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PALYNOLOGY OF AN UPPER CRETACEOUS SECTION, HORTON RIVER, DISTRICT OF MACKENZIE, N.W.T.

D. J. McINTYRE

1974



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ABSTRACT

An Upper Cretaceous section from the Horton River, District of Mackenzie, N.W.T. yielded rich and diverse dinoflagellate assemblages from the "Bituminous zone" and abundant dinoflagellates, pollen and spores from the "Pale shale zone". Three distinct microfloral divisions have been recognized. The evidence for these zones is discussed and the possibility of further subdivision noted. The palynologic and other evidence available indicates a Santonian-Campanian age for the "Bituminous zone" and a Campanian-Maastrichtian age for the "Pale shale zone".

RÉSUMÉ

Une coupe du Crétacé supérieur de la rivière Horton, dans le district du Mackenzie, Territoires du Nord-Ouest, présente des assemblages riches et diversifiés de dinoflagellés provenant de la "zone bitumineuse" et un grand nombre de dinoflagellés, de pollens et de spores dans la "zone de schiste pâle". Trois divisions distinctes de flore microscopique ont été reconnues. L'auteur traite de l'existence de ces zones et de l'existence possible d'autres subdivisions. Des preuves palynologiques et autres indiquent que la "zone bitumineuse" remonterait du Santonien-Campanien et la "zone de schiste pâle" au Campanien-Maastrichtien.

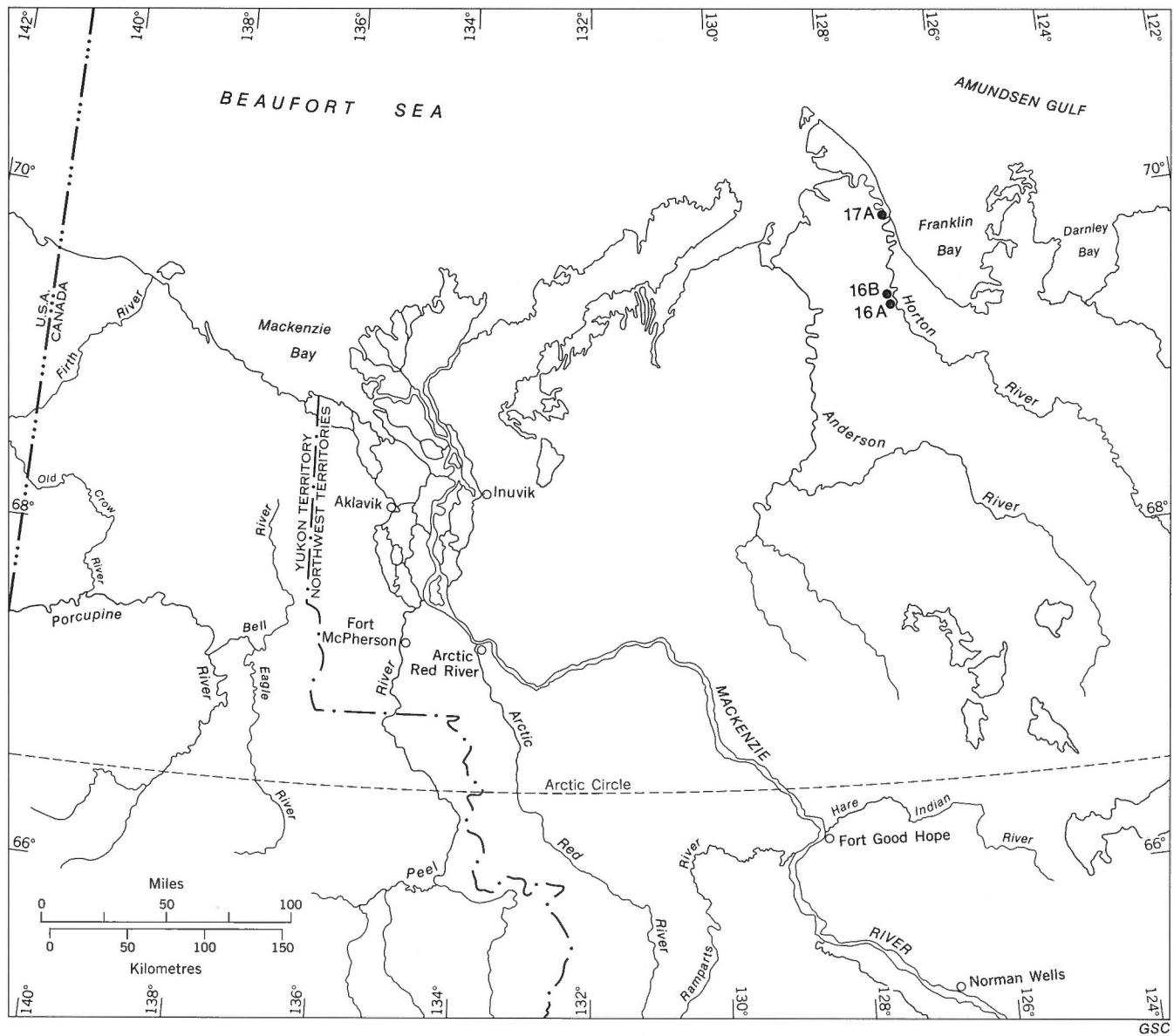


Figure 1. Index map showing location of Horton River section,
District of Mackenzie, N.W.T.

Palynology of an Upper Cretaceous section, Horton River, District of Mackenzie, N.W.T.

INTRODUCTION

As part of Operation Norman in the summer of 1968, the Geological Survey of Canada carried out studies of the geology of the Anderson Plain, which is situated about 160 miles east of Inuvik. Included in these studies were investigations of the Upper Cretaceous "Bituminous zone" and "Pale shale zone" which are well exposed along the Anderson and Horton Rivers in the Anderson Plain. T. P. Chamney, of the Institute of Sedimentary and Petroleum Geology, collected sections from these two units along both the Anderson and Horton Rivers primarily for microfaunal studies. The distribution of both units was mapped and discussed by Yorath *et al.* (1969) who noted that the "Bituminous zone" was overlain conformably by the "Pale shale zone". The "Bituminous zone" was described briefly as consisting of a variable sequence of black bituminous shale, bedded yellow jarosite and, locally, dark maroon beds of earthy hematite. The "Pale shale zone" was described as consisting generally of a lower member composed of pale grey weathering, recessive shale with minor amounts of mudstone and rusty, dark ferruginous dolomite concretionary beds; a middle division of medium to locally dark grey shale with some gypsum; and an upper member of medium to dark grey-brown and brown ferruginous shale that grades upward into grey sandy shale. More detailed descriptions of the Cretaceous rocks of the Anderson Plain and an introduction of formal nomenclature for the lithologic units are in preparation (C. J. Yorath, pers. com.). The informal names for these units are retained in this paper.

As part of a Geological Survey of Canada co-operative research project, 89 Upper Cretaceous samples of the Horton River section were made available in 1969 to Chevron Standard Limited, Calgary, Alberta for detailed palynological study and preparation of a report on zonation and age. This paper contains the results of the study of three sections collected along the Horton River and beside Mackenzie Lake by T. P. Chamney. The three sections are as follows (*see Fig. 1 for locations*):

- (a) CR 16A N-68 (Lat. $69^{\circ}27'30''N$, Long. $126^{\circ}58'W$), 330 feet, "Bituminous zone"
- (b) CR 16B N-68 (Lat. $69^{\circ}28'N$, Long. $126^{\circ}58'W$), 410 feet, "Pale shale zone"

- (c) CR 17A N-68 (Lat. $69^{\circ}58'30''N$, Long. $127^{\circ}04'W$), 205 feet, "Pale shale zone"

The purpose of this paper is to list and illustrate the microfloras present in the Horton River section, and to establish their age and zonation. Therefore, the detailed systematics of the pollen, spore, dinoflagellate and acritarch species recorded are not discussed in this paper. All species are listed on the distribution chart (Fig. 2) and most are illustrated on Plates 1 to 24. The more significant forms are shown on the range and zone chart (Fig. 3). Species of *Deflandrea* and some other peridinioid dinoflagellates will be described and discussed in more detail by McIntyre (in press).

Previous work

No accounts have been published previously on Upper Cretaceous palynology of the Anderson Plain and there have been few papers published on Upper Cretaceous palynology of the Mackenzie Delta and Arctic Islands. However, the oil industry and the Geological Survey of Canada have been active in the area and a considerable amount of palynological information is contained in their files.

The first record of Upper Cretaceous palynology in the Arctic Islands was given by McGregor (*in Thorsteinsson and Tozer, 1962*), who listed a microflora from Banks Island. One of the earliest works, and still of great importance, is that of Manum and Cookson (1964), who described and illustrated Upper Cretaceous dinoflagellates from Graham and Ellef Ringnes Islands. Previously, Manum (1963) had described four new species of *Deflandrea* from the Graham Island material. Some pollen and dinoflagellate assemblages of Campanian or Maastrichtian age from near Fort Norman were recorded and illustrated by Brideaux (1971). Hopkins (1971, and *in Dixon et al., 1973*) listed a Senonian microflora from Somerset Island. Campanian and Maastrichtian microfloras from the IOE Ellice 0-14 well in the Mackenzie Delta and Late Cretaceous assemblages from the IOE Tuk F-18 well on the Tuktoyaktuk Peninsula were recorded by Brideaux (*in Norford et al., 1972*). Hopkins (*in Norford et al., 1972*) listed a probable late Cretaceous microflora from the IOE Eskimo J-07 well, also located on the Tuktoyaktuk Peninsula. Rouse and Srivastava (1972) discussed and illustrated Maastrichtian spores and pollen from the northern Yukon. Hopkins (1973) noted some pollen types that occur in Campanian and Maastrichtian strata on Amund Ringnes and Ellef

Ringnes Islands. Maastrichtian pollen floras from Ellef Ringnes Island have been described and illustrated by Felix and Burbridge (1973).

There are even fewer published records of Upper Cretaceous microfloras from Alaska but, as in Canada, various oil companies have much detailed information in their files. Tabbert (1967) has noted a Maastrichtian pollen flora from Arctic Alaska. Tschudy (1969) described *Aquilapollenites* species and Tschudy and Leopold (1970) recorded some occurrences of *Aquilapollenites* from Alaska.

Acknowledgments

The opportunity provided by the Geological Survey of Canada and Chevron Standard Limited to study the detailed palynology of this interesting material is gratefully acknowledged. Thanks are extended to W. W. Brideaux, Institute of Sedimentary and Petroleum Geology, and B. G. T. van Helden, Chevron Standard Limited, for much helpful discussion during the course of this work.

MICROFLORAL ZONATION

Diverse palynomorph assemblages were found in samples from sections CR 16A and CR 16B. Section CR 16A contains abundant dinoflagellates but pollen and spores are not common. In section CR 16B, dinoflagellates, pollen and spores are abundant throughout and there is an increase in pollen abundance in the top half of the section. Samples from section CR 17A yielded sparse microfloras which contain few species of pollen, spores and dinoflagellates.

In the Horton River section, three well-defined microfloral divisions have been recognized (Fig. 3). The term division is used in this report in the same sense as in Williams and Brideaux (in press). The divisions have not been accorded formal zone status in this report because it is not known whether they have a wider distribution than their occurrence in the Horton River section. The divisions could be named formally as zones if further palynological work on outcrop and well material from the Anderson Plain and Tuktoyaktuk Peninsula confirms the validity of the divisions recognized in this report. It may be possible to subdivide some of these divisions, and species which are of possible value for this purpose are indicated in the discussion of each division. The locations of the possible subdivisions are shown on figure 3. Species used to define the three divisions are readily identifiable and are common constituents of the microfloral assemblages.

Division H1

The base of Division H1 in the Horton River section coincides with the base of section CR 16A which in this area is at the base of the "Bituminous zone" which rests disconformably on the Middle Albian "Bentonitic zone" (Yorath *et al.*, 1969). Division H1 is characterized by the presence, in abundance, of *Deflandrea* sp. cf. *D. victoriensis*, *D. spectabilis* and *Spongodinium delitiense*. Species of *Dinogymnium*

occur throughout the zone but never are abundant. The top of Division H1 occurs at the 10-foot level of section CR 16B near the base of the "Pale shale zone" and is defined by the last appearance, in abundance, of *Deflandrea* sp. cf. *D. victoriensis* which appears only occasionally thereafter. The last appearances of "*Broomea*" sp. 2, *Impletosphaeridium* sp. cf. *I. whitei*, Deflandreoid Form 2 and *Trityrodinium ornatum*, all restricted to Division H1, also are used in defining the top of the division. Many species make their first appearance in Division H1 (Figs. 2, 3) including *Palaeostomocystis laevigata*, *Kalyphea aceras*, *Deflandrea acuminata*, *D. sp. cf. D. belfastensis*, *D. sp. 3* and *Palaeoperidinium pyrophorum*.

