Proc. Royal Soc. Victoria, New Ser. v. 77, pt. 1, p. 22, 23, pl. 1, figs. 4, 5.
Cyathidites minor COUPER, 1953, ENGELHARDT, 1964, Mississippi Geol., Econ. and Topo. Survey Bull. 104, p. 68, 69, pl. 1, fig. 1.
Cyathidites minor COUPER, 1953, HARRIS, 1965, Palaeontographica, v. 115, pt. B, p. 79, pl. 24, fig. 12.
Cyathidites minor COUPER 1953, SRIVASTAVA, 1966, Pollen et Spores, v. 8, no. 3, p. 507, pl. 1, figs. 8, 16.
Cyathidites minor COUPER, 1953, HEDLUND, 1966, Okla. Geol. Survey Bull. 112, p. 12, pl. 2, fig. 2.
Cyathidites minor COUPER, NORRIS, 1967, Palaeontographica, v. 120, pt. B, p. 86, pl. 10, fig. 2.

Description.—Trilete spore. Triangular with broadly rounded corners and straight to slightly concave sides in equatorial outline. Wall 1μ to 1.5μ thick and psilate. Laesurae are straight and extend almost to equator; Commissure gapes up to 0.5μ at the pole and tapers uniformly to the end where it is closed; Margo is thickened, psilate, and narrow. Overall size 23μ to 30μ. These spores crush readily.

Differential Diagnosis.—The forms in these samples are slightly smaller than those described by Couper. *Cyathidites minor* Couper, 1953, is distinguished from other trilete spores in this sequence by its small to moderate size, psilate walls, triangular equatorial outline, and slightly gaping commissures bordered by narrow margos.

Occurrence.—*Cyathidites minor* Couper, 1953, is present in the lower and middle parts of the lower portion and upper portion of the Kaiparowits Formation.

Frequency.—Rare to frequent.

Figured Specimen.—BYU-Py-2, CFL-K-256+1250 ft. Orig. (12.65, 6.75).

Family SCHIZAEACEAE (provisional assignment)
Genus CICATRICOSISPORITES Potonié and Gelletich, 1933 Sitz. Ber.

Cicatricosisporites POTONIÉ AND GELLETICH, 1933, Sitz. Ber. Ges. Naturf. Freunde, Berlin, p. 522.
Mohriodites THIERGART, 1950, Geol. Jb., v. 65, p. 84.
Mohrioisporites POTONIÉ, 1951, Palaeontographica, v. 91, pt. 8, p. 114.
Cicatricosisporites POTONIÉ AND GELLETICH, THOMSON AND PFLUG, 1953, Palaeontographica, v. 94, pt. B, p. 48.
Mohriosporites COOKSON, 1953, Australian Jour. Bot., v. 1, no. 3, p. 470.
Cicatricosisporites POTONIÉ AND GELLETICH, DELCOURT AND SPRUMONT, 1955, Mem. Soc. Belge Géol., Nouv. Ser., v. 4, no. 5, p. 21.
Cicatricosisporites POTONIÉ AND GELLETICH 1933, POTONIÉ, 1956, Beih. Geol. Jb., v. 23, p. 47, 48.
Cicatricosisporites POTONIÉ AND GELLETICH, COUPER, 1958, Palaeontographica, v. 103, pt. B, p. 136.
Cicatricosisporites POTONIÉ AND GELLETICH, 1933, GROOT AND PENNY, 1960, Micropaleontology, v. 6, no. 2, p. 230.
Cicatricosisporites POTONIÉ AND GELLETICH 1933, POTONIÉ, 1960, Beih. Geol. Jb., v. 39, p. 50.
Cicatricosisporites POTONIÉ AND GELLETICH 1933, GROOT, PENNY AND GROOT, 1961, Palaeontographica, v. 108, pt. B, p. 128.
Mohria SWARTZ, 1806, MARKOVA in SAMOILVITCH AND MTCHEDLISHVILI, 1961 (in part), Pollen and Spores from Western Siberia, p. 84.
Cicatricosisporites POTONIÉ AND GELLETICH, POCOCK, 1962, Palaeontographica, v. 111, pt. B, p. 39.
Cicatricosisporites POTONIÉ AND GELLETICH, 1932, BRENNER, 1963, Maryland Dept. Geol., Mines and Water Resources Bull. 27, p. 47.

Cicatricosisporites POTONIÉ AND GELLETICH, 1933, DETTMANN, 1963, Proc. Royal Soc. Victoria, New Ser. v. 77, pt. 1, p. 52, 53.
Cicatricosisporites POTONIÉ AND GELLETICH, 1933, SINGH, 1964, Research Council of Alberta Bull. 15, p. 56.
Cicatricosisporites POTONIÉ AND GELLETICH, 1933, ENGELHARDT, 1964, Miss. Geol., Econ. and Topo. Survey Bull. 104, p. 69.
Cicatricosisporites POTONIÉ AND GELLETICH, 1933, HARRIS, 1965, Palaeontographica, v. 115, pt. B, p. 11.
Cicatricosisporites POTONIÉ AND GELLETICH, 1933, HEDLUND, 1966, Okla. Geol. Survey Bull. 112, p. 18.
Cicatricosisporites POTONIÉ AND GELLETICH, 1933, DRUGG, 1967, Palaeontographica, v. 120, pt. B, p. 39.
Cicatricosisporites POTONIÉ AND GELLETICH, NORRIS, 1967, Palaeontographica, v. 120, pt. B, p. 92.

Type Species.—Cicatricosisporites dorogensis Potonié and Gelletich, 1933.

Description.—Trilete spores. Triangular with rounded corners and straight to concave to convex sides in equatorial outline. Distal surface is convex and proximal surface flattened in lateral view. Exine has a canaliculate to cicatricose sculpture. Muri are essentially uniform height and width and develop generally parallel to each other and to the equator. They more or less converge toward the apices of the triangle which are not thickened. Outline of grain is uniformly crenulate.

Often opposing surfaces are observed in the same view giving the illusion of a criss-cross wall sculpture.

Botanical Affinities.—Schizaeaceae?

CICATRICOSISPORITES DOROGENSIS Potonié and Gelletich, 1933

Plate 1, figs. 3, 4

Cicatricosisporites dorogensis, POTONIÉ AND GELLETICH, 1933, Sitz. Ber. Ges. Naturf. Freunde, Berlin, v. 33, p. 522, pl. 1, figs. 1-5.
Sporites dorogensis (POTONIÉ AND GELLETICH 1933) POTONIÉ, 1934, Arb. Inst. Paläobot. u. Petrogr. Brennsteine, v. 4, p. 40, pl. 1, figs. 21, 23.
Mohriosporites dorogenis (POTONIÉ AND GELLETICH, POTONIÉ, 1951, Palaeontographica, v. 91, pl. 20, fig. 14.
Cicatricosisporites dorogensis POTONIÉ, THOMSON AND PFLUG, 1953, Palaeontographica, v. 94, pt. B, p. 48, pl. 1, fig. 1.
Cicatricosisporites cf. *dorogensis* POTONIÉ AND GELLETICH, DELCOURT AND SPRUMONT, 1955, Mem. Soc. Belge Géol., Nouv. Ser., v. 4, no. 5, p. 21.
Cicatricosisporites dorogensis POTONIÉ AND GELLETICH 1933, POTONIÉ, 1956, Beih. Geol. Jb., v. 23, p. 47, 48, pl. 7, fig. 60.
Cicatricosisporites dorogensis POTONIÉ AND GELLETICH, COUPER, 1958, Palaeontographica, v. 103, pt. B, p. 136, pl. 17, figs. 10-12.
Cicatricosisporites dorogenis POTONIÉ AND GELLETICH, GROOT AND PENNY, 1960, Micropaleontology, v. 6, no. 2, p. 230, pl. 1, fig. 2.
Sporites dorogensis (POTONIÉ AND GELLETICH 1933) POTONIÉ (1934), KREMP AND AMES, 1961, Catalog of Fossil Spores and Pollen, v. 14, p. 75.
Cicatricosisporis dorogensis POTONIÉ AND GELLETICH 1933, GROOT, PENNY AND GROOT, 1961, Palaeontographica, v. 108, pt. B, p. 128, pl. 24, fig. 8.
Mohria dorogensis (POTONIÉ et GELLETISCH) MARKOVA in SAMOILOVITCH AND MTCHEDLISHVILI, 1961, Pollen and Spores from Western Siberia, p. 86, pl. 22, fig. 4.
Cicatricosisporites dorogensis POTONIÉ AND GELLETICH, POCOCK, 1962, Palaeontographica, v. 111, pt. B, p. 39, 40, pl. 2, figs. 35, 36; pl. 3, figs. 37-41.
Cicatricosisporites dorogensis POTONIÉ AND GELLETICH, emended, KEDVES, BRENNER, 1963, Maryland Dept. Geol., Mines Water Res. Bull. 27, p. 49, pl. 8, fig. 4.
Cicatricosi-sporites dorogensis POTONIÉ AND GELLETICH (1932), AMES AND KREMP, 1964, Catalog of Fossil Spores and Pollen, v. 21, p. 36.
Cicatricosisporites dorogensis POTONIÉ AND GELLETICH, 1933, SINGH, 1964, Research Council Alberta Bull. 15, p. 57, pl. 6, fig. 1.
Cicatricosisporites dorogensis POTONIÉ AND GELLETICH, 1933, ENGELHARDT, 1964, Miss. Geol., Econ. and Topo. Survey Bull. 104, p. 69, pl. 1, fig. 4.

Cicatricosisporites dorogensis POTONIÉ AND GELLETICH, 1933, HEDLUND, 1965, Okla., Geol. Survey Bull. 112, p. 18, 19, pl. 3, figs. 5a, b.
Cicatricosisporites dorogensis POTONIÉ AND GELLETICH 1933, DRUGG, 1967, Palaeontographica, v. 120, pt. B, p. 39, pl. 6, fig. 30.

Description.—Trilete spore. Triangular with rounded apices and straight to slightly concave or convex sides in equatorial outline; distal surface broadly convex and proximal surface flattened in lateral outline. Distal walls $1\frac{1}{2}\mu$ to 3μ thick and composed of muri in a striate to slightly rugulate pattern, muri 1μ to 2.5μ high and centers 2μ to 5μ apart, form a sine curve in cross section. Proximal walls are approximately 1μ thick and psilate to scabrate. Laesurae extend mostly to the equator; commissure is straight and narrow; margo is thickened and narrow. Overall equatorial diameter is 25μ to 50μ. These grains are usually observed in lateral view.

Differential Diagnosis.—*Cicatricosisporites dorogensis* Potonié and Gelletich, 1933, is distinguished from other trilete spores in this sequence by muri arranged into a striate wall structure.

Occurrence.—*Cicatricosisporites dorogensis* Potonié and Gelletich, 1933, is present in the lower portion of the Kaiparowits Formation.

Frequency.—Rare to frequent.

Figured Specimens.—BYU-Py-3, FL-P-166+91.5 ft. Orig. (20.6, 1.3) BYU-Py-4, JRB-Ka-1+5 ft. Orig. (6.45, 13.8).

Genus TRIPLANOSPORITES Pflug, 1957

Triplanosporites PFLUG, 1952, Paläontol. z., v. 26, p. 113.
Triplanosporites PFLUG, emended PFLUG in THOMSON AND PFLUG, 1953, Palaeontographica, v. 94, pt. B, p. 58.
Triplanosporites PFLUG in THOMSON AND PFLUG 1952, 1953, POTONIÉ, 1956. Beih. Geol. Jb., v. 23, p. 16.
Triplanosporites PFLUG, KRUTZSCH, 1959, Geologie, v. 8, nos. 21, 22, p. 83.
Triplanosporites PFLUG, KRUTZSCH, 1962, Atlas, pt. 1, p. 8.
Triplanosporites PFLUG, 1952, HARRIS, 1965, Palaeontographica, v. 115, pt. B, p. 81.
Triplanosporites PFLUG, 1952, STANLEY, 1965, Bull. Amer. Paleont., v. 49, no. 222, p. 263.

Type Species.—*Triplanosporites sinuosus* Pflug in Thomson and Pflug, 1953.

Description.—Trilete spore. Ovaloid in polar outline, polar axis longer than equatorial axis. Exine psilate to perhaps scabrate. Laesurae are distinct and reach to, or almost to, the periphery.

Differential Diagnosis.—*Triplanosporites* Pflug, 1952, is distinguished by the longer polar axis and shorter equatorial axis.

Botanical Affinities.—Schizaeaceae?

TRIPLANOSPORITES n. sp. A

Plate 1, fig. 5

Description.—Trilete spore. Ovaloid to subcircular in polar outline. Walls approximately 2.5μ thick, slightly thicker in the proximal polar area, ektexine is psilate except contact areas which may be scabrate. Laesurae are straight and narrow and extend to, or almost to, the equator; commissure is a straight, narrow slit; no margo is present. Overall size 45μ to 65μ. *T.* n. sp. A has a polar diameter only slightly longer than the equatorial diameter.

Differential Diagnosis.—*Triplanosporites* n. sp. A is the only form in this sequence that is consistently observed in polar outline. Its extremely long laesurae and thick walls distinguish it also.

Occurrence.—*Triplanosporites* n. sp. A is present in the lower and middle parts of the lower portions of the Kaiparowits Formation.

Frequency.—Rare to frequent.

Figured Specimens.—BYU-Py-5, CFL-K-256+1250 ft. Orig. (4.6, 8.8).

Family POLYPODIACEAE (provisional assignment)
Genus LAFVIGATOSPORITES (Ibrahim[8] emended Schopf, Wilson, and Bentall, 1944.

Sporonites IBRAHIM, in POTONIÉ, IBRAHIM AND LOOSE, 1932, Neues Jb. Min., Geol. Palaont., v. 67, pt. B. p. 448.
Laevigato-sporites (IBRAHIM) IBRAHIM 1933, doctoral dissertation, Tech. Hochschule zu Berlin (privately published), p. 39, 40.
Sporites POTONIÉ, 1893, in POTONIÉ AND VENITZ, 1934, Arb. Inst. Paläobot. u. Petrogr. Brennstein, v. 5, p. 13.
Polypodoumsporites RAATZ, 1937, Abb. preuss. geol. L.-A.N.F., v. 183, p. 10.
Polypodiaceaesporites (POTONIÉ AND VENITZ) THIERGART, 1938, Jb. preuss. geol. L.A., v. 58, p. 297.
Phaseolites WILSON AND COE, 1940, Am. Midland Nat., v. 23, no. 1, p. 182.
Laevigatosporites (IBRAHIM), emended SCHOPF, WILSON AND BENTALL, 1944, Illinois Geol. Survey Rept. Invest. No. 91, p. 36, 37.
Monolites ERDTMAN, 1947, Svensk Bot. Tidskrift, v. 41. pt. 1, p. 110.
Laevigato-sporites (IBRAHIM), emended SCHOPE, WILSON AND BENTALL, 1944, KOSANKE, 1950, Illinois Geol. Survey Bull. No. 74, p. 27.
Laevigatosporites IBRAHIM, POTONIÉ AND KREMP, 1954, Geol. Jb., v. 69, p. 165.
Monolites ERDTMAN, emended POTONIÉ, 1956, Beih. Geol. Jb., v. 23, p. 77.
Polypodiaceaesporites THIERGART, 1938, POTONIÉ, 1956, Geol. Jb., v3, p. 76.
Laevigatosporites IBRAHIM, POTONIÉ, 1956, Beih. Geol. Jb., v. 23, p. 75.
Laevigatosporites IBRAHIM, POTONIÉ AND KREMP, 1956, Palaeontographica, v. 99, pt. B, II, p. 137.
Laevigatosporites IBRAHIM, MANUM, 1962, Norsk Polarinstitutt Skrifter, no. 125, p. 20.
Laevigatosporites IBRAHIM, emended SCHOPF, WILSON, AND BENTALL, 1944, SINGH, 1964, Research Council of Alberta Bull. 15, p. 98, 99.
Laevigatosporites IBRAHIM, emended SCHOPE, WILSON AND BENTALL, 1944, in STANLEY, 1965, Bull. Amer. Paleont., v. 49, no. 222, p. 251.

Type Species.—*Laevigatosporites vulgaris* (Ibrahim), Ibrahim, 1933.

Description.—Monolete spores. Reniform to suboval in lateral equatorial outline. Walls psilate and of moderate thickness. Laesura distinct and straight. Overall size moderate.

Discussion.—Potonié (1956, p. 75, 76) proposed to reserve the organ generic name *Laevigatosporites* exclusively for Paleozoic psilate monolete spores and that all post-Paleozoic psilate monolete spores be placed in the organ genus *Polypodiaceaesporites* Thiergart. Potonié (1956, p. 76) claimed that *Laevigatosporites* Ibrahim ". . . . is differentiated from younger spores of more or less similar outline whose exine is usually less rigid." Were this correct it would still be essentially impossible to differentiate between Paleozoic and younger *Laevigato*-type spores. Stanley (1965, p. 251) and Manum (1962, p. 20) indicate that until a more clear definition is set forth it is necessary to place *Laevigato*-type spores of all ages into the same organ genus, *Laevigatosporites.* Slight differences of wall rigidity is, at best, poor criterion for differentiation of organ genera.

Differential Diagnosis.—*Laevigatosporites* is distinguished from other monolete organ genera on the basis of its psilate exine.

Botanical Affinities.—*Laevigatosporites* is generally attributed to the fern family Polypodiaceae which produces, among other types of spores, bean-shaped monolete spores. The Polypodiaceae at present have worldwide distribution for they are found ". . . over most of the land areas of the earth, especially abundant in forests and humid areas, but occurring in almost all floristic areas or zones from desert to rain forests from tropics to arctic or antarctic" (Lawrence, 1951, p. 349). No specific climate can therefore be postulated for the Kaiparowits Formation by the occurrence of *Laevigatosporites.* Schopf, Wilson, and Bentall (1944, p. 36) related the *Laevigatosporites* forms to at least three Paleozoic plant groups, the Filicineae, Sphenopsida, and the Pteridospermae.

LAEVIGATOSPORITES HAARDTI (Potonié and Venitz) Thomson and Pflug, 1953

Plate 1, fig. 6

Sporites haardti POTONIÉ AND VENITZ, 1934, Arb. Inst. Paläobot. u. Petrogr. Brennsteine, v. 5, p. 13, pl. 1, fig. 13.

Laevigatosporites gracilis WILSON AND WEBSTER, 1946, Amer. Jour. Bot., v. 33, p. 273, fig. 4.
Monolites minor COOKSON, 1947, British, Australian, and New Zealand Antarctic Res. Expedition. 1929-31, Rept. Ser. A., v. 2, pt. 8, p. 135, pl. 15, fig. 57.
Laevigatosporites haardti (POTONIÉ AND VENITZ), THOMSON AND PFLUG, 1953, Palaeontographica, v. 94, pt. B, p. 59, pl. 3, figs. 27-38.
Laevigatosporites haardti (POTONIÉ AND VENITZ), THOMSON AND PFLUG, 1953, MANUM, 1962, Norsk Polarinstitutt Skrifter, no. 125, p. 21, pl. 1, fig. 1.
Laevigatosporites haardti (POTONIÉ AND VENITZ), THOMSON AND PFLUG, 1953, STANLEY, 1965, Bull. Am. Paleont., v. 49, no. 222, p. 252, pl. 32 ,figs. 1-3.

Description.—Monolete spore. Reniform in lateral equatorial view. Walls 1μ to 1.5μ thick and psilate. Laesura is simple and straight and extends $\frac{2}{3}$ to $\frac{3}{4}$ the length of the grain; commissure is simple, narrow, and straight; margo is thickened and approximately 0.5μ wide. Major diameter 20μ to 35μ.

Differential Diagnosis.—This species is distinguished from *Laevigatosporites ovatus* Wilson and Webster, the only other similar form encountered in these samples, by its characteristically reniform outline and the presence of the thickened margo.

Occurrence.—*Laevigatosporites haardti* (Pontié and Venitz), Thomson and Pflug is present throughout the Kaiparowits Formation.

Frequency.—Rare to common.

Figured Specimen.—BYU-Py-6, CFL-K-256+1250 ft. Orig. (10.3, 9.75).

LAEVIGATOSPORITES OVATUS Wilson and Webster, 1946

Plate 1, fig. 7

Laevigatosporites ovatus WILSON AND WEBSTER, 1946, Am. Jour. Bot., v. 33, p. 273, fig. 5.
Monolites major COOKSON, 1947, British, Australian, and New Zealand Antarctic Res. Expedition. 1929-31, Rept. Ser. A., v. 2, pt. 8, p. 135.
Laevigatosporites discordatus PFLUG in THOMSON AND PFLUG, 1953, Palaeontographica, v. 94, pt. B, p. 59, pl. 3, figs. 39-44.
Laevigatosporites ovatus WILSON AND WEBSTER, STANLEY, 1965, Bull. Am. Paleont., v. 49, no. 222, p. 253, pl. 32, figs. 4-6.

Description.—Monolete spore. Broadly reniform to circular with one flattened side in polar area in lateral equatorial view. Walls 0.5μ to 1μ thick; slight thickening in area of laesura; exine is psilate. Laesura is a straight, narrow slit that extends $\frac{1}{3}$ to $\frac{1}{2}$ the length of the grain. Laesura occurs on the flattened side of the grain. Major diameter 25μ to 45μ. Grains may have secondary folds in the exine.

Differential Diagnosis.—This species is distinguished from *Laevigatosporites haardti* (Potonié and Venitz) Thomson and Pflug, 1953, by its much more circular outline, absence of a margo, and shorter leasura length. Chance of preservation and orientation can make it almost impossible to distinguish these two species.

Occurrence.—*Laevigatosporites ovatus* Wilson and Webster, 1946, is present only in the lower portion of the Kaiparowits Formation.

Frequency.—Rare to frequent.

Figured Specimen.—BYU-Py-7, CFL-K-256+1250 ft. D(30.0, 5.7).

Genus LEIOTRILETES Naumova, ex Potonié and Kremp, 1954

Leiotriletes NAUMOVA, 1937, Report 17th Int. Geol. Congress, v. 1, p. 355.
Leiotriletes NAUMOVA ex POTONIÉ AND KREMP, 1954, Geol. Jb., v. 69, p. 120.
Leiotriletes NAUMOVA ex POTONIÉ AND KREMP, 1955, Palaeontographica, v. 98, pt. B, p. 36.
Leiotriletes (NAUMOVA 1937) POTONIÉ AND KREMP 1954, POTONIÉ, 1956, Beih. Geol. Jb., v. 23, p. 13.

Leiotriletes (NAUMOVA), POTONIÉ AND KREMP, KRUTZSCH, 1959, Geologie, v. 8, nos. 21, 22, p. 56.
Leiotriletes (NAUMOVA 1937?, 1939) POTONIÉ AND KREMP 1954, POTONIÉ, 1960, Beih. Geol. Jb., v. 39, p. 26, 27.
Leiotriletes (NAUMOVA), POTONIÉ AND KREMP, KRUTZSCH, 1962, Atlas, pt. 1, p. 7.
Leiotriletes NAUMOVA, ex POTONIÉ AND KREMP, 1954, STANLEY, 1965, Bull. Amer. Paleont., v. 49, no. 222, p. 253, 254.
Type Species.—Leiotriletes sphaerotriangulus (Loose), Potonié and Kremp, 1954, Krutzsch, 1962.

Description.—Trilete spore. Semitriangular to subround in equatorial outline. Walls thin to moderate; sculpture lacking or poorly developed. Laesurae distinct and approximately $\frac{3}{4}$ radius.

Differential Diagnosis.—Leiotriletes Naumova, ex Potonié and Kremp, 1954, is distinguished by its psilate walls and thin laesurae with no margo.

Botanical Affinities.—Polypodiaceae (provisional assignment).

LEIOTRILETES PSEUDOMAXIMUS (Pflug and Thomson), Stanley, 1965

Plate 2, fig. 1

Laevigatisporites pseudomaximus PFLUG AND THOMSON in THOMSON AND PFLUG, 1953, Palaeontographica, v. 94, pt. B, p. 54, pl. 2, figs. 18-23.
Laevigatisporites pseudomaximus PFLUG AND THOMSON in THOMSON AND
Laevigatisporites pseudomaximus PFLUG AND THOMSON in THOMSON AND PFLUG (1953), KREMP, AMES AND GREBE, 1958, Catalog of Fossil Spores and Pollen, v. 3, p. 21.
Leiotriletes maxoides maximus KRUTZSCH, 1962, Atlas, pt. 1, p. 20.
Leiotriletes pseudomaximus (PFLUG AND THOMSON), STANLEY, 1965, Bull. Amer. Paleont., v. 49, no. 222, p. 254, pl. 31, figs. 10-12.

Description.—Trilete spore. Semitriangular to subround with broadly rounded corners and straight to convex to concave sides in equatorial view. Walls approximately 1.5μ thick and psilate. Laesurae are straight to slightly curved slits that extend $\frac{2}{3}$ to $\frac{3}{4}$ the radius. No margo is present. Overall size 45μ to 55μ. Secondary folds may be present.

Differential Diagnosis.—Leiotriletes pseudomaximus (Pflug and Thomson), Stanley, 1965, is distinguished by its psilate walls and simple laesurae with no margo.

Occurrence.—Leiotriletes pseudomaximus (Pflug and Thomson), Stanley, 1965, is present throughout the lower and upper portions of the Kaiparowits Formation.

Frequency.—Rare to frequent.

Figured Specimen.—BYU-Py-9, CFL-K-256+1250 ft. Orig. (12.4, 7.9).

LEIOTRILETES n. sp. A

Plate 1, figs. 8, 9

Description.—Trilete spore. Semitriangular with broadly rounded apices and straight to slightly concave or convex sides in equatorial outline. Walls 2.5μ to 3μ thick and uniformly scabrate. Laesurae are straight to slightly curved and extend $\frac{2}{3}$ to $\frac{3}{4}$ of the radius; commissure is a simple narrow slit; no margo is present. Overall size 35μ to 60μ. Grains may be folded.

Differential Diagnosis.—Leiotriletes n. sp. A is distinguished by its relatively heavy scabrate walls and long laesurae which lack a margo.

Occurrence.—Leiotriletes n. sp. A is present in the lower part of the lower portion and in the upper portion of the Kaiparowits Formation.

Frequency.—Rare to frequent.

Figured Specimen.—BYU-Py-8, JRB-Ka-1+5 ft. Orig. (1.15, 9.4).

Family SALVINIACEAE
Genus AZOLLA Lamarck, 1783

Azolla LAMARCK, ARNOLD, 1955, Cont. Mus. Paleont., Univ. Mich., v. 12, no. 4, p. 41.
Azolla LAMARCK, POTONIÉ, 1956, Beih. Geol. Jb., v. 23, p. 84.
Azolla LAMARCK, DUIGAN AND COOKSON, 1956, Proc. Royal Soc. Victoria, New Ser. v. 69, p. 5.
Azolla LAMARCK, POTONIÉ, 1958, Beih. Geol. Jb., v. 31, p. 33, 34.
Azolla LAMARCK, DOROFEEV, 1959, Botanicheskij Zhurnal SSSR. v. 44, p. 1756.
Azolla, FLORSCHÜTZ ET MENÉNDEZ AMOR, 1960, Pollen et Spores, v. 2, no. 2, p. 285.
Azolla POTONIÉ, 1961, Pollen et Spores, v. 3, no. 1, p. 67.
Azolla, TSCHUDY, 1961, Wyoming Geol. Assoc. Guidebook, p. 55.
Azolla LAMARCK, 1873, ROUSE, 1962, Micropaleontology, v. 8, no. 2, p. 198, 199.
Azolla LAMARCK, POTONIÉ, 1962, Beih. Geol. Jb., v. 52, p. 119, 120.
Azolla LAMARCK, KRUTZSCH, 1962, Atlas, pt. 1, p. 70, 71.
Azolla LAMARCK (1783), HILLS AND WEINER, 1965, Micropaleontology, v. 11, no. 2, p. 255.
Azolla LAMARCK, 1783, STANLEY, 1965, Bull. Amer. Paleont., v. 49, no. 222, p. 256.
Azolla LAMARCK 1783, SRIVASTAVA, 1966, Pollen et Spores ,v. 8, no. 3, p. 508.
Azolla LAMARCK 1783, HILLS AND GOPAL, 1967, Canadian Jour. Bot., v. 45, no. 8, p. 1182.

Type Species.—None designated.

Description.—Megaspores-trilete; overall size 200μ to 400μ; a gula-like structure is present on the proximal pole, and the entire megaspore is covered by a perispore. Microspore-trilete; overall size approximately 30μ; exine is psilate to scabrate. Massula-oval to round in outline; overall size 100μ to more than 500μ; characterized by moderately long shaft-like appendages bearing anchor-shaped distal tips (glochidia).

Botanical Affinities.—*Azolla* Lamarck, 1783, is one of the two extant genera belonging to family Salviniaceae.

AZOLLA CRETACEA Stanley, 1965
Plate 2, figs. 2-4

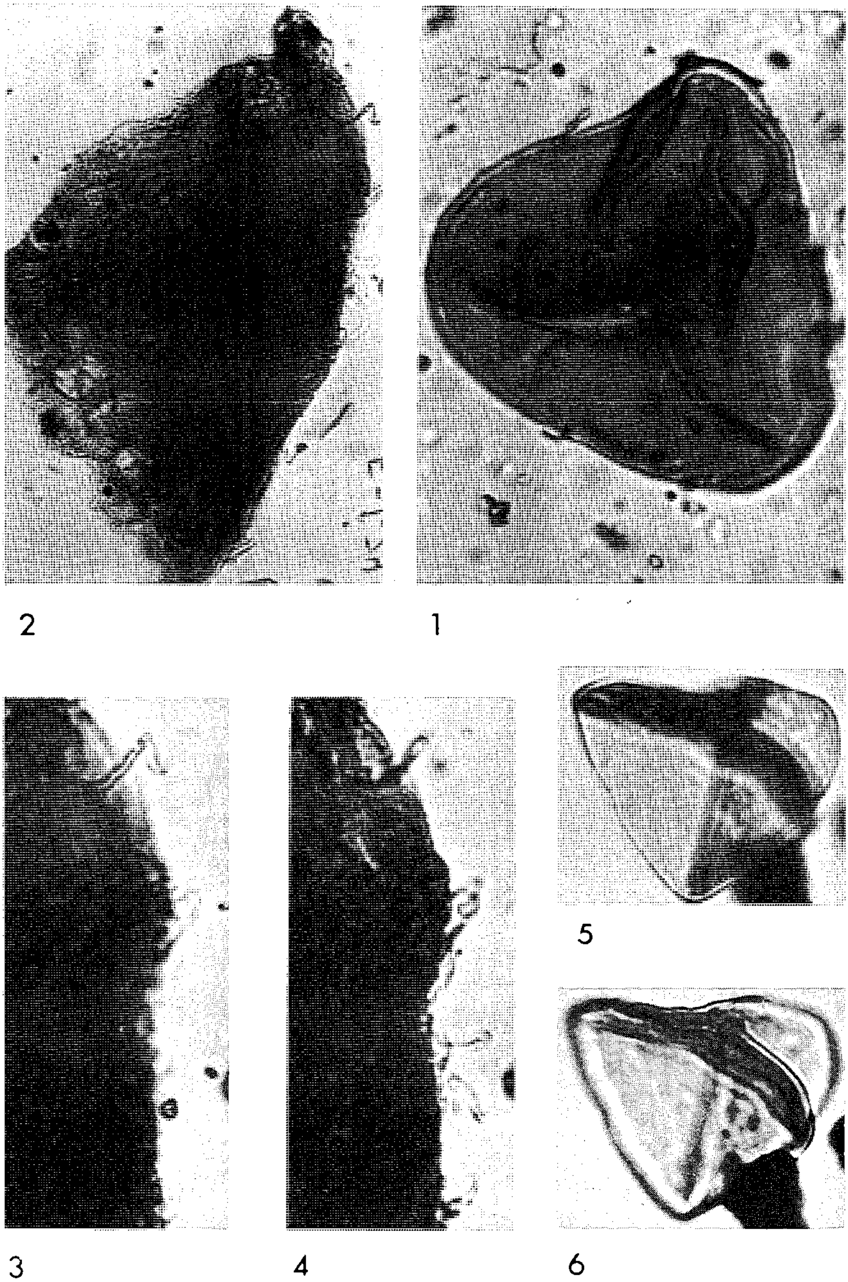
Azolla cretacea STANLEY, 1965, Bull. Amer. Paleont., v. 49, no. 222, p. 256, 257, pl. 33, figs. 1-5.
Azolla cretacea STANLEY, 1965, SRIVASTAVA, 1966, Pollen et Spores, v. 8, no. 3, p. 508, 510, pl. 3, figs. 12-15.
Azolla creacea STANLEY, 1965, SRIVASTAVA, 1967, Palaeogeog., Palaeoclim., Palaeoecology, v. 3, no. 1, p. 139, pl. 1, fig. P.

Description.—Massulae small for *Azolla* microspore massulae, 90μ to 175μ. Glochidia up to 25μ long and 0.75μ to 1μ in diameter; uniform except the proximal end which is narrow. An anchor-shaped structure is present on the distal end of the glochidia. The flukes are 2μ to 3μ at their widest part; they do not join the glochidia quite symmetrically. Glochidia are not segmented. Microspores are 28μ to 32μ diameter and appear to have psilate to scabrate walls. No microspores were observed outside of the massulae (even though a special effort was made to locate some). No megaspores were observed, probably because they were not transferred to the slides due to their large size.

EXPLANATION OF PLATE 2

FIG. 1.—*Leiotriletes pseudomaximus* (Pflug and Thomson), Stanley, 1965, X1000, polar view, BYU-Py-9, CFL-K-256+1250 ft. Orig. (12.4, 7.9).
FIGS. 2-4.—*Azolla cretacea* Stanley, 1965, BYU-Py-10, JRB-Ka-1+5 ft. Orig. (31.05, 12.35). *2.* X500, complete microspore massula. *3,4.* X1000, close-up of glochidia on microspore massula in Fig. 2.
FIGS. 5, 6.—*Concavisporites* n. sp. A, X1000, oblique view, BYU-Py-11, JRB-Ka-1+5 ft. Orig. (31.0, 3.3). *5.* focus on distal surface. *6.* focus on proximal surface.

