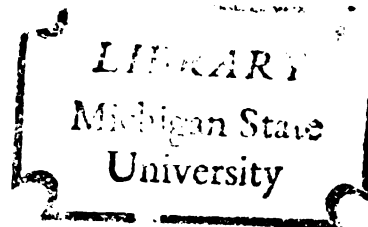


PALYNOLOGY OF THE ALMOND FORMATION (UPPER
CRETACEOUS), ROCK SPRINGS UPLIFT, WYOMING

Thesis for the Degree of Ph. D.
MICHIGAN STATE UNIVERSITY

J. FRED STONE

1971



This is to certify that the

thesis entitled

PALYNOLOGY OF THE ALMOND FORMATION (UPPER
CRETACEOUS), ROCK SPRINGS UPLIFT, WYOMING

presented by

J. Fred Stone

has been accepted towards fulfillment
of the requirements for

Ph.D. degree in Geology

Amel J. Cross

Major professor

Date May 13, 1971

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ABSTRACT

PALYNOLOGY OF THE ALMOND FORMATION (UPPER CRETACEOUS), ROCK SPRINGS UPLIFT, WYOMING

By

J. Fred Stone

The palynomorph content of the Almond Formation was investigated using 80 samples from six measured sections on the east flank of the Rock Springs Uplift. A composite standard reference section of the total Almond and four additional sections of the marine interval of the upper Almond were used. One hundred thirteen species of palynomorphs were identified. Of these, one genus and six species are thought to be new and previously undescribed. The affinities or possible relationships of the form species with living plants are noted.

Paleoenvironmental and paleoecological investigations were made using the distribution and stratigraphic range of the species, the relative abundance of species and groups of species; the absolute abundance of species, groups of species and dispersed plant tissues; the ratio of marine species to nonmarine species, the diversity of the palynomorphs and the cluster analysis grouping of samples and species. The marine upper Almond Formation is easily distinguished by the presence of 25 species, mainly dinoflagellates and acritarchs, which are restricted to it in the sections studied. The dinoflagellate species, Trithyrodinium sp. A, is abundant and restricted to the marine upper Almond and may be used to characterize it. The dinoflagellate species, Deflandrea cooksoni, has a restricted range within the upper Almond and is used to subdivide the marine interval.

The criteria which are most useful in subdividing the upper Almond are the ratio of marine to nonmarine species and the absolute abundance of marine species and nonmarine species. Three subunits,

A, B and C, are defined using the ratio and absolute abundance as observed from plots of this information for each section.

A Q-mode cluster analysis was performed using the Jaccard Coefficient of similarity with species presence-absence data and weighted pair group clustering. A Q-mode analysis was also performed using the Coefficient of Geometric Distance with the species count data. Some grouping of samples to their respective measured sections was noted.

An R-mode cluster analysis was made using the Jaccard Coefficient and resulted in some distinct groupings of species at a high similarity level. The marine species were clustered as one large group, and a subgroup at a higher similarity level contained the more relatively abundant marine species which, it is suggested, represent the most marine association of species. One high level cluster group contains species restricted to the lower Almond and has possible significance as a nonmarine species association.

**PALYNOLOGY OF THE ALMOND FORMATION (UPPER
CRETACEOUS), ROCK SPRINGS UPLIFT, WYOMING**

by

J. Fred Stone

A Thesis

**Submitted to
Michigan State University
in partial fulfillment of the requirements
for the degree of**

DOCTOR OF PHILOSOPHY

Department of Geology

1971

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R. L. Tabbert and others of the Atlantic Richfield Company supported the thesis and contributed helpful suggestions. J. N. Minick and his associates measured and described the geologic sections and collected most of the samples. J. E. Bennett advised as to the chemical processing of the samples and J. W. Dial assisted in the processing.

The facilities of the Field Research Laboratory of the Mobil Research and Development Corporation were made available to the author during the completion of the thesis. Of particular value was the use of the computer center. The program for the distribution-range charts was written by T. Nash. The programs for relative abundance, absolute abundance and diversity were written by Dr. R. J. Pauken. The cluster analysis program was written by Dr. Ed Hagmeier of the Department of Biology of the University of Victoria, British Columbia, Canada, and implemented for Mobil's computer by Dr. R. J. Pauken and D. Duncan.

This study was supported in part by National Science Foundation Grant GA429, "Palynological Analysis and the Determination of Environments of Deposition in the Rocky Mountain Cretaceous," A. T. Cross, principal investigator.

The author's wife, Judith C. Stone, assisted in compiling the manuscript and in typing the thesis.

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INTRODUCTION

Purpose and Scope

The objective of this study is to investigate the palynomorph content of the Upper Cretaceous Almond Formation from measured sections in the area of outcrop on the east flank of the Rock Springs Uplift, Wyoming. The palynomorphs are documented, identified and classified into form taxa. New form species encountered are described. The affinities or possible relationships of the form species with living plants are noted.

Paleoenvironmental and paleoecological inferences are made on the basis of the distribution and stratigraphic range of the species, the relative abundance of species and groups of species, the absolute abundance of species, groups of species and dispersed plant tissues, the ratio of marine species to nonmarine species, the diversity of the palynomorphs and the cluster analysis grouping of samples and species.

Previous Investigations

Palynological investigations of Upper Cretaceous rocks in the Western Interior of the United States and Canada have mainly dealt with the Upper Cretaceous-Tertiary boundary and include mainly formations of Maestrichtian and Paleocene age. The major contributions of this type include those of Rouse (1957, 1962), Anderson (1960), Stanley (1965), Srivastava (1966), Drugg (1967), Norton and Hall (1969), Oltz (1969) and Snead (1969). With the exception of a reprint by Leffingwell (1971) the proceedings volume of the Geological Society of America symposium on Late Cretaceous and Early Tertiary palynomorphs (Kosanke and Cross, ed., 1971) was not received in time for inclusion in the present study.

Few published palynological studies concerning this geographic area deal with rocks of Campanian age. One important exception is the work of Newman (1964, 1965) which gives the stratigraphic occurrence of selected palynomorphs of Campanian, Maestrichtian and Paleocene ages in rocks from northwestern Colorado. Most of the palynomorphs which

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were encountered in the Almond Formation have been illustrated without identification or explanation by Leopold and Tschudy (1965, unpublished, U.S.G.S. Open-File Report) as a result of their study of upper Campanian-lower Maestrichtian age rocks near Redbird, Niobrara County, Wyoming. Two papers of interest in terms of paleoenvironmental interpretations involving slightly older rocks are those of Sarmiento (1957) and Burgess (1970). The Upper Cretaceous palynological literature through 1966 has been adequately reviewed by Srivastava (1967).

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STRATIGRAPHY

General Statement

The Rock Springs Uplift, a large, anticlinal, structural feature, is located in Sweetwater County in southwestern Wyoming. The structural axis of the uplift trends north-south and lies east of the town of Rock Springs. The uplift has been breached by erosion, exposing Upper Cretaceous rocks of Santonian, Campanian and Maestrichtian age. The formational names applied to these rock units are, from oldest to youngest, Baxter Formation, Blair Formation, Rock Springs Formations, Ericson Sandstone, Almond Formation, Lewis Shale, Fox Hills Sandstone and Lance Formation.

The Mesaverde rock unit name is widely used in the Western Interior of the United States, both with formational and group status. In the Rock Springs area, the Mesaverde is given group status and consists of four formations, Blair, Rock Springs, Ericson and Almond. The Mesaverde Group is correlated, in part, with the Pierre Shale, also of the Western Interior, and, in part, with the Taylor and Navarro Groups of the Gulf Coastal Plain (Cobban and Reeside, 1952). The Almond Formation, in a stratigraphic framework, is the uppermost formation of the Mesaverde Group, Gulf Series, (Upper) Cretaceous System of the Mesozoic rocks.

Almond Formation

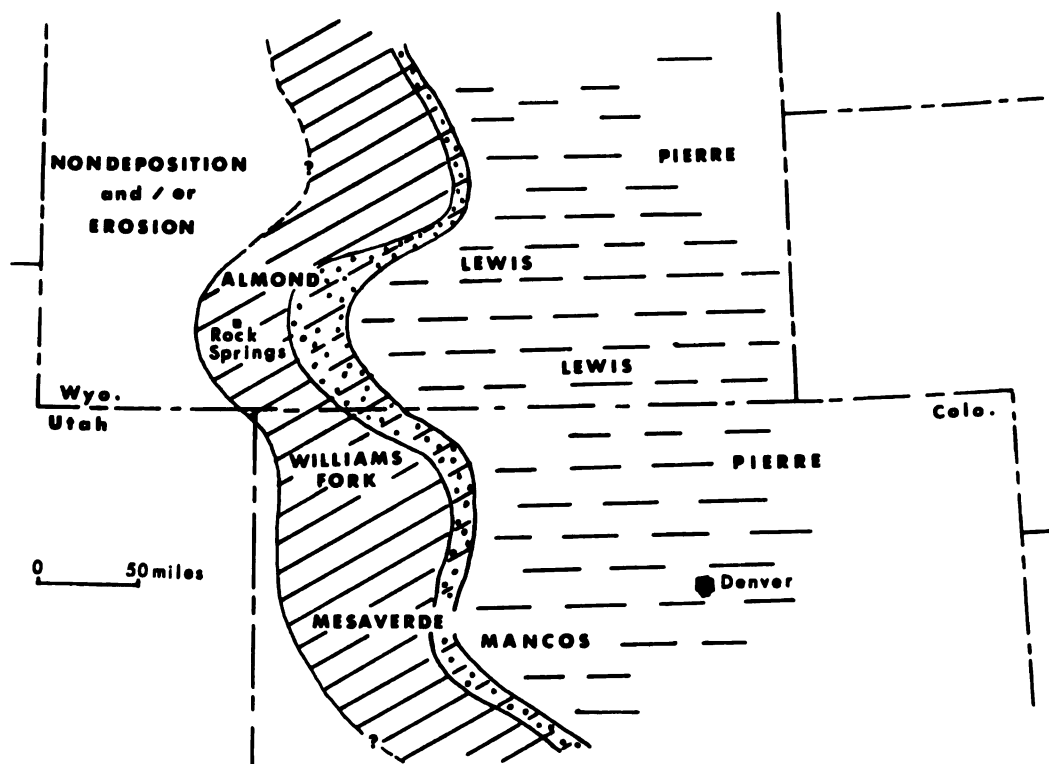
The Almond Formation consists of a body of sediments of both nonmarine and marine origin. These were deposited along the western margin of the Late Cretaceous epicontinental sea (Figure 1). This seaway was elongate north-south and extended from the present Gulf of Mexico to northern Canada. It was bordered on the east by the lowlands of the stable interior of the continent and on the west by the Laramide Highland (Clark and Stearn, 1960). The tectonically positive Laramide Highland is considered to be the source of the Almond Formation sediments.

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Figure 1



LATE CAMPANIAN LITHOFACIES MAP



Neritic shale and siltstone

Barrier bar sandstone and coastal plain deposits

Coastal plain claystone, siltstone, sandstone, and coal

Modified from Weimer, 1965

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Measured surface sections of the Almond Formation on the east flank of the Rock Springs Uplift have been published by Lewis (1965). The thickness ranged from 555' to 671' for six sections. The composite section used as a standard in this study has a total thickness of 660'. Lithologically the Almond may be divided into a lower 'nonmarine' portion (377' at the standard section) and an upper 'marine' portion (283'). Each of these two units may be further subdivided into two parts; the lower nonmarine portion into a Lower Siltstone Unit and Lower Sandstone Unit, and the upper marine portion into an Upper Shale Unit and Upper Sandstone Unit.

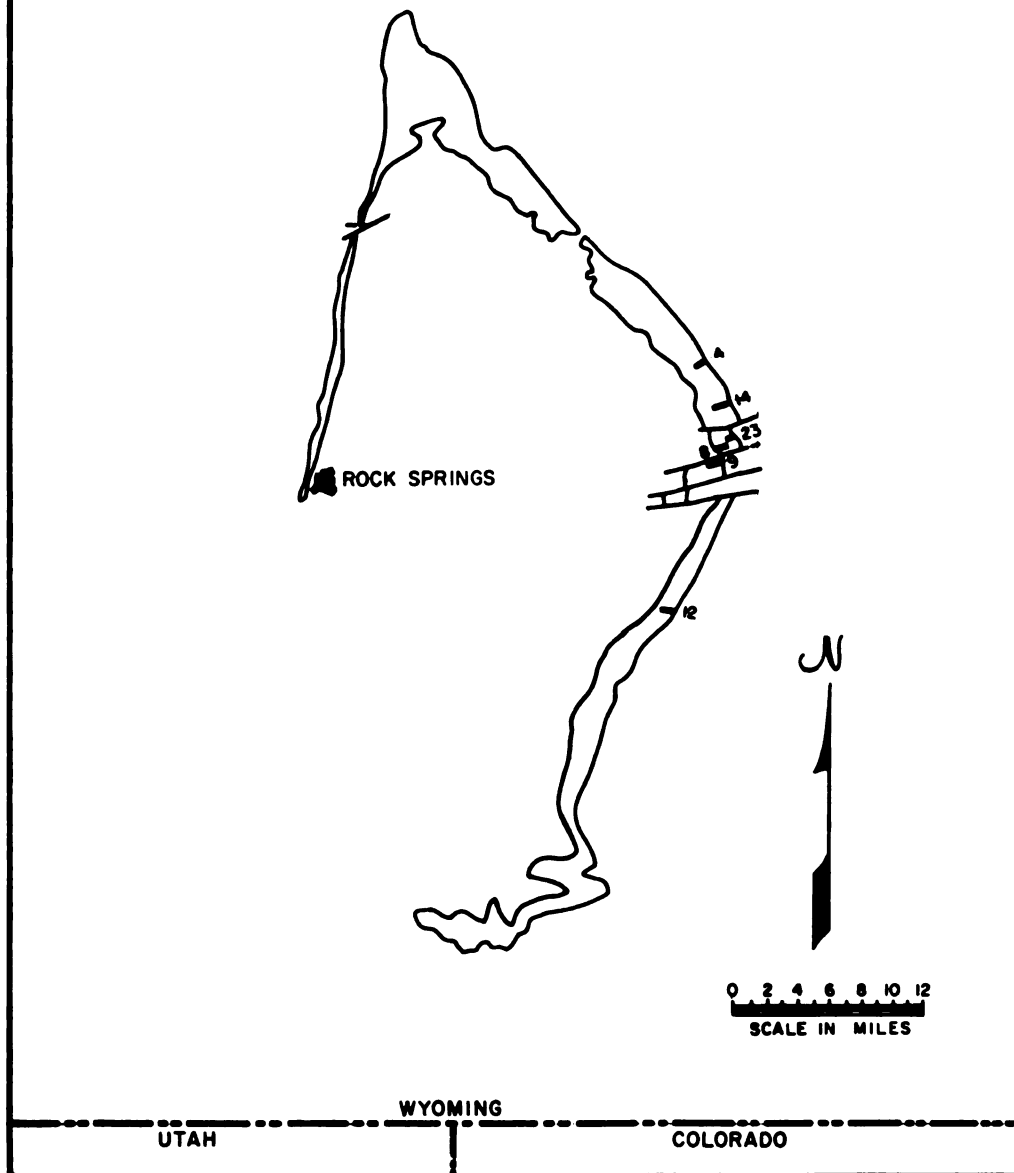
At its base the Almond Formation contrasts sharply with the underlying Ericson, a coarse white to buff-colored sandstone. The Lower Siltstone Unit is a lithologically variable unit of siltstones interbedded with shales, sandstones and coals which is 331' thick in the standard section. As a unit these sediments are fluviatile in origin. The Lower Sandstone Unit (46') consists of light gray to buff-colored, thick-bedded or massively crossbedded, fine grained sandstone probably of barrier-bar origin. The Upper Shale Unit, the 'marine tongue' of the Almond Formation, is a gray marine shale and siltstone sequence about 200' thick with occasional thin layers and lenses of sandstone. The Upper Sandstone Unit is a barrier-bar sequence comparable to the Lower Sandstone Unit. It is not particularly well developed at the standard section (about 83' thick). The marine shales of the Upper Almond interfinger with the overlying Lewis Shale. The depositional environments and geologic history of the Almond Formation have been studied in considerable detail on the outcrop by Jacka (1965) and in the subsurface by Weimer (1961, 1966) and McCubbin and Brady (1969).

Measured Sections and Sample Localities

The location of the six measured sections utilized in this study may be seen in Figure 2. The sections used are numbered, from north to south, 4, 14, 23, 9, 12 (Upper Almond) and 8 (Lower Almond). The composite section, 8-14, which is used here as the standard section for this study was selected because it has the closest sample interval. These six particular stratigraphic sections were chosen from several

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FIGURE 2
**OUTCROP PATTERN OF ALMOND FORMATION
SHOWING LOCATION OF MEASURED GEOLOGIC SECTIONS**



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available sections because of their location on the easternmost portion of the outcrop area where the Upper Shale Unit is best developed. The marine shale thins and pinches out both to the north and the south. Reliable lithologic correlations are present between these sections. The outcrop is continuous and may be "walked out."

The sections were measured, described and sampled by J. N. Minick and other geologists of the Atlantic Richfield Co. in 1966 and represent unpublished information. In 1967 the author inspected all of the sections in the field with the field geologists and in some cases supplemented the sampling. The measured sections and the position of the samples are presented in Figures 3 - 8.

Figure 3

MEASURED SECTION 8

J. N. Minick, 1966, Unpublished

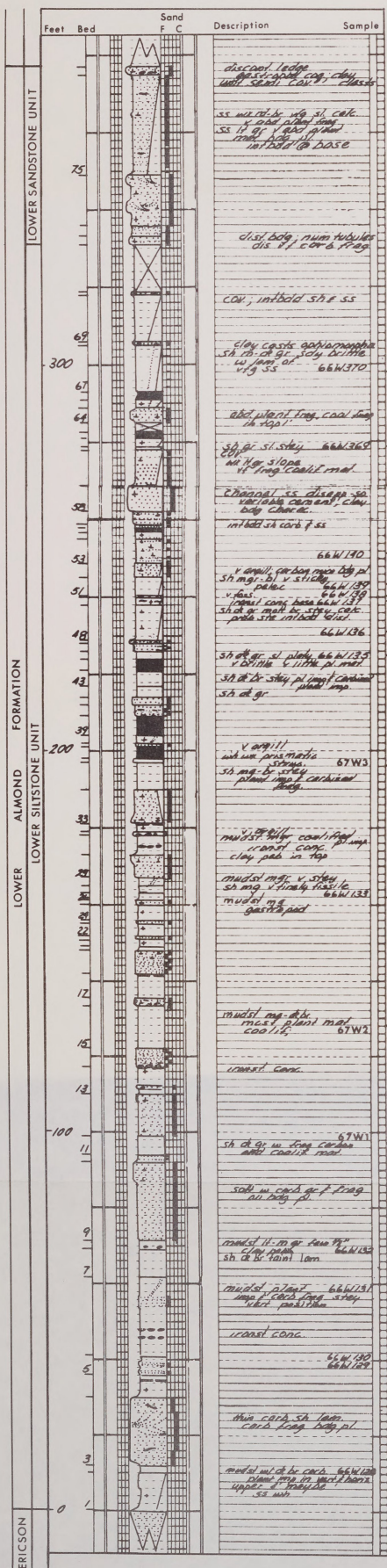
Sec. 12, T19N, R101W
Sweetwater Co., Wyoming

Figure 4

MEASURED SECTION 4

J. N. Minick 1966, Unpublished

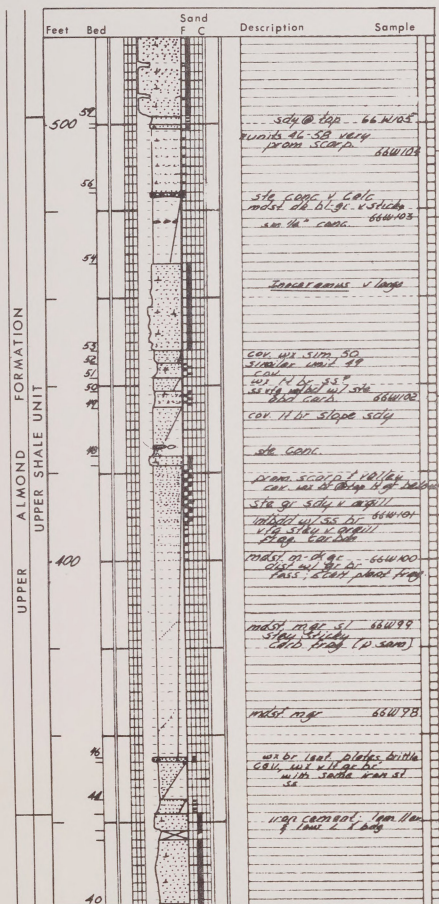
Sec. 25, 26, T20N, R101
Sweetwater Co., Wyoming

Figure 5

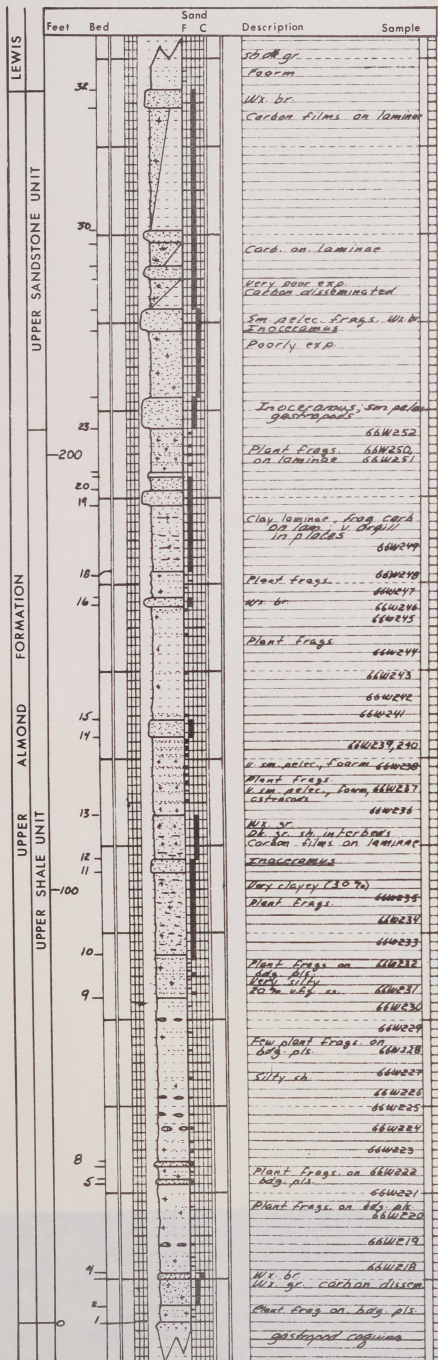
MEASURED SECTION 14

J. N. Minick, 1966, Unpublished

Sec. 36, T20N, R101W

Sec. 31, T20N, R100W

Sweetwater Co., Wyoming



J. N. Minick, 1966, Unpublished

Sweetwater Co., Wyoming

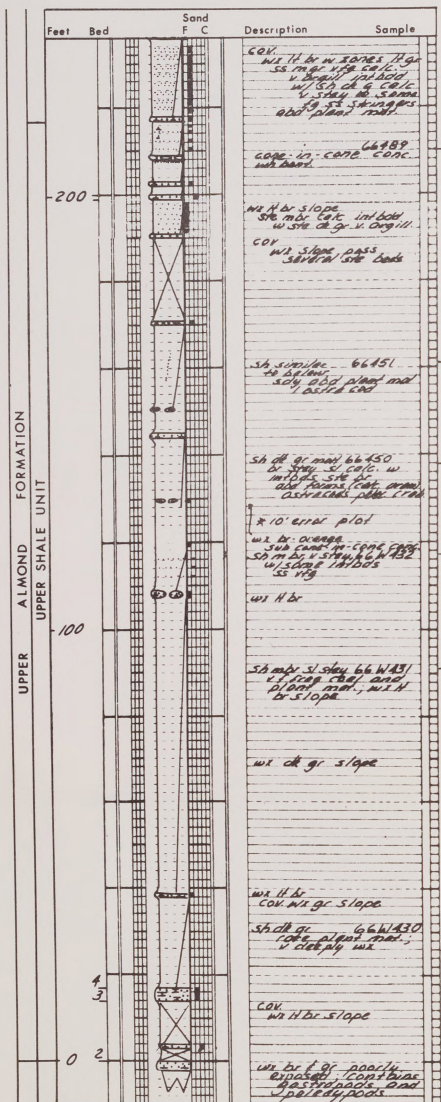
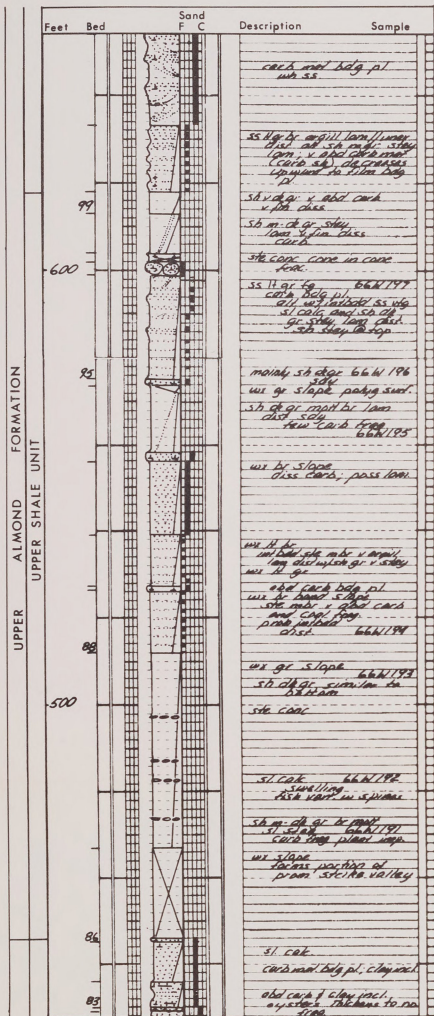


Figure 8

MEASURED SECTION 12

J. N. Minick, 1966, Unpublished

Sec. 16, T17N, R101W
Sweetwater Co., Wyoming

TECHNIQUES

Sample Collecting

To avoid modern pollen and spore contamination and to avoid to some extent the destructive effects of surface weathering on fossil palynomorphs, all samples were collected from channels dug two to three feet into the outcrop. The samples were composited from approximately one-foot intervals which were exposed in the channel. The samples were placed in cloth bags with plastic liners to prevent contamination. Only the finer clastic rocks, e.g., shales and siltstones were collected.

Sample Processing

The following procedures were used in the laboratory processing of the samples.

1. Weigh crushed sample, 10 g.
2. Demineralization
 - A. Hydrochloric acid, concentrated, 24 hours
 - B. Hydrofluoric acid, concentrated, 24 hours
3. Heavy liquid separation, 2.0 specific gravity, zinc bromide, 20 minutes at 2000 r.p.m.
4. Oxidation, Schulze solution, 3 minutes, saturated solution of potassium chlorate in concentrated nitric acid.
5. Oxidation, potassium hydroxide, 5% solution, one minute.
6. Heavy liquid separation, 1.7 specific gravity, 15 minutes at 2000 r.p.m.
7. Stain, safranin O

Slide Making

Processing of a known weight of sample permits one to arrive at an estimation of the absolute abundance of palynomorphs in the sample. The technique used was essentially that of Davis (1966) and represents some refinement of the technique of Stone (1967). When a precise aliquot of a known volume of residue from a known weight of sample is counted, the number of "grains per gram" of sediment may be calculated. Critical to the technique is the use of a pipette controlled by a hypodermic syringe. Using a small volume

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slides with

(generally .01 ml) of residue permits the counting of all palynomorphs on the slide. In addition to the known aliquot slide, ordinary slides with a high concentration of palynomorphs were also made.

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Polypo

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ASSEMBLAGE ATTRIBUTES

Distribution and Range of Species

The observed distribution and inferred range of each species at each of the six measured sections and the standard section (8 and 14 combined) are presented in Figures 9-15. The presence of a given species in a sample is noted by one or more X's (reflecting relative abundance in the sample) and the resulting range is noted by connecting with dashes. The ranges of palynomorphs or groups thought to be characteristic for lower and upper Almond are indicated by solid bars on Figures 9 through 15. The arrangement of species is on a "first occurrence-longest range" basis and is not consistent from section to section. A consistent "taxonomic arrangement" of species giving distribution was used in the analysis but is not reproduced here. The numbers given with the species names are code numbers used solely for the computer construction of the distribution-range charts.

A number of observations may be made concerning the distribution of species. The most outstanding distribution characteristic is the restriction of many dinoflagellate and acritarch species to the Upper Almond. The following 25 species are restricted to the Upper Almond:

Trithyrodinium sp. A
Deflandrea magnifica
D. cf. D. verrucosa
D. pannucea
D. cooksoni
Palaeocystodinium benjaminii
Hystrichosphaera ramosa var. membranacea
Dinogymnium sp. 1
D. nelsonense
Cordosphaeridium fibrospinosum
Hystrichosphaeridium tubiferum
Diphyes colligerum
Palaeostomocystis laevigata
Michrhystridium inconspicuum
M. piliferum
M. fragile
Pterospermopsis australiensis
Sporopollis cf. S. laqueaeformis
Trudopollis meekeri
Todisporites cf. T. minor
Polypodiisporites favus
Styx major
Liliacedites complexus

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Measured Section 4

0 < X	≤ 4
4 < XX	≤ 10
10 < XXX	≤ 20
20 < XXXX	≤ 40
40 < XXXXXX	

Sample
501' 66W105
493' 66W104
478' 66W103
437' 66W102
410' 66W101
400' 66W100
385' 66W99
365' 66W98

TAYLOR

94. *INITEFFITIFID* SPORES
124. *INAPICOTITES* MAGNUS
137. *ALISPORITES* GRANDIS
139. *INAPERTHROPOLLENITES* DIBIUS
- 162. *ILITACTITES* COMPLEXUS
194. *INITEFFITIFID* ANGIOSPERMS
- 29. *TRITHYRIDIUM* SP. A
4. *INITEFFITIFID* DINOFLAGELLATES
137. *ARITYNEAPOLLENITES* PHUOPEYICULATUS
4. *INITEFFITIFID* ACITARCHUS
136. *TAXODIACEAPOLLENITES* MIATUIS
23. *NEFLANDROA* MICROGRAMMATA
142. *INITEFFITIFID* GYMNOSPERMS
161. *ANFOTITES* RETICULATUS
24. *NEFLANDROA* CF. D. PIRNAENSI
169. *TRICOLPORITES* MATHWRETICULATUS
177. *TRYPIDIPOLLENITES* VARIANTILIS
174. *PHICAFIDOLLENITES* RALLUS
187. *TRICOLPORITES* PSILASCABRATUS
184. *TRICOLPOROLLENITES* MICRORETICULATUS
28. *SPHINTININUM* DENSISPINATUM
123. *CYCADOPITES* FOLLICULARIS
104. *ALITIDIPOLLENITES* SP. A
- 37. *PALAEOCYSTODINIUM* BENJAMINI
62. *PEODIATOUN* PALFOGOMEIFES
84. *SCHIZOSPODIS* COOKSONI
104. *TRICOLPOROLLENITES* SP. 1
187. *TRICOLPOROLLENITES* MICROSCABRATUS
- 2. *MICROCYSTODINIUM* INCONSPICUUM
193. *TRIPOROPOLLENITES* RUBRUS
164. *TRICOLPOROLLENITES* CLAVIRETICULATUS
137. *PHICATOSPORITES* OVATUS
4. *MICROCYSTODINIUM* FIREFLORES
- 204. *CONCLAVIPOLLIS* WOLFCKREKENSI
94. *COMBRACHIA* SPORITES UNULATUS
44. *LAEVIGATOSPORITES* OVATUS
24. *NEFLANDROA* COOKSONI
- 31. *CONOSPHAERIDIUM* FIRROSPINOSUM
- 64. *MYSTICOPHAEOPHORA* RAMOSA VAP. MEMBRANACEA
61. *PALAEOMORPH* SP. A
93. *NELOTINOSPARA* DIAPHARA
94. *ALSOPIHILITES* KERGUELENSIS
134. *CONOSILITES* SCABRATUS
107. *PROTACTITES* RETUSUS
164. *PROTACTITES* THALMANNI
184. *QUILAPOLLENITES* POLARIS
- 3. *MICROCYSTODINIUM* PLIFERUM
177. *TRICOLPORITES* NETICULATUS
- 27. *NEFLANDROA* PANNICIA
134. *ARALICOTACTITES* LYMBATUS
- 37. *DIDYVES* COLLIGERUM
- 7. *PALAEOTYRHOCCYSTIS* LAEVIGATA
- 1. *TRICRYSTODINIUM* DENSISPINATUM
192. *ENGLHARTIQUITES* MINUTUS
121. *VITRESPORITES* PALLIDUS
36. *EUHODONOSPHAERA* MAASTRICHTICA
175. *CUPATITITES* MAJOR
- 30. *MYSTICOPHAEOPHORA* TUBIFERUM
124. *CLASSOPOLIS* CLASSOIDES
164. *CUPIDIPOLLENITES* PUSILLUS
32. *FORMA* A SP. 1
174. *PROTANTIPOLLIS* PACHYSANDROITES
147. *INAPERTHROPOLLENITES* ATYPICUS
194. *TRIPOROPOLLENITES* SP. A
87. *IMMUNATISPORITES* SP.
131. *CENOTITES* PARVUS
124. *PHYLLICLAUDITES* MANSONI
- 195. *ALTIPODOLIS* MEKREI
194. *ALTIPODOLLENITES* QUADRIPOLLENITES
- 4. *MICROCYSTODINIUM* FRAGILE
- 4. *PTERODERMIDITES* AUSTRALIENSIS
94. *GLITCHENIIDITES* RENONICUS
139. *FUCOCITITES* CHUPREI
- 24. *NEFLANDROA* MAGNIFICA
39. *PALAEOMORPH* INFUSORIOIDES
125. *MONOCARDITES* MAXIMUS
74. *INITEFFITIFID* MEGASPORES
- 91. *CLICATOCOSPORITES* ODORGENSIS
- 99. *TONISPORITES* CF. T. MINOR

- Restricted to Upper Almond

Subzone 11B

Zone 11

UPPER ALMOND FORMATION

[illegible]

- Rest Upper

Figure 12

DISTRIBUTION AND
RANGE OF PALYNOMORPHSSpecies % of
Total per Sample

Measured Section 23

	31'	91'	117'	138'	161'	210'	Sample
	66W430	66W431	66W432	66W450	66W451	66W489	
0X ≤ 4							
4XX ≤ 10							
10XXX ≤ 20							
20XXXX ≤ 40							
40XXXXX							
TAXON							
84. SCHIZOSPORIS COOKSONI							
94. LAEVIGATOSPORITES OVATUS							
94. UNIDENTIFIED SPORES							
123. CYCLOPSITES FOLLICULARIS							
124. LAPIDOSPITES MAGNUS							
134. TAXODIACEEPOLLENITES HIATUS							
134. THAPERTHROPOLLENITES DUBIUS							
142. LILIACIOLITES COMPLEXUS							
167. PROTAFIOLITES RETUSUS							
177. THICOLPITES METICULATUS							
176. UNIDENTIFIED ANGIOSPERMS							
20. TRITHYROIDINIUM SP. A							
30. UNIDENTIFIED DINOFLAGELLATES							
62. PENIACHTHUM PALEOGENEITES							
104. AGUILAPOLLENITES POLARIS							
41. PALAEMARES FORM A							
23. DEFLANDROA MICROGRANULATA							
26. DEFLANDROA CF. D. PIRNAENSIS							
24. SPINTODINIUM DENSISPINATUM							
37. PALAEOCYSTODINIUM BENJAMINI							
80. SCHIZOSPORIS PARVUS							
174. PHACIOLIPOLLENITES VENTRILIS							
72. PALAEOHYMNOCTYIA LAEVIGATA							
102. THICOLPOLLINITES MICROSCABRATUS							
27. DEFLANDROA PANNUCEA							
5. NICHYSTRIDIUM EUPLOS							
32. FORM A SP. 1							
132. ARIFTINPAEPOLLENITES FOVEORETICULATUS							
142. UNIDENTIFIED GYMNOSPERMS							
161. PHACIOLITES RETICULATUS							
164. PROTAFIOLITES THALMANNI							
183. THICOLPITES PSILASCABRATUS							
144. THICOLPOLLINITES MICRORETICULATUS							
103. THIRAPOLLENITES RUBATUS							
31. COPROSPHAERIDIUM FIBROSPINOSUM							
133. ALISPORITES GRANDIS							
74. UNIDENTIFIED MEGASPORES							
100. POLYDOLISPORITES FAVUS							
194. THIRAPOLLENITES SP. B							
194. THIRAPOLLIS MEERFI							
171. CRANWELLIA ROSEVENSIS							
170. PHICACEOPOLLENITES RALLUS							
136. PAUCACIACITES LINNATUS							
22. DIRMOMNIUM SP. 1							
121. VITRIFERITES PALLIDUS							
2. NICHYSTRIDIUM INCONSPICUUM							
97. MELTITODOSPORA DIAPHANA							
99. ALSIPHILIOLITES KERQUELENSIS							
181. TRICOLPITES MITARILIS							
34. MYSTICHOCPHAERA RAMOSA VAR. MEMORANACEA							
139. FUCOMITIDITES COMPERI							
30. MYSTICHOCPHAERIDIUM TUBIFERUM							
204. CONCLAVIPOLLIS WOLFCKREKENSIS							
71. STYX MINOR							
94. GLEICHENIOLITES SEMONICUS							
174. ENDOTMANIPALLIS PACHYSANDROIDES							
180. TRICOLPOLLINITES SP. 1							
145. THICOLPOLLINITES DELICLAVATUS							
189. AGUILAPOLLENITES PULCHER							

- Restricted to
Upper Almond

Zone II

UPPER ALMOND FORMATION

Spe
Total

0
4
10
20
40

24. 0.0000
25. 0.0000
26. 0.0000
27. 0.0000
28. 0.0000
29. 0.0000
30. 0.0000
31. 0.0000
32. 0.0000
33. 0.0000
34. 0.0000
35. 0.0000
36. 0.0000
37. 0.0000
38. 0.0000
39. 0.0000
40. 0.0000
41. 0.0000
42. 0.0000
43. 0.0000
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88. 0.0000
89. 0.0000
90. 0.0000
91. 0.0000
92. 0.0000
93. 0.0000
94. 0.0000
95. 0.0000
96. 0.0000
97. 0.0000
98. 0.0000
99. 0.0000
100. 0.0000

Rest
Upper

Figure 13

DISTRIBUTION AND
RANGE OF PALYNOMORPHS

Measured Section 9

Species % of
Total per Sample

0 < X ≤ 4
 4 < XX ≤ 10
 10 < XXX ≤ 20
 20 < XXXX ≤ 40
 40 < XXXXX

TAXON	109' 66W143	168' 66W378	185' 66W379	222' 66W144	233' 66W467	240' 66W468	254' 66W469	261' 66W470	Sample
24. SPINTINIUM DENSISPINATUM	---	---	---	---	---	---	---	---	
134. INAPERTHROPOLLENITES DUBIUS	---	---	---	---	---	---	---	---	
134. MICROSTYDIUM DENSISPINUM	---	---	---	---	---	---	---	---	
5. MICROSTYDIUM EUPELOS	---	---	---	---	---	---	---	---	
87. SCHIZOPHYTES COOKSONI	---	---	---	---	---	---	---	---	
21. DEFLANDRA MICROGRAMMATA	---	---	---	---	---	---	---	---	
29. TRITHYROIDINIUM SP. A	---	---	---	---	---	---	---	---	
34. UNIDENTIFIED DINOFLAGELLATES	---	---	---	---	---	---	---	---	
94. UNIDENTIFIED SPORES	---	---	---	---	---	---	---	---	
140. LAFIACIDITES MAGNUS	---	---	---	---	---	---	---	---	
102. UNIDENTIFIED GYMNOSPERMUS	---	---	---	---	---	---	---	---	
101. ANFICIDITES RETICULATUS	---	---	---	---	---	---	---	---	
102. LILIACIDITES COMPLEXUS	---	---	---	---	---	---	---	---	
170. PHAXINOIPOLLENITES VARIABILIS	---	---	---	---	---	---	---	---	
104. UNIDENTIFIED ANGIOSPERMUS	---	---	---	---	---	---	---	---	
90. CYCLOMORPHIUM SP. 1	---	---	---	---	---	---	---	---	
71. STYX MINOR	---	---	---	---	---	---	---	---	
93. DELTOIDOSPORA DIAPHANA	---	---	---	---	---	---	---	---	
95. ALGOMILIDITES KERQUELENSIS	---	---	---	---	---	---	---	---	
94. LAFIACIDITES OVATUS	---	---	---	---	---	---	---	---	
90. GENUS A SPECIES A	---	---	---	---	---	---	---	---	
104. POLYTRICHOPOLLENITES FAVUS	---	---	---	---	---	---	---	---	
34. MICROSTYDIUM TUBIFERUM	---	---	---	---	---	---	---	---	
132. ANILYMPHROPOLLENITES FOVEOPETICULATUS	---	---	---	---	---	---	---	---	
134. TARDIACEAPOLLENITES HIATUS	---	---	---	---	---	---	---	---	
134. ORCULITES SCABRATUS	---	---	---	---	---	---	---	---	
31. COUMOPHAEPIIDIUM FIBROSPINOSUM	---	---	---	---	---	---	---	---	
32. FORM A SP. 1	---	---	---	---	---	---	---	---	
167. UNIDENTIFIED RETUSUS	---	---	---	---	---	---	---	---	
104. TRICOLPOROLLENITES SP. 1	---	---	---	---	---	---	---	---	
104. TRICOLPOROLLENITES MICRORETICULATUS	---	---	---	---	---	---	---	---	
104. AQUILAPOLLENITES POLARIS	---	---	---	---	---	---	---	---	
103. TRIPOROPOLLENITES RUGATUS	---	---	---	---	---	---	---	---	
123. CYCLOPORITES FOLLICULARIS	---	---	---	---	---	---	---	---	
104. PROTFACIDITES THALMANI	---	---	---	---	---	---	---	---	
34. MICROSTYDIUM RAMOSA VAR. MEMBRANACEA	---	---	---	---	---	---	---	---	
175. CUPACIDITES MAJOR	---	---	---	---	---	---	---	---	
102. MICELHARTIODITES MINUTUS	---	---	---	---	---	---	---	---	
125. PODOCARRITES MAXIMUS	---	---	---	---	---	---	---	---	
103. TRICOLPORITES PSILASCABRATUS	---	---	---	---	---	---	---	---	
67. PENTASTOM PALLOREMITES	---	---	---	---	---	---	---	---	
90. TUDISPORITES CF. T. MINOR	---	---	---	---	---	---	---	---	
37. PHIPYES COLLIGERIUM	---	---	---	---	---	---	---	---	
140. POLYTRICHOPOLLENITES KREMBII	---	---	---	---	---	---	---	---	
24. DEFLANDRA CF. D. PINNAENSIS	---	---	---	---	---	---	---	---	
2. MICROSTYDIUM INCONSPICUUM	---	---	---	---	---	---	---	---	
176. ERICACOIDIPOLLENITES RALLIS	---	---	---	---	---	---	---	---	
104. POLYTRICHOPOLLENITES SP. A	---	---	---	---	---	---	---	---	
174. POLYTRICHOPOLLENITES PACHYSANDROITES	---	---	---	---	---	---	---	---	
104. TRIPOROPOLLENITES SP. B	---	---	---	---	---	---	---	---	
171. CRATHELLIA RUMSEYENSIS	---	---	---	---	---	---	---	---	
143. MICROSTYDIUM FLORIDUS	---	---	---	---	---	---	---	---	
27. DEFLANDRA PANNUCEA	---	---	---	---	---	---	---	---	
90. COUMACULATISPORITES UNDULATUS	---	---	---	---	---	---	---	---	
90. UNIDENTIFIED ACRITARCHS	---	---	---	---	---	---	---	---	
179. DISTILLIPOLLENITES SP. A	---	---	---	---	---	---	---	---	
101. TRICOLPORITES MUTABILIS	---	---	---	---	---	---	---	---	
7. PALAEOSTOMOCYSTIS LAEVOBATA	---	---	---	---	---	---	---	---	
27. MICROSTYDIUM SP. 1	---	---	---	---	---	---	---	---	
24. DEFLANDRA COOKSONI	---	---	---	---	---	---	---	---	
34. PALAEOMYSTRICHOPHORA INFUSORIOIDES	---	---	---	---	---	---	---	---	
81. STEPHENSPORITES ANTIQUASPORITES	---	---	---	---	---	---	---	---	
81. MACULATISPORIS MACULATUS	---	---	---	---	---	---	---	---	
87. MACULATISPORITES SP.	---	---	---	---	---	---	---	---	
127. INAPERTHROPOLLENITES ATLANTICUS	---	---	---	---	---	---	---	---	
171. CENHIDITES PARVUS	---	---	---	---	---	---	---	---	

— Restricted to
 Upper Almond

Subzone IIA	Subzone IIB
Zone II	
UPPER ALMOND FORMATION	

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Botryococcus sp.
Aquilapollenites reticulatus

The following seven species are restricted to the Lower Almond:

Cassidium fragilis
Cingulatisporites dakotaensis
Spermatites sp.
Appendicisporites cf. A. dentimarginatus
Tsugaepollenites igniculus
Azolla sp.
Foveasporis triangulus

There was little variation in the geographic distribution of species between the Upper Almond sections. Three species, Dinogymnium nelsonense, Botryococcus sp. and Aquilapollenites reticulatus, are restricted to Section 14. Aquilapollenites pulcher is restricted to Section 23. Cicatricosisporites dorogensis is restricted to Section 4 and Hamulatisporis hamulatis is restricted to Section 9. All are rare species and little significance is attached to their geographic distribution.