There are some apparently significant microfloral changes in Division H1 which indicate four possible subdivisions (Fig. 3). The first important change occurs at 110 feet in section CR 16A with the last appearance of *Dorocysta litotes* and *Ellipsodinium rugulosum* and the first appearance of *Kalyphea aceras*, Deflandreoid Form 2 and *Impletosphaeridium* sp. cf. *I. whitei*.

A second change occurs at 200 feet in section CR 16A with the last appearance of *Trityrodinium suspectum* preceded by the last appearance of "*Broomea*" sp. 1. *Deflandrea* sp. cf. *D. belfastensis* and *D. acuminata* make their first appearances at this level.

The third change occurs at 310 feet in section CR 16A with the last appearance of *Dinogymnium* sp. 1, *D. sp. cf. D. westrailium* and *Deflandrea acuminata* and the first appearance of *Palaeoperidinium pyrophorum*. *Fromea amphora* last appears just below this level and *Deflandrea* sp. 3 first appears at 320 feet.

Division H2

This division covers an interval of only 40 feet in the lower part of section CR 16B and the "Pale shale zone" and is a zone of considerable microfloral change. The base of Division H2 is placed at the first appearance of *Adnatosphaeridium* sp. and the first occurrence, in abundance, of *Deflandrea* sp. 3 which occurs initially in Division H1. The top of Division H2 is marked by the last appearances of *Deflandrea* sp. 4, *Diconodinium* sp. 2, both of which are abundant, and *Canningia* sp. 1. These three species are restricted to Division H2. Species which make their last appearance in this division include *Dinogymnium euclaensis*, *Exochosphaeridium* sp. cf. *E. striolatum* and *Trigonopyxidium ginella*. Species which make their first appearance include *Hystrichosphaeridium* sp. 2, *Deflandrea* sp. 8, *Palaeoperidinium basilium* and *Diconodinium firmum* Harland (1973). Among the biostratigraphically useful pollen species which first appear in this division are *Orbiculapolis globosus*, *Loranthacites* sp. 1 and *Loranthacites* sp. 2.

Division H3

The base of Division H3 occurs at the first appearance, in abundance, of *Deflandrea* sp. 5 which

is abundant in most samples of this division. The division continues through section CR 16B, from 50 feet above the base of the section, and at least into the upper part of section CR 17A. *Deflandrea* sp. 5 appears rarely at the top of Division H2. The top of the division may occur at the 150-foot level in section CR 17A with the last appearance of *Deflandrea* sp. 5 but it has not been defined here because of the sparse microfloral assemblages in samples from this section. For the same reason, the last appearances of many species at the top of section CR 16B are not used to define a possible division top or subdivision.

Although many changes occur in the species of dinoflagellates present in Division H3, there are few well-defined breaks suitable for subdivision. Of possible importance for a subdivision near the base of the division is the last appearance of *Deflandrea spectabilis* and *D. minor* and the first occurrence of *Lejeunia kazlowskii* and *Hystrichosphaeropsis* sp.

There are a number of changes in the interval between 160 and 200 feet in section CR 16B which may be useful for subdivision. In this interval, *Diconodinium arcticum*, *Dictyopyxidium circulata*, *Adnatosphaeridium* sp., *Hystrichosphaeropsis* sp. and Dinoflagellate Form 1 make their last appearance and *Deflandrea diebeli*, *Wodehouseia spinata*, *Erdtmanipollis procumbentiformis*, *Extratriporopollenites* sp. 1 and 2, *Triporopollenites* sp. 3, *Orbiculapollenites* sp. 2, *Stereisporites regium*, *Hamulatisporis amplus* and *Integricorpus* sp. make their first appearance. Many species of *Aquilapollenites*, *Triprojectus*, *Mancicorpus*, *Integricorpus*, *Expressipollis* and *Wodehouseia* have their first occurrence in Division H3, particularly near the base of the division.

Age of the Horton River Section

Yorath *et al.* (1969) assigned a late Late Cretaceous age to the "Bituminous zone" and correlated this unit with part of the Kanguk Formation of Santonian to early Campanian age. Russell (1967) recorded vertebrate fossils of Campanian age from the "Bituminous zone" along the Anderson River and Chamney (1973) assigned a provisional age of late Santonian to early Campanian to the "Bituminous zone".

The "Pale shale zone" was considered tentatively to be of Late Cretaceous age by Yorath *et al.* (1969). Chamney (in Russell, 1967) suggested that strata which apparently belong to this zone along the Anderson River were of Maastrichtian age. However, Chamney (1973) provisionally assigned a Campanian age to the "Pale shale zone" but (pers. com.) indicated that microfaunas from this zone contain few foraminifers.

Hopkins (1973) noted that such genera as *Aquilapollenites* (sensu lato), *Orbiculapollenites*, *Wodehouseia* and *Expressipollis* occur in the upper Kanguk Formation (probably Campanian) and the lower Eureka Sound Formation (Maastrichtian) of Ellef Ringnes and Amund Ringnes Islands. Tschudy and Leopold (1970) recorded the appearance of species of *Aquilapollenites* (sensu lato) through the Campanian and Maastrichtian in the Rocky Mountains of the United States. Tschudy (1969) recorded species of *Aquilapollenites* (sensu

lato) from the Campanian and Maastrichtian in Alaska and Stanley (1970) noted that genera of the *Triprojectacites* group (*Aquilapollenites*, *Triprojectus*, *Mancicorpus*, *Integricorpus*) probably first appeared in North America in Campanian time.

In the Horton River section, pollen of the genera *Mancicorpus*, *Integricorpus*, *Triprojectus*, *Aquilapollenites*, *Orbiculapollenites*, *Expressipollis* and *Wodehouseia* appear low in the "Pale shale zone" and continue to increase in abundance throughout section CR 16B. Therefore, a Campanian age is considered likely for at least the lower part of this section.

Norris *et al.* (1973) recorded the appearance of many species of *Aquilapollenites* (sensu lato) in a series of microfloral suites of Campanian age in Alberta and noted that there were many differences between these microfloras and those of Maastrichtian age recorded by Srivastava (1970) also from Alberta. Pollen floras from the Horton River section have similarities with the microfloras of both Norris *et al.* (1973) and Srivastava (1970), particularly in genera, but there are more differences and few species in common. The Horton River assemblages are not as rich in pollen and spore species as the Alberta microfloras.

Norris *et al.* (1973) recorded *Erdtmanipollis procumbentiformis* (as *E. pachysandroides*) in their middle Campanian Advanced Angiosperm Suite and *Cranwellia striata* in their upper Campanian Cranwellia Suite. The occurrence of *Erdtmanipollis procumbentiformis* and *Cranwellia* sp. (probably *C. striata*) in the lower part of section CR 16B suggests also that this interval is Campanian. Samoilovitch *et al.* (1961) and Chlonova (1961) also have recorded *Cranwellia striata* (as *Elytranthe*) from strata of Campanian age in Siberia.

However, the occurrence of *Wodehouseia spinata* at the 170-foot level in section CR 16B suggests that this interval may be as young as Maastrichtian. Srivastava (1969a, 1970) recorded *W. spinata* in the Middle and Upper Edmonton Formation (Maastrichtian) and Leffingwell *et al.* (1970) noted that this species had been found only in the Maastrichtian in North America. Norris *et al.* (1973) did not record the occurrence of *W. spinata* in any of their Campanian microfloral suites. Srivastava (1969a, 1970) extended the range of *Wodehouseia fimbriata* in North America down into the Maastrichtian. The occurrence of *W. fimbriata* in the top part of section CR 16A further suggests a Maastrichtian age for this interval. Thus, it appears that the lower part of section CR 16B is of Campanian age and the upper part Maastrichtian. Detailed information on Campanian pollen floras is limited and the Campanian-Maastrichtian boundary is difficult to determine with precision on the basis of pollen assemblages. In section CR 16B, the boundary apparently occurs at or near the 170-foot level based on the pollen evidence discussed above.

Paraalnippollenites confusus, a Maastrichtian-Paleocene species (Hills and Wallace, 1969), occurs in the sparse microfloras found in section CR 17A. There is no sign of any typical Paleocene species and other late Late Cretaceous species also are

found in the section which is considered to be Maastrichtian in age.

Dinoflagellate assemblages from the lower part of section CR 16A (lower half of Division H1) have many species in common with microfloras described by Manum and Cookson (1964) and supposedly from the Hassel Formation of Late Albian-Cenomanian age. However, it is probable that the assemblages of Manum and Cookson (1964) came from the Kanguk Formation and are as young as Campanian (Hopkins, 1973; Brideaux, 1973). Some of the species common to the "Bituminous zone" (Horton River section CR 16A) and the material of Manum and Cookson (1964) include:

Trityrodinium suspectum
Deflandrea granulifera
Deflandrea acuminata
Canningia minor
Odontochitina costata
Spongodinium delitiense (= *Scrinodinium obscurum* M and C)
"Broomea" sp. 1 (= *Canningia* sp. M and C)
Wallodinium anglicum
Hystrichosphaeridium difficile
Cyclonephelium distinctum
Fromea amphora
Palaeostomocystis fragilis
Diconodinium arcticum
Kalyptea aceras
Kalyptea monoceras
Palambages Form A and C

The definite similarities suggest that a close correlation is possible between Manum and Cookson's assemblages and microfloras from the interval between 130 and 200 feet in section CR 16A and the available evidence suggests they are of Campanian to possibly Santonian age.

In the Horton River material, *Deflandrea* sp. cf. *D. victoriensis* is abundant to the top of Division H1 (base of section CR 16B, "Pale shale zone"), then occurs very rarely in Divisions H2 and H3 (remainder of section CR 16B). Williams and Brideaux (in press) recorded this species (as *Australiella victoriensis*) in Santonian and Campanian strata of the Grand Banks and Clarke and Verdier (1967) found the species in Santonian strata of the Isle of Wight. The Santonian-Campanian species *Deflandrea spectabilis* and *D. minor* are found in Divisions H1 and H2 and into the base of Division H3. Harland (1973) found the former species in the Campanian Bearpaw Formation in southern Alberta. Also occurring in Divisons H1, H2 and part of H3 are *Diconodinium arcticum*, *Spinidinium clavum* and *Microdininium irregulare*, all of which were found also in the Bearpaw Formation by Harland (1973).

Diconodinium firmum Harland (1973) is found in Divisions H2 and H3, and also is found in the Bearpaw Formation. The Turonian-Campanian species *Gillinia hymenophora* occurs rarely in the lower part of Division H3 and *Odontochitina costata*, recorded as late as Campanian by Clarke and Verdier (1967), appears in Division H1. *Ellipsodinium rugulosum*, recorded in the Santonian by Clarke and Verdier (1967), occurs rarely in the lower part of Division H1 along with the unusual species *Dorocysta litotes*, which previously was recorded only in the Cenomanian of France (Davey, 1970). This indicates that the

range of *D. litotes* extends at least into the Santonian. In the Horton River section, the top of the Santonian is placed tentatively at 110 feet in section CR 16A (the lower part of Division H1), and the top of the Campanian is considered to be at about 170 feet in section CR 16B (within Division H3), primarily on the pollen evidence discussed previously and with supplementary evidence from dinoflagellates.

Therefore, the total evidence available at present indicates that the "Bituminous zone" is Santonian and Campanian in age and the "Pale shale zone" is Campanian and Maastrichtian in age.

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PLATES 1-24

All bright field illumination unless otherwise stated.

All stage co-ordinates are from Leitz Ortholux microscope 646441,
Chevron Standard Limited, Calgary, Alberta.

All photographs were taken on Ilford Pan F film using a Leitz
Orthomat automatic camera.

Plates 1-14, all figures; x500

Plate 15, figures 1-12; x500

Plate 15, figures 13-20; x1,000

Plates 16-24, all figures; x1,000

Plate captions show section number, footage, slide number,
stage co-ordinates and GSC type numbers.