PLATE 2



Occurrence.—*Azolla cretacea* Stanley, 1965, is present in the lower portion of the Kaiparowits Formation.

Frequency.—Rare.

Figured Specimen.—BYU-Py-10, JRB-Ka-1+5 ft. Orig. (31.05, 12.35).

Order FILICALES-INCERTAE SEDIS
Genus BALMEISPORITES Cookson and Dettmann, 1958

Balmeisporites COOKSON AND DETTMANN, 1958, Micropaleontology, v. 4, no. 1, p. 42.
Balmeisporites COOKSON AND DETTMANN 1958, POTONIÉ, 1960, Beih. Geol. Jb., v. 39, p. 51, 52.
Balmeisporites COOKSON AND DETTMANN 1958, DETTMANN, 1963, Proc. Royal Soc. Victoria, New Ser. v. 77, pt. 1, p. 56.
Balmeisporites COOKSON AND DETTMANN, 1958, HEDLUND, 1966, Okla. Geol. Survey Bull. 112, p. 15.
Balmeisporites COOKSON, TSCHUDY, 1961, Wyoming Geol. Assoc. Guidebook, p. 55.
Balmeisporites COOKSON et DETTMANN 1958, DEAK AND COMBAZ, 1967, Rev. Micropaléont., v. 10, no. 2, p. 76.

Type Species.—*Balmeisporites holodictus* Cookson and Dettmann, 1958.
Description.—"'Megaspore' consisting of a spherical body, 70-135μ in equatorial diameter, with three equidistant reticulate equatorial outgrowths of the exoexine and a more prominent neck at the proximal pole composed of three united leaf-like segments, which surround the tetrad scar." (Cookson and Dettmann, 1958, p. 42). Dettmann (1963, p. 56) stated "Transverse sections confirm that the stratified exine forms the surface reticulum and the three, highly elevated laesurate lips (neck segments of Cookson and Dettmann 1958a, p. 42); the lips are developed at the laesurate margins and not in the interlaesurate regions as shown in Cookson and Dettmann's Fig. 3."
Botanical Affinities.—Filicales.

BALMEISPORITES n. sp. A

Plate 3, figs. 1, 2

Description.—Trilete "megaspore." Circular in polar and equatorial outline (grain was essentially spherical and therefore was randomly oriented). Walls 2μ to 2.5μ thick; proximal surface is psilate; distal surface and periphery of proximal surface is covered by a coarse reticulum; Muri are 8μ to 13μ high by 4μ to 7μ wide at the base but thinning rapidly and becoming membranous for most of their height; "spines" are formed where the muri intersec; lumina are 18μ to 25μ across and polygonal in outline; floors of the lumina are psilate. Laesurae are slightly raised and extend almost to the equator; commissure is a straight, simple, narrow slit; margo is raised slightly, 1μ to 2μ wide, psilate, and thickened; thin membranous lips arise from the laesurae forming a pyramid the apex of which is equal to approximately ⅓ the diameter of the central body of the grain. Overall size of the central body is 50μ to 70μ.

Differential Diagnosis.—*Balmeisporites* n. sp. A is distinguished by its coarse reticulum with membranous muri and the laesurae lips.

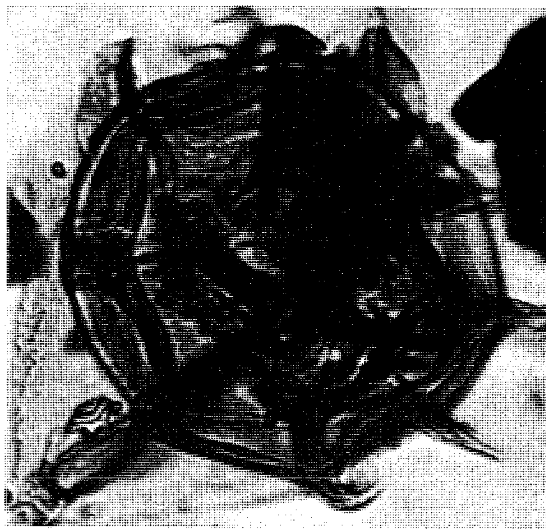
Occurrence.—*Balmeisporites* n. sp. A is present in the lower and upper portion of the Kaiparowits Formation.

Frequency.—Rare to frequent.

Figured Specimens.—BYU-Py-12, JRB-Ka-1+5 ft. Orig. (18.3, 19.3). BYU-Py-13, JRB-Ka-1+5 ft. Orig. (23.2, -2.3).

Genus CONCAVISPORITES Pflug in Thomson and Pflug, 1953

Concavisporites PFLUG in THOMSON AND PFLUG, 1953 ,Palaeontographica, v. 94, pt. B, p. 49.
Concavisporites PFLUG in THOMSON AND PFLUG, 1953, DELCOURT AND SPRUMONT, 1955, Mem. Soc. Belge Géol., Nouv. Ser. v. 4, no. 5, p. 24.



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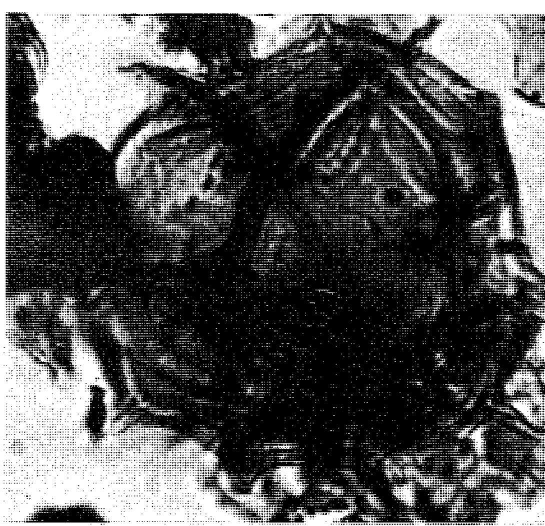


2

EXPLANATION OF PLATE 3

FIGS. 1, 2.—*Balmeisporites* n. sp. A, X1000, *1.* lateral view, BYU-Py-12, JRB-Ka-1+5 ft. Orig. (18.3, 19.3). *2.* polar view, BYU-Py-13, JRB-Ka-1+5 ft. Orig. (23.2, —2.3).

Concavisporites (PFLUG, 1952, and THOMSON AND PFLUG, 1952 plus 1953), DELCOURT AND SPRUMONT 1955, POTONIÉ, 1956, Beih. Geol. Jb., v. 23, p. 15.
Concavisporites PFLUG, COUPER, 1958, Palaeontographica, v. 103, pt. B, p. 142.
Concavisporites (PFLUG), KREMP, AMES AND GREBE, 1958, Catalog of Fossil Spores and Pollen, v. 3, p. 172.
Concavisporites PFLUG, 1953, ANDERSON, 1960, New Mexico State Bureau Mines and Mineral Res. Memoir 6, p. 15.
Concavisporites PFLUG 1953, GROOT, PENNY AND GROOT, 1961, Palaeontographica, v. 108, pt. B, p. 129.
Concavisporites PFLUG, POCOCK, 1962, Palaeontographica, v. 111, pt. B, p. 46.
Concavisporites PFLUG, 1953, HEDLUND, 1966, Okla. Geol. Survey Bull. 112, p. 12.

Type Species.—Concavisporites rugulatus Pflug in Thomson and Pflug, 1953.

Description.—Trilete spore. Walls psilate, rarely structured. Generally exhibit a torus (or kyrtom) and concave equatorial outline.

Botanical Affinities.—Pflug (in Thomson and Pflug, 1953, p. 49) suggests these may be related to the family Gleicheniaceae.

CONCAVISPORITES n. sp. A

Plate 2, figs. 5, 6

Description.—Trilete spore. Subtriangular with rounded apices and extremely concave sides in equatorial outline; proximal surface is flat and distal surface is strongly convex to pointed. Walls are approximately 1μ thick and psilate. Laesurae extend to the equator; commissure is a straight, narrow slit; margo is thickened, psilate to scabrate, and 2.5μ to 3.5μ wide. Overall size, polar axis 22μ to 30μ; each ray 14 μ to 20μ long. In polar view this form is 3-rayed.

Differential Diagnosis.—Concavisporites n. sp. A is distinguished by its extremely concave sides.

Occurrence.—Concavisporites n. sp. A is present in the lower and middle parts of the lower portion and in the upper portion of the Kaiparowits Formation.

Frequency.—Rare to frequent.

Figured Specimen.—BYU-Py-11, JRB-Ka-1+5 ft. Orig. (31.0, 3.3).

CONCAVISPORITES n. sp. B

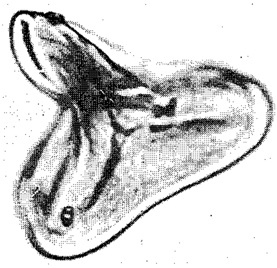
Plate 4, fig. 1

Description.—Trilete spore. Triangular with rounded apices and straight to slightly concave sides in equatorial outline. Walls 1.25μ to 1.5μ thick and finely scabrate. Laesurae are straight to slightly curved and extend $\frac{2}{3}$ to $\frac{3}{4}$ the radius; commissure is a simple narrow slit; no margo is present. Overall size 30μ to 40μ. Grains may be folded.

EXPLANATION OF PLATE 4

FIG.— 1.—*Concavisporites* n. sp. B, X1000, palor view, BYU-Py-14, CFL-K-344+2270 ft. W (6.8, 11.05).
FIG. 2.—*Deltoidospora psilostoma* Rouse, 1959, X1000, polar view, BYU-Py-15, CFL-K-256+1250 ft. Orig. (20.5, 6.7).
FIGS. 3, 4.—*Foveotriletes* n. sp. A, X1000, polar view, BYU-Py-16, CFL-K-256+1250 ft. Orig. (8.45, 10.65). *3.* focus on proximal surface. *4.* focus on distal surface.
FIG. 5.—*Intertriletes* cf. *I. scrobiculatus* Anderson, 1960, X1000, polar view, BYU-Py-17, CFL-K-256+1250 ft. Orig. (8.65, 7.3).
FIG. 6.—*Lycopodiumsporites* cf. *L. austroclavatidites* (Cookson, 1953) Potonié, 1956, X1000, polar view, BYU-Py-18, CFL-K-344+2270 ft. W (12.5, 7.3).

PLATE 4



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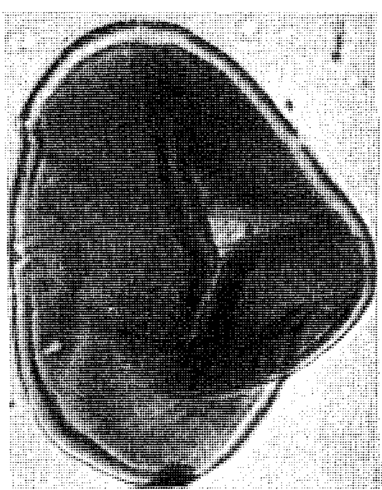

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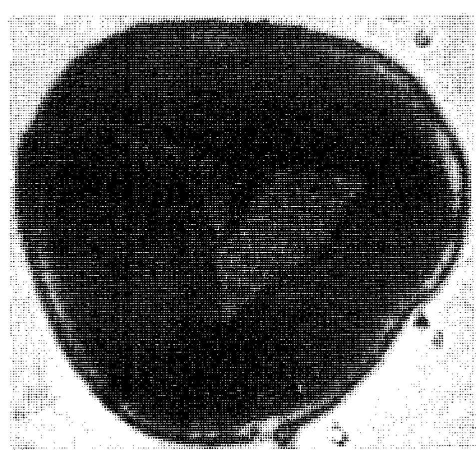

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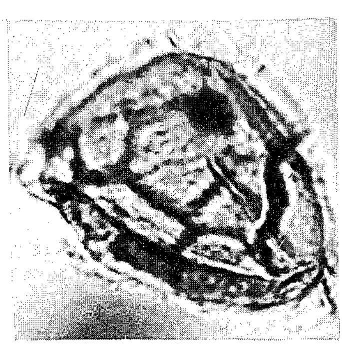

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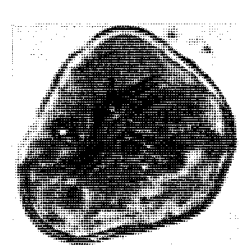


5

Differential Diagnosis.—*Concavisporites* n. sp. B is distinguished from other trilete spores in this sequence by its intermediate size, moderately thick scabrate walls, and simple laesurae with no margo.

Occurrence.—*Concavisporites* n. sp. B is present in the lower and upper portions of the Kaiparowits Formation.

Frequency.—Rare to frequent.

Figured Specimen.—BYU-Py-14, CFL-K-344+2270 ft. W(6.8, 11.05).

Genus DELTOIDOSPORA (Miner, 1935) emended Potonié, 1956

Deltoidospora MINER, 1935, Am. Mid. Nat., v. 16, no. 4, p. 618.
Deltoidospora (MINER 1935) emended POTONIÉ, 1956, Beih. Geol. Jb., v. 23, p. 13.
Deltoidospora MINER (1935) ROUSE, 1959, Micropaleontology, v. 5, no. 3, p. 310.
Deltoidospora (MINER) POTONIÉ, POCOCK, 1962, Palaeontographica, v. 111, pt. B, p. 48.
Deltoidospora MINER, GROOT AND GROOT, 1962, Palaeontographica, v. 111, pt. B, p. 163.
Deltoidospora MINER, emended POTONIÉ, 1956, BRENNER, 1963, Maryland Dept. Geol., Mines Water Res. Bull. 27, p. 61.
Deltoidospora MINER, 1935, emended POTONIÉ, 1956, SINGH, 1964, Research Council Alberta Bull. 15, p. 80.
Deltoidospora (MINER, 1935) POTONIÉ, 1956, HEDLUND, 1966, Okla. Geol. Survey Bull. 112, p. 10.
Deltoidospora MINER emended POTONIÉ, 1956, SRIVASTAVA, 1966, Pollen et Spores, v. 8, no. 3, p. 510.
Deltoidospora MINER emended POTONIÉ 1956, DRUGG, 1967, Palaeontographica, v. 120, pt. B, p. 36.
Deltoidospora MINER emended POTONIÉ, NORRIS, 1967, Palaeontographica, v. 120, pt. B, p. 86.

Type Species.—*Deltoidospora hallii* Miner, 1935, (designated by Potonié, 1956).

Description.—Trilete spore. Triangular with broadly rounded apices and straight to slightly concave or convex sides in equatorial outline. Exine is psilate. Laesurae extend $\frac{2}{3}$ or more the length of the radius. Miner (1935, p. 618) gave a size range of 33μ to 39μ for the type species.

Differential Diagnosis.—This genus resembles *Cyathidites* Couper, 1953, but differs in that its sides are nearly straight while those of *Cyathidites* Couper, 1953, are distinctly concave, both being viewed in equatorial outline. It differs from *Gleicheniidites* (Ross, 1949) Delcourt and Sprumont, 1955, in that in the latter the laesurae always reach the equator and apices are pointed. Kyrtome are present in *Concavisporites* Pflug in Thomson and Pflug, 1953, but lacking in *Deltoidospora* (Miner, 1935) emended Potonié, 1956 (after Potonié, 1956, p. 13).

Botanical Affinities.—Miner (1935, p. 618) suggested this genus may be related to *Gleichenites, Gleicheniopsis, Laccopteris,* or other Mesozoic ferns.

DELTOIDOSPORA PSILOSTOMA Rouse, 1959

Plate 4, fig. 2

Deltoidospora psilostoma ROUSE, 1959, Micropaleontology, v. 5, no. 3, p. 311, pl. 2, figs. 7, 8.
Deltoidospora psilostoma ROUSE, POCOCK, 1962, Palaeontographica, v. 111, pt. B, p. 48, pl. 5, figs. 82, 83.
Deltoidospora psilostoma ROUSE, 1959, SINGH, 1964, Research Council of Alberta Bull. 15, p. 80, 81, pl. 9, fig. 15.
Deltoidospora psilostoma ROUSE, NORRIS, 1967, Palaeontographica, v. 120, pt. B, p. 86, pl. 10, fig. 8.

Description.—Trilete spore. Semitriangular with broadly rounded apices and straight to slightly convex or concave sides in equatorial view. Walls 2μ to 3μ thick and psilate, except contact areas may be finely foveolate. Laesurae extend ⅔ or more the length of the radius; commissue is a narrow slit that may gape at the proximal pole; gaping of the commissures may give the illusion of a thickened psilate margo up to 5μ wide. Overall size 35μ to 60μ. Secondary folds may be present.

Differential Diagnosis.—*Deltoidospora psilostoma* Rouse, 1959, is distinguished from other trilete spores in this sequence by its thick, psilate walls and long laesurae with no margo.

Occurrence.—*Deltoidospora psilostoma* Rouse, 1959, is present throughout the lower and upper portions of the Kaiparowits Formation.

Frequency.—Rare to frequent.

Figured Specimen.—BYU-Py-15, CFL-K-256+1250 ft. Orig. (20.5, 6.7).

Genus FOVEOTRILETES (van der Hammen, 1954) ex Potonié, 1956

Foveotriletes, VAN DER HAMMEN, 1954, Boletin Geológico, v. 2, no. 1, p. 14.
Foveotriletes (VAN DER HAMMEN 1954) ex POTONIÉ, 1956, Beih. Geol. Jb., v. 23, p. 43.
Foveotriletes VAN DER HAMMEN ex POTONIÉ, NORRIS, 1967, Palaeontographica, v. 103, pt. B, p. 143.
Foveotriletes (VAN DER HAMMEN) POTONIÉ, 1956, ANDERSON, 1960, New Mexico State Bureau of Mines and Mineral Res. Memoir 6, p. 15.
Foveotriletes VAN DER HAMMEN, 1954, ex POTONIÉ, 1956, BRENNER, 1963, Maryland Dept. Geol., Mines and Water Resources Bull. 27, p. 62.
Foveotriletes VAN DER HAMMEN ex POTONIÉ, 1956, DETTMANN, 1963, Proc. Royal Soc. Victoria, New Ser. v. 77, pt. 1, p. 42.
Foveotriletes VAN DER HAMMEN ex POTONIÉ, 1956, DRUGG, 1967, Palaeontographica, v. 120, pt. B, p. 39.
Foveotriletes VAN DER HAMMEN ex POTONIÉ, NORRIS, 1967, Palaeontographica, v. 120, pt. B, p. 92.

Type Species.—*Foveotriletes scrobiculatus* (Ross, 1949) Potonié, 1956. (Van der Hammen, 1954, p. 14, designated no type species.)

Description.—Trilete spore. Triangular with rounded apices and straight sides in equatorial outline, in lateral view, the distal surface is broadly rounded and the proximal has three flat facets. Laesurae are straight, reaching almost to equator. Exine is thick and finely reticulate; lumina are small, approximately equal in size, and circular in outline. Type species is approximately 34μ in overall size.

Botanical Affinities.—Couper (1958, p. 141) suggests these belong in Order Filicales.

FOVEOTRILETES n. sp. A

Plate 4, figs. 3, 4

Description.—Trilete spore. Semitriangular with broadly rounded apices and straight to slightly concave or convex sides in equatorial outline. Walls approximately 2μ thick and foveolate on both proximal and distal surfaces; foveae are 0.2μ to 0.4μ deep by 1μ to 1.3μ diameter with centers 1.2μ to 1.5μ apart. The rims between foveae are smoothly rounded. Laesurae are straight and extend ⅔ to ¾ of the radius; commissure is a straight, narrow slit; margo is thickened, psilate, 2.5μ to 3.5μ wide. Overall size is 50μ to 65μ. Contact areas may be folded back.

Differential Diagnosis.—*Foveotriletes* n. sp. A. is distinguished from other trilete spores in this sequence by its small foveae and wide, thickened, psilate margos.

Occurrence.—*Foveotriletes* n. sp. A is present in the lower and middle parts of the lower portions of the Kaiparowits Formation.

Frequency.—Rare to frequent.

Figured Specimen.—BYU-Py-16, CFL-K-256+1250 ft. Orig. (8.45, 10.65).

Genus HYMENOZONOTRILETES (Naumova, 1937) ex Naumova, 1953

Hymenozonotriletes NAUMOVA, 1937, Report 17th Int. Geol. Congress, v. 1, p. 60, 61.
Hymenozonotriletes (NAUMOVA 1937) ex NAUMOVA, 1953, Trudy Inst. Geol. Nauk, Akad. Nauk SSSR, v. 143, p. 27.
Hymenozonotriletes NAUMOVA, 1937, POTONIÉ, 1956, Beih. Geol. Jb., v. 23, p. 66.
Hymenozonotriletes (NAUMOVA 1937?, 1939) ex NAUMOVA, 1953, POTONIÉ, 1958, Beih. Geol. Jb., v. 31, p. 29.
Hymenozonotriletes (NAUMOVA 1937) ex NAUMOVA, 1953, POCOCK, 1962, Palaeontographica, v. 111, pt. B, p. 49.
Hymenozonotriletes NAUMOVA, 1937, ex NAUMOVA, 1953, SINGH, 1964, Research Council Alberta Bull. 15, p. 83.

Type Species.—*Hymenozonotriletes polyacanthus* Naumova, 1953 (Naumova, 1937, designated no type species for this genus, therefore this is the Lectogenotype).

Description.—Trilete spore. Subtriangular in equatorial outline. Exine is covered with cones or spines. A membranous equatorial zona is present.

Botanical Affinities.—Filicales.

HYMENOZONOTRILETES n. sp. A

Plate 5, fig. 1

Description.—Trilete spore. Semitriangular with broadly rounded apices and convex sides in equatorial outline. Walls 1.5μ to 2.5μ thick; endexine and ektexine of approximately equal thickness; proximal surface is psilate; distal surface is covered with echinate to baculate projections 1.5μ to 2.5μ high by 1μ to 1.5μ diameter at the base. Projections are concentrated at the distal pole and become more sparsely spaced toward the equator. A membranous zona 2μ to 8μ wide is equatorially located with the outer edge ragged. Laesurae are distinct, straight or sinuous, raised up to 5μ at the pole and extend to the outer edge of the zona; commissure is a simple, narrow slit; margo is thickened, psilate, approximately 1μ wide. Overall size (including zona) 50μ to 60μ, (central body 35μ to 50μ. Grains may be split.

Differential Diagnosis.—Hymenozonotriletes n. sp. A is distinguished from other trilete spores in this sequence by its membranous zona and concentration of spines at the distal pole.

Occurrence.—*Hymenozonotriletes* n. sp. A is present in the lower and upper portions of the Kaiparowits Formation.

Frequency.—Rare to frequent.

Figured Specimen.—BYU-Py-19, JRB-Ka-1+5 ft. Orig. (11.4, 19.1).

Division PTERIDOPHYTA-INCERTAE SEDIS
Genus INTERTRILETES Anderson, 1960

Intertriletes ANDERSON, 1960, New Mexico State Bureau of Mines and Mineral Res. Memoir 6, p. 15.

Type Species.—*Intertriletes scrobiculatus* Anderson, 1960.

Description.—"Trilete spore with a short polar axis and circular to triangular outline in polar view. Sculpturing confined to, or distinctly different in, the triangular areas between laesurae." Anderson (1960, p. 15).

Differential Diagnosis.—*Intertriletes* Anderson, 1960, is distiguished from similar trilete spores by the sculpturing being confined to, or being distinctly different in, the contact areas.

Botanical Affinities.—Anderson (1960, p. 15) suggests these spores belong to Division Pteridophyta.

INTERTRILETES cf. I. SCROBICULATUS Anderson, 1960

Plate 4, fig. 5

Intertriletes scrobiculatus ANDERSON, 1960, New Mexico State Bureau Mines and Mineral Res. Memoir 6, p. 15, pl. 5, figs. 3, 4.

Description.—Trilete spore. Triangular with broadly rounded corners and sides straight to slightly convex or concave in equatorial outline. Walls approximately 1μ thick; endexine and ektexine equal in thickness; ektexine is psilate except in contact areas which are scabrate. Laesurae are distinct, extend ½ to ¾ the radius; commissures are straight, narrow slits; margo is thickened, psilate, less than 0.5μ wide. Overall size 25μ to 30μ. Secondary folds may be present.

Differential Diagnosis.—The forms in this sequence are smaller than those described by Anderson but otherwise similar. *Intertriletes* cf. *I. scrobiculatus* Anderson, 1960, is distinguished from other trilete spores in this sequence by the sculpture being concentrated only in the contact areas.

Occurrence.—*Intertriletes* cf. *I. scrobiculatus* Anderson, 1960, is present only in the lower and middle parts of the lower portion of the Kaiparowits Formation.

Frequency.—Rare.

Figured Specimen.—BYU-Py-17, CFL-K-256+1250 ft. Orig. (8.65, 7.3).

Division LYCOPHYTA
Class LYCOPSIDA
Family LYCOPODIACEAE
Genus LYCOPODIUMSPORITES Thiergart, 1938, ex Delcourt and Sprumont, 1955

Lycopodiumsporites THIERGART, 1938, Jb., preuss. Geol. L.A., v. 58, p. 293.
Lycopodium LINNEAUS, COUPER, 1953, New Zealand Geol. Survey Paleont. Bull. 22, p. 18.
Lycopodiumsporites THIERGART ex DELCOURT AND SPRUMONT, 1955, Mem. Soc. Belge Géol., Nouv. Ser., v. 4, no. 5, p. 31.
Lycopodiumsporites THIERGART, 1938 (non 1937), POTONIÉ, 1956, Beih. Geol. Jb., v. 23, p. 45, 46.
Lycopodiumsporites THIERGART ex DELCOURT AND SPRUMONT, 1955, DELCOURT AND SPRUMONT, 1957, Bull. Soc. Belge Géol. Paléont. Hydrol., v. 66.
Lycopodium LINNEAUS, BALME, 1957, Commonwealth Sci. Ind. Res. Organization, Coal Res. Sec., T. C. 25, p. 16.
Lycopodiumsporites THIERGART, COUPER, 1958, Palaeontographica, v. 103, pt. B, p. 132.
Lycopodium (DILLENIUS) LINNEAUS, ROUSE, 1959, Micropaleontology, v. 5, no. 3, p. 309.
Lycopodiumsporites THIERGART, 1938, GROOT AND PENNY, 1960, Micropaleontology, v. 6, no. 2, p. 230.
Lycopodium LINNÉ, ANDERSON, 1960, New Mexico State Bureau Mines and Mineral Res. Memoir 6, p. 14.
Lycopodiumsporites THIERGART, 1938, GROOT, PENNY AND GROOT, 1961, Palaeontographica, v. 108, pt. B, p. 128.
Lycopodiumsporites THIERGART, POCOCK, 1962, Palaeontographica, v. 111, pt. B, p. 32.
Lycopodiumsporites THIERGART, 1938, BRENNER, 1963, Maryland Dept. Geol., Mines and Water Res. Bull. 27, p. 44.
Lycopodiumsporites THIERGART ex DELCOURT AND SPRUMONT, 1955, DETTMANN, 1963, Proc. Royal Soc. Victoria, New Ser. v. 77, pt. 1, p. 43, 44.
Lycopodiumsporites THIERGART ex DELCOURT AND SPRUMONT, 1955, DELCOURT, DETTMANN, AND HUGHES, 1963, Palaeontology, v. 6, pt. 2, p. 286.
Lycopodiumsporites THIERGART, 1938 ex DELCOURT AND SPRUMONT, 1955, SINGH, 1964, Research Council Alberta Bull. 15, p. 39.
Lycopodiumsporites THIERGART ex DELCOURT AND SPRUMONT, 1955, HARRIS, 1965, Palaeontographica, v. 115, pt. B, p. 80.
Lycopodiumsporites THIERGART, 1938, HEDLUND, 1966, Okla. Geol. Survey Bull. 112, p. 19.

Lycopodiumsporites THIERGART ex DELCOURT AND SPRUMONT, 1955, SRIVASTAVA, 1966, Pollen et Spores, v. 8, no. 3, p. 501.
Lycopodiumsporites THIERGART ex DELCOURT AND SPRUMONT, 1955, DRUGG, 1967, Palaeontographica, v. 120, pt. B, p. 40.
Lycopodiumsporites THIERGART ex DELCOURT AND SPRUMONT, NORRIS, 1967, Palaeontographica, v. 120, pt. B, p. 89.
Lycopodiumsporites (THIERGART) ex DELCOURT AND SPRUMONT, 1955, BOLTENHAGEN, 1967, Pollen et Spores, v. 9, no. 2, p. 338.
Type Species.—*Lycopodiumsporites agathoecus* (Potonié, 1934) Thiergart, 1938. (Designated as the Lectogenotype by Delcourt and Sprumont, 1955, p. 31).

Description.—Trilete spore. Subtriangular in equatorial outline. Distal surface is covered by a more or less regular reticulum of rather straight muri. Muri may or may not pass over on to periphery of the proximal surface. Muri may be high enough that they stand in relief around the equator. A membranous perispore may be present and envelop the reticulum.

Differential Diagnosis.—The lumina of its reticulum are larger and more circular than those of *Microreticulatisporites* and generally smaller and more regular than those of *Reticulatisporites*. *Lycopodiacidites* is rugulate, not reticulate.

Botanical Affinities.—Lycopodiaceae.

LYCOPODIUMSPORITES cf. L. AUSTROCLAVATIDITES (Cookson, 1953) Potonié, 1956

Plate 4, fig. 6

Lycopodium austroclavatidites COOKSON, 1953, Australian Jour. Bot., v. 1, no. 3, p. 496, pl. 2, fig. 35.
Lycopodiumsporites austroclavatidites (COOKSON, 1953) POTONIÉ, 1956, Beih. Geol. Jb., v. 23, p. 46.
Lycopodium perplicatum BOLKHOVITINA, 1956, Atlas of the Spores and Pollen Grains in Jurassic and Lower Cretaceous Coals of the Viliusk Basin, p. 63, pl. 8, figs. 104a, b. (In Russian).
Lycopodiumsporites cf. *austroclavatidites* (COOKSON) POTONIÉ, DELCOURT AND SPRUMONT, 1957, Bull. Soc. Belge Géol. Paléont. Hydrol., v. 66, pl. 3, fig. 27.
Lycopodium austroclavatidites COOKSON, BALME, 1957, Commonwealth Sci. Ind. Res. Organization, Coal Res. Sec., T. C. 25, p. 16, pl. 1, fig. 8.
Lycopodiumsporites clavatoides COUPER, 1958 (in part), Palaeontrographica, v. 103, pt. B, p. 132, pl. 15, figs. 12, 13.
Lycopodiumsporites clavatoides COUPER, LANTZ, 1958, Rev. Inst. Franç. Pétrole., v. 13, p. 935.
Lycopodiumsporites reticulumsporites ROUSE, 1959 (in part), Micropaleontology, v. 5, no. 3, p. 309, pl. 1, fig. 3.
Lycopodiumsporites clavatoides COUPER, GROOT AND PENNY, 1960, Micropaleontology, v. 6, no. 2, p. 230, pl. 1, fig. 1.
Lycopodium sporites clavatoides COUPER 1958, GROOT, PENNY AND GROOT, 1961, Palaeontographica, v. 108, pt. B, p. 128, pl. 24, figs. 2-4.
Lycopodium austroclavatidites COOKSON (1953), KREMP AND AMES, 1962, Catalog of Fossil Spores and Pollen, v. 15, p. 45.
Lycopodiumsporites austroclavatidites (COOKSON), POCOCK, 1962, Palaeontographica, v. 111, pt. B, p. 33, pl. 1, figs. 5, 6.
Lycopodiumsporites austroclavatidites (COOKSON) POTONIÉ, BRENNER, 1963, Maryland Dept. Geol., Mines Water Res. Bull. 27, p. 44, pl. 5, fig. 3.
Lycopodiumsporites austroclavatidites (COOKSON) POTONIÉ, 1956, DETTMANN, 1963, Proc. Royal Soc. Victoria, New Ser. v. 77, pt. 1, p. 44, pl. 6, figs. 18-21.
Lycopodiumsporites austroclavatidites (COOKSON) POCOCK, 1962, SINGH, 1964, Research Council Alberta Bull. 15, p. 39, 40, pl. 1, figs, 3, 4.
Lycopodiumsporites austroclavatidites (COOKSON) POTONIÉ, 1956, HARRIS, 1965, Palaeontographica, v. 115, pt. B, p. 80, pl. 25, fig. 2.
Lycopodiumsporites austroclavatidites (COOKSON) POTONIÉ 1965 (sic), DRUGG, 1967, Palaeontographica, v. 120, pt. B, p. 40, pl. 6, fig. 33.
Lycopodiumsporites austroclavatidites (COOKSON) POTONIÉ, NORRIS, 1967, Palaeontographica, v. 120, pt. B, p. 89, 90, pl. 10, fig. 21.

Description.—Trilete spore. Semitriangular with broadly rounded apices and convex sides in equatorial outline. Walls 1μ to 1.5μ thick; proximal surface is psilate to finely scabrate, and distal surface is covered by a coarse reticulum that may extend on to the periphery of the proximal surface giving the illusion of an equatorial cingulum where the muri stand in relief of the main body of the spore. Muri are 1μ to 2.5μ high by approximately 1μ wide at the base and membranous at the top which is ragged. Lumina are 8μ to 15μ across and irregularly polygonal. Laesurae equal ¾ or more the radius in length but are not always distinct; commissure are straight, narrow slits; no margo is present. Overall size 40μ to 60μ.

Differential Diagnosis.—This form differs from the type description of Cookson (1953, p. 469) by being larger and by muri that are more variable in height. It is distinguished from other trilete spores in this sequence by the membranous muri on the distal surface and the muri forming what appears to be a cingulum where the reticulum extends onto the periphery of the proximal surface.

Occurrence.—*Lycopodiumsporites* cf. *L. austroclavatidites* (Cookson, 1953) Potonié, 1956, is present only in the upper portion of the Kaiparowits Formation.

Frequency.—Rare to frequent.

Figured Specimen.—BYU-Py-18, CFL-344+2270 ft. W(12.5, 7.3).