A biostratigraphic zonation of the Almond Formation may be accomplished using the vertical distribution of species. The criteria used for zonation are restricted ranges, first occurrences and last occurrences. An obvious Zone I (Lower Almond) and Zone II (Upper Almond) may be constructed since most dinoflagellate and acritarch species are restricted to the Upper Almond. Zone I is characterized by the restricted species, Cassidium fragilis and Cingulatisporites dakotaensis. Zone II is characterized by Trithyrodinium sp. A. Five subzones seem evident at the standard section but they can be traced to the other Upper Almond sections only to a limited extent. Subzone IA contains no restricted palynomorphs. Subzone IB is characterized by the first occurrence of several species and by the restricted Tsugaepollenites igniculus. Subzone IIA is characterized by Diphyes colligerum and Palaeostomocystis laevigata. Subzone IIB is characterized by Deflandrea cooksoni. This species is restricted in all the Upper Almond Sections to a particular portion of the upper Upper Almond. Subzone IIB is terminated and Subzone IIC started by the last occurrence of several species. Correlation by subzones between sections is limited at

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best and the zonation would not be expected to persist if a greater stratigraphic interval or greater geographic area were studied.

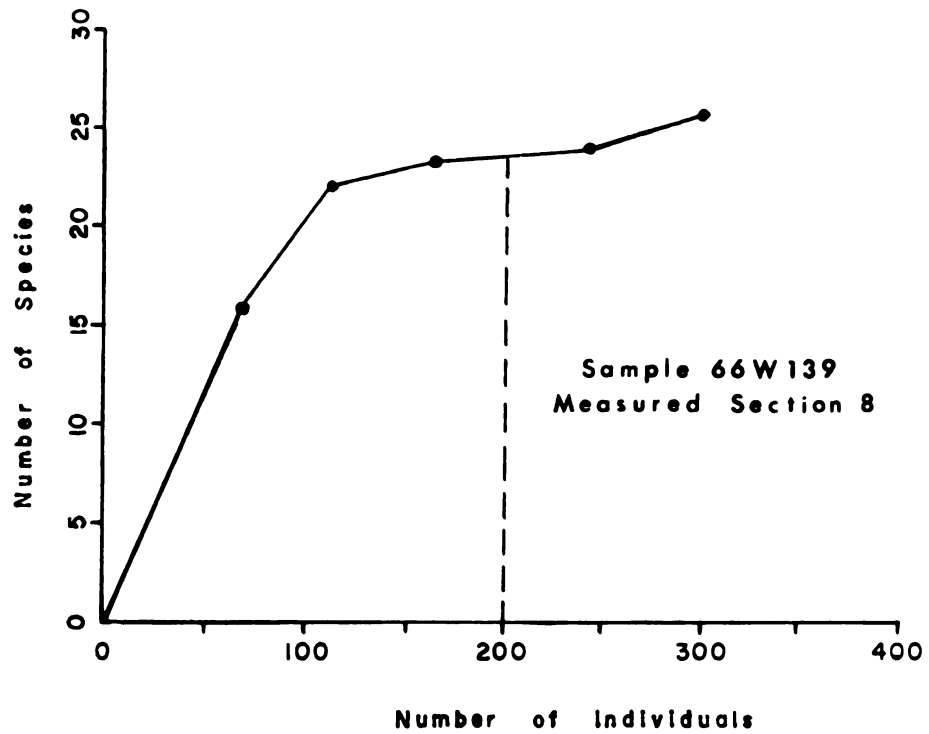
Relative Abundance of Species and Various Groups of Species

The conventional microscope slide making technique involves extracting a drop of thoroughly mixed sample residue and spreading it evenly over the surface of a cover glass a process which is assumed to result in a slide which contains a random sample of the palynomorphs which were separated from the rock.

A uniform method of counting the number of individuals observed for each species was used for each slide. Arbitrarily chosen straight line traverses were made across the slide. Every individual which came into the field of vision was counted as to species if it was sufficiently well preserved to be identified. Unidentifiable specimens could usually be assigned to one of the following counting groups: Unidentified Acritarchs, Unidentified Dinoflagellates, Unidentified Algae, Unidentified Megaspores, Unidentified Spores, Unidentified Gymnosperms and Unidentified Angiosperms. Damaged and incomplete specimens could then be used in calculating the relative abundance of the major groups. For several abundant samples, the optimum number of specimens to be counted per sample was determined by plotting the number of specimens versus the number of species (Figure 16). When the resulting curve "leveled off" and approached a horizon line, a number of specimens was indicated above which additional counting did not produce an important increase in the number of species (Wilson, 1959). An optimum of 200 was chosen. Using the "200 count" data, where necessary the following items of information were computer calculated and tabulated for each sample:

- (1) the species code,
- (2) the count for each species,
- (3) the total number of species,
- (4) the total count of palynomorphs,
- (5) the percent of each species of the total palynomorphs,
- (6) the count for each group (Acritarchs, Dinoflagellates, Algae, Megaspores, Spores, Gymnosperms and Angiosperms),
- (7) the percent of each group of the total palynomorphs,
- (8) the count for marine and nonmarine groups,
- (9) the percent of marine and nonmarine palynomorphs of the total palynomorphs,

Number of Species



DETERMINATION OF AN OPTIMUM COUNT

Figure 16

- (10)
- (11)
- (12)
- (13)

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- (10) the ratio of marine to nonmarine entities,
- (11) the percent of each species in its group,
- (12) the percent of each species of the marine or nonmarine total,
- (13) the percent of each group of the marine or nonmarine total.

A print out of one sample is included (Table I) but the relative abundance information is not reproduced in its entirety. After analysis this information has been summarized in ways which characterize the assemblage and/or provide biostratigraphic information. The number of species per sample is presented with the diversity calculations. The ratio of marine to nonmarine entities is plotted on Figures 17 and 45 (45 in pocket). The percent of selected abundant dinoflagellate species (of the total dinoflagellates) has been plotted in Figures 25-29, in appendix and the percent of selected abundant nonmarine species (of the total nonmarine species) has been plotted in Figures 18, 20-24, in appendix. No particular trends are noted in the relative abundance of these species. The relative abundance of the major groups of palynomorphs has been plotted for each section (Figures 19, 30-34, in appendix).

Absolute Abundance of Groups of Species and Tissue

Counts were made for 45 samples using the known aliquot slides. The dispersed plant tissue in general consisted of cuticles, tracheids and other cells with bordered pits and secondary thickenings. The palynomorphs were counted as to major group and an additional count was made of the tissue with recognizable cell structure.

Consecutive and non-overlapping traverses were used so that all palynomorphs on the slide were counted. As noted in the slide preparation discussion, counting all the palynomorphs from an aliquot (.01ml) of a known volume of residue (15ml) from a weighted sample (10g) permits calculation of the number of palynomorphs per gram of sediment. Computer calculations were made of the "grains per gram" of the seven major groups, of the tissue, of the total marine palynomorphs, of the total nonmarine palynomorphs (excluding tissue) and of the total palynomorphs (also excluding tissue). The variations in absolute abundance are tabulated (Tables II-VI, in appendix) and are summarized in Figures 35-39. The absolute abundance of marine and nonmarine palynomorphs are plotted in Figure 45, in pocket.

TOTAL POLYMONOMORPHS	SECTION 14	SAMPLE ANALYSIS	NUMBER OF RECIPIES P2	LATIO MARINE /NONMARINE	.43
130 TOTAL MARINE	40 PCT. 20.0	TOTAL NONMARINE	90 PCT. 70.6		

SECTION 14 SAMPLE 66W240 NUMBER OF SPECIES 22 RATIO MARINE /NONMARINE .42
 TOTAL PALYNOFORMS 136 TOTAL MARINE 40 PCT. 29.4 TOTAL NONMARINE 96 PCT. 70.6

TOTAL GROUP
 COUNTS COUNTS
 BY IN
 GROUP PERCENT

ACRIT 0.0 0.0
 DINO 40.0 29.4
 ALGAE 2.0 1.5
 MEGAS 1.0 .7
 SPORE 8.0 5.9
 GYMNO 66.0 48.5
 ANGIO 19.0 14.0

ACRIT PCT. OF MARINE FORMS 0.0
 DINO PCT. OF MARINE FORMS 100.0
 ALGAE PCT. OF NONMARINE FORMS 2.1
 MEGAS PCT. OF NONMARINE FORMS 1.0
 SPORE PCT. OF NONMARINE FORMS 9.3
 GYMNO PCT. OF NONMARINE FORMS 68.8
 ANGIO PCT. OF NONMARINE FORMS 19.8

TABLE I
 Representative Printout of
 Relative Abundance Data

SPP. SPP.	PCT. OF MARINE	NONMARINE	ACRIT.	DINO.	ALGAE	MEGA.	SPORE	GYMNO.	ANGIO.
CODE CTS.	TOTAL SPP.	SPP.	SPP.	SPP.	SPP.	SPP.	SPP.	SPP.	SPP.
NO.	PALYN.	PCT.	PCT.	PCT.	PCT.	PCT.	PCT.	PCT.	PCT.
25	6	4.4	15.0	15.0	100.0	100.0	100.0	100.0	100.0
27	1	.7	2.5	2.5	100.0	100.0	100.0	100.0	100.0
29	20	14.7	50.0	50.0	100.0	100.0	100.0	100.0	100.0
31	2	1.5	5.0	5.0	100.0	100.0	100.0	100.0	100.0
39	11	8.1	27.5	27.5	100.0	100.0	100.0	100.0	100.0
63	2	1.5			100.0	100.0	100.0	100.0	100.0
74	1	.7			100.0	100.0	100.0	100.0	100.0
93	1	.7			100.0	100.0	100.0	100.0	100.0
98	7	5.1			100.0	100.0	100.0	100.0	100.0
125	1	.7			100.0	100.0	100.0	100.0	100.0
128	4	2.9			100.0	100.0	100.0	100.0	100.0
132	7	5.1			100.0	100.0	100.0	100.0	100.0
133	1	.7			100.0	100.0	100.0	100.0	100.0
134	3	2.2			100.0	100.0	100.0	100.0	100.0
135	37	27.2			100.0	100.0	100.0	100.0	100.0
142	13	9.6			100.0	100.0	100.0	100.0	100.0
161	4	2.9			100.0	100.0	100.0	100.0	100.0
162	1	.7			100.0	100.0	100.0	100.0	100.0
168	2	1.5			100.0	100.0	100.0	100.0	100.0
178	1	.7			100.0	100.0	100.0	100.0	100.0
188	2	1.5			100.0	100.0	100.0	100.0	100.0
196	9	6.6			100.0	100.0	100.0	100.0	100.0

GYMNOSPERM 1.5
 GYMNOSEPM 6.1
 GYMNOSEPM 10.6
 GYMNOSEPM 1.5
 GYMNOSEPM 4.5
 GYMNOSEPM 56.1
 GYMNOSEPM 19.7
 21.1 ANGIOSPERM
 5.3 ANGIOSPERM
 10.5 ANGIOSPERM
 5.3 ANGIOSPERM
 10.5 ANGIOSPERM
 47.4 ANGIOSPERM

Figure 17

RATIO MARINE TO NONMARINE SPECIES
RANGE OF RESTRICTED SPECIES
SPECIES DIVERSITY

Measured Section 8
Lower Almond Formation

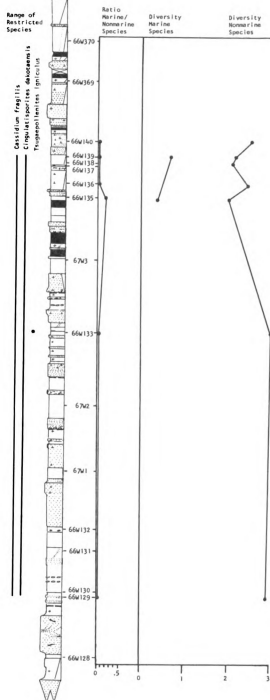


Figure 35

ABSOLUTE ABUNDANCE OF
SELECTED PALYNOMORPH GROUPS

Measured Section 4
Upper Almond Formation

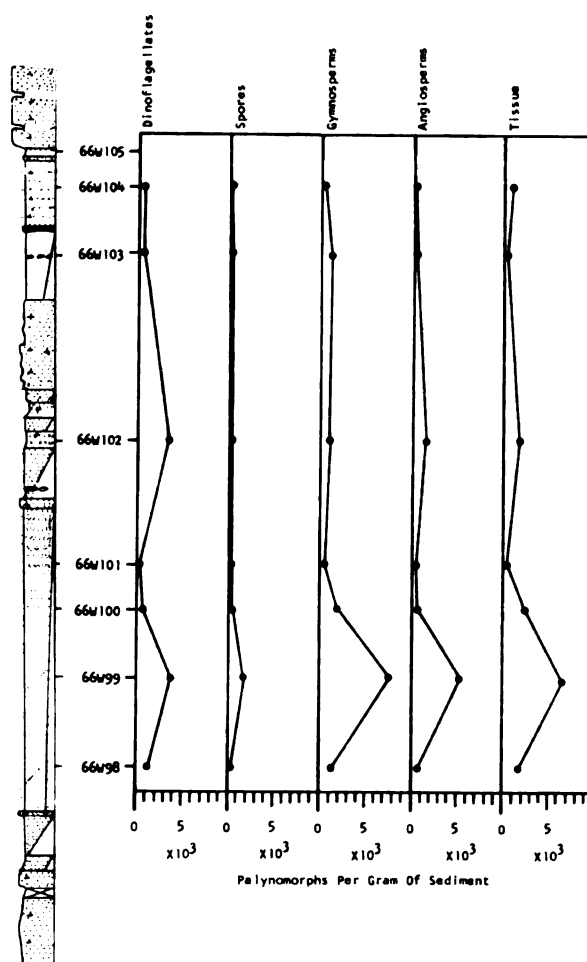


Figure 36

ABSOLUTE ABUNDANCE OF
SELECTED PALYNOMORPH GROUPS
Measured Section 14
Upper Almond Formation

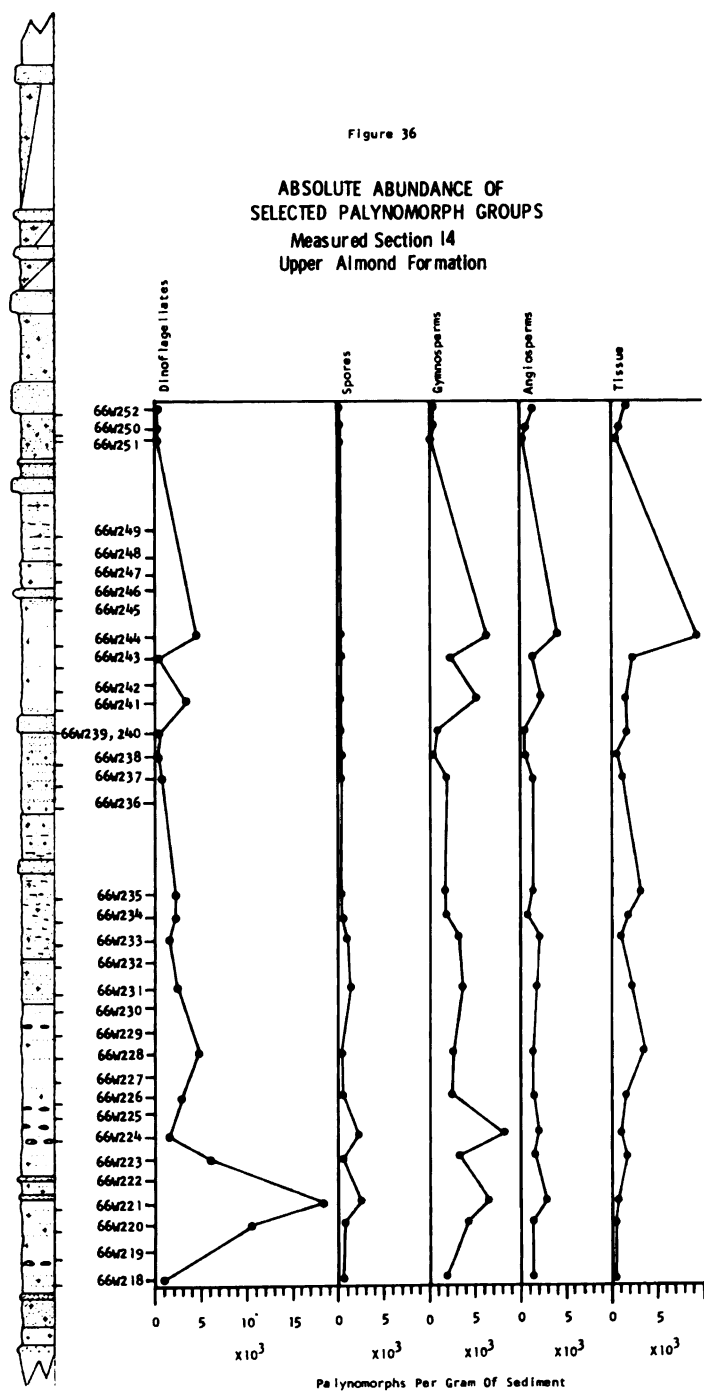


Figure 37

ABSOLUTE ABUNDANCE OF
SELECTED PALYNOMORPH GROUPS

Measured Section 23
Upper Almond Formation

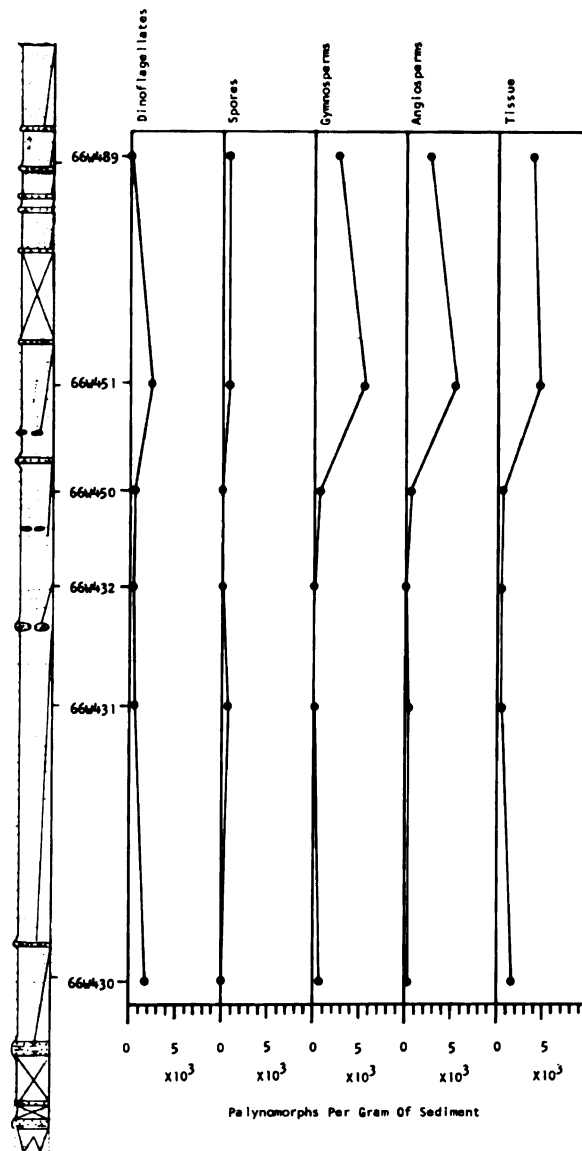


Figure 38

ABSOLUTE ABUNDANCE OF
SELECTED PALYNOMORPH GROUPS

Measured Section 9
Upper Almond Formation

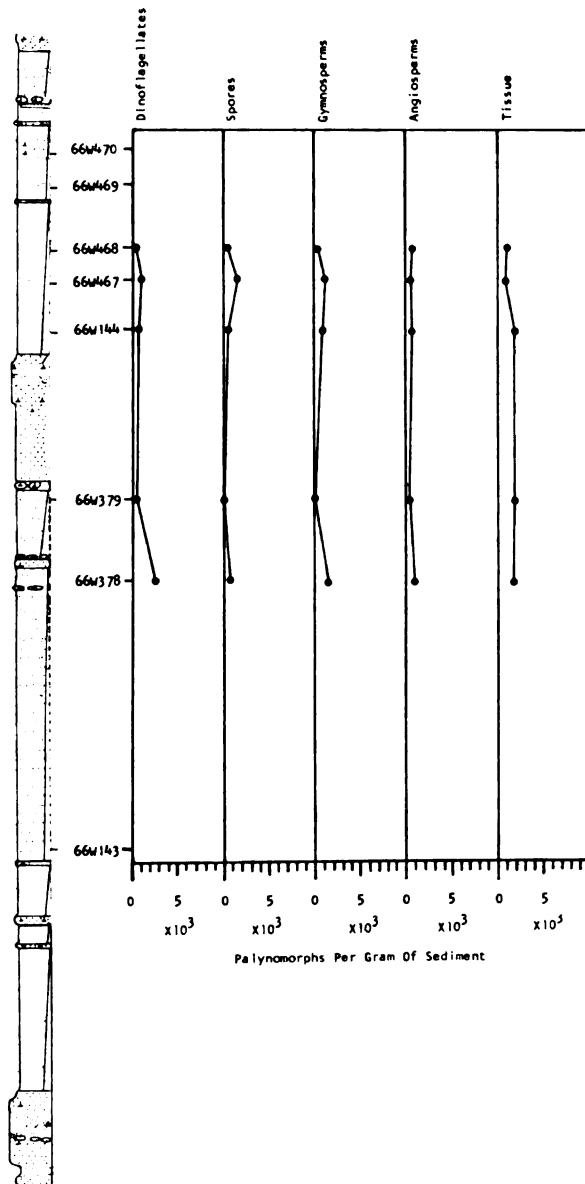
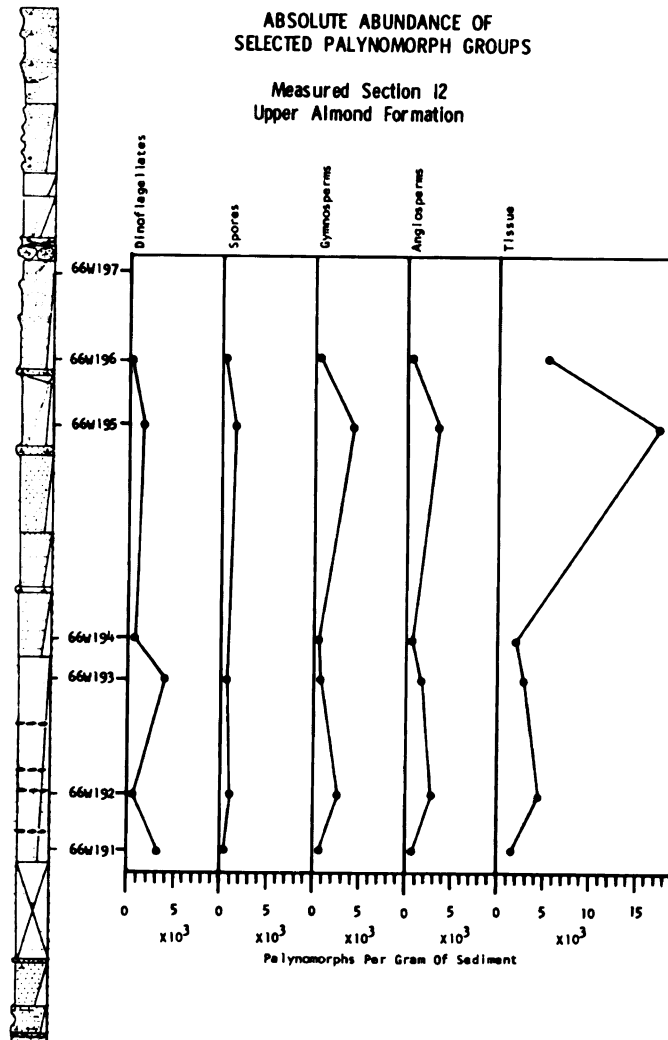


Figure 39



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In light of modern sediment studies of the distribution of palynomorphs (Muller, 1959; McKee, Chronic and Leopold, 1959; Rossignol, 1961; Stanley, 1966; Cross, Thompson and Zaitzeff, 1966; Traverse and Ginsburg, 1966) the "grains per gram" statistic may prove to be one of the more useful in determining sedimentary environments through the use of palynomorphs. Confident comparison of samples is limited by some unknown factors such as the size, composition (and hence the density) and rate of accumulation of the sedimentary particles making up the rock. In the present study all the samples are terrigenous clastics in the clay and silt size fractions with varying sand content. The mineralogic composition has not been investigated and the rate of accumulation is unknown. Evaluation of the absolute abundance data is deferred to the Discussion and Conclusion section.

Diversity

Ecologists have applied a measure of diversity which is derived from information theory and takes into consideration the number of species and the distribution of individuals among the species. Pielou (1969) discusses ecological diversity and its measurement. Beerbower and Jordan (1969) have investigated diversity of paleontological assemblages. The expression of diversity, $\bar{H}$, used in this study is:

$$\bar{H} = -k \sum_{i=1}^m p_i \log p_i, \text{ where } p_i = \frac{n_i}{N}.$$

The number of individuals in species "i" is n_i . The total number of individuals in the sample is N . The number of species in the sample is m , and k is a constant which may be set equal to 1. The number of species and the total individuals determine the range of diversity available to a community. The derivation of this statistic given by Patten (1962) is particularly lucid. Authors vary as to the base of the logarithms used in the calculation. For comparison purposes with other studies the diversity statistic has been computer calculated using base e , base 10 and base 2 logarithms (Tables VII-IX). The diversity statistics analyzed here use the base e logarithms and are plotted in Figure 17 and 45, 45 in pocket. The diversity statistics have been calculated for the total palynomorphs, the marine palynomorphs and the nonmarine palynomorphs.

TABLE VII
DIVERSITY AND
EQUITABILITY OF
ALL SPECIES

SAMPLE	NO. SPECIES	DIVERSITY-E	DIVERSITY-10	DIVERSITY-2	EQUITABILITY
MS 4	66 98	2.76	1.20	.004	.002
	66 99	2.68	1.16	.004	.002
	66 100	2.63	1.14	.004	.003
	66 101	2.86	1.24	.004	.002
	66 102	2.60	1.13	.004	.003
	66 103	2.87	1.25	.004	.002
	66 104	2.96	1.29	.004	.002
	66 129	2.95	1.28	.004	.002
	66 133	3.08	1.34	.005	.001
MS 8	66 135	2.19	.95	.003	.005
	66 136	2.54	1.11	.004	.004
	66 138	2.10	.91	.003	.007
	66 139	2.29	.99	.003	.004
	66 140	2.58	1.12	.004	.003
	66 218	2.47	1.07	.004	.003
	66 220	2.31	1.00	.003	.004
	66 221	2.63	1.14	.004	.003
	66 223	2.68	1.17	.004	.003
	66 224	2.47	1.07	.004	.003
	66 225	2.47	1.07	.004	.003
MS 14	66 226	2.52	1.10	.004	.003
	66 228	2.07	.90	.003	.007
	66 231	2.36	1.02	.003	.004
	66 233	2.59	1.13	.004	.003
	66 234	2.17	.94	.003	.005
	66 235	2.39	1.04	.004	.004
	66 237	3.11	1.35	.005	.001
	66 238	2.53	1.10	.004	.004
	66 239	2.77	1.20	.004	.002
	66 240	2.05	.89	.003	.008
	66 241	2.80	1.21	.004	.002
	66 243	2.63	1.14	.004	.003
	66 244	2.74	1.19	.004	.002
	66 251	2.52	1.09	.004	.004
	66 250	2.70	1.17	.004	.002
MS 23	66 252	2.55	1.11	.004	.003
	66 430	2.19	.95	.003	.005
	66 431	2.24	.97	.003	.006
MS 23	66 450	2.56	1.11	.004	.004
MS 9	66 451	2.44	1.06	.004	.003
	66 489	2.29	.99	.003	.004
MS 9	66 378	3.09	1.34	.005	.001
	66 144	2.56	1.11	.004	.003
MS 9	66 467	2.84	1.23	.004	.002
MS 9	66 468	2.93	1.27	.004	.002
MS 12	66 191	2.32	1.01	.003	.004
	66 192	2.78	1.21	.004	.002
MS 12	66 193	3.03	1.32	.004	.001
	66 194	2.59	1.12	.004	.003
	66 195	2.78	1.21	.004	.002
	66 196	2.85	1.24	.004	.002

UNITED STATES

DEPARTMENT OF THE ARMY

OFFICE OF THE ADJUTANT GENERAL

HEADQUARTERS

WASHINGTON, D. C.

ADJUTANT GENERAL

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TABLE VIII
DIVERSITY AND
EQUITABILITY OF
MARINE SPECIES

SAMPLE	N.O. SPECIES	DIVERSITY-E	DIVERSITY-10	DIVERSITY-2	EQUITABILITY
66498	7	1.61	.70	.002	.49
66499	11	2.07	.90	.003	.11
66100	5	1.47	.64	.002	.46
66101	7	1.53	.66	.002	.31
66102	10	1.36	.59	.002	.26
66103	11	1.84	.80	.003	.14
66104	10	1.86	.81	.003	.16
66124	1	-0.00	-0.00	0.000	1.000
66125	1	-0.00	-0.00	0.000	1.000
66133	3	.37	.10	.001	.40
66135	1	-0.00	-0.00	0.000	1.000
66136	4	-0.00	-0.00	0.000	0.000
66138	3	.64	.30	.001	.168
66139	1	-0.00	-0.00	0.000	1.000
66140	12	2.22	.96	.003	.009
66148	11	1.41	.91	.002	.22
66220	10	1.68	.75	.002	.19
66221	11	2.06	.90	.003	.12
66223	6	1.49	.65	.002	.38
66224	3	1.29	.56	.002	.31
66225	4	1.75	.76	.003	.19
66226	5	1.23	.53	.002	.58
66228	8	1.77	.77	.003	.21
66231	7	1.65	.72	.002	.27
66233	8	1.09	.47	.002	.42
66234	10	1.44	.63	.002	.24
66235	11	1.69	.73	.002	.17
66237	4	1.15	.50	.002	.79
66238	6	1.44	.63	.002	.39
66239	4	.88	.38	.001	.103
66240	7	1.54	.67	.002	.31
66241	4	1.15	.50	.002	.79
66243	10	1.71	.74	.003	.18
66244	4	1.15	.50	.002	.79
66251	4	1.15	.50	.002	.319
66250	2	.45	.20	.001	.67
66252	4	1.32	.57	.002	.35
66430	8	1.27	.55	.002	.47
66431	6	1.27	.55	.002	.39
66450	6	1.45	.63	.002	.65
66451	5	1.12	.49	.002	.250
66451	7	.63	.30	.001	.44
66469	12	1.97	.65	.003	.31
66378	17	1.19	.54	.002	.09
66144	7	1.54	.67	.002	.20
66467	12	2.20	.96	.003	.25
66468	11	1.51	.66	.002	.13
66191	7	1.73	.75	.003	.49
66192	11	1.97	.80	.003	.25
66193	9	1.23	.54	.002	.26
66194	8	1.62	.71	.002	.03
66195	7	1.71	.74	.003	
66196					

MS 4

MS 8

Measured Section 14

MS 23

MS 9

MS 12

MS 12

TABLE IX
DIVERSITY AND
EQUITABILITY OF
NONMARINE SPECIES

SAMPLE	Nr. SPECIES	DIVERSITY-E	DIVERSITY-J0	DIVERSITY-V-2	EQUITABILITY
MS 4					
66w08	21	2.38	1.03	.003	.04
66w09	21	2.17	.94	.003	.05
66w10	20	2.25	.98	.003	.05
66w11	23	2.59	1.13	.004	.03
66w12	19	2.46	1.07	.004	.04
66w13	23	2.50	1.09	.004	.04
66w14	21	2.59	1.12	.004	.04
66w15	30	2.91	1.27	.004	.02
66w16	32	3.03	1.32	.004	.02
66w17	19	2.02	.88	.003	.07
66w18	20	2.48	1.08	.004	.04
66w19	14	2.10	.91	.003	.07
66w20	23	2.18	.95	.003	.05
66w21	26	2.53	1.10	.004	.03
66w22	14	1.76	.77	.003	.11
66w23	14	1.88	.82	.003	.10
66w24	17	2.28	.94	.003	.06
66w25	16	1.95	.85	.003	.09
66w26	14	2.10	.91	.003	.06
66w27	19	2.19	.95	.003	.06
66w28	14	1.91	.83	.003	.09
66w29	13	1.50	.65	.002	.17
66w30	17	1.91	.83	.003	.09
66w31	22	2.20	.96	.003	.05
66w32	14	1.95	.85	.003	.05
66w33	14	1.93	.84	.003	.09
66w34	32	2.84	1.23	.004	.02
66w35	14	2.33	1.01	.003	.05
66w36	23	2.55	1.11	.004	.03
66w37	13	1.68	.73	.002	.14
66w38	25	2.46	1.07	.004	.03
66w39	13	1.51	.69	.004	.03
66w40	22	2.38	1.03	.003	.04
66w41	14	2.26	.98	.003	.07
66w42	25	2.43	1.14	.004	.03
66w43	22	2.40	1.08	.004	.04
66w44	15	1.92	.83	.003	.10
66w45	12	1.92	.83	.003	.12
66w46	15	2.20	.95	.003	.07
66w47	20	2.23	.97	.003	.05
66w48	24	2.23	.97	.003	.04
66w49	25	2.77	1.20	.004	.03
66w50	21	2.31	1.00	.003	.05
66w51	21	2.55	1.11	.004	.04
66w52	22	2.52	1.19	.004	.04
66w53	15	2.00	.90	.003	.08
66w54	22	2.55	1.11	.004	.04
66w55	24	2.47	1.16	.004	.03
66w56	17	2.30	1.00	.003	.06
66w57	14	2.45	1.06	.004	.05
66w58	21	2.49	1.08	.004	.04
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MS 9					
MS 12					
MS 23					
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An additional statistic, the equitability (E) of the sample, reflects the distribution of individuals among the species (Buzas and Gibson, 1969). Equitability is e raised to the $\bar{H}$ power ($E = \frac{e^{\bar{H}}}{k}$) and uses the value of $\bar{H}$ calculated with base e logarithms. The equitability varies from 0 to 1 with 1 being the condition in which all species have an equal number of specimens. The equitability has been calculated for all samples for which the diversity was calculated (Tables VII-IX).

Diversity is a parameter of a community which is independent of its generic and specific composition. It is apparently dependant on the physical, chemical and biological (interspecific competition) environment (Odum, Cantlon and Kornicker, 1960). Various diversity indices have been given considerable biostratigraphic importance and used as a correlation tool within individual coal seams (Gibson and Clarke, 1968). Comments concerning the diversity data are deferred to the Discussion and Conclusion section.

Cluster Analysis

Cluster analysis in the Q-mode permits comparison of samples as to their species content (or as to the counts of the contained species) and permits the grouping of like samples at various levels of similarity ("community"-approach). In the case of presence or absence data each sample is compared with all other samples and a coefficient of similarity is generated which expresses the comparison. Cheetham and Hazel (1969) have listed in a standardized notation, the various similarity coefficients which have been used for presence-absence data. Using the matrix of similarity coefficients the samples are clustered into a hierarchy of pairs and groups of samples which are related at various levels of similarity as determined by consecutive cycles of clustering. Several clustering techniques are discussed by Sokal and Sneath (1963). The final product of cluster analysis is a dendrogram which displays the groups of samples and the similarity levels at which they are grouped.

Cluster analysis in the R-mode is a population approach and is used to group species on a basis of their comparable occurrence. Cluster analysis has been widely used by ecologists and is being used in

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the study of fossil organisms, e.g. Fox (1968) and Hazel (1970). Cluster analysis in the R-mode has been applied to palynological data by Oltz (1969).

In the present study the techniques of cluster analysis were applied to the "presence or absence" data and the "200 count" data for 113 species from 76 samples from six measured sections. A 200 count was available for only 51 of the samples. For the Q-mode cluster analysis of presence-absence data the Jaccard Coefficient of Community was used (Jaccard, 1908). The Jaccard Coefficient is a simple coefficient of similarity which has been widely used. It places emphasis on those samples which contain many individuals and many species (Mello and Buzas, 1968). The coefficient ignores negative matches, i.e., no contribution is made to the coefficient if a species is absent from both samples being compared. In the notation of Cheetham and Hazel (1969), this coefficient is as follows:

$$\begin{aligned} \text{Jaccard Coefficient} &= \frac{C}{(C+E_1) + (C+E_2) - C} \\ &= \frac{C}{N_1 + N_2 - C} \end{aligned}$$

C, species present in both samples
 E_1 , species present only in first sample
 E_2 , species present only in second sample
 N_1 , total species present in first sample
 N_2 , total species present in second sample

For any two samples being compared, a value of 1 is contributed to C if a given species is present in both samples, a value of 1 is contributed to E_1 if a given species is present only in the first sample and a value of 1 is contributed to E_2 if a given species is present only in the second sample. After the contribution of all species occurring in both samples is compiled, the coefficient is calculated. Each sample is compared with all other samples under consideration and the coefficients are compiled in a data matrix.