All slides listed are stored in the collection of the Institute
of Sedimentary and Petroleum Geology, Calgary, Alberta. A
duplicate set of slides is kept at Chevron Standard Limited,
Calgary, Alberta.

PLATE 1
(all figures x500)

Dinogymnium sp. 1

- Figure 1. 16A, 70-80 ft., 12553/3, 173 x 1142, 38001
Figure 2. 16A, 40-50 ft., 12550/3, 120 x 1079, 38002
Figure 3. 16A, 120-130 ft., 12558/3, 394 x 1044, 38003

Dinogymnium sp. cf. *D. westrålum* (Cookson and Eisenack)
Evitt, Clarke and Verdier, 1967

- Figure 4. 16A, 260-270 ft., 12589/4, 358 x 1100, 38004
Figure 5. 16A, 260-270 ft., 12589/3, 391 x 1090, 38005

Dinogymnium eucalaensis Cookson and Eisenack, 1970

- Figure 6. 16A, 70-80 ft., 12553/3, 358 x 1097, 38006
Figure 7. 16A, 290-300 ft., 12591/3, 107 x 1083, 38007

Dinogymnium sp. cf. *Gymnodinium sibiricum* Vozzhennikova, 1967

- Figure 10. 16A, 70-80 ft., 12553/3, 247 x 1190, 38008
Figure 11. 16A, 290-300 ft., 12591/3, 189 x 1164, 38009
Figure 12. 16A, 300-310 ft., 12592/3, 308 x 1112, 38010

Dinogymnium sp. cf. *Gymnodinium kasachstanicum* Vozzhennikova,
1967

- Figure 17. 16A, 70-80 ft., 12553/3, 247 x 1148, 38011
Figure 18. 16A, 70-80 ft., 12553/3, 321 x 1133, 38012

Deflandrea spectabilis Alberti, 1959

- Figure 8. 16A, 40-50 ft., 12550/3, 075 x 1006, 38013
Figure 9. 16A, 40-50 ft., 12550/3, 201 x 1017, 38014
Figure 13. 16A, 40-50 ft., 12550/3, 319 x 998, 38015
Figure 14. 16A, 40-50 ft., 12550/3, 228 x 1046, 38016

Deflandrea acuminata Cookson and Eisenack, 1958

- Figure 15. 16A, 270-280 ft., 12590/5, 152 x 1036, 38017

Deflandrea sp. cf. *D. cooksonii* Alberti, 1959

- Figure 16. 16B, 90-100 ft., 12631/3, 416 x 1113, 38018

Deflandrea sp. 5

- Figure 19. 16B, 180-190 ft., 12652/3, 121 x 1155, 38019
Figure 20. 16B, 180-190 ft., 12652/5, 110 x 1174, 38020

Plate 1

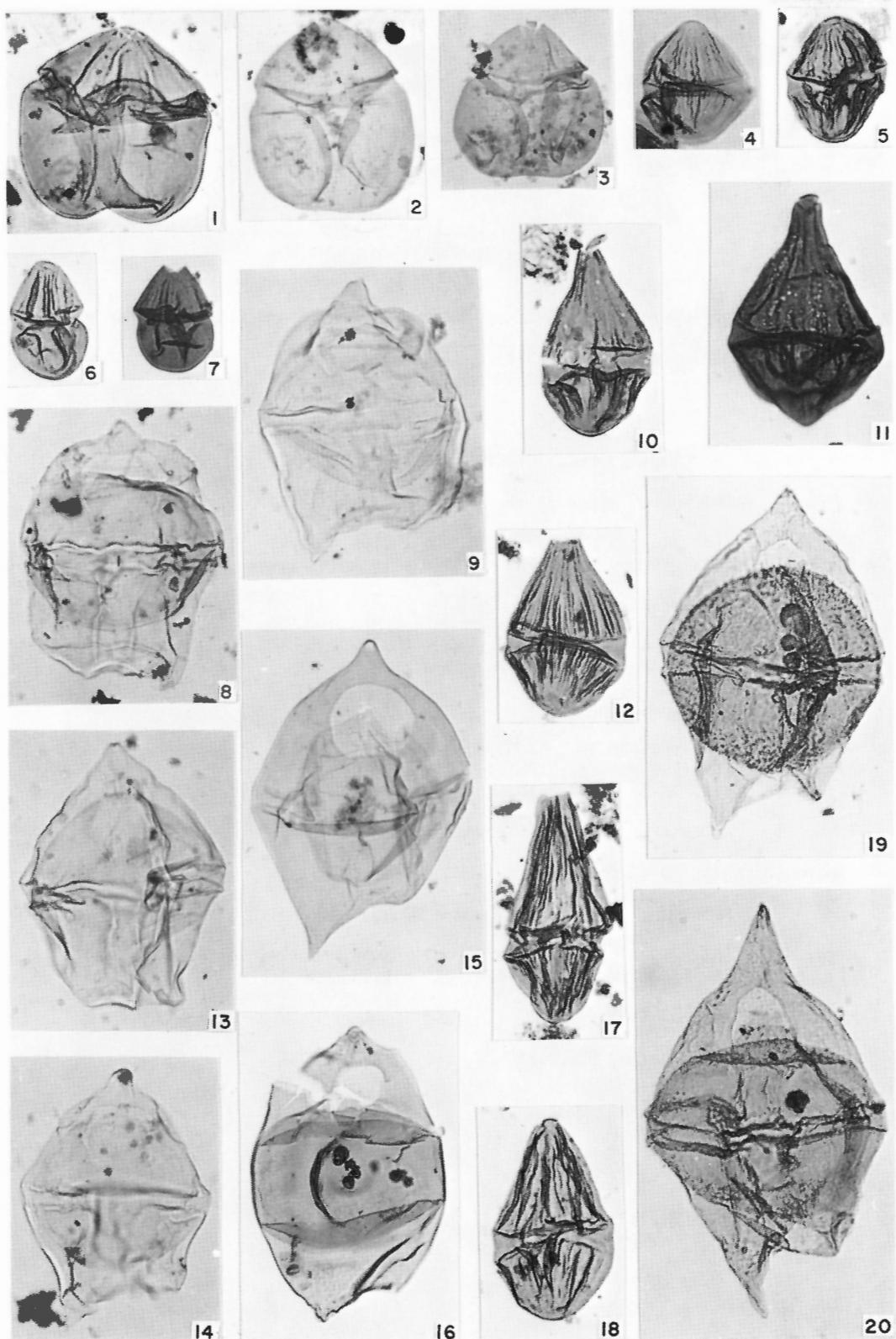


PLATE 2
(all figures x500)

Deflandrea sp. cf. *D. belfastensis* Cookson and Eisenack, 1961

- Figure 1. 16A, 210-220 ft., 12584/5, 208 x 1115, 38021
Figure 2. 16A, 210-220 ft., 12584/5, 150 x 1121, 38022

Deflandrea granulifera Manum, 1963

- Figure 3. 16A, 130-140 ft., 12559/4, 436 x 1022, 38023

Deflandrea minor Alberti, 1959

- Figure 4. 16A, 140-150 ft., 12560/3, 300 x 1188, 38024
Figure 5. 16A, 260-270 ft., 12589/3, 380 x 1036 Interference Contrast, 38025

Deflandrea sp. 8

- Figure 6. 16B, 30-40 ft., 12625/4, 384 x 1093, 38026
Figure 7. 16B, 30-40 ft., 12625/4, 262 x 1047, 38027

Deflandrea sp. 2

- Figure 8. 16B, 160-170 ft., 12650/3, 320 x 1114, 38028
Figure 9. 16B, 180-190 ft., 12652/4, 274 x 1079, 38029
Figure 10. 16B, 70-80 ft., 12629/3, 350 x 1191, 38030

Deflandrea sp. cf. *D. pannacea* Stanley, 1965

- Figure 11. 17A, 30-40 ft., 6929/A2, 202 x 1165, 38031

Deflandrea sp. cf. *D. obscura* Drugg, 1967

- Figure 12. 16A, 260-270 ft., 12589/3, 422 x 1052, 38032
Figure 13. 16A, 260-270 ft., 12589/4, 325 x 1133, 38033

Deflandrea sp. cf. *D. victoriensis* Cookson and Manum, 1964

- Figure 14. 16A, 190-200 ft., 12582/5, 246 x 1060, 38034

Plate 2

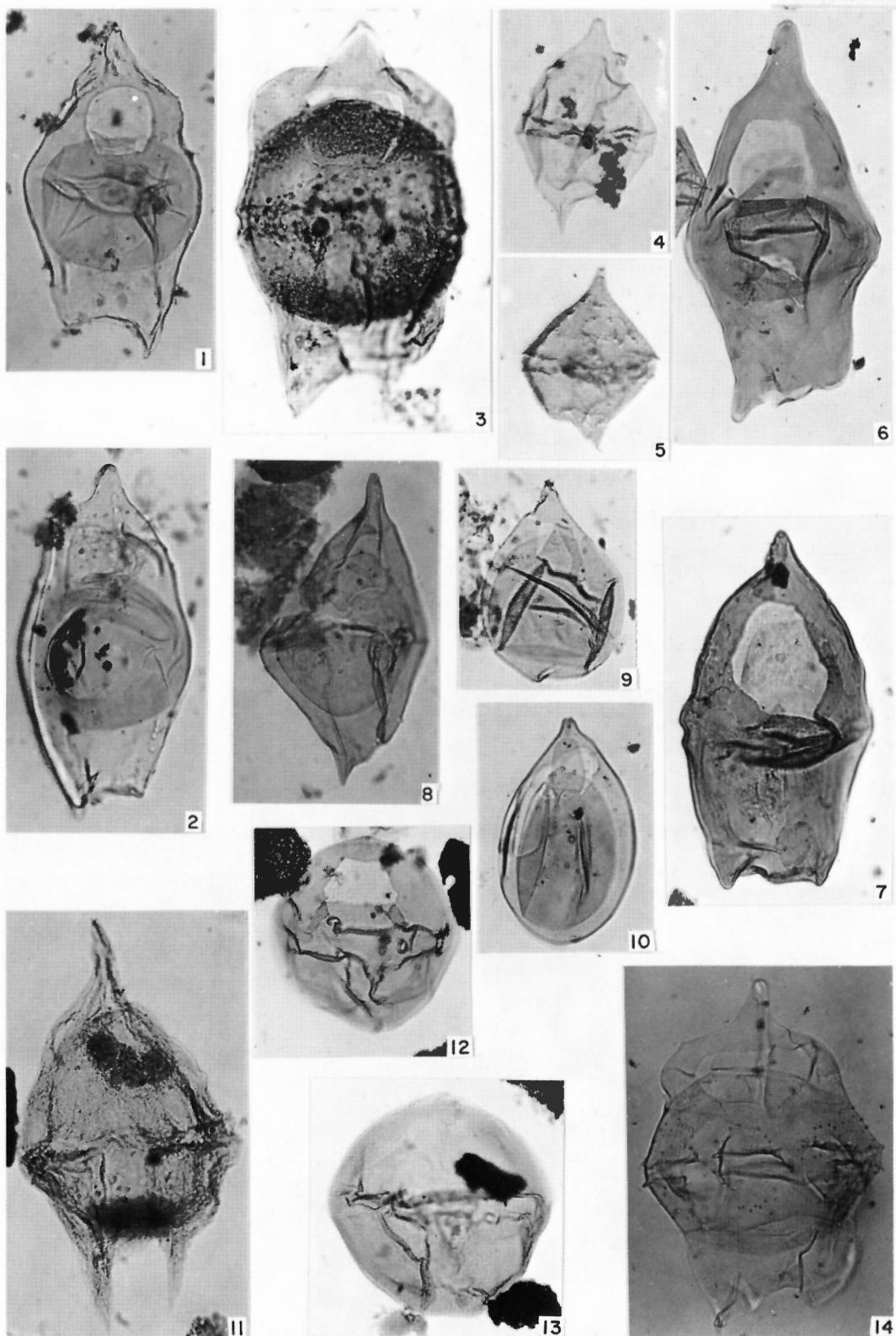


PLATE 3
(all figures x500)