LYCOPODIUMSPORITES cf. L. FASTIGIOIDES (Couper, 1953) Boltenhagen, 1967

Plate 5, fig. 2

Lycopodium fastigioides COUPER, 1953, New Zealand Geol. Survey Paleont. Bull. 22, p. 19, pl. 1, fig. 3.
Lycopodium fastigioides COUPER (1953), KREMP, AMES AND GREBE, 1957, Catalog of Fossil Spores and Pollen, v. 2, p. 114.
Lycopodiumsporites fastigioides (COUPER, 1953), BOLTENHAGEN, 1967, Pollen et Spores, v. 9, no. 2, p. 338, 339, pl. 1, figs. 4-7.

Description.—Trilete spore. Triangular with broadly rounded apices and concave to convex sides in equatorial outline. Walls approximately 1.5μ thick; endexine and ektexine of equal thickness and ektexine in a low reticulate structure. Muri are 0.75μ to 1.25μ wide by 1μ high; lumina 2.5μ to 5μ across and polygonal to rounded outline. Laesurae are straight and extend ⅔ to ¾ the length of the radius and may gape at the proximal pole; commissure is straight and narrow; margo is 1.25μ to 1.5μ wide at the proximal pole and narrows uniformly to zero at outer end of the laesurae. Overall size is 50μ to 65μ.

Differential Diagnosis.—This form is larger than Boltenhagen's (1967, p. 388, 389) and has a finer reticulum. It is distinguished from other trilete spores in the Kaiparowits Formation by its low, blunt reticulum.

Occurrence.—*Lycopodiumsporites* cf. *L. fastigioides* (Couper, 1953), Boltenhagen, 1967, is present in the middle part of the lower portion of the Kaiparowits Formation.

Frequency.—Rare.

Figured Specimen.—BYU-Py-20, CFL-K-256+1250 ft. Orig. (14.25, 6.25).

Family SELAGINELLACEAE (provisional assignment)
Genus ACANTHOTRILETES (Naumova, 1937) ex Potonié and Kremp, 1954

Acanthotriletes NAUMOVA, 1937, Report 17th Int. Geol. Congress. v. 1, p. 60, 61.
Acanthotriletes (NAUMOVA 1937) POTONIÉ AND KREMP, 1954, Geol. Jb., v. 69.
Acanthotriletes (NAUMOVA 1937) POTONIÉ AND KREMP, 1955, Palaeontographica, v. 98, pt. B, p. 83.
Acanthotriletes (NAUMOVA 1937) POTONIÉ AND KREMP, 1954, POTONIÉ, 1956 Beih. Geol. Jb., v. 23, p. 32.
Acanthotriletes NAUMOVA, ROUSE, 1957, Canadian Jour. Bot., v. 35, p. 355.
Acanthotriletes (NAUMOVA 1937? 1939) ex POTONIÉ AND KREMP, 1954, POTONIÉ, 1958, Beih. Geol. Jb., v. 31, p. 20, 21.
Acanthotriletes (NAUMOVA 1937?) POTONIÉ AND KREMP, 1954, POTONIÉ, 1960, Beih. Geol. Jb., v. 39, p. 41.

Acanthotriletes (NAUMOVA) POTONIÉ AND KREMP, POCOCK, 1962, Palaeontographica, v. 111, pt. B, p. 36.
Acanthotriletes NAUMOVA, 1937?, 1939 ex POTONIÉ AND KREMP, 1954, SINGH, 1964, Research Council Alberta Bull. 15, p. 43.
Acanthotriletes NAUMOVA ex POTONIÉ AND KREMP, 1954, SRIVASTAVA, 1966, Pollen et Spores, v. 8, no. 3, p. 502.
Acanthotriletes NAUMOVA emended POTONIÉ AND KREMP, NORRIS, 1967, Palaeontographica, v. 120, pt. B, p. 89.

Type Species.—*Acanthotriletes ciliatus* (Knox) Potonié and Kremp, 1955.

Description.—Trilete spores. Covered with spines with little or no space between them; spines are sharply pointed to barely rounded; spine length is much greater than basal diameter.

Botanical Affinities.—Selaginellaceae?

ACANTHOTRILETES n. sp. A

Plate 5, fig. 3

Description.—Trilete spore. Triangular with rounded apices and sides straight to slightly concave or convex in equatorial outline. Walls approximately 1μ thick. Proximal surface is psilate; distal surface and the periphery of the proximal surface with echinate spines 2μ to 3μ long by 1μ to 1.5μ in basal diameter, centered 2μ to 4μ apart. Laesurae are straight and extend to the equator. Commissure is a straight, narrow slit. Margo is psilate, thickened, 0.4μ to 0.6μ wide. Overall size 18μ to 28μ.

Differential Diagnosis.—This is the only form in these samples with exclusively echinate spines and no zona or cingulum.

Occurrence.—*Acanthotriletes* n. sp. A is present in the lower part of the lower portion and in the upper portion of the Kaiparowits Formation.

Frequency.—Rare to frequent.

Figured Specimen.—BYU-Py-21, CFL-K-344+2270 ft. X(9.7, 11.4).

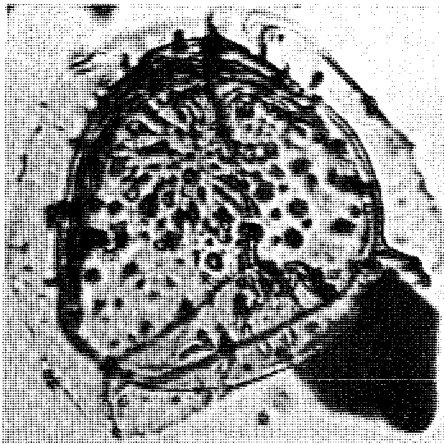
Genus CERATOSPORITES Cookson and Dettmann, 1958

Ceratosporites COOKSON AND DETTMANN, 1958, Proc. Royal Soc. Victoria, New Ser. v. 70, pt. 2, p. 101.
Ceratosporites COOKSON AND DETTMANN, 1958, POTONIÉ, 1960, Beih. Geol. Jb., v. 39, p. 42, 43.
Ceratosporites COOKSON AND DETTMANN, 1958, DETTMANN, 1963, Proc. Royal Soc. Victoria, New Ser. v. 77, pt. 1, p. 36.

EXPLANATION OF PLATE 5

FIG. 1.—*Hymenozonotriletes* n. sp. A, X1000, polar view, BYU-Py-19, JRB-Ka-1+5 ft. Orig. (11.4, 19.1).
FIG. 2.—*Lycopodiumsporites* cf. *L. fastigioides* (Couper, 1953) Boltenhagen, 1967, X1000, polar view, BYU-Py-20, CFL-K-256+1250 ft. Orig. (14.25, 6.25).
FIG. 3.—*Acanthotriletes* n. sp. A, X100, polar view, BYU-Py-21, CFL-K-344+2270 ft. X (9.7, 11.4).
F|7. 4.—Ceratosporites n. sp. A, X1000, polar view, BYU-Py-22, JRB-Ka-1+5 ft. Orig. (11.9, 6.4).
FIG. 5.—*Cingulatisporites* cf. *C. scabratus* Couper, 1958, X1000, polar view, BYU-Py-23, CFL-K-344+2270 ft. G (11.0, 4.05).
FIG. 6.—cf. *Cingulatisporites* n. sp. A, X1000, polar view, BYU-Py-24, JRB-Ka-1+5 ft. Orig. (12.8, 4.75).

PLATE 5



1

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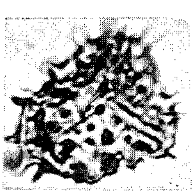
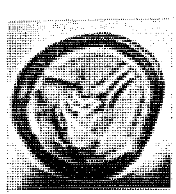


3



5

6

Ceratosporites COOKSON AND DETTMANN, 1958, BRENNER, 1963, Maryland Dept. Geol., Mines Water Res. Bull. 27, p. 57.
Ceratosporites COOKSON AND DETTMANN, 1958, HARRIS, 1965, Palaeontographica, v. 115, pt. B, p. 80.
Ceratosporites COOKSON AND DETTMANN, 1958, SRIVASTAVA, 1966, Pollen et Spores, v. 8, no. 3, p. 501.
Ceratosporites COOKSON AND DETTMANN, 1958, DRUGG, 1967, Palaeontographica, v. 120, pt. B, p. 37.

Type Species.—*Ceratosporites equalis* Cookson and Dettmann, 1958.

Description.—Trilete spore. Semitriangular in equatorial outline. Walls are thin; proximal surface is psilate; distal surface is covered with thin, straight-sided, blunt, capitate or occasionally bifurcate processes. Laesurae extend to equator and are raised on a low tecta. Overall size is 32μ to 52μ.

Differential Diagnosis.—*Ceratosporites* Cookson and Dettmann, 1958, is distinguished by the ornamentation being confined to the distal surface.

Botanical Affinities.—Selaginellaceae?

CERATOSPORITES n. sp. A

Plate 5, fig. 4

Description.—Trilete spore. Semitriangular with broadly rounded apices and straight to convex sides in equatorial outline. Walls approximately 1.5μ thick. Proximal surface is psilate; distal surface has baculate to echinate sculpture. Projections 1μ to 2μ long by 0.5μ to 1.5μ diameter at base. Laesurae are straight, simple, and slightly raised extending essentially to the equator. Commissure is a straight, narrow slit. Margo is raised, slightly thickened psilate, approximately 0.5μ wide. Overall size 30μ to 45μ.

Differential Diagnosis.—*Ceratosporites* n. sp. A is distinguished from the other similarly sculptured spores by its lack of a cingulum or zona.

Occurrence.—*Ceratosporites* n. sp. A is present in the lower portion of the Kaiparowits Formation.

Frequency.—Rare to frequent.

Figured Specimen.—BYU-Py-22, JRB-Ka-1+5 ft. Orig. (11.9, 6.4).

Genus CINGULATISPORITES Thomson in Thomson and Pflug, 1953, emended Potonié, 1956

Cingulatisporites (THOMSON) in THOMSON AND PFLUG, 1953, Palaeontographica, v. 94, pt. B, p. 58.
Cingulatisporites THOMSON, DELCOURT AND SPRUMONT, 1955, Mem. Soc. Belge Géol., Nouv. Ser., v. 4, no. 5, p. 38.
Cingulatisporites THOMSON (in THOMSON AND PFLUG 1953) emended POTONIÉ, 1956, Beih. Geol. Jb., v. 23, p. 58.
Cingulatisporites THOMSON, COUPER, 1958, Palaeontographica, v. 103, pt. B, p. 145.
Cingulatisporites THOMSON AND PFLUG, 1953, WEYLAND, PFLUG AND PANTIC, 1958, Palaeontographica, v. 105, pt. B, p. 83.
Cingulatisporites THOMSON, 1953, GROOT AND PENNY, 1960, Micropaleontology, v. 6, no. 2, p. 231.
Cingulatisporites THOMSON, 1953, ANDERSON, 1960, New Mexico State Bureau Mines and Mineral Res. Memoir 6, p. 15.
Cingulatisporites THOMSON, 1953, POCOCK, 1961, Jour. Paleont., v. 35, no. 6, p. 1235.
Cingulatisporites PFLUG, emended POTONIÉ, 1956, STANLEY, 1965, Bull. Amer. Paleont., v. 49, no. 222, p. 243.

Type Species.—*Cingulatisporites levispeciosus* Pflug in Thomson and Pflug, 1953.

Description.—Trilete spore. More or less circular in equatorial outline. Walls psilate to perhaps scabrate. Laesurae extend to, or almost to, the inner edge of the cingulum. Width of cingulum less than 1/5 greatest spore body diameter. Overall size moderate.

Differential Diagnosis.—*Cingulatisporites* Thomson in Thomson and Pflug, 1953, emended Potonié, 1956, is distinguished by the presence of a true cingulum.

Botanical Affinities.—Selaginellaceae (provisional assignment).

CINGULATISPORITES cf. C. SCABRATUS Couper, 1958

Plate 5, fig. 5

Cingulatisporites scabratus COUPER, 1958, Palaeontographica, v. 103, pt. B, p. 147, pl. 25, figs. 3, 4.

Description.—Trilete spore. Semitriangular with broadly rounded apices and convex sides to subround in equatorial outline. Walls approximately 1μ thick and uniformly scabrate. Grain is surrounded equatorially by a thickened scabrate cingulum 2μ to 2.5μ wide. Laesurae are straight and extend to the inner edge of the cingulum. Commissure is a simple, straight slit. Margo is psilate to finely scabrate, thickened 1μ to 1.25μ wide. Overall size (excluding cingulum) 15μ to 25μ. These grains are commonly folded or split.

Differential Diagnosis.—This form differs from *Cingulatisporites scabratus* Couper, 1958, in its smaller size, heavier cingulum, and more uniform sculpture. It is distingiushed from other forms in this sequence by its smaller size, uniform scabrate sculpturing, and thickened cingulum.

Occurrence.—*Cingulatisporites* cf *C. scabratus* Couper, 1958, is present only in the upper portion of the Kaiparowits Formation.

Frequency.—Rare to frequent.

Figured Specimen.—BYU-Py-23, CFL-K-344+2270 ft. G(11.0, 4.05).

cf. CINGULATISPORITES n. gen. A

Plate 5, fig. 6

Description.—Trilete spore. Triangular with broadly rounded apices and slightly convex sides in equatorial outline. Walls approximately 1μ thick; proximal surface is psilate; distal surface is scabrate with a few thick, blunt spines 1μ in diameter by 1.5μ to 2μ long. A cingulum 2.5μ wide along the sides to 4μ wide at the apices surrounds the grain equatorially. It has the same sculpture as the remainder of the grain, and a psilate, fiberous membranous zona up to 4μ wide surrounds the grain equatorially on the outside of the cingulum. Laesurae extend to the inner edge of the cingulum. Commissure is a straight, narrow slit. Margo is thickened; psilate, 1μ to 1.5μ wide. It is wider at each end and narrower in the middle. Overall size (excluding cingulum and zona) 20μ to 30μ.

Differential Diagnosis.—This form is distinguished by the presence of both a cingulum and a zona. Probably this form belongs in a new genus.

Occurrence.—cf. *Cingulatisporites* n. gen. A is present in the lower part of the lower portion of the Kaiparowits Formation.

Frequency.—Rare to frequent.

Figured Specimen.—BYU-Py-24, JRB-Ka-1+5 ft. Orig. (12.8, 4.75).

Genus RETICULATASPORITES Leschik, 1955

Reticulatasporites LESCHIK, 1955, Schweiz. Palaeont., v. 72, p. 28.
Reticulatasporites LESCHIK, 1955, POTONIÉ, 1958, Beih. Geol. Jb., v. 31, p. 83.
Reticulatasporites LESCHIK, 1955, STANLEY, 1965, Bull. Amer. Paleont., v. 49, no. 222, p. 266.

Type Species.—*Reticulatasporites densus* Leschik, 1955.

Description.—"Alete iso- or microspores; shape more or less spherical. Exine moderate to thick-walled. No tetrad scar present." Stanley, 1965, p. 266.

Differential Diagnosis.—*Reticulatasporites* Leschik, 1955, is separated from other similar genera by the absence of a tetrad scar and presence of a reticulate sculpture.

Botanical Affinities.—Unknown.

RETICULATASPORITES n. sp. A

Plate 6, fig. 1

Description.—Inaperturate pollen grain. Circular to slightly oval in outline. Walls 6μ to 7μ thick and covered by a coarse reticulum; muri 5μ to 6μ high by 0.5μ to 0.8μ thick. An individual muri is of uniform thickness; lumina 4.5μ to 5.5μ across and 4- to 6-sided. Overall size 30μ to 35μ.

Differential Diagnosis.—*Reticulatasporites* n. sp. A is distinguished from other similar forms by its intermediate size and high, thin muri.

Occurrence.—*Reticulatasporites* n. sp. A is present in the lower and middle portions of the Kaiparowits Formation.

Frequency.—Rare to frequent.

Figured Specimen.—BYU-Py-25, CFL-K-256+1250 ft. Orig. (8.5, 10.4).

RETICULATASPORITES n. sp. B

Plate 6, figs. 4, 5

Description.—Inaperturate pollen grain. Semitriangular to subrounded outline. Walls are 3.5μ to 4μ thick and uniformly covered by a reticulum. Muri approximately 2μ high by 0.5μ thick. Lumina is 2μ to 3μ across and 4- to 6-sided. Overall size is 40μ to 45μ.

Differential Diagnosis.—*Reticulatasporites* n. sp. B is distinguished from other similar forms by its lower, finer reticulum.

Occurrence.—*Reticulatasporites* n. sp. B is present only in the upper portion of the Kaiparowits Formation.

Frequency.—Rare.

Figured Specimen.—BYU-Py-28, CFL-K-344+2270 ft. Z(33.85, 8.35).

RETICULATASPORITES n. sp. C

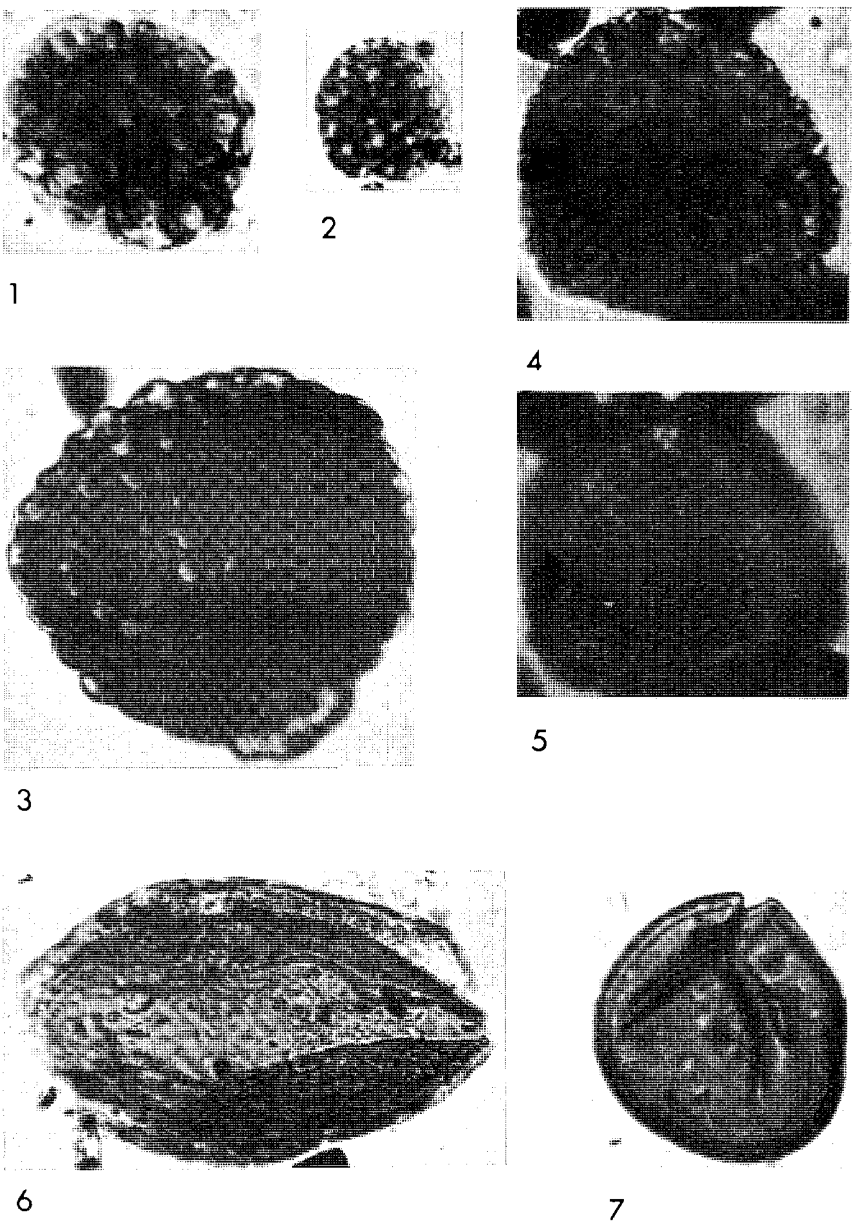
Plate 6, fig. 3

Description.—Inaperturate pollen grain. Semitriangular to subround in outline. Walls 4.5μ to 5μ thick and uniformly reticulate. Muri approximately 2μ high by 1μ thick. Lumina approximately 7μ across and subround. Overall size 50μ to 60μ.

EXPLANATION OF PLATE 6

FIG. 1.—*Reticulatasporites* n. sp. A, X1000, BYU-Py125, CFL-K-256+1250 ft. Orig. (8.5, 10.4).
FIG. 2.—*Reticulatasporites* n. sp. D, X1000, BYU-Py-26, CFL-K-344+2270 ft. Z (33.85, 8.35).
FIG. 3.—*Reticulatasporites* n. sp. C, X1000, BYU-Py-27, JRB-Ka-1+5 ft. Orig. (25.0, 17.2).
FIGS. 4, 5.—*Reticulatasporites* n. sp. B, X1000, BYU-Py-28, CFL-K-344+2270 ft. Z (33.85, 8.35).
FIG. 6.—*Schizosporis* cf. *S. parvus* Cookson and Dettmann, 1959, X500, BYU-Py-29, CFL-K-256+1250 ft. Orig. (8.3, 9.05).
FIG. 7.—*Schizosporis* n. sp. A, X1000, BYU-Py-30, CFL-K-256+1250 ft. Orig. (16.55, 9.2).

PLATE 6



Differential Diagnosis.—*Reticulatasporites* n. sp. C is distinguished from other similar forms by its coarser reticulum with subround lumina and large size.

Occurrence.—*Reticulatasporites* n. sp. C is present only in the basal part of the Kaiparowits Formation.

Frequency.—Rare.

Figured Specimen.—BYU-Py-27, JRB-Ka-1+5 ft. Orig. (25.0, 17.2).

RETICULATASPORITES n. sp. D

Plate 6, fig. 2

Description.—Inaperturate pollen gran. Walls 2μ to 2.5μ thick and reticulate. Muri 1.5μ to 2μ high by 1μ wide at the top and thinner at the base; Lumina 1μ to 1.5μ across and subcircular to circular in outline. Overall size 17μ to 22μ.

Differential Diagnosis.—*Reticulatasporites* n. sp. D is distinguished by its small size and proportionately coarse reticulum.

Occurrence.—*Reticulatasporites* n. sp. D is present in the lower portion of the Kaiparowits Formation.

Frequency.—Rare to frequent.

Figured Specimen.—BYU-Py-26, JRB-Ka-1+5 ft. Orig. (20.4, 15.55).

Genus SCHIZOSPORIS Cookson and Dettmann, 1959

Schizosporis COOKSON AND DETTMANN, 1959, Micropaleontology, v. 5, no. 2, p. 213.
Schizosporis COOKSON AND DETTMANN, POCOCK, 1962, Palaeontographica, v. 111, pt. B, p. 75.
Schizosporis COOKSON AND DETTMANN, 1959, BRENNER, 1963, Maryland Dept. Geol., Mines and Water Res. Bull. 27, p. 96.
Schizosporis COOKSON AND DETTMANN, 1959, DETTMANN, 1963, Proc. Royal Soc. Victoria, New Ser. v. 77, pt. 1, p. 106.
Schizosporis COOKSON AND DETTMANN, 1959, SINGH, 1964, Research Council Alberta Bull. 15, p. 100.
Schizosporis COOKSON AND DETTMANN, 1959, STANLEY, 1965, Bull. Amer. Paleont., v. 49, no. 222, p. 267.
Schizosporis COOKSON AND DETTMANN, 1959, SRIVASTAVA, 1966, Pollen et Spores, v. 8, no. 3, p. 518.

Type Species.—*Schizosporis reticulatus* Cookson and Dettmann, 1959.

Description.—"Microspore medium to large with an equatorial line or furrow along which a separation into two approximately equal parts takes place." Cookson and Dettmann (1959, p. 213).

Differential Diagnosis.—*Schizosporis* Cookson and Dettmann, 1959, is distinguished from *Ovoidites* Potonié, 1951, by its more spherical outline as opposed to *Ovoidites* Potonié, 1951, with its more fusiform outline.

Botanical Affinities.—Unknown.

SCHIZOSPORIS cf. S. PARVUS Cookson and Dettmann, 1959

Plate 6, fig. 6

Schizosporis parvus COOKSON AND DETTMANN, 1959, Micropaleontology, v. 5, no. 2, p. 216, pl. 1, figs. 15-20.
Schizosporis parvus COOKSON AND DETTMANN (1959), KREMP AND AMES, 1962, Catalog of Fossil Spores and Pollen, v. 15, p. 90.
Schizoporis parvus COOKSON AND DETTMANN, POCOCK, 1962, Palaeontographica, v. 111, pt. B, p. 76, pl. 13, figs. 200, 201.
Schizosporis parvus COOKSON AND DETTMANN, 1959, DETTMANN, 1963, Proc. Royal Soc. Victoria, New Ser. v. 77, pt. 1, p. 108, pl. 26, figs. 18, 19.

Schizosporis parvus COOKSON AND DETTMANN, 1959, SINGH, 1964, Research Council Alberta Bull. 15, p. 101, pl. 13, fig. 15.

Description.—Inaperturate schizospore. Oval in outline. Walls approximately 3μ thick; endexine and ektexine approximately equal in thickness and psilate with a sort of "scabby" appearance. Overall size 70μ to 80μ by 110μ to 130μ. Grain splits into two approximately equal halves.

Differential Diagnosis.—This form is larger than those described by Cookson and Dettmann, 1959. It is larger and with much thicker walls than any other form observed in these samples.

Botanical Affinities.—Cookson and Dettmann (1959, p. 216) indicate *Schizosporis parvus* Cookson and Dettmann, 1959, resembles pollen grains of *Rapatea spectabilis* Pilger and *Cephalostemon angustatus* Malme as described and figured by Erdtman (1952, p. 374, text-fig. 218). However, their affinities remain unknown.

Occurrence.—*Schizosporis* cf. *S. parvus* Cookson and Dettmann, 1959, is present only in sample CFL-K-256+1250 ft. in the middle of the lower portion of the Kaiparowits Formation.

Frequency.—Rare.

Figured Specimen.—BYU-Py-29, CFL-K-256+1250 ft. Orig. (8.3, 9.05).

SCHIZOSPORIS n. sp. A

Plate 6, fig. 7

Description.—Inaperturate schizospore. Circular to subcircular in outline. Walls 2.5μ to 3μ thick; endexine slightly thinner than ektexine; ektexine is scabrate. Overall size 33μ to 39μ. Grain may split into two approximately equal halves that remain attached; some secondary folds may be present.

Differential Diagnosis.—*Schizosporis* n. sp. A is distinguished from similar forms on the basis of its heavy walls and fine wall sculpture.

Occurrence.—*Schizosporis* n. sp. A is present in the middle part of the lower portion and in the middle portion of the Kaiparowits Formation.

Frequency.—Rare to frequent.

Figured Specimen.—BYU-Py-30, CFL-K-256+1250 ft. Orig. (16.55, 9.2).

Class GYMNOSPERMAE
Order CYCADALES
Family CYCADACEAE (provisional assignment)
Genus CYCADOPITES Wodehouse ex Wilson and Webster, 1946

Cycadopites WODEHOUSE, 1933, Bull. Torrey Bot. Club, v. 60, p. 483.
Cycadopites WODEHOUSE ex WILSON AND WEBSTER, 1946, Amer. Jour. Bot., v. 33, p. 274.
Monocolpites VAN DER HAMMEN, 1956, Bóletin Geológico, Bogotá, v. 4, nos. 2, 3, p. 82 (in part).
Cycadopites (WODEHOUSE 1933) ex WILSON AND WEBSTER 1946, POTONIÉ, 1958, Beih. Geol. Jb., v. 31, p. 92.
Cycadopites WODEHOUSE, 1933 ex WILSON AND WEBSTER, 1946, SINGH, 1964, Research Council Alberta Bull. 15, p. 103.
Cycadopites WODEHOUSE ex WILSON AND WEBSTER, 1946, STANLEY, 1965, Bull. Amer. Paleont., v. 49, no. 222, p. 270.
Cycadopites WODEHOUSE ex WILSON AND WEBSTER 1946, SRIVASTAVA, 1966, Pollen et Spores, v. 8, no. 3, p. 518.
Cycadopites WODEHOUSE ex WILSON AND WEBSTER, NORRIS, 1967, Palaeontographica, v. 120, pt. B, p. 105.

Type Species.—*Cycadopites follicularis* Wilson and Webster, 1946.

Description.—Monosulcate pollen grains. More or less fusiform in outline. Walls of moderate thickness; ornamentation lacking or poorly developed. Sulcus extends length of grain; characteristically the ends are open and the central part is touching or overlapping. Size variable.

Differential Diagnosis.—*Cycadopites* Wodehouse ex Wilson and Webster, 1946, is distinguished from other monosulcate grains in this sequence by the character of the central part of the sulcus touching or overlapping and the ends being open.

Botanical Affinities.—Cycadales or Bennettitales.

CYCADOPITES cf. C. GIGANTEOUS Stanley, 1965

Plate 7, figs. 1, 2

Cycadopites giganteous STANLEY, 1965, Bull. Amer. Paleont., v. 49, no. 222, p. 270, 271, pl. 37, figs. 6-9.

Description.—Monosulcate pollen grain. Fusiform in outline. Walls approximately 2.5μ thick and psilate; endexine and ektexine about equal in thickness. Sulcus extends length of grain; central portion overlaps; ends gape open. Overall size 120μ to 150μ.

Differential Diagnosis.—This form differs from Stanley's in the fact that it is much larger. *Cycadopites* cf. *C. giganteous* Stanley, 1965, is distinguished from other monosulcate grains in these samples by its extremely large size.

Occurrence.—*Cycadopites* cf. *C. giganteous* Stanley, 1965, is present in the lower and middle parts of the lower portion of the Kaiparowits Formation.

Frequency.—Rare.

Figured Specimen.—BYU-Py-31, CFL-K-256+1250 ft. Orig. (7.2, 4.3).

CYCADOPITES n. sp. A

Plate 7, fig. 3

Description.—Monosulcate pollen grain. Fusiform to spindle-form in outline. Walls approximately 1μ thick and scabrate to granulate. Sulcus extends most of length of grain, up to 6μ wide; center overlaps; ends may or may not gape. Overall size 11μ to 17μ by 24μ to 34μ.

Differential Diagnosis.—*Cycadopites* n. sp. A is distinguished from other monosulcate pollen grains in these samples by its fusiform to spindle-form outline and its wall sculpture.

EXPLANATION OF PLATE 7

FIGS. 1, 2.—*Cycadopites* cf. *C. giganteous* Stanley, 1965, X500, polar view, BYU-Py-31, CFL-K-256+1250 ft. Orig. (7.2, 4.3).

FIG. 3.—*Cycadopites* n. sp. A, X1000, polar view, BYU-Py-32, CFL-K-256+1250 ft. Orig. (13.6, 8.2).

FIG. 4.—*Entylissa* cf. *E. nitidus* Balme, 1957, X1000, polar view, BYU-Py-33, CFL-K-256+1250 ft. Orig. (16.0, 7.3).

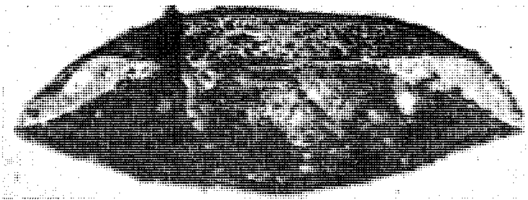
FIG. 5.—*Entylissa* n. sp. A, X1000, polar view, BYU-Py-34, JRB-Ka-1+5 ft. Orig. (10.75, 12.85).

FIG. 6.—*Araucariacites australis* Cookson, 1947, X1000, BYU-Py-35, JRB-Ka-1+5 ft. Orig. (14.8, 12.05).

FIG. 7.—*Inaperturopollenites dubius* (Potonié and Venitz), Pflug and Thomson *in* Thomson and Pflug, 1953, X1000, BYU-Py-36, CFL-K-256+1250 ft. Orig. (8.4, 8.85).

FIG. 8.—*Laricoidites magnus* (Potonié, 1931) Potonié, Thomson and Thiergart, 1950, X500, BYU-Py-37, CFL-K-256+1250 ft. Orig. (1.0, 3.4).

PLATE 7



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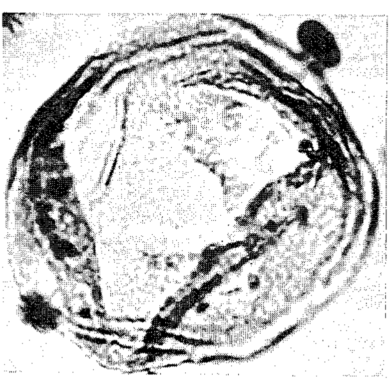

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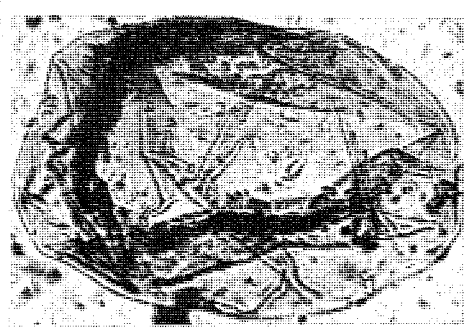


8

Occurrence.—*Cycadopites* n. sp. A is present throughout the Kaiparowits Formation.

Frequency.—Rare to frequent.

Figured Specimen.—BYU-Py-32, CFL-K-256+1250 ft. Orig. (13.6, 8.2).

Orders CYCADALES-BENNETTITALES-GINKGOALES complex
Genus ENTYLISSA (NAUMOVA) ex POTONIÉ AND KREMP, 1954

Entylissa NAUMOVA, 1937, Report 17th Int. Geol. Congress, v. 1, no. 4, p. 355.
Entylissa (NAUMOVA), POTONIÉ AND KREMP, 1954, Geol. Jb., v. 69, p. 181.
Entylissa (NAUMOVA, 1937) ex POTONIÉ AND KREMP, 1954, POTONIÉ AND KREMP, 1956, Palaeontographica, v. 99, pt. B, p. 186.
Entylissa (NAUMOVA) ex POTONIÉ AND KREMP, 1954, BALME, 1957, Commonwealth Sci. Ind. Res. Organization, Coal Res. Sec., T. C. 25, p. 30.
Entylissa (NAUMOVA, 1937) ex POTONIÉ AND KREMP, 1954, POTONIÉ, 1958, Beih. Geol. Jb., v. 31, p. 93.
Entylissa (NAUMOVA) POTONIÉ AND KREMP, 1954, ANDERSON, 1960, New Mexico State Bureau Mines and Mineral Res. Memoir 6, p. 12, 28.
Cycadopites WODEHOUSE, 1933, ANDERSON, 1960, New Mexico State Bureau Mines and Mineral Res. Memoir 6, p. 12.
Entylissa (NAUMOVA) ex POTONIÉ AND KREMP, BRENNER, 1963, Maryland Dept. Geol., Mines Water Res. Bull. 27, p. 74.