The clustering was done by the weighted pair group method with simple arithmetic averages (Sokal and Sneath, 1963). In the initial clustering step the matrix of similarity coefficients is examined and all samples are paired which have values higher than that value at which a third sample

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becomes eligible to join the initial cluster. A new matrix is then generated in which the relationship between a bonded pair of cycle 1 and an unbonded sample is the arithmetic mean (simple average) of the two similarity coefficients between the unbonded sample and each member of the bonded pair. A second cycle of clustering is then undertaken on the second matrix. Weighting occurs in this cycle and subsequent cycles since the value of all members of an existing cluster is averaged with the value of a potential sample or cluster of samples. The clustering and recalculation is repeated until all samples have been clustered or the relationships are zero. This explanation of clustering follows that of Mello and Buzas (1968).

The dendrogram resulting from the cluster analysis of the presence-absence data using the Jaccard Coefficient and the weighted pair group method with arithmetic means is presented in Figure 40, in pocket.

A Q-mode cluster analysis was performed using the count data, in which a coefficient of geometric distance was used for the initial comparison of samples. This coefficient is the Coefficient of Taxonomic Distance, based on standardized characters (Sokal and Sneath, 1963). In the notation of Sokal and Sneath (1963) the expression for geometric distance (the concept of Euclidean distance between two points in an n - dimensional space is

$$\Delta_{jk} = \left[\sum_{i=1}^n (X_{ij} - X_{ik})^2 \right]^{1/2},$$

Where Δ is the geometric distance between sample j and sample k and X_{ij} is the count of species i in sample j and X_{ik} is the count of species i in sample k . The two samples contain n species. A matrix of geometric distances was calculated and clustering was done by the weighted pair group method. The dendrograms of this analysis are presented in Figures 41-43, 41 in pocket. These include a Coefficient of Geometric Distance comparison of all samples, all "200 count" samples and the "200 count" samples from Section 14.

An R-mode cluster analysis was performed utilizing the same presence-absence data as was used in the Q-mode analysis. In this

Figure 42

Q-MODE CLUSTER ANALYSIS, 200 COUNT SAMPLES

Geometric Distance Coefficient
Weighted Pair Group Clustering

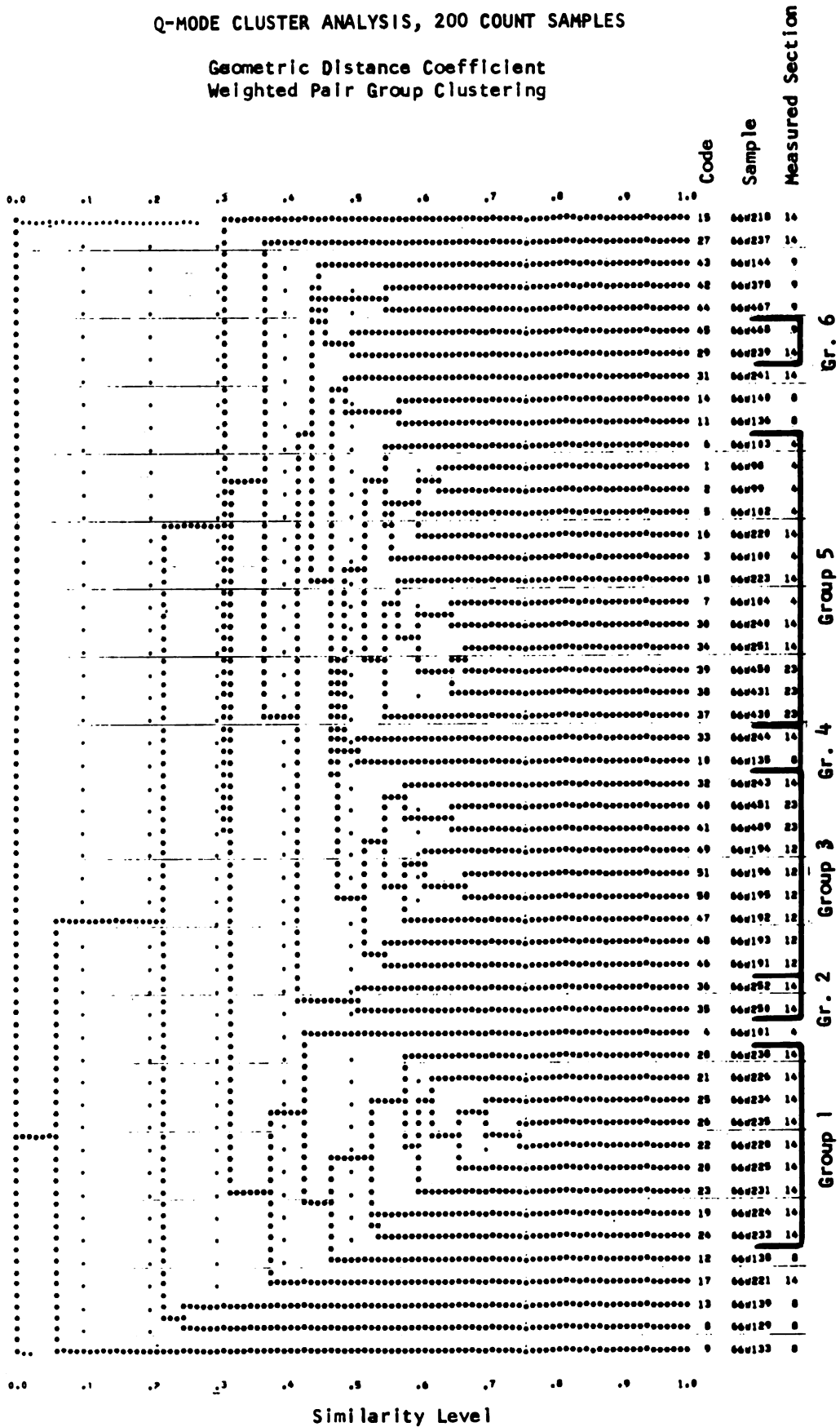
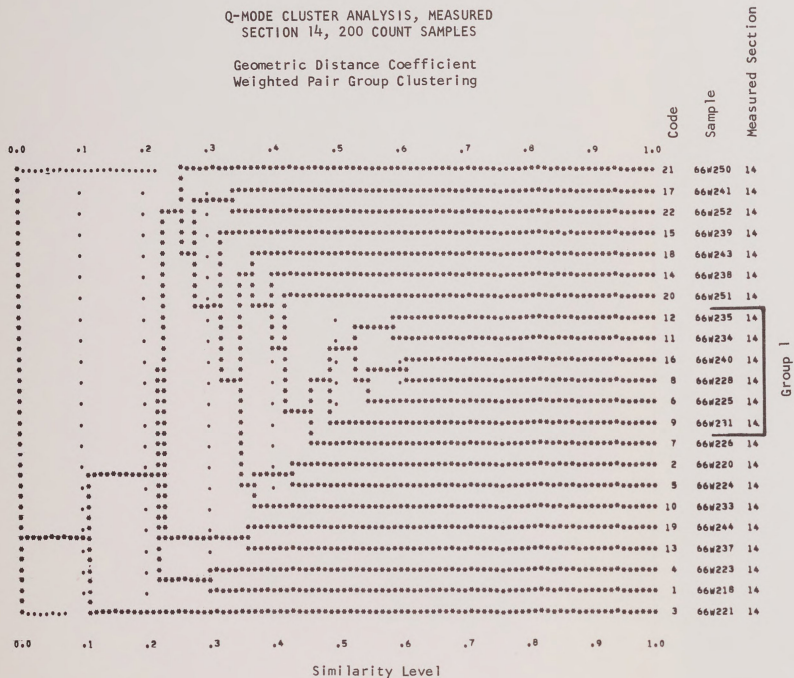


Figure 43

Q-MODE CLUSTER ANALYSIS, MEASURED
SECTION 14, 200 COUNT SAMPLESGeometric Distance Coefficient
Weighted Pair Group Clustering

instance a species to species comparison is made as to presence or absence in each of the samples. A Jaccard Coefficient is calculated for each species compared with all other species and a matrix of coefficients is generated which is clustered by the weighted pair group method. The resulting dendrogram shows the clustering of related species (Figure 44, in pocket).

Evaluation of the cluster analyses is deferred to the Discussion and Conclusions section.

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DISCUSSION AND CONCLUSIONS

Age of the Almond Formation

Upper Cretaceous relative age dating is based primarily on a standard of ammonoid fossils. In the Western Interior the Campanian Stage encompasses 21 megafossil zones with the end of the Campanian coinciding with the top of the Baculites eliasi Zone. In south-central Wyoming the Almond Formation corresponds (in ascending order) to the upper part of Baculites reesidei Zone, the B. jenseni Zone and the B. eliasi Zone. In the Rock Springs Uplift the Almond Formation also includes the lower part of the overlying B. baculus Zone (Gill, Merewether and Cobban, 1970). The Campanian-Maestrichtian boundary is placed at the B. eliasi-B. baculus Zonal boundary. Since the upper Shale Unit of the Upper Almond interfingers imperceptibly into overlying Lewis Shale the Campanian-Maestrichtian boundary is not a sharp contact except in the area where the Upper Sand Unit of the Upper Almond is present. The indigenous palynomorph assemblage of the Almond Formation is, by virtue of the associated ammonoids, Upper Campanian in age (possibly Maestrichtian in the Uppermost Almond).

On cursory inspection the Almond Formation palynomorph assemblage is not vastly different from North American Maestrichtian assemblages. At least 25 Almond pollen and spore species have been reported from Maestrichtian-Paleocene rocks of Montana by Norton and Hall (1969), and at least 10 Almond dinoflagellate and acritarch species have been reported from Maestrichtian and Paleocene rocks of South Dakota by Stanley (1965). Many species are reported here for the first time from rocks as old as Campanian. These lower extensions of ranges are not surprising because of the similarity of Upper Campanian and Maestrichtian assemblages and the species are not tabulated here but may be ascertained from the occurrences in the descriptive section.

Seven species are reported for the first time from rocks as young as Campanian:

Deflandrea cf. D. verrucosa
Michystridium densispinum
M. inconspicuum
M. eupeplos
Schizosporis cooksoni
Inaperturopollenites atlanticus

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Rugubivesiculites floridus.

Little biostratigraphic significance is attached to their occurrence because of their rarity, morphological ambiguity and the possibility of reworking.

The palynological age assessment of the Almond Formation must depend on the total assemblage and the percentages (or absolute abundance) of its constituents. The assemblage may be recognized as Upper Cretaceous by the presence of Aquilapollenites spp., Proteacidites spp., Styx spp., and Liliacidites (Schizosporis) complexus. Considering the total assemblage and with the presence of the genera and species just mentioned, the absence of Wodehouscia spp. is suggestive of, but does not prove an age older than Maestrichtian. With the exception of two index fossils there are no Campanian age-distinctive species. Trudopollis meekeri and Conclavipollis wolfcreekensis have been reported only from restricted intervals within Campanian age rocks (Newman, 1965). Three species, Trithyrodinium sp. A, Cycadopites sp. A and Genus A sp. A, are considered to be new and in any future work their possible Campanian age significance should be investigated.

Depositional Environments

The Almond Formation consists of sediments formed in three major depositional environments, the nonmarine coastal-plain and lagoonal environment, the shoreline (barrier-bar) environment and the near shore (neritic) marine environment. These environments may be recognized from the distinctive sediment types which they produced (Weimer, 1966). The coastal-plain (fluvial) sediments are claystones, siltstones, nonmarine shales, coals and sandstones. The near-shore sediments are barrier bar sandstones, and the neritic sediments are shales. The variations in environment and in corresponding sediment type are the result of minor transgressions and regressions of the Late Cretaceous sea and their cyclic nature has been described in detail by Jacka (1965).

With the exception of coals, which were not studied, and sandstones, the depositional environments of the Almond Formation sediments have been determined by their palynomorph content. Palynomorphs are ordinarily not recovered from sandstone and this lithology was not sampled. The coal beds were not sampled because the palynomorphs they contain

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represent the very restricted environment of the coal swamp. The nonmarine environment of the Lower Siltstone Unit is evidenced by the near absence of dinoflagellates and acritarchs. When present these palynomorphs comprise about 1-3% of the sample with the single exception of sample 66W135 which contains 15.8%. This sample represents a dark gray shale bed of only two feet in thickness. The marine environment of the Upper Shale Unit is evident from the 17 species of dinoflagellates and acritarchs which are restricted to it. These palynomorphs comprise from 20-50% of the total palynomorphs in samples from this unit.

Within the Upper Shale Unit, variations, both vertical and horizontal, are noted in the absolute abundance of dinoflagellates and their counterparts in distribution, the acritarchs. To what extent these variations reflect changes in depositional environment is unknown. Living dinoflagellates are known from fresh water and marine environments, but in the rock record they appear to be limited to rocks of estuarine and marine origin. As a generalization, dinoflagellates increase in number away from shores and to some extent the plots of the absolute abundance of marine species (Figure 45, in pocket) reflect distance from shore. (It is to be remembered that all of the samples represent shallow marine deposition in an epicontinental sea and never an open marine environment.) This generalization is complicated by the fact that dinoflagellates, as do other plankton, have maxima and minima in their distribution that reflect variations in their physico-chemical environment. Such fluctuations have been noted near river mouths and areas of current influence such as upwelling. The absolute abundances of dinoflagellates in the Almond Formation are comparable to those observed in the modern Gulf of California with values of several hundreds to a few thousands per gram of sediment and occasional maxima up to 16-17,000 per gram of sediment (Cross, Thompson and Zaitzeff, 1966). One such maximum is noted in Section 14, Samples 66W220 and 66W221, which represents an interval of at least five feet with a highest value of 18,000 per gram.

As a generalization the land derived pollen and spores show a decrease in abundance away from shore in a marine environment. They also show

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maxima and minima in their distribution which are controlled at least in part by the proximity of the parent plants and the sorting action and distribution by water currents.

The assemblage attribute which in the author's opinion best measures the proximity to shore line is the ratio of marine to non-marine species. This ratio when combined with the absolute abundance information may be used to subdivide the Upper Shale Unit of Section 14 into three subunits. Subunit A from Sample 66W218 to Sample 66W229 is an interval of a high ratio marine-nonmarine species and high abundance. Subunit B from Sample 66W230 to Sample 66W236 is an interval of high ratio and relatively low abundance. Subunit C from Sample 66W237 to Sample 66W252 is an interval of a relatively low ratio and a relatively low abundance. These subunits are present to some extent in the other measured sections of the Upper Shale Unit.

It may be observed in each section of the Upper Shale Unit that the sterile samples show some relationship to the sand content of the interval sampled. In general there is a drop in abundance and sterile samples appear as the Upper Sandstone Unit is approached and the sand content of the shale increases.

The diversity of the nonmarine species is consistently higher than that of the marine species. Samples with high diversity indices for the most part are not samples with the highest absolute abundance. Any relationship between diversity and depositional environment has not been demonstrated.

Within the Upper Shale Unit no relationship has been demonstrated between the presence-absence or relative abundance of any individual species and the depositional environment other than what has already been discussed for the formation as a whole.

Palynological Correlations

The Upper Shale Unit is defined on a lithologic basis and correlation between the five Upper Almond sections may be accomplished by marker beds including a gastropod zone (shells are abundant enough locally for the rock to be considered a coquina) at the base of Sections 14, 23 and 9, a bentonite layer between Sections 23 and 9 and a cone-

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in-cone layer between Sections 23, 9 and 12.

As a unit the Upper Shale Unit may be correlated palynologically within the Almond Formation by the dinoflagellates, acritarchs and other species which are restricted to it. The Upper Shale Unit may be subdivided at the standard section (14) by several criteria, see Figure 45, in pocket, the most useful of which are considered to be the ratio of marine to nonmarine species, the absolute abundance of marine species and nonmarine species, species restricted in range, and the diversity of the marine and nonmarine species. Attempts have been made to correlate between the five sections using these criteria. The subunits A, B and C based on the ratio and abundance of marine and nonmarine species (defined above) may be correlated with some success between sections. A zone of Deflandrea cooksoni may be correlated with little success since it varies a great deal in thickness and is absent in Section 23. Some corresponding peaks on the diversity curves may correlate but they are not evident in all sections.

Four dendrograms are presented (Figures 40-43, 40 and 41 in pocket) which give the results of the Q-mode cluster analysis. These include a Jaccard Coefficient comparison of all samples, a Coefficient of Geometric Distance comparison of all samples, all "200 count" samples and the "200 count" samples from Section 14. Evaluation of the dendrogram from the comparison of samples using the Jaccard Similarity Coefficient reveals little clustering above the .5 similarity level (Figure 40 in pocket). Clustering between the .2-.5 level tends to group samples from the different individual sections. Six groups of samples are designated which possibly have significance. Group 1 is predominately composed of Section 4 samples, Group 2 of Section 14 samples, Group 3 of Section 14 samples, Group 4 of Section 12 samples, Group 5 of Section 5 and Section 23 samples and Group 6 of Section 14 and 23 samples. It is postulated that a greater individuality, based on presence of species, exists for the sections than was apparent from studying the distribution and range charts. This dendrogram shows a clustering of the near sterile samples which have less than 10 species and equally few individuals.

The geometric distance comparison is judged to be the more powerful tool since it evaluates the count data. In all cases examined it results

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in the initial clustering at a higher similarity level (.5 and greater). The comparison of all samples resulted in three distinct clusters of those samples with fewer than 10 species and individuals (Figure 41 in pocket). This dendrogram has not been evaluated beyond identifying these clusters (Groups 1-3). This analysis was rerun using only those samples with a count of approximately 200 individuals (Figure 42). Clusters are apparent at a high similarity level (.5-.7). Six groups have been recognized which tend to relate samples as to the number of individuals in the species which they contain. Clustering of this type has potential as a correlation tool, but in this instance it does not seem as meaningful as the other criteria discussed above. An additional analysis was run of Section 14 samples in an attempt to subdivide it (Figure 43). One cluster (Group 1) resulted at a high similarity level (.5) which groups samples from the center of the Upper Shale Unit and roughly corresponds to Subunit B which is based on the ratio and absolute abundance of marine and nonmarine species.

Plant Associations

The R-mode cluster analysis results in groups of species which are related by their common occurrence (co-occurrence) in samples. Since these species are related by common occurrence it may be hypothesized that the groups to some degree represent plant communities. It must be remembered that the program is designed so that all species will eventually cluster. Whether or not a given cluster on the dendrogram has ecological significance is a value judgement on the part of the interpreter and must be based on some knowledge of the species comprising the cluster. The similarity scale of the dendrogram varies from 0 (complete dissimilarity) to 1 (complete similarity).

The species stems of the R-mode dendrogram (Figure 44 in pocket) which cluster at .5 or greater have been drawn as solid lines for emphasis. These pairs and clusters of species have the greatest similarity of occurrence and are thought to represent portions of synecological units. Eight clusters at approximately the .3-.4 level have been designated as subgroups and 12 clusters at approximately the .2-.3 similarity level have been designated as groups.

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Some comments and interpretations may be made concerning the following clusters, but no special significance is attached to the other clusters.

Group 10. Virtually all of the dinoflagellates and acritarchs occur in this cluster. Group 10 represents the marine phytoplankton community.

Subgroup 10A. This subgroup is of interest since Palambages Form A, a supposed green alga, has a distribution parallel to that of the dinoflagellates.

Subgroup 10B. The two species of Dinogymnium have parallel distributions.

Subgroup 10D. This highly similar subgroup contains the most abundant (relatively abundant) dinoflagellate species (Figure 25-29). They are closely related in their distribution, and it is suggested that they represent the most marine association of species.

Group 11. This cluster contains two species, Cassidium fragilis and Cingulatisporites dakotaensis, with parallel distribution which are restricted to the Lower Almond. This cluster may characterize the nonmarine to estuarine Lower Almond.

Group 12. Group 12 is an artificial group of extremely rare species with only one or two specimen occurrences.

Group 4. This group is a large and closely related cluster of angiosperms and gymnosperms whose significance is unknown.

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PALYNOMORPH DESCRIPTIONS

Taxonomic Listing

Form genera and form species have been used almost exclusively in the identification of the palynomorphs encountered in this study. To the author's knowledge form taxa have not been published for Botryococcus sp., Pediastrum paleogeneites and Azolla sp. of this study. The affinities of the form species with living plants and in some cases with extinct plant megafossils have been noted in the specific descriptions. These suggested affinities are for the most part the modern genus and family indicated by the original author of the species. To provide the complete taxonomic placement of the palynomorphs the following list has been compiled (Table X). The acritarchs have not yet been classified so only their unofficial group and subgroup status may be given. Their placement following the dinoflagellates reflects the fact that their distribution parallels that of the dinoflagellates and they are presumed to be marine phytoplankton.

Table X
Taxonomic Placement of Form Genera and Species

	Page
Kingdom Plantae	
Subkingdom Thallophyta	
Division Chlorophyta	
Class Chlorophyceae	
Order Chlorococcales	
Family Botryococcaceae	
Genus <u>Botryococcus</u> (<u>B. braunii</u>)	
<u>Botryococcus</u> sp.	60
Family Hydrodictyaceae	
Genus <u>Pediastrum</u>	
<u>Pediastrum paleogeneites</u>	60
Family Uncertain	
<u>Palambages</u> Form A	61
Division Pyrrophyta	
Class Dinophyceae	
Order Gymnodiniales	
Family Gymnodiniaceae	
<u>Dinogymnium nelsonense</u>	61
<u>Dinogymnium</u> sp. 1	62

Table X (cont'd)

Order Peridinales	
Family Deflandreaceae	
<u>Deflandrea microgranulata</u>	62
<u>Deflandrea</u> cf. <u>D. pirnaensis</u>	62
<u>Deflandrea cooksoni</u>	63
<u>Deflandrea magnifica</u>	64
<u>Deflandrea pannucea</u>	64
<u>Deflandrea</u> cf. <u>D. verrucosa</u>	64
<u>Splnidinium densispinatum</u>	65
<u>Trithyrodinium</u> sp. A	66
<u>Palaeocystodinium benjaminii</u>	66
Order Uncertain	
Family Hystrichosphaeridiaceae	
<u>Hystrichosphaeridium tubiferum</u>	67
<u>Cordosphaeridium fibrospinosum</u>	68
Forma A sp. 1	68
<u>Diphyes colligerum</u>	68
<u>Hystrichosphaera ramosa</u> var. <u>membranacea</u>	69
Family Areoligeraceae	
<u>Cyclonephelium</u> sp. 1	70
<u>Cassidium fragilis</u>	70
Family Uncertain	
<u>Membranosphaera maastrichtica</u>	70
<u>Palaeohystrichophora infusorioides</u>	71
Division Uncertain	
Group Acritarcha	
Subgroup Acanthomorphitae	
<u>Micrhystridium densispinum</u>	71
<u>Micrhystridium inconspicuum</u>	72
<u>Micrhystridium piliferum</u>	72
<u>Micrhystridium fragile</u>	72
<u>Micrhystridium eupeplos</u>	73
Subgroup Pteromorphitae	
<u>Pterospermopsis australiensis</u>	74
Subgroup Uncertain	
<u>Palaeostomocystis laevigata</u>	74
Genus A species A	73
Subkingdom Embryophyta	
Division Bryophyta	
Class Musci	
Order Sphagnales	
Family Sphagnaceae	
<u>Stereisporites antiquasporites</u>	79
Division Tracheophyta	
Subdivision Lycopsida	
Class Lycopodiaceae	
Order Lycopodiales	
Family Lycopodiaceae	
<u>Foveosporites canalis</u>	80
<u>Hamulatisporis hamulatis</u>	81
<u>Lycopodiumsporites austroclavatidites</u>	84

Table X (cont'd)

<u>Foveasporis triangulus</u>	83
<u>Zlivisporis novomexicanum</u>	83
Order Selaginellales	
Family Selaginellaceae	
<u>Cingulatisporites dakotaensis</u>	79
Subdivision Uncertain	
<u>Undulatisporites</u> sp.	81
<u>Styx minor</u> (megaspore?)	85
<u>Styx major</u> (megaspore)	85
<u>Schizosporis cooksoni</u> (spore?)	74
<u>Schizosporis parvus</u> (spore?)	75
Subdivision Pteropsida	
Class Filicineae	
Subclass Leptosporangiatæ	
Order Eufilicales	
Family Osmundaceae	
<u>Conbaculatisporites</u> sp.	80
<u>Todisporites</u> cf. <u>T. minor</u>	77
Family Schizæaceae	
<u>Cicatricosisporites dorogensis</u>	82
<u>Appendicisporites</u> cf. <u>A. dentimarginatus</u>	83
Family Gleicheniaceae	
<u>Deltoidospora diaphana</u>	77
<u>Gleicheniidites senonicus</u>	78
Family Dicksoniaceae	
<u>Alsophilidites kerquelensis</u>	78
Family Polypodiaceae	
<u>Laevigatosporites ovatus</u>	75
<u>Polypodiisporites favus</u>	76
Order Hydropteridales	
Family Salviniaceae	
Genus <u>Azolla</u>	
<u>Azolla</u> sp.	86
Class Gymnospermae	
Order Pteridospermae (extinct)	
Family Caytoniaceae	
Genus <u>Caytonanthus</u>	
<u>Vitreisporites pallidus</u>	92
Order Cycadales	
Family Cycadaceae	
<u>Cycadopites</u> sp. A	90
<u>Cycadopites follicularis</u>	90
Order Coniferales	
Family Podocarpaceae	
<u>Phyllocladidites mawsoni</u>	93
<u>Podocarpidites maximus</u>	93

Table X (cont'd)

<u>Rugubivesiculites floridus</u>	95
Family Cheirolepidaceae (extinct)	
<u>Classopollis classoides</u>	96
Family Araucariaceae	
<u>Inaperturopollenites atlanticus</u>	87
<u>Araucariacites limbatus</u>	88
Family Pinaceae	
<u>Laricoidites magnus</u>	87
<u>Laricoidites gigantus</u>	88
<u>Tsugaepollenites igniculus</u>	95
<u>Cedripites parvus</u>	93
<u>Abietineaepollenites foveoreticulatus</u>	94
<u>Alisporites grandis</u>	94
Family Taxodiaceae	
<u>Taxodiaceapollenites hiatus</u>	89
Families Taxodiaceae and Cupressaceae	
<u>Inaperturopollenites dubius</u>	86
Order Gnetales	
Family Ephedraceae	
<u>Equisetosporites ovatus</u>	92
Orders Bennettitales, Cycadales and Ginkgoales	
<u>Monosulcites scabratus</u>	91
Order Uncertain	
<u>Euconmiidites couperi</u>	91
<u>Quadripollis krempii</u>	95
<u>Spermatites</u> sp. (ovule).	96
Class Angiospermae	
Subclass Monocotyledoneae	
Order Uncertain	
<u>Arecipites reticulatus</u>	97
<u>Liliacidites complexus</u>	98
<u>Liliacidites leei</u>	97
Subclass Dicotyledoneae	
Order Salicales	
Family Salicaceae	
<u>Tricolpopollenites clavireticulatus</u>	99
Order Fagales	
Family Fagaceae	
<u>Cupuliferoipollenites pusillus</u>	107
Family Betulaceae	
<u>Alnipollenites quadrapollenites</u>	113
Order Urticales	
Family Ulmaceae	
<u>Ulmipollenites</u> sp. A	112

Table X (cont'd)

Order Proteales	
Family Proteaceae	
<u>Proteacidites retusus</u>	111
<u>Proteacidites thalmanni</u>	111
Orders Santalales and Lamiales	
Families Olacaceae and Labiatae	
<u>Tricolpites bathyreticulatus</u>	102
Family Olaceaceae	
<u>Fraxinoipollenites variabilis</u>	103
Family Loranthaceae	
<u>Cranwellia rumseyensis</u>	104
Order Ranales	
Family Trochodendraceae	
<u>Tricolpopollenites compactus</u>	100
Family Ranunculaceae	
<u>Tricolpites lillei</u>	101
Order Sapindales	
Family Buxaceae	
<u>Erdtmanipollis pachysandroides</u>	113
Family Sapindaceae	
<u>Cupanieidites major</u>	108
Order Rhamnales	
Family Vitaceae	
<u>Tricolporopollenites affluens</u>	107
Order Myrtiflorae	
Family Haloragaceae	
<u>Tricolpites reticulatus</u>	106
Order Ericales	
Family Ericaceae	
Genus <u>Kalmia?</u>	
<u>Ericaceopollenites rallus</u>	105
Order Contortae	
Family Gentianaceae	
<u>Pistillipollenites</u> sp. A	104
Order Uncertain	
<u>Tricolpopollenites</u> sp. 1	98
<u>Tricolpites mutabilis</u>	100
<u>Tricolpopollenites microscabratus</u>	98
<u>Tricolpites psilascabratus</u>	100
<u>Tricolpopollenites microreticulatus</u>	99
<u>Tricolpopollenites delictavatus</u>	100
<u>Tricolpites anguloluminosus</u>	103
<u>Aquilapollenites polaris</u>	105
<u>Aquilapollenites pulcher</u>	106
<u>Aquilapollenites striatus</u>	106
<u>Aquilapollenites reticulatus</u>	106

Table X (cont'd)

<u>Engelhardtoidites minutus</u>	108
<u>Triporopollenites rugatus</u>	109
<u>Triporopollenites</u> sp. B	109
<u>Trudopollis meekeri</u>	111
<u>Plicapollis</u> sp.	110
<u>Sporopollis</u> cf. <u>S. laqueaeformis</u>	110
<u>Conclavipollis wolfcreekensis</u>	110

Descriptive Listing

An arbitrary arrangement of the form species has been chosen for the descriptive section. The arrangement consists of six groups: the Algae (exclusive of the dinoflagellates), the Dinoflagellates, the Acritarchs, the Spores, the Gymnosperms and the Angiosperms. This arrangement into groups reflects the gross affinities of each species, and within each group it reflects increasing morphologic complexity. The following list (Table XI) gives the order of each species as it appears in the descriptions and the plates.

Table XI

Arrangement of Species in the Descriptions and Plates

	Page
Algae excluding dinoflagellates	
1. <u>Pediastrum paleogeneites</u>	60
2. <u>Botryococcus</u> sp. A	60
3. <u>Palambages</u> Form A	61
Dinoflagellates	
4. <u>Dinogymnium nelsonense</u>	61
5. <u>D.</u> sp. 1	62
6. <u>Deflandrea microgranulata</u>	62
7. <u>D.</u> cf. <u>D. pirnaensis</u>	62
8. <u>D. cooksoni</u>	63
9. <u>D. magnifica</u>	64
10. <u>D. pannucea</u>	64
11. <u>D.</u> cf. <u>D. verrucosa</u>	64
12. <u>Spinidinium densispinatum</u>	65
13. <u>Trithyrodinium</u> sp. A	66
14. <u>Palaeocystodinium benjaminii</u>	66
15. <u>Hystrichosphaeridium tubiferum</u>	67
16. <u>Cordosphaeridium fibrospinosum</u>	68
17. Form A sp. 1	68
18. <u>Diphyes colligerum</u>	68
19. <u>Hystrichosphaera ramosa</u> var. <u>membranacea</u>	69
20. <u>Cyclonephelium</u> sp. 1	70
21. <u>Cassidium fragilis</u>	70

Table XI (cont'd)

22.	<u>Membranosphaera maastrichtica</u>	70
23.	<u>Palaeohystrichophora infusorioides</u>	71
24.	<u>Micrhystridium densispinum</u>	71
25.	<u>M. inconspicuum</u>	72
26.	<u>M. piliferum</u>	72
27.	<u>M. fragile</u>	72
28.	<u>M. eupeplos</u>	73
29.	Genus A sp. A	73
30.	<u>Palaeostomocystis laevigata</u>	74
31.	<u>Pterospermopsis australiensis</u>	74
Spores		
32.	<u>Schizosporis cooksoni</u>	74
33.	<u>S. parvus</u>	75
34.	<u>Laevigatosporites ovatus</u>	75
35.	<u>Polypodiisporites favus</u>	76
36.	<u>Todisporites</u> cf. <u>T. minor</u>	77
37.	<u>Deltoidospora diaphana</u>	77
38.	<u>Alsophilidites kerquelensis</u>	78
39.	<u>Gleicheniidites senonicus</u>	78
40.	<u>Stereisporites antiquasporites</u>	79
41.	<u>Cingulatisporites dakotaensis</u>	79
42.	<u>Foveosporites canalis</u>	80
43.	<u>Conbaculalisporites undulatus</u>	80
44.	<u>Undulatisporites</u> sp.	81
45.	<u>Hamulatisporis hamulatis</u>	81
46.	<u>Cicatricosisporites doroqensis</u>	82
47.	<u>Appendicisporites</u> cf. <u>A. dentimarginatus</u>	83
48.	<u>Foveasporis triangulus</u>	83
49.	<u>Zlivisporis novomexicanum</u>	83
50.	<u>Lycopodium sporites austroclavatidites</u>	84
51.	<u>Styx minor</u>	85
52.	<u>S. major</u>	85
53.	<u>Azolla</u> sp.	86
Gymnosperms		
54.	<u>Inaperturopollenites dubius</u>	86
55.	<u>I. atlanticus</u>	87
56.	<u>Laricoidites magnus</u>	87
57.	<u>L. gigantus</u>	88
58.	<u>Araucariacites limbatus</u>	88
59.	<u>Taxodiaceapollenites hiatus</u>	89
60.	<u>Cycadopites follicularis</u>	90
61.	C. sp. A	90
62.	<u>Monosulcites scabratus</u>	91
63.	<u>Eucommiidites couperi</u>	91
64.	<u>Equisetosporites ovatus</u>	92
65.	<u>Vitreisporites pallidus</u>	92
66.	<u>Phyllocladidites mawsonii</u>	93
67.	<u>Podocarpidites maximus</u>	93
68.	<u>Cedripites parvus</u>	93
69.	<u>Abietineaepollenites foveoreticulatus</u>	94

Table XI (cont'd)

70.	<u>Alisporites grandis</u>	94
71.	<u>Rugubivesiculites floridus</u>	95
72.	<u>Tsugaepollenites igniculus</u>	95
73.	<u>Quadripollis krempii</u>	95
74.	<u>Classopollis classoides</u>	96
75.	<u>Spermatites</u> sp.	96
Angiosperms		
76.	<u>Arecipites reticulatus</u>	97
77.	<u>Liliacidites leei</u>	97
78.	<u>L. complexus</u>	98
79.	<u>Tricolpopollenites</u> sp. 1	98
80.	<u>T. microscabratus</u>	98
81.	<u>T. microreticulatus</u>	99
82.	<u>T. clavireticulatus</u>	99
83.	<u>T. deliclavatus</u>	100
84.	<u>T. compactus</u>	100
85.	<u>Tricolpites mutabilis</u>	100
86.	<u>T. psilascabratus</u>	101
87.	<u>T. lillei</u>	101
88.	<u>T. reticulatus</u>	102
89.	<u>T. bathyreticulatus</u>	102
90.	<u>T. anguloluminosus</u>	103
91.	<u>Fraxinoipollenites variabilis</u>	103
92.	<u>Cranwellia rumseyensis</u>	104
93.	<u>Pistillipollenites</u> sp. A	104
94.	<u>Ericaceoipollenites rallus</u>	105
95.	<u>Aquilapollenites polaris</u>	105
96.	<u>A. pulcher</u>	106
97.	<u>A. striatus</u>	106
98.	<u>A. reticulatus</u>	106
99.	<u>Cupuliferoipollenites pusillus</u>	107
100.	<u>Tricolporopollenites affluens</u>	107
101.	<u>Cupanieidites major</u>	108
102.	<u>Engelhardtoidites minutus</u>	108
103.	<u>Tripoporopollenites</u> sp. B	109
104.	<u>T. rugatus</u>	109
105.	<u>Conclavipollis wolfcreekensis</u>	110
106.	<u>Sporopollis</u> cf. <u>S. laqueaeformis</u>	110
107.	<u>Plicapollis</u> sp.	110
108.	<u>Trudopollis meekeri</u>	111
109.	<u>Proteacidites retusus</u>	111
110.	<u>P. thalmani</u>	111
111.	<u>Ulmipollenites</u> sp. A	112
112.	<u>Alnipollenites quadrapollenites</u>	113
113.	<u>Erdtmanipollis pachysandroides</u>	113

Alphabetical Listing

To facilitate locating the form genera and species in the descriptive section and on the plates the following alphabetical listing has been compiled (Table XII).

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TABLE XII

Alphabetical Arrangement of Genera and Species

	Page	Plate	Figure
<u>Abietinaepollenites foveoreticulatus</u>	94	15	88
<u>Allsporites grandis</u>	94	16	89
<u>Alnipollenites quadrapollenites</u>	113	20	147
<u>Alsophilidites kerkuelensis</u>	78	10	53
<u>Appendicisporites cf. A. dentimarginatus</u>	83	11	63
<u>Aquillapollenites polaris</u>	105	19	123, 124
<u>A. pulcher</u>	106	19	125
<u>A. reticulatus</u>	196	19	127
<u>A. striatus</u>	106	19	126
<u>Araucariacites limbatus</u>	88	15	76
<u>Arecipites reticulatus</u>	97	17	95
<u>Azolla</u> sp.	86	13	71
<u>Botryococcus</u> sp. A	60	1	2
<u>Cassidium fragilis</u>	70	8	32, 33
<u>Cedripites parvus</u>	93	15	87
<u>Cicatricosisporites dorogensis</u>	82	11	62
<u>Cingulatisporites dakotaensis</u>	79	10	56
<u>Classopollis classoides</u>	96	16	93
<u>Conbaculatisporites undulatus</u>	80	11	58, 59
<u>Conclavipollis wolfeekensis</u>	110	20	136
<u>Cordosphaeridium fibrospinosum</u>	68	7	25
<u>Cranwellia rumseyensis</u>	104	18	118, 119
<u>Cupanieldites major</u>	108	20	131, 132
<u>Cupuliferoipollenites pusillus</u>	107	19	128, 129
<u>Cycadopites follicularis</u>	90	15	78
<u>C. sp. A</u>	90	15	79
<u>Cyclonephelium</u> sp. 1	70	8	31
<u>Deflandrea cf. D. pirnaensis</u>	62	2	8, 9, 10, 11
<u>D. cf. D. verrucosa</u>	64	4	16
<u>D. cooksoni</u>	63	3	12, 13
<u>D. magnifica</u>	64	3	14
<u>D. microgranulata</u>	62	2	7
<u>D. pannucea</u>	64	4	15
<u>Deltoidospora diaphana</u>	77	10	52
<u>Dinogymnium nelsonense</u>	61	2	4
<u>D. sp. 1</u>	62	2	5, 6
<u>Diphyes colligerum</u>	68	8	28, 29
<u>Engelhardtoidites minutus</u>	108	20	133
<u>Equisetosporites ovatus</u>	92	15	83
<u>Erdtmanipollis pachysandroides</u>	113	20	148, 149, 150
<u>Ericaceoipollenites rallus</u>	105	18	125
<u>Eucommiidites couperi</u>	91	15	82
<u>Form A sp. 1</u>	68	7	26, 27

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TABLE XII, (cont'd)

	Page	Plate	Figure
<u>Foveasporis triangulus</u>	83	11	64
<u>Foveasporites canalis</u>	80	11	57
<u>Fraxinopollenites variabilis</u>	103	18	116, 117
Genus A sp. A	73	9	42, 43
<u>Gleichenioidites senonicus</u>	78	10	54
<u>Hamulatisporis hamulatis</u>	81	11	61
<u>Hystrichosphaera ramosa</u> var. <u>membranacea</u>	69	8	30
<u>Hystrichosphaeridium tubiferum</u>	67	6	22, 23, 24
<u>Inaperturopollenites atlanticus</u>	87	14	73
<u>I. dubius</u>	86	14	72
<u>Laevigatosporites ovatus</u>	75	10	48
<u>Laricoidites gigantus</u>	88	14	75
<u>L. magnus</u>	87	14	74
<u>Liliacidites complexus</u>	98	17	97, 98
<u>L. leei</u>	97	17	96
<u>Lycopodiumsporites austroclavatidites</u>	84	11	66
<u>Membranosphaera maastrichtica</u>	70	9	34, 35
<u>Microhystridium densispinum</u>	71	9	37
<u>M. eupeplos</u>	73	9	41
<u>M. fragile</u>	72	9	40
<u>M. inconspicuum</u>	72	9	38
<u>M. piliferum</u>	72	9	39
<u>Monosulcites scabratus</u>	91	15	80, 81
<u>Palaeocystodinium benjaminii</u>	66	5, 6	20, 21
<u>Palaeohystrichophora infusorioides</u>	71	9	36
<u>Palaeostomocystis laevigata</u>	74	9	44
<u>Palambages</u> Form A	61	1	3
<u>Pediastrum paleogeneites</u>	60	1	1
<u>Phyllocladidites mawsonii</u>	93	15	85
<u>Pistillipollenites</u> sp. A	104	18	120, 121
<u>Plicapollis</u> sp.	110	20	138
<u>Podocarpidites maximus</u>	93	15	86
<u>Polypodiisporites favus</u>	76	10	49, 50
<u>Proteacidites retusus</u>	111	20	140, 141, 142
<u>P. thalmani</u>	111	20	143, 144
<u>Pterospermopsis australiensis</u>	74	9	45
<u>Quadripollis krempii</u>	95	16	92
<u>Rugubivesiculites floridus</u>	95	16	90
<u>Schizosporis cooksoni</u>	74	9	46
<u>S. parvus</u>	75	10	47
<u>Spermatites</u> sp.	96	17	94
<u>Spinidinium densispinatum</u>	65	4	17
<u>Sporopollis</u> cf. <u>S. laqueaeformis</u>	110	20	137

TABLE XII, (cont'd).