Deflandrea sp. cf. *D. victoriensis*

Figure 1. 16A, 260-270 ft., 12589/5, 297 x 1178, 38035

Spinidinium clavum Harland, 1973

Figure 2. 16A, 290-300 ft., 12591/3, 245 x 1070, 38036

Figure 3. 16A, 290-300 ft., 12591/3, 417 x 1087, 38037

Figure 4. 16A, 290-300 ft., 12591/3, 345 x 1055 Interference Contrast, 38038

Deflandrea sp. 3

Figure 5. 16B, 10-20 ft., 12623/4, 272 x 1129, 38039

Figure 6. 16B, 20-30 ft., 12624/5, 303 x 1120, 38040

Deflandrea sp. 4

Figure 7. 16B, 30-40 ft., 12625/4, 240 x 1104, 38041

Trithyrodinium suspectum (Manum and Cookson) Davey, 1969b

Figure 8. 16A, 100-110 ft., 12556/4, 267 x 1111, 38042

Figure 9. 16A, 100-110 ft., 12556/4, 427 x 1168, 38043

Figure 10. 16A, 100-110 ft., 12556/4, 376 x 1023, 38044

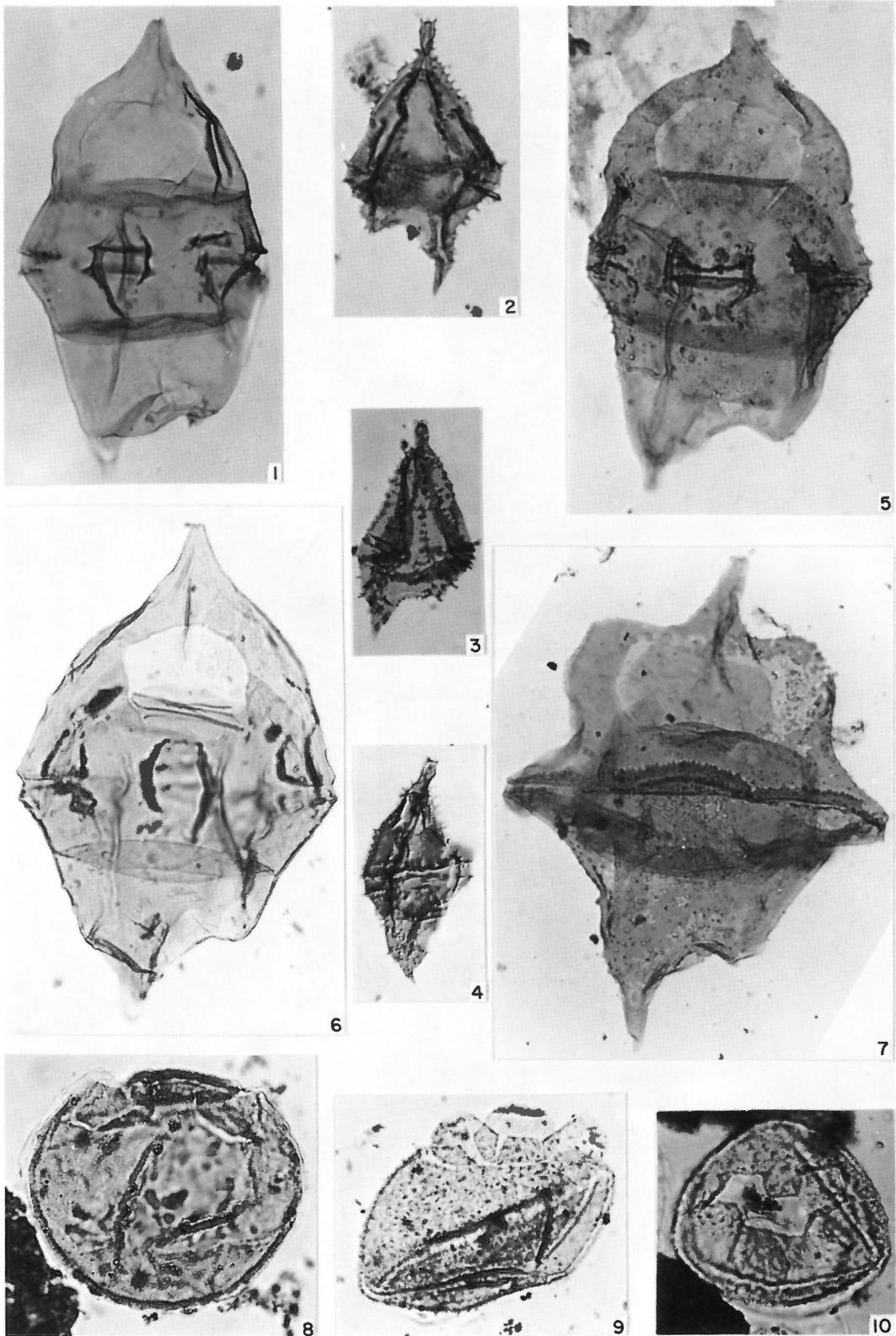


PLATE 4
(all figures x500)

Deflandrea sp. 4

Figure 1. 16B, 30-40 ft., 12625/4, 137 x 1021, 38045

Lejeunia kozlowskii Gorka, 1963

Figure 2. 16B, 170-180 ft., 12651/3, 277 x 1023, 38046
Figure 3. 16B, 170-180 ft., 7057/A1, 211 x 1068, 38047

Deflandrea diebeli Alberti, 1959

Figure 4. 16B, 350-360 ft., 7075/A2, 425 x 1015, 38048
Figure 5. 16B, 250-260 ft., 12659/3, 287 x 1052, 38049

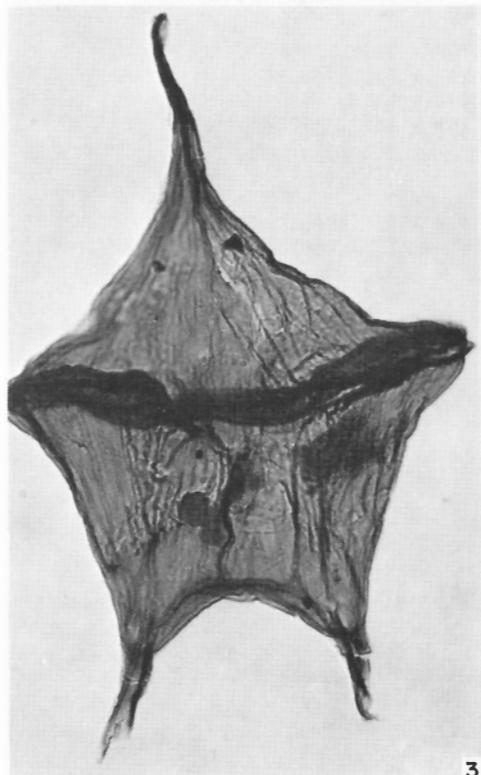
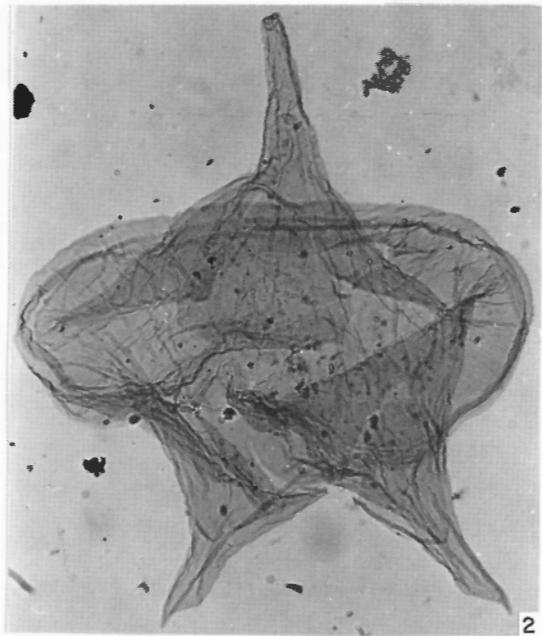
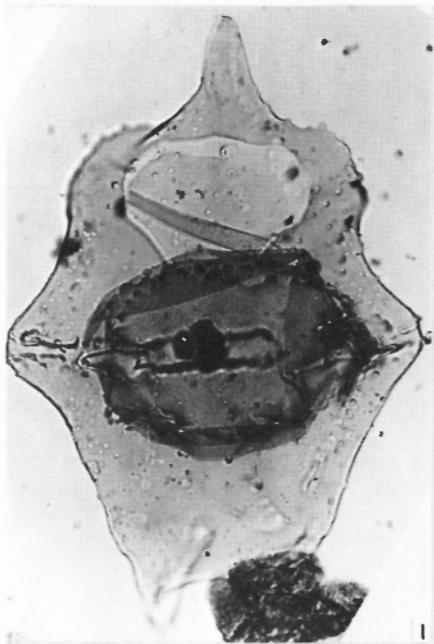


PLATE 5
(all figures x500)

Deflandrea sp. 6

- Figure 1. 17A, 100-110 ft., 6933/A1, 100 x 1051, 38050
Figure 2. 17A, 80-90 ft., 6932/A2, 405 x 1090, 38051

Nelsoniella aceras Cookson and Eisenack, 1960a

- Figure 3. 16B, 20-30 ft., 12624/5, 369 x 1023, 38052

Trithyrodinium ornatum Felix and Burbridge, 1973

- Figure 4. 16A, 70-80 ft., 12553/4, 408 x 1080, 38053
Figure 5. 16A, 110-120 ft., 12557/5, 428 x 1170, 38054
Figure 6. 16A, 170-180 ft., 12580/5, 322 x 1035, 38055
Figure 7. 16A, 80-90 ft., 12554/3, 258 x 1117, 38056

Deflandreoid Form 2

- Figure 8. 16A, 270-280 ft., 12590/5, 158 x 1197, 38057
Figure 9. 16A, 260-270 ft., 12589/3, 237 x 1107, 38058
Figure 10. 16A, 140-150 ft., 12560/3, 292 x 1180, 38059
Figure 11. 16A, 270-280 ft., 12590/5, 363 x 1072, 38060

Diconodinium sp. 2

- Figure 12. 16B, 20-30 ft., 12624/5, 369 x 1023, 38061
Figure 13. 16B, 40-50 ft., 12626/3, 408 x 1111 Interference Contrast, 38062
Figure 14. 16B, 30-40 ft., 12625/4, 355 x 1150, 38063

Plate 5

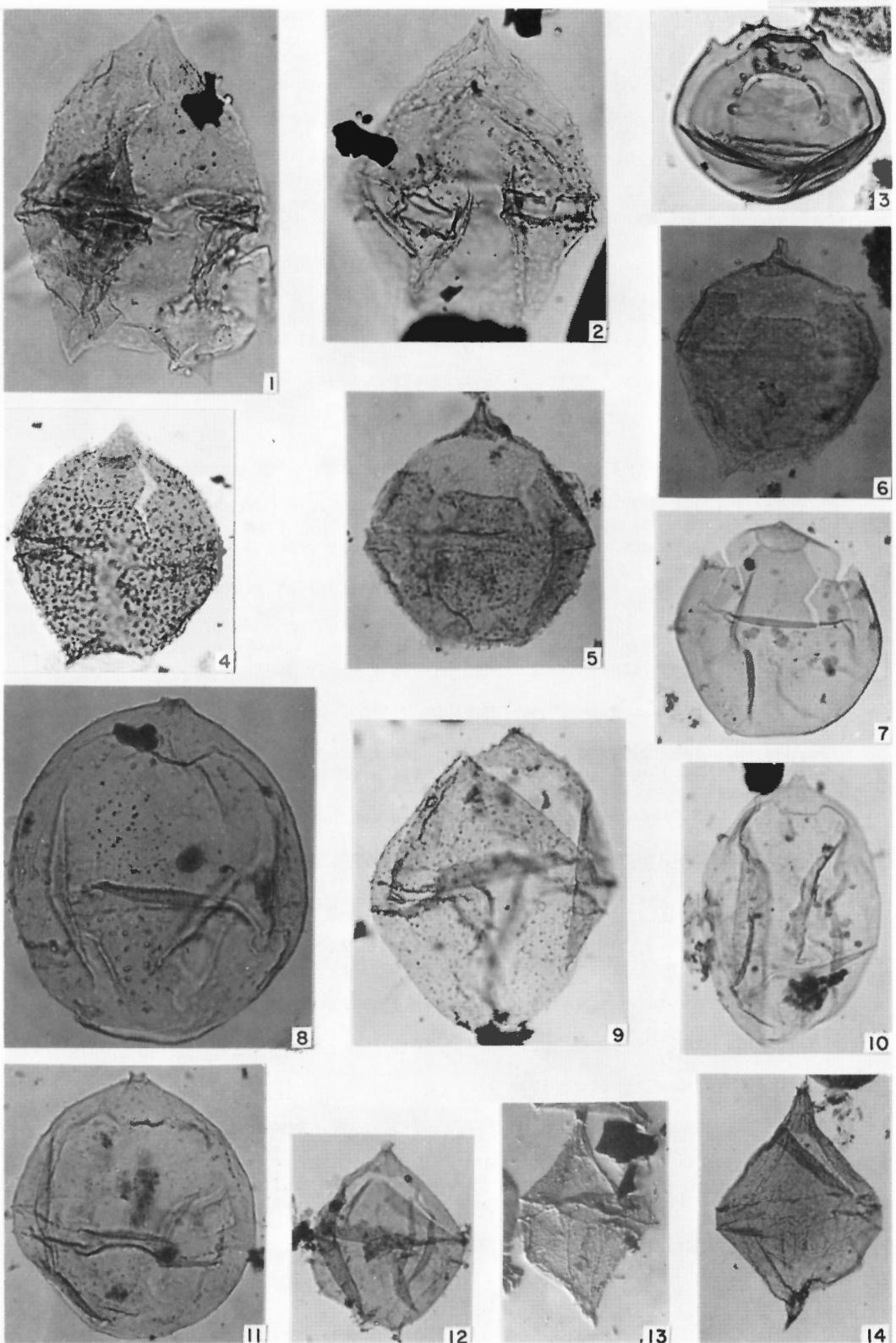


PLATE 6
(all figures x500)