Type Species.—Not designated.

Description.—Monosulcate pollen grain. Oval to fusiform in outline. Walls of variable thickness, and sculpture either lacking or fine. Sulcus constricted at midpoint and gradually expanding toward the ends. Size variable.

Differential Diagnosis.—*Entylissa* (Naumova) ex Potonié and Kremp, 1954, is essentially synonymous with *Cycadopites* Wodehouse ex Wilson and Webster, 1946. Both names have been retained in this work because they are both widely used in the literature.

Botanical Affinities.—Brenner (1963, p. 74) suggests that forms in this genus belong to the Cycadales-Bennettitales-Ginkgoales Complex of morphologically similar pollen types.

ENTYLISSA cf. E. NITIDUS Balme, 1957

Plate 7, fig. 4

Entylissa nitidus BALME, 1957, Commonwealth Sci. Ind. Res. Organization, Coal Res. Sect., T. C. 25, p. 30, pl. 6, figs. 78-80.
Entylissa nitidus BALME (1957), KREMP AND AMES, 1962, Catalog of Fossil Spores and Pollen, v. 16, p. 138.
Entylissa nitidus BALME, BRENNER, 1963, Maryland Dept. Geol., Mines Water Res. Bull. 27, p. 74, 75, pl. 25, figs. 3, 4.

Description.—Monosulcate pollen grain. Oval in outline. Walls approximately 0.5μ thick and psilate. Sulcus extends entire length of grain, constricted at midpoint, expanding uniformily to the ends. Central half of the sulcus is bordered by a thickened psilate margo 2.5μ to 3.5μ wide. Overall size 15μ to 32μ.

Differential Diagnosis.—*Entylissa* cf. *E. nitidus* Balme, 1957, is distinguished on the basis of its small size and constricted sulcus with bordering margo.

Occurrence.—*Entylissa* cf. *E. nitidue* Balme 1957, is present in all samples studied from the Kaiparowits Formation.

Frequency.—Rare to frequent.

Figured Specimen.—BYU-Py-33, CFL-K-256+1250 ft. Orig. (16.0, 7.3).

ENTYLISSA n. sp. A

Plate 7, fig. 5

Description.—Monosulcate pollen grain. Oval to fusiform in outline. Walls 0.7μ to 0.9μ

thick and scabrate. Sulcus extends length of grain, constricted in central portion and open at the ends. Overall size 10μ to 20μ.

Differential Diagnosis.—*Entylissa* n. sp. A is distinguished from other monsulcate grains in this sequence by its small size, open sulcus, and fine sculpture.

Occurrence.—*Entylissa* n. sp. A is present in all samples studied from the Kaiparowits Formation.

Frequency.—Frequent to common.

Figured Specimen.—BYU-Py-34, JRB-Ka-1+5 ft. Orig. (10.75, 12.85).

Order PINALES
Family ARAUCARIACEAE
Genus ARAUCARIACITES Cookson ex Couper, 1953

Araucariacites COOKSON ex COUPER, 1953, New Zealand Geol. Survey Paleont. Bull. 22, p. 39.
Araucariacites COOKSON ex COUPER, COUPER, 1958, Palaeontographica, v. 103, pt. B., p. 151.
Araucariacites (COOKSON) ex COUPER, 1953, BRENNER, 1963, Maryland Dept. Geol., Mines Water Res. Bull. 27, p. 76.
Araucariacites COOKSON ex COUPER, 1953, DETTMANN, 1963, Proc. Royal Soc. Victoria, New Ser. v. 77, pt. 1, p. 105.
Araucariacites COOKSON, LEOPOLD AND PAKISER, 1964, U. S. Geol. Survey Bull. 1160-E, p. 82.
Araucariacites COOKSON ex COUPER, 1953, HARRIS, 1965, Palaeontographica, v. 115, pt. B, p. 88.
Araucariacites COOKSON ex COUPER, 1953, SRIVASTAVA, 1966, Pollen et Spores, v. 8, no. 3, p. 520.
Araucariacites COOKSON ex COUPER, NORRIS, 1967, Palaeontographica, v. 120, pt. B, p. 104.

Type Species.—*Araucariacites australis* Cookson, 1947. Couper (1953, p. 39) designated this as the type species.

Description.—Cookson (1947, p. 130) described the sporomorph *Araucariacites* as "spherical non-aperturate grains with granular exines of the type met with amongst recent members of the Araucariaceae."

Botanical Affinities.—Araucariaceae.

ARAUCARIACITES AUSTRALIS Cookson, 1947

Plate 7, fig. 6

Granulonapites (*Araucariacites*) *australis* COOKSON, 1947, British, Australian, and New Zealand Antarctic Res. Expedition, 1929-31, Rept. Ser. A, v. 2, pt. 8, p. 130, 131, pl. 13, figs. 1-4.
Araucariacites cf. *australis* COOKSON, COUPER, 1953, New Zealand Geol. Survey. Paleont. Bull. 22, p. 39.
Araucariacites australis COOKSON, COUPER, 1958, Palaeontographica, v. 103, pt. B, p. 151, pl. 27, figs. 3-5.
Granulonapites (*Araucariacites*) *australis* COOKSON (1947), KREMP AND AMES, 1962, Catalog of Fossil Spores and Pollen, v. 15, p. 5.
Araucariacites australis COOKSON, BRENNER, 1963, Maryland Dept. Geol., Mines Water Res. Bull. 27, p. 76, pl. 25, figs. 9, 10.
Araucariacites australis COOKSON, 1947, DETTMANN, 1963, Proc. Royal Soc. Victoria, New Ser. v. 77, pt. 1, p. 105, 106, pl. 26, fig. 15.
Araucariacites australis COOKSON, 1947, LEOPOLD AND PAKISER, 1964, U. S. Geol. Survey Bull. 1160-E, pl. 6, fig. 29.
Araucariacites australis COOKSON, 1947, HARRIS, 1965, Palaeontographica, v. 115, pt. B, p. 88, pl. 26, fig. 24.
Araucariacites australis COOKSON 1947, SRIVASTAVA, 1966, Pollen et Spores, v. 8, no. 3, p. 520, pl. 5, figs. 11, 13.

Araucariacites australis COOKSON, NORRIS, 1967, Palaeontographica, v. 120, pt. B, p. 104, pl. 16, fig. 9.

Description.—Inaperturate pollen grain. Circular to subcircular in outline. Walls 1μ to 3μ thick and scabrate to granulate, wall in central part of some grains is extremely thin. Overall size 45μ to 70μ. May have secondary folds. Some grains appear to have a rudimentary bladder up to 6μ wide entirely surrounding them.

Differential Diagnosis.—*Araucariacites australis* Cookson, 1947, is distinguished from other inaperturate grains in this sequence by its size and sculpture.

Occurrence.—*Araucariacites australis* Cookson 1947, is present throughout the Kaiparowits Formation.

Frequency.—Rare to common.

Figured Specimen.—BYU-Py-35, JRB-Ka-1+5 ft. Orig. (-4.8, 12.1).

Family TAXODIACEAE or CUPRESSACEAE (provisional assignment)

Genus INAPERTUROPOLLENITES Pflug and Thomson in Thomsan and Pflug, 1953

Inaperturopollenites PFLUG AND THOMSON in THOMSON AND PFLUG, 1953, Palaeontographica, v. 94, p. 64.

Inaperturopollenites (PFLUG 1952, ex THOMSON AND PFLUG, 1953) emended POTONIÉ, 1958, Beih. Geol. Jb., v. 31, p. 77, 78.

Inaperturopollenites PFLUG AND THOMSON, 1953, GROOT AND PENNY, 1960, Micropaleontology, v. 6, no. 2, p. 232.

Inaperturopollenites PFLUG AND THOMSON, 1953, GROOT, PENNY AND GROOT, 1961, Palaeontographica, v. 108, pt. B, p. 130.

Inaperturopollenites THOMSON AND PFLUG, 1953, BRENNER, 1963, Maryland Dept. Geol., Mines Water Res. Bull. 27, p 87.

Inaperturopollenites PFLUG (1952) ex THOMSON AND PFLUG (1953), emended POTONIÉ (1958), KIMYAI, 1966, Micropaleontology, v. 12, no. 4, p. 470.

Inaperturopollenites PFLUG ex THOMSON AND PFLUG emended POTONIÉ, 1958, SRIVASTAVA, 1966, Pollen et Spores, v. 8, no. 3, p. 520.

Inaperturopollenites PFLUG ex THOMSON AND PFLUG emended POTONIÉ, NORRIS, 1967, Palaeontographica, v. 120, pt. B, p. 104.

Type Species.—*Inaperturopollenites dubius* (Potonié) Pflug and Thomson in Thomson and Pflug, 1953, p. 64, pl. 4, fig. 89, pl. 5, figs. 1-13.

Description.—Without apertures. Outline more or less spherical to ellipsoidal. Exine unstructured and unsculptured.

Differential Diagnosis.—*Inaperturopollenites* is distinguished from other inaperturate pollen grains, especially *Laricoidites* Potonié, by its smaller size (generally less than approximately 50μ) and thin psilate walls.

Botanical Affinities.—Thomson and Pflug (1953, p. 64) and Leopold and Pakiser (1964, p. 82, 83) indicate that the organ genus *Inaperturopollenites* belongs with the extant plant family Taxodiaceae.

Family CUPRESSACEAE (provisional assignment)

INAPERTUROPOLLENITES DUBIUS (Potonié and Venitz), Pflug and Thomson in Thomson and Pflug, 1953

Plate 7, fig. 7

Pollenites magnus dubius POTONIÉ AND VENITZ, 1934, Arb. Inst. Paläobot. u. Petrogr. Brennsteine, v. 5, p. 17, pl. 2, fig. 21.

Inaperturopollenites dubius (POTONIÉ AND VENITZ), PFLUG AND THOMSON in THOMSON AND PFLUG, 1953, Palaeontographica, v. 94, pt. B, p. 65, pl. 4, fig. 89, and pl. 5, figs. 1-13.

Inaperturopollenites dubius (POTONIÉ AND VENITZ), THOMSON AND PFLUG, 1953, POTONIÉ, 1958, Beih. Geol. Jb., v. 31, p. 77, 78.

Inaperturopollenites dubius POTONIÉ AND VENITZ, GROOT AND PENNY, 1960, Micropaleontology, v. 6, no. 2, p. 232, pl. 2, figs. 16-17.

Inaperturopollenites dubius (POTONIÉ AND VENITZ), THOMSON AND PFLUG, KEDVES, 1960, Pollen et Spores, v. 2, no. 1, p. 106, pl. 7, figs. 2, 3.

Inaperturopollenites dubius PFLUG AND THOMSON, 1953, GROOT, PENNY AND GROOT, 1961, Palaeontographica, v. 108, pt. B, p. 130, pl. 24, fig. 15.
Inaperturopollenites dubius (POTONIÉ AND VENITZ) THOMSON AND PFLUG, BRENNER, 1963, Maryland Dept. Geol., Mines Water Res. Bull. 27, p. 87, 88, pl. 35, figs. 5, 6.
Inaperturopollenites dubius (POTONIÉ AND VENITZ) THOMSON AND PFLUG, LEOPOLD AND PAKISER, 1964, U. S. Geol. Survey Bull. 1160-E, p. 82, 83, pl. 6, figs. 25, 26.
Inaperturopollenites dubius (POTONIÉ AND VENITZ) THOMSON AND PFLUG, 1953, SRIVASTAVA, 1966, Pollen et Spores, v. 8, no. 3, p. 520, pl. 4, fig. 18, pl. 5, figs. 12, 14.
Inaperturopollenites dubius (POTONIÉ AND VENITZ) THOMSON AND PFLUG, NORRIS, 1967, Palaeontographica, v. 120, pt. B, p. 104, pl. 16, fig. 14.

Type Species.—Inaperturopollenites dubius (Potonié) Pflug and Thomson in Thomson and Pflug, 1953.

Description.—Inaperturate pollen grain. Circular to oval in outline. Walls approximately 0.5μ thick and psilate. Overall size 30μ to 50μ. Walls may be split and commonly with numerous secondary folds.

Differential Diagnosis.—Inaperturopollenites dubius (Potonié) Pflug and Thomson in Thomson and Pflug, 1953, is distinguished from other inaperturate grains in these samples by its thin walls, large size, psilate walls, and secondary folds.

Botanical Affinities.—Groot, Penny and Groot (1961, p. 130) indicate that this species belongs to the Family Cupressaceae based upon morphological similarity of the pollen.

Occurrence.—This form is present throughout the entire Kaiparowits Formation.

Frequency.—Rare to frequent.

Figured Specimen.—BYU-Py-36, CFL-K-256+1250 ft. Orig. (8.4, 8.85).

Family PINACEAE (provisional assignment)
Genus LARICOIDITES Potonié, Thomson and Thiergart, 1950, Potonié, 1958

Laricoidites POTONIÉ, THOMSON AND THIERGART, 1950, Geol. Jb., v. 65, p. 48.
Inaperturopollenites PFLUG AND THOMSON in THOMSON AND PFLUG, 1953, Palaeontographica, v. 94, pt. B, p. 64.
Laricoidites POTONIÉ, THOMSON AND THIERGART ex POTONIÉ, 1958, Beih. Geol. Jb., v. 31, p. 76.
Laricoidites POTONIÉ, THOMSON AND THIERGART, 1950, BRENNER, 1963, Maryland Dept. Geol., Mines Water Res. Bull. 27, p. 88.
Laricoidites POTONIÉ, 1958, STANLEY, 1965, Bull. Amer. Paleont., v. 49, no. 222, p. 278.
Laricoidites POTONIÉ, THOMSON AND THIERGART, 1950, SRIVASTAVA, 1966, Pollen et Spores, v. 8, no. 3, p. 522.

Type Species.—Laricoidites magnus (Potonié), Potonié, 1958.

Description.—Inaperturate pollen grains. Shape more or less spherical with many secondary folds. Large size, 50μ to more than 100μ. Exine thin and smooth to infrascabrate.

Discussion.—Laricoidites apparently did not become a completely valid generic name until 1958 when Potonié (p. 78, 79) published a clear definition of it.

Differential Diagnosis.—Laricoidites Potonié, Thomson and Thiergart, 1950, Potonié, 1958, is differentiated artificially separated on the basis of its larger size.

Botanical Affinities.—Larix?

LARICOIDITES MAGNUS (Potonié, 1931) Potonié, Thomson and Thiergart, 1950

Plate 7, fig. 8

Sporonites (?) *magnus* POTONIÉ, 1931, Z. Braunkohle, v. 30, p. 556, fig. 6.
Pollenites magnus (POTONIÉ), POTONIÉ, 1934, Arb. Inst. Paläont., u. Petrogr. Brennsteine, v. 4, p. 48, p. 6, fig. 5.

Pollenites magnus (POTONIÉ), POTONIÉ, 1934, Arb. Inst. Palaeont., v. 5, p. 16, pl. 1, fig. 19.
Larix-pollenites magnus (POTONIÉ), RAATZ, 1937, Abb. preuss, geol. L.-A.N.F., v. 183, p. 15.
Laricoidites magnus (POTONIÉ), POTONIÉ, THOMSON AND THIERGART, 1950, Geol. Jb., v. 65, p. 48, pl. C, figs. 9, 10.
Inaperturopollenites magnus (POTONIÉ), THOMSON AND PFLUG, 1953, Palaeontographica, v. 94, pt. B, p. 64, pl. 4, figs. 83-88.
Sporonites (?) *magnus* POTONIÉ (1931), KREMP, AMES AND KOVAR, 1958, Catalog Fossil Spores and Pollen, v. 4, p. 110.
Inaperturopollenties magnus (POTONIÉ) THOMSON AND PFLUG, KEDVES, 1960, Pollen et Spores, v. 2, no. 1, p. 104, pl. 7, fig. 1.
Inaperturopollenites magnus (POTONIÉ) THOMSON AND PFLUG, 1953, KEDVES, 1961, Pollen et Spores, v. 3, no. 1, p. 143, pl. 9, fig. 4.
Pollenites magnus (POTONIÉ), POTONIÉ in KREMP AND AMES, 1962, catalog Fossil Spores and Pollen, v. 14, p. 77a, b.
Inaperturopollenites cf. *magnus* (POTONIÉ), THOMSON AND PFLUG, MANUM, 1962, Norsk Polarinstitutt Shrifter, no. 125, p. 39.
Laricoidites magnus (POTONIÉ, 1931) POTONIÉ, THOMSON AND THIERGART, BRENNER, 1963, Maryland Dept. Geol., Mines Water Res. Bull. 27, p. 88 pl. 37, figs. 1, 2.
Laricoidites magnus (POTONIÉ), POTONIÉ, THOMSON AND THIERGART, STANLEY, 1965, Bull. Amer. Paleont., v. 49, no. 222, p. 278, 279, pl. 40, figs. 8, 9.

Description.—Inaperturate pollen grain. Oval to circular in outline. Walls approximately 1.5μ thick and psilate. Overall size 80μ to 110μ by 100μ to 140μ. Secondary folds numerous.

Differential Diagnosis.—*Laricoidites* Potonié, Thomson and Thiergart, 1950, Potonié, 1958, is distinguished on the basis of its large size and thin walls.

Occurrence.—*Laricoidites magnus* (Potonié, 1931) Potonié, Thomson and Thiergart, 1950, is present only in samples CFL-K-256+1250 ft. and CFL-K-257G+1330 ft.

Frequency.—Rare.

Figured Specimen.—BYU-Py-37, CFL-K-256+1250 ft. Orig. (1.0, 3.4).

Genus PICEAEPOLLENITES Potonié, 1931

Piceaepollenites POTONIÉ, 1931, Jb., preuss. geol. L.A., v. 52, p. 5.
Piceapollenites THIERGART, 1938, Jb., preuss. geol. L.A., v. 58, p. 306.
Piceaepollenites POTONIÉ, 1931, POTONIÉ, 1958, Beih. Geol. Jb., v. 31, p. 64.
Piceaepollenites POTONIÉ, 1931, SINGH, 1964, Research Council Alberta Bull. 15, p. 121.
Piceaepollenites POTONIÉ, 1931, HEDLUND, 1966, Okla. Geol. Survey Bull. 112, p. 23.

Type Species.—*Piceaepollenites alatus* Potonié, 1931.

Description.—Disaccate, bilaterally symmetrical pollen grain. Central body more or less oval in equatorial outline. Bladders small in comparison to central body; bladders nearly as long as the central body. In lateral view a small reentrant angle is visible between the bladder and body. Base of bladders may reach beyond the equator on proximal side. Central body is scabrate to granulate sculpture; bladders are reticulate.

Botanical Affinities.—Morphologically this form is similar to the extant genus *Picea,* family Pinaceae.

PICEAEPOLLENITES n. sp. A

Plate 8, fig. 1

Description.—Disaccate, bilaterally symmetrical pollen grain. Central body is oval to circular in equatorial outline, proximal surface is convex. Proximal cap is 1.75μ to 2.25μ thick and finely reticulate; muri are 0.2μ to 0.3μ wide; lumina are 0.3μ to 0.4μ across and circular in outline. Central body is 45μ to 60μ in length by 40μ to 55μ in breadth.

Bladders are equatorially attached on the distal surface, strongly pendant, and curved to follow the equatorial outline of the grain. Base of the bladders are approximately equal to the length of the central body, 45μ to 60μ by 20μ to 30μ in breadth. In lateral view the bladders are bluntly pointed. The walls have a fine reticulate structure; muri are 0.4μ to 0.6μ wide; lumina are 0.5μ to 0.7μ across and circular to subcircular in outline. The bladders are covered by a slightly coarser reticulum than the central body. The distal furrow is distinct and extends the length of the central body.

Occurrence.—Piceaepollenites n. sp. A is present throughout the Kaiparowits Formation.

Frequency.—Rare to frequent.

Figured Specimen.—BYU-Py-38, CFL-K-256+1250 ft. Orig. (5.2, 9.3).

Family PODOCARPACEAE
Genus PHYLLOCLADIDITES Cookson, 1947 ex Couper, 1953

Disaccites (*Phyllocladidites*) COOKSON, 1947, British, Australian, and New Zealand Antarctic Res. Expedition. 1929-31, Rept. Ser. A, v. 2, pt. 8, p. 133.
Phyllocladidites COOKSON ex COUPER, 1953, New Zealand Geol. Survey Paleont. Bull. 22, p. 38.
Dacrydiumites COOKSON, 1953, Australian Jour. Bot., v. 1, no. 1, p. 66.
Dacrydium COOKSON, 1957 (in part), Proc. Royal Soc. Victoria, New Ser. v. 69, p. 53.
Phyllocladidites (COOKSON, 1947) COUPER, 1953, POTONIÉ, 1958, Beih, Geol. Jb., v. 31, p. 69, 70.
Dacrydiumites COOKSON, 1953; 1957, POTONIÉ, 1960, Beih. Geol. Jb., v. 39, p. 78.
Dacrydiumites COOKSON, COUPER, 1960, New Zealand Geol. Survey Paleont. Bull. 32, p. 43.
Phyllocladidites COOKSON ex COUPER 1953, GROOT, PENNY AND GROOT, 1961, Palaeontographica, v. 108, pt. B, p. 130.
Phyllocladidites (COOKSON, 1947) ex COUPER, 1953, BRENNER, 1963, Maryland Dept. Geol., Mines Water Res. Bull. 27, p. 79.
Phyllocladidites COOKSON, 1947 ex COUPER, 1953, SINGH, 1964, Research Council Alberta Bull., 15, p. 113.
Phyllocladidites COOKSON ex COUPER, 1953, HARRIS, 1965, Palaeontographica, v. 115, pt. B, p. 86.
Phyllocladidites COOKSON ex COUPER, NORRIS, 1967, Palaeontographica, v. 120, pt. B, p. 120.

Type Species.—Phyllocladidites mawsonii Cookson, 1947. (Designated by Couper, 1953).

Description.—"Grains of medium size, with two small air bladders, which, when expanded, do not extend far beyond the equator of the grain; body of grain ellipsoidal, with a wide clearly defined furrow. The exine is firm, finely granular and conspicuously thickened at the proximal root of each bladder." (Cookson, 1947, p. 132).

Botanical Affinities.—Cookson (1957, p. 53) suggests *Phyllocladidites* is related to the genus *Dacrydium,* family Podocarpaceae.

PHYLLOCLADIDITES MAWSONII Cookson, 1947

Plate 8, fig. 4

Disaccites (*Phyllocladidites*) *Mawsonii* COOKSON, 1947, British, Australian, and New Zealand Antarctic Res. Expedition. 1929-31, Dept. Ser. A, v. 2, pt. 8, p. 133, pl. 14, figs. 22-28.
Phyllocladidites mawsonii COOKSON, COUPER, 1953, New Zealand Geol. Survey Paleont. Bull. 22, p. 38, pl. 9, fig. 135.
Dacrydiumites mawsonii (COOKSON) COOKSON, 1953, Australian Jour. Bot., v. 1, no. 1, p. 66, pl. 1, figs. 9-26.
Dacrydium mawsonii (COOKSON) COOKSON, 1957, Proc. Royal Soc. Victoria, New Ser. v. 69, p. 53.
Dacrydiumites mawsonii COOKSON, COUPER, 1960, New Zealand Geol. Survey Paleont. Bull. 32, p. 43, pl. 3, figs. 7, 8.
Disaccites (*Phyllocladidites*) *mawsoni* COOKSON (1947), KREMP AND AMES, 1962, Catalog of Fossil Spores and Pollen, v. 15, p. 2.

Phyllocladidites mawsonii COOKSON, 1947, HARRIS, 1965, Palaeontographica, v. 115, pt. B, p. 86, pl. 26, figs. 13-15.

Description.—Disaccate, bilaterally symmetrical pollen grain. Central body is oval to subcircular in equatorial outline; proximal surface is convex. Proximal cap is 1.75μ to 2.25μ thick and granulate. Overall size of central body is 27μ to 33μ long by 25μ to 28μ in breadth. Two small bladders are present on the distal surface of the grain. The bladders are rhomboid-shaped in outline, 12μ to 14μ in breadth by 17μ to 20μ in width. They are covered by a fine reticulum; muri are 0.3μ to 0.5μ wide; lumina are 0.8μ to 1μ across and subcircular. The bladders are attached equatorially on each side of the distal furrow; the base of each bladder is much thickened. The distal furrow is clear and well defined extending almost the length of the central body and approximately ¾ the breadth. The walls are scabrate.

Differential Diagnosis.—*Phyllocladidites mawsonii* Cookson, 1947, is distinguished by its small rhomboid-shaped bladders.

Occurrence.—*Phyllocladidites mawsonii* Cookson, 1947, is present throughout the lower portion of the Kaiparowits Formation.

Frequency.—Rare to frequent.

Figured Specimen.—BYU-Py-41, JRB-Ka-1+5 ft. Orig. (30.95, 18.3).

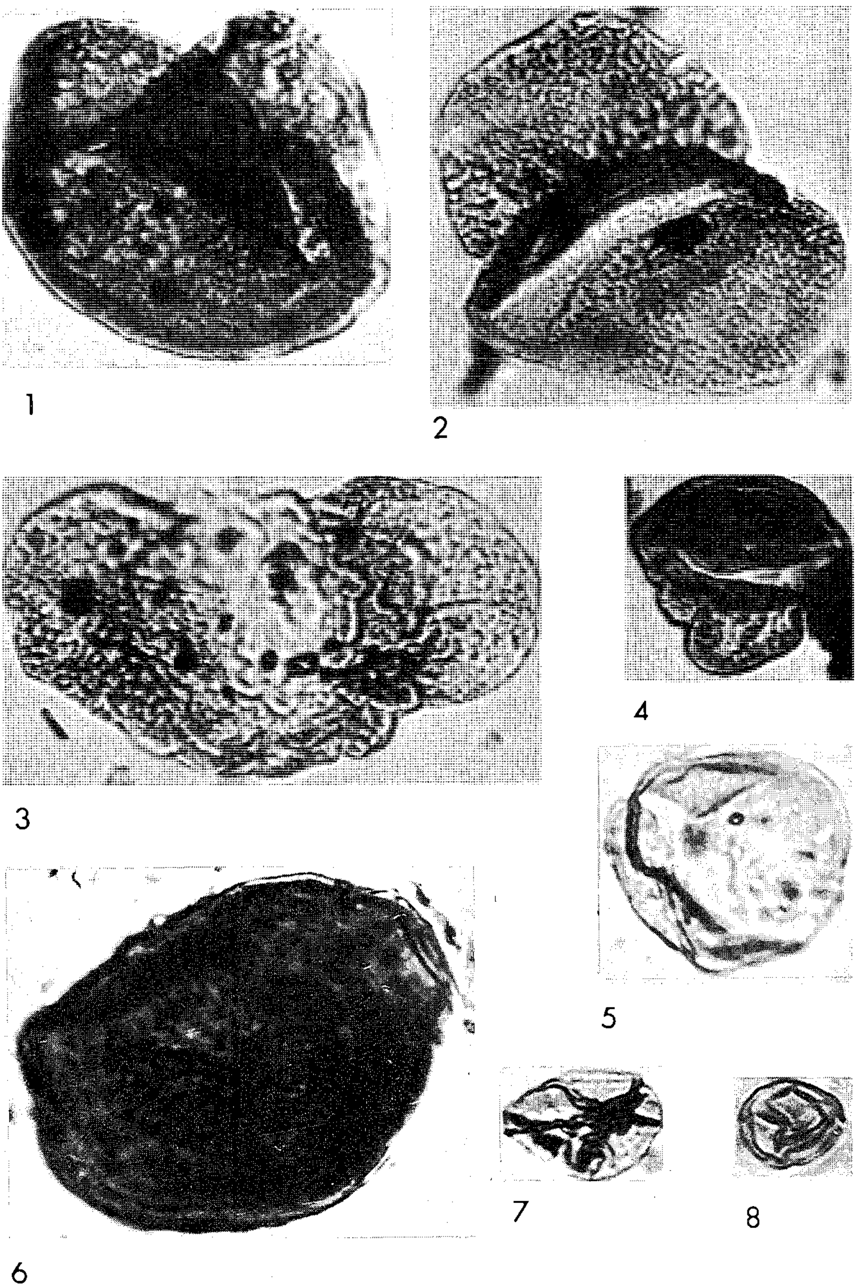
Genus PODOCARPIDITES Cookson, 1947, ex Couper, 1953

Disaccites (*Podocarpidites*) COOKSON, 1947, British, Australian, and New Zealand Antarctic Res. Expedition. 1929-31, Rept. Ser. A, v. 2, pt. 8, p. 131.
Podocarpidites COOKSON ex COUPER, 1953, New Zealand Geol. Survey Paleont. Bull. 22, p. 35.
Podocarpidites COOKSON, ROUSE, 1957, Canadian Jour. Bot., v. 35, no. 3, p. 367.
Podocarpidites (COOKSON, 1947) emended POTONIÉ, 1958, Beih. Geol. Jb., v. 31, p. 68.
Podocarpidites COOKSON, (1947) ex COUPER, (1953), ROUSE, 1959, Micropaleontology, v. 5, no. 3, p. 313.
Podocarpidites COOKSON ex COUPER, COUPER, 1960, New Zealand Geol. Survey Paleont. Bull. 32, p. 45.
Podocarpidites COOKSON, POCOCK, 1962, Palaeontographica, v. 111, pt. B, p. 65.
Podocarpidites (COOKSON, 1947) ex COUPER, 1953, BRENNER, 1963, Maryland Dept. Geol., Mines Water Res. Bull. 27, p. 81.

EXPLANATION OF PLATE 8

FIG. 1.—*Piceaepollenites* n. sp. A, X1000, lateral view, BYU-Py-38, CFL-K-256+1250 ft. Orig. (5.2, 9.3).
FIG. 2.—*Pityosporites constrictus* Singh, 1964, X1000, polar view, BYU-Py-39, JRB-Ka-1+5 ft. Orig. (30.55, 4.7).
FIG. 3.—*Podocarpidites* n. sp. A, X1000, polar viey, BYU-Py-40, JRB-Ka-1+5 ft. Orig. (29.9, 2.45).
FIG. 4.—*Phyllocladidites mawsonii* Cookson, 1947, X1000, lateral view, BYU-Py-41, JRB-Ka-1+5 ft. Orig. (30.95, 18.3).
FIG. 5.—*Inaperturopollenites rugosa* Groot, Penny and Groot, 1961, X1000, BYU-Py-42, CFL-K-256+1250 ft. Orig. (13.1, 8.8).
FIG. 6.—*Inaperturopollenites* cf. *I. limbatus* Balme, 1957, X1000, BYU-Py-43, CFL-K-256+1250 ft. Orig. (10.9, 9.3).
FIG. 7.—*Inaperturopollenites minor* Kedves, 1961, X1000, BYU-Py-44, JRB-Ka-1+5 ft. Orig. (1.3, 16.5).
FIG. 8.—*Inaperturopollenites* n. sp. A, X1000, BYU-Py-45, CFL-K-256+1250 ft. Orig. (7.6, 3.25).

PLATE 8



Podocarpidites COOKSON ex COUPER, 1953, DETTMANN, 1963, Proc. Royal Soc. Victoria, New Ser. v. 77, pt. 1, p. 102.
Podocarpidites COOKSON, 1947, ex COUPER, 1953, SINGH, 1964, Research Council Alberta Bull. 15, p. 115.
Podocarpidites COOKSON ex COUPER, 1953, HARRIS, 1965, Palaeontographica, v. 115, pt. B, p. 85.
Podocarpidites COOKSON ex COUPER 1953, SRIVASTAVA, 1966, Pollen et Spores, v. 8, no. 3, p. 520.
Podocarpidites COOKSON ex COUPER, 1953, DRUGG, 1967, Palaeontographica, v. 120, pt. B, p. 45.
Podocarpidites COOKSON ex COUPER, NORRIS, 1967, Palaeontographica, v. 120, pt. B, p. 102.

Type Species.—*Podocarpidites ellipticus* Cookson, 1947. (Designated by Couper, 1953).

Description.—Disaccate, bilaterally symmetrical pollen grain. Equatorial outline of central body is oval to polygonal. Marginal crest is visible. Bladders are large, distally pendant, and cover the distal surface except for a parallel-sided area corresponding to the distal leptoma. Length of central body generally less than length of bladders. This genus also includes polysaccate pollen grains as emended by Couper (1953, p. 35).

Botanical Affinities.—Podocarpaceae.

PODOCARPIDITES n. sp. A

Plate 8, fig. 3

Description.—Disaccate, bilaterally symmetrical pollen grain. Central body is oval to circular in equatorial outline. Central body is 30μ to 40μ in length by 35μ to 45μ in breadth. Proximal cap is coarsely rugulate. Rugae are scabrate and crenulate, 2.5μ to 4μ high and 2.5μ to 4μ apart. Two reniform bladders, slightly pendant to pendant, are present, one on each side of the distal furrow. Bladders are granulate, 30μ to 34μ in length by 22μ to 26μ in breadth. Bladders are equatorially attached. Distal furrow is scabrate. Overall size 65μ to 75μ in breadth by 35μ to 45μ in length.

Differential Diagnosis.—*Podocarpidites* n. sp. A is distinguished by its coarsely rugulate proximal cap.

Occurrence.—*Podocarpidites* n. sp. A is present throughout the Kaiparowits Formation.

Frequency.—Rare to frequent.

Figured Specimen.—BYU-Py-40, JRB-Ka-1+5 ft. Orig. (29.9, 2.45).