	Page	Plate	Figure
<u>Stereisporites antiquasporites</u>	79	10	55
<u>Styx major</u>	85	13	70
<u>S. minor</u>	85	12	67, 68, 69
<u>Taxodiaceaepollenites hiatus</u>	89	15	77
<u>Gleicheniidites senonicus</u>	77	10	51
<u>Tricolpites anquiloluminosus</u>	103	18	114, 115
<u>T. bathyreticulatus</u>	102	18	113
<u>T. lillei</u>	101	18	111
<u>T. mutabilis</u>	100	18	108
<u>T. psilascabratus</u>	101	18	109, 110
<u>T. reticulatus</u>	102	18	112
<u>Tricolpopollenites clavireticulatus</u>	99	18	104, 105
<u>T. compactus</u>	100	18	107
<u>T. deliclavatus</u>	100	18	106
<u>T. microreticulatus</u>	99	18	102, 103
<u>T. microscabratus</u>	98	18	101
<u>T. sp. 1</u>	98	18	99, 100
<u>Tricolporopollenites affluens</u>	107	19	130
<u>Tripoporopollenites rugatus</u>	109	20	135
<u>T. sp. B</u>	109	20	134
<u>Trithyrodinium</u> sp. A	66	5	18, 19
<u>Trudopollis meekeri</u>	111	20	139
<u>Tsugaepollenites igniculus</u>	95	16	91
<u>Ulmipollenites</u> sp. A	112	20	145, 146
<u>Undulatisporites</u> sp.	81	11	60
<u>Vitreisporites pallidus</u>	92	15	84
<u>Zlivisporis novomexicanum</u>	83	11	65

Descriptions

The palynomorph descriptions consist of the generic citation, the type species of the genus, the species citation and synonymy, a discussion, the suggested affinities and the occurrence and Almond Formation distribution. The discussion includes the size range, a notation of important morphology, comparisons with closely related species and the justification of any transfers or combinations. The

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known stratigraphic range of each species is given as it has been interpreted from the literature. The occurrences given are in general limited to the Upper Cretaceous-lower Tertiary of North America and are not meant to be all inclusive. The description of those species which are unpublished and have not been previously described includes a diagnosis, formal description and a holotype designation.

Genus Pediastrum Meyer, 1829

Type species: Unknown

Pediastrum paleogeneites Wilson and
Hoffmeister, 1953
Pl. 1, Fig. 1

1953 Pediastrum paleogeneites Wilson and Hoffmeister, p. 756, pl. 1, figs. 7, 8.

Discussion: The size range of the coenobia was 43 (65) 86 μ based on six specimens. To the author's knowledge a form genus has not been proposed for fossil specimens related to this living genus.

Suggested affinities: Hydrodictyaceae, Pediastrum

Occurrence: Upper Campanian-Eocene (?). "Lower Formation", Tertiary (probably Eocene), Sumatra (Wilson and Hoffmeister, 1953); lower Dos Palos Shale, upper Moreno Formation, Maestrichtian-Danian, California (Drugg, 1967). This species occurs in the lower and upper Almond Formation.

Genus Botryococcus Kutzing, 1849

Type species: Botryococcus braunii Kutzing, 1849

Botryococcus sp. A
Pl. 1, Figs. 2a, 2b

Discussion: The sizes of the two colonies observed were 34 μ and 79 μ . The presence of Botryococcus in sediments has been discussed by Cookson (1953), Traverse (1955) and Tschudy (1961). To the author's knowledge a form genus has not been proposed for fossil specimens related to this living genus.

Suggested affinities: Botryococcaceae, Botryococcus braunii Kutzing

Occurrence: Cretaceous-Tertiary. Upper Cretaceous and lower Tertiary, Montana (Norton and Hall, 1969). This species is rare in the upper Almond Formation.

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Genus Palambages O. Wetzel, 1961

Type species: Palambages morulosa O. Wetzel, 1961

Palambages Form A Manum and
Cookson, 1964
Pl. 1, Fig. 3

1964 Palambages Form A Manum and Cookson, p. 24, pl. VII, figs. 3-6.

1967 Palambages sp. Drugg, p. 12, pl. 1, fig. 2.

Discussion: Manum and Cookson (1964) indicate that P. Form A is is comparable to P. morulosa but do not place it in that species since the ornamentation of the wall of P. morulosa was not known. P. Form A was described as "smooth to very finely granular."

Specimens from the Almond Formation are psilate. The size of the individuals is about 20 μ . The size range of the colonies (ca. 30 individuals) was 79 (82) 86 μ for the three colonies which were measured.

Suggested affinities: Algae?, Chlorococcales?

Occurrence: Cretaceous. upper Moreno Formation, Maestrichtian-Danian, California (Drugg, 1967). This species occurs in the lower and upper Almond Formation.

Genus Dinogymnium Evitt, Clarke
and Verdier, 1967

Type species: Dinogymnium acuminatum Evitt, Clarke and Verdier, 1967

Dinogymnium nelsonense (Cookson)
Evitt, Clarke and Verdier, 1967
Pl. 2, Fig. 4

1956 Gymnodinium nelsonense Cookson, p. 183, pl. 1, figs. 8-11.

1967 Dinogymnium nelsonense (Cookson) Evitt, Clarke and Verdier, p 5.

Discussion: The observed size range was 50 (63) 72 μ for three specimens.

Suggested affinities: Gymnodiniaceae

Occurrence: Upper Campanian-Paleocene. Cannonball Member, Fort Union Formation, Paleocene, South Dakota (Stanley, 1965); upper Moreno Formation, Maestrichtian, California (Drugg, 1967); Navarro Group, Maestrichtian, Texas (Zaitzeff, 1967). This species occurs only in Section 14 of the upper Almond Formation.

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Dinogymnium sp. 1 (Zaitzeff)

Pl. 2, Figs. 5, 6

1967 Gymnodinium sp. 1 Zaitzeff, p. 83, pl. 21, figs 1-4.Discussion: The observed size range was 32 (34) 37 μ for eight specimens.Suggested affinities: GymnodiniaceaeOccurrence: Upper Campanian-Maestrichtian. Corsicana and Escondido Formations, Navarro Group, Maestrichtian, Texas (Zaitzeff, 1967). This species occurs in the upper Almond Formation.Genus Deflandrea Eisenack, 1938Type species: Deflandrea phosphoritica Eisenack, 1938Deflandrea microgranulata Stanley, 1965

Pl. 2, Fig. 7

1965 Deflandrea microgranulata Stanley, p. 219, pl. 19, figs. 4-6.Discussion: The slightly smaller size of this species distinguished it from D. ventriosa Alberti, 1959, which has a size range of 65-78 μ .D. obscura Drugg, 1967, with a size range of 45-60 μ , closely resembles D. microgranulata but is separated by its "nongranular cyst". D. microgranulata has a microgranulate ($\pm 3\mu$) endophram. The observed size range was 32 (43) 54 μ for 13 specimens.Suggested affinities: DeflandreaceaeOccurrence: Upper Campanian-Paleocene. Cannonball Member, Fort Union Formation, Paleocene, South Dakota (Stanley, 1965); Navarro Group, Maestrichtian, Texas (Zaitzeff, 1967); Upper Cretaceous? or Paleocene?, Montana (Oltz, 1969). This species occurs in the lower and upper Almond Formation.Deflandrea cf. D. pirnaensis Alberti, 1959

Pl. 2, Figs. 8, 9, 10, 11

1959 Deflandrea pirnaensis Alberti, p. 100, pl. 8, figs. 1-5.1960 Scriniodium cooksonae Anderson, p. 30, pl. IX, figs. 1-3.Discussion: The outline of the periphragm is polygonal to almost rhombic. The periphragm exhibits scattered granules ($\pm 1\mu$ in diameter). The second antapical horn is reduced to fairly well developed in some specimens. The cingulum is well developed and wide. The longitudinal furrow is obscure. The endophragm is circular and smaller than the periphragm.

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The archeopyle is obscure in some specimens (Pl. 2 fig. 10), but in most specimens it involves a single intercalary plate (Pl. 2 fig. 9) which may be attached, or detached and found in the interior or missing. Archeopyle formation may also involve the flap-like detachment of the adjacent precingular plate (Pl. 2, fig. 8). A comparable opening is present in the endophragm. The observed size range was 58 (67) 82 μ for 16 specimens.

The Almond Formation specimens are comparable to D. pirnaensis as defined by Alberti (1959). An archeopyle was not observed in Alberti's specimens. The size range was 80 to 106 μ .

Sarjeant and Anderson (1969) have attributed poorly preserved specimens ranging from 75-80 μ to D. piraensis. They indicate an attached single-plate intercalary archeopyle for their specimens.

This species is only tentatively assigned to D. piraensis due to the uncertainty regarding the archeopyle and the slightly smaller size.

Suggested affinities: Deflandreaceae

Occurrence: Turonian-Maestrichtian. Turonian-Coniacian, Germany (Alberti, 1959); Lewis Shale, Maestrichtian, New Mexico (Anderson, 1960 and Sarjeant and Anderson, 1969); ?(Deflandre and Deflandre, 1965). This species occurs in the lower and upper Almond Formation.

Deflandrea cooksoni Alberti, 1959
Pl. 3, Figs. 12, 13

1959 Deflandrea cooksoni Alberti, p. 97, pl. 9, figs. 1-6.

Discussion: Considerable variation in shape exists in this species as a result of the development of the "shoulder" of the epitheca. The endophragm is usually wider (transverse dimension) than it is long resulting in a three part shape of the outline. D. cooksoni is distinct from D. tripartita Cookson and Eisenack, 1960, which it closely resembles, and D. cincta Cookson and Eisenack, 1958, in that it does not exhibit an obvious girdle. Specimens designated D. cf. D. cooksoni by Manum and Cookson (1964) are distinctly different in shape and should be excluded from the species. Specimens designated D. cf. D. cooksoni by Clarke and Verdier (1967) have a distinct girdle and should also be excluded. The observed size range for this species was 72 (89) 118 μ for 12 specimens.

Suggested affinities: Deflandreaceae

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Occurrence: Upper Senonian-Danian. Upper Senonian, Germany (Alberti, 1959); upper Moreno Formation, Maestrichtian-Danian, California (Drugg, 1967). This species occurs in the upper Almond Formation.

Deflandrea magnifica Stanley, 1965
Pl. 3, Fig. 14

1965 Deflandrea magnifica Stanley, p. 218, pl. 20, figs. 1-6.

Discussion: The observed size range was 86 (106) 123 μ for nine specimens.

Suggested affinities: Deflandreaceae

Occurrence: Upper Campanian-Paleocene. Cannonball Member, Fort Union Formation, Paleocene, South Dakota (Stanley, 1965); upper Moreno Formation, Maestrichtian-Danian, California (Drugg, 1967); Navarro Group, Maestrichtian, Texas (Zaitzeff, 1967). This species occurs in the upper Almond Formation.

Deflandrea pannucea Stanley, 1965
Pl. 4, Fig. 15

1965 Deflandrea pannucea Stanley, p. 220, pl. 22, figs. 1-4, 8-10.

Discussion: The size range of the periphragm, including horns was 104 (129) 144 μ while the endophragm was 61 (70) 84 μ for six specimens.

Suggested affinities: Deflandreaceae

Occurrence: Upper Campanian-Paleocene. Cannonball Member, Fort Union Formation, Paleocene, South Dakota (Stanley, 1965); Navarro Group, Maestrichtian, Texas (Zaitzeff, 1967). This species occurs in the upper Almond Formation.

Deflandrea cf. D. verrucosa Manum, 1963
Pl. 4, Fig. 16

1963 Deflandrea verrucosa Manum, p. 60, pl. III, figs. 1-4.

Discussion: The size, verrucate ornamentation and hexagonal intercalary archeopyle of this species is comparable to D. verrucosa, 112 (124) 135 μ . A point of difference is the more fully expanded endophram seen in the Almond Formation specimens. A definite assignment has not been made since only three incomplete specimens have been found and none exhibits the "shoulders" of the expanded periphragm above the endophragm or the apical horn. The sizes observed were 86 μ , 94 μ and 124 μ in length. The average length was 101 μ .

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Suggested affinities: Deflandreaceae

Occurrence: Cenomanian?-Campanian. Lower Upper Cretaceous to mid-Upper Cretaceous, Graham and Ellef Ringnes Islands, Arctic Canada (Manum, 1963 and Manum and Cookson, 1964). This species occurs only in Sample 66W218 of Section 14 of the upper Almond Formation.

Genus Spinidinium Cookson
and Eisenack, 1962

Type species: Spinidinium styloniferum Cookson and Eisenack, 1962

Spinidinium densispinatum Stanley, 1965
Pl. 4, Fig. 17

1965 Spinidinium densispinatum Stanley, p. 226, pl. 21, figs. 1-5.

1965 Spinidinium microceratum Stanley, p. 227, pl. 22, figs. 5-6.

Discussion: Variations in shape, density of the spine coat and length of the apical horn were used to distinguish S. densispinatum and S. microceratum by Stanley (1965). It is here suggested that the differences are so slight that two species are not warranted and that S. microceratum be placed in synonymy with S. densispinatum. The Almond Formation specimens are encompassed by the following description. The test is covered with sharp curved spines, 1.5-2 μ in length. The apical horn is 5-10 μ long. Two antapical horns are present, one about 8 μ long and a shorter one, 1-4 μ long. The girdle is about 6 μ wide with spine covered flanges at each side. A longitudinal furrow is not obvious, but one is suggested by folding. The archeopyle is intercalary and polygonal in outline. The overall length is 48 (59) 67 μ for eight specimens. Excluding the horns, the length is 37 (44) 50 μ , and the width is 42 (45) 64 μ .

Suggested affinities: Deflandreaceae

Occurrence: Upper Campanian-Maestrichtian. Cannonball Member, Fort Union Formation, Paleocene, South Dakota (Stanley, 1965); upper Moreno Formation, Danian, California (Drugg, 1967), Navarro Group, Maestrichtian, Texas, (Zaitzeff, 1967). This species occurs throughout the Almond Formation.

Genus Trithyrodinium Drugg, 1967

Type species: Trithyrodinium evittii Drugg, 1967

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Trithyrodinium sp. A
Pl. 5, Figs. 18, 19

Diagnosis: The distinctive cyst is scabrate-granulate and exhibits apical and antapical tufts of granules. The archeopyle as observed on the cyst is formed by the removal of three intercalary plates which may become disassociated.

Description: The test wall is thin (less than 1μ) and smooth. An apical horn about 28μ in length is present. Two shorter antapical horns are present. A girdle and sulcus are not known to be present. The test cavity contains a rounded cyst. The cyst wall is scabrate with tufts of larger granules (ca. 1μ) on the apical and antapical ends. As observed on the cyst, an intercalary archeopyle is formed by the removal of three plates which may become dissociated. Additional tabulation has not been observed. The range of the length of the test was 95 (108) 130μ for the specimens. The width of the test is about 62μ . The size range of the length of the cyst is 58 (69) 81μ for 17 specimens.

Holotype: Pl. 5, fig. 18. Slide No. 3109A1, Coor. 43.2-118.6, Collection No. 66W231, Section 14, Almond Formation, Late Campanian, Sec. 36, T20N, R101W and Sec. 31, T20N, R101W, Sweetwater County, Wyoming.

Discussion: A single specimen with a test and cyst was observed. The exact nature of the antapical horns is not known. The detached cysts are abundant. T. evittii Drugg, 1967, is a comparable species, but it differs in having a finely punctate cyst wall, in exhibiting a girdle and in having tripartite opercula with fused plates.

Suggested affinities: Deflandreaceae

Occurrence: Upper Campanian. This species is abundant in the upper Almond Formation and absent from the lower Almond Formation.

Genus Palaeocystodinium Alberti, 1961

Type species: Palaeocystodinium golzowense Alberti, 1961

Palaeocystodinium benjaminii Drugg, 1967

Pl. 5, Figs. 20a, 20b; Pl. 6, Fig. 21

1967 Palaeocystodinium benjaminii Drugg, p. 31, pl. 3, fig. 1.

1967 Svalbardella cf. S. lidiae (Gorka) Zaitzeff, p. 102, pl. 30, figs. 9-9a, pl. 31, fig. 1.

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Discussion: Six specimens were observed from the Almond Formation. They exhibit an inner body, apical horn and an antapical horn which has a rudimentary second antapical horn bifurcating from it. The archeopyle is occasionally obscured by longitudinal folding. Hairs were not observed on the apical horn. The overall length was 183-236 μ (average 213 μ) for 6 specimens. The inner body is about 133 μ in length. The width is about 54 μ .

Suggested affinities: Deflandreaceae?

Occurrence: Upper Campanian-Danian. Upper Moreno Formation, Maestrichtian-Danian, California (Drugg, 1967); Navarro Group, Maestrichtian, Texas (Zaitzeff, 1967). This species occurs in the upper Almond Formation.

Genus Hystrichosphaeridium Deflandre
emend. Eisenack, 1958

Type species: Hystrichosphaeridium tubiferum (Ehrenberg) Deflandre, 1937

Hystrichosphaeridium tubiferum (Ehrenberg)
Deflandre, 1937
Pl. 6, Figs. 22, 23, 24

1838 Xanthidium tubiferum Ehrenberg, pl. 1, fig. 16.

1933 Hystrichosphaera tubifera (Ehrenberg) Wetzel, p. 40, pl. 4, fig. 16.

1937 Hystrichosphaeridium tubiferum (Ehrenberg) Deflandre, p. 68.

Discussion: The observed size of the central body was 34 (43) 49 μ for 9 specimens. The processes were 16-20 μ in length.

Suggested affinities: Hystrichosphaeridiaceae

Occurrence: Cenomanian-middle Miocene. Cannonball Member, Fort Union Formation, Paleocene, South Dakota (Stanley, 1965); Navarro Group, Maestrichtian, Texas (Zaitzeff, 1967); upper Moreno Formation, Maestrichtian-Danian, California (Drugg, 1967). This species occurs in the upper Almond Formation.

Genus Cordosphaeridium Eisenack, 1963

Type species: Cordosphaeridium inodes (Klumpp) Eisenack, 1963

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Cordosphaeridium fibrospinosum Davey,
et al., 1966
Pl. 7, Fig. 25

1965 Hystrichosphaeridium inodes Klumpp. Stanley, p. 231, pl. 25, figs. 1-6.

1966 Cordosphaeridium fibrospinosum Davey, et al., p. 86, pl. 5, fig. 5.

Discussion: The maximum diameter of the central body varies from 66-94 μ , with an average of 81 μ . The width of the processes varies from 11-30 μ and the length from 14-29 μ as observed on six specimens.

Suggested affinities: Hystrichosphaeridiaceae

Occurrence: Upper Campanian-Eocene. Cannonball Member, Fort Union Formation, Paleocene, South Dakota, (as H. inodes), (Stanley, 1965); London Clay, Eocene, England (Davey, et al., 1966); Navarro Group, Maestrichtian, Texas (Zaitzeff, 1967). This species occurs in the upper Almond Formation.

Genus Forma A Zaitzeff, 1967

Type species: Forma A sp. 1 Zaitzeff, 1967

Forma A sp. 1 Zaitzeff, 1967
Pl. 7, Figs. 26, 27

1967 Forma A sp. 1 Zaitzeff, p. 54, pl. 9, fig. 12, pl. 10, figs. 1-10.

Discussion: The observed size range was 52 (62) 72 μ for seven specimens.

Suggested affinities: Hystrichosphaeridiaceae

Occurrence: Upper Campanian-Maestrichtian. Navarro Group, Maestrichtian, Texas (Zaitzeff, 1967), This species occurs in the lower and upper Almond Formation.

Genus Diphyes Cookson emend. Davey, et al., 1966

Type species: Diphyes colligerum (Deflandre and Cookson) Cookson emend. Davey, et al., 1966

Diphyes colligerum (Deflandre and Cookson)
Cookson emend. Davey, et al., 1966
Pl. 8, Figs. 28, 29

1953 Hystrichosphaeridium sp. C Cookson, p. 115, pl. 2, figs. 29, 30.

1955 Hystrichosphaeridium colligerum Deflandre and Cookson, p. 278, pl. 7, fig. 3.

1963 Baltisphaeridium colligerum (Deflandre and Cookson) Downie and Sarjeant, pl. 91.

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1965 Diphyes colligerum (Deflandre and Cookson) Cookson, p. 86, pl. 9, figs. 1-12.

1966 Diphyes colligerum (Deflandre and Cookson) Cookson emend. Davey, et al., p. 96, pl. 4, figs. 2, 3.

Discussion: This species is distinguished by a single large antapical process. The size range of the test was 28 (32) 36 μ for six specimens.

Suggested affinities: Hystrichosphaeridiaceae

Occurrence: Senonian? - Eocene. Cannonball Member, Fort Union Formation, Paleocene, South Dakota (Stanley, 1965); Navarro Group, Maestrichtian, Texas (Zaitzeff, 1967). This species occurs in the upper Almond Formation.

Genus Hystrichosphaera Wetzel ex
Deflandre, 1937

Type species: Hystrichosphaera ramosa (Ehrenberg) Deflandre, 1937

Hystrichosphaera ramosa var. membranacea
(Rossignol) Davey, et al., 1966
Pl. 8, Fig. 30

1964 Hystrichosphaera furcata var. membranacea Rossignol, p. 86, pl. 1, figs. 4, 9, 10, pl. 3, figs. 7, 12.

1966 Hystrichosphaera ramosa var. membranacea (Rossignol), Davey, et al., p. 37, pl. 4, fig. 8, 12.

1967 Hystrichosphaera aff. H. furcata (Ehrenberg) Wetzel Drugg, p. 23, pl. 4, figs. 3, 4.

1967 Hystrichosphaera sp. 1 Zaitzeff, p. 64, pl. 15, figs. 7-9.

Discussion: The observed size range of the central body was 33 (39) 58 μ while the processes were about 12 μ long as measured on eight specimens. The genus Spiniferites Mantell, 1850, will apparently be accepted as having priority, but the name change has not been incorporated here (Wall and Dale, 1970, Sarjeant, 1970).

Suggested affinities: Hystrichosphaeraceae

Occurrence: Upper Campanian-Pleistocene. Upper Moreno Formation, Maestrichtian-Danian, California (Drugg, 1967); Corsicana Formation, Navarro Group, Maestrichtian, Texas (Zaitzeff, 1967). This species occurs in the upper Almond Formation.

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Genus Cyclonephelium Deflandre and
Cookson emend. Davey, et. al., 1966

Type species: Cyclonephelium compactum Deflandre and Cookson, 1955

Cyclonephelium sp. 1 Zaitzeff, 1967
Pl. 8, Fig. 31

1967 Cyclonephelium sp. 1 Zaitzeff, p. 68, pl. 16, figs. 1-3.

Discussion: The tabulation of this species was not determined. It exhibits a chorate cyst of the Cylonephelium-Areoligera type with an apical archeopyle and anastomosing processes 12-40 μ in length. The operculum was detached in all specimens examined. The size range of the maximum dimension, exclusive of the processes, was 58 (61) 65 μ for five specimens.

Suggested affinities: Areoligeraceae

Occurrence: Upper Campanian-Maestrichtian. Navarro Group, Maestrichtian, Texas (Zaitzeff, 1967). This species occurs in the upper Almond Formation.

Genus Cassidium Drugg, 1967

Type species: Cassidium fragilis (Harris) Drugg, 1967

Cassidium fragilis (Harris) Drugg, 1967
Pl. 8, Figs. 32, 33

1965 Ovoidites fragilis Harris, p. 97, pl. 27, figs. 4-5.

1967 Cassidium fragilis (Harris) Drugg, p. 22, pl. 3, figs 15-16.

Discussion: The observed size range was 52 (56) 66 μ on five specimens.

Suggested affinities: Areoligeraceae

Occurrence: Upper Campanian-Paleocene. Pebble Point Formation and Dilwyn Clay, Paleocene, Australia (Harris, 1965); upper Moreno Formation, Maestrichtian-Danian, California (Drugg, 1967). This species occurs in the lower Almond Formation.

Genus Membranosphaera Samoilovitch ex.
Norris and Sarjeant emend. Drugg, 1967

Type species: Membranosphaera maastrichtica Samoilovitch, 1961

Membranosphaera maastrichtica Samoilovitch, 1961
Pl. 9, Figs. 34, 35

1961 Membranosphaera maastrichtica Samoilovitch in Samoilovitch and Mtchedlishvili, p. 252, pl. 83, figs. 1, 2.

Discussion: The observed size range was 30 (34) 39 μ for five specimens. Zaitzeff's (1967) Hexagonifera sp. 1 may be referable to this species.

Suggested affinities: Unknown

Occurrence: Upper Cretaceous. Upper Moreno Formation, Maestrichtian-Danian, California (Drugg, 1967). This species occurs in the lower and upper Almond Formation.

Genus Palaeohystrichophora Deflandre
emend. Deflandre and Cookson, 1955

Type species: Palaeohystrichophora infusorioides Deflandre, 1934

Palaeohystrichophora infusorioides
Deflandre, 1934
Pl. 9, Fig. 36

1934 Palaeohystrichophora infusorioides Deflandre, p. 967, fig. 8.

Discussion: The figured specimen appears to exhibit a girdle and sulcus. They are not apparent on other specimens. The observed size range exclusive of the hair-like processes was 33 (49) 59 μ for five specimens.

Suggested affinities: Unknown

Occurrence: Cenomanian-Maestrichtian. Navarro Group, Maestrichtian, Texas (Zaitzeff, 1967). This species occurs in the lower and upper Almond Formation.

Genus Micrhystridium Deflandre
emend. Downie and Sarjeant, 1963

Type species: Micrhystridium inconspicuum (Deflandre) Delandre, 1937

Micrhystridium densispinum Valensi, 1953
Pl. 9, Fig. 37

1953 Micrhystridium densispinum Valensi, p. 52, pl. XIV, fig. 4.

Discussion: This species is distinguished by a dense coat of short spines, 1-2.5 μ in length. "It differs from M. castaninum by its denser, shorter and sharper spines which never appear flexible" (Valensi, 1953, p. 53). This size range of three Almond Formation specimens was 11-12 μ exclusive of the spines.

Suggested affinities: Unknown

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1967).

Occurrence: Middle Jurassic-Campanian. Middle Jurassic, France (Valensi, 1953). Drugg (1967) reported the similar species, M. castaninum, from the Maestrichtian-Danian of California. M. densispinum occurs in the lower and upper Almond Formation.

Micrhystridium inconspicuum (Deflandre)

Deflandre, 1937

Pl. 9, Fig. 38

1935 Hystrichosphaera inconspicua Deflandre, p. 233, pl. IX, figs. 11, 12.

1937 Micrhystridium inconspicuum Deflandre, p. 80, pl. XII, figs. 11-13.

Discussion: The observed size range was 10 (13) 17 μ for the test of seven specimens. The spines are about 2.5 μ in length.

Suggested affinities: Unknown

Occurrence: Middle Jurassic-Campanian. The species has been reported from the Middle Jurassic (Deflandre, 1947) and Cenomanian (Deflandre, 1937). The species occurs in the upper Almond Formation.

Micrhystridium piliferum Deflandre, 1937

Pl. 9, Figs. 39

1937 Micrhystridium piliferum Deflandre, p. 80, pl. XV, fig. 11.

Discussion: The observed size range was 19 (21) 24 μ for six specimens.

Suggested affinities: Unknown

Occurrence: Cretaceous-Paleocene. Silex 8, Cretaceous, Paris, France (Deflandre, 1937); Cannonball Member, Fort Union Formation, Paleocene, South Dakota (Stanley, 1965). This species occurs in the upper Almond Formation.

Micrhystridium fragile Deflandre, 1947

Pl. 9, Fig. 40

1947 Micrhystridium fragile Deflandre, p. 8, figs. 13-18.

Discussion: The observed size range of the test was 16 (18) 20 μ for three specimens. The spines are about 16 μ in length.

Suggested affinities: Unknown

Occurrence: Middle Jurassic-Oligocene. Upper Moreno Formation, Danian, California (Drugg, 1967); Navarro Group, Maestrichtian, Texas (Zaitzeff, 1967). This species occurs in the upper Almond Formation.

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Micrhystridium eupeplos Valensi, 1953
Pl. 9, Fig. 41

1953 Micrhystridium eupeplos Valensi, p. 48, pl. XIV fig. 14, 15, 19.

Discussion: This species exhibits an irregular reticulum. The muri are thin and membranous. The junctions of muri are dark and extend as "processes" beyond the margin of the test. The size range of the test is 12 (16) 18 μ for size specimens.

Suggested affinities: Unknown

Occurrence: Middle Jurassic-Campanian. This species was described from the Middle Jurassic of France. Late Cretaceous occurrences are not known. It occurs in the lower and upper Almond Formation.

Genus A

Type species: Genus A species A

Genus A species A
Pl. 9, Figs. 42, 43

Diagnosis: Spherical body with a coarse reticulum.

Description: Specimens consist of a compressed spherical body with a coarse reticulum. The central body is dark, psilate? and without openings. The reticulum extends about 3 μ above the body as measured at the periphery. The reticulum is composed of muri $\pm 2.5\mu$ wide and lumina $\pm 3\mu$ in diameter. The reticulum is supported by rods about 2.5 μ in diameter. The rods connect at their tips forming the reticulum. The muri are 2 μ high above the rods and minute (1 μ) spines project out as crests on the muri. The size range of the maximum dimension of five specimens is 26 (30) 34 μ . The holotype is 32 μ overall and has a 28 μ central body.

Holotype: Pl. 9, Fig. 42. Slide 3131 AIV, Coor. 44.8-113.7, Collection No. 66W468, Section 9, Upper Almond Formation, Late Campanian, Sec. 12, T19N, R101W, Sweetwater County, Wyoming.

Discussion: This species is grossly comparable to Reticulatasporites jardinus Brenner, 1968, but this species has a coarser more closely appressed reticulum and a slightly smaller size.

Suggested affinities: Unknown

Occurrence: Coniacian-Campanian, Mancos Formation, Coniacian-Santonian, Colorado (Thompson, 1969). This species occurs in the lower Almond Formation.

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Genus Palaeostomocystis Deflandre, 1937

Type species: Palaeostomocystis reticulata Deflandre, 1937.

Palaeostomocystis laevigata Drugg, 1967
Pl. 9, Fig. 44

1967 Palaeostomocystis laevigata, Drugg, p. 35, pl. 6, figs. 14, 15.

Discussion: The observed size range was 38 (46) 52 μ for six specimens.

Suggested affinities: Unknown

Occurrence: Upper Campanian-Danian. Upper Moreno Formation, Maestrichtian-Danian, California (Drugg, 1967). This species occurs in the upper Almond Formation.

Genus Pterospermopsis Wetzel, 1952

Type species: Pterospermopsis danica Wetzel, 1952

Pterospermopsis australiensis Deflandre
and Cookson, 1955
Pl. 9, Fig. 45

1955 Pterospermopsis australiensis Deflandre and Cookson, p. 286, pl. 3, fig. 4.

Discussion: Warren (1967) discusses the status of various species of Pterospermopsis. The size range was 24 (45) 88 μ overall and 14 (26) 58 μ for the body of the five specimens observed.

Suggested affinities: Pterosperma, an extant phytoplankton of uncertain taxonomic placement. Pteromorphitae, the acritarch subgroup of Downie, Evitt and Sarjeant (1963).

Occurrence: Jurassic-Tertiary. Fort Union Formation, Paleocene, South Dakota (Stanley, 1965). This species occurs in the upper Almond Formation.

Genus Schizosporis Cookson and Dettmann, 1959

Type species: Schizosporis reticulatus Cookson and Dettmann, 1959

Schizosporis cooksoni Pocock, 1962
Pl. 9, Fig. 46

1962 Schizosporis cooksoni Pocock, p. 76, pl. 13, figs. 197, 198.

Discussion: A two layered exine was not apparent. Specimens up to 56 μ in maximum dimension are included here. Pocock gave a size range of 32-42 μ . The size range of this species should be expanded to 64 μ making it continuous with S. parvus Cookson and Dettmann, 1959.

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The observed size range was 38 (49) 56 μ for four specimens.

Suggested affinities: Unknown. Cookson and Dettmann (1959) referred to the species of Schizosporis as alete spores. Subsequent authors, e.g. Stanley (1965), have considered them to be inaperturate pollen.

Occurrence: Upper Jurassic-Campanian. Upper Vanguard Formation, Mannville Group, Upper Jurassic-Lower Cretaceous, western Canada (Pocock, 1962). This species occurs in the lower and upper Almond Formation.

Schizosporis parvus Cookson
and Dettmann, 1959
Pl. 10, Fig. 47

1959 Schizosporis parvus Cookson and Dettmann, p. 216, pl. 1, figs. 15-19.

1965 Schizosporis laevigatus Stanley, p. 268, pl. 23, figs. 6-7, pl. 37, figs. 4-5.

Discussion: The observed size range was 83 (90) 98 μ for three specimens. A two layered exine was not observed on these specimens, presumably due to weathering.

Suggested affinities: Unknown

Occurrence: Cretaceous-Paleocene. Albian-Cenomanian?, Eastern Australia (Cookson and Dettmann, 1959); Mannville Group, upper Neocomian, Western Canada (Pocock, 1962); Mannville Group, Barremian?-Cenomanian? Alberta (Singh, 1964); Cannonball Member, Fort Union Formation, Paleocene, South Dakota (S. laevigatus) (Stanley, 1965); Red Branch Member, Woodbine Formation, Cenomanian, Oklahoma (Hedlund, 1966); 'Walnut Clay', Fredericksburg Group, Albian, Oklahoma, (Hedlund and Norris, 1968); Dakota Sandstone, Cenomanian, Arizona (Agasie, 1969); Hell Creek Formation, uppermost Cretaceous and Tullock Formation, Paleocene, Montana (Norton and Hall, 1969); Hell Creek Formation, Maestrichtian and Tullock Formation, Paleocene, Montana (Oltz, 1969). This species occurs in the lower and upper Almond Formation.

Genus Laevigatosporites (Ibrahim) Schopf,
Wilson and Bentall, 1944

Type species: Laevigatosporites vulgaris (Ibrahim) Ibrahim, 1933

Laevigatosporites ovatus Wilson and Webster, 1946
Pl. 10, Fig. 48

1946 Laevigatosporites ovatus Wilson and Webster, p. 273, fig. 5.

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Discussion: The observed size range was 30 (41) 59 μ for nine specimens.

Suggested affinities: Polypodiaceae

Occurrence: Upper Jurassic-Paleocene. Fort Union Series, Paleocene, Carbon County, Montana (Wilson and Webster, 1946); Comox Formation, Vancouver Island and Oldman Formation, Upper Cretaceous, Alberta, (Rouse, 1957); upper Vanguard Formation, Upper Jurassic, Mannville Group and Lower Cretaceous, Western Canada (Pocock, 1962); Mannville Group, Lower Cretaceous, Alberta (Singh, 1964); Hell Creek Formation, Upper Cretaceous and Fort Union Formation, Paleocene, South Dakota (Stanley, 1965); Red Branch Member, Woodbine Formation, Cenomanian, Oklahoma (Hedlund, 1966); Edmonton Formation, Maestrichtian, Alberta (Srivastava, 1966); upper Moreno Formation, Maestrichtian-Danian, California (Drugg, 1967); Hell Creek Formation, uppermost Cretaceous and Tullock and Lebo Formations, Paleocene, Montana (Norton and Hall, 1969); Bearpaw, Fox Hills and Hell Creek formations, Maestrichtian and Tullock Formation, Paleocene, Montana (Oltz, 1969). This species occurs throughout the Almond Formation.

Genus Polypodiisporites Potonié, 1934

Type species: Polypodiisporites favus (Potonié) Potonié, 1934

Polypodiisporites favus (Potonié)

Potonié, 1934

Pl. 10, Figs. 49, 50

- 1931 Polypodii(?) -sporonites favus Potonié, p. 556, fig. 3.
- 1934 Polypodiisporites favus (Potonié) Potonié, p. 38, pl. 1, figs. 19-20.
- 1938 Polypodiumsporites favus (Potonié) Thiergart, p. 295, pl. 22, fig. 14.
- 1953 Verrucatosporites favus (Potonié) Thomson and Pflug, p. 60, pl. 3, figs. 52-55, pl. 4, figs. 1-4.
- 1957 Polypodiaceasporites favus (Potonié) Thiergart, 1938, Rouse, p. 364, pl. 3, figs. 70-72.
- 1971 Reticuloidosporites pseudomurii Elsik, 1968, Leffingwell, p. 24, pl. 5, figs. 1a, 1b.

Discussion: The synonymy follows that of Srivastava (1966). The observed size range of the species was 44 (54) 65 μ for five specimens.

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Hall, 1969.

Suggested affinities: Polypodiaceae

Occurrence: Upper Cretaceous-Tertiary. The precise stratigraphic range has not been determined. Vermejo Formation, Maestrichtian, Colorado (Clarke, 1963); Edmonton Formation, Maestrichtian, Alberta, Canada (Srivastava, 1966); Lance Formation, Maestrichtian and Fort Union Formation, Paleocene, Wyoming, (Leffingwell, 1971). This species occurs in the upper Almond Formation.

Genus Todisporites Couper, 1958

Type species: Todisporites major Couper, 1958

Todisporites cf. T. minor Couper, 1958
Pl. 10, Fig. 51

1958 Todisporites minor Couper, p. 135, pl. 16, figs. 9, 10.

Discussion: Two specimens were measured, each 25 μ in diameter. The size range as given by Couper (1958) is 32 (45) 50 μ . Although smaller, the Almond Formation specimens agree in other characters.

Suggested affinities: Osmundaceae, Todites

Occurrence: Middle Jurassic-Upper Cretaceous. Vermejo Formation, Maestrichtian, Colorado (Clarke, 1963). This species is rare in the upper Almond Formation.

Genus Deltoidospora Miner emend. Potonié, 1956

Type species: Deltoidospora hallii Miner, 1935

Deltoidospora diaphana Wilson
and Webster, 1946
Pl. 10, Fig. 52

1946 Deltoidospora diaphana, Wilson and Webster, p. 273, fig. 3.

1965 Cardoiangulina diaphana (Wilson and Webster) Stanley, p. 248, pl. 30, figs. 17-21.

Discussion: The observed size range was 28 (37) 48 μ based on eight specimens.

Suggested affinities: Gleicheniaceae

Occurrence: Upper Campanian-Paleocene. Fort Union Series, Paleocene, Montana (Wilson and Webster, 1946); Hell Creek Formation, uppermost Cretaceous and Fort Union Formation, Paleocene, South Dakota (Stanley, 1965); Hell Creek Formation, uppermost Cretaceous, Montana (Norton and Hall, 1969). This species occurs throughout the Almond Formation.

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Genus Alsophilidites Cookson ex Potonié, 1956

Type species: Alsophilidites kerguelensis Cookson, 1947

Alsophilidites kerguelensis Cookson, 1947
Pl. 10, Fig. 53

1947 Alsophilidites kerguelensis Cookson, p. 136, pl. XVI, fig. 69.

Discussion: The size range was 20 (26) 37 μ for five specimens.

The trilete rays extend to the equator and distinguish this species from Deltoidospora diaphana which has shorter rays. There is no equatorial thickening observed between the apices as in species of Gleicheniidites.

Suggested affinities: Dicksoniaceae?

Occurrence: Upper Campanian-Tertiary. Tertiary, Kerguelen (Cookson, 1947); Hell Creek Formation, Maestrichtian, and Fort Union Formation, Paleocene, South Dakota (Stanley, 1965); Lebo Formation, Paleocene, Montana (Norton and Hall, 1969); Tullock Formation, Paleocene, Montana (Oltz, 1969). This species occurs throughout the Almond Formation.

Genus Gleicheniidites Ross ex Delcourt
and Sprumont, 1955

Type species: Gleicheniidites senonicus Ross, 1949

Gleicheniidites senonicus Ross, 1949
Pl. 10, Fig. 54

1949 Gleicheniidites senonicus Ross, p. 31, pl. 1, fig. 3.

1957 Gleichenia concavisporites Rouse, p. 363, pl. 2, figs. 36, 48; pl. 3, fig. 49.

1961 Gleichenia senonica (Ross) Grigorjeva in Samoilovitch et. al., p. 46, pl. 13, figs. 1a-b, 2a-b, 3a-b.

Discussion: The observed size range was 19 (22) 26 μ for five specimens.

Suggested affinities: Gleicheniaceae, Gleichenia

Occurrence: Jurassic-Paleocene. This species is widely distributed in Jurassic and Cretaceous rocks. Upper Cretaceous and Paleocene occurrences include the following: Upper Cretaceous, Scania, Sweden (Ross, 1949); Matawan and Monmouth Groups, Senonian, Delaware and New Jersey (Gray and Groot, 1966); Red Branch Member, Woodbine Formation, Cenomanian, Oklahoma (Hedlund, 1966); Dakota Sandstone, Cenomanian, Arizona (Agasie, 1969); Bearpaw Shale, Fox Hills Sandstone and Hell Creek Formation, uppermost Cretaceous and Tullock and Lebo

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formations, Paleocene, Montana (Norton and Hall, 1969). This species occurs throughout the Almond Formation.