Palaeoperidinium pyrophorum (Ehrenberg) Deflandre, 1934

- Figure 1. 16B, 300-310 ft., 12664/3, 085 x 1097, 38064
Figure 2. 16B, 210-220 ft., 12655/3, 175 x 1092, 38065
Figure 3. 16B, 280-290 ft., 12662/3, 170 x 1151, 38066

Palaeoperidinium basilium Drugg, 1967

- Figure 4. 16B, 280-290 ft., 12662/3, 223 x 1057, 38067
Figure 5. 16B, 260-270 ft., 12660/3, 178 x 1205, 38068
Figure 6. 16B, 40-50 ft., 12626/5, 479 x 1062, 38069

Membranosphaera maastrichtia Samoilovitch ex Norris and Sarjeant, 1965

- Figure 7. 16A, 140-150 ft., 12560/3, 432 x 1014, 38070
Figure 8. 16B, 160-170 ft., 12650/3, 275 x 1197, 38071

Diconodinium firmum Harland, 1973

- Figure 9. 16B, 230-240 ft., 12657/3, 289 x 1000, 38072
Figure 10. 16B, 300-310 ft., 12664/3, 148 x 1075, 38073

Ellipsodinium rugulosum Clarke and Verdier, 1967

- Figure 11. 16A, 80-90 ft., 12554/3, 418 x 1208, 38074

Diconodinium arcticum Manum and Cookson, 1964

- Figure 12. 16A, 50-60 ft., 12551/3, 322 x 1205, 38075
Figure 13. 16A, 0-10 ft., 12546/1, 387 x 1094, 38076

Dictyopyxidia circulata Clarke and Verdier, 1967

- Figure 14. 16A, 20-30 ft., 12548/4, 384 x 1062, 38077

Dinoflagellate Form 1

- Figure 15. 16B, 160-170 ft., 12650/3, 143 x 995, 38078

Plate 6

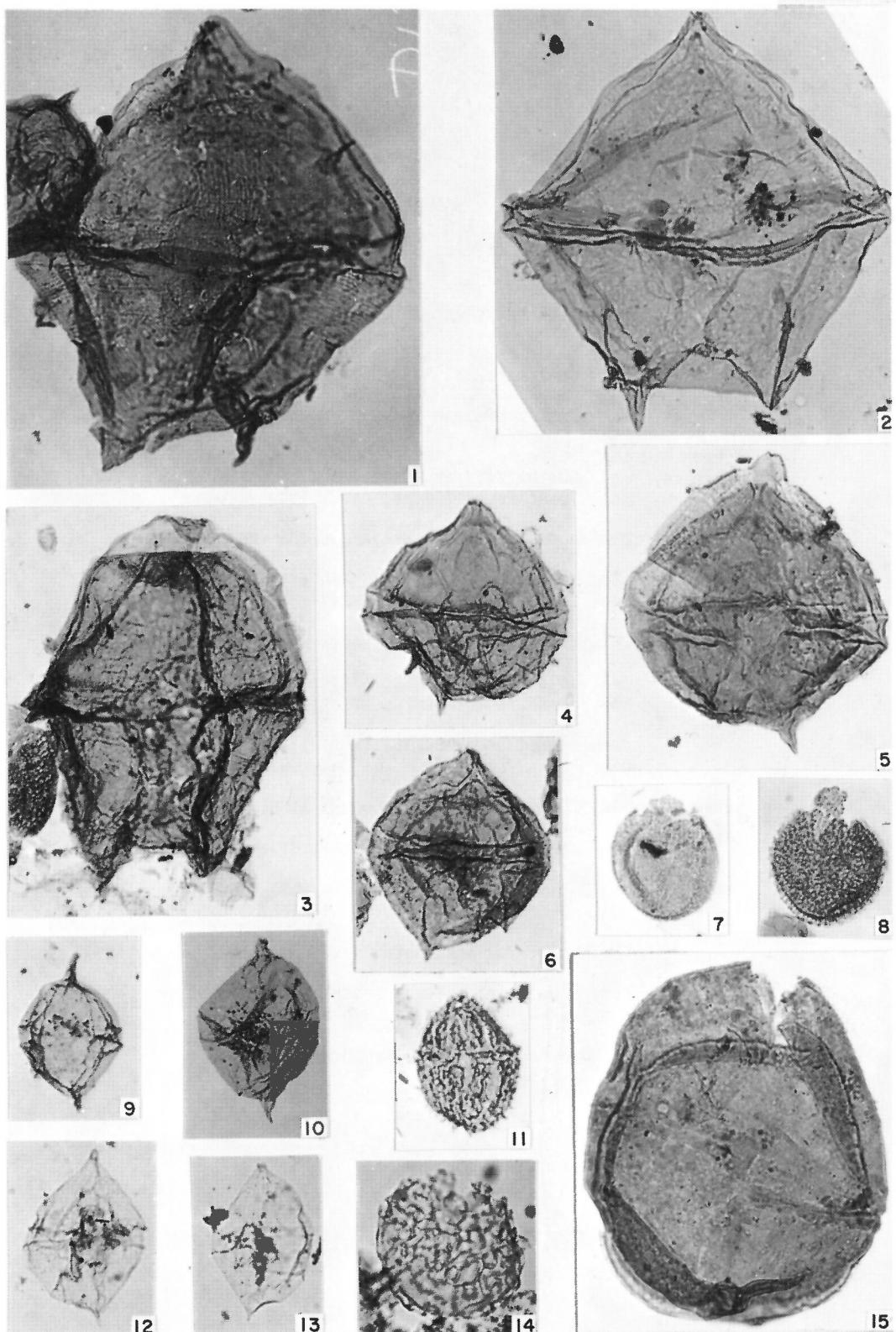


PLATE 7
(all figures x500)

Microdinium sp. cf. *M. irregulare* Clarke and Verdier, 1967

- Figure 1. 16A, 50-60 ft., 12551/3, 352 x 1173, 38079
Figure 2. 16A, 60-70 ft., 12552/3, 324 x 1197, 38080

Microdinium ornatum Cookson and Eisenack, 1960

- Figure 3. 16A, 60-70 ft., 12552/3, 336 x 1166, 38081
Figure 4. 16A, 90-100 ft., 12555/3, 355 x 1150, 38082
Figure 5. 16A, 70-80 ft., 12553/3, 247 x 1190, 38083

Canningia sp. cf. *C. minor* Cookson and Hughes, 1964

- Figure 6. 16B, 240-250 ft., 12658/3, 460 x 1062, 38084
Figure 7. 16B, 210-220 ft., 12655/3, 217 x 1057, 38085

Gillinia hymenophora Cookson and Eisenack, 1960a

- Figure 8. 16B, 40-50 ft., 12626/5, 478 x 1060, 38086
Figure 9. 16B, 40-50 ft., 12626/5, 177 x 1030, 38087

Odontochitina operculata (Wetzel) Deflandre and Cookson, 1955

- Figure 10. 16A, 20-30 ft., 12548/4, 390 x 1188, 38088

Odontochitina costata (Alberti) Clarke and Verdier, 1967

- Figure 11. 16A, 40-50 ft., 12550/3, 268 x 1021, 38089
Figure 12. 16A, 50-60 ft., 12551/3, 409 x 1166, 38090

Cyclonephelium distinctum Deflandre and Cookson, 1955

- Figure 13. 16B, 230-240 ft., 12657/3, 385 x 998, 38091
Figure 14. 16B, 10-20 ft., 12623/4, 386 x 1022, 38092

Palaeostomcystis laevigata Drugg, 1967

- Figure 15. 16A, 70-80 ft., 12553/3, 174 x 1210, 38093
Figure 16. 16B, 30-40 ft., 12625/4, 477 x 1018, 38094

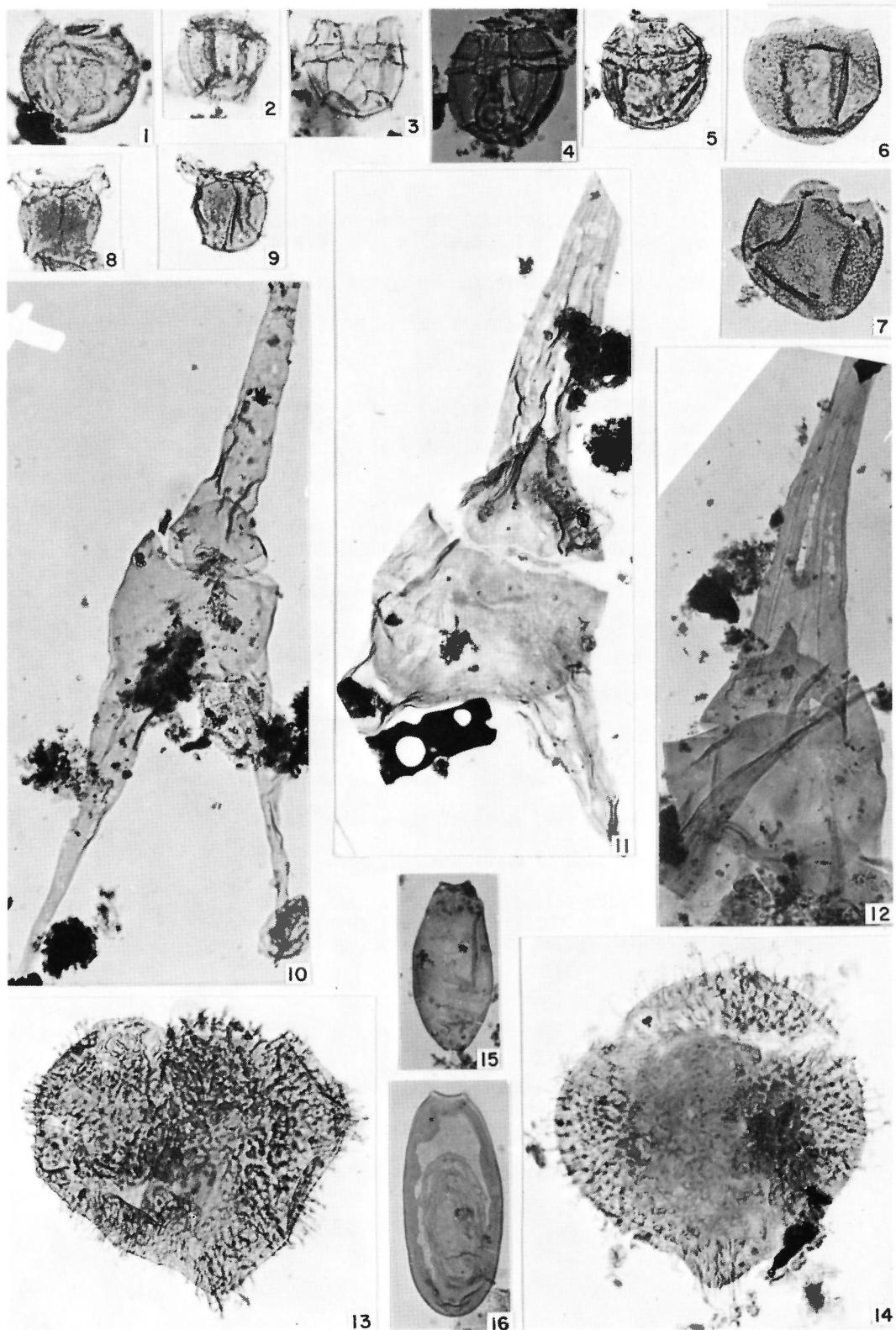


PLATE 8
(all figures x500)

Areoligera sp.