Family PODOCARPACEAE (provisional assignment)
Genus PITYOSPORITES Seward, 1914, emended Manum, 1960

Pityosporites SEWARD, 1914, British Antarctic (Terra Nova) Expedition 1910, Nat. Hist. Rept., Geol. 1, p. 23.
Pityosporites SEWARD, emended POTONIÉ AND KLAUS, 1954, Geol. Jb., v. 68, p. 534.
Pityosporites (SEWARD, 1914) emended POTONIÉ AND KLAUS, 1954, POTONIÉ, 1958, Beih. Geol. Jb., v. 31, p. 56, 57.
Pityosporites SEWARD, emended MANUM, 1960, Nytt. Mag. Bot. v. 8, p. 14.
Pityosporites SEWARD, 1914, emended MANUM, 1960, SINGH, 1964, Research Council Alberta Bull. 15, p. 121, 122.
Pityosporites SEWARD emended MANUM, 1960, SRIVASTAVA, 1966, Pollen et Spores v. 8, no. 3, p. 524.

Type Species.—*Pityosporites antarcticus* Seward, 1914.

Description.—Disaccate, bilaterally symmetrical pollen grain. Bladders are distally pendant, narrowing at the roots, but flaring; proximally the roots reach the equator of the central body or slightly beyond; distally the roots are separated by a more or less narrow furrow. The bladders are reticulate; the central body is psilate or finely sculptured. Walls are of moderate thickness and do not increase markedly toward the bladder roots.

Discussion.—See Singh, (1964, p. 122).

Botanical Affinities.—Seward (1914, p. 23) suggested that *Pityosporites* has an affinity to the family Pinaceae, however he stated that ". . . on geographical grounds it would seem more probable that the spores belong to some plant allied to *Podocarpus, Dacrydium* or *Microcachrys*."

PITYOSPORITES CONSTRICTUS Singh, 1964

Plate 8, fig. 2

Pityosporities constrictus SINGH, 1964, Research Council Alberta Bull. 15, p. 122 p. 16, figs. 8, 9.
Pityosporites constrictus SINGH, 1964, SRIVASTAVA ,1966, Pollen et Spores, v. 8, no. 3, p. 524, pl. 6, fig. 2.

Description.—Disaccate, bilaterally symmetrical pollen grain. Central body is oval in equatorial outline, 40μ to 60μ in length by 25μ to 35μ in breadth. Distal furrow is narrow, ½ to ⅓ the breadth of the central body, with straight sides. Walls are finely scabrate. Bladders are rooted on the distal surface near the equator. They are 40μ to 50μ in length by 20μ to 25μ in breadth. They are slightly to decidedly distally pendant. Bladders are covered with a fine reticulum; muri are 0.3μ to 0.5μ wide; lumina are 0.3μ to 0.5μ across and subcircular in outline. Bladders are hemicircular in outline. Commonly the bladders are decidedly pendant and are usually observed in edge view giving them the appearance of being extremely heavy but small.

Occurrence.—Pityosporites constrictus Singh, 1964, is present throughout the Kaiparowits Formation.

Frequency.—Rare to common.

Figured Specimen.—BYU-Py-39, JRB-Ka-1+5 ft. Orig. (30.55, 4.7).

INAPERTUROPOLLENITES RUGOSA Groot, Penny and Groot, 1961

Plate 8, fig. 5

Inaperturopollenites rugosa GROOT, PENNY and GROOT, 1961, Palaeontographica, v 108, pt. B, p. 130, pl. 24, fig. 17.

Description.—Inaperturate pollen grain. Subround to round in outline. Walls approximately 0.5μ thick and uniformly scabrate. Overall size 25μ to 40μ. Secondary folds are common. Grains may be broken.

Differential Diagnosis.—Inaperturopollenites rugosa Groot, Penny and Groot, 1961, is distinguished from *I. dubius* by its scabrate wall sculpture and other inaperturate grains in this sequence by its thin walls and intermediate size.

Botanical Affinites.—Taxodiaceae or Cupressaceae.

Occurrence.—Inaperturopollenites rugosa Groot, Penny and Groot, 1961, is present in all samples studied from the Kaiparowits Formation.

Frequency.—Frequent to common.

Figured Specimen.—BYU-Py-42, CFL-K-256+1250 Ft. Orig. (13.1, 8.8).

Order CONIFERALES-INCERTAE SEDIS
INAPERTUROPOLLENITES cf. I. LIMBATUS Balme, 1957

Plate 8, fig. 6

Inaperturopollenites limbatus BALME, 1957, Commonwealth Sci. Ind. Res. Organization, Coal Res. Sec., T.C. 25, p. 31, pl. 7, figs, 83, 84.
Inaperturopollenites limbatus BALME, 1957, ANDERSON, 1960, New Mexico State Bureau Mines and Mineral Res. Memoir 6, p. 28, pl. 11, figs. 14, 15.
Inaperturopollenites limbatus BALME (1957), KREMP AND AMES, 1962, Catalog of Fossil Spores and Pollen, v. 16, p. 141.

Description.—Inaperturate pollen grain. Oval to subcircular in outline. Walls approximately 1μ thick in center of grain thickening to 2.5μ to 3μ at the edge; walls scabrate to "scaly" appearing. Overall size 45μ to 60μ.

Discussion.—The forms observed in the Kaiparowits Formation are generally smaller than those described by Balme from Australia.

Differential Diagnosis.—*Inaperturopollenites* cf. *I. limbatus* Balme, 1957, is distinguished from other inaperturate grains in these samples by the thin central wall and unusually heavy wall at the edge.

Occurrence.—*Inaperturopollenites* cf. *I. limbatus* Balme, 1957, is present in only a few samples in the lower and middle portions of the Kaiparowits Formation.

Frequency.—Rare to frequent.

Figured Specimen.—BYU-Py-43, CFL-K-256+1250 ft. Orig. (10.9, 9.3).

INAPERTUROPOLLENITES MINOR Kedves, 1961

Plate 8, fig. 7

Inaperturopollenites minor KEDVES, 1961, Pollen et Spore, v. 3, no. 1, p. 143, pl. 19, fig. 6.

Description.—Inaperturate pollen grain. Oval to circular in outline. Walls 0.6μ to 0.8μ thick and scabrate to finely granulate. Overall size 10μ to 20μ. May be ruptured; may have secondary folds.

Differential Diagnosis.—*Inaperturopollenites minor* Kedves, 1961, is distinguished from others in this sequence by its small size, thin walls, and fine sculpture.

Botanical Affinities.—Kedves (1961, p. 143) suggests a relationship to the Coniferae.

Occurrence.—*Inaperturopollenites minor* Kedves, 1961, is present in all studied samples from the Kaiparowits Formation.

Frequency.—Frequent to common.

Figured Specimen.—BYU-Py-44, JRB-Ka-1+5 ft. Orig. (1.3, 16.5).

INAPERTUROPOLLENITES n. sp. A

Plate 8, fig. 8

Description.—Inaperturate pollen grain. Oval to circular in outline. Walls 0.3μ to 0.6μ thick and psilate. Overall size 10μ to 20μ. Secondary folds and breaks in the walls not uncommon.

Differential Diagnosis.—*Inaperturopollenites* n. sp. A is distinguished from other inaperturate grains in these samples by its small size and thin, psilate walls.

Botanical Affinities.—Unknown.

Occurrence.—*Inaperturopollenites* n. sp. A is present in all samples studied from the Kaiparowits Formation.

Frequency.—Frequent to common.

Figured Specimen.—BYU-Py-45, CFL-K-256+1250 ft. Orig. (7.6, 3.25).

INAPERTUROPOLLENITES n. sp. B

Plate 9, fig. 1

Description.—Inaperturate pollen grain. Circular in outline. Walls 0.6μ to 1μ thick and granulate. Overall size 15μ to 20μ. Some grains (i.e., the one figured) have an irregular opening that appears to be a distintegration feature.

Differential Diagnosis.—*Inaperturopollenites* n. sp. B is distinguished from other inaperturate grains in this sequence by its small size and distinctive granulate wall sculpture.

Botanical Affinities.—Unknown.

Occurrence.—*Inaperturopollenites* n. sp. B is present in the lower part of the lower portion and in the upper portion of the Kaiparowits Formation.

Frequency.—Rare to frequent.

Figured Specimen.—BYU-Py-46, JRB-Ka-1+5 ft. Orig. (0.9, 12.25).

INAPERTUROPOLLENITES n. sp. C

Plate 9, fig. 4

Description.—Inaperturate pollen grain. Oval to circular in outline. Walls approximately 1.5μ thick and finely scabrate. Overall size 50μ to 65μ. Secondary folds may be present.

Differential Diagnosis.—*Inaperturopollenites* n. sp. C is distinguished from other inaperturate pollen grains in these samples by its large size, thick walls, and extremely fine sculpture.

Botanical Affinities.—Unknown.

Occurrence.—*Inaperturopollenites* n. sp. C is present only in the lower and middle parts of the lower portions of the Kaiparowits Formation.

Frequency.—Rare to frequent.

Figured Specimen.—BYU-Py-47, CFL-K-256+1250 ft. Orig. (20.7, 10.75).

INAPERTUROPOLLENITES n. sp. D

Plate 9, fig. 5

Description.—Inaperturate pollen grain. Circular in outline. Walls approximately 6μ thick and psilate with a few widely scattered shallow pits 1μ to 2μ diameter. Overall size 55μ to 65μ.

Differential Diagnosis.—*Inaperturopollenites* n. sp. D is distinguished from other inaperturate grains in this sequence by its large size and psilate walls but especially its extremely thick walls.

Botanical Affinities.—Unknown.

Occurrence.—*Inaperturopollenites* n. sp. D is present in the lower and middle parts of the lower portion of the Kaiparowits Formation.

Frequency.—Rare to frequent.

Figured Specimen.—BYU-Py-48, FL-P-166+91.5 ft. Orig. (5.6, 3.3).

INAPERTUROPOLLENITES n. sp. E

Plate 9, fig. 6

Description.—Inaperturate pollen grain. Circular to subcircular in outline. Walls approximately 3.5μ thick and scabrate to granulate. Overall size 40μ to 50μ. Some of these grains (i.e., the one figured) have an irregular opening that appears to be a distintegration feature.

Differential Diagnosis.—*Inaperturopollenites* n. sp. E is distinguished on the basis of its intermediate size and thick walls. Differs from *I.* n. sp. B on the basis of larger size, thicker walls, and finer sculpture; openings are similar though.

Botanical Affinities.—Unknown.

Occurrence.—*Inaperturopollenites* n. sp. E is present in the lower part of the lower portion of the Kaiparowits Formation.

Frequency.—Rare to frequent.

Figured Specimen.—BYU-Py-49, FL-P-166+91.5 ft. Orig. (1.3, 11.05).

Class ANGIOSPERMAE
Family ERICACEAE
Genus ERICACEOIPOLLENITES Potonié, 1951, emended Potonié, 1960

Ericaceoipollenites POTONIÉ, 1951, Palaeontographica, v. 91, pt. B, p. 147.
Ericaceoipollenites POTONIÉ, 1951, Mikroskopie, v. 6, p. 281.
Ericaceoipollenites (POTONIÉ, 1951) emended POTONIÉ, 1960, Beih. Geol. Jb., v. 39, p. 138.
Ericaceaipollenites POTONIÉ, 1960, STANLEY, 1965, Bull. Amer. Paleont., v. 49, no. 222, p. 296.
Type Species.—*Ericaceoipollenites roboreus* (Potonié, 1931), Potonié, 1960.

Description.—Inaperturate to weakly tricolpate pollen grains that are arranged into a tetrahedral tetrad; individual grains more or less spherical in shape. Exine thin to moderately thick; sculpture lacking to well developed. Colpi (Potonié, 1960, p. 138) ". . . relatively small, in part indistinct."

Differential Diagnosis.—*Ericaceoipollenites* Potonié, 1951, emended Potonié, 1960, is distinguished from *Ericipites* Wodehouse, 1933, by the absence of well-defined colpi.

Botanical Affinities.—Ericaceae.

ERICACEOIPOLLENITES RALLUS Stanley, 1965

Plate 9, figs. 7, 8

Ericaceoipollenites rallus STANLEY, 1965, Bull. Amer. Paleont., v. 49, no. 222, p. 296, 297, p. 44, figs. 15-18.

Description.—Inaperturate pollen grains generally observed as individual grains but some in tetrahedral tetrads. Circular to subcircular in outline. Endexine approximately 0.3μ thick, ektexine approximately 0.6μ thick and granulate to scabrate. Colpi were not observed. Individual grains 12μ to 25μ diameter, tetrad; overall size 26μ to 35μ.

Differential Diagnosis.—*Ericaceoipollenites rallus* Stanley, 1965, is distinguished from other similar grains in this sequence by its smaller size and coarse sculpture.

Occurrence.—*Ericaceoipollenites rallus* Stanley, 1965, is present in all except one sample studied from the Kaiparowits Formation.

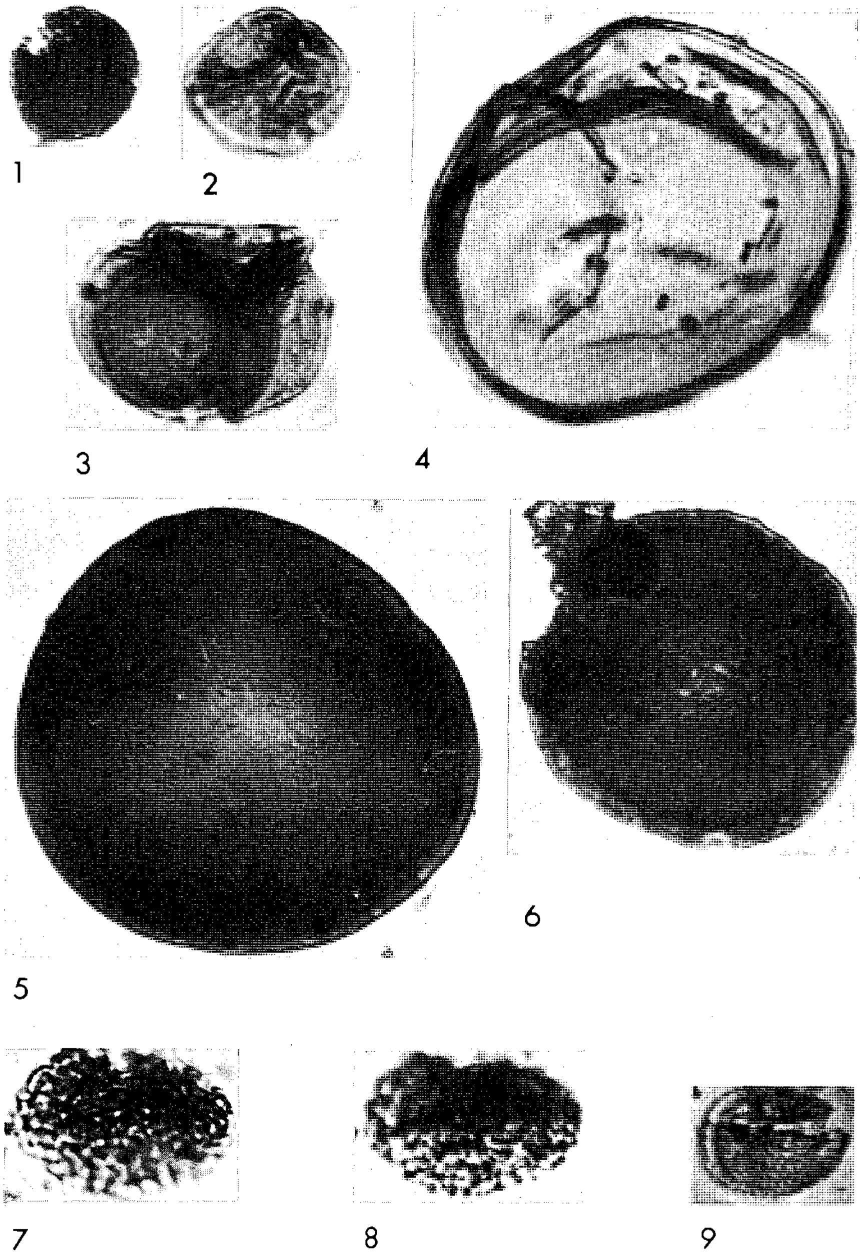
Frequency.—Frequent to common.

Figured Specimens.—BYU-Py-50, CFL-K-256+1250 ft. Orig. (32.15, 6.65). BYU-Py-51, CFL-K-256+1250 ft. Orig. (16.1, 10.4).

EXPLANATION OF PLATE 9

FIG. 1.—*Inaperturopollenites* n. sp. B, X1000, BYU-Py-46, JRB-Ka-1+5 ft., Orig. (0.9, 12.25).
FIGS. 2, 3.—*Ericaceoipollenites rallus* Stanley, 1965, X1000, *2.* individual pollen grain, BYU-Py-50, CFL-K-256+1250 ft. A (32.15, 6.65), *3.* tetrad of pollen grains, BYU-Py-51, CFL-K-256+1250 ft. Orig. (16.1, 10.4).
FIG. 4.—*Inaperturopollenites* n. sp. C, X1000, BYU-Py-47, CFL-K-256-+1250 ft. Orig. (20.7, 10.75).
FIG. 5.—*Inaperturopollenites* n. sp. D, X1000, BYU-Py-48, FL-P?166+91.5 ft. Orig. (5.6, 3.3).
FIG. 6.—*Inaperturopollenites* n. sp. E, X1000, BYU-Py-49, FL-P-166+91.5 ft. Orig. (1.3, 11.05).
FIGS. 7, 8.—*Liliacidites variegatus* Couper, 1953, X1000, polar view, BYU-Py-52, CFL-K-256+1250 ft. Orig. (10.85, 9.85).
FIG. 9.—*Liliacidites* n. sp. A, X1000, polar view, BYU-Py-53, CFL-K-370+2580 ft. A (32.9, 7.2).

PLATE 9



Family LILIACEAE
Genus LILIACIDITES Couper, 1953

Liliacidites COUPER, 1953, New Zealand Geol. Survey Paleont. Bull. 22, p. 56.
Liliacidites COUPER, 1953, POTONIÉ, 1958, Beih. Geol. Jb., v. 31, p. 96.
Liliacidites COUPER, COUPER, 1960, New Zealand Geol. Survey Paleont. Bull. 32, p. 60.
Liliacidites COUPER, 1953, ANDERSON, 1960, New Mexico State Bureau Mines Mineral Res., Memoir 6, p. 11, 12, 18.
Liliacidites COUPER, 1953, GROOT, PENNY AND GROOT, 1961, Palaeontographica, v. 108, pt. B, p. 132.
Liliacidites COUPER, 1953, BRENNER, 1963, Maryland Dept. Geol., Mines Water Res. Bull. 27, p. 93.
Liliacidites COUPER, 1953, SRIVASTAVA, 1966, Pollen et Spores, v. 8, no. 3, p. 525.
Liliacidites COUPER, 1953, HEDLUND, 1966, Okla. Geol. Survey Bull. 112, p. 28.
Liliacidites COUPER, 1953, DRUGG, 1967, Palaeontographica, v. 120, pt. B, p. 46.
Liliacidites COUPER, NORRIS, 1967, Palaeontographica, v. 120, pt. B, p. 106.

Type Species.—*Liliacidites kaitangataensis* Couper, 1953.

Description.—"Free, anisopolar, bilateral, monosulcate to trichotomosulcate; sulcus long, broad. Grain usually elongate. Exine clearly reticulate, lumen of reticulum variable in size, clavate, baculate, in optical section." (Couper, 1953, p. 56).

Differential Diagnosis.—*Liliacidites* Couper, 1953, is distinguished from other monosulcate grains by its reticulate wall structure.

Botanical Affinities.—Liliaceae.

LILIACIDITES VARIEGATUS Couper, 1953

Plate 9, figs. 7, 8

Liliacidites variegatus COUPER, 1953, New Zealand Geol. Survey Paleont. Bull. 22, p. 56, pl. 7, figs. 98, 99.
Liliacidites variegatus COUPER, (1953), KREMP, AMES AND GREBE, 1957, Catalog of Fossil Spores and Pollen, v. 2, p. 154.
Liliacidites variegatus COUPER, COUPER, 1960, New Zealand Geol. Survey Paleont. Bull. 32, p. 61, pl. 9, figs, 9, 10.
Liliacidites variegatus COUPER, 1953, GROOT, PENNY AND GROOT, 1961, Palaeontographica, v. 108, pt. B, p. 132, pl. 26, figs. 1, 2.
Liliacidites variegatus COUPER, 1953, SRIVASTAVA, 1966, Pollen et Spores, v. 8, no. 3, p. 525, pl. 4, figs. 15, 16.
Liliacidites cf. *L. variegatus* COUPER, 1953, HEDLUND, 1966, Okla. Geol. Survey Bull. 112, p. 28, 29, pl. 8, fig. 9.
Liliacidites variegatus COUPER, 1953, DRUGG, 1967, Palaeontographica, v. 120, pt. B, p. 46, 47, pl. 7, fig. 23.

Description.—Monosulcate pollen grain. Oval in outline. Endexine approximately 0.5μ thick and structureless; ektexine 1μ to 1.5μ thick and reticulate; muri 1μ to 1.5μ high by approximtely 0.5μ thick; lumina 1μ to 1.5μ across polygonal outline. Sulcus approximately 2μ wide; extends $\frac{3}{4}$ length of grain and has rounded ends. Overall size 25μ to 35μ.

Differential Diagnosis.—*Liliacidites variegatus* Couper, 1953, is the only monosulcate pollen form in this sequence with reticulate wall structure.

Occurrence.—*Liliacidites variegatus* Couper, 1953, is present throughout the Kaiparowits Formation.

Frequency.—Rare to frequent.

Figured Specimen.—BYU-Py-52, CFL-K-256+1250 ft. Orig. (10.85, 9.85).

LILIACIDITES n. sp. A

Plate 9, fig. 9

Description.—Monosulcate pollen grain. Oval in outline. Endexine approximately 0.5μ thick; ektexine 1μ to 1.5μ thick and reticulate; reticulum is clavate in cross section; muri

1μ to 1.5μ high by 0.25μ to 0.3μ wide; lumina up to 0.5μ across and round. Walls thicken slightly next to sulcus. Sulcus extends length of grain, at the ends and gapes equatorially. Overall size 12μ to 20μ by 15μ to 25μ.

Differential Diagnosis.—*Liliacidites* n. sp. A is distinguished by its fine reticulum of clavate cross-section.

Occurrence.—*Liliacidites* n. sp. A is present in all samples studied from the Kaiparowits Formation.

Frequency.—Frequent.

Figured Specimen.—BYU-Py-53, CFL-K-370+2580 ft. A (32.9, 7.2).

Family PALMAE

Genus MONOCOLPOPOLLENITES Pflug and Thomson in Thomson and Pflug, 1953

Pollenites POTONIÉ, 1934 (in part), Arb. Inst. Paläeobot. u. Petrogr. Brennsteine, v. 4, p. 51.

Sabalpollenites THIERGRAT, 1938, Jb, Preuss. Geol. L.A., v. 58, p. 308.

Sabaloidites POTONIÉ, THOMSON AND THIERGART, 1950, Geol. Jb., v. 65, p. 49.

Palmaepollenites POTONIÉ, 1951, Palaeontographica, v. 91, pt. B, pl. 11, fig. 138.

Monocolpopollenites PFLUG AND THOMSON in THOMSON AND PFLUG, 1953, Palaeontographica, v. 94, pt. B, p. 62.

Monocolpopollenites PFLUG AND THOMSON, TAKAHASHI, 1961, Mem. Faculty Science Kyushu Univ., Ser. D (Geol.), v. 11, no. 3, p. 292.

Type Species.—*Monocolpopollenites tranquillas* (Potonié) Pflug and Thomson in Thomson and Pflug, 1953.

Description.—One colpus. Outline not uniform; *viz.,* in lateral view the equator is the plane of symmetry; in equatorial view it is asymmetrical. Outline is not reniform. Colpus frequently has a thickened margo.

Differential Diagnosis.—This form genus is separated by the presence of a thickened margo and its lack of symmetry.

Botanical Affinities.—Takahashi (1961, p. 291-293) and Kedves (1961, p. 146-148) have indicated an affinity to the family Palmae.

MONOCOLPOPOLLENITES MINOR Kedves, 1961

Plate 10, fig. 1

Monocolpopollenites minor KEDVES, 1961, Pollen et Spores, v. 3, no. 1, p. 149, pl. 10, figs. 15-17.

Description.—Monocolpate pollen grain. Oval in outline to slightly flattened on one side. Walls approximately 1μ thick and psilate to finely scabrate. Colpus extends most of the length of the grain; tends to be bowed a bit. Margo extends the length of the colpus and wraps smoothly around the ends; it is psilate, thickened and approximately 1μ wide. Long dimension 10μ to 25μ.

Differential Diagnosis.—This species can be distinguished from other species of *Monocolpopollenites* encountered in these samples by its small size and psilate sculpture. The grains encountered in this sequence differ from Kedves' by being somewhat smaller in size.

Occurrence.—*Monocolpopollenites minor* Kedves, 1961, is present in the lower and middle portions of the Kaiparowits Formation.

Frequency.—Rare to frequent.

Figured Specimen.—BYU-Py-54, CFL-K-256+1250 ft. Orig (11.85, 7.3).

MONOCOLPOPOLLENITES VERRUCATUS Takahashi, 1961

Plate 10, fig. 2

Monocolpopollenites verrucatus TAKAHASHI, 1961, Mem. Faculty of Science, Kyushu Univ., Ser. D (Geol.), v. 11, no. 3, p. 293, pl. 16, figs. 28, 29.

Description.—Monocolpate pollen grain. Oval in outline; may be flattened on one side. Walls approximately 1.5μ thick with verrucate to granulate sculpture; individual sculptural elements approximately 1μ high. Colpus extends ⅘ the length of the grain; tends to be curved; may, or may not, gape equatorially. Margo extends length of colpus and wraps smoothly around the ends; it is psilate or finely scabrate, thickened, and approximately 2μ wide. Long dimension 20μ to 35μ.

Differential Diagnosis.—This species is distinguished from other species of *Monocolpopollenites* encountered in these samples by its larger size and coarser wall sculpture.

Occurrence.—*Monocolpopollenites verrucatus* Takahashi, 1961, is present throughout the Kaiparowits Formation.

Frequency.—Rare to frequent.

Figured Specimen.—BYU-Py-55, CFL-K-256+1250 ft. Orig. (6.85, 9.3).

MONOCOLPOPOLLENITES n. sp. A

Plate 10, fig. 3

Description.—Monocolpate pollen grain. Broadly oval to subcircular in outline. Walls approximately 1μ thick and uniformly scabrate. Colpus extends most of length of grain; generally straight; may gape equatorially. Margo extends length of colpus and warps smoothly around the slightly pointed ends; it is thickened, psilate, and 1.5μ to 2.5μ wide. Overall size 15μ to 25μ.

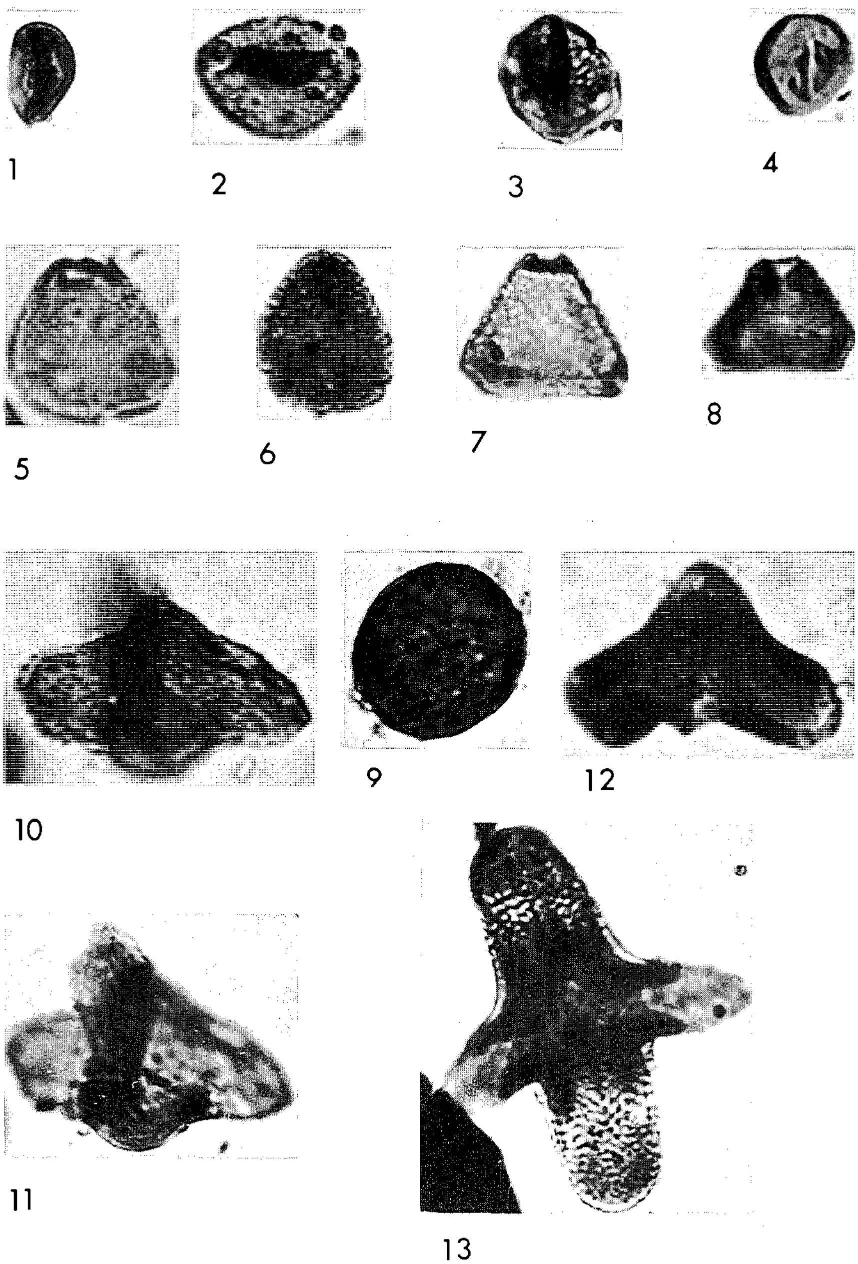
Differential Diagnosis.—This species can be distinguished from other species of *Monocolpopollenites* encountered in these samples by its intermediate size, uniform scabrate sculpture, wider margo, and more globose outline.

Occurrence.—*Monocolpopollenites* n. sp. A is present throughout the Kaiparowits Formation.

EXPLANATION OF PLATE 10

FIG. 1.—*Monocolpopollenites minor* Kedves, 1961, X1000, lateral view, BYU-Py-54, CFL-K-256+1250 ft. Orig. (11.85, 7.3).
FIG. 2.—*Monocolpopollenites verrucatus* Takahashi, 1961, X1000, lateral view, BYU-Py-55, CFL-K-256+1250 ft. Orig. (6.85, 9.3).
FIG. 3.—*Monocolpopollenites* n. sp. A, X1000, lateral view, BYU-Py-56, CFL-K-256+1250 ft. Orig. (1.9, 9.8).
FIG. 4.—*Monocolpopollenites* n. sp. B, X1000, lateral view, BYU-Py-57, CFL-K-256+1250 ft. Orig. (5.3, 7.3).
FIG. 5.—*Proteacidites retusus* Anderson, 1960, X1000, polar view, BYU-Py-58, CFL-K-256+1250 ft. Orig. (15.1, 6.8).
FIG. 6.—*Proteacidites subpalisadus* Couper, 1953, X1000, polar view, BYU-Py-59, CFL-K-256+1250 ft. Orig. (21.45, 10.25).
FIG. 7.—*Proteacidites thalmanni* Anderson, 1960, X1000, polar view, BYU-Py-60, CFL-K-256+1250 ft. Orig. (10.7, 5.9).
FIG. 8.—*Proteacidites* n. sp. A, X1000, polar view, BYU-Py-61, CFL-K-256+1250 ft. Orig. (18.75, 4.7).
FIG. 9.—*Inaperturopollenites* cf. *I. incertus* subsp. *foveolatus* Pflug and Thomson *in* Thomson and Pflug, 1953, X1000, BYU-Py-62, FL-P-166+91.5 ft. Orig. (13.0, 19.0).
FIGS. 10, 11.—*Aquilapollenites* cf. *A. delicatus* Stanley, 1961, X1000, lateral view, BYU-Py-63, CFL-K-256+1250 ft. A (27.0, 6.7).
FIG. 12.—*Aquilapollenites pyriformis* Norton, 1965, X1000, lateral view, BYU-Py-64, CFL-K-256+1250 ft. A (27.75, 9.7).
FIG. 13.—*Aquilapollenites* n. sp. A, X1000, lateral view, BYU-Py-65, JRB-Ka-1+5 ft. Orig. (6.3, 17.95).

PLATE 10



Frequency.—Frequent.

Figured Specimen.—BYU-Py-56, CFL-K-256+1250 ft. Orig. (1.9, 9.8).

MONOCOLPOPOLLENITES n. sp. B

Plate 10, fig. 4

Description.—Monocolpate pollen grain. Oval to subround in outline. Walls 1μ to 1.5μ thick and scabrate to granulate. Colpus extends approximately ⅔ the length of the grain and tends to be slightly curved. Margo extends length of colpus; equatorially it is approximately 1μ wide and narrows uniformly toward the ends; it is thickened and finely scabrate. Overall size 10μ to 20μ.

Differential Diagnosis.—This species can be distinguished from other species of *Monocolpopollenites* encountered in these samples by its intermediate size, the poleward narrowing of the margo, and its sculptured nature.

Occurrence.—*Monocolpopollenites* n. sp. B is present throughout the Kaiparowits Formation.

Frequency.—Rare to frequent.

Figured Specimen.—BYU-Py-57, CFL-K-256+1560 ft. Orig. (5.3, 7.3).