Genus Stereisporites Pflug, 1953

Type species: Stereisporites stereoides (Potonié and Venitz)
Pflug, 1953

Stereisporites antiquasporites (Wilson and
Webster) Dettmann, 1963
Pl. 10, Fig. 55

1946 Sphagnum antiquasporites Wilson and Webster, p. 273, fig. 2.

1953 Sphagnites australis (Cookson) forma parva Cookson, p. 464,
pl. 2, figs. 25, 26.

1956 Sphagnumsporites antiquasporites (Wilson and Webster) Potonié,
p. 17.

1959 Sphagnum punctaesporites Rouse, p. 308, pl. 1, figs 25, 26.

1963 Stereisporites antiquasporites (Wilson and Webster) Dettmann,
p. 25, pl. 1, figs. 20, 21.

Discussion: As described by Dettmann (1963), this species has a
1-2 μ equatorial thickening and a low, circular, distal polar thickening,
6-8 μ in diameter. The observed size range was 23 (26) 30 μ based on
six specimens.

Suggested affinities: Bryophyta

Occurrence: This species is widely distributed in the Jurassic,
Cretaceous and Tertiary of the northern and southern hemispheres.
Hell Creek Formation, Upper Cretaceous and Fort Union Formation,
Paleocene, South Dakota (Stanley, 1965); Edmonton Formation,
Maestrichtian, Alberta (Srivastava, 1966; upper Moreno Formation,
Maestrichtian-Danian, California (Drugg, 1967); Fox Hills Sandstone
and Hell Creek Formation, uppermost Cretaceous and Tullock Formation,
Paleocene, Montana (Norton and Hall, 1969); Bearpaw, Fox Hills and
Hell Creek formations, Maestrichtian and Tullock Formation, Paleocene,
Montana (Oltz, 1969). This species occurs throughout the Almond Forma-
tion.

Genus Cingulatisporites Pflug,
emend. Potonié, 1956

Type species: Cingulatisporites levispeciosus Pflug, 1953

Cingulatisporites dakotaensis Stanley, 1965
Pl. 10, Fig. 56

1965 Cingulatisporites dakotaensis Stanley, p. 243, pl. 30, figs. 1-8.

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Discussion: The observed size range was 26 (28) 30 μ for six specimens.

Suggested affinities: Selaginellaceae, Selaginella

Occurrence: Upper Campanian-Paleocene. Hell Creek Formation, Maestrichtian and Ludlow Member, Fort Union Formation, Paleocene, South Dakota (Stanley, 1965); Hell Creek Formation, uppermost Cretaceous and Tullock Formation, Paleocene, Montana (Norton and Hall, 1967, 1969); Edmonton Formation, Maestrichtian, Alberta, Canada (Snead, 1969); Tullock Formation, Paleocene, Montana (Oltz, 1969). This species occurs in the Lower Almond Formation.

Genus Foveosporites Balme, 1957

Type species: Foveosporites canalis Balme, 1957

Foveosporites canalis Balme, 1957

Pl. 11, Fig. 57

1957 Foveosporites canalis Balme, p. 17, pl. 1, figs. 15-17.

Discussion: The observed size range was 32-45 μ based on two specimens.

Suggested affinities: Lycopodiaceae. Balme (1957) referred this species to the Lycopodium verticillatum group.

Occurrence: Cretaceous. Donnybrook Sandstone, Lower Cretaceous?. Perth Basin, Western Australia (Balme, 1957); Hell Creek Formation, Uppermost Cretaceous, South Dakota (Stanley, 1965). This species is rare in the lower and upper Almond Formation.

Genus Conbaculatisporites Klaus, 1960

Type species: Conbaculatisporites mesozoicus Klaus, 1960

Conbaculatisporites undulatus (Leffingwell)

Pl. 11, Figs. 58, 59

1971 Foraminisporis undulatus Leffingwell, p. 25, pl. 4, figs. 5a, 5b.

Description: The spores are triapsidately triangular in shape with strongly convex sides and well rounded apices. The trilete rays of the faint trilete mark extend 1/2 to 2/3 of the spore radius. Lips are not present and the commissure is closed. A sparse coat of essentially baculate projections is present on both the proximal and distal surfaces. The projections may vary to clavate and a few have blunt bifurcations at the tip. The baculae are ca. 2 μ wide and up to 2.5 μ in length. The exine is slightly thickened at the equator (1.5 μ). A size range of

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34 (39) 44μ was observed on five specimens.

Discussion: This species is not considered to be cingulate. It has been transferred to Conbaculatisporites because of its baculate ornament and its triangular shape. It differs from C. mesozoicus Klaus, 1960 in having a sparse coat of baculae and from Baculatisporites comaumensis (Cookson) Potonié, 1956, in having a triangular shape as well as in the spacing of the baculae. The cingulate nature of Foraminisporis foraminis Krutzsch, 1959, and F. wonthaggiensis Dettman, 1963, which this species closely resembles, is also questionable.

Suggested affinities: Osmundaceae

Occurrence: Upper Campanian-Maestrichtian. Lance Formation, Maestrichtian, Wyoming (Leffingwell, 1971). This species occurs in the lower and upper Almond Formation.

Genus Undulatisporites Pflug, 1953

Type species: Undulatisporites microcutic Pflug in Thomson and Pflug, 1953.

Undulatisporites sp. Pl. 11, Fig. 60

1966 Undulatisporites cf. U. undulapolus Brenner, 1963. Srivastava, p. 515, pl. III, fig. 8.

Discussion: The rugulate ornamentation is sufficient basis for a new species. The description remains as given by Srivastava (1966). The size range of Almond Formation specimens is 22 (29) 38μ for three specimens.

Suggested affinities: "Pteridophyta"

Occurrence: Upper Campanian-Maestrichtian. Edmonton Formation, Maestrichtian, Alberta, Canada (Srivastava, 1966). This species occurs in the lower and upper Almond Formation.

Genus Hamulatisporis Krutzsch, 1959

Type species: Hamulatisporis humulatis Krutzsch, 1959

Hamulatisporis hamulatis Krutzsch, 1959 Pl. 11, Fig. 61

1959 Hamulatisporis hamulatis Krutzsch, p. 157, pl. 29, figs. 326-328.

Discussion: The observed size range was 27 (29) 31μ for three specimens.

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Suggested affinities: Lycopodiaceae Lycopodium?

Occurrence: Upper Campanian-Eocene. Eocene, Germany (Krutzsch, 1959); Hell Creek Formation, Maestrichtian, South Dakota (Stanley, 1965); Fox Hills Formation, Maestrichtian, Montana (Norton and Hall, 1969); Edmonton Formation, Maestrichtian, Alberta, Canada (Snead, 1969); Bearpaw, Fox Hills and Hell Creek Formations, uppermost Cretaceous and Tullock Formation, Paleocene, Montana (Oltz, 1969). This species occurs in the lower and upper Almond Formation.

Genus Cicatricosisporites Potonié
and Gelletich, 1933

Type species: Cicatricosisporites dorogensis Potonié and Gelletich, 1933

Cicatricosisporites dorogensis Potonié and
Gelletich, 1933
Pl. 11, Fig. 62

1933 Cicatriosisporites dorogensis Potonié and Gelletich, p. 522,
pl. 1, figs. 1-5.

1951 Mohriosisporites dorogensis Potonié, p. 135, pl. 20, fig 14.

1953 Mohriosisporites australiensis Cookson, p. 470, pl. 2, figs. 31-34.

1956 Cicatricosisporites austratiensis (Cookson) Potonié, p. 48.

1961 Mohria dorogensis (Potonié) Markova in Samoilovitch, et al., p. 86,
pl. 22, fig. 4.

Discussion: Two specimens were observed, 38 μ and 39 μ in equatorial diameter.

Suggested affinities: Schizaeaceae, Anemia

Occurrence: Jurassic-Tertiary. Oldman Formation, Upper Cretaceous, Alberta, Canada (Rouse, 1957); upper Moreno Formation, Maestrichtian-Danian, California (Drugg, 1967); Hell Creek Formation, Maestrichtian, Montana (Norton and Hall, 1969); Bear Paw and Hell Creek Formations, Maestrichtian and Tullock Formation, Paleocene, Montana (Oltz, 1969). This species occurs only in Sample 66W140 of Section 8 of the lower Almond and Sample 66W105 of Section 4 of the upper Almond.

Genus Appendicisporites Weyland and Krieger, 1953

Type species: Appendicisporites tricuspidatus Weyland and Krieger, 1953

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Appendicisporites cf. A. dentimarginatus

Brenner, 1963

Pl. 11, Fig. 63

1963 Appendicisporites dentimarginatus Brenner, p. 45, pl. 6, figs. 2, 3.

Discussion: The specimen illustrated here (60 μ) and those recorded by Clarke (1963) (63-80 μ) are considerably larger than Brenner's specimens, 22 (30) 34 μ .

Suggested affinities: Schizaeaceae, Anemia

Occurrence: Lower Cretaceous (Barremian) - lower Tertiary. Potomac Group, Barremian-Albian, Maryland (Brenner, 1963); Vermejo Formation, Maestrichtian, Colorado (Clarke, 1963); Midway and Wilcox Groups, lower Tertiary, Gulf Coast, U.S.A. (Fairchild and Elsik, 1969). This species occurs in sample 66W133 of the lower Almond Formation.

Genus Foveasporis Krutzsch, 1959

Type species: Foveasporis fovearis Krutzsch, 1959

Foveasporis triangulus Stanley, 1965

Pl. 11, Fig. 64

1965 Foveasporis triangulus Stanley, p. 239, pl. 27, figs. 18-22.

Discussion: A single specimen, 56 μ in diameter, was found.

Suggested affinities: Lycopodiaceae, Selaginella

Occurrence: Upper Campanian-Paleocene. Fort Union Formation, Paleocene, South Dakota (Stanley, 1965). This species was found only in Sample 66W133 of Section 8 of the lower Almond Formation.

Genus Zlivisporis Pacltova, 1961

Type species: Zlivisporis blanensis Pacltova, 1961

Zlivisporis novomexicanum (Anderson) Leffingwell, 1971

Pl. 11, Fig. 65

1960 Lycopodium novomexicanum Anderson, p. 14, pl. 1, fig. 2, pl. 8, fig. 1.

1967 Lycopodiumsporites novomexicanum (Anderson) Drugg, p. 40, pl. 6, fig. 27.

1971 Zlivisporis novomexicanum (Anderson) Leffingwell, p. 25, figs. 3a, 3b, 4.

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Discussion: The distinctness of Z. blanensis from Z. novomexicanum as maintained by Norton and Hall (1969) deserves further investigation. This species resembles individuals of the Lower Cretaceous Rouseisporites Pocock, 1962, with missing equatorial flanges. It is also comparable to the Cenomanian Retitriletes pluricellulus of Pierce (1961).

Inaperturopollenites sp. A of Orlansky (1967) is apparently identical. The observed size range of Almond Formation specimens was 32 (47) 59 μ for four specimens.

Suggested affinities: Lycopodiaceae?

Occurrence: Upper Campanian-Paleocene. Kirtland Shale, uppermost Cretaceous and Nacimiento Formation, Paleocene, New Mexico (Anderson, 1960); upper Moreno Formation, Maestrichtian, California (Drugg, 1967); Lance Formation, Maestrichtian and Fort Union Formation, Paleocene, Wyoming (Leffingwell, 1971). This species occurs in the lower and upper Almond Formation.

Genus Lycopodiumsporites Thiergart ex Delcourt
and Sprumont, 1955

Type species: Lycopodiumsporites agathoecus (Potonié) Thiergart, 1938

Lycopodiumsporites austroclavatidites (Cookson)
Potonié, 1956
Pl. 11, Fig. 66

1953 Lycopodium austroclavatidites Cookson, p. 469, pl. 2, fig. 35.

1956 Lycopodiumsporites austroclavatidites (Cookson) Potonié, p. 46.

1958 Lycopodiumsporites clavatoides Couper, p. 132, pl. 15, figs. 12, 13.

1959 Lycopodiumsporites reticulumsporites Rouse, p. 309, pl. 1, fig. 3.

Discussion: The selected synonymy above follows Dettmann (1963). The observed size range was 31-39 μ for two specimens.

Suggested affinities: Lycopodiaceae. This species has been related to the recent Lycopodium clavatum group of Knox (1950).

Occurrence: Jurassic-Paleocene. This species is widely distributed in Jurassic and Cretaceous rocks. Upper Cretaceous occurrences include the following: Magothy Formation, Turonian-Senonian, Atlantic Coastal Plain, Eastern United States (L. clavatoides) (Groot, Penny and Groot, 1961); Bearpaw Shale, Fox Hills and Hell Creek Formations, Maestrichtian and Tullock Formation, Paleocene, Montana (Oltz, 1969). This species is rare in the lower and upper Almond Formation.

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Genus Styx Norton, 1967

Type species: Styx minor Norton, in Norton and Hall, 1967

Styx minor Norton, 1967
Pl. 12, Figs. 67, 68, 69

1967 Styx minor Norton, in Norton and Hall, p. 104, pl. 1, fig. C.

Discussion: The observed size range of the maximum dimension was 108-122 μ (two specimens) while that of the endospore excluding spines was 50 (58) 66 μ on a total of 10 specimens. A foveolate inner layer of the perispore was not observed. As noted by Oltz (1969) S. minor has an extension of the perispore into an arcolamella. The other morphological characters agree favorably especially the size and the radiating ridges within the lumina of the reticulum of the perispore. One specimen with a partially detached perispore clearly reveals a well defined trilete mark (Pl. 12, Fig. 69). In comparing Norton's description with his plate, it is apparent that the photographs of figures B and C have been reversed. Fig. C exhibits the "radiating ridges".

Refer to Norton and Hall (1969).

Suggested affinities: Filicinae?, megaspore?

Occurrence: Upper Campanian-Maestrichtian. Hell Creek Formation, uppermost Cretaceous, eastern Montana (Norton and Hall, 1967); Hell Creek Formation, uppermost Cretaceous, Montana (Norton and Hall, 1969); Bearpaw, Fox Hills and Hell Creek Formations, Maestrichtian, Montana (Oltz, 1969). This species occurs throughout the Almond Formation.

Styx major Norton, 1967
Pl. 13, Fig. 70

1967 Styx major Norton and Hall, p. 105, pl. 1, fig. B.

Discussion: As noted by Oltz (1969) S. major has an extension of the perispore into an arcolamella. The size was 300 μ overall and 115 μ for the spore body of the single specimen observed.

Suggested affinities: Filicinae?, megaspore

Occurrence: Upper Campanian-Maestrichtian. Hell Creek Formation, Maestrichtian, Montana (Norton and Hall, 1967, 1969 and Oltz, 1969). This species occurs only in Sample 66W221, Section 14, of the upper Almond Formation.

Genus Azolla Lamarck, 1783

Type species: Unknown

Azolla sp.
Pl. 13, Fig. 71

Discussion: Glaucidia, 75 μ in length, were found with seven alternating hooks about 4 μ in length and 3 μ wide at the base. The hooks taper rapidly to a sharp point and are recurved. Cross walls are present in the glaucidia with one hook per division. Three divisions are present at the base without hooks. The glaucidia are similar to those illustrated by Stough (1968) for Azolla polyancrya from the Upper Cretaceous of Argentina and Chile. To the author's knowledge a form genus has not been proposed for fossil specimens related to this living genus.

Suggested affinities: Salviniaceae, Azolla

Occurrence: Upper Campanian. This species was found only in Sample 66W133 of Section 8 of the lower Almond Formation.

Genus Inaperturopollenites Thomson
and Pflug, 1953

Type species: Inaperturopollenites dubius (Potonié and Venitz) Thomson and Pflug, 1953

Inaperturopollenites dubius (Potonié and Venitz)
Thomson and Pflug, 1953
Pl. 14, Fig. 72

1934 Pollenites magnus dubius Potonié and Venitz, p. 17, pl. 2, fig. 21.

1953 Inaperturopollenites dubius (Potonié and Venitz) Thomson and Pflug, p. 65, pl. 4, fig. 89, pl. 5, figs. 1-13.

1962 Inaperturopollenites juniperoides Rouse, p. 201, pl. 2, fig. 6.

Discussion: The observed size range was 28 (36) 46 μ for seven specimens. Brenner (1963, p. 88) and Norris (1967, pl. 16, fig. 14) have included deeply split specimens in this species. Such specimens could be contained in the morphological circumscription of Taxodiaceae-pollenites hiatus; however, in the Almond Formation the individuals of T. hiatus have slightly thicker, more distinctly scabrate exines.

Suggested affinities: Cupressaceae, Taxodiaceae

Occurrence: Inaperturopollenites dubius is widely distributed in Jurassic, Cretaceous and Tertiary rocks. Upper Cretaceous occurrences include: Raritan, Tuscaloosa and Magothly Formations, Cenomanian-

Senonian, Eastern United States (Groot, Penny and Groot, 1961); Burrard Formation, Eocene (in part), British Columbia, Canada (Rouse, 1962); Edmonton Formation, Maestrichtian, Scollard, Alberta, Canada (Srivastava, 1966); Hell Creek Formation, Maestrichtian and Tullock Formation, Paleocene, Montana (Oltz, 1969). This species occurs throughout the Almond Formation.

Inaperturopollenites atlanticus Groot,
Penny and Groot, 1961
Pl. 14, Fig. 73

1961 Inaperturopollenites atlanticus Groot, Penny and Groot, p. 130, pl. 24, fig. 18.

Discussion: The size range was 46 (54) 59 μ for three specimens.

Suggested affinities: Araucariaceae

Occurrence: Cenomanian-Campanian. Tuscaloosa Formation, Cenomanian-Senonian (?), Eastern United States (Groot, Penny and Groot, 1961).

This species occurs in the lower and upper Almond Formation.

Genus Laricoidites Potonié, Thomson and
Thiergart ex Potonié, 1958

Type species: Laricoidites magnus (Potonié) Potonié, 1958

Laricoidites magnus (Potonié) Potonié,
Thomson and Thiergart, 1950
Pl. 14, Fig. 74

1931 Sporonites (?) magnus Potonié, p. 556, fig. 6.

1934 Pollenites magnus (Potonié) Potonié, p. 48, pl. 6, fig. 5.

1937 Larix-pollenites magnus (Potonié) Raatz, p. 15.

1950 Laricoidites magnus (Potonié) Potonié, Thomson and Thiergart,

1953 Inaperturopollenites magnus (Potonié) Thomson and Pflug, p. 64, pl. 4, figs. 83-88.

1962 Larix plicatipollenites Rouse, p. 200, pl. 1, figs. 14, 15.

Discussion: The arbitrary size designation of 50-100 μ (Thomson and Pflug, 1953) of L. magnus is intermediate between that of Inaperturopollenites dubis (Potonié and Venitz) Thomson and Pflug, 1953 and L. gigantus Brenner, 1963. The observed size range was 50 (69) 95 μ for 10 specimens.

Suggested affinities: Pinaceae, Larix. Affinities for this species have been suggested with the Pinaceae, Larix, and the Araucariaceae

(Hedlund, 1966). On the basis of available modern reference material, the Larix designation seems the most plausible. Pollen of Larix americana, L. decidua and L. loricina are thinner, highly folded and often ruptured, closely resembling Laricoidites magnus. The pollen of Araucaria cunninghamii is scabrate, thicker and less commonly folded. Occurrence: Cenomanian-Paleocene. Tertiary, Germany (Potonié, 1931, 1934), Thomson and Pflug, 1953); Burrard Formation, Eocene (in part), British Columbia, Canada (Rouse, 1962); Cannonball Member, Fort Union Formation, Paleocene, South Dakota (Stanley, 1965); Red Branch Member, Woodbine Formation, Cenomanian, Oklahoma (Hedlund, 1966); Fort Union Group, Paleocene, Montana (Norton and Hall, 1969); Hell Creek Formation, Maestrichtian and Tullock Formation, Paleocene, Montana (Oltz, 1969). This species occurs throughout the Almond Formation.

Laricoidites gigantus Brenner, 1963
Pl. 14, Fig. 75

1963 Laricoidites gigantus Brenner, p. 88, pl. 36, figs. 1, 2.

1964 Inaperturopollenites giganteus Goczan, p. 239, pl. V, fig. 1.

Discussion: The observed size range was 101-127 μ for the two specimens observed.

Suggested affinities: Pinaceae, Larix

Occurrence: Lower Cretaceous (Barremian)-Maestrichtian. Edmonton Formation, Maestrichtian, Alberta, Canada (Srivastava, 1966). This species is rare in the lower and upper Almond Formation.

Genus Araucariacites Cookson ex Couper, 1953

Type species: Araucariacites australis Cookson, 1947

Araucariacites limbatus (Balme) Habib, 1969
Pl. 15, Fig. 76

1957 Inaperturopollenites limbatus Balme, p. 31, pl. 7, figs. 83, 84.

1969 Araucariacites limbatus (Balme) Habib, p. 91, pl. 4, fig. 6.

Discussion: The observed size range was 66 (78) 95 μ for five specimens.

Suggested affinities: Araucariaceae

Occurrence: Jurassic(?) - Maestrichtian. Lewis Shale, uppermost Cretaceous, New Mexico (Anderson, 1960). This species occurs in the lower and upper Almond Formation.

Genus Taxodiaceapollenites Kremp, 1949

Type species: Taxodiaceapollenites hiatus (Potonié) Kremp, 1949

Taxodiaceapollenites hiatus (Potonié)

Kremp, 1949

Pl. 15, Fig. 77

- 1931 Pollenites hiatus Potonié, p. 5, fig. 27.
 1933 Taxodium hiatipites Wodehouse, p. 493, fig. 19.
 1949 Taxodiaceapollenites hiatus (Potonié) Kremp, p. 59, pl. 5, figs. 31, 37, 38.
 1950 Taxodoidites hiatus (Potonié) Potonié, Thomson and Thiergart, p. 49, pl. A, fig. 23.
 1951 Taxodioipollenites hiatus (Potonié) Potonié, p. 143, fig. 17.
 1953 Inaperturopollenites hiatus (Potonié) Thomson and Pflug, p. 65, pl. 5, figs. 14-20.
 1965 Thuja? hiatus (Potonié) Stanley, p. 273, pl. 38, figs. 1-3.

Discussion: The grains from the Almond Formation are scabrate. The ornamentation consists of isodiametric granules which are less than 0.5μ in size. The observed size range was 25 (30) 37μ and was based on 7 specimens.

Suggested affinities: Taxodiaceae, Taxodium

Occurrence: Cretaceous-Tertiary. Pollen of this species is widely dispersed in Cretaceous and Tertiary rocks. The occurrences given here are selected to illustrate the stratigraphic range. Oligocene-Miocene, Germany, (Kremp, 1949); upper Moreno Formation, Maestrichtian-Danian, California (Drugg, 1967); Hell Creek and Fort Union Formations, Upper Cretaceous-Paleocene, South Dakota (Stanley, 1965); Tuscaloosa, Raritan and Magothy Formations, Cenomanian-Senonian, Alabama, Georgia, North Carolina, Delaware, Maryland and New Jersey, (Groot, Penny and Groot, 1961); Fredericksburg Group, Albian, Oklahoma (Hedlund and Norris, 1968); Bearpaw Shale, Fox Hills Sandstone and Hell Creek Formation, uppermost Cretaceous and Tullock and Lebo Formations, Paleocene, Montana (Norton and Hall, 1969); Bearpaw, Fox Hills and Hell Creek Formations, Maestrichtian and Tullock and Lebo Formations, Paleocene, Montana (Oltz, 1969). This species occurs throughout the Almond Formation.

Genus Cycadopites Wodehouse ex
Wilson and Webster, 1946

Type species: Cycadopites follicularis Wilson and Webster, 1946

Cycadopites follicularis Wilson and
Webster, 1946
Pl. 15, Fig. 78

1946 Cycadopites follicularis Wilson and Webster, p. 274, fig. 7.

Discussion: The observed size range was 33 (38) 48 μ for five specimens.

Suggested affinities: Cycadaceae?

Occurrence: Upper Campanian-Paleocene. Fort Union Group, Paleocene, Montana (Wilson and Webster, 1946); Edmonton Formation, Maestrichtian, Alberta, Canada. (Srivastava, 1966); Lance Formation, Maestrichtian and Fort Union Formation, Paleocene, Wyoming (Leffingwell, 1971).

This species occurs throughout the Almond Formation.

Cycadopites sp. A
Pl. 15, Fig. 79

Diagnosis: The subcircular outline, psilate exine and broad sulcus distinguish this species.

Description: The shape is subcircular to slightly elliptical. The sulcus extends the entire length of the grain. It is about 2.5 μ wide at the center and expands at the ends to about 5 μ wide. The exine is psilate and about 1 μ thick. The size range is 17 (23) 30 μ in the long dimension for eight specimens.

Holotype: Pl. 15, Fig. 79. Slide No. 1649-3, Coor. 30.4-125.1, Collection No. 66W133, Section 8, Almond Formation, late Campanian, Sec. 12, T19N, R101W, Sweetwater County, Wyoming.

Discussion: Slightly weathered specimens appear roughened and pitted. It is not known if this is the scabrate ornamentation of other authors, e.g. Stanley (1965, p. 271). Monosulcites latus Norton in Norton and Hall, 1969 is comparable but larger (30-37 μ) and scabrate.

Suggested affinities: Cycadaceae?

Occurrence: Upper Campanian. This species occurs in the lower and upper Almond Formation.

Genus Monosulcites Cookson ex Couper, 1953

Type species: Monosulcites minimus Cookson, 1947

Monosulcites scabratus (Stanley) n. comb.
Pl. 15, Figs. 80, 81

1965 Schizosporis scabratus Stanley, p. 269, pl. 35, figs. 10-17.

Discussion: The aperture of this species is considered to be monosulcate with occasional flaring at the ends and not inaperturate with splitting as indicated by Stanley (1965). The observed size was 20 (30) 40 μ for four specimens.

Suggested affinities: Gymnospermae

Occurrence: Upper Campanian-Maestrichtian. Hell Creek Formation, Maestrichtian, South Dakota (Stanley, 1965). This species occurs in the lower and upper Almond Formation.

Genus Eucommiidites Erdtman emend.
Couper, 1958

Type species: Eucommiidites troedssonii Erdtman, 1948

Eucommiidites couperi Anderson, 1960
Pl. 15, Fig. 82

1960 Eucommiidites couperi Anderson, p. 21, pl. 11, figs. 7, 8.

Discussion: Anderson (1960) considered this species to be tricolpate. In light of Hughes' (1961) discussion, the morphology of the apertures seems best interpreted as a sulcus and a ring furrow (zonisulcate); however, from the orientation of specimens illustrated by Anderson and those observed from the Almond Formation it is not readily apparent that the two apertures are on opposite faces. The observed size range was 24 (26) 31 μ for six specimens.

Suggested affinities: Gymnospermae

Occurrence: Upper Campanian-Maestrichtian. Lewis Shale, uppermost Cretaceous, New Mexico (Anderson 1960). This species occurs in the lower and upper Almond Formation.

Genus Equisetosporites Daugherty emend.
Singh, 1964

Type species: Equisetosporites chinleana Daugherty, 1941

Equisetosporites ovatus (Pierce) Singh, 1964
Pl. 15, Fig. 83

1961 Striainaperturites ovatus Pierce, p. 45, pl. III, fig. 80.

1964 Equisetosporites ovatus (Pierce) Singh, p. 133, pl. 17, fig. 16.

1969 Ephedripites ovatus (Pierce) Norton in Norton and Hall, p. 34, pl. 3, fig. 19.

Discussion: The observed size range was 28 (37) 45 μ for the polar dimension of 11 specimens.

Suggested affinities: Ephedraceae, Ephedra

Occurrence: Aptian-Maestrichtian. Cenomanian, Minnesota, (Pierce, 1961); Ellerslie Member, McMurray Formation, Aptian, Alberta, Canada (Singh, 1964); Bearpaw Shale, Maestrichtian, Montana (Norton and Hall, 1969). This species occurs in the lower and upper Almond Formation.

Genus Vitreisporites Leschik, 1955

Type species: Vitreisporites signatus Leschik, 1955

Vitreisporites pallidus (Reissinger)
Nilsson, 1958
Pl. 15, Fig. 84

1938 Pityosporites pallidus Reissinger, p. 14.

1950 Pityopollenites pallidus (Reissinger) Reissinger, p. 109, pl. 15, figs. 1-5.

1958 Caytonipollenites pallidus (Reissinger) Couper, p. 150, pl. 26, figs. 7, 8.

1958 Vitreisporites pallidus (Reissinger) Nilsson, p. 77, pl. 7, figs. 12-14.

Discussion: The observed size range was 24 (35) 45 μ for nine specimens.

Suggested affinities: Caytoniaceae, Caytonanthus

Occurrence: Jurassic-Cretaceous. This species is widely reported from Jurassic and Cretaceous rocks. Vermejo Formation, Maestrichtian, Colorado (Clarke, 1963). It occurs in the lower and upper Almond Formation.

Genus Phyllocladidites Cookson ex Couper, 1953

Type species: Phyllocladidites mawsonii Cookson ex Couper, 1953

Phyllocladidites mawsonii Cookson ex
Couper, 1953
Pl. 15, Fig. 85

1947 Phyllocladidites mawsonii Cookson, p. 133, pl. XIV, figs. 22-28.

1953 Phyllocladidites mawsonii Cookson ex Couper, p. 38, pl. 9, fig. 135.

Discussion: The observed size range was 45-50 μ for two specimens.

Suggested affinities: Podocarpaceae, Dacrydium

Occurrence: Lower Cretaceous-Lower Oligocene. Hell Creek Formation, Maestrichtian, Montana (Norton and Hall, 1969); Bear Paw and Hell Creek Formations, Maestrichtian, Tullock Formation, Paleocene, Montana (Oltz, 1969). This species occurs in the lower and upper Almond Formation.

Genus Podocarpidites Cookson ex Couper, 1953

Type species: Podocarpidites ellipticus Cookson ex Couper, 1953

Podocarpidites maximus (Stanley)
Norton, 1969
Pl. 15, Fig. 86

1965 Podocarpus maximus Stanley, p. 281, pl. 41, figs. 1-8.

1969 Podocarpidites maximus (Stanley) Norton in Norton and Hall, p. 31, pl. 4, fig. 12.

Discussion: The observed size range was 50 (55) 58 μ for the overall dimension of four specimens.

Suggested affinities: Podocarpaceae, Podocarpus

Occurrence: Upper Campanian-Paleocene. Fort Union Formation, Paleocene, South Dakota (Stanley, 1965); Tullock and Lebo Formations, Paleocene, Montana (Norton and Hall, 1967, 1969); Hell Creek Formations, Maestrichtian and Tullock and Lebo Formations, Paleocene, Montana (Oltz, 1969). This species occurs in the lower and upper Almond Formation.

Genus Cedripites Wodehouse, 1933

Type species: Cedripites eocenicus Wodehouse, 1933

Cedripites parvus Norton, 1969
Pl. 15, Fig. 87

1969 Cedripites parvus Norton in Norton and Hall, p. 29, pl. 4, fig. 7.

Discussion: The overall size range was 60 (65) 69 μ for five specimens.

Suggested affinities: Pinaceae, Cedrus?

Occurrence: Upper Campanian-Paleocene. Tullock Formation, Paleocene, Montana (Norton and Hall, 1969); Fox Hills and Hell Creek Formations, Maestrichtian and Tullock and Lebo Formations, Paleocene, Montana (Oltz, 1969). This species occurs in the lower and upper Almond Formation.

Genus Abietinaepollenites Potonié, 1951

Type species: Abietinaepollenites microalatus (Potonié) Potonié, 1951.

Abietinaepollenites foveoreticulatus

Norton, 1969
Pl. 15, Fig. 88

1969 Abietinaepollenites foveoreticulatus, Norton in Norton and Hall, p. 28, pl. 4, fig. 4.

Discussion: The overall size range was 58 (62) 68 μ for four specimens.

Suggested affinities: Pinaceae

Occurrence: Upper Campanian-Paleocene. Fort Union Group, Paleocene, Montana (Norton and Hall, 1969). This species occurs throughout the Almond Formation.

Genus Alisporites Daugherty, 1941

Type species: Alisporites opii Daugherty, 1941

Alisporites grandis (Cookson) Dettmann, 1963

Pl. 16, Fig. 89

1953 Dissaccites grandis Cookson, p. 471, pl. 2, fig. 41.

1957 Pityosporites grandis (Cookson) Balme, p. 36, pl. 10, figs. 110, 111.

1959 Alisporites rotundus Rouse, p. 316, pl. 1, figs. 15, 16.

1963 Alisporites grandis (Cookson) Dettmann, p. 102, pl. XXV, figs 1-4.

Discussion: The overall size range was 79 (93) 113 μ for five specimens.

Suggested affinities: Pinaceae

Occurrence: Upper Jurassic-Cretaceous. This species has been reported from the Upper Jurassic-Lower Cretaceous by Balme (1957) and from the Lower Cretaceous by Cookson (1953) Rouse (1959) Pocock (1962) Dettmann (1963) and Singh (1964). Edmonton Formation, Maestrichtian, Alberta, Canada (Srivastava, 1966). This species occurs in the lower and upper Almond Formation.

Genus Rugubivesiculites Pierce, 1961Type species: Rugubivesiculites convolutus Pierce, 1961Rugubivesiculites floridus Pierce, 1961
Pl. 16, Fig. 901961 Rugubivesiculites floridus Pierce, p. 40, pl. 11, fig. 63.Discussion: The overall size of the single specimen observed was 50 μ .Suggested affinities: PodocarpaceaeOccurrence: Cenomanian-Campanian. To the author's knowledge this species has not been previously reported above the Cenomanian (Pierce, 1961). The genus is known to range throughout the Upper Cretaceous. This species occurs only in Sample 66W144 of Section 9 of the upper Almond Formation.Genus Tsugaepollenites Potonié and Venitz
emend. Potonié, 1958Type species: Tsugaepollenites igniculus (Potonié) Potonié and Venitz, 1934Tsugaepollenites igniculus (Potonié)
Potonié and Venitz, 1934
Pl. 16, Figs. 911931 Sporonites igniculus Potonié, p. 556, fig. 2.1934 Tsugaepollenites igniculus (Potonié) Potonié and Venitz, p. 17, pl. 1, fig. 8.1953 Zonalapollenites igniculus (Potonié) Thomson and Pflug, p. 66, pl. 4, figs. 75-79.Discussion: The observed size range was 44 (49) 53 μ for six specimens. A tetrad mark was present on some specimens.Suggested affinities: Pinaceae, TsugaOccurrence: Upper Campanian-Pliocene. Miocene-Pliocene, Middle Europe (Thomson and Pflug, 1953); upper Moreno Formation, Maestrichtian-Danian, California (Drugg, 1967). This species occurs only in Sample 66W133, Section 8, of the lower Almond Formation.Genus Quadripollis Drugg, 1967Type species: Quadripollis krempii Drugg, 1967Quadripollis krempii Drugg, 1967
Pl. 16, Fig. 921967 Quadripollis krempii Drugg, p. 62, pl. 8, figs. 55, 56.

Discussion: Drugg (1967) compares this species with Inaperturopollenites limbatus Balme, 1957. The size range was 41 (46) 56 μ for the three tetrads observed.

Suggested affinities: Gymnospermae?

Occurrence: Upper Campanian-Maestrichtian. upper Moreno Formation, Maestrichtian, California (Drugg, 1967). This species occurs in the lower and upper Almond Formation.

Genus Classopollis Pflug emend.

Pocock and Jansonius, 1961

Type species: Classopollis classoides Pflug emend. Pocock and Jansonius, 1961

Classopollis classoides Pflug emend.

Pocock and Jansonius, 1961

Pl 16, Fig. 93

1953 Classopollis classoides Pflug, p. 91, pl. 16, figs. 29-31.

1961 Classopollis classoides Pflug emend. Pocock and Jansonius, p. 443, pl. 1, figs. 1-9.

Discussion: The observed size range was 22 (25) 31 μ for five specimens.

Suggested affinities: Gymnospermae. Classopollis pollen occurs in the Mesozoic conifer family Cheirolepidaceae (Barnard, 1968.)

Occurrence: Jurassic-Cretaceous. Vermejo Formation, Maestrichtian, Colorado (Clarke, 1963). This species occurs in the lower and upper Almond Formation.

Genus Spermatites Miner, 1935

Type species: None designated.

Spermatites sp.

Pl. 17, Fig. 94

Discussion: A single partial specimen was found measuring 279 μ in length. No pollen was found in the pollen chamber of this ovule. It has not been identified as to species.

Suggested affinities: Gymnospermae.

Occurrence: Cretaceous occurrences are reported by Miner (1935), Hughes (1961), Hedlund (1966) and Brenner (1967). This species occurs only in Sample 67W1 of Section 8 of the lower Almond Formation.

Genus Arecipites Wodehouse emend.
Anderson, 1960

Type species: Arecipites punctatus Wodehouse, 1933

Arecipites reticulatus (van der Hammen)
Anderson, 1960
Pl. 17, Fig. 95

- 1954 Monocolpites reticulatus van der Hammen, p. 89.
1954 Pollenites reticulatus van der Hammen, p. 96.
1960 Arecipites reticulatus (van der Hammen) Anderson, p. 18, pl. 1, fig. 19, pl. 7, fig. 6, pl. 8, fig. 3, pl. 10, fig. 7.
1965 Pseudotricolpites reticulatus Stanley, p. 317, figs. 26-37.
1966 Liliacidites variegatus Couper. Srivastava, p. 525, pl. IV, figs. 15, 16.
1969 Liliacidites sp. Norton and Hall, p. 36, pl. 5, fig. 3.

Discussion: The observed size range was 27 (29) 32 μ for the polar diameter of four specimens.

Suggested affinities: Monocotyledoneae?

Occurrence: Upper Campanian-Paleocene. Kirtland and Lewis Shales, uppermost Cretaceous and Nacimiento Formation, Paleocene, New Mexico (Anderson, 1960); Hell Creek Formation, Maestrichtian and Fort Union Formation, Paleocene, South Dakota (Stanley, 1965); Edmonton Formation, Maestrichtian, Alberta, Canada (Srivastava, 1966); Hell Creek Formation, Maestrichtian, Montana (Norton and Hall, 1969). This species occurs throughout the Almond Formation.

Genus Liliacidites Couper, 1953

Type species: Liliacidites kaitangataensis Couper, 1953

Liliacidites leei Anderson, 1960
Pl. 17, Fig. 96

- 1960 Liliacidites leei Anderson, p. 18, pl. 1, figs. 9-11; pl. 5, fig. 10; pl. 7, fig. 7; pl. 8, figs. 4, 5.

Discussion: The observed size range was 25 (35) 54 μ for 13 specimens.

Suggested affinities: Angiospermae

Occurrence: Upper Campanian-lower Paleocene. Kirtland Shale, Ojo Alamo Sandstone and Nacimiento Formation, uppermost Cretaceous-Paleocene, San Juan Basin, New Mexico (Anderson, 1960). This species occurs in the lower and upper Almond Formation.

Liliacidites complexus (Stanley) Leffingwell, 1971
Pl. 17, Figs. 97, 98

1965 Schizosporis complexus Stanley, p. 267, pl. 36, figs. 7-17.

1971 Liliacidites complexus (Stanley) Leffingwell, p. 41, pl. 7, figs. 3a, 3b.

Discussion: This species is thought to have a monosulcate aperture. The size range was 22 (37) 48μ for seven specimens.

Suggested affinities: Angiospermae. The complex exine serves to relate this species to the angiosperms.

Occurrence: Upper Campanian-Maestrichtian, Paleocene? Hell Creek Formation, Maestrichtian, South Dakota (Stanley, 1965). Fox Hills and Hell Creek Formations, Maestrichtian, Montana (Norton and Hall, 1967 and 1969), Edmonton Formation, Maestrichtian, Alberta, Canada (Snead, 1969); Bear Paw, Fox Hills and Hell Creek Formations, uppermost Cretaceous and lower Tullock Formation. Paleocene, Montana (Oltz, 1969), Lance Formation, Maestrichtian, Wyoming (Leffingwell, 1971). This species occurs in the upper Almond Formation.

Genus Tricolpopollenites Pflug and Thomson, 1953

Type species: Tricolpopollenites parmularius (Potonié) Thomson and Pflug, 1953

Tricolpopollenites sp. 1 Norton and Hall, 1969
Pl. 18, Figs. 99, 100

1969 Tricolpopollenites sp. 1 Norton and Hall, p. 49, pl. 7, fig. 15.

Discussion: The observed size range was 11 (12) 15μ in the polar diameter for three specimens and 9-12 μ for the equatorial diameter of two specimens.

Suggested affinities: Dicotyledonae

Occurrence: Upper Campanian-Maestrichtian. Bearpaw Shale, uppermost Cretaceous, Montana (Norton and Hall, 1969). This species occurs throughout the Almond Formation.

Tricolpopollenites microscabratus
Norton, 1969
Pl. 18, Fig. 101

1969 Tricolpopollenites microscabratus, Norton in Norton and Hall, p. 47, pl. 7, fig. 8.

Discussion: The observed size range was 16 (19) 22μ in the polar diameter for six specimens.

Suggested affinities: Dicotyledoneae

Occurrence: Upper Campanian-Maestrichtian. Hell Creek Formation, uppermost Cretaceous, Montana (Norton and Hall, 1969). This species occurs in the lower and upper Almond Formation.