- Figure 1. 16A, 20-30 ft., 12548/3, 410 x 1029, 38095
Figure 2. 16A, 20-30 ft., 12548/3, 267 x 1126, 38096

Cyclonephelium distinctum Deflandre and Cookson, 1955

- Figure 3. 16B, 220-230 ft., 12656/3, 211 x 1074, 38097

Palaeostomocystis chytra Drugg, 1967

- Figure 4. 16B, 40-50 ft., 12626/5, 225 x 1133, 38098
Figure 5. 16B, 40-50 ft., 12626/5, 221 x 1133, 38099
Figure 6. 16B, 10-20 ft., 12623/4, 210 x 1035, 38100

Canningia sp. 1

- Figure 7. 16B, 30-40 ft., 12625/4, 239 x 992, 38101
Figure 8. 16B, 30-40 ft., 12625/4, 260 x 1160, 38102

'*Broomea*' sp. 1 (cf. *Canningia* sp. Manum and Cookson, 1964)

- Figure 9. 16A, 20-30 ft., 12548/3, 099 x 998, 38103
Figure 10. 16A, 70-80 ft., 12553/3, 197 x 1118, 38104

Palaeostomocystis sp. 2

- Figure 11. 16A, 40-50 ft., 12550/3, 374 x 1164, 38105

Horologinella apiculata Cookson and Eisenack, 1962a

- Figure 12. 16B, 100-110 ft., 12632/3, 320 x 1209, 38106

Dorocysta litotes Davey, 1970

- Figure 13. 16A, 110-120 ft., 12557/3, 298 x 1123, 38107
Figure 14. 16A, 20-30 ft., 12548/3, 269 x 1070, 38108
Figure 15. 16A, 70-80 ft., 12553/3, 244 x 1074, 38109

'*Broomea*' sp. 2

- Figure 16. 16A, 270-280 ft., 12590/3, 200 x 1102, 38110
Figure 17. 16A, 300-310 ft., 12592/3, 164 x 1097, 38111

Fromea amphora Cookson and Eisenack, 1958

- Figure 18. 16A, 210-220 ft., 12584/5, 226 x 1094, 38112

Trigonopyxidium ginella (Cookson and Eisenack) Cookson
and Eisenack, 1961

- Figure 19. 16A, 200-210 ft., 12583/5, 496 x 1051, 38113

Plate 8

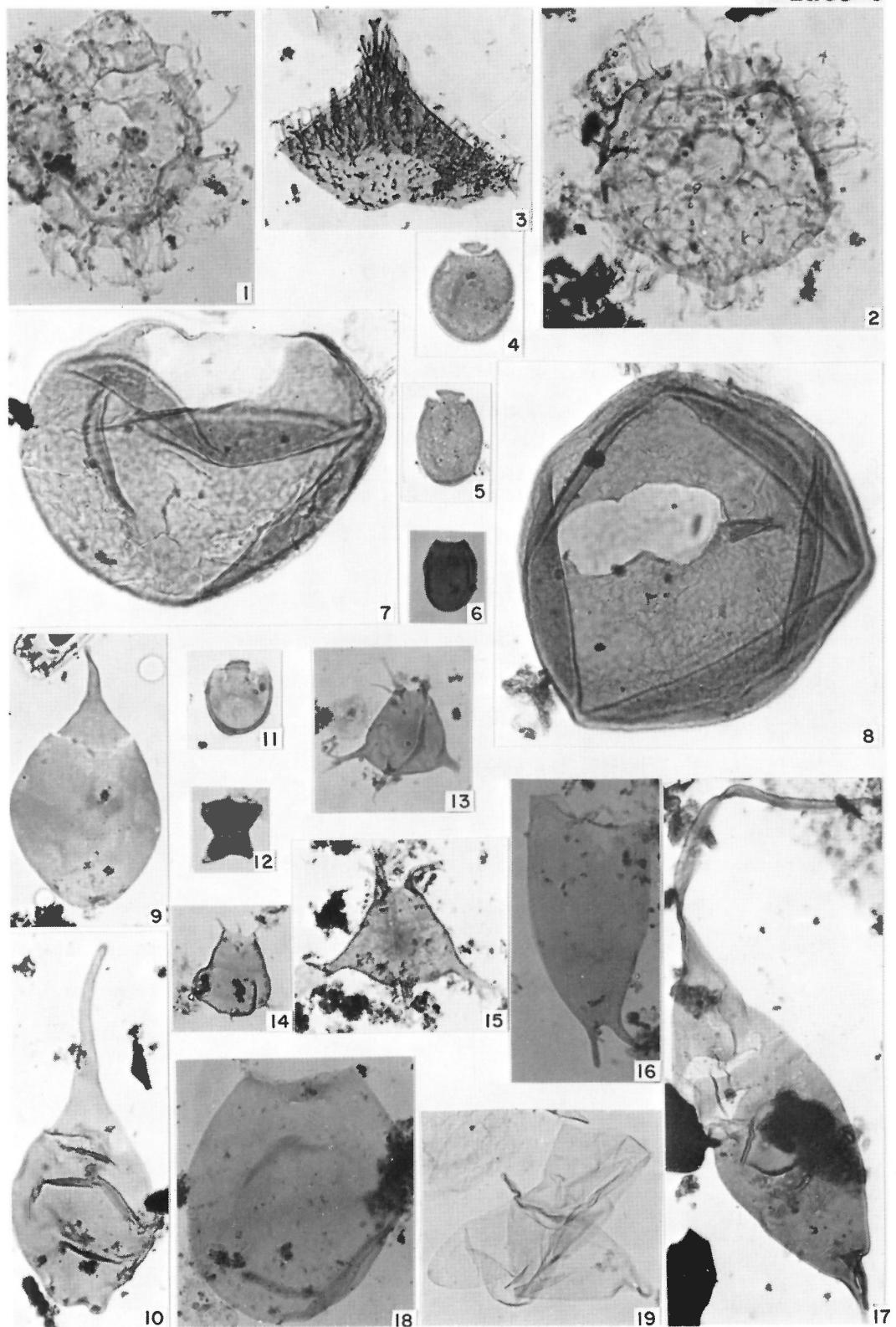


PLATE 9
(all figures x500)

Palaeostomocystis fragilis Cookson and Eisenack, 1962

Figure 1. 17A, 40-50 ft., 6930/A1, 235 x 1125, 38114

Wallodinium anglicum (Cookson and Hughes) Lentini and Williams, 1973

Figure 2. 16A, 80-90 ft., 12554/3, 470 x 1138, 38115

Figure 3. 16A, 130-140 ft., 12559/3, 366 x 996, 38116

Kalyptea aceras Manum and Cookson, 1964

Figure 4. 16B, 70-80 ft., 12629/3, 100 x 1027, 38117

Figure 5. 16B, 210-220 ft., 12655/3, 354 x 1208, 38118

Kalyptea monoceras Cookson and Eisenack, 1960b

Figure 6. 16A, 70-80 ft., 12553/3, 446 x 1178, 38119

Spiniferites ramosus (Ehrenberg) Mantell, 1854

Figure 7. 16A, 130-140 ft., 12559/3, 278 x 998, 38120

Figure 9. 16A, 100-110 ft., 12556/3, 355 x 1196, 38121

Spiniferites sp. 1

Figure 8. 16A, 70-80 ft., 12553/3, 272 x 1075, 38122

Oligosphaeridium complex (White) Davey and Williams, 1966

Figure 10. 16A, 290-300 ft., 12591/3, 308 x 1038 Interference Contrast, 38123

Oligosphaeridium pulcherrimum (Deflandre and Cookson) Davey and Williams, 1966

Figure 11. 16A, 180-190 ft., 12581/3, 454 x 1033, 38124

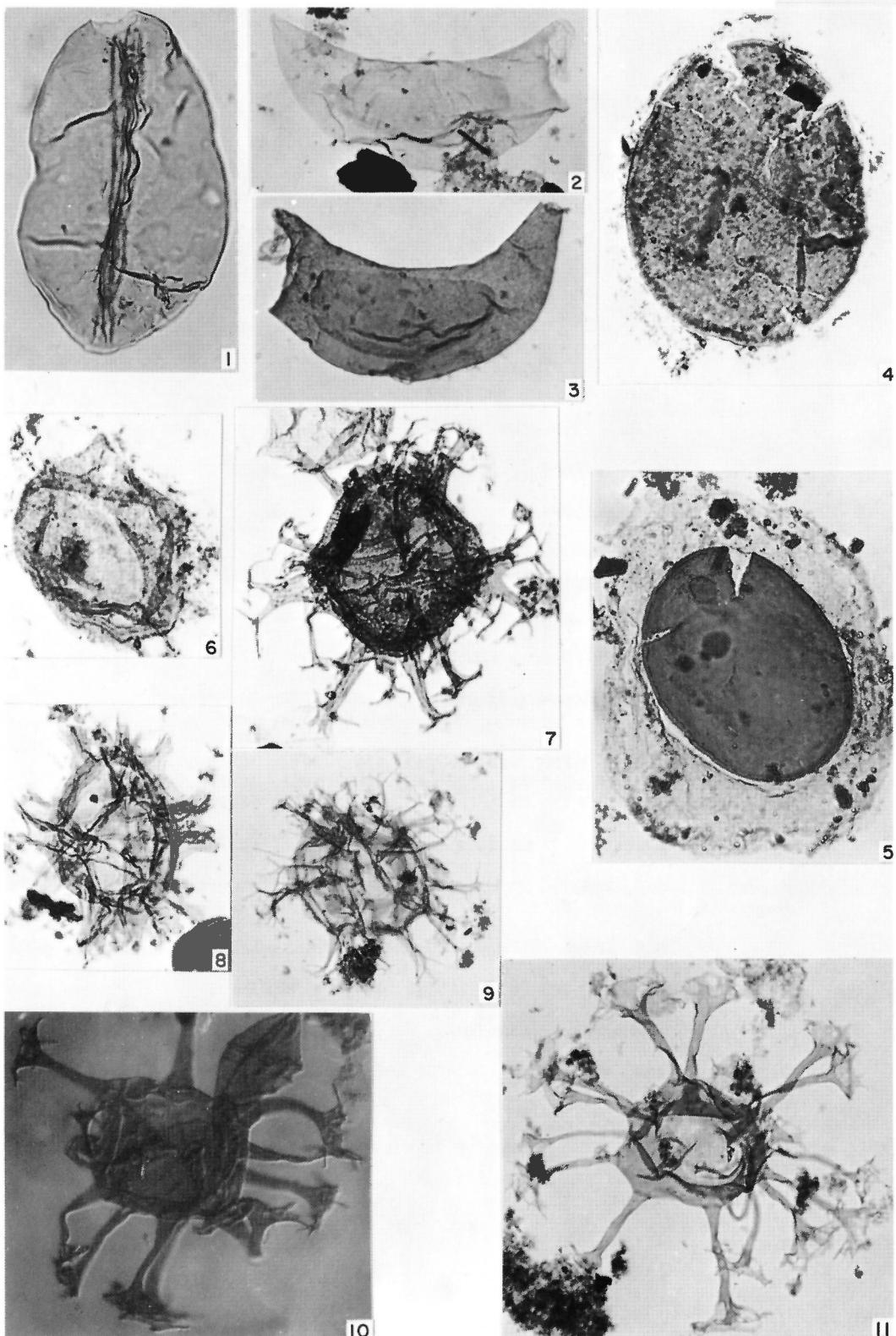


PLATE 10
(all figures x500)

Oligosphaeridium pulcherrimum

Figure 1. 16A, 70-80 ft., 12553/3, 083 x 1054, 38125

Oligosphaeridium anthophorum (Cookson and Eisenack)
Davey and Williams, 1966

Figure 2. 16B, 250-260 ft., 12659/3, 420 x 997, 38126

Achmosphaera ramulifera (Deflandre) Evitt, 1963

Figure 3. 16A, 70-80 ft., 12553/3, 196 x 1189, 38127

Hystrichosphaeridium sp. cf. *H. difficile* Manum
and Cookson, 1964

Figure 4. 16B, 170-180 ft., 12651/3, 430 x 1032, 38128

Figure 5. 16B, 140-150 ft., 12636/3, 400 x 1152, 38129

Figure 6. 16A, 300-310 ft., 12592/3, 213 x 1115, 38130

Hystrichosphaeridium sp. 3 (cf. *H. difficile*)

Figure 7. 16B, 220-230 ft., 12656/3, 288 x 1049 Interference Contrast, 38131

Figure 8. 16B, 70-80 ft., 12629/3, 089 x 1192, 38132

Chlamydophorella nyei Cookson and Eisenack, 1958

Figure 9. 16A, 290-300 ft., 12591/3, 434 x 1105, 38133

Adnatosphaeridium sp.