Family PROTEACEAE (provisional assignment)
Genus PROTEACIDITES Cookson, 1950, ex Couper, 1953

Proteacidites COOKSON, 1950, Australian Jour. Sci., Ser. B, v. 3, no. 2, p. 170.
Proteacidites COOKSON ex COUPER, 1953, New Zealand Geol. Survey Paleont. Bull. 22, p. 42.
Proteacidites (COOKSON) COUPER, 1953, ANDERSON, 1960, New Mexico State Bureau Mines Mineral Res., Memoir 6, p. 21,
Proteacidites COOKSON, 1950, POTONIÉ, 1960, Beih. Geol. Jb., v. 39, p. 122.
Proteacidites COOKSON ex COUPER, COUPER, 1960, New Zealand Geol. Survey Paleont. Bull. 32, p. 49.
Proteacidites COOKSON, 1950, ENGELHARDT, 1964, Miss. Geol., Econ. and Topo. Survey Bull. 104, p. 75.
Proteacidites COOKSON, 1950, HARRIS, 1965, Palaeontographica, v. 115, pt. B, p. 91.
Proteacidites COOKSON, 1950, STANLEY, 1965, Bull. Amer. Paleont., v. 49, no. 222, p. 307.
Proteacidites COOKSON ex COUPER, 1953, SRIVASTAVA, 1966, Pollen et Spores, v. 8, no. 3, p. 536.
Proteacidites COOKSON, 1950, DRUGG, 1967, Palaeontographica, v. 120, pt. B, p. 57.

Type Species.—*Proteacidites adenanthoides* Cookson, 1950, (designated by Couper, 1953, p. 42).

Description.—"Free, isopolar or sub-isopolar, triorate, occasionally diorate. Grain triangular to sub-triangular, sides concave to convex between ora in polar view. Exine clearly differentiated into nexinous and sexinous layers. Sexine baculate, clavate, or tuberculate, forming a very variable pitted-reticulate, reticulate, or pseudo-reticulate sculpture in surface view." (Couper, 1953, p. 42).

Differential Diagnosis.—*Proteacidites* Cookson, 1950, ex Couper, 1953, is distinguished from other similar forms by its outline and two-layered wall structure.

Botanical Affinities.—Proteaceae?

PROTEACIDITES RETUSUS Anderson, 1960

Plate 10, fig. 5

Proteacidites retusus ANDERSON, 1960, New Mexico State Bureau Mines Mineral Res., Memoir 6, p. 21, pl. 2, figs. 5-7.
Proteacidites retusus ANDERSON, 1960, STANLEY, 1965, Bull. Amer. Paleont., v. 49, no. 222, p. 307, 308, pl. 46, figs. 1-6.

Proteacidites cf. *P. retusus* ANDERSON, 1960, DRUGG, Palaeontographica, v. 120, pt. B, p. 58, pl. 8, fig. 36.

Description.—Triporate pollen grain. Semitriangular in outline, apices concave, sides convex. Endexine thin, ektexine 1μ to 1.5μ thick and finely reticulate. Muri 0.2μ to 0.4μ wide and 0.1μ to 0.2μ high. Lumina 1μ to 2μ across and round to subround. Pores 2μ to 2.5μ diameter, round, apically located, with apertural collars 2μ to 3μ thick. Overall size 20μ to 30μ.

Differential Diagnosis.—*Proteacidites retusus* Anderson, 1960, is distinguished by its convex sides and low, uniform reticulum.

Occurrence.—*Proteacidites retusus* Anderson, 1960, is present throughout the Kaiparowits Formation.

Frequency.—Rare to Frequent.

Figured Specimen.—BYU-Py-58, CFL-K-256+1250 ft. Orig. (15.1, 6.8).

PROTEACIDITES SUBPALISADUS Couper, 1953

Plate 10, fig. 6

Proteacidites subpalisadus COUPER, 1953, New Zealand Geol. Survey Paleont. Bull. 22, p. 43, pl. 5, fig. 55.
Proteacidites subpalisadus COUPER, (1953), KREMP, AMES AND GREBE, 1957, Catalog of Fossil Spores and Pollen ,v. 2, p. 143.
Proteacidites subpalisadus COUPER, COUPER, 1960, New Zealand Geol. Survey Paleont. Bull. 32, p. 50, pl. 5, fig. 20.

Description.—Triporate pollen grain. Semitriangular in outline, apices blunt; sides convex; two longer than the third. Endexine approximately 0.5μ thick; ektexine 1μ to 1.5μ thick and clavate to baculate. Pores 1μ to 2.5μ wide and deep, appearing as apically located notches. Overall size 11μ to 20μ by 12μ to 24μ.

Differential Diagnosis.—*Proteacidites subpalisadus* Couper, 1953, is distinguished by its clavate to baculate sculpture.

Occurrence.—*Proteacidites subpalisadus* Couper, 1953, is present throughout the Kaiparowits Formation.

Frequency.—Rare to frequent.

Figured Specimen.—BYU-Py-59, CFL-K-256+1250 ft. Orig. (21.45, 10.25).

PROTEACIDITES THALMANNI Anderson, 1960

Plate 10, fig. 7

Proteacidites thalmanni ANDERSON, 1960, New Mexico State Bureau Mines Mineral Res., Memoir 6, p. 21, pl. 2, figs. 1-3; pl. 10, figs. 9-13.
Proteacidites thalmanni ANDERSON, 1960, DRUGG, 1967, Palaeontographica, v. 120, pt. B, p. 58, pl. 8, fig. 38.

Description.—Triporate pollen grain. Triangular in outline, apices appear notched, sides straight to slightly convex. Endexine thin, ektexine approximately 1.5μ thick and irregularly reticulate; Muri hemispheric in cross section, 0.4μ to 0.6μ high; Lumina subround, up to 1μ across. Pores 2μ to 2.5μ across, round, apically located; an apertural collar 2μ to 3μ wide is present at each pore. Overall size 16μ to 22μ.

Differential Diagnosis.—*Proteacidites thalmanni* Anderson, 1960, is distinguished by its irregular reticulum and hemispheric cross section muri.

Occurrence.—*Proteacidites thalmanni* Anderson, 1960, is present in the lower and upper portions of the Kaiparowits Formation.

Frequency.—Rare to common.

Figured Specimen.—BYU-Py-60, CFL-256+1250 ft. Orig. (10.7, 5.9).

PROTEACIDITES n. sp. A

Plate 10, fig. 8

Description.—Triporate pollen grain. Triangular in outline, apices flat to concave, sides straight to slightly concave. Walls 1μ to 1.2μ thick; endexine and ektexine about equal and scabrate to granulate. Pores approximately 3.5μ in diameter and round to oval; pore apically located and with an apertural collar approximately 2μ wide. Overall size 17μ to 21μ.

Differential Diagnosis.—*Proteacidites* n. sp. A is distinguished by its fine sculpture.

Occurrence.—*Proteacidites* n. sp. A is present in the lower and upper portions of the Kaiparowits Formation.

Frequency.—Rare to frequent.

Figured Specimen.—BYU-Py-61, CFL-K-256+1250 ft. Orig. (18.75, 4.7).

Family SALICACEAE (provisional assignment)
INAPERTUROPOLLENITES cf. I. INCERTUS subsp. FOVEOLATUS Pflug and Thomson in Thomson and Pflug, 1953

Plate 10, fig. 9

Inaperturopollenites incertus subsp. *foveolatus* PFLUG AND THOMSON in THOMSON AND PFLUG, 1953, Palaeontographica, v. 94, pt. B, p. 66, pl. 5, figs. 31-35
Inaperturopollenites incertus subsp. *foveolatus* PFLUG AND THOMSON in THOMSON AND PFLUG (1953), KREMP, AMES AND GREBE, 1958, Catalog of Fossil Spores and Pollen, v. 3, p. 42.

Description.—Inaperturate pollen grain. Circular in outline. Walls approximately 0.5μ thick and foveolate. Foveae are circular, approximately 1μ in diameter, and extremely shallow. Overall size 20μ to 25μ.

Discussion.—The forms observed in the Kaiparowits Formation are smaller than those described by Pflug and Thomson (1953, p. 66) and with much thinner walls.

Differential Diagnosis.—*Inaperturopollenites* cf. *I. incertus* subsp. *foveolatus* Pflug and Thomson in Thomson and Pflug, 1953, is the only foveolate inaperturate grain in this sequence.

Occurrence.—This form is present in the lower part of the lower portion and in the upper portion of the Kaiparowits Formation.

Frequency.—Rare to frequent.

Figured Specimen.—BYU-Py-62, FL-P-166+91.5 ft. Orig. (13.0, 19.0).

Family SANTALACEAE or DIPSACACEAE
Genus AQUILAPOLLENITES Rouse, 1957, emended Funkhouser, 1961

Pollen, N_2, RADFORTH AND ROUSE, 1954, Canadian Jour. Bot., v. 32, p. 195, fig. 14.
Aquilapollenites ROUSE, 1957, Canadian Jour. Bot., v. 35, no. 3, p. 370.
Proteaceae? pollen, SEDOVA in POKROVSKAIA AND STELMAK, 1960, V.S.E.G.E.I. Pub., No. 30, p. 324.
Aquilapollenites ROUSE, 1957, POTONIÉ, 1960, Beih. Geol. Jb., v. 39, p. 83.
Aquilapollenites ROUSE, CHLONOVA, 1961, Akad. Nauk SSSR, Inst. Geol. Geophys., No. 7, p. 82.
Taurocephalus SIMPSON, 1961, Royal Soc. Edinburgh, Trans., v. 64, no. 16, p. 440.

Aquilapollenites ROUSE ex MTCHEDLISHVILI in SAMOILOVITCH AND MTCHEDLISHVILI, 1961, Pollen and Spores from Western Siberia, p. 209.
Aquilapollenites ROUSE, emended FUNKHOUSER, 1961, Micropaleontology, v. 7, no. 2, p. 193, 194.
Aquilapollenites ROUSE, 1957, emended FUNKHOUSER, STANLEY, 1961, Pollen et Spores, v. 3, no. 2, p. 338.
Aquilapollenites ROUSE, 1957, ROUSE, 1962, Micropaleontology, v. 8, no. 2, p. 214.
Aquilapollenites ROUSE, 1957, BELSKY, BOLTENHAGEN AND POTONIÉ, Paläont. Z., v. 39, nos. 1, 2, p. 80.
Aquilapollenites ROUSE, 1957, STANLEY, 1965, Bull. Amer. Paleont., v. 49, no. 222, p. 312.
Aquilapollenites ROUSE emended FUNKHOUSER, 1961, SRIVASTAVA, 1966, Pollen et Spores, v. 8, no. 3, p. 540.
Aquilapollenites ROUSE emended FUNKHOUSER, SRIVASTAVA, 1967, Bot. Review, v. 33, no. 3, p. 264.

Type Species.—Aquilapollenites quadrilobus Rouse, 1957.

Description.—"Angiosperm pollen that are either heteropolar or isopolar; one or both of the poles is extended into what may be called polar protrusions; three, often winglike, equatorial protrusions. Apertures of several types, often difficult to see in normal orientation; these are usually three colpi or three pairs of demicolpi borne on the outer margins of the equatorial protrusions. In addition there may be three colpi on and parallel to the equator between the equatoral protrusions. Grains may be more or less smooth or sculptured (punctae, reticulae, spines, striae, etc.)" (Funkhouser, 1961, p. 193.)

Discussion.—Aquilapollenites Rouse, 1957, emended Funkhouser, 1961, seems to be restricted stratigraphically from the Albian to Lower Eocene. This genus displays its greatest diversity during the Upper Cretaceous.

Botanical Affinities.—It is suggested this genus is related to the extant families Santalaceae or Dipsacaceae (Funkhouser, 1961, p. 193; Stanley, 1961, p. 334, 336).

AQUILAPOLLENITES cf. A. DELICATUS Stanley, 1961

Plate 10, figs. 10, 11

Aquilapollenites delicatus STANLEY, 1961, Pollen et Spores, v. 3, no. 2, p. 346, pl. 4, figs. 1-12.
Aquilapollenites delicatus STANLEY, 1961, STANLEY, 1965, Bull. Amer. Paleont., v. 49, no. 222, p. 314, pl. 49, figs. 1-4.

Description.—Heteropolar tridemicolpate pollen grain. Triangular in polar outline and three-rayed in equatorial outline. Polar axis of main body is 24μ to 28μ long. Main body is 7μ to 10μ in diameter. The long end of the main body has a rounded apex; walls are approximately 1.5μ thick and baculate; baculae are adjacent, forming a fine reticulum. Short end is only slightly convex. Equatorial protrusions are three in number and blade-like in shape. They intersect the polar axis at right angles and are situated approximately 120° apart. The equatorial protrusions are 17μ to 21μ long by 12μ to 15μ high by 3μ to 5μ thick. The walls are 0.5μ to 0.7μ thick and finely clavate; clavae are less than 0.5μ high and are in contact with each other and form a fine reticulum; spines approximately 1μ long are scattered over the equatorial protrusions. Spines are oriented perpendicular to the surface and are centered 1μ to 5μ apart. Demicolpi are indistinct and are confined to outer end of the equatorial protrusions.

Differential Diagnosis.—Aquilapollenites cf. *A. delicatus* Stanley, 1961, is distinguished by the main body with no spines and the equatorial protrusions with the fine sculpture and small spines. This form differs from the one described by Stanley by the finer sculpture of the main body and its lack of spines.

Occurrence.—Aquilapollenites cf. *A. delicatus* Stanley, 1961, is present in the lower and middle part of the lower portion of the Kaiparowits Formation.

Frequency.—Rare.

Figured Specimen.—BYU-Py-63, CFL-K-256+1250 ft. A (27.0, 6.7).

AQUILAPOLLENITES PYRIFORMIS Norton, 1965

Plate 10, fig. 12

Aquilapollenites pyriformis NORTON, 1965, Pollen et Spores, v. 7, no. 1, p. 136, 140, figs. 1-4.

Description.—Heteropolar tridemicolpate pollen grain. Triangular in polar outline and three-rayed in equatorial outline. Polar axis of main body is 20μ to 24μ long. Main body is 11μ to 14μ in diameter. The three equatorial protrusions all point in the same direction and make an obtuse angle of 115° to 120° with the polar axis. The pole toward which the equatorial protrusions point is pointed, making an obtuse angle in polar outline (this is the short end of the main body measured from the junction with the equatorial protrusions). The opposite end of the main body (the long end measured from the junction with the equatorial protrusions) is broadly rounded. Walls of the entire grain are approximately 1μ thick with a low striate structure, striae essentially parallel with the polar axis and each other; they are 0.2μ to 0.4μ apart. Equatorial protrusions are three in number and blade-like in equatorial outline; they are spaced approximately 120° apart. In polar outline the equatorial protrusions are rectangular in shape with the apolar end broadly rounded. They are 20μ to 22μ in length (from polar axis) by 11μ to 14μ wide. A demicolpus is present on both polar sides of each equatorial protrusion. Demicolpi extend along the edge of the equatorial protrusions from their junctions with the main body. Demicolpi on the long polar side are shallow at the junction with the main body and deepen gradually until they are approximately 2.5μ deep where they end abruptly 3/4 to 4/5 the distance from the junction to the end of the equatorial protrusion. Demicolpi on the opposite side (short polar side) are essentially rectangular in lateral view approximately 2.5μ deep and extend 3/4 to 4/5 the distance from the junction with the main body to the end. The demicolpi are bordered by a narrow, thickened, psilate margo.

Differential Diagnosis.—*Aquilapollenites pyriformis* Norton, 1965, is distinguished by its triangular polar outline and striate wall structure with the striae essentially paralleling the polar axis.

Occurrence.—*Aquilapollenites pyriformis* Norton, 1965, is present only in sample CFL-K-256+1250 ft.

Frequency.—Rare.

Figured Specimen.—BYU-Py-64, CFL-K-256+1250 ft. A (27.75, 9.7).

AQUILAPOLLENITES n. sp. A

Plate 10, fig. 13

Description.—Isopolar, tridemicolpate pollen grain. Cruciform in polar outline. Main body 50μ to 55μ long by 16μ to 19μ diameter with poles broadly rounded and gradually flaring toward equator. Endexine 0.5μ to 0.6μ thick, ektexine is gemmate, ranging from 0.6μ thick at poles to 1.3μ equatorially. Equatorial protrusions are three in number with rounded ends and circular to oval outline, 22μ to 26μ long (measured from polar axis) by 8μ to 10μ in diameter; walls are scabrate and of indeterminate thickness. The equatorial protrusions are spaced approximately 120° apart. A demicolpus, or furrow, is present on each polar side of each equatorial protrusion; (6 demicolpi in total). Demicolopi are oriented into the plane of the polar axis, 2.5μ to 3μ deep at the junction of the central body and equatorial protrusions; they (demicolpi) extend 7μ to 9μ in each direction and gradually shallow. A narrow, thickened, psilate margo borders the demicolpi.

Differential Diagnosis.—*Aquilapollenites* n. sp. A is distinguished from other species of *Aquilapollenites* Rouse, 1957, emended Funkhouser, 1961, by its gemmate wall sculpture.

Occurrence.—*Aquilapollenites* n. sp. A is present only in JRB-Ka-1+5 ft.

Frequency.—Rare.

Figured Specimen.—BYU-Py-65, JRB-Ka-1+5 ft. Orig. (6.3, 17.95).

AQUILAPOLLENITES n. sp. B

Plate 11, figs. 1-3

Description.—Heteropolar tridemicolpate pollen grain. Triangular in polar outline and three-rayed in equatorial outline. Polar axis of main body is 28μ to 33μ long. Main body is 8μ to 12μ in diameter. Walls of main body are approximately 1μ thick and granulate to echinate. Spines are approximately 1μ long and with broad bases; spines The short pole is a pointed, minor convexity. Equatorial protrusions meet the main body at an angle of 115° to 135°. They are distributed approximately 120° apart. They are 20μ to 25μ long by 9μ to 12μ wide by 2μ to 3μ thick. The walls are 0.75μ to 1μ thick and scabrate. The demicolpi extend from the junction of the main body along the equatorial protrusion for approximately ½ its length. One demicolpus is present on each edge of the equatorial protrusion. The demicolpi are rectangular in lateral view.

Occurrence.—*Aquilapollenites* n. sp. B is present in the middle part of the lower portion of the Kaiparowits Formation.

Frequency.—Rare to frequent.

Figured Specimen.—BYU-Py-66, CFL-K-212+860 ft. A(26.75, 15.0); BYU--Py-67, CFL-K-212+860 ft. A(19.0, 14.45).

Family SAPOTACEAE

Genus TETRACOLPOROPOLLENITES Pflug and Thomson in Thomson and Pflug, 1953

Tetracolporopollenites PFLUG AND THOMSON in THOMSON AND PFLUG, 1953, Palaeontographica, v. 94, pt. B, p. 108.

Type Species.—*Tetracolporopollenites sapotoides* Pflug and Thomson in Thomson and Pflug, 1953.

Description.—Normally with four germinal apparatus (rarely three). These are symmetrical with each other. Germinal apparatus with meridional colpi and equatorial pores. Four-fold (rarely three-fold) symmetry in polar view.

Botanical Affinities.—Possibly related to the Sapotaceae.

TETRACOLPOROPOLLENITES ABDITUS Pflug in Thomson and Pflug, 1953

Plate 11, fig. 4

Tetracolporopollenites abditus PFLUG in THOMSON AND PFLUG, 1953, Palaeontographica, v. 94, pt. B, p. 108, pl. 14, figs. 100, 101.

Description.—Tetracolporate pollen grain. Walls approximately 1μ thick and psilate. Colpi are straight, narrow slits that extend almost to the poles, distributed 90° apart at equator. Pores approximately 1.5μ diameter, round, equatorially located. Maximum dimension 18μ to 24μ.

Differential Diagnosis.—*Tetracolporopollenites abditus* Pflug in Thomson and Pflug, 1953, is the only tetracolporate form in this sequence.

Occurrence.—*Tetracolporopollenites abditus* Pflug in Thomson and Pflug, 1953, is present in the lower and middle parts of the lower portion of the Kaiparowits Formation.

Frequency.—Rare.

Figured Specimen.—BYU-Py-68, JRB-Ka-1+5 ft. Orig. (2.35, 9.8).

Family SYMPLOCACEAE

Genus PORCOLOPOPOLLENITES Pflug in Thomson and Pflug, 1953

Porocolpollenites PFLUG in THOMSON AND PFLUG, 1953, Palaeontographica, v. 94, pt. B, p. 92.

Porocolpopollenites (PFLUG, 1952) THOMSON AND PFLUG, 1953, POTONIÉ, 1960, Beih. Geol. Jb., v. 39, p. 107.

Porocolpopollenites (PFLUG) in THOMSON AND PFLUG, 1953, TAKAHASHI, 1961, Mem. Faculty of Science, Kyushu Univ., Ser. D, (Geol.) v. 11, no. 3, p. 311.
Porocolpopollenites THOMSON AND PFLUG, LEOPOLD AND PAKISER, 1964, U.S. Geol. Survey Bull. 1160-E, p. 90.

Type Species.—Porocolpopollenites vestibuloformis Pflug in Thomson and Pflug, 1953.

Description.—A widely gaping postvestibule is always present. Besides they display one of the following characteristics: (1) Variably tri- or tetraporate; without colpi. Exine psilate and transparent. (2) Tetraporate, sometimes pentaporate; with indistinct colpi. Exine psilate and transparent. (3) Always triporate; with colpi. Exine psilate and transparent. (4) Always triporate, with colpi. Exine sculptured. (Thomson and Pflug, 1953, p. 92).

Discussion.—Potonié (1960), p. 107) stated that *Porocolpopollenites* Pflug, 1952. Thomson and Pflug, is synonymous with *Symplocoipollenites* Potonié, 1951. Leopold and Pakiser (1964, p. 90) indicate these are both valid genera and are so treated in this report.

Differential Diagnosis.—Porocolpopollenites Pflug in Thomson and Pflug, 1953, is distinguished by its broadly open postvestibule.

Botanical Affinities.—Thomson and Pflug (1953, p. 92) suggest this genus is related to the family Symplocaceae.

POROCOLPOPOLLENITES MIIKENSIS Takahashi, 1961

Plate 11, fig. 5

Porocolpopollenites miikensis TAKAHASHI, 1961, Mem. Faculty of Science, Kyushu Univ., Ser. D (Geol.), v. 11, no. 3, p. 311, pl. 22, figs. 8-11.

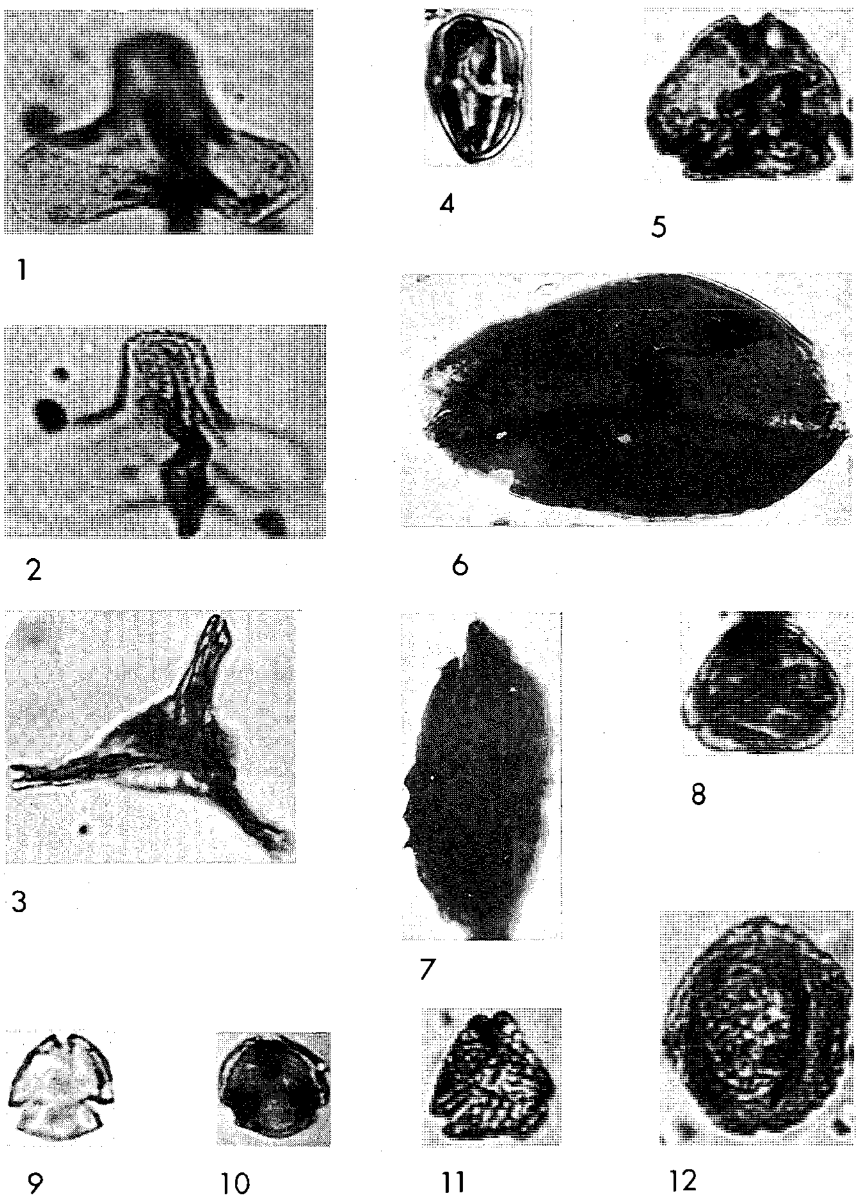
Description.—Tricolporate pollen grain. Triangular in equatorial outline; apices broadly rounded; sides straight to slightly concave or convex. Walls about 1μ thick and scabrate. Colpi extend approximately ¾ the apex to pole distance, gape up to 45° (5μ to 6μ at apices of triangle). Pores 2.5μ to 4μ diameter; postvestibules form notches at the apices of the triangle where they border the pores. Overall size 20μ to 30μ.

Differential Diagnosis.—Porocolpopollenites miikensis Takahashi, 1961, is distinguished

EXPLANATION OF PLATE 11

FIGS. 1-3.—*Aquilapollenites* n. sp. B, X1000, *1, 2.* lateral view, BYU-Py-66, CFL-K-212+860 ft. A (26.75, 15.0), *3,* polar view, BYU-Py-67, CFL-K-212+860 ft. A (19.0, 14.45).
FIG. 4.—*Tetracolporopollenites abditus* Pflug *in* Thomson and Pflug, 1953, X1000, lateral view, BYU-Py-68, JRB-Ka-1+5 ft. Orig. (2.35, 9.8).
FIG. 5.—*Porocolpopollenites miikensis* Takahashi, 1961, X1000, polar view, BYU-Py-69, CFL-K-256+1250 ft. Orig. (9.65, 8.8).
FIG. 6.—*Monosulcites* cf. *M. carpentieri* Delcourt and Sprumont, 1955, X1000, polar view, BYU-Py-70, CFL-K-256+1250 ft. Orig. (4.35, 8.85).
FIG. 7.—*Monosulcites* cf. *M. perspinosus* Couper, 1953, X1000, polar view, BYU-Py-71, CFL-K-391+746 ft. A (18.35, 3.8).
FIG. 8.—*Extratriporopollenites pompeckji* (Potonié) Thomson and Pflug, 1953, X1000, polar view, BYU-Py-72, CFL-K-256+1250 ft. Orig. (13.4, 9.8).
FIG. 9.—*Tricolpites erugatus* Hedlund, 1966, X1000, polar view, BYU-Py-73, CFL-K-256+1250 ft. Orig. (13.1, 4.1).
FIG. 10.—*Tricolpites membranus* Couper, 1960, X1000, polar view, BYU-Py-74, JRB-Ka-1+5 ft. Orig. (7.95, 2.3).
FIG. 11.—*Tricolpites reticulata* Cookson, 1947, X1000, polar view, BYU-Py-75, CFL-K-256+1250 ft. Orig. (7.7, 11.45).
FIG. 12.—*Tricolpites* cf. *T. thomasii* Cookson and Pike, 1954, X1000, lateral view, BYU-Py-76, JRB-Ka-1+5 ft. Orig. (20.4, 11.3).

PLATE 11



from other tricolporate grains in this sequence by its large size and colpus poleward tapering colpi.

Occurrence.—*Porocolpopollenites miikensis* Takahashi, 1961, is present in the lower and middle portions of the Kaiparowits Formation.

Frequency.—Rare to frequent.

Figured Specimen.—BYU-Py-69, CFL-K-256+1250 ft. Orig. (9.65, 8.8).

MONOCOTYLEDONEAE POLLEN-INCERTAE SEDIS
Genus MONOSULCITES Cookson, 1947, ex Couper, 1953

Monosulcites ERDTMAN, 1947, Svensk Bot. Tidskrift, v. 41, no. 1, p. 110.
Monosulcites COOKSON, 1947, British, Australian, and New Zealand Antarctic Res. Expedition. 1929-31, Rept. Ser. A, v. 2, pt. 8, p. 134, 135.
Monosulcites COOKSON, ex COUPER, 1953, New Zealand Geol. Survey Paleont. Bull. 22, p. 65.
Monosulcites (ERDTMAN, 1947, COOKSON, 1947) ex COUPER, 1953, POTONIÉ, 1958, Beih. Geol. Jb., v. 31, p. 95.
Monosulcites COOKSON ex COUPER, COUPER, 1958, Palaeontographica, v. 103, pt. B, p. 157.
Monosulcites COOKSON ex COUPER, COUPER, 1960, New Zealand Geol. Survey Paleont. Bull. 32, p. 69.
Monosulcites (COOKSON) COUPER, 1953, ANDERSON, 1960, New Mexico State Bureau Mines Mineral Res., Memoir 6, p. 12, 13, 27.
Monosulcites (ERDTMAN 1947, COOKSON 1947) ex COUPER, 1953, GROOT, PENNY AND GROOT, 1961, Palaeontographica, v. 108, pt. B, p. 129.
Monosulcites (COOKSON) ex COUPER, 1953, POCOCK, 1962, Palaeontographica, v. 111, pt. B, p. 77.
Monosulcites (COOKSON) ex COUPER, 1953, BRENNER, 1963, Maryland Dept. Geol., Mines Water Res. Bull. 27, p. 75.
Monosulcites COOKSON ex COUPER, 1953, SRIVASTAVA, 1966, Pollen et Spores, v. 8, no. 3, p. 540.
Monosulcites COOKSON, 1947, ex COUPER, 1953, HEDLUND, 1966, Okla Geol. Survey Bull. 112, p. 28.
Monosulcites ex COUPER, 1953, BOLTENHAGEN, 1967, Pollen et Spores ,v. 9, no. 2, p. 343.

Type Species.—*Monosulcites minimus* Cookson, 1947. (Designated by Couper, 1953).

Description.—"Free, anisopolar, bilateral, monosulcate. Grain elongate to sub-circular. Exine variable in thickness and sculpture. Size variable." (Couper, 1953, p. 65).

Differential Diagnosis.—*Monosulcites* Cookson, 1947, ex Couper, 1953, is distinguished by the fact the middle section of the sulcus gapes open.

Botanical Affinites.—Unknown.

MONOSULCITES cf. M. CARPENTIERI Delcourt and Sprumont, 1955

Plate 11, fig. 6

Monsulcites carpentieri DELCOURT AND SPRUMONT, 1955, Mem. Soc. Belge. Géol., Nouv. Ser., v. 4, no. 5, p. 54, text-fig. 14.
Monosulcites carpentieri DELCOURT AND SPRUMONT, COUPER, 1958, Palaeontographica, v. 103, pt. B, p. 158, pl. 26, figs. 26, 27.
Monosulcites carpentieri DELCOURT AND SPRUMONT (1955), KREMP, AMES AND KOVAR, 1958, Catalog of Fossil Spores and Pollen, v. 4, p. 35.
Monosulcites cf. *M. carpentieri* DELCOURT AND SPRUMONT, 1955, HEDLUND, 1966, Okla. Geol. Survey Bull. 112, p. 28, pl. 8, fig. 4.

Description.—Monosulcate pollen grain. Oval in outline. Walls approximately 2.5μ thick and psilate; endexine and ektexine equal in thickness. Sulcus extends length of grain; narrow in central portion and gaping at the ends. Overall size 105μ to 115μ.

Differential Diagnosis.—The grain described here is larger and with thicker walls than *Monosulcites carpentieri* Delcourt and Sprumont, 1955. It is distinguished from other monosulcate grains in this sequence by its large size and gaping sulcus.

Occurrence.—*Monosulcites* cf. *M. carpentieri* Delcourt and Sprumont, 1955, is present only in sample CFL-K-256+1250 ft.

Frequency.—Rare.

Figured Specimen.—BYU-Py-70, CFL-K-256+1250 ft. Orig. (4.35, 8.85).

MONOSULCITES cf. M. PERSPINOSUS Couper, 1953

Plate 11, fig. 7

Monosulcites perspinosus COUPER, 1953, New Zealand Geol. Survey Paleont. Bull. 22, p. 65, pl. 8, fig. 133.
Monosulcites perspinosus COUPER (1953), KREMP, AMES, AND GREBE, 1957, Catalog of Fossil Spores and Pollen, v. 2, p. 171.
Monosulcites perspinosus COUPER, 1953, ANDERSON, 1960, New Mexico Bureau Mines Mineral Res., Memoir 6, p. 27, pl. 3, fig. 1.
Monosulcites perspinosus COUPER, 1953, BOLTENHAGEN, 1967, Pollen et Spores, v. 9, no. 2, p. 343, 344, pl. 2, figs. 8-8b, pl. 3, figs. 1, 2.

Description.—Monosulcate pollen grain. Oval to fusiform in outline. Walls 1.5μ to 2.5μ thick and echinate. Spines are broad based 1.2μ to 1.5μ and 1.5μ to 2μ high, tapering uniformly; spines are centered 2.5μ to 3μ apart, bluntly to sharply pointed. Sulcus extends full length of grain and is fairly wide with no border. Overall size 15μ to 20μ by 28μ to 41μ.

Differential Diagnosis.—This form differs from Couper's in the shape of the spines (these taper uniformly). The spines are more densely spaced on these grains than on Couper's. *Monosulcites* cf. *M. perspinosus* Couper, 1953, is distinguished from other monosulcate grains in these samples by its echinate wall sculpture.

Occurrence.—*Monosulcites* cf. *M. perspinosus* Couper, 1953, was observed only in sample CFL-K-391+746 feet where it comprises 5 percent of the flora.