Tricolpopollenites microreticulatus Norton, 1969
Pl. 18, Figs. 102, 103

1969 Tricolpopollenites microreticulatus Norton in Norton and Hall, p. 47, pl. 7, fig. 8.

1969 Tricolpopollenites tersus Oltz, p. 152, pl. 42, fig. 147.

Discussion: The observed size range was 12 (14) 16 μ for the polar axis as observed on six specimens and 10 (13) 17 μ for the equatorial axis as observed on nine specimens. The small size and microreticulate exine (lumina ca. 0.5 μ) distinguish this species. It closely resembles T. micromunus Groot and Penny, 1960, except in having a finer reticulum.

Suggested affinities: Dicotyledoneae

Occurrence: Upper Campanian-Paleocene. Hell Creek Formation, Maestrichtian, Montana (Norton and Hall, 1969); Tullock Formation, Paleocene, Montana (Oltz, 1969). This species occurs throughout the Almond Formation.

Tricolpopollenites clavireticulatus
Norton, 1969
Pl. 18, Figs. 104, 105

1969 Tricolpopollenites clavireticulatus Norton in Norton and Hall, p. 49, pl. 7, fig. 14.

1969 Salixipollenites sp. B Snead, p. 35, pl. 6, figs. 8, 9.

1969 Tricolpites sp. C Oltz, p. 159, pl. 42, fig. 138.

Discussion: This species is distinguished by a variable reticulum in which the lumina become larger at the equator between the colpi. The size range was 14 (18) 21 μ for the polar diameter of five specimens and 12 (13) 14 μ in the equatorial diameter for four specimens.

Suggested affinities: Salicaceae

Occurrence: Upper Campanian-Maestrichtian. Bearpaw, Fox Hills and Hell Creek Formations, uppermost Cretaceous, Montana (Norton and Hall, 1969); Hell Creek Formation, Maestrichtian, Montana, (Tricolpites sp. C)

(Oltz, 1969); Edmonton Formation, Maestrichtian (Snead, 1969). This species occurs in the lower and upper Almond Formation.

Tricolpopollenites deliclavatus

Oltz, 1969

Pl. 18, Fig. 106

1969 Tricolpopollenites deliclavatus Oltz, p. 151, pl. 42, fig. 140.

Discussion: The size range of this species was 16-17 μ for three specimens. The Upper Albian-Cenomanian species T. micromunus Groot and Penny, 1960 is comparable but slightly smaller (ca. 14 μ).

Suggested affinities: Dicotyledoneae

Occurrence: Upper Campanian-Maestrichtian. Hell Creek Formation, Maestrichtian, Montana (Oltz, 1969). This species occurs in the lower and upper Almond Formation.

Tricolpopollenites compactus Norton, 1969

Pl. 18, Fig. 107

1969 Tricolpopollenites compactus Norton in Norton and Hall, p. 47, pl. 7, fig. 9.

Discussion: The observed size range of the polar axis was 20 (24) 27 μ for six specimens.

Suggested affinities: Trochodendroceae?

Occurrence: Upper Campanian-Paleocene. Lebo Formation, Paleocene, Montana (Norton and Hall, 1969). This species occurs in the lower and upper Almond Formation.

Genus Tricolpites Cookson ex Couper, 1953

Type species: Tricolpites reticulatus Cookson, 1947

Tricolpites mutabilis Leffingwell, 1971

P. 18, Fig. 108

1964 "Tricolpopollenites" sp. Leopold and Pakiser, pl. 5, figs. 1, 2 (figs. 3-5 excluded).

1965 Tricolpites sp. Jardiné and Magloire, p. 214, pl. X, figs. 9, 10, 13, 14 (figs. 8, 11, 12 excluded).

1971 Tricolpites mutabilis Leffingwell, p. 44, pl. 8, figs. 1-3.

Description: The pollen are rounded triangular, with convex sides, and oblate. The three colpi extend into the grain for 3/4 of the radius as seen in polar view and divide the grain into distinct lobes.

The exine is about 1μ in thickness, psilate to microgranulate (scabrate or infraonctué). The granules are less than $.5\mu$ in size. The size range is 12 (15) 20μ as observed on nine specimens.

Discussion: Stanley (1965, p. 320) lists the synonymy of the genus. Descriptions or sizes are not provided for the specimens listed as "Tricolpopollenites" by Leopold and Pakiser (1964), but they appear to be conspecific from the photographs. Tricolpites mutabilis is conspecific with T. sp. of Jardiné and Maglorie (1965). The psilate-scabrate exine of T. mutabilis distinguishes it from the reticulate species of the genus. T. pachyexinus Couper, 1953 is a psilate species, but it has a thicker exine and a large size ($26-40\mu$).

Suggested affinities: Angiospermae, Dicotyledoneae

Occurrence: Cenomanian-Paleocene. Tuscaloosa Group, Cenomanian-Turonian, Alabama (Leopold and Pakiser, 1964); Turonian?-Lower Senonian, Sénégal and Côte-d'Ivoire (Jardiné and Magloire, 1965), (the Senonian as used by Jardiné and Magloire excludes the Maestrichtian); Lance Formation, Maestrichtian and Fort Union Formation, Paleocene, Wyoming (Leffingwell, 1971). This species occurs throughout the Almond Formation.

Tricolpites psilascabratus Norton, 1969
Pl. 18, Figs. 109, 110

1969 Tricolpites psilascabratus Norton in Norton and Hall, p. 45, pl. 7, fig. 3.

Discussion: The observed size range was 19 (23) 27μ for the equatorial diameter of four specimens and $23-24\mu$ for the polar diameter of two specimens.

Suggested affinities: Dicotyledoneae

Occurrence: Upper Campanian-Paleocene. Hell Creek Formation, Maestrichtian and Fort Union Formation, Paleocene, Montana (Norton and Hall, 1969); Fox Hills and Hell Creek Formations, Maestrichtian and Tullock Formation, Paleocene, Montana (Oltz, 1969). This species occurs throughout the Almond Formation.

Tricolpites lillei Couper, 1953
Pl. 18, Fig. 111

1953 Tricolpites lillei Couper, p. 62, pl. 8, figs. 116, 117.

Discussion: The observed size range was 26-27 μ for the equatorial diameter of two specimens.

Suggested affinities: Ranunculaceae

Occurrence: Cretaceous-Paleocene. Cretaceous, New Zealand (Couper, 1953); Lebo Formation, Paleocene, Montana (Norton and Hall, 1969). This species is rare in the lower and upper Almond Formation.

Tricolpites reticulatus Cookson, 1947
Pl. 18, Fig. 112

1947 Tricolpites reticulatus Cookson, p. 134, pl. XV, fig. 45.

1954 Gunnerites reticulatus Cookson, in Cookson and Pike, p. 201, pl. 1, figs. 18, 19.

1965 Tricolpites interangulus Newman, p. 10, pl. 1, fig. 3.

1971 Gunnera microreticulata (Belsky, Botenhagen and Potonié) Leffingwell, p. 37, pl. 6, figs. 7, 8.

Discussion: Specimens from the Almond Formation are gradational in shape from circular to subcircular with slight convexity between the colpi. The latter condition does not seem to warrant the separate species, T. interangulus. The observed size range was 20 (26) 30 μ for 12 specimens.

Suggested affinities: Haloragaceae, Gunnera

Occurrence: Campanian-Tertiary. Tertiary, Kerguelen, (Cookson, 1947); Tertiary, New Guinea and Australia (Cookson and Pike, 1954); upper Mancos, Mesaverde, Iles and Williams Fork Formations, Campanian and Lewis Formation, Maestrichtian, Colorado (Newman, 1965); Edmonton Formation, Maestrichtian, Alberta, Canada (Srivastava, 1966); Hell Creek Formation, Maestrichtian, Montana (Norton and Hall, 1967, 1969 and Oltz, 1969); Lance Formation, Maestrichtian, Wyoming, (Leffingwell, 1971). This species occurs in the lower and upper Almond Formation.

Tricolpites bathyreticulatus Stanley, 1965
Pl. 18, Fig. 113

1965 Tricolpites bathyreticulatus Stanley, p. 320, pl. 47, figs. 18-23.

1969 Salixipollenites sp. Snead, p. 34, pl. 1, fig. 8.

Discussion: The observed size range was 21 (23) 26 μ for six specimens.

Suggested affinities: Dycotyledoneae

Occurrence: Upper Campanian-Paleocene. Fort Union Formation, Paleocene, South Dakota (Stanley, 1965); Tullock and Lebo Formations, Paleocene,

Montana (Norton and Hall, 1967, 1969); Teurian, Paleocene, New Zealand, (McIntyre, 1968); Edmonton Formation, Maestrichtian, Alberta, Canada (Snead, 1969); Tullock Formation, Paleocene, Montana (Oltz, 1969); Fort Union Formation, Paleocene, Wyoming (Leffingwell, 1971). This species occurs in the lower and upper Almond Formation.

Tricolpites cf. T. anguloluminosus Anderson, 1960
Pl. 18, Fig. 114, 115

1960 Tricolpites anguloluminosus Anderson, p. 26, pl. 6, figs. 15-17; pl. 8, figs. 17, 18.

Discussion: The specimens from the Almond Formation have slightly coarser muri (1μ) in comparison to Anderson's specimens (0.5μ), but they compare favorably in the height of the muri (1.5μ) and the width (ca. 2μ) of the angular lumina. The size range of the polar axis of two specimens was $39-43\mu$ and the equatorial axis of a third specimen was 37μ .

Suggested affinities: Angiospermae, Dicotyledoneae

Occurrence: Upper Campanian-lower Paleocene. Ojo Alamo Sandstone and Nacimiento Formation, lower Paleocene, San Juan Basin, New Mexico (Anderson, 1960); Fort Union Formation, Paleocene, Wyoming (Leffingwell, 1971). This species occurs in the lower and upper Almond Formation.

Genus Fraxinopollenites Potonié, 1960

Type species: Fraxinopollenites pudicus (Potonié) Potonié, 1960

Fraxinopollenites variabilis Stanley, 1965
Pl. 18, Figs. 116, 117

1965 Fraxinopollenites variabilis Stanley, p. 306, pl. 45, figs. 29-35.

Discussion: The observed size range was 18 (20) 27μ for the polar diameter of 12 specimens and 18 (19) 21μ for the equatorial diameter of five specimens.

Suggested affinities: Oleaceae, Fraxinus?

Occurrence: Upper Campanian-Paleocene. Fort Union Formation, Paleocene, South Dakota (Stanley, 1965); Fort Union Formation, Paleocene, Wyoming (Leffingwell, 1971). This species occurs throughout the Almond Formation.

Genus Cranwellia Srivastava, 1966

Type species: Cranwellia striata (Couper) Srivastava, 1966

Cranwellia rumseyensis Srivastava, 1966

Pl. 18, Figs. 118, 119

1966 Cranwellia rumseyensis Srivastava, p. 538, pl. 11, figs. 3, 7.

Discussion: "C. rumseyensis differs from C. striata in having very inconspicuous or no pore chambers, slightly straight to convex sides, bluntly rounded equatorial arms, less pronounced striations in the polar area" (Srivastava, 1966). The observed size range was 22 (27) 38 μ for the equatorial diameter of seven specimens.

Suggested affinities: Loranthaceae, Elytranthe

Occurrence: Upper Campanian-Maestrichtian. Edmonton Formation, Maestrichtian, Alberta, Canada (Srivastava, 1966 and Snead, 1969). This species occurs in the lower and upper Almond Formation.

Genus Pistillipollenites Rouse, 1962

Type species: Pistillipollenites mcgregorii Rouse, 1962

Pistillipollenites sp. A

Pl. 18, Figs. 120, 121

1963 Pistillipollenites? sp. Clarke, p. 100, pl. 11, figs. 18, 19.

Diagnosis: This species is distinguished by its closely spaced gemmate ornamentation.

Description: The pollen grains are subcircular when seen in polar view and elliptical in equatorial view. The exact nature of the apertures is uncertain. Three equatorially positioned indentations which are elongate parallel to the polar axis are interpreted as colpi. These are best seen in Pl. 18, Fig. 120. The colpi are closed in equatorial view. The gemmate ornamentation is closely spaced. The gemmae are slightly bulbose at the apex, and they are approximately 1.5 μ wide and approximately 2 μ high. The size range was 21 (24) 28 μ for nine specimens. The polar diameter is approximately the same as the equatorial diameter.

Holotype: Pl. 18, Fig. 120. Slide No. 1649-3, Coor. 27.7-122.8, Collection No. 66W133, Section 8, Almond Formation, late Campanian, Sec. 12, T19N, R101W, Sweetwater County, Wyoming.

Discussion: Pistillipollenites sp. A is conspecific with P.? sp. of Clarke (1963). It has a closely spaced gemmate ornamentation and is distinct from P. mcgregorii Rouse (1962) which has a widely spaced gemmate ornamentation. Drugg (1967, p. 50) identified a comparable species as

Illexpollenites sp., but it is somewhat larger (48μ). I. megagemmatus McIntyre, 1968 is similar, but it has large gemmae ($3-4\mu$ in height and width).

Suggested affinities: Gentianaceae, Rusbyanthus. This species agrees well with Rusbyanthus cinchonifolius as illustrated and described by Erdtman (1952, p. 185). Drugg (1967) referred his species to the Aquifoliaceae.

Occurrence: Upper Campanian-Maestrichtian. Vermejo Formation, Maestrichtian, Colorado (Clarke, 1963). The species occurs in the lower and upper Almond Formation.

Genus Ericaceoipollenites Potonié, 1960

Type species: Ericaceoipollenites roboreus (Potonié) Potonié, 1960

Ericaceoipollenites rallus Stanley, 1965
Pl. 18, Fig. 122

1965 Ericaceoipollenites rallus Stanley, p. 296, pl. 44, figs. 15-18.

Discussion: All specimens appear to be weathered. Stanley (1965) describes the species as scabrate with partially pitted exines. Specimens from the Almond are best described as reticulate but agree in other characters. The observed size range was $23 (29) 37\mu$ for 13 specimens.

Suggested affinities: Ericaceae, Kalmia?

Occurrence: Upper Campanian-Paleocene. Fort Union Formation, Paleocene, South Dakota (Stanley, 1965). This species occurs throughout the Almond Formation.

Genus Aquilapollenites Rouse emend.
Funkhouser, 1961

Type species: Aquilapollenites quadrilobus Rouse, 1957

Aquilapollenites polaris Funkhouser, 1961
Pl. 19, Figs. 123, 124

1961 Aquilapollenites polaris Funkhouser, p. 198, pl. 1, figs. 1, 2.

Discussion: The observed size range of the polar axis was $23 (38) 52\mu$ for 17 specimens.

Suggested affinities: Angiospermae

Occurrence: Upper Campanian-Maestrichtian. Lance Formation, Maestrichtian, Wyoming (Funkhouser, 1961); Hell Creek Formation, Maestrichtian, Montana, (Norton, 1965 and Norton and Hall, 1969); Edmonton Formation,

Maestrichtian, Alberta, Canada (Srivastava, 1966 and Snead, 1969). This species occurs throughout the Almond Formation.

Aquilapollenites pulcher Funkhouser, 1961
Pl. 19, Fig. 125

1961 Aquilapollenites pulcher Funkhouser, p. 198, pl. 1, fig. 7.

Discussion: The observed size range of the polar axis was 26 (30) 35 μ for three specimens.

Suggested affinities: Angiospermae

Occurrence: Upper Campanian-Maestrichtian. Lance Formation, Maestrichtian, Wyoming (Funkhouser, 1961). This species occurs in the lower and upper Almond Formation.

Aquilapollenites striatus Funkhouser, 1961
Pl. 19, Fig. 126

1961 Aquilapollenites striatus Funkhouser, p. 196, pl. 2, fig. 4.

Discussion: The size range of the polar axis was 27-43 μ on two specimens.

Suggested affinities: Angiospermae

Occurrence: Upper Campanian-Maestrichtian. Lance Formation, Maestrichtian, Wyoming (Funkhouser, 1961). This species occurs in the lower and upper Almond Formation.

Aquilapollenites reticulatus Stanley, 1965
Pl. 19, Fig. 127

1965 Aquilapollenites reticulatus Stanley, p. 348, pl. 8, figs. 1-12.

Discussion: The reticulate exine of the body and the striate exine of the protrusions serve to distinguish this species. The size was 56 μ for the polar axis of the single specimen observed.

Suggested affinities: Angiospermae

Occurrence: Upper Campanian-Maestrichtian. Hell Creek Formation, Maestrichtian, South Dakota (Stanley, 1961, 1965); Hell Creek Formation, Maestrichtian, Montana (Norton, 1965; Norton and Hall, 1969; Oltz, 1969); Edmonton Formation, Maestrichtian, Alberta, Canada (Snead, 1969). This species occurs only in Sample 66W237, Section 14, of the upper Almond Formation.

Genus Cupuliferoipollenites Potonié, 1951

Type species: Cupuliferoipollenites pusillus (Potonié) Potonié, 1951

Cupuliferoipollenites pusillus (Potonié)

Potonié, 1951

Pl. 19, Figs. 128, 129

1934 Pollenites quisqualis forma pusillus Potonié, p. 71, pl. 3, fig. 21.1951 Cupuliferoipollenites pusillus (Potonié) Potonié, p. 150, pl. 20, fig. 69.

Discussion: The observed size range was 13 (16) 20 μ for the polar dimension of six specimens.

Suggested affinities: Fagaceae, Castanea

Occurrence: Upper Campanian-Miocene. Brightseat Formation, Paleocene, Maryland (Groot and Groot, 1962); Upper Moreno Formation, Danian, California (Drugg, 1969); Edmonton Formation, Maestrichtian, Alberta, Canada (Snead, 1969). This species occurs in the lower and upper Almond Formation.

Genus Tricolporopollenites Thomson and Pflug, 1953

Type species: Tricolporopollenites dolium (Potonié) Thomson and Pflug, 1953

Tricolporopollenites affluens (Stanley) n. comb.

Pl. 19, Fig. 130

1962 Tricolporopollenites sp. Rouse, p. 216, pl. 5, fig. 1.1965 Vitis? affluens Stanley, p. 311, pl. 46, figs. 18-21.1969 Vitis sp. cf. V.? affluens Snead, p. 29, pl. 7, figs. 8, 9.1969 Tricolpites abatus Oltz, p. 147, pl. 41, fig. 123.

Discussion: The description of this species remains as designated by Stanley. The porate nature is not obvious on all individuals. The colpi are open only at the equator and not for their entire depth as seen in the polar view. The subtriangular shape is definitive. An equatorial orientation has not been observed. The size range of the Almond Formation specimens was 14 (17) 24 μ for seven specimens.

Suggested affinities: Vitaceae, Vitis

Occurrence: Upper Campanian-Eocene. Terminal Dock Locality, Burrard Formation, Eocene, British Columbia, Canada (Rouse, 1962); Ludlow Member, Fort Union Formation, Paleocene, South Dakota (Stanley, 1965); Edmonton Formation, Maestrichtian, Alberta, Canada (Snead, 1969); Tullock Formation, Fort Union Group, Paleocene, Montana (Oltz, 1969). This species occurs in the lower and upper Almond Formation.

Genus Cupanieidites Cookson and Pike, 1954

Type species: Cupanieidites orthoteichus Cookson and Pike, 1954

Cupanieidites major Cookson and Pike, 1954
Pl. 20, Figs. 131, 132

1954 Cupanieidites major Cookson and Pike, p. 213, pl. 2, figs. 83-85.

1965 Cupanieidites speciosus Stanley, p. 309, pl. 46, figs. 12-17.

1966 Cupanieidites sp. Srivastava, p. 533, pl. VII, fig. 20.

1971 Cupanieidites inaequalis Leffingwell, p. 49, pl. 9, figs. 5, 9, 10.

Discussion: C. speciosus (18-25 μ) is apparently identical to C. major, 29-35 μ (Cookson and Pike, 1954) and 25-35 μ (Norton and Hall, 1969), except for its slightly smaller size. The observed size range of nine specimens from the Almond Formation was 17 (21) 24 μ . This species exhibits a tricolporate aperture with the colpi uniting at the poles. The morphological term "syncolporate" is preferred to describe this condition. It is analogous to the term "syncolpate".

Suggested affinities: Sapindaceae, Cupanieae

Occurrence: Upper Campanian-Eocene. Eocene, Victoria, Australia, (C. major) (Cookson and Pike, 1954); Hell Creek Formation, Maestrichtian, South Dakota (Stanley, 1965); Edmonton Formation, Maestrichtian, Alberta, Canada, (C. sp.) (Srivastava, 1966); upper Moreno Formation, Maestrichtian-Danian, California, (C. major) (Drugg, 1967); Hell Creek Formation, Maestrichtian and Tullock Formation, Paleocene, Montana, (C. major) (Norton and Hall, 1969); Hell Creek Formation, Maestrichtian, Montana (Oltz, 1969); Lance Formation, Maestrichtian and Tullock Member, Fort Union Formation Paleocene, Wyoming (Leffingwell, 1971). This species occurs in the lower and upper Almond Formation.

Genus Engelhardtoidites Potonié,
Thomson and Thiergart, 1950

Type species: Engelhardtoidites microcoryphaeus (Potonié) Potonié,
Thomson and Thiergart, 1950

Engelhardtoidites minutus Newman, 1965
Pl. 20, Fig. 133

1965 Engelhardtoidites minutus Newman, p. 13, pl. 1, fig. 8.

Discussion: The size range was 10 (13) 14 μ for 11 specimens.

Suggested affinities: Angiospermae

Occurrence: Campanian-Maestrichtian. Upper Mesaverde, lower Wasatch, Williams Fork, Lewis and Lance Formations, Campanian, Maestrichtian, Colorado (Newman, 1965). This species occurs in the lower and upper Almond Formation.

Genus Triporopollenites Pflug ex Thompson
and Pflug, 1953

Type species: Triporopollenites coryloides Pflug in Thompson and Pflug, 1953

Triporopollenites sp. B Clarke, 1963
Pl. 20, Fig. 134

1963 Triporopollenites sp. B Clarke, p. 94, pl. 11, figs. 5, 6.

Discussion: The observed size range was 25 (28) 32 μ for eight specimens.

Suggested affinities: Betulaceae

Occurrence: Upper Campanian-Maestrichtian. Vermejo Formation, Maestrichtian, Colorado (Clarke, 1963). This species occurs in the lower and upper Almond Formation.

Triporopollenites rugatus Newman, 1965
Pl. 20, Fig. 135

1964 Caryapollenites sp. Newman, pl. 1, fig. 16.

1965 Triporopollenites rugatus Newman, p. 12, pl. 1, fig. 7.

Discussion: The observed size range was 19 (26) 32 μ for 10 specimens.

Caryapollenites scabratus Groot and Groot of Snead (1969) may be conspecific.

Suggested affinities: Juglandaceae, Engelhardtia (Norton and Hall, 1969).

Occurrence: Upper Campanian-Paleocene. Wasatch and Fort Union Formations, Paleocene, Colorado (Newman, 1965); Hell Creek Formation, Maestrichtian, Montana (Norton and Hall, 1967, 1969). This species occurs in the lower and upper Almond Formation.

Genus Conclavipollis Pflug, 1953

Type species: Conclavipollis anulopyramis Pflug, 1953.

Conclavipollis wolfcreekensis Newman, 1965
Pl. 20, Fig. 136

1965 Conclavipollis wolfcreekensis Newman, p. 13, pl. 1, fig. 10.

Discussion: The observed size range was 18 (21) 26 μ for five specimens.

Suggested affinities: Angiospermae, Dicotyledoneae

Occurrence: Campanian. Upper Mancos, lower Mesaverde, Iles and lower Williams Fork formations, Campanian, Colorado (Newman, 1965). This species occurs in the upper Almond Formation.

Genus Sporopollis Pflug, 1953

Type species: Sporopollis documentum Pflug, 1953

Sporopollis cf. S. laqueaeformis Weyland
and Greifeld, 1953
Pl. 20, Fig. 137

1953 Sporopollis laqueaeformis Weyland and Greifeld, p. 45, pl. 13, figs. 111, 112.

Discussion: The size of the single specimen observed was 20 μ . It seems to be identical with S. laqueaeformis as used by Newman (1965); however, Weyland and Greifeld's specimens have more strongly protruding pores.

Suggested affinities: Angiospermae, Dicotyledoneae

Occurrence: Upper Cretaceous. Mancos, Mesaverde, Iles and Williams Fork formations, Campanian, Colorado (Newman, 1965). This species occurred only in Sample 66W218 of Section 14 of the upper Almond Formation.

Genus Plicapollis Pflug, 1953

Type species: Plicapollis sarta Pflug, 1953

Plicapollis sp.
Pl. 20, Fig. 138

Discussion: Two specimens were observed, 24 μ and 26 μ in size. They were not identified as to species but appear to belong in the genus Plicapollis and somewhat resemble P. conserta Pflug, 1953.

Suggested affinities: Angiospermae, Dicotyledoneae

Occurrence: Upper Campanian. This species occurred only in Sample 66W129 of Section 8 and Sample 66W241 of Section 4 of the lower and upper Almond respectively.

Genus Trudopollis Pflug, 1953Type species: Trudopollis pertrudens (Pflug) Pflug, 1953Trudopollis meekeri Newman, 1965
Pl. 20, Figs. 139a, 139b1965 Trudopollis meekeri Newman, p. 14, pl. 1, fig. 12.Discussion: The observed size range was 25 (28) 32 μ for three specimens.Suggested affinities: Angiospermae, Dicotyledoneae.Occurrence: Campanian. Mancos Shale, Mesaverde, Iles and Williams Fork formations, Campanian, Colorado (Newman, 1965). This species occurs in the upper Almond Formation.Genus Proteacidites Cookson ex Couper, 1953Type species: Proteacidites adenanthoides Cookson, 1950Proteacidites retusus Anderson, 1960
Pl. 20, Figs. 140, 141, 1421960 Proteacidites retusus Anderson, p. 21, pl. 2, figs. 5-7.Discussion: This species is distinguished from P. thalmani on the basis of its pores which appear circular in polar view; whereas, those of P. thalmani are notch-like in polar view. The two species probably represent end members of a continuum of pore shapes. Individuals which conform in size, ornament and pore shape but which have thinner annuli are included in this species (Pl. 20, Fig. 141). Even though Anderson's description specifies a thick endannulus there does not seem to be sufficient difference to warrant a new species. The observed size range was 18 (27) 34 μ for 18 specimens.Suggested affinities: ProteaceaeOccurrence: Upper Campanian-Danian. Kirtland Shale, uppermost Cretaceous, San Juan Basin, New Mexico (Anderson, 1960); Hell Creek Formation, uppermost Cretaceous, South Dakota (Stanley, 1965); upper Moreno Formation, Maestrichtian-Danian, California (Drugg, 1967). This species occurs throughout the Almond Formation.Proteacidites thalmani Anderson, 1960
Pl. 20, Figs. 143, 1441960 Proteacidites thalmani Anderson, p. 21, pl. 2, figs. 1-4, pl. 10, figs. 9-13.

1962 Proteacidites terrazus Rouse, p. 205, pl. 2, figs. 20-22.

1966 Proteacidites thalmanni var. major Srivastava, p. 536, pl. VII, fig. 7.

Discussion: This species is distinguished on the basis of its pores which are a shallow notch-like "V" shape in polar view and are not circular as in P. retusus. The observed size range was 19 (26) 35 μ for 10 specimens. Published sizes vary from 17-54 μ .

Suggested affinities: Proteaceae

Occurrence: Upper Campanian-Danian. Kirtland Shale and Lewis Shale, uppermost Cretaceous, San Juan Basin, New Mexico (Anderson, 1960); Burrard Formation (Brothers Creek Locality), Upper Cretaceous, Vancouver, British Columbia, (P. terrazus), (Rouse, 1962); Mt. Laurel-Navesink Formation, Woodbury Clay and Merchantville Formation, Senonian, Delaware and New Jersey (Gray and Groot, 1966); upper Edmonton Formation, Maestrichtian, Scollard, Alberta, (P. thalmanni var. major), (Srivastava, 1966); upper Moreno Formation, Maestrichtian-Danian, California (Drugg, 1967). Campanian and Turonian occurrences have been indicated for the genus Proteacidites by Tschudy (1965) and Orlansky (1968); Fox Hills and Hell Creek formations, Maestrichtian and Tullock Formation, Paleocene, Montana (Oltz, 1969). This species occurs throughout the Almond Formation.

Genus Ulmipollenites Wolff, 1934

Type species: Ulmipollenites undulosus Wolff, 1934

Ulmipollenites sp. A
Pl. 20, Figs. 145, 146

Diagnosis: The granulate exine and the absence of arci distinguish this species.

Description: The grains are rounded-triangular to subcircular in shape. The three or four pores are equatorial, circular in outline and about 2.5 μ in diameter. The annuli are very slightly developed and about 2 μ in width. Arci were not observed. The exine is about 1.5 μ in thickness and ornamented with circular granules 1.5-2 μ in diameter. The observed size range was 18 (22) 25 μ for seven specimens.

Holotype: Pl. 20, Fig. 145. Slide No. 3055 AVII, Coor. 40.5-113.5,

Collection No. 66W250, Section 14, Almond Formation, Late Campanian, Sec. 36, T20N, R101W and Sec. 31, T20N, R100W, Sweetwater County, Wyoming.

Discussion: This species may be conspecific with Ulmipollenites undulosus Wolff, 1934, as used Norton and Hall (1969). U. sp. A was not included in that species because U. sp. A lacks distinct arci and its ornamentation is not considered to be rugulate. Triporate individuals were observed most often.

Suggested affinities: Ulmaceae?, Zelkova?

Occurrence: Upper Campanian-Paleocene. Lance Formation, Maestrichtian and Fort Union Formation, Paleocene, Wyoming (Leffingwell, 1971). This species occurs in the lower and upper Almond Formation.

Genus Alnipollenites Potonié 1931

Type species: Alnipollenites verus (Potonié) Potonié, 1934

Alnipollenites quadrapollenites (Rouse)

Srivastava, 1966

Pl. 20, Fig. 147

1962 Alnus quadrapollenites Rouse, p. 202, pl. 2, figs. 9, 36.

1966 Alnipollenites quadrapollenites (Rouse) Srivastava, p. 530, pl. VII, fig. 3.

Discussion: The size range was 21 (25) 30 μ for the three specimens measured. A specimen of Alnus trina Stanley, 1965, (Pl. 43, fig. 6) is comparable but smaller (range 13-19 μ).

Suggested affinities: Betulaceae, Alnus

Occurrence: Upper Campanian-Eocene. Burrard Formation, Eocene (in part?), British Columbia, Canada (Rouse, 1962); Edmonton Formation, Maestrichtian, Alberta, Canada (Srivastava, 1966). This species occurs in the lower and upper Almond Formation.

Genus Erdtmanipollis Krutzsch, 1962

Type species: Erdtmanipollis pachysandroides Krutzsch, 1962

Erdtmanipollis pachysandroides Krutzsch, 1962

Pl. 20, Figs. 148, 149a, 149b, 150

1962 Erdtmanipollis pachysandroides Krutzsch, p. 281, pl. 8, figs. 1-8.

1965 Pachysandra cretacea Stanley, p. 294, pl. 44, figs. 1-9.

1969 Erdtmanipollis cretaceous (Stanley) Norton in Norton and Hall, p. 43, pl. 5, figs. 21.

1969 Erdtmanipollis cretacea (Stanley) Oltz, p. 140, pl. 41, fig. 100.

Discussion: The size variation of P. cretacea, 20-40 μ , (Stanley, 1965) is not considered sufficient basis for its separation from E. pachysandroides, 25-35 μ , (Krutzsch, 1962). This contention was advanced by Snead (1969). Specimens with the ectexine removed were common. The observed size range was 29 (34) 40 μ for eight specimens.

Suggested affinities: Buxaceae, Pachysandra or Sarcococca

Occurrence: Upper Campanian-Oligocene. Oligocene, Germany (Krutzsch, 1962); Hell Creek Formation, Maestrichtian and Ludlow Member, Fort Union Formation, Paleocene, South Dakota (Stanley, 1965); upper Moreno Formation, Maestrichtian-Danian, California (Drugg, 1967); Bearpaw, Fox Hills and Hell Creek formations, Uppermost Cretaceous and Tullock Formation, Paleocene, Montana (Norton and Hall, 1969); Edmonton Formation, Maestrichtian, Alberta, Canada (Snead, 1969); Bearpaw, Fox Hills and Hell Creek formations, Uppermost Cretaceous, Montana (Oltz, 1969). This species occurs throughout the Almond Formation.

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APPENDIX

Figure 18

RELATIVE ABUNDANCE OF SELECTED
NONMARINE SPECIES OF THE
TOTAL NONMARINE SPECIES

Measured Section 8
Upper Almond Formation

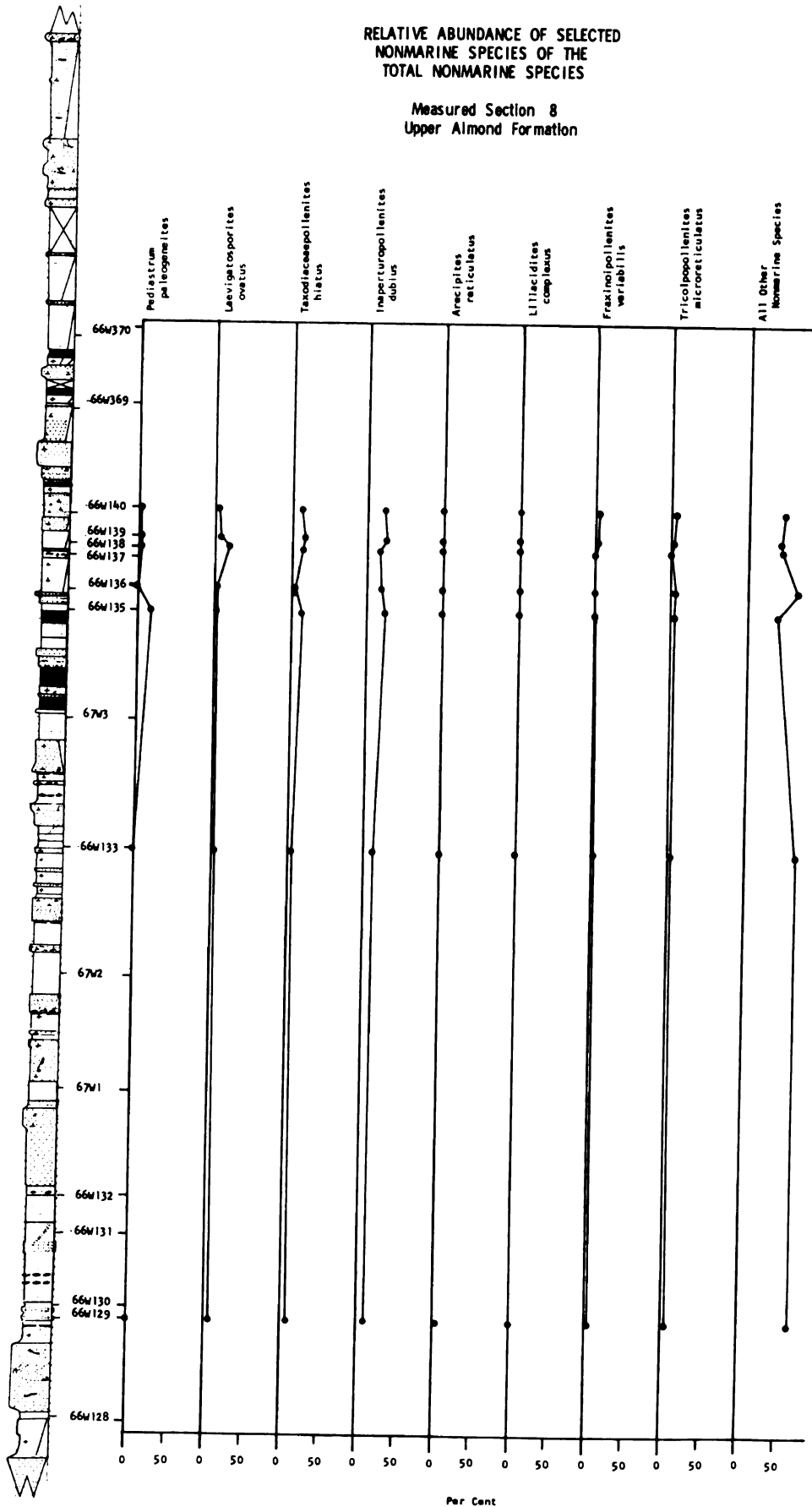


Figure 19

RELATIVE ABUNDANCE OF
MAJOR PALYNOMORPH GROUPS

Measured Section 8
Lower Almond Formation

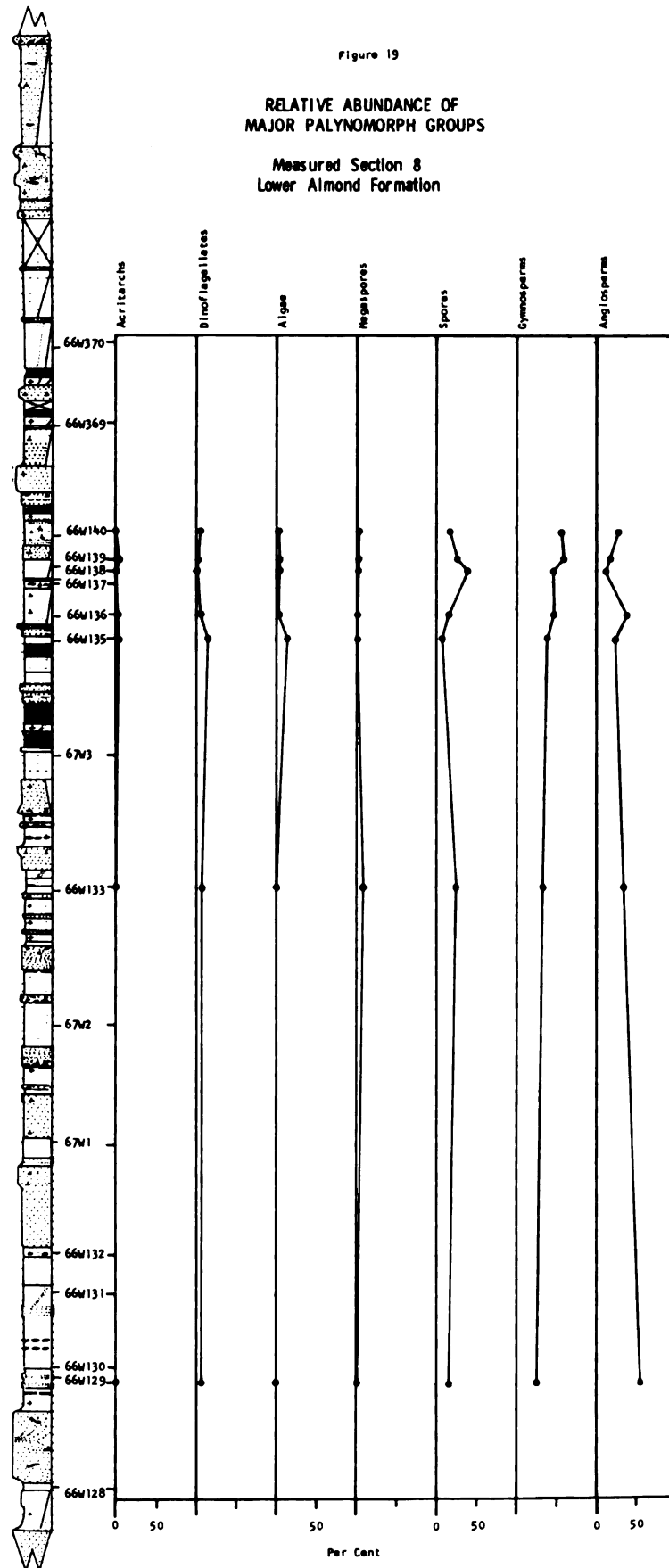


Figure 20

RELATIVE ABUNDANCE OF SELECTED
NONMARINE SPECIES OF THE
TOTAL NONMARINE SPECIES

Measured Section 4
Upper Almond Formation

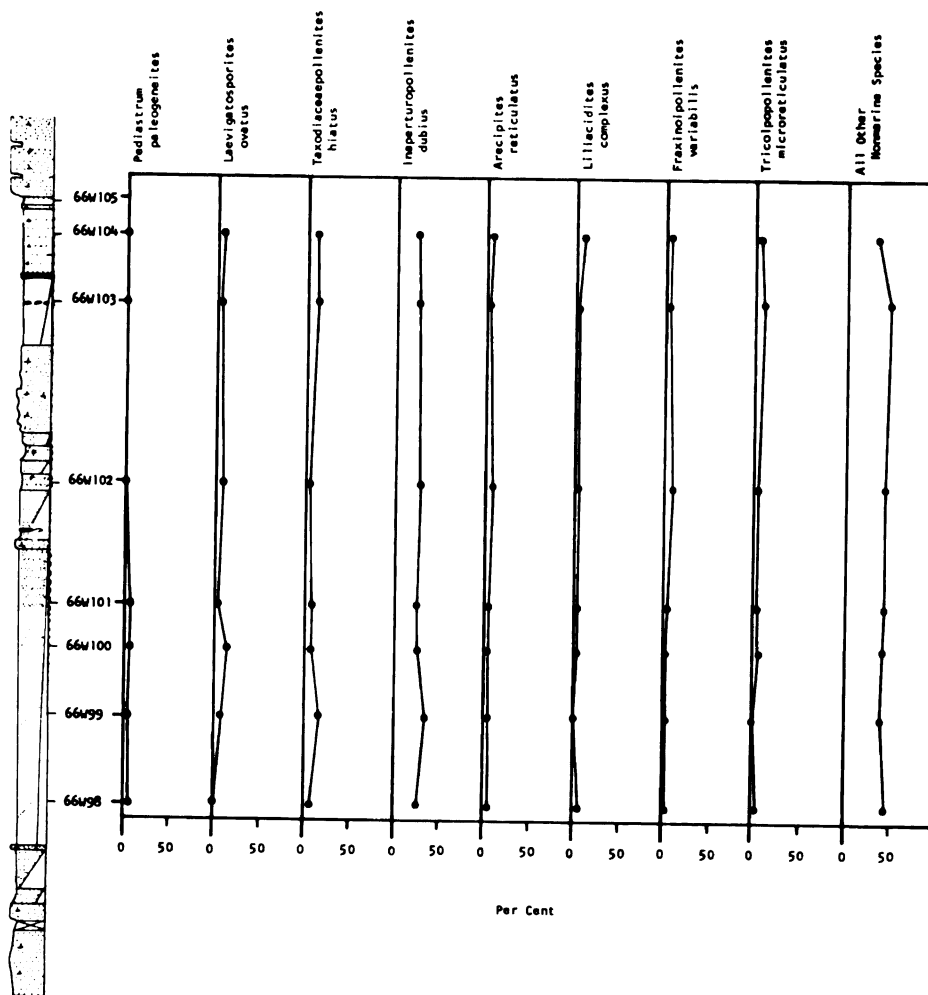
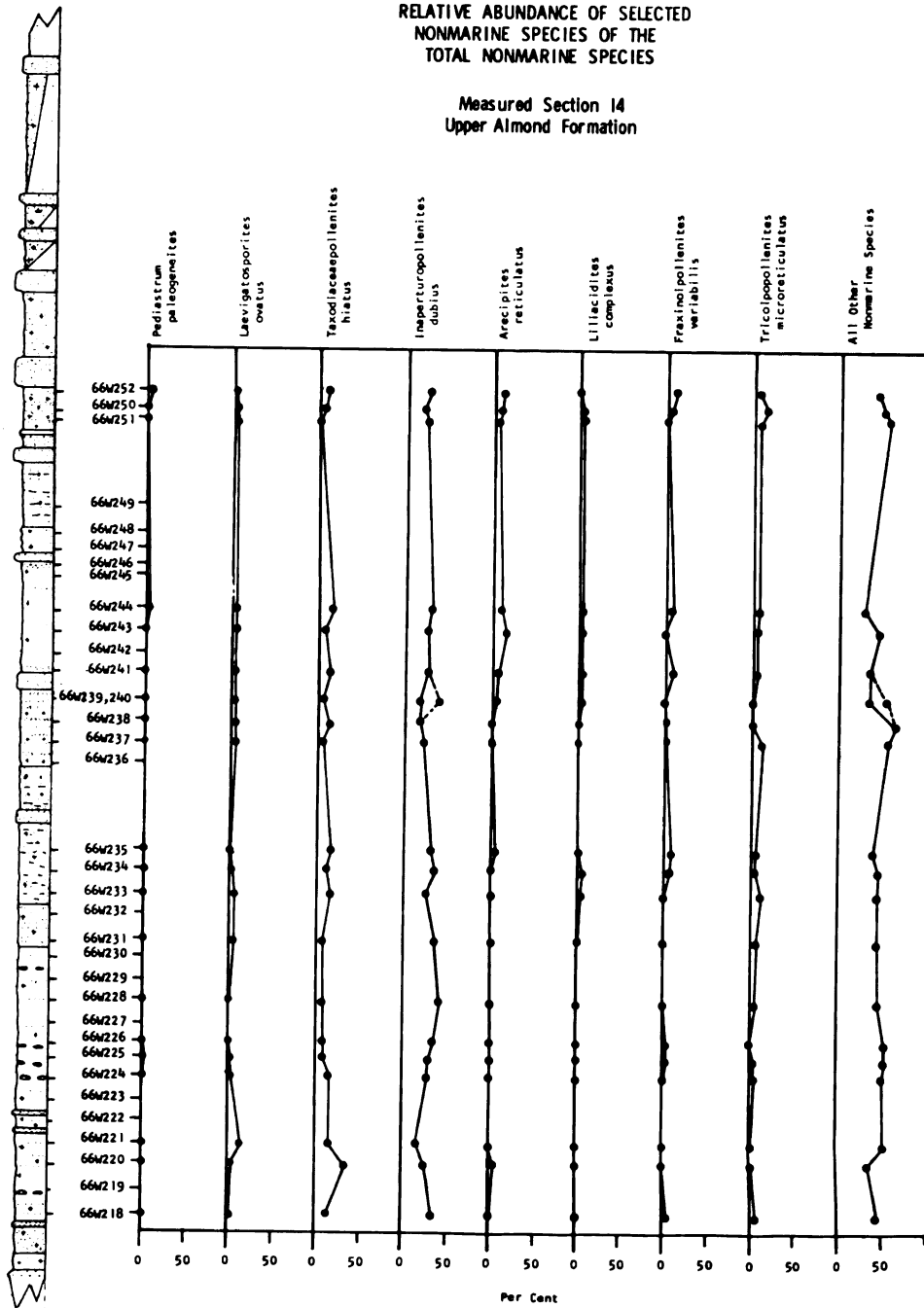