Figure 10. 16B, 40-50 ft., 12626/3, 297 x 1144, 38134

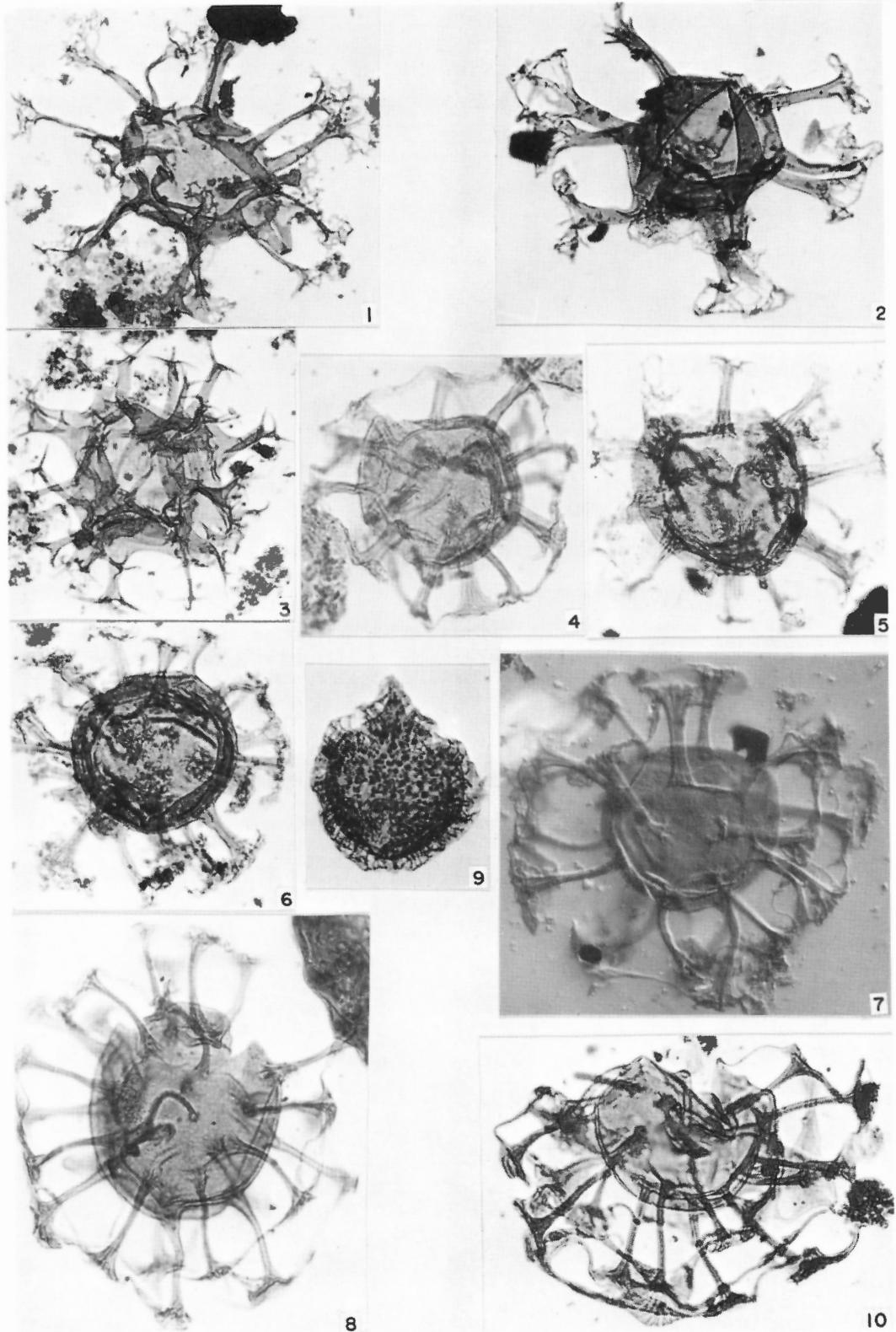


PLATE 11
(all figures x500)

Adnatosphaeridium sp.

Figure 1. 16B, 40-50 ft., 12626/5, 414 x 996, 38135

Hystrichosphaeridium sp. 2

Figure 2. 16B, 30-40 ft., 12625/4, 453 x 985, 38136

Figure 3. 16B, 40-50 ft., 12626/3, 409 x 1111 Interference Contrast, 38137

Figure 4. 16B, 30-40 ft., 12625/4, 281 x 1132, 38138

Cribroperidinium sp.

Figure 5. 16B, 0-10 ft., 12622/4, 384 x 1128, 38139

Figure 6. 16B, 30-40 ft., 12625/4, 464 x 1087, 38140

Hexagonifera chlamydata Cookson and Eisenack, 1962b

Figure 7. 16A, 270-280 ft., 12590/5, 177 x 1030, 38141

Figure 8. 16B, 40-50 ft., 12626/3, 408 x 1201, 38142

Figure 9. 16B, 30-40 ft., 12625/4, 324 x 1147, 38143

Plate 11

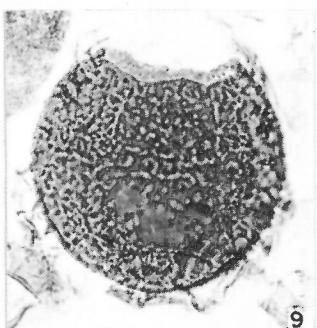
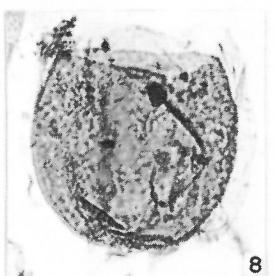
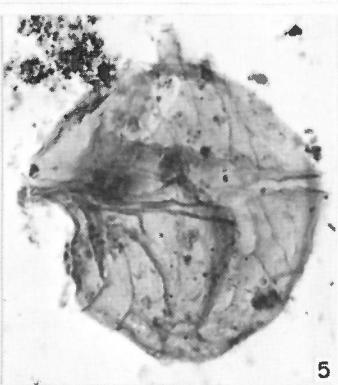
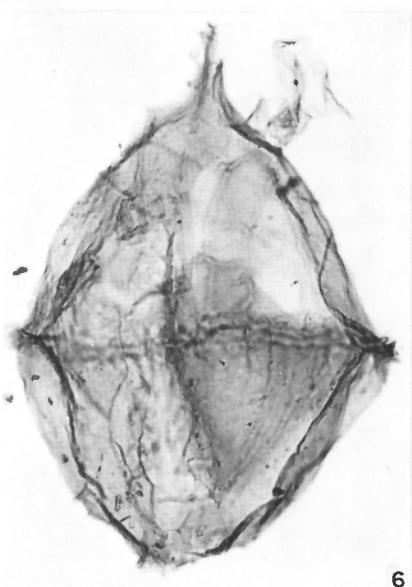
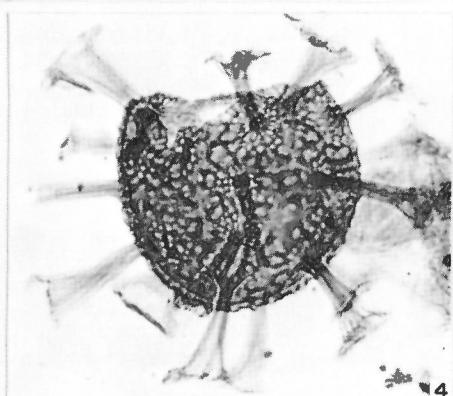
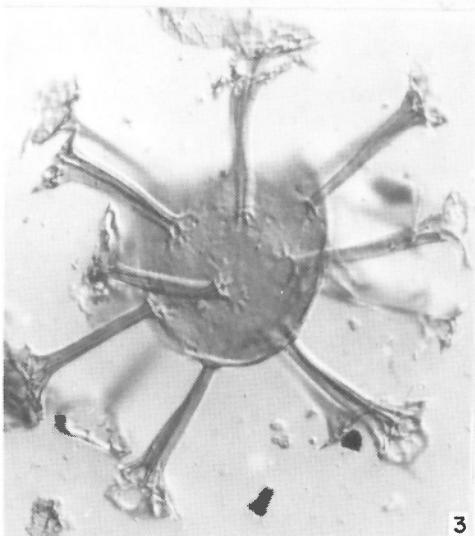
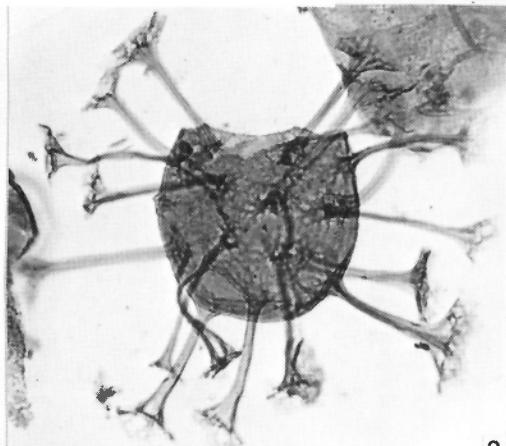
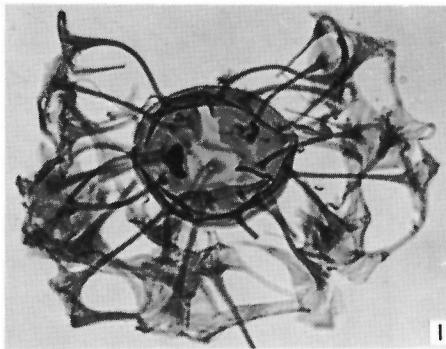


PLATE 12
(all figures x500)

Spongodinium delitiense (Ehrenberg) Deflandre, 1936

- Figure 1. 16A, 320-330 ft., 12594/5, 121 x 1001, 38144
Figure 2. 16A, 60-70 ft., 12552/3, 189 x 1039, 38145

Trichodinium castaneum (Deflandre) Clarke and Verdier,
1967

- Figure 3. 16A, 70-80 ft., 12553/3, 460 x 1113, 38146

Pterodinium sp. 1

- Figure 4. 16A, 100-110 ft., 12556/3, 444 x 1184, 38147
Figure 5. 16A, 70-80 ft., 12553/3, 326 x 1096, 38148

Pterodinium sp. 2

- Figure 6. 16B, 40-50 ft., 12626/5, 301 x 1120, 38149

Hystrichosphaeropsis sp.