Frequency.—Rare to frequent.

Figured Specimen.—BYU-Py-71, CFL-K-391+746 ft. A(18.35, 3.8).

DICOTYLEDONEAE POLLEN-INCERTAE SEDIS
Genus EXTRATRIPOROLLENITES Pflug in Thomson and Pflug, 1953

Extratriporopollenites PFLUG in THOMSON AND PFLUG, 1953, Palaeontographica, v. 94, pt. B, p. 69.
Extratriporopollenites (PFLUG 1952) THOMSON AND PFLUG 1952, ex 1953, POTONIÉ, 1960, Beih. Geol. Jb., v. 39, p. 126.
Extratriporopollenites PFLUG, 1953, Anderson, 1960, New Mexico State Bureau Mines Mineral Res., Memoir 6, p. 24.
Extratriporopollenites PFLUG, GROOT AND GROOT, 1962, Palaeontographica, v. 111, pt. B, p. 169.
Extratriporopollenites (PFLUG, 1952), ENGELHARDT, 1964, Miss. Geol., Econ. and Topo. Survey Bull. 104, p. 78.

Type Species.—*Extratriporopollenites fractus* Pflug in Thomson and Pflug, 1953.

Description.—Triporate pollen with triangular equatorial outline and apically located pores. Symmetry three-fold in polar view and two-fold equatorial. They display one or two of the following characteristics: (1) Pore canal index greater than 0.3 Centrifugal annulus thick or without an annulus. Outline of grain concave. Vestibules copious. Pore canal blending smoothly into a free nozzle-shaped extension. Rudimentary colpus. (2) With interloculum and meridianal solution channels. Either with vestibule or Atrium.

Sometimes with an oculus or praevestibule. Pore canal flows smoothly into a free nozzle-shaped extension. (Thomson and Pflug, 1953, p. 69).

Botanical Affinities.—Unknown.

EXTRATRIPOROPOLLENITES POMPECKJI Potonié, 1931, Thomson and Pflug, 1953

Plate 11, fig. 8

Pollenites pompeckji POTONIÉ, 1931, Z. Braunkohle, v. 30, pt. 16, p. 322, pl. 1, fig. 9.
Pollenites pompeckji POTONIÉ, 1931, POTONIÉ, 1934, Arb. Inst. Paläobot. u. Petrogr. Brennsteine, v. 4, p. 78, pl. 4, fig. 12.
Extratriporopollenites pompeckji (POTONIÉ) THOMSON AND PFLUG, 1953, Palaeontographica, v. 94, Pt. B, p. 76, pl. 6, figs. 124-144.
Pollenites pompeckji POTONIÉ (1931), KREMP, AMES AND GREBE, 1957, Catalog of Fossil Spores and Pollen, v. 2, p. 68.
Extratriporopollenites pompeckji (POTONIÉ) THOMSON AND PFLUG, KEDVES, 1960, Pollen et Spores, v. 2, no. 1, p. 111, pl. 10, fig. 9.

Description.—Triporate pollen grain. Triangular in equatorial outline; apices rounded and notched; sides convex. Endexine approximately 0.1μ thick halfway between pores but thickening to 0.7μ to 0.9μ near pores. Ektexine 1μ to 1.2μ thick half way between pores and intrabaculate, thickening to 1.7μ to 2μ thick next to pores; surface of ektexine reflects the intrabaculate structure with a scabrate sculpture. Pores are 0.1μ to 0.2μ diameter, are reflected at the surface by a shallow but pronounced notch at each apex; pores extend ¾ apex-to-pole distance and are surrounded by an endannulus 1.3μ to 1.5μ wide and smoothly rounded at the poleward end. A small trilete mark is present on the pole of these grains; rays are ¼ to ⅓ the apex-to-pole distance. The marks are slightly curved with a 1.2μ to 1.5μ wide margo. Overall size 23μ to 27μ.

Discussion.—*Extratriporopollenites pompeckji* Potonié, 1931, Thomson and Pflug, 1953, is the only grain in this sequence with a wide endannulus.

Occurrence.—*Extratriporopollenites pompeckji* Potonié, 1931, Thomson and Pflug, 1953, is present only in the lower and upper portions of the Kaiparowits Formation.

Frequency.—Rare to frequent.

Figured Specimen.—BYU-Py-72, CFL-K-256+1250 ft. Orig. (13.4, 9.8).

Genus TRICOLPITES Cookson, 1947, ex Couper, 1953

Tricolpites COOKSON, 1947, British, Australian, and New Zealand Antarctic Res. Expedition. 1929-31, Rept. Ser. A, v. 2, pt. 8, p. 134.
Tricolpites ERDTMAN, 1947, Svensk Bot. Tidskrift, v. 41, no. 1, p. 109.
Tricolpites COOKSON ex COUPER, 1953, New Zealand Geol. Survey Paleont. Bull. 22, p. 61.
Gunnerites COOKSON AND PIKE, 1954, Australian Jour. Bot., v. 2, no. 2, p. 201.
Tricolpites COOKSON ex COUPER emended POTONIÉ, 1960, Beih. Geol. Jb., v. 39, p. 95.

Type Species.—*Tricolpites reticulatus* Cookson, 1947, (designated by Couper, 1953, p. 61).

Description.—"*Tricolpites* is here considered a form genus and diagnosed as follows: free, isopolar, tricolpate. Exine variable in thickness and sculpture. Size variable." (Couper, 1953, p. 61).

Discussion.—Couper's definition is followed more closely in this paper than the later emendation by Potonié (1960, p. 95).

Differential Diagnosis.—This organ genus is distinguished from other tricolpate organ genera by its commonly closed colpi with bordering margo.

Botanical Affinities.—Unknown.

TRICOLPITES ERUGATUS Hedlund, 1966

Plate 11, fig. 9

Tricolpites erugatus HEDLUND, 1966, Okla. Geol. Survey Bull. 112, p. 30, pl. 9, figs. 2a,b.

Description.—Tricolpate pollen grain. Semitriangular in equatorial outline. Walls approximately 1μ thick and psilate to scabrate. Colpi extend most of length of grain and approximately $\frac{3}{4}$ the distance from the equator to the pole; gape up to 30°; colpi are apically located. Overall diameter 12μ to 18μ.

Differential Diagnosis.—*Tricolpites erugatus* Hedlund, 1966, is distinguished from other tricolpate species in these samples by its semitriangular equatorial outline, gaping colpi, small size, and fine wall sculpture.

Occurrence.—*Tricolpites erugatus* Hedlund, 1966, is present throughout the Kaiparowits Formation.

Frequency.—Rare to frequent.

Figured Specimen.—BYU-Py-73, CFL-K-256+1250 ft. Orig. (13.1, 4.1).

TRICOLPITES MEMBRANUS Couper, 1960

Plate 11, fig. 10

Tricolpites membranus COUPER, 1960, New Zealand Geol. Survey Paleont. Bull. 32, p. 66, pl. 10, figs. 25,26.

Description.—Tricolpate pollen grain. Subcircular to circular in equatorial outline. Walls 0.75μ to 1μ thick and scabrate. Colpi extend approximately $\frac{3}{4}$ length of grain; gape up to 45°; colpi are completely floored by a thin psilate membrane that takes stain more readily than the remainder of the grain; an undercut lip approximately 1μ wide extends out over the membranous area. Overall size 15μ to 25μ.

Differential Diagnosis.—*Tricolpites membranus* Couper, 1960, is distinguished from other tricolpate grains in these samples by the membranous covering in the colpi. The specimens observed in these samples are smaller than those described by Couper.

Occurrence.—*Tricolpites membranus* Couper, 1960, is present in the lower and upper parts of the lower portion of the Kaiparowits Formation.

Frequency.—Rare to frequent.

Figured Specimen.—BYU-Py-74, JRB-Ka-1+5 ft. Orig. (7.95, 2.3).

TRICOLPITES RETICULATA Cookson, 1947

Plate 11, fig. 11

Tricolpites reticulata COOKSON, 1947, British, Australian, and New Zealand Antarctic Res. Expedition, 1929-31, Rept. Ser. A, v. 2, pt. 8, p. 134, pl. 15, fig. 45.
Tricolpites cf. *reticulata* COOKSON, 1947, HEDLUND, 1966, Okla. Geol. Survey Bull. 112, p. 29, pl. 9, figs. 3a-d.

Description.—Tricolpate pollen grain. Oval to subround in polar outline. Walls 1μ to 1.5μ thick and reticulate; muri low, approximately 0.4μ wide; lumina round, 1μ to 1.5μ in diameter. Colpi extend $\frac{3}{4}$ to almost equal long dimension of grain, approximately 2μ wide at equator and narrowing toward poles. Maximum diameter 25μ to 40μ.

Differential Diagnosis.—*Tricolpites reticulata* Cookson, 1947, is distinguished from other tricolpate pollen grains in these samples by its larger size, globose outline, and low, reticulate sculpture.

Occurrence.—*Tricolpites reticulata* Cookson, 1947, is present throughout the Kaiparowits Formation.

Frequency.—Rare to frequent.

Figured specimen.—BYU-Py-75, CFL-K-256+1250 ft. Orig. (7.7, 11.45).

TRICOLPITES cf. T. THOMASII Cookson and Pike, 1954

Plate 11, fig. 12

Tricolpites thomasii COOKSON AND PIKE, 1954, Australian Jour. Bot., v. 2, no. 2, p. 214, pl. 2, figs. 92-94.

Description.—Tricolpate pollen grain. Triangular in equatorial outline with sides straight to slightly concave or convex, apices blunt. Walls 1μ to 1.5μ thick and reticulate, muri approximately 0.4μ high and wide; lumina subround 1μ to 1.5μ diameter. Colpi extend ½ to ¾ length of grain; are straight, narrow slits that are bordered by a thickened psilate margo approximately 1μ wide. They are apically located and appear as smoothly rounded notches. Overall size 15μ to 20μ.

Differential Diagnosis.—*Tricolpites* cf. *T. thomasii* Cookson and Pike, 1954, is distinguished from other tricolpate grains in this sequence by its strongly triangular outline and reticulate wall structure. Differs from Cookson and Pike's species in that it is uniformly reticulate and is smaller in size.

Occurrence.—*Tricolpites* cf. *T. thomasii* Cookson and Pike, 1954, is present in the lower portion of the Kaiparowits Formation.

Frequency.—Rare to frequent.

Figured Specimen.—BYU-Py-76, JRB-Ka-1+5 ft. Orig. (20.4, 11.3).

TRICOLPITES n. sp. A

Plate 12, fig. 1

Description.—Tricolpate pollen grain. Triangular in equatorial outline, apices blunt, sides straight to slightly concave or convex. Walls approximately 1.5μ thick and gemmate to verrucate and/or clavate. Colpi are straight, narrow slits extending ½ length of the grain, and ½ to ⅗ distance from equator to pole. They are bordered by a thickened, psilate margo approximately 1μ wide. Colpi are apically located and form a smoothly rounded notch at each apex. Overall size 16μ to 23μ.

Differential Diagnosis.—*Tricolpites* n. sp. A can be distinguished from other tricolpate grains in these samples by its distinctly triangular outline; colpi with thickened, psilate margos; and the distinctive gemmate to verrucate and/or clavate wall structure.

Occurrence.—*Tricolpites* n. sp. A is present in the lower portion of the Kaiparowits Formation.

Frequency.—Rare to frequent.

Figured Specimen.—BYU-Py-77, JRB-Ka-1+5 ft. Orig. (10.0, 2.35).

Genus TRICOLPOPOLLENITES Pflug and Thomson in Thomson and Pflug, 1953

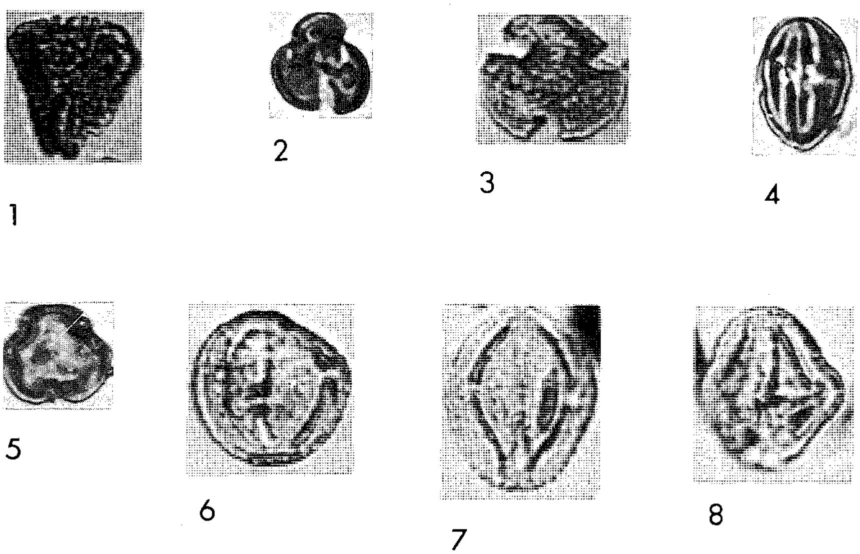
Tricolpopollenites PFLUG AND THOMSON in THOMSON AND PFLUG, 1953, Palaeontographica, v. 94, pt. B, p. 95.

Type Species.—*Tricolpopollenites parmularius* Potonié, 1934, Thomson and Pflug, 1953.

Description.—Tricolpate pollen grains. Colpi are symmetrical to each other. Openings in the colpi are meridianally located only. Three-fold symmetry in polar view.

Differential Diagnosis.—This organ genus is separated from other tricolpate genera by the exclusively meridianally located apertures in the germinal apparatus.

Botanical Affinities.—Unknown.



EXPLANATION OF PLATE 12

FIG. 1.—*Tricolpites* n. sp. A, X1000, polar view, BYU-Py-77, JRB-Ka-1+5 ft. Orig. (10.0, 2.35).

FIG. 2.—*Tricolpopollenites parvulus* Groot and Penny, 1960, X1000, polar view, BYU-Py-78, CFL-K-256+1250 ft. Orig. (10.2, 11.4).

FIG. 3.—*Tricolpopollenites* n. sp. A, X1000, polar view, BYU-Py-79, JRB-Ka-1+5 ft. Orig. (0.75, 14.8).

FIG. 4.—*Tricolporites prolata* Cookson, 1947, X1000, lateral view, BYU-Py-80, CFL-K-256+1250 ft. Orig. (12.0, 11.4).

FIG. 5.—*Tricolporopollenites microreticulatus* Pflug and Thomson *in* Thomson and Pflug, 1953, X1000, polar view, BYU-Py-81, CFL-K-256+1250 ft. Orig. (13.7, 5.6).

FIG. 6.—*Tricolporopollenites* n. sp. A, X1000, lateral view, BYU-Py-82, JRB-Ka-1+5 ft. Orig. (3.8, 5.35).

FIG. 7.—*Tricolporopollenites* n. sp. B, X1000, lateral view, BYU-Py-83, JRB-Ka-1+5 ft. Orig. (10.85, 4.75).

FIG. 8.—*Tricolporopollenites* n. sp. C, X1000, lateral view, BYU-Py-84, JRB-Ka-1+5 ft. Orig. (5.45, 1.75).

TRICOLPOPOLLENITES PARVULUS Groot and Penny, 1960

Plate 12, fig. 2

Tricolpopollenites parvulus GROOT AND PENNY, 1960, Micropaleontology, v. 6, no. 2, p. 232, pl. 2, figs. 8, 9.
Tricolpopollenites parvulus GROOT AND PENNY, 1960, DRUGG, 1967, Palaeontographica, v. 120, pt. B, p. 48, pl. 7, fig. 30.

Description.—Tricolpate pollen grain. Circular to subcircular in equatorial outline. Wall 1μ to 1.5μ thick and psilate to finely scabrate. Colpi gape approximately 30°, extend most of the length of the grain. Overall size 9μ to 16μ. Grains commonly are crushed and deformed.

Differential Diagnosis.—*Tricolpopollenites parvulus* Groot and Penny, 1960, is distinguished from other tricolpate grains in this sequence by its small size, fine wall structure, and circular outline.

Occurrence.—*Tricolpopollenites parvulus* Groot and Penny, 1960, is present throughout the Kaiparowits Formation.

Frequency.—Rare to common.

Figured Specimen.—BYU-Py-78, CFL-K-256+1250 ft. Orig. (10.2, 11.4).

TRICOLPOPOLLENITES n. sp. A

Plate 12, fig. 3

Description.—Tricolpate pollen grain. Subcircular to circular in equatorial outline. Walls 0.5μ to 1μ thick and granulate. Colpi extend most of length of grain and approximately ½ the distance from the equator to pole; may be closed or gape up to 60°. Overall size 16μ to 22μ.

Differential Diagnosis.—*Tricolpopollenites* n. sp. A is distinguished from other tricolpate grains in these samples by its circular outline, thin walls, and intermediately coarse wall sculpture.

Occurrence.—*Tricolpopollenites* n. sp. A is present throughout the Kaiparowits Formation.

Frequency.—Rare to frequent.

Figured Specimen.—BYU-Py-79, JRB-Ka-1+5 ft. Orig. (0.75, 14.8).

Genus TRICOLPORITES Erdtman, 1947

Tricolporites ERDTMAN, 1947, Svensk Bot. Tidskrift, v. 41, no. 1, p. 110.
Tricolporites ERDTMAN, 1947, COOKSON, 1947, British, Australian, and New Zealand Antarctic Res. Expedition. 1929-31, Rept. Ser. A, v. 2, pt. 8, 134.
Tricolporites ERDTMAN, 1947, COOKSON, 1947, Proc. Linn. Soc. New South Wales, v. 72, pts. 3, 4, p. 195.
Tricolporites ROSS, 1949, Bull. Geol. Inst. Uppsala, v. 34, p. 34.
Tricolporites ERDTMAN 1947, POTONIÉ, 1960, Beih. Geol. Jb., v. 39, p. 154.
Tricolporites COOKSON, 1947, HARRIS, 1965, Palaeontographica, v. 115, pt. B, p. 96.

Type Species.—*Tricolporites protrudens* Erdtman in Ross, 1949.

Description.—Tricolporate sporomorphs. Variable size, shape, wall sculpture, etc.

Discussion.—This form genus is not clearly defined.

Botanical Affinities.—Erdtman (1947, p. 110) ". . . (tricolporate spores have been found in at least 165 dicotyledonous families)."

TRICOLPORITES PROLATA Cookson, 1947

Plate 12, fig. 4

Tricolporites prolata COOKSON, 1947, British, Australian, and New Zealand Antarctic Res. Expedition. 1929-31, Rept. Ser. A, v. 2, pt. 8, p. 134, pl. 15, fig. 46.
Tricolporites prolata COOKSON, 1947, HARRIS, 1965, Palaeontographica, v. 115, pt. B, p. 96, pl. 27, figs. 14-16.

Description.—Tricolporate pollen grain. Oval to elliptical in polar outline. Walls approximately 1μ thick and psilate to finely scabrate. Colpi extend most of length of grain, approximately 0.3μ wide at equator, tapering uniformly poleward. Pores approximately 1.5μ diameter, round, equatorially located. Maximal dimension 18μ to 25μ.

Differential Diagnosis.—*Tricolporites prolata* Cookson, 1947, is distinguished from other tricolporate grains in this sequence by its smaller size and psilate to finely scabrate walls.

Occurrence.—*Tricolporites prolata* Cookson, 1947, is present in the lower and middle portion of the Kaiparowits Formation.

Frequency.—Rare to frequent.

Figured Specimen.—BYU-Py-80, CFL-K-256+1250 ft. Orig. (12.0, 11.4).

Genus TRICOLPOROPOLLENITES Pflug and Thomson in Thomson and Pflug, 1953

Tricolporopollenites PFLUG AND THOMSON in THOMSON AND PFLUG, 1953, Palaeontographica, v. 94, pt. B, p. 98.
Tricolporopollenites POTONIÉ, 1931, GROOT AND PENNY, 1960, Micropaleontology, v. 6, no. 2, p. 232.
Tricolporopollenites (PFLUG 1952) THOMSON AND PFLUG, 1953, POTONIÉ, 1960, Beih. Geol. Jb., v. 39, p. 101.
Tricolporopollenites PFLUG AND THOMSON, 1953, GROOT, PENNY AND GROOT, 1961, Palaeontographica, v. 108, pt. B, p. 134.
Tricolporopollenites (PFLUG, 1952) THOMSON AND PFLUG, 1953, ENGELHARDT, 1964, Miss. Geol., Econ. and Topo. Survey Bull. 104, p. 73.
Tricolporopollenites PFLUG, 1952, ex THOMSON AND PFLUG, 1953, NEWMAN, 1965, Univ. Colo. Studies, Ser. in Earth Sci., no. 2, p. 11.
Tricolporopollenites PFLUG, 1952, ex THOMSON AND PFLUG, 1953, HEDLUND, 1966, Okla. Geol. Survey Bull. 112, p. 30.
Tricolporopollenites PFLUG AND THOMSON in THOMSON AND PFLUG, 1953, DRUGG, 1967, Palaeontographica, v. 120, pt. B, p. 50.

Type Species.—*Tricolporopollenites dolium* (Potonié) Thomson and Pflug, 1953.

Description.—Three germinal apparatus always symmetrical to each other. Each germinal apparatus includes a meridional colpus and equatorial pore. Three-fold symmetry in polar view.

Discussion.—Potonié (1960, p. 101) stated that the form genus *Tricolporopollenites* (Pflug, 1952), Thomson and Pflug, 1953, is synonomyous with *Rhoipites* Wodehouse, 1933. If this transfer is affected no valid genus remains for fossil tricolporate pollen grains of unknown affinities with characteristics included in the form genus *Tricolporopollenites*. The transfer is therefore not followed here.

Botanical Affinities.—Unknown.

TRICOLPOROPOLLENITES MICRORETICULATUS Pflug and Thomson in Thomson and Pflug, 1953

Plate 12, fig. 5

Tricolporopollenites microreticulatus PFLUG AND THOMSON in THOMSON AND PFLUG, 1953, Palaeontographica, v. 94, pt. B, p. 106, pl. 14, figs. 27-42.

Tricolporopollenites microreticulatus PFLUG AND THOMSON in THOMSON AND PFLUG (1953), KREMP, AMES AND GREBE, 1958, Catalog of Fossil Spores and Pollen, v. 3, p. 146.

Tricolporopollenites microreticulatus PFLUG AND THOMSON, 1953, DRUGG, 1967, Palaeontographica, v. 120, pt. B, p. 50, pl. 7, figs. 27, 28.

Description.—Tricolporate pollen grain. Semitriangular in equatorial outline, apices blunt, sides convex. Endexine 0.2μ to 0.3μ thick, unstructured; ektexine 1.1μ to 1.3μ thick and finely baculate with the surface appearing scabrate. Walls thin slightly and terminate abruptly at the colpi. Germinal apparatus is recessed and located at the apices of the triangle. Colpi gape up to 45° and are unstructured. Pores are 0.4μ to 0.7μ diameter, round, and equatorially located.

Differential Diagnosis.—*Tricolporopollenites microreticulatus* Pflug and Thomson in Thomson and Pflug, 1953, is distinguished from other tricolporate grains by its baculate ektexine.

Occurrence.—*Tricolporopollenites microreticulatus* Pflug and Thomson in Thomson and Pflug, 1953, is present in the lower and middle portions of the Kaiparowits Formation.

Frequency.—Rare to frequent.

Figured Specimen.—BYU-Py-81, CFL-K-256+1250 ft. Orig. (13.7, 5.6).

TRICOLPOROPOLLENITES n. sp. A

Plate 12, fig. 6

Description.—Tricolporate pollen grain. Subcircular to circular with a slight equatorial bulge in polar outline. Wall approximately 1.5μ thick and scabrate. Colpi are narrow, uniform width slits extending most of length of grain; poleward ends of colpi are blunt to slightly rounded. Pores approximately 1μ diameter, round, equatorially located; ends of the pores are slightly flared. Overall size 16μ to 25μ.

Differential Diagnosis.—*Tricolporopollenites* n. sp. A is separated from *T.* n. sp. B and C by its more circular outline, blunt ended colpi, and pores with flared ends.

Occurrence.—*Tricolporopollenites* n. sp. A is present only in the lower portion of the Kaiparowits Formation.

Frequency.—Rare to frequent.

Figured Specimen.—BYU-Py-82, JRB-Ka-1+5 ft. Orig. (3.8, 5.35).

TRICOLPOROPOLLENITES n. sp. B

Plate 12, fig. 7

Description.—Tricolporate pollen grain. Oval to circular in polar outline. Walls 0.75μ to 1μ thick and scabrate. Colpi are narrow slits extending most of the length of the grains; poleward ends of the colpi have a small concave (to the surface) bend and are pointed. Pores are approximately 1.5μ diameter, round, equatorially located; colpi end bluntly at the pores and the pores are uniform in diameter. Overall size 18μ to 25μ.

Differential Diagnosis.—*Tricolporopollenites* n. sp. B is distinguished from *T.* n. sp. A and C by its more oval polar outline, small slightly concave hook on the poleward ends of the colpi, and uniform diameter pores.

Occurrence.—*Tricolporopollenites* n. sp. B is present throughout the Kaiparowits Formation.

Frequency.—Rare to frequent.

Figured Specimen.—BYU-Py-83, JRB-Ka-1+5 ft. Orig. (10.85, 4.75).

TRICOLPOROPOLLENITES n. sp. C

Plate 12, fig. 8

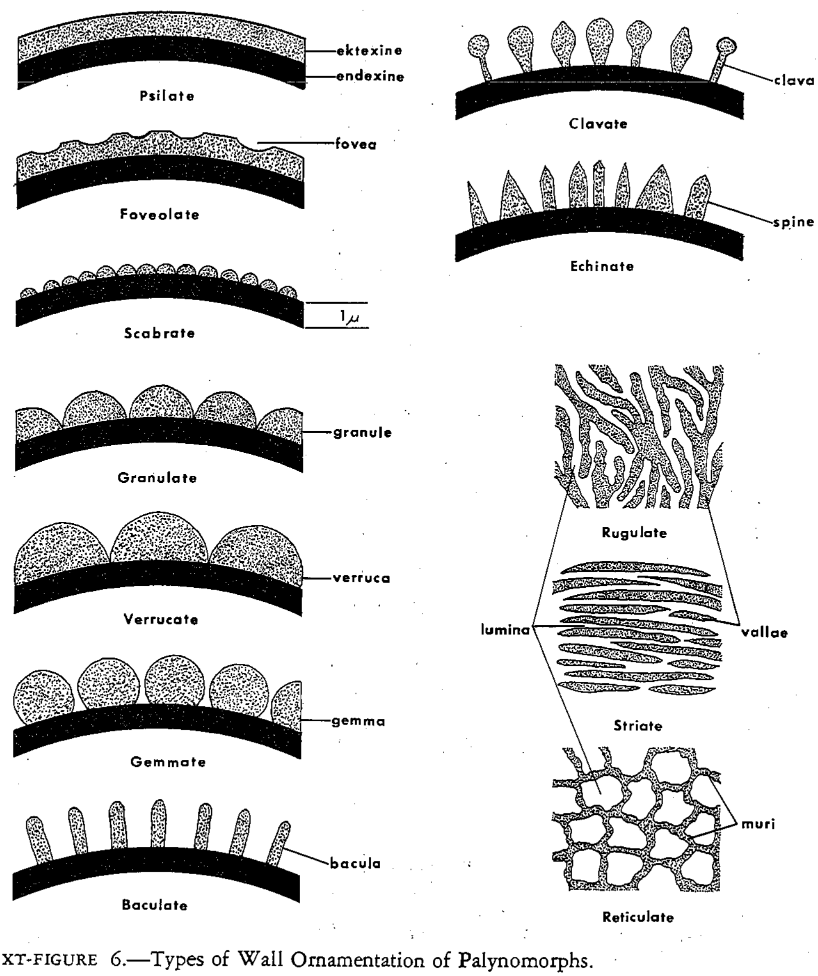
Description.—Tricolporate pollen grain. Semitetragonal to suboval in polar outline. Poles are broadly rounded. Sides are straight to slightly concave or convex. There is a smoothly rounded, but pronounced, equatorial bulge 5μ to 7μ wide. Walls approximately 1μ thick and scabrate. Colpi are straight, narrow slits that extend most of the length of the grain; poleward ends taker uniformly and thicken into a small "lip" at the equator. Pores 0.4μ to 0.8μ diameter, round, and uniform. They are long because of the thickening of the colpi equatorially. Overall size 18μ to 24μ.

Differential Diagnosis.—*Tricolporopollenites* n. sp. C is distinguished from *T.* n. sp. A and B by the pronounced equatorial bulge and equatorially thickened colpi.

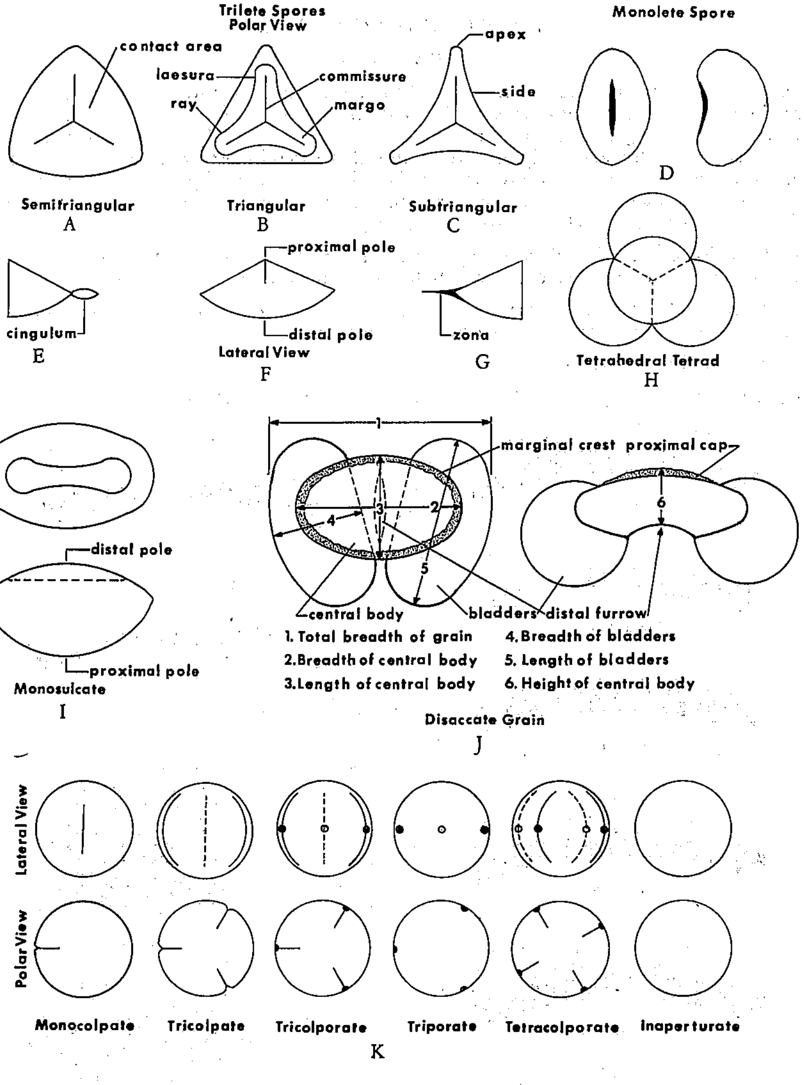
Occurrence.—*Tricolporopollenites* n. sp. C is present only in the lower and middle parts of the lower portion of the Kaiparowits Formation.

Frequency.—Rare to frequent.

Figured Specimen.—BYU-Py-84, JRB-Ka-1+5 ft. Orig. (5.45, 1.75).



TEXT-FIGURE 6.—Types of Wall Ornamentation of Palynomorphs.



TEXT-FIGURE 7.—Morphological Features of Palynomorphs.

APPENDIX A

Composite measured section of the Kaiparowits Formation in the Type Locality, The Blues, southern Garfield County, Utah. The section lies within Secs. 34, 35, 36, T. 36 S., R. 1 W., Sec. 1, T. 37 S., R. 1 W., and Sec. 31, T. 36 S., R. 1 E.

WASATCH FORMATION.—Basal portion consists of pebble-cobble conglomerate, dark brown color, coarse sand matrix. Overlying this, the formation is pink and white limestone, having the appearance generally associated with the Wasatch Formation. The contact between the Kaiparowits Formation and the Wasatch Formation is a regional angular unconformity having only 5° to 10° difference in attitude.

KAIPAROWITS FORMATION.—Unit 97, 2,580 ft. to 2,756 ft. C NW¼ NE¼ SE¼, Sec. 31, T. 36 S., R. 1 E. Across the ravine about 200 feet from the last increment and about 25 feet below the first juniper tree in the east fork. The slump material here from within the Kaiparowits Formation plus minor percentages from the overlying Wasatch Formation is extremely thick.

Unit 97, 2,350 ft. to 2,580 ft. SE¼ NE¼ NW¼ SE¼, Sec. 31, T. 36 S, R. 1 E., moved to the second spur east, about 400 yards, from the preceding increment.
Unit 97, 2,190 ft . to 2,350 ft. SW¼ NW¼ NW¼ SE¼, Sec. 31, T. 36 S., R. 1 E., moved about 200 yards to the east to the furthest spur visible from the top of the next lowest increment of this unit.

Unit 97, base to 2,190 ft. SE¼ NE¼ NE¼ SW¼, Sec. 31, T. 36 S., R. 1 E. Beginning from the top of the east end of the thick, cliff-forming sandstone that comprises Unit 96.

Unit	*Description*	*Thickness* *Unit*	*Total*
97	Mudstone, bentonite, sandstone; mudstone (45%), clean to silty to sandy, chestnut brown to gray-brown to brown-gray to olive-gray to light yellow-gray. Bentonite (15%), gray, hard. Sandstone (40%), lithic to quartzose, brown to yellow to white to olive, well- to poorly-cemented; not extensive for more than a few tens of yards laterally; some conglomerate lenses. There was no logical place to break this into thinner units.	565	2756

Unit 96, 2,060 ft. to top, SE¼ NE¼ NE¼ SW¼, Sec. 31, T. 36 S., R. 1 E. at the east end of the thick sandstone cliffs. The upper 30 or 40 feet of Unit 96 or lower part of Unit 97 interfinger. Lower part of Unit 96 and Units 91 through 95 were measured in E½ E½ NW¼ SW¼, Sec. 31, T. 36 S., R. 1 E. This increment was measured along the divide about ¼ mile down stream from the cliffs and is between two right angle bends in the stream.