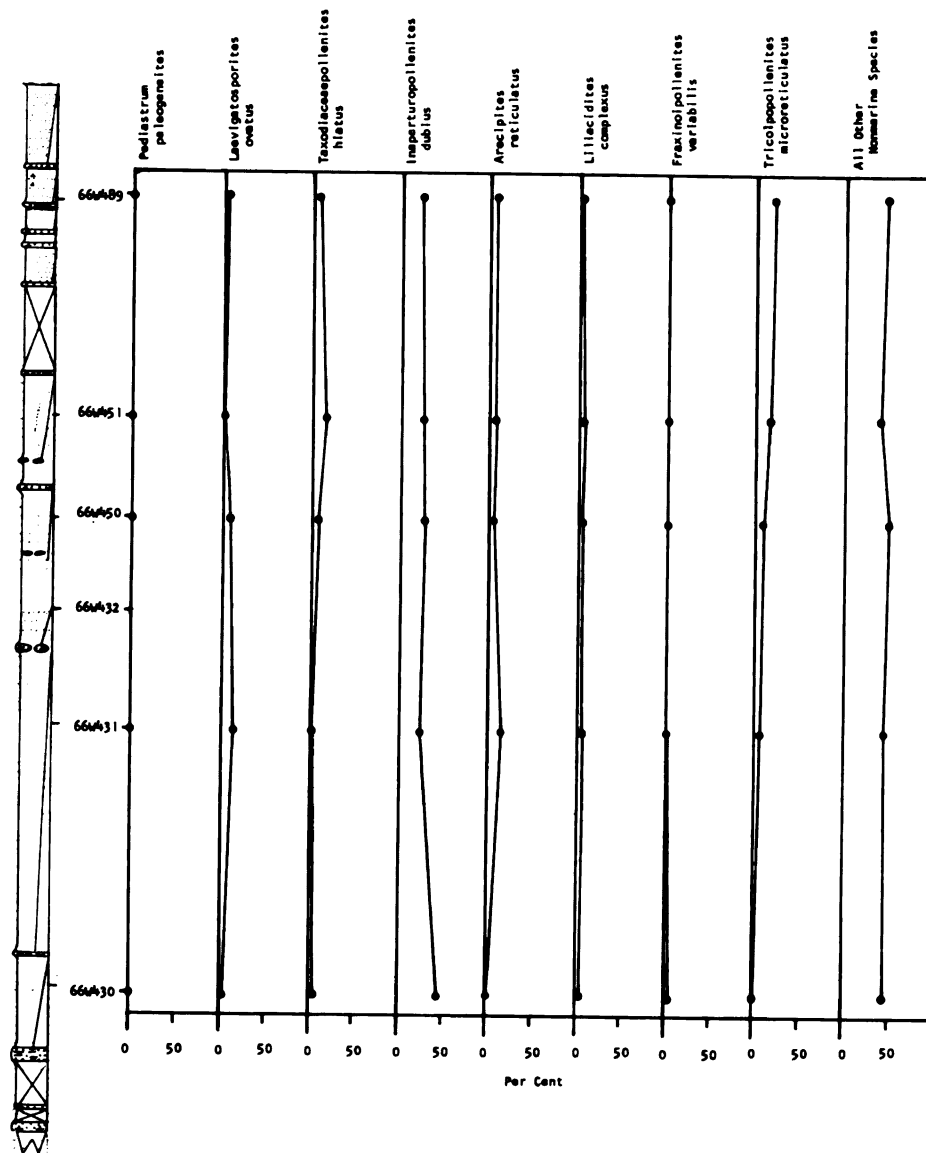
Figure 21

RELATIVE ABUNDANCE OF SELECTED
NONMARINE SPECIES OF THE
TOTAL NONMARINE SPECIES

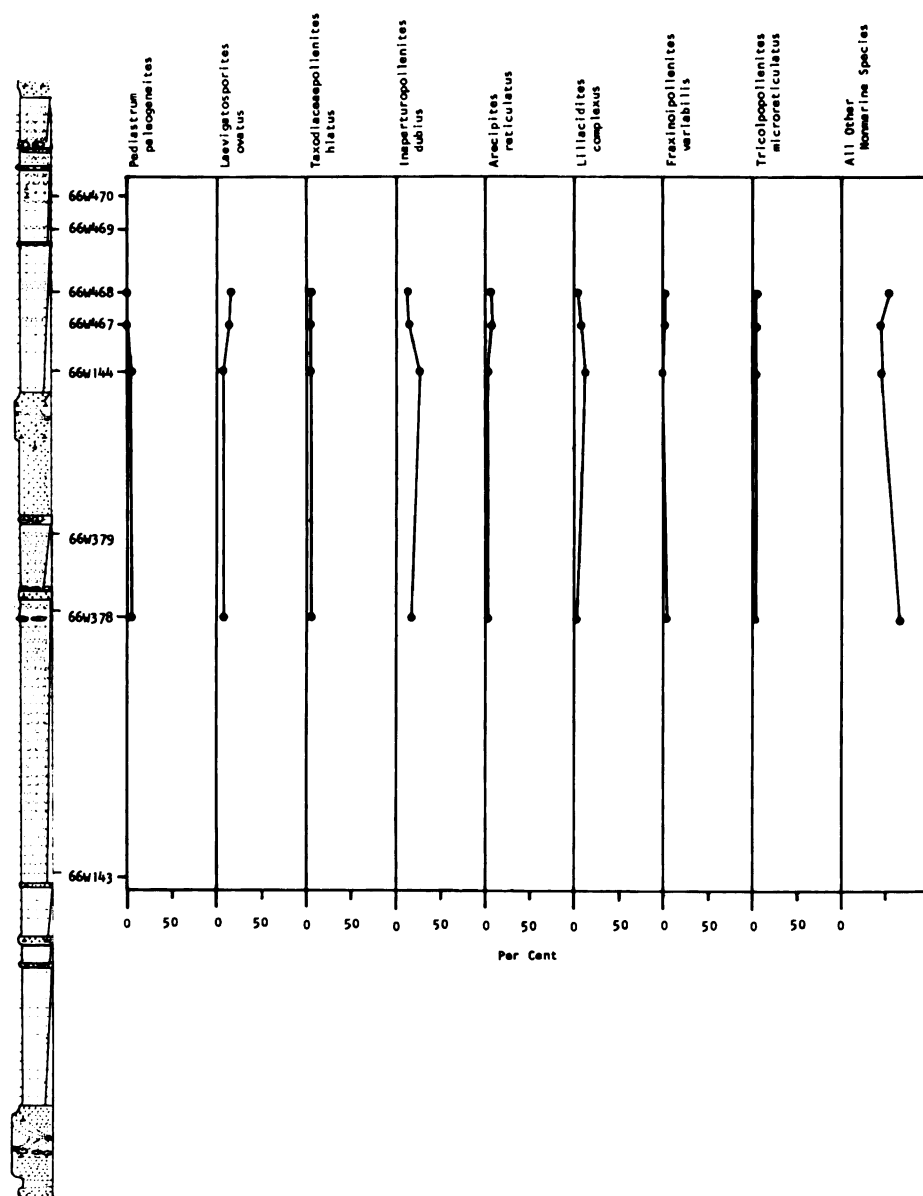
Measured Section 14
Upper Almond Formation



Measured Section 23
Upper Almond Formation



Measured Section 9
Upper Almond Formation



Measured Section 12
Upper Almond Formation

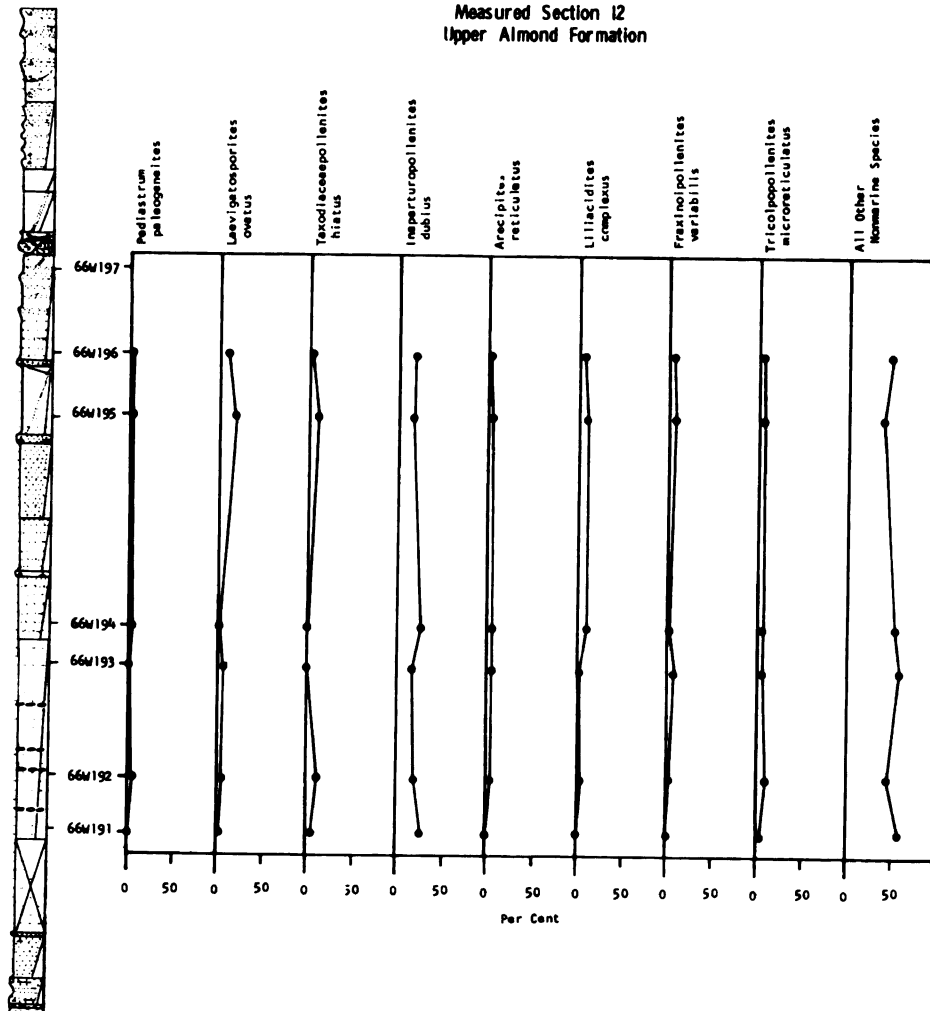


Figure 25

RELATIVE ABUNDANCE OF SELECTED
DINOFAGELLATE SPECIES OF THE
TOTAL DINOFAGELLATE SPECIES

Measured Section 4
Upper Almond Formation

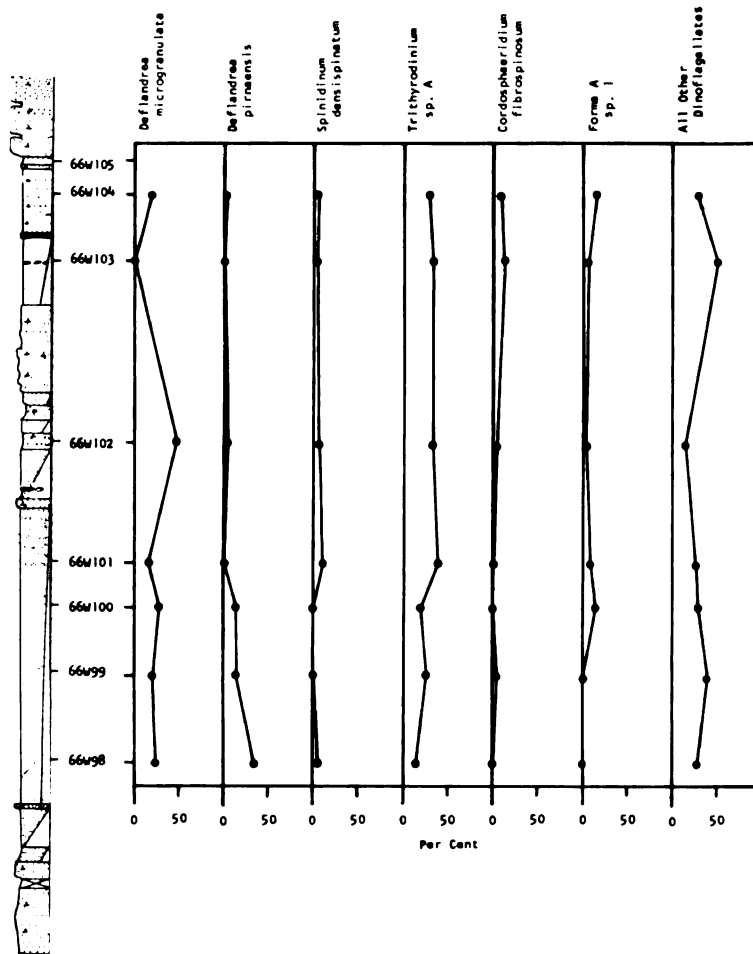


Figure 26

RELATIVE ABUNDANCE OF SELECTED
DINOFLAGELLATE SPECIES OF THE
TOTAL DINOFLAGELLATE SPECIES

Measured Section 14
Upper Almond Formation

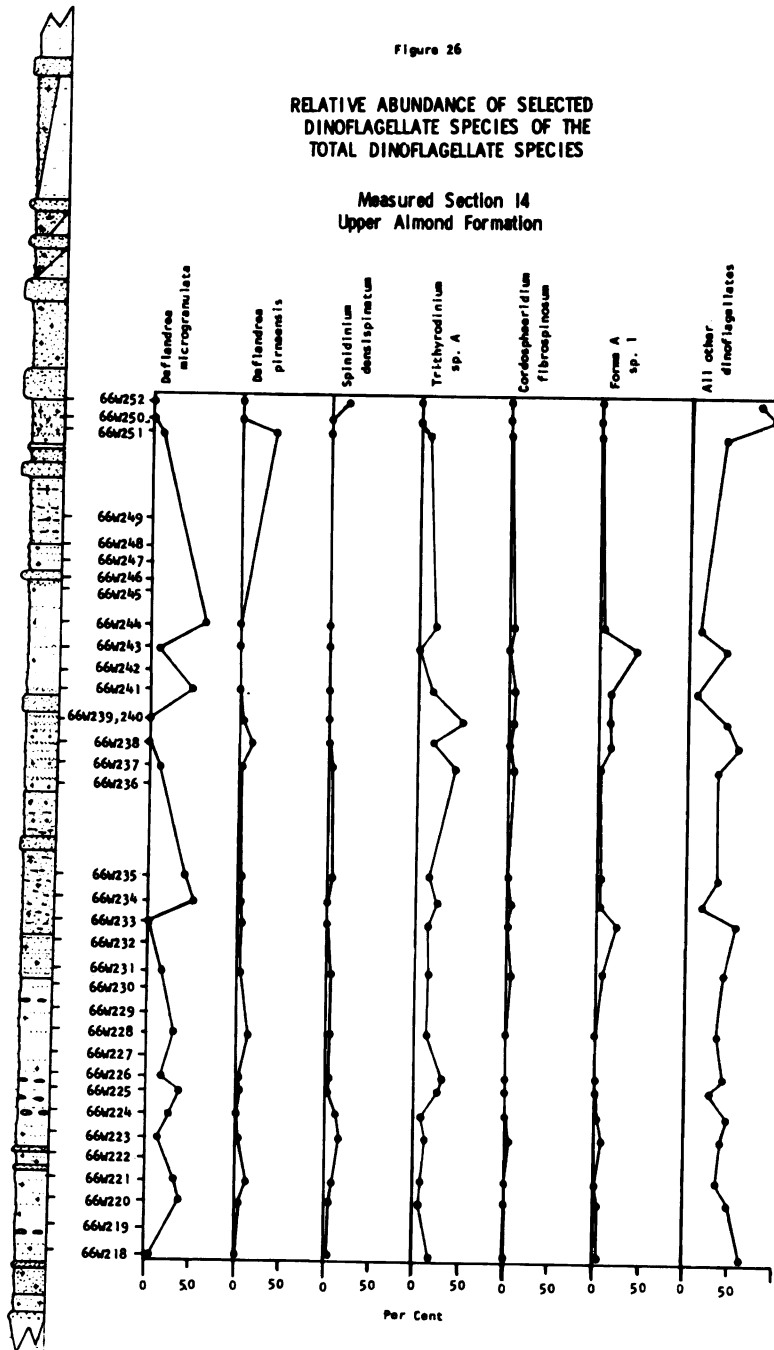


Figure 27

RELATIVE ABUNDANCE OF SELECTED
DINOFLAGELLATE SPECIES OF THE
TOTAL DINOFLAGELLATE SPECIES

Measured Section 23
Upper Almond Formation

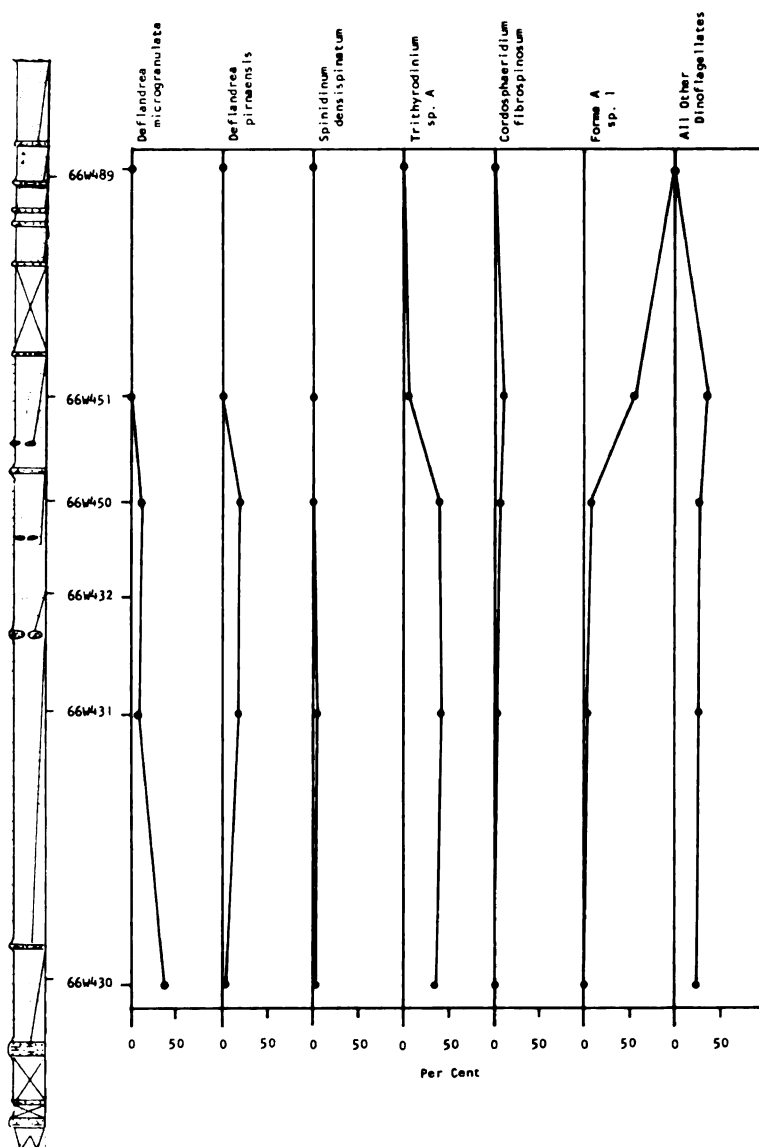


Figure 28

RELATIVE ABUNDANCE OF SELECTED
DINOFAGELLATE SPECIES OF THE
TOTAL DINOFAGELLATE SPECIES

Measured Section 9
Upper Almond Formation

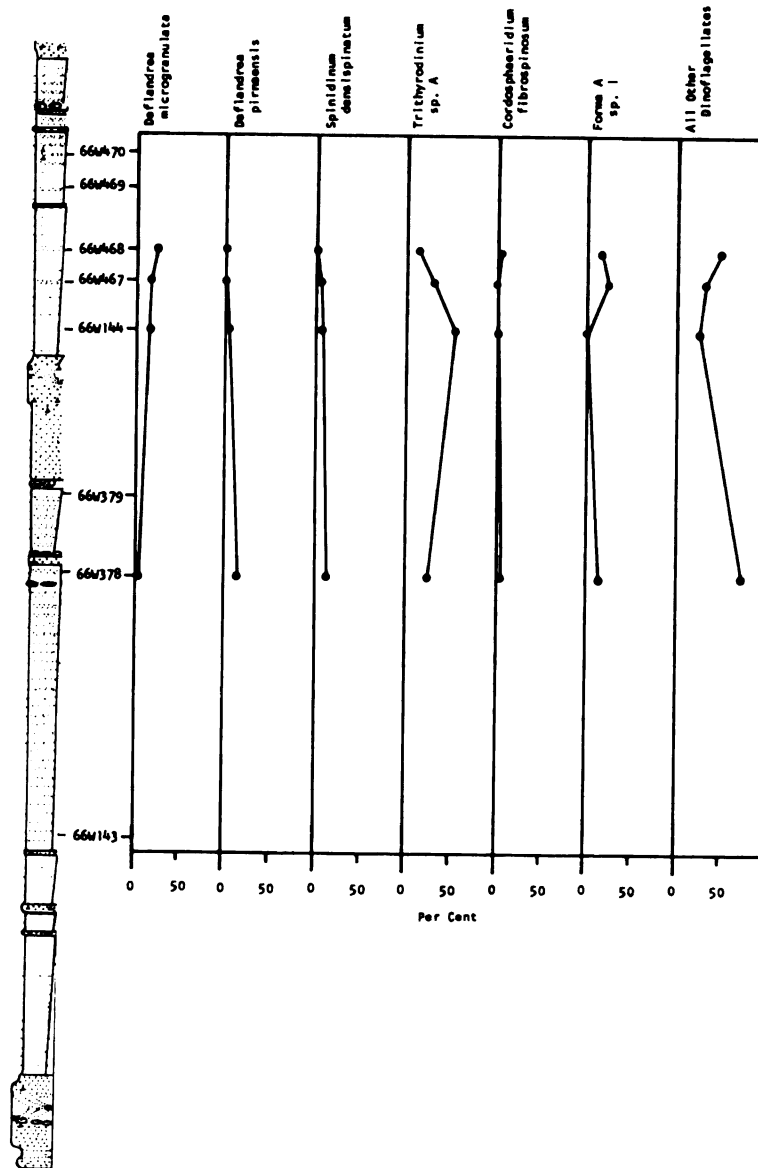


Figure 29

RELATIVE ABUNDANCE OF SELECTED
DINOFLAGELLATE SPECIES OF THE
TOTAL DINOFLAGELLATE SPECIES

Measured Section 12
Upper Almond Formation

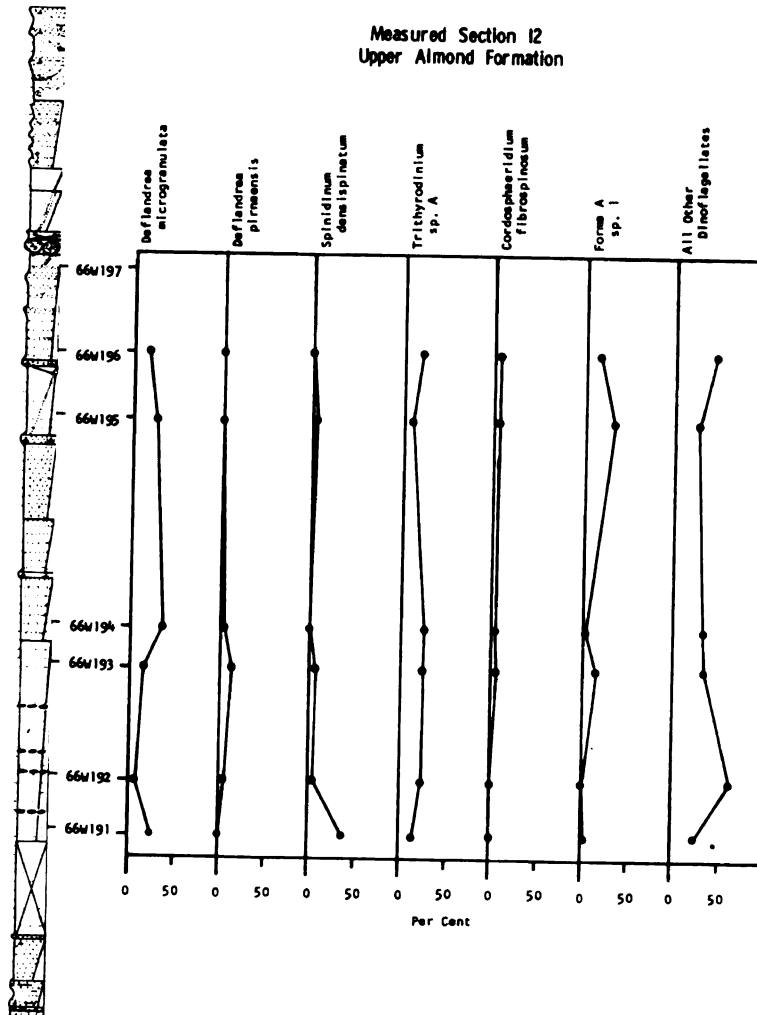


Figure 30

RELATIVE ABUNDANCE OF
MAJOR PALYNOMORPH GROUPS

Measured Section 4
Upper Almond Formation

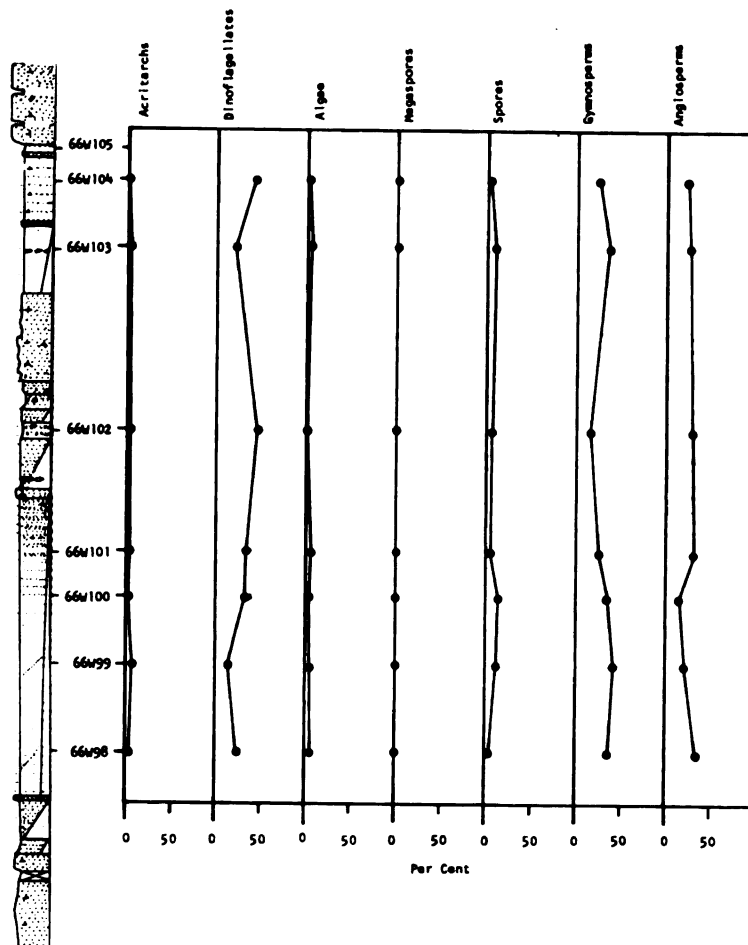


Figure 31

RELATIVE ABUNDANCE OF
MAJOR PALYNOMORPH GROUPS

Measured Section 14
Upper Almond Formation

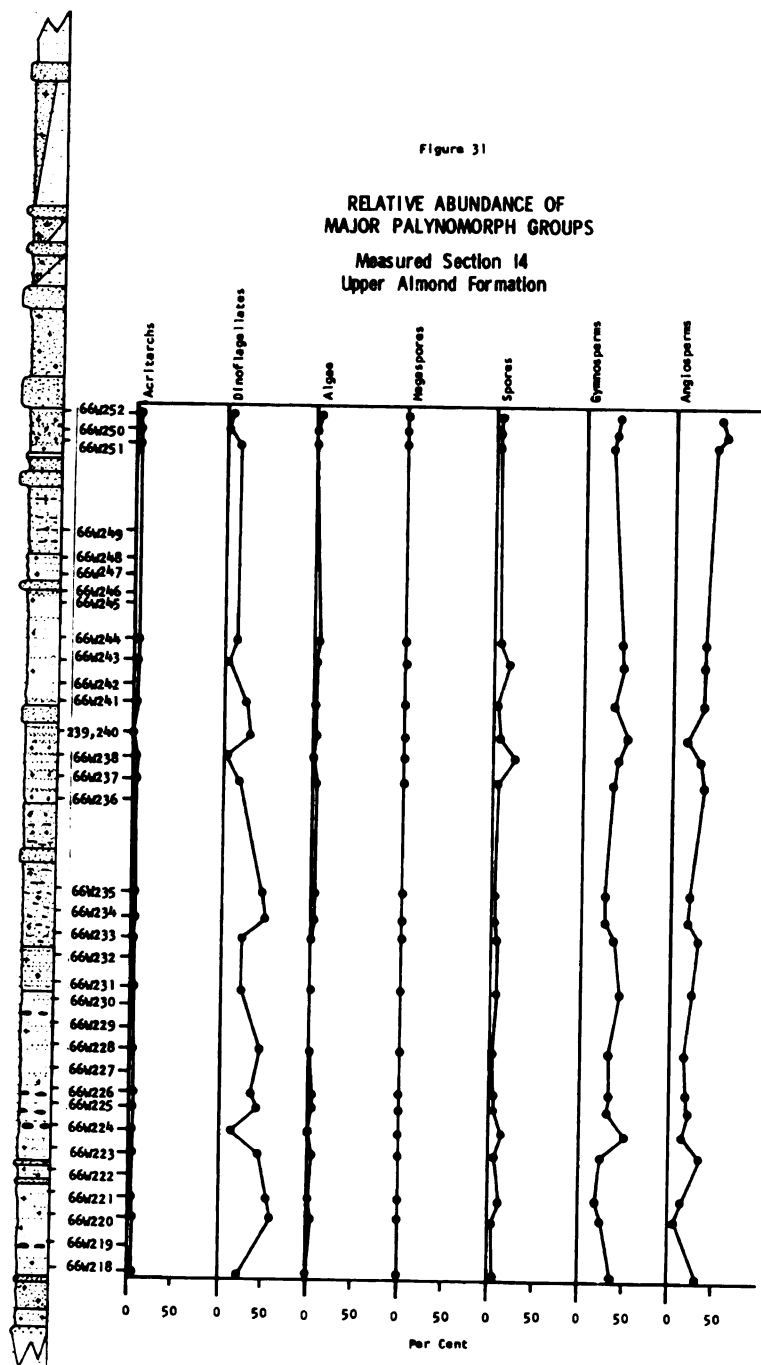


Figure 32

RELATIVE ABUNDANCE OF
MAJOR PALYNOMORPH GROUPS

Measured Section 23
Upper Almond Formation

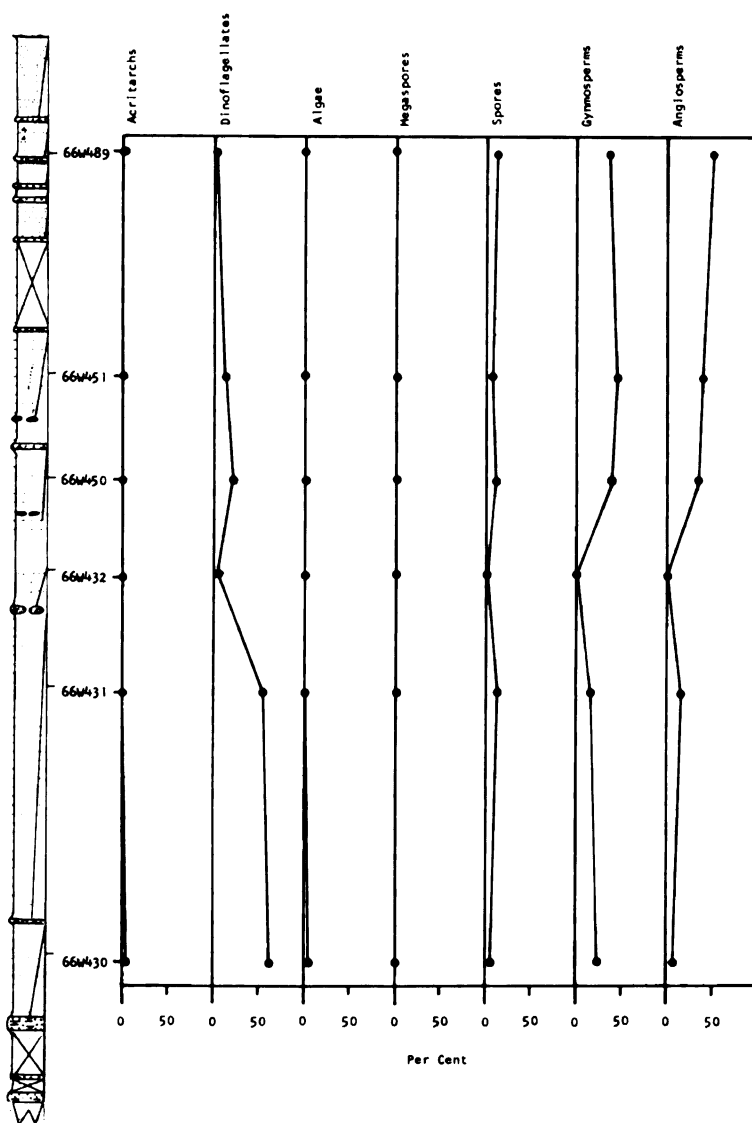


Figure 33

RELATIVE ABUNDANCE OF
MAJOR PALYNOMORPH GROUPS
Measured Section 9
Upper Almond Formation

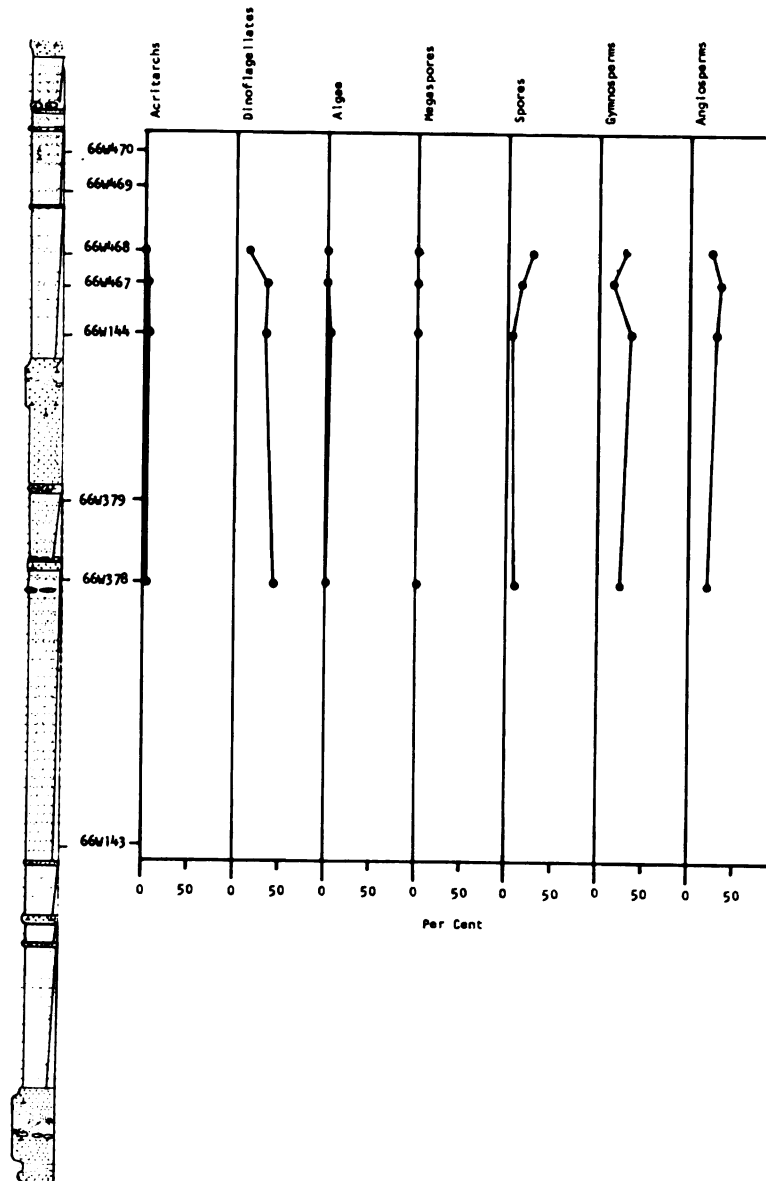


Figure 34

RELATIVE ABUNDANCE OF
MAJOR PALYNOMORPH GROUPS
Measured Section 12
Upper Almond Formation

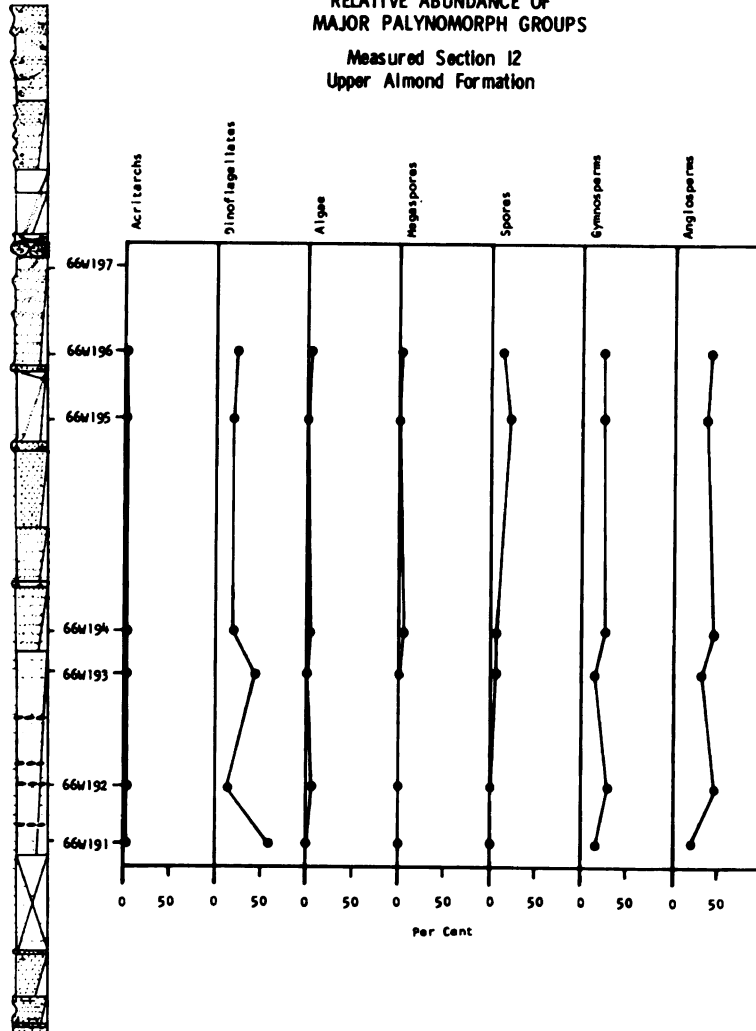


TABLE 11

MEASURED SECTION 4
ABSOLUTE ABUNDANCE OF PALYNOMORPH GROUPS

Sample	Aliquot*	Acritarchs		Dinoflagellates		Algae		Megaspores		Spores		Gymnosperms		Angiosperms		Tissue	
		Count	g/g**	Count	g/g	Count	g/g	Count	g/g	Count	g/g	Count	g/g	Count	g/g	Count	g/g
66W105	.01	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
66W104	.01	0	0	19	950	0	0	0	0	4	200	8	400	9	450	20	1000
66W103	.01	1	50	17	850	2	100	0	0	4	200	22	1100	13	650	15	150
66W102	.05	1	10	333	3330	1	10	0	0	19	190	84	840	149	1490	182	1820
66W101	.03	1	17	10	167	0	0	0	0	2	33	11	183	13	217	31	517
66W100	.01	0	0	17	850	2	100	0	0	5	250	40	2000	14	700	43	2150
66W 99	.03	42	700	238	3967	18	300	0	0	116	1937	470	7833	312	5200	390	6501
66W 98	.02	4	100	47	1175	11	275	0	0	8	200	50	1250	37	925	75	1875

* Aliquots from 5ml of residue, from 10g of rock.