Unit	*Description*	*Thickness* *Unit*	*Total*
96	Sandstone, lithic, light olive-brown to light gray, medium- to fine-grained, conglomeratic layers; clay blebs scattered through the unit; well-cemented. This unit is cross-bedded and lenticular, containing abundant convolute laminations and flame structures. Bone fragments and wood fragments are also present. This unit forms a set of massive cliffs in this area and also across Utah Highway 54 where it forms the cliffs about 100 feet to 150 feet high along the South Rim of Upper Valley. These cliffs stand in bold relief against the badlands topography of The Blues.	97	2191
95	Mudstone-sandstone; mudstone (60%), clean to silty to sandy, olive-brown to brown-gray to olive-gray laminated to massive bedding. Some molluscs present. Sandstone (40%), lithic, light olive-brown, medium- to fine-grained, well- to poorly-cemented, parts are thinly laminated.	71	2094
94	Sandstone, lithic, light gray to light orange-gray, fine- to coarse-grained, with conglomeratic layers, well- to poorly-cemented, forming prominent ledges in places, cross-bedding, lensing, convolute laminations, punch-ups, clay-blebs, wood fragments. Top 1½ to 2½ feet is well cemented and looks like point-bar deposits.	43	2023
93	Mudstone, clean to silty to sandy, olive-brown to brown-gray to dark gray to green-gray to gray-green to chestnut brown. A few thin sandstone lenses occur throughout this unit. Molluscs are scattered throughout the mudstone portion of this unit.	121	1980
92	Sandstone, lithic, light to dark olive-brown to brown-		

	gray, fine- to medium-grained with conglomeratic layers. The sandy portions are laminated, well-cemented to friable.	46	1859
91	Mudstone-sandstone; mudstone (80%), clean to silty to sandy, olive-brown to brown-gray, some parts with plant fragments; some portions with mollusc fragments. Sandstone (20%), lithic, medium gray to brown-gray, fine- to medium-grained, well- to poorly-cemented.	67	1813

Units 88 through 90, measured in SE¼ NW¼ SW¼, Sec. 31, T. 36 S., R. 1 E. Measured along a small gully on the downstream side of the cliffs that are about 50 feet high, starting about 25 feet above stream level.

		Thickness	
Unit	*Description*	*Unit*	*Total*
90	Sandstone, lithic, light olive-brown, fine- to coarse-grained, conglomeratic layers, well-cemented, cross-bedded, lenticular; this unit appears to be a bar complex.	18	1746
89	Mudstone, clean to silty to sandy, olive-brown to brown-gray to gray-green to green-gray.	51	1728
88	Sandstone, lithic, light to dark olive-brown to medium gray, fine-grained to conglomeratic, well-cemented, cross-bedded, lensing, some concretionary-appearing bodies.	46	1677

Units 84 through 87 measured in NW¼ SW¼ SW¼, Sec. 31, T. 36 S., R. 1 E. This increment was measured in the vicinity of the first waterfall encountered going upstream from the junction of this stream with Henrieville Creek (the falls are about three to four feet high and are held up by a resistant sandstone). Beginning about 30 yards downstream to the falls, then vertically up the northwest valley wall directly above the falls.

		Thickness	
Unit	*Description*	*Unit*	*Total*
87	Mudstone-sandstone; mudstone (80%), clean to silty to sandy, olive-brown to green-gray, hard to crumbly. Sandstone (20%), lithic.	34	1631
86	Sandstone, lithic, medium gray to orange-gray to yellow-brown, fine-grained, well-cemented ledge former.	8	1597
85	Mudstone-sandstone; mudstone (85%), clean to silty to sandy, chestnut brown to olive-brown to green-gray to maroon-gray, hard to crumbly; pelecypods and gastropods in various parts of the unit. Sandstone (15%), lithic, medium olive-brown, fine-grained, friable.	94	1589
84	Sandstone, lithic, light to dark olive-brown to brown-gray to yellow-brown, fine- to coarse-grained, layers of conglomerate, well- to poorly-cemented, cross-bedded, lenticular.	47	1495

Unit 83, measured in W½ NE¼ SW¼ NE¼ SE¼, Sec. 36, T. 36 S., R. 1 W., about ½ mile upstream from the major stream junction; a large block of white Wasatch limestone is lying on the outside downstream side of the meander. This increment was measured on the northwest side of the valley wall. A six-inch layer of lignitic shale is at stream level, which is thought to be the lateral equivalent of the sandstone that overlies Unit 82 where it was measured.

		Thickness	
Unit	*Description*	*Unit*	*Total*
83	Mudstone-sandstone-lignitic shale; mudstone (80%), clean to silty to sandy, brown-gray to green-gray to chestnut brown to olive-brown to dark gray. Sandstone (19%), lithic, light olive-brown to light gray-brown, medium- to fine-grained, well- to poorly-cemented. Lignitic shale (1%), dark brown, crumbly. Limestone, dark		

	maroon, fine-grained, excellent leaf impressions. This is probably a fresh water limestone and is about six inches thick.	153	1448

Units 80 through 82, measured in W½ SE¼ SE¼, Sec. 36, T. 36 S, R. 1 W., directly up the divide between the two major streams. This increment begins about 20 feet above stream level at a 1½ inch resistant bentonite bed.

Unit	*Description*	*Thickness* *Unit*	*Total*
82	Mudstone, clean to silty to sandy, chestnut brown to olive-brown to brown-gray to medium to light gray; molluscs at various levels. Some thin lenses of sandstone, lithic, fine- to medium-grained, well- to poorly-cemented, scattered though the unit.	159	1295
81	Sandstone, lithic, light gray fresh, rust to light orange-gray weathered, fine- to medium-grained, poorly- to well-cemented ledge forming unit. Lower 1½ feet is cross-bedded, resistant, ledge former.	17	1136
80	Mudstone-sandstone-limestone; mudstone (50%), is clean to silty to sandy, olive-brown to olive-gray, molluscs present. Sandstone (49%), lithic, light gray to light olive-brown, fine- to medium-grained, well- to poorly-cemented. Limestone (1%), medium to dark gray, fine-grained.	31	1119

Unit 79 measured in NE¼ NW¼ NE¼, Sec. 1, T. 37 S., R. 1 W., in the small gully on the downstream side of the first major spur downstream from the major stream junction.

Unit	*Description*	*Thickness* *Unit*	*Total*
79	Mudstone-sandstone; mudstone (75%), clean to silty to sandy, olive-brown to brown-gray to green-gray to light brown-gray to olive-gray to light yellow-brown. Sandstone (25%), lithic, light brown, fine- to medium-grained, well- to poorly-cemented, occurs as thin lenses scattered throughout the unit. Section begins about 10 feet above stream level.	110	1088

Units 77 and 78, measured in NW¼ NW¼ NE¼, Sec. 1, T. 37 S., R. 1 W., along the spur on the upstream side of the large meander about 150 yards upstream from the next lower increment of this section.

Unit	*Description*	*Thickness* *Unit*	*Total*
78	Sandstone, lithic, yellow to gray, fine- to coarse-grained, well-cemented.	21	978
77	Mudstone, clean to silty to sandy, olive-brown to green-gray to gray-brown to brown-gray fresh, weathers light to medium gray, hard, gastropod and pelecypod fragments. A few thin lenses of sandstone, light gray to gray-green, fine- to medium-grained, well- to poorly-cemented.	80	957

Units 73 through 76, measured in NE¼ NW¼, Sec. 1, T. 37 S., R. 1 W., on the large spur about 100 yards upstream from the next lower increment of the section, measured on the north side of the valley.

Unit	*Description*	*Thickness* *Unit*	*Total*
76	Sandstone, lithic, light to medium gray fresh, rust colored weathered, fine- to medium-grained, conglomeratic in parts, cross-bedded. This unit is the first major ledge-former going up the slope.	3	877
75	Mudstone, clean to silty to sandy, olive-brown to olive-		

	gray, hard.	26	874
74	Sandstone, lithic, light to medium gray, fine- to coarse-grained, well-cemented. Unit forms a slight bench.	4	848
73	Mudstone; olive-brown to greenish gray, hard.	6	844

Units 65 through 72, measured in NW¼ NW¼ NE¼ NW¼, Sec. 1, T. 37 S., R. 1 W., on the south side of the low divide between Henrieville Creek and the major tributary that enters a few hundred yards west of milepost 26 on Utah Highway 54. The increment was measured on the west side of a small spur that slopes toward the south-southwest.

		Thickness	
Unit	*Description*	*Unit*	*Total*
72	Sandstone, lithic, light gray fresh, rust colored weathered, fine- to medium-grained, well-cemented, cross-bedded, massive, large pelecypods, and gastropods abundant in in the lower part.	1½	838
71	Mudstone, clean to silty to sandy, olive-brown to light olive-brown, stem material and leaf imprints.	28	836½
70	Sandstone, lithic, medium to light gray fresh, rust colored weathered, fine- to medium-grained, massive.	½	808½
69	Sandstone, lithic, yellow-brown-gray, medium- to fine-grained, well- to poorly-cemented.	9½	808
68	Sandstone, lithic, medium gray fresh, rust colored weathered, medium- to fine-grained, conglomeratic in part, cross-bedded. Large variety of gastropods and pelecypods present.	1	798½
67	Mudstone, clean to silty to sandy, dark green-gray to chestnut brown to maroon-gray.	16	797½
66	Sandstone, lithic, medium olive-brown fresh, light brown-gray weathered, fine- to medium-grained, friable to well-cemented, unit is partially muddy, some small pockets of mudstone.	15	781½
65	Mudstone, clean to silty to sandy, olive-gray to olive-gray-brown to chestnut brown, hard.	24	766½

Units 62 through 64, measured in SW¼ SE¼ SW¼, Sec. 36, T. 36 S., R. 1 W., on the north side of the highway at the east end of the road cut.

		Thickness	
Unit	*Description*	*Unit*	*Total*
64	Sandstone, lithic, medium gray to light olive-brown, medium- to fine-grained, friable to well-cemented. Upper 1 foot is well-cemented, cross-bedded, conglomeratic, rust colored weathered, molds of molluscs.	10	742½
63	Mudstone, clean to silty to sandy, olive-brown to dark brown, mollusc fragments. Some small lenses of sandstone,, lithic, yellow-brown to yellow-gray, medium- to fine-grained, well- to poorly-cemented.	72	732½
62	Sandstone-mudstone; sandstone in 2 to 4 inch layers and mudstone in ½ to 1 inch layers, this is an interlensing unit and occupies most of the thickness on this side of the roadcut. Sandstone (80%), lithic, dark brown-gray to light yellow-gray, medium- to fine-grained, well-cemented. Mudstone (20%), sandy, light yellow-gray.	18	660½

Units 53B through 61, measured in S½ SW¼ SW¼, Sec. 36, T. 36 S., R. 1 W., along Utah Highway 54. Unit 53B is in the roadcut about 0.3 miles east of milepost 26 on Utah Highway 54; the section continues along the north side of the highway for about 200 yards, through Unit 57, crosses the highway to the south side at the west end of the second road cut from the start of this increment and continues along the south side through Unit 61.

Unit	Description	Thickness Unit	Thickness Total
61	Sandstone, lithic, yellow-gray to light gray, fine- to coarse-grained, well- to poorly-cemented, with calcareous cement. This unit appears to be a distributary sequence of cross-beds, foreset beds, channels, etc. There are some thin stringers of organic material several feet long throughout this formation.	12	642½
60	Mudstone, sandy, chestnut brown to dark brown, hard. Lenses of sandstone, lithic, medium gray, medium-grained.	24	630½
59	Sandstone, lithic, light gray-brown to orange-gray, fine-grained, well-cemented, laminated.	4	606½
58	Mudstone, silty, olive-brown to dark chocolate brown; abundant fossil molluscs.	3	603½
57	Sandstone, lithic, light gray fresh, rust colored weathered, medium- to fine-grained, friable to well-cemented, cross-bedded, laterally this unit becomes conglomeratic with molds of molluscs; portions of the unit weather into concretionary-like bodies.	2	599½
56	Mudstone, silty, light olive-brown to medium gray to gray-brown.	10	597½
55	Sandstone, lithic, gray-brown to medium gray, medium-grained, friable to well-cemented.	9	587½
54	Mudstone, sandy becoming silty then clean going upward, green-gray to dark gray-green to gray-brown.	5	578½
53B	Sandstone, lithic, olive-brown fresh, medium to light gray weathered, fine-grained, poorly- to well-cemented.	1	573½

Units 45 through 53, measured in SW¼ SE¼ SE¼, Sec. 35, T. 36 S., R. 1 W., along the north side of the hill that is next to the highway on the north side. This increment begins in about the middle of the hill and runs eastward and upward to the small saddle at the head of the gully opposite milepost 26 on Utah Highway 54.

Unit	Description	Thickness Unit	Thickness Total
53	Mudstone, sandy, olive-brown, mollusc fragments, a few pebbles, some organic material, hematitic concentrations.	23	592½
52	Sandstone, lithic, gray-brown fresh, light brownish gray weathered, medium- to fine-grained, friable to well-cemented, forms some small ledges, clayey in portions.	12	549½
51	Mudstone-sandstone mixed; mudstone (75%), sandy to silty, greenish gray to gray-brown to chestnut brown; molluscs in portions. Sandstone (25%), muddy, gray-brown.	8	537½
50	Mudstone, slightly silty, greenish-brownish gray to green-gray, hard at the base becoming crumbly upward.	14½	529½
49	Mudstone, light yellow-brown, calcareous. Weathered surfaces covered with hematitic balls ¼ to 1 inch in diameter.	½	515
48	Mudstone, silty to sandy, chestnut brown fresh, green-gray to dark gray-brown to light gray weathered, crumbly.	26	514½
47	Sandstone, lithic, gray-brown fresh, light gray to light brown-gray weathered, medium- to fine-grained, friable.	24	488½
46	Sandstone, lithic, orange-brown fresh, brown-gray weathered, medium- to fine-grained, highly conglomeratic, calcareous, ledge-former. Grades upward into a brownish, conglomeratic, lithic sandstone with layers of pebbles, clay blebs, and gastropod steinkerns.	4½	464½
45	Mudstone-sandstone; mudstone (60%), sandy, grading		

	upward into sandstone (40%), muddy, dark gray to dark olive-brown to olive-gray fresh, light gray weathered, crumbly or friable.	19½	460
44B	Sandstone, brown-gray, fine-grained, friable.		

Units 38 through 44, measured in NW¼ SW¼ SE¼, Sec. 35, T. 36 S., R. 1 W., this increment of the section runs along the divide immediately east of the main channel, around the most southeasterly hill and out the point on its south side. This increment is about ¼ mile southeast across the drainage basin from unit 37.

		Thickness	
Unit	*Description*	*Unit*	*Total*
44	Mudstone, silty, olive-gray to dark gray.	6	440½
43	Mudstone-sandstone; mudstone (80%), silty, gray-brown to brown-gray to olive-brown. Sandstone (20%), muddy, orange-brown to medium brown, medium- to fine-grained, poorly- to well-cemented, with calcareous cement.	10	434½
42	Sandstone, lithic, medium gray to gray-brown, friable to well-cemented.	17½	424½
41	Sandstone, lithic, yellow-brown to brown-gray fresh, gray-brown weathered, fine grained. Upper ½ to 1 foot is well-cemented, calcareous, medium gray fresh, brick red weathered, cross-bedded, conglomeratic, lower part is less well consolidated and contains petrified wood.	11½	407
40	Mudstone, silty, medium gray fresh, olive-brown to brown-gray weathered.	2½	395½
39	Sandstone, lithic, medium gray, fine-grained, poorly-cemented, wood fragments and pebbles present.	4½	393
38	Sandstone, lithic, yellow-gray fresh, gray-orange to brown-orange weathered, well-cemented ledge-former, conglomeratic in upper ¾. Unit grades laterally into sandstone, lithic, medium gray, medium-grained, cross-bedded.	½	388½

Units 23 through 37 measured along the drainage divide that lies in NE¼ NE¼ SW¼ and N½ NW¼ SE¼, Sec. 35, T. 36 S., R. 1 W. This increment runs toward the east along this east-west divide.

		Thickness	
Unit	*Description*	*Unit*	*Total*
37	Sandstone, lithic, medium gray, friable, laminated.	3	388
36	Mudstone, silty, olive-brown to green-gray-brown.	4½	385
35	Sandstone, lithic, orange-brown, fine-grained, forms a small ledge.	1	380½
34	Sandy mudstone to muddy sandstone; olive-brown fresh, light brown-gray weathered.	3	379½
33	Siltstone, yellow-brown-olive, friable.	3	376½
32	Mudstone-sandstone; mudstone (60%), sandy, dark gray to olive-gray to yellow-brown. Sandstone (40%), lithic, brown to olive-brown, fine-grained, friable, two to six inch layers, limonitic concretions.	6	373½
31	Sandstone, lithic, gray-brown to orange-brown, fine-grained, well-cemented, cross-bedded, rib and furrow structure, looks like a point bar deposit.	2½	367½
30	Sandstone, clean quartz, gray-brown to orange-brown to dark brown fresh, gray-brown weathered, fine-grained, friable to well-cemented. Small sets of cross-beds, stringers of organic material.	6	365
29	Sandstone, fairly clean quartz, fine-grained, friable, small pockets of silty mudstone, dark olive-gray.	½	359
28	Sandstone, lower part lithic, fine-grained, organic frag-		

	ments, highly ferruginous, upper part, fairly clean quartz, well- to poorly-cemented, entire unit is cross-bedded.	4	358.6
27	Mudstone, silty, dark gray to dark brown-gray fresh, medium gray-brown to brown-gray to medium gray weathered.	11	354.6
26	Mudstone-sandstone; mudstone (50%), sandy, olive-brown. Sandstone (50%), lithic, gray to orange-brown, fine-grained, friable. These two lithologies are interbedded.	3	343.6
25	Sandstone, lithic, medium gray fresh, gray-brown weathered, fine-grained, well- to poorly-cemented, calcareous. This is a thin stringer of sandstone.	.3	340.6
24	Mudstone-sandstone; mudstone (50%), sandy, gray-brown to olive-brown, alternating in two to four inch layers with sandstone (50%), lithic, brown-gray fresh, medium to light gray-brown weathered, medium- to fine-grained.	8	340.3
23	Sandstone, lithic, gray-brown to orange-brown fresh, brown-gray weathered, medium- to fine-grained, friable to well-cemented. Six inch thick clay pebble layer about three feet above the base.	11	332.3

Units 20 through 22, measured in N½ NW¼ NE¼ SW¼, Sec. 35, T. 36 S., R. 1 W., along the drainage divide on the south side of the tributary of Henrieville Creek up which the power lines run (1966).

		Thickness	
Unit	*Description*	*Unit*	*Total*
22	Covered, seems to be sandstone.	8	321.3
21	Sandstone, highly conglomeratic, light yellowish gray, sand is fine to coarse, gastropods and articulated pelecypods abundant.	.3	313.3
20	Covered, appears to be a mudstone-sandstone unit.	27	313

Units 12 through 19, measured in SW¼ SW¼ NW¼, Sec. 35, T. 36 S., R. 1 W., on the outside of the upstream end of the large meander, about 100 yards downstream from where the power lines cross Henrieville Creek on the downstream crossing (the power lines cross the Creek three times, [1966]).

		Thickness	
Unit	*Description*	*Unit*	*Total*
19	Sandstone lithic, conglomeratic, gray-brown to orange-brown, sand is fine- to coarse-grained, cross-bedded, pebbles are segregated into thin layers. This unit forms a prominent ledge about five feet thick.	5	286
18	Mudstone, greenish gray to medium gray to brown-gray fresh, brownish gray weathered, hematitic stringers throughout, limy layers in the upper part.	11½	281
17	Sandstone, lithic, medium gray to gray-brown to brown-gray, medium- to fine-grained, well- to poorly-cemented. An eight inch thick highly hematitic layer occurs about three feet above the base.	14½	269½
16	Sandstone, lithic, brown-gray fresh, light gray to orange-brown weathered, medium- to fine-grained, friable to well-cemented, some clay blebs scattered through.	5½	255
15	Mudstone, medium gray to gray-brown to brown to gray-green fresh, greenish gray weathered, a two-inch thick sandy-conglomeratic layer, orange colored, occurs about six inches below the top.	9½	249½
14	Sandstone-mudstone; sandstone (70%), lithic, gray-brown fresh and weathered, fine-grained, friable, hematitic		

	stringers. Mudstone (30%), sandy, medium gray to gray-brown fresh, light gray weathered, crumbly.	10	240
13	Sandstone, lithic, light gray fresh, light gray to orange-brown weathered, medium- to fine-grained, well- to poorly-cemented.	11	230
12	Sandstone, lithic, medium brown-gray fresh and weathered, medium- to fine-grained, friable.	26	219

Units 1M through 11, measured in SE¼, SE¼ NE¼, Sec. 34, T. 36 S., R. 1 W., on the small hill on the inside of the meander.

		Thickness	
Unit	*Description*	*Unit*	*Total*
11	Sandstone, lithic, medium gray fresh, gray-brown to medium gray weathered, medium- to fine-grained, poorly cemented.	1	193
10	Conglomerate, light yellow-brown, clay and limestone pebbles, hematitic. Lens extending several hundred yards.	3	192
9	Mudstone, silty, medium brownish gray fresh, and weathered, lenses of sandstone, lithic, brown-gray, medium-grained.	3	189
8	Sandstone, lithic, gray-brown fresh, gray-brown to light gray weathered, poorly- to well-cemented.	13	186
7	Sandstone, lithic, medium gray fresh, brick red weathered, well-cemented ledge-former, cross-bedded. Gastropod and pelecypod molds abundant in lower part.	½	173
6	Mudstone, yellow-brown to gray-brown fresh, medium brown-gray weathered, crumbly.	24½	172½
5	Mudstone, sandy, medium gray fresh, light gray weathered, crumbly.	1	148
4	Sandstone, lithic, dark gray-brown fresh, gray-brown weathered, medium- to fine-grained, friable.	9	147
3	Sandstone, lithic, orange-brown to gray-brown fresh, medium to light gray weathered, medium- to fine-grained, friable, contains clay blebs.	6½	138
2	Sandstone, lithic, medium gray fresh, brick red weathered, medium-grained, well-cemented, calcareous cement.	½	131½
1M	Sandstone, lithic, gray-brown to yellow-brown-gray, fine-grained, friable.	21	131

Units 1A through 1L, measured in W½ NE¼ NE¼ SW¼ and W½ SE¼ SE¼ NW¼, Sec. 34, T. 36 S., R. 1 W., on the north side of the north fork of the west-east stream about 200 yards from the point where the stream enters Henrieville Creek. The small stream enters Henrieville Creek on the west side just upstream from the 75-foot cliffs carved in the Wahweap Sandstone.

		Thickness	
Unit	*Description*	*Unit*	*Total*
1L	Sandstone, lithic, brownish to gray, friable.	7	110
1K	Mudstone, silty, dark grayish brown.	3½	103
1J	Sandstone, lithic, gray, fine-grained, friable. This unit grades into the base of unit 1K; forms a slight break in slope.	22	99½
1I	Mudstone, greenish gray.	4½	77½
1H	Sandstone, orange-brown, fine-grained, friable, lenses of silty mudstone, coal, some pyritic nodules up to three inches in diameter.	9	73
1G	Mudstone, sandy, gray.	5½	64
1F	Sandstone, lithic, gray, coarse-grained; contains clay blebs up to ½ inch in diameter; lower part of unit is cross-		

	bedded. Commonly weathers to form ledges but may form slopes.	23½	58½
1E	Mudstone, sandy, brownish gray.	1½	35
1D	Sandstone, lithic, fine-grained, friable.	2½	33½
1C	Mudstone, silty to sandy, light grayish brown to medium gray; weathers to look like lumps of cornstarch. Unit has lenses of sandstone; buff to reddish brown; friable.	22	31
1B	Sandstone, buff, medium-grained.	½	9
1A	Mudstone, silty, grading to sandy shale, grayish brown to maroon to medium brown.	8½	8½
	TOTAL		2756

WAHWEAP FORMATION. Upper part of this formation in the area of measurement is clean quartzose sandstone, light tan to yellow to white weathered, medium- to coarse-grained, well-cemented, forms high ledges and cliffs. Interlensing with the sandstone is mudstone, sandy to silty, colors in shades of gray and brown. The interlensing character is on a large scale.

Fisher, *et al.* (1960, p. 40) have suggested that the Kaiparowits-Wahweap formational boundary is disconformable. No evidence to support this thesis was observed in the field. The boundary between these formations appears to be gradational over a stratigraphic span of 20 feet to 40 feet. The boundary was established at the top of the uppermost prominent, thick, massive sandstone. Bentonitic-appearing mudstones become abundant in the Kaiparowits Formation. The sandstone lithology changes from clean quartzose in nature in the Wahweap Formation to lithic in the Kaiparowits Formation.

APPENDIX B

GLOSSARY

Anisopolar—Not symmetrical about the equatorial plane.
Aperture(s)—An opening, gap, or hole.
Apex (apices)—The angle or point formed by the junction of two sides of a triangle See Text-fig. 7.
Bacula(e)—Structural elements of the ektexine; rodlets generally greater than 1μ long and diameter less than length. See Text-fig. 6.
Baculate—Ornamentation composed of baculae. See Text-fig. 6.
Bias—". . . a tendency to favor some hypothesis or to lean toward a numerical result which is not purely objective." (Simpson, Roe, Lewontin, 1963, p. 27).
Bladder(s)—An air sac. See Text-fig. 7.
Canaliculate—Refers to striate exine sculpturing in which the muri are as broad as, or broader than, the lumina.
Central body—The main body of disaccate grains. See Text-fig. 7.
Cicatricose—Refers to striate exine sculpturing in which the muri are narrower than the lumina.
Cingulum—A massive flange equatorially surrounding a spore; oval to wedge-shaped in cross-section. See Text-fig. 7.
Clava(e)—Club-shaped structural elements of the ektexine, usually greater than 1μ in length. See Text-fig. 6.
Clavate—Ornamentation composed of clavae. See Text-fig. 6.
Colpus (colpi)—A slit or cleft in the exine that is oriented meridianally and crosses the equator at right angles.
Commissure(s)—The line of dehiscence in the tetrad scar. See Text-fig. 7.
Contact area—The area of contact between two adjacent spores in a tetrad; the area between any two rays of the tetrad scar on a spore. See Text-fig. 7.
Corner—Apex.
Crenulate—Striate.
Cruciform—Cross-shaped.
Demicolpus—Colpus that is broken into two parts, one part above and the other below the equator.

Diorate—A pollen grain with two oras.
Disaccate—A pollen grain bearing two air sacs. See Text-fig. 7.
Distal—The surface opposite the point of mutual contact of the four spores or pollen grains in a tetrad. See Text-fig. 7.
Distal furrow—The furrow, or cleft (sulcus), formed on the distal surface of disaccate pollen grain. See Text-fig. 7.
Echinate—Ornamentation composed of prominent, sharp spines. See Text-fig. 6.
Ektexine—The outer of two principal layers of the exine. See Text-fig. 6.
Endannulus—Inflation of the ektexine surrounding the pore.
Endexine—The inner of two principal layers of the exine. See Text-fig. 6.
Equatorial outline—Polar view.
Exine—The outer, more resistant, stronger layer of fresh pollen grains and spores; the wall layer that is preserved in fossils. See Text-fig. 6.
Exoexine—Ektexine.
Fovea(e)—Pit-shaped structural elements. See Text-fig. 6.
Foveolate—Ornamentation composed of foveae. See Text-fig. 6.
Fusiform—Wheat-grain shaped.
Gemma(e)—Essentially spherical structural elements; usually greater than 1μ high. See Text-fig. 6.
Gemmate—Ornamentation composed of gemmae. See Text-fig. 6.
Germinal apparatus—"We designate as the 'germinal apparatus' the totality of all differentiations of a sporomorph in which we assume, on the basis of extant examples, that they function, or may function, during the development of the pollen tube." (translated from Thomson and Pflug, 1953, p. 24, by Kremp, 1965, p. 60).
Glochidia—Shaft-like appendages commonly with anchor-shaped tips, present on the massula of *Azolla*.
Granulate—Ornamentation composed of granules. See Text-fig. 6.
Granule(s)—Hemispheric-shaped sculptural elements 0.5 μ to 1μ high. See Text-fig. 6.
Hemicircular—Half circle.
Hemisphere—Half sphere.
Heteropolar—Anisopolar.
Inaperturate—Pollen grain or spore lacking openings. See Text-fig. 7.
Intrabaculate—Exine, or one layer thereof, composed of baculae or rodlets, oriented perpendicular to the surface.
Isopolar—Symmetrical about the equatorial plane.
Laesura(e)—Combined term for the commissure and margo (if present) on a spore. See Text-fig. 7.
Lateral view—View of a grain oriented with the polar axis perpendicular to the line of sight. See Text-fig. 7.
Leptoma—A thinned area in the exine, usually part of an aperture; distal furrow.
Lumen (lumina)—The space(s), or hole(s), in a reticulate, striate, or rugulate wall structure. See Text-fig. 7.
Marginal crest—A slightly projecting rim on the proximal cap of a disaccate pollen grain. See Text-fig. 7.
Margo—The area of different ornamentation, thickness, etc., from the remainder of the exine that border the commissure; part of the laesura(e). See Text-fig. 7.
Megaspore—Spore greater than approximately 200μ diameter (arbitrary classification).
Meridian—A line connecting the poles of a spherical to subspherical body and lying on the surface of that body.
Microflora—Referring to the flora that is identified from microscopic parts; palynomorphs.
Microspore—Spore less than approximately 200μ diameter (arbitrary classification); male spore produced by a heterosporous plant.
Monocolpate—A pollen grain bearing a single colpus. See Text-fig. 7.
Monolete—A spore bearing a single laesura, or tetrad scar. See Text-fig. 7.
Monosulcate—A pollen grain bearing a single sulcus. See Text-fig. 7.
Mudstone—A rock composed of clay-sized particles and lacking fissility.
Murus (muri)—Low ridge(s) on the surface of a grain with reticulate, striate, or rugulate wall structure. See Text-fig. 6.
Nexine—Endexine.
Nonaperturate—Inaperturate.
Ora(s)—Equatorially located pore(s) on a pollen grain.

Ovaloid—Elliptical.
Palynomorph—Acid insoluble phyto- and zoomicroorganisms.
Perispore—A membrane, or case, surrounding a spore.
Polar outline—Lateral view.
Polar view—View of a grain oriented with the polar axis parallel to the line of sight. See Text-fig. 7.
Pole—The point of the spore or pollen grain that is formed at the center of the tetrad and the point 180° away from it. See Text-fig. 7.
Pollen—A microspore containing a mature male gametophyte.
Pore—A small circular to subcircular aperture.
Postvestibulum—When the endexine and ektexine split in the pore region and the endexine also lamellarly splits, but the pore continues through all of the layers without disintegration.
Proximal—The surface that forms in the interior of the tetrad and in contact with the other three grains. See Text-fig. 7.
Proximal cap—A thickened area of exine formed on the proximal surface of disaccate grains. See Text-fig. 7.
Psilate—Smooth wall structure; lacking ornamentation. See Text-fig. 6.
Ray—More or less corresponding to a laesura; radiating from the proximal pole. See Text-fig. 7.
Reniform—Kidney-shaped. See Text-fig. 7.
Reticulate—Bearing sculpture composed of a reticulum. See Text-fig. 6.
Reticulum—A network-like sculpture of the exine. See Text-fig. 6.
Rugula(e)—Sculpture of the exine composed of branching muri. See Text-fig. 6.
Rugulate—Bearing sculpture composed of rugulae. See Text-fig. 6.
Scabrate—Ornamentation composed of minor projections less than 0.5μ high. See Text-fig. 6.
Schizospore—A spore or pollen grain that splits equatorially into two approximately equal halves.
Semitriangular—Triangular in equatorial outline and having convex sides. See Text-fig. 7.
Sexine—Ektexine.
Side(s)—The leg(s) of a triangle that join(s) any two of the three apices. See Text-fig. 7.
Spine—Pointed, conical structural elements. See Text-fig. 6.
Spore—The reproductive organs of a plant that contain a female or male gametophyte.
Striate—Bearing structural and sculptural elements arranged in a linear manner. See Text-fig. 6.
Subtriangular—Triangular in equatorial outline and having concave sides. See Text-fig. 7.
Sulcus—A slit or cleft on the pollen grain that touches or passes through the distal pole. See Text-fig. 7.
Tectum—An outer layer formed by fusion of the structural or sculptural elements of the ektexine.
Tetracolporate—A pollen grain bearing four colpi and four pores. See Text-fig. 7.
Tetrad—A group of four spores or pollen grains formed from the division of a spore mother cell. See Text-fig. 7.
Triangular—A three-sided geometric figure. See Text-fig. 7.
Trichotomosulcate—A pollen grain bearing a sulcus modified into a three-slit opening.
Tricolpate—A pollen grain bearing three colpi. See Text-fig. 7.
Tricolporate—A pollen grain bearing three colpi and three pores. See Text-fig. 7.
Tridemicolpate—A pollen grain bearing three demicolpi.
Trilete—A spore bearing three laesurae; a three-rayed tetrad scar. See Text-fig. 7.
Triorate—Triporate.
Triporate—A pollen grain bearing three pores, usually equatorially. See Text-fig. 7.
Tuberculate—Bearing structural elements composed of knobby or warty projections, usually more than 1μ high.
Valla(e)—The ridges in a striate exine structure. See Text-fig. 6.
Verruca(e)—Hemispheric structural elements greater than 1μ high. See Text-fig. 6.
Verrucate—Ornamentation composed of verrucae. See Text-fig. 6.
Wall—Exine.
Zona—A broad, continuous, more or less membranous rim or collar equatorially situated on a spore; an extension of the ektexine. See Text-fig. 7.

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