** "Grains per gram", palynomorphs per gram of sediment.

TABLE III

MEASURED SECTION 14
ABSOLUTE ABUNDANCE OF PALYNOMORPH GROUPS

Sample	Aliq. no.*	Acritarchs		Dinoflagellates		Algae		Megaspores		Spores		Gymnosperms		Angiosperms		Tissue	
		Count	g/g*	Count	g/g	Count	g/g	Count	g/g	Count	g/g	Count	g/g	Count	g/g	Count	g/g
66W252	.03	1	17	4	69	3	50	0	0	1	17	32	533	74	1233	87	1450
66W250	.03	2	33	0	0	0	0	0	0	7	117	34	567	47	783	55	917
66W251	.03	0	0	0	67	0	0	0	0	0	0	2	33	3	50	11	183
66W249	.03	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
66W248	.01	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
66W247	.01	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
66W246	.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
66W245	.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
66W244	.01	10	500	10	4900	10	500	0	0	13	650	135	6750	83	4150	193	9650
66W243	.01	1	50	7	350	0	0	2	100	17	850	44	2200	28	1400	50	2500
66W242	.01	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
66W241	.01	0	0	74	3700	0	0	0	0	5	250	108	5400	51	2550	63	1800
66W240	.01	0	0	6	300	0	0	0	0	2	100	5	250	3	150	39	1950
66W239	.01	0	0	8	400	0	0	0	0	6	300	23	1150	11	550	36	1800
66W238	.01	0	0	2	100	0	0	0	0	7	350	10	500	12	600	10	500
66W237	.02	8	200	43	1075	2	50	0	0	8	200	82	2050	55	1375	47	1175
66W236	.01	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
66W235	.01	0	0	51	2550	0	0	0	0	8	400	39	1950	25	1250	63	3150
66W234	.01	0	0	44	2200	0	0	0	0	10	500	41	2050	16	800	38	1900
66W233	.01	3	150	36	1800	0	0	1	50	21	1050	63	3150	43	2150	21	1050

TABLE 111, (cont'd)

Sample	Aliquot*	Acritarchs		Dinoflagellates		Algae		Megaspores		Spores		Gymnosperms		Angiosperms		Tissue	
		Count	g/g**	Count	g/g	Count	g/g	Count	g/g	Count	g/g	Count	g/g	Count	g/g	Count	g/g
66W232	.01	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
66W231	.01	1	50	56	2800	2	100	0	0	32	1600	75	3950	38	1900	44	2200
66W230	.01	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
66W229	.01	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
66W228	.01	2	100	101	5000	0	0	1	50	9	450	56	2800	33	1650	71	3550
66W227	.01	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
66W226	.01	6	300	59	2950	1	50	0	0	8	400	51	2550	29	1450	36	1800
66W225	.01	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
66W224	.01	7	350	38	1900	0	0	0	0	45	2250	162	8100	41	2050	21	1050
66W223	.01	2	100	124	6200	0	0	0	0	8	400	65	3250	31	1550	36	1800
66W222	.01	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
66W221	.01	23	1150	371	18550	0	0	0	0	59	2950	134	6700	61	3050	17	850
66W220	.01	13	650	216	10800	2	100	0	0	18	900	85	4250	24	1200	2	100
66W219	.01	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
66W218	.01	4	200	20	1000	0	0	0	0	6	300	37	1850	24	1200	13	650

* Aliquots from 5ml of residue, from 10g of rock.

** 'Grains per gram', palynomorphs per gram of sediment.

TABLE IV

MEASURED SECTION 23
ABSOLUTE ABUNDANCE OF PALYNOFORM GROUPS

Sample	Aliquot*	Acritarchs		Dinoflagellates		Algae		Megaspores		Spores		Gymnosperms		Angiosperms		Tissue	
		Count	g/g**	Count	g/g	Count	g/g	Count	g/g	Count	g/g	Count	g/g	Count	g/g	Count	g/g
66W489	.01	0	0	0	0	0	0	0	0	17	850	49	2450	54	2700	72	3600
66W451	.01	6	300	47	2350	11	550	0	0	15	750	107	5350	104	5200	92	4600
66W450	.01	0	0	4	200	0	0	0	0	0	0	4	200	2	100	7	350
66W432	.01	0	0	3	150	0	0	0	0	0	0	0	0	0	0	3	150
66W431	.01	0	0	12	600	1	50	0	0	1	50	0	0	1	50	8	400
66W430	.01	2	100	37	1850	4	200	0	0	0	0	7	350	2	100	23	1150

* Aliquots from 5ml of residue, from 10g of rock.

** 'Grains per gram', palynomorphs per gram of sediment.

TABLE V

MEASURED SECTION 9
ABSOLUTE ABUNDANCE OF PALYNOMORPH GROUPS

Sample	Aliquot*	Acritarchs		Dinoflagellates		Algae		Megaspores		Spores		Gymnosperms		Angiosperms		Tissue	
		Count	g/g**	Count	g/g	Count	g/g	Count	g/g	Count	g/g	Count	g/g	Count	g/g	Count	g/g
66W470	.01	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
66W469	.01	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
66W468	.01	0	0	7	350	0	0	0	0	7	350	7	350	14	700	20	1000
66W467	.01	0	0	20	1000	0	0	0	0	22	1100	20	1000	11	550	17	850
66W144	.01	0	0	15	750	0	0	0	0	1	50	14	700	8	400	40	2000
66W379	.01	0	0	5	250	0	0	0	0	0	0	0	0	1	50	40	2000
66W378	.01	0	0	44	2200	0	0	0	6	0	650	27	1350	16	800	37	1850
66W143	.01	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

* Aliquots from 5ml of residue, from 10g of rock.

** "Grains per gram", palynomorphs per gram of sediment.

TABLE V I

MEASURED SECTION 12
ABSOLUTE ABUNDANCE OF PALYNOFORM GROUPS

Sample	Aliquot*	Acritarchs		Dinoflagellates		Algae		Megaspores		Spores		Gymnosperms		Angiosperms		Tissue	
		Count	g/g**	Count	g/g	Count	g/g	Count	g/g	Count	g/g	Count	g/g	Count	g/g	Count	g/g
66W197	.01	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
66W196	.01	0	0	0	0	1	50	0	0	2	100	7	350	15	750	104	5200
66W195	.01	1	50	31	1550	0	0	0	0	29	1450	82	4100	67	3350	349	17450
66W194	.01	0	0	9	450	2	100	0	0	0	0	8	400	14	700	38	1900
66W193	.01	1	50	80	4000	2	100	0	0	12	600	17	850	38	1900	54	2700
66W192	.01	7	350	9	450	22	1100	0	0	20	1000	55	2750	57	2850	87	4350
66W191	.01	3	150	61	3050	1	50	0	0	4	200	13	650	14	700	33	1650

* Aliquots from 5ml of residue, from 10g of rock.

** "Grains per gram", palynomorphs per gram of sediment.

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PLATE 1

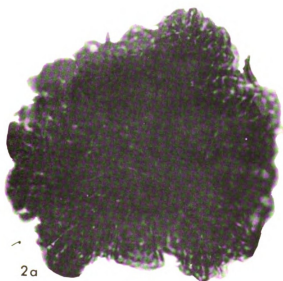
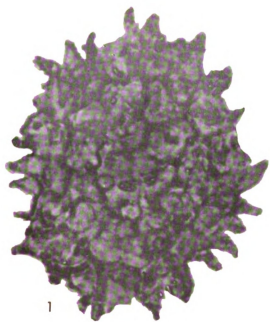


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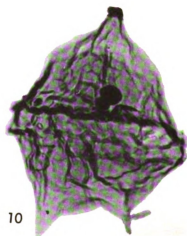
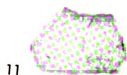
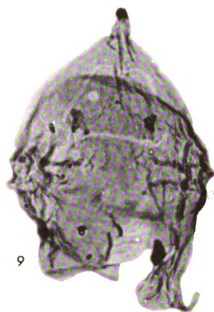
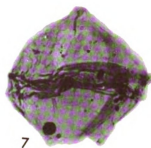


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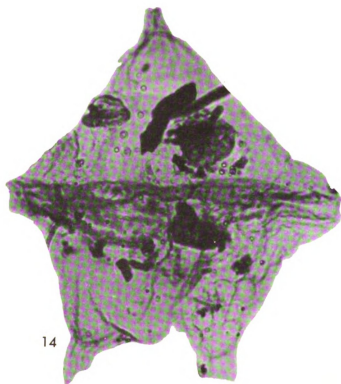


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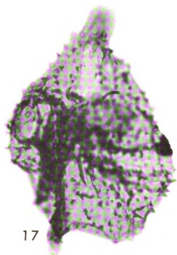
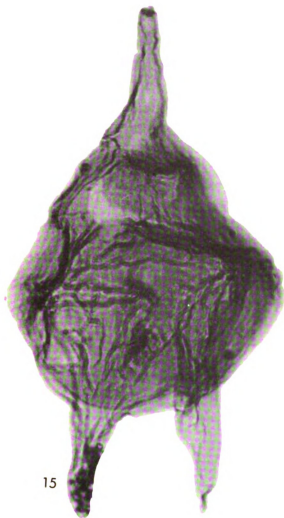


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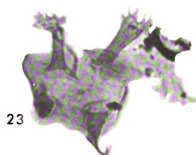
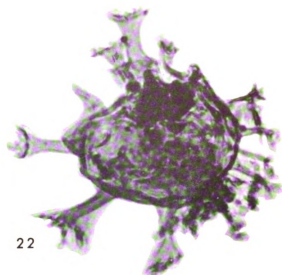
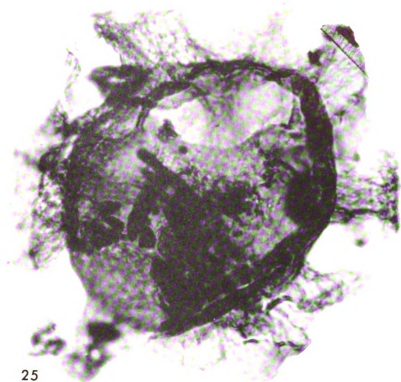


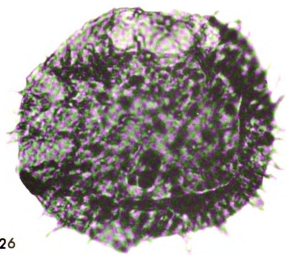
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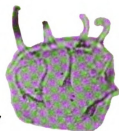
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PLATE 8

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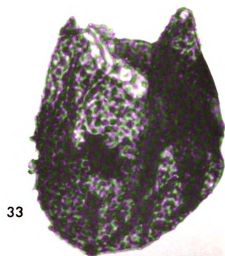
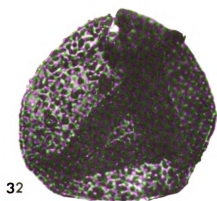
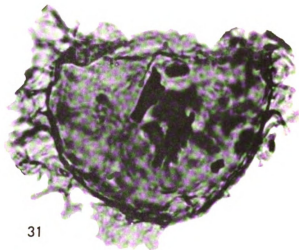
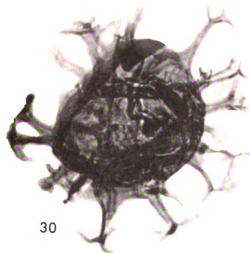
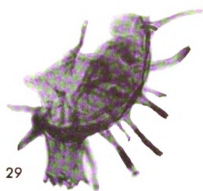
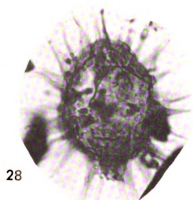


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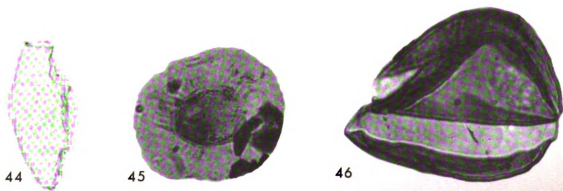
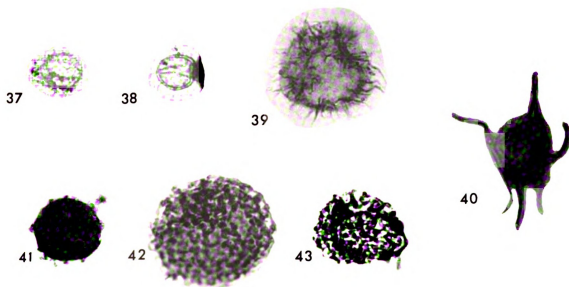
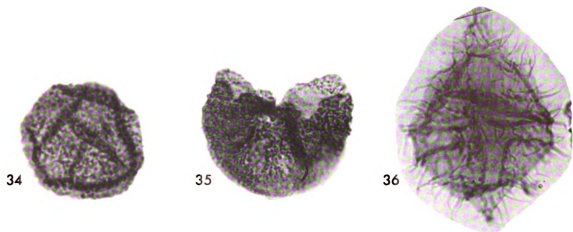


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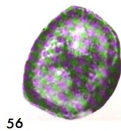
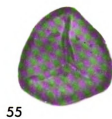
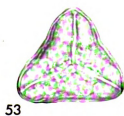
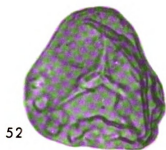
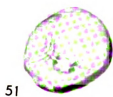
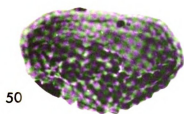
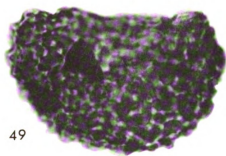
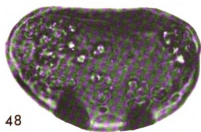
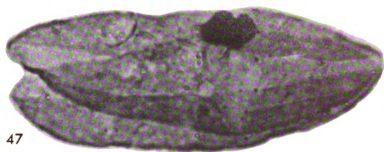
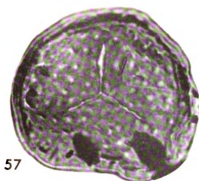


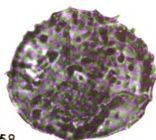
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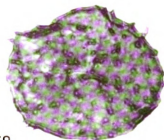
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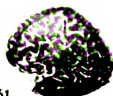
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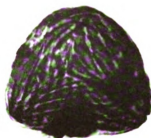
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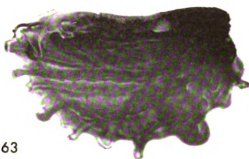
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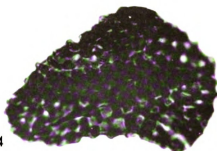
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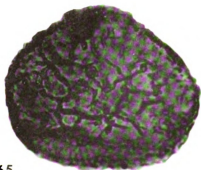
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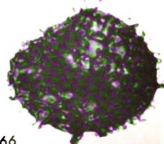
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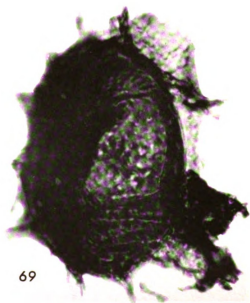
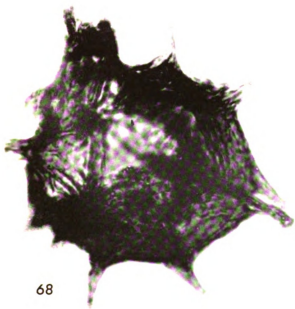
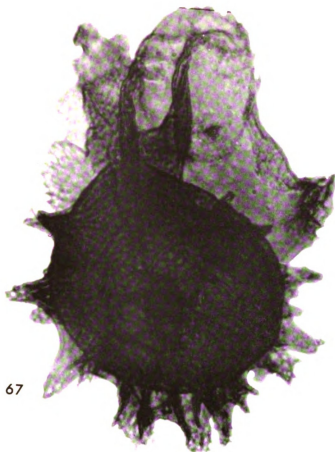
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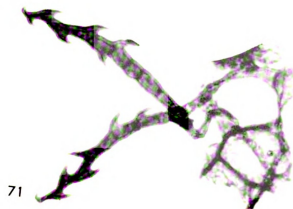


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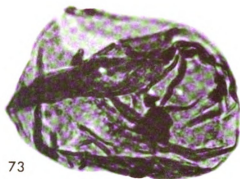
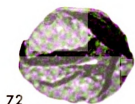


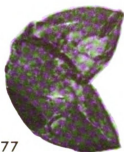
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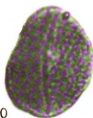
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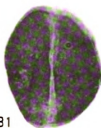
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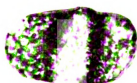
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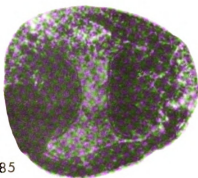
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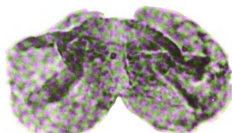
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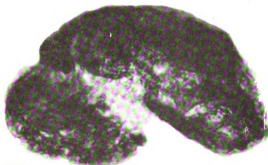
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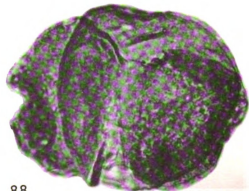
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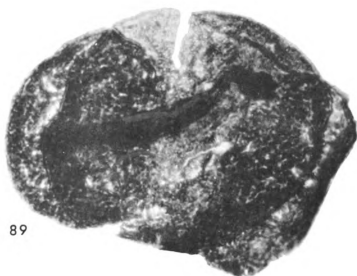


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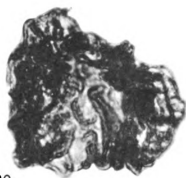
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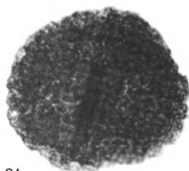
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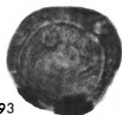
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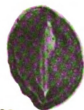
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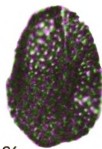
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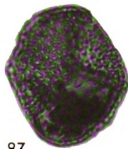
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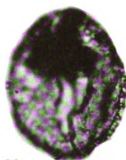
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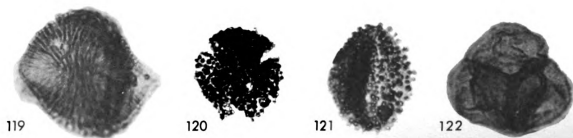
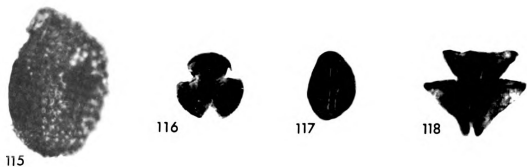
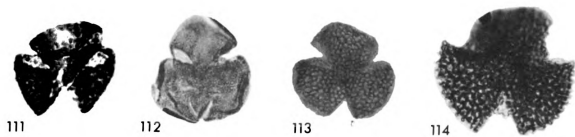


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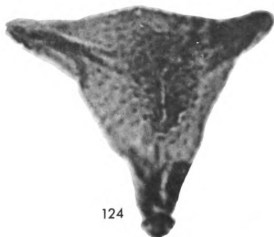
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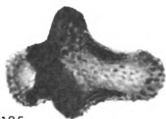
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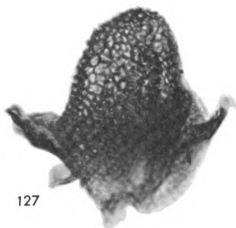
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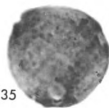
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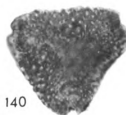
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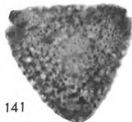
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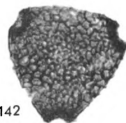
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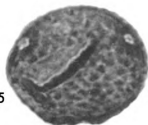
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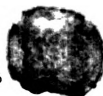
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144



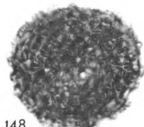
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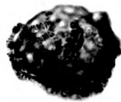
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147



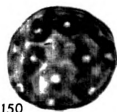
148



149a



149b



150

127
080
TUE
Table
13

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Table XIII
COUNT DATA

200 count data only,
unidentifiable specimens
excluded, specimen observed
but not included in 1
200 counts are excluded

Samples		Species	
SECTION 4	68048	MICROSTRELOM DENSIPINUM	0
	68049	MICROSTRELOM INCONSPICUUM	0
	68050	MICROSTRELOM FILIFORME	0
	68051	MICROSTRELOM FRAGILE	0
	68052	MICROSTRELOM EUPLEUM	0
	68053	PERISTOMATOPUS RUSTICUS	0
	68054	PERISTOMATOPUS LEVIBR	0
	68055	PERISTOMATOPUS SPECIES A	0
	68056	DIATOMUM MELANOE	0
	68057	DIATOMUM SP. 1	0
SECTION 8	68058	DIATOMUM MICROSTRELOM	11
	68059	DIATOMUM CF. D. PINNULIS	16
	68060	DIATOMUM CONOIDI	12
	68061	DIATOMUM PLEIOFID	8
	68062	DIATOMUM FRACIDA	1
	68063	DIATOMUM SP. 1	1
	68064	DIATOMUM SP. 2	1
	68065	DIATOMUM SP. 3	1
	68066	DIATOMUM SP. 4	1
	68067	DIATOMUM SP. 5	1
SECTION 14	68068	DIATOMUM SP. 6	1
	68069	DIATOMUM SP. 7	1
	68070	DIATOMUM SP. 8	1
	68071	DIATOMUM SP. 9	1
	68072	DIATOMUM SP. 10	1
	68073	DIATOMUM SP. 11	1
	68074	DIATOMUM SP. 12	1
	68075	DIATOMUM SP. 13	1
	68076	DIATOMUM SP. 14	1
	68077	DIATOMUM SP. 15	1
SECTION 23	68078	DIATOMUM SP. 16	1
	68079	DIATOMUM SP. 17	1
	68080	DIATOMUM SP. 18	1
	68081	DIATOMUM SP. 19	1
	68082	DIATOMUM SP. 20	1
	68083	DIATOMUM SP. 21	1
	68084	DIATOMUM SP. 22	1
	68085	DIATOMUM SP. 23	1
	68086	DIATOMUM SP. 24	1
	68087	DIATOMUM SP. 25	1
SECTION 9	68088	DIATOMUM SP. 26	1
	68089	DIATOMUM SP. 27	1
	68090	DIATOMUM SP. 28	1
	68091	DIATOMUM SP. 29	1
	68092	DIATOMUM SP. 30	1
	68093	DIATOMUM SP. 31	1
	68094	DIATOMUM SP. 32	1
	68095	DIATOMUM SP. 33	1
	68096	DIATOMUM SP. 34	1
	68097	DIATOMUM SP. 35	1
SECTION 12	68098	DIATOMUM SP. 36	1
	68099	DIATOMUM SP. 37	1
	68100	DIATOMUM SP. 38	1
	68101	DIATOMUM SP. 39	1
	68102	DIATOMUM SP. 40	1
	68103	DIATOMUM SP. 41	1
	68104	DIATOMUM SP. 42	1
	68105	DIATOMUM SP. 43	1
	68106	DIATOMUM SP. 44	1
	68107	DIATOMUM SP. 45	1

Measured Section 14

0<X	≤ 4
4<XX	≤ 10
10<XXX	≤ 20
20<XXXX	≤ 40
40<XXXXX	

[illegible]

UPPER ALMOND FORMATION

DISTRIBUTION AND
RANGE OF PALYNOMORPHS

Measured Sections 8 and 14
Standard Reference Section
Almond Formation

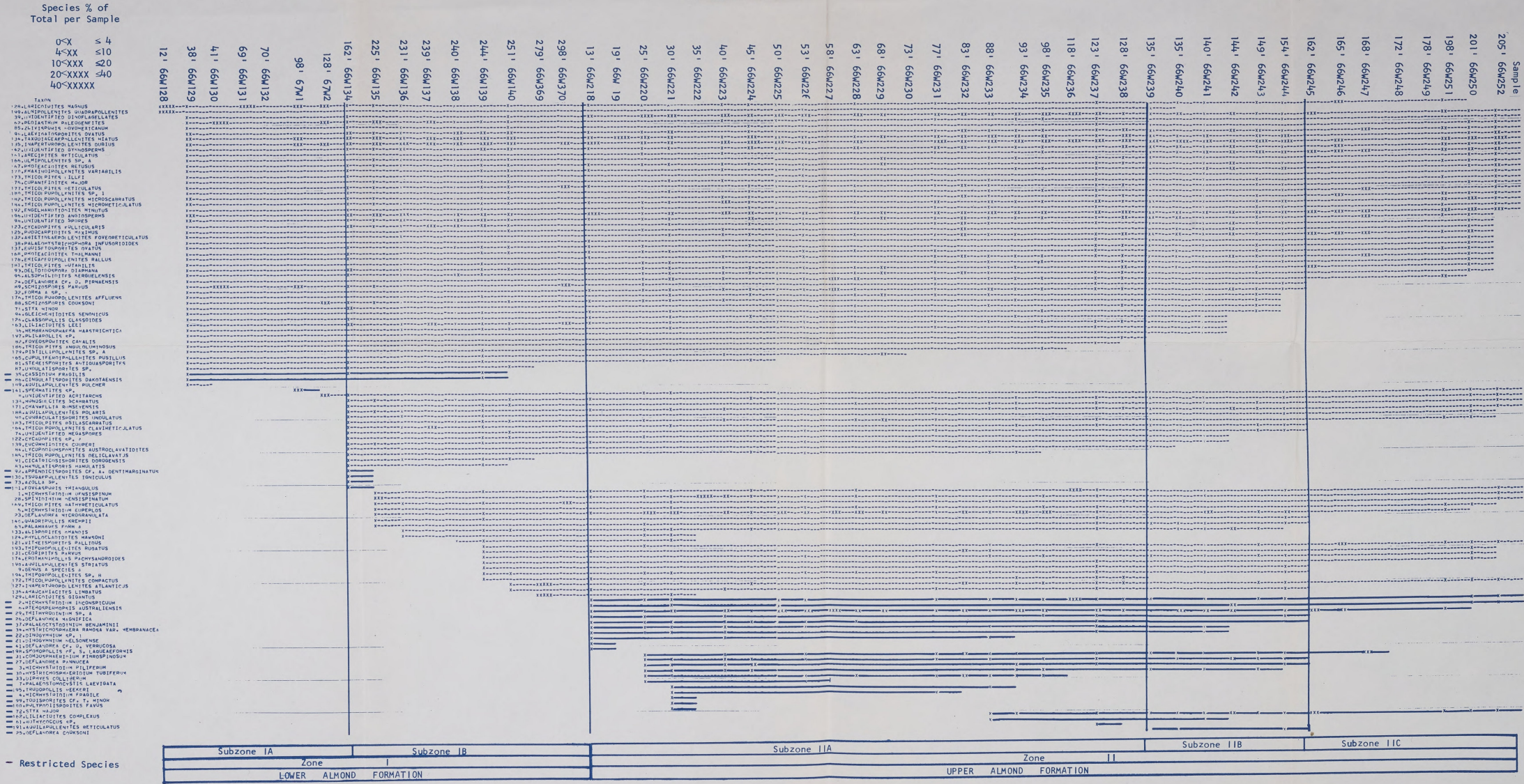
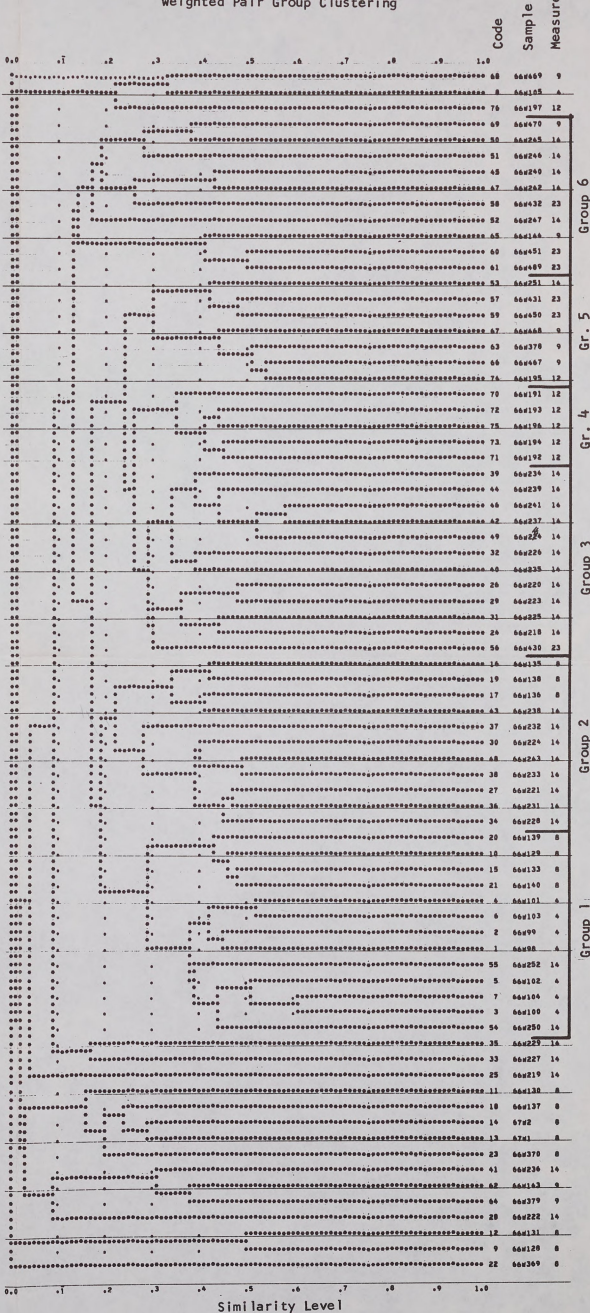


Figure 40

Q-MODE CLUSTER ANALYSIS, ALL SAMPLES

Jaccard Coefficient
Weighted Pair Group Clustering



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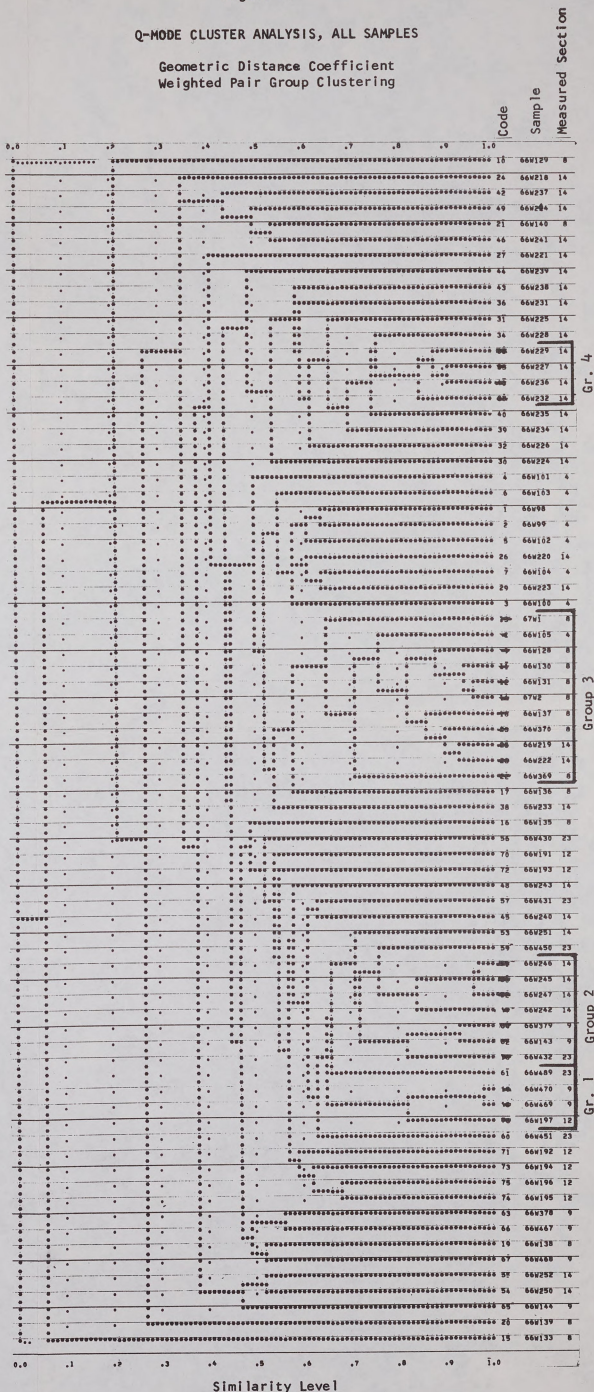
127
090
T43
Fig.
40

127
090
THS
Fig
41

Figure 41

Q-MODE CLUSTER ANALYSIS, ALL SAMPLES

Geometric Distance Coefficient
Weighted Pair Group Clustering



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SUPPLEMENTARY
MATERIAL

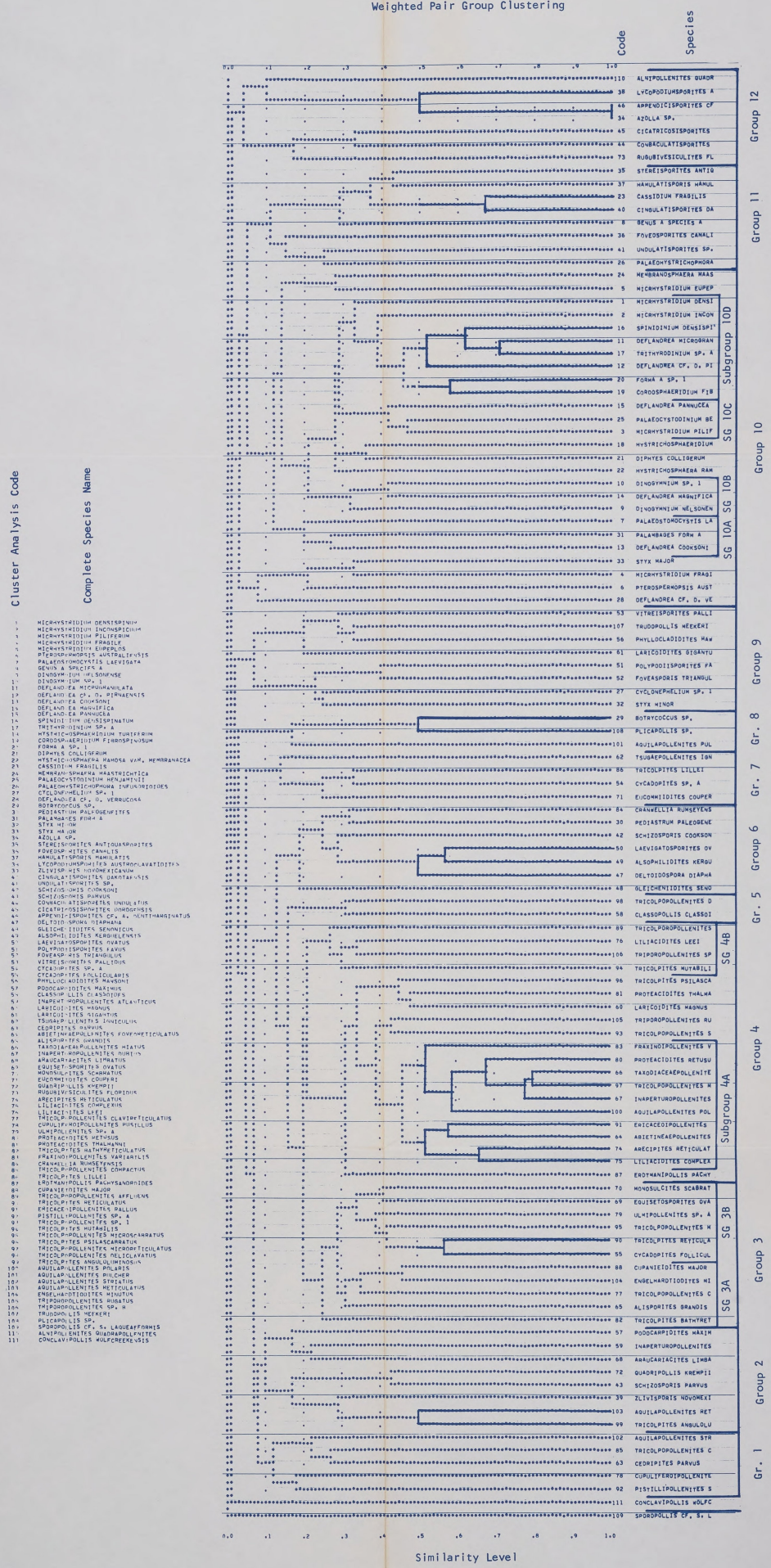
127
070
P43
Fig.
44

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Figure 44

R-MODE CLUSTER ANALYSIS,
ALL SAMPLES, ALL SPECIES

Jaccard Coefficient
Weighted Pair Group Clustering



Pocket has: fig. 9, 11, 15, 40, 41, 44/45 & Table 13 = 8

127
070
745
Fig. 9

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