- Figure 7. 16B, 150-160 ft., 12637/3, 385 x 1098, 38150
Figure 8. 16B, 80-90 ft., 12630/3, 424 x 1054 Interference Contrast, 38151
Figure 9. 16B, 70-80 ft., 12629/3, 232 x 1152, 38152

Cleistosphaeridium sp. cf. *C. aciculare* Davey, 1969a

- Figure 10. 16B, 50-60 ft., 12627/3, 282 x 1051, 38153
Figure 11. 16B, 70-80 ft., 12629/3, 444 x 1154, 38154

Implatosphaeridium sp. cf. *I. whitei* (Deflandre and Courteville) Morgenroth, 1966

- Figure 12. 16A, 140-150 ft., 12560/3, 438 x 996, 38155

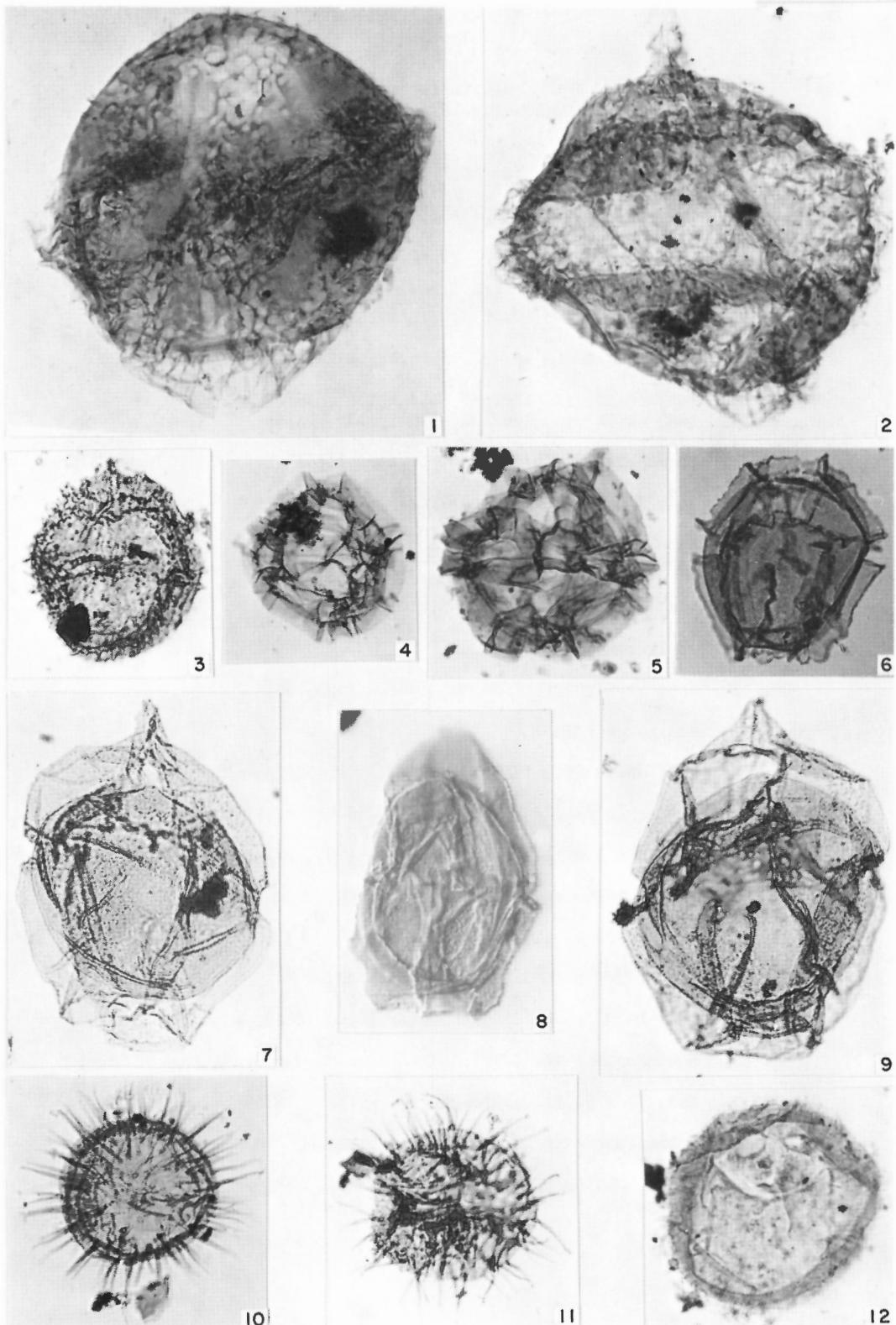


PLATE 13
(all figures x500)

Hystrichosphaeridium stellatum Maier, 1959

Figure 1. 16B, 130-140 ft., 12635/3, 416 x 1057, 38156

Cleistosphaeridium sp. cf. *C. polypes* (Cookson and Eisenack)
Davey, 1969a

Figure 2. 16A, 20-30 ft., 12548/3, 175 x 1043, 38157

Polysphaeridium sp. cf. *P. subtile* Davey and Williams, 1966

Figure 3. 16B, 40-50 ft., 12626/3, 453 x 1212, 38158

Figure 4. 16B, 40-50 ft., 12626/5, 375 x 1199, 38159

Exochosphaeridium sp. cf. *E. striolatum* (Deflandre) Davey, 1969a

Figure 5. 16A, 270-280 ft., 12590/5, 285 x 1031, 38160

Figure 6. 16A, 290-300 ft., 12591/3, 220 x 1001, 38161

Ophiobolus lapidaris O. Wetzel, 1933

Figure 7. 16A, 300-310 ft., 12592/3, 109 x 1072, 38162

Acritarch Form 2

Figure 8. 16B, 110-120 ft., 12633/3, 421 x 1093, 38163

Acritarch Form 1

Figure 9. 16A, 40-50 ft., 12550/3, 282 x 1191, 38164

Schizocystia laevigata Cookson and Eisenack, 1962a

Figure 10. 16B, 290-300 ft., 12663/3, 115 x 1205, 38165

Palambages Form C Manum and Cookson, 1964

Figure 11. 16B, 10-20 ft., 12623/4, 290 x 1020, 38166

Palambages Form A Manum and Cookson, 1964

Figure 12. 16A, 50-60 ft., 12551/4, 181 x 1000, 38167

Schizosporis sp. 1 (cf. *Disulcites magnus* Srivastava, 1969b)

Figure 13. 16B, 170-180 ft., 12651/3, 434 x 1170, 38168

Schizosporis sp. 2

Figure 14. 16B, 400-410 ft., 13508/1, 231 x 1083, 38169

Plate 13

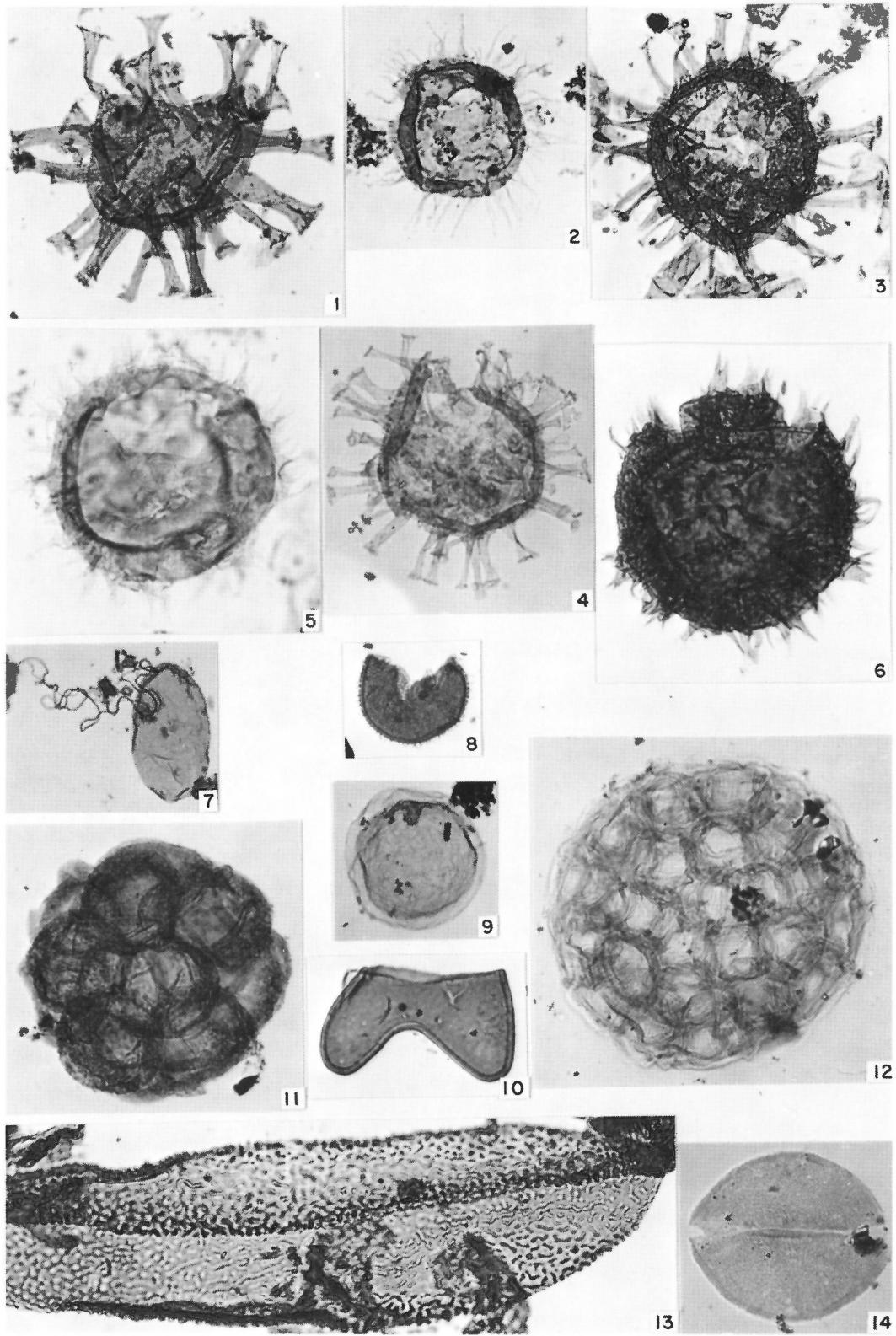


PLATE 14
(all figures x500)

- Stereisporites antiquasporites* (Wilson and Webster) Dettmann, 1963
- Figure 1. 16B, 320-330 ft., 7072/A1, 411 x 1160, 38170
- Stereisporites regium* (Drozhastchich) Drugg, 1967
- Figure 2. 16B, 270-280 ft., 12661/3, 405 x 1058, 38171
- Figure 3. 16B, 240-250 ft., 12658/3, 285 x 1161, 38172
- Gleicheniidites senonicus* Ross, 1949
- Figure 4. 17A, 25-30 ft., 6928/A1, 375 x 1034, 38173
- Figure 5. 16B, 240-250 ft., 12658/3, 223 x 1126, 38174
- Ornamentifera tuberculata* (Grigorjeva) Bolkhovitina, 1968
- Figure 6. 16A, 70-80 ft., 12553/3, 298 x 1207, 38175
- Figure 7. 16B, 120-130 ft., 12634/3, 358 x 1141, 38176
- Cyathidites minor* Couper, 1953
- Figure 8. 16B, 0-10 ft., 12622/3, 449 x 1042, 38177
- Baculatisporites comauensis* (Cookson) Potonié, 1956
- Figure 9. 16B, 140-150 ft., 12636/3, 098 x 1157, 38178
- Osmundacidites wellmanii* Couper, 1953
- Figure 10. 16B, 160-170 ft., 12650/3, 266 x 1023, 38179
- Figure 11. 16B, 270-280 ft., 12661/3, 432 x 1180, 38180
- Lycopodiumsporites austroclavatidites* (Cookson) Potonié, 1956
- Figure 12. 16B, 50-60 ft., 12627/3, 282 x 1054, 38181
- Neoraistrickia* sp. cf. *N. truncata* (Cookson) Potonié, 1956
- Figure 13. 16B, 50-60 ft., 12627/3, 411 x 1152, 38182
- Figure 14. 16B, 200-210 ft., 12654/3, 427 x 1164, 38183
- Radialisporis radiatus* (Krutzsch) Krutzsch, 1967
- Figure 15. 16B, 210-220 ft., 12655/3, 296 x 1026, 38184
- Figure 16. 16B, 290-300 ft., 12663/3, 246 x 1087, 38185
- Ceratosporites* sp. cf. *C. couliensis* Srivastava, 1972
- Figure 17. 16B, 270-280 ft., 12661/3, 425 x 1117, 38186
- Figure 18. 16B, 390-400 ft., 7079/A3, 349 x 1007, 38187
- Polycingulatisporites reduncus* (Bolkhovitina) Playford and Dettmann, 1965
- Figure 19. 16B, 300-310 ft., 12664/3, 435 x 1155, 38188
- Figure 20. 16B, 270-280 ft., 12661/3, 440 x 1047, 38189
- Camarozonosporites insignis* Norris, 1967
- Figure 21. 16B, 50-60 ft., 12627/3, 340 x 1142, 38190
- Figure 22. 16B, 250-260 ft., 12659/3, 423 x 1159, 38191
- Figure 23. 16B, 120-130 ft., 12634/3, 164 x 1203, 38192
- Hamulatisporis amplius* Stanley, 1965
- Figure 24. 16B, 380-390 ft., 7078/A1, 315 x 1075, 38193
- Figure 25. 16B, 230-240 ft., 12657/3, 067 x 1030, 38194
- Hazaria sheoparii* Srivastava, 1971
- Figure 26. 16B, 290-300 ft., 12663/3, 269 x 1187, 38195
- Figure 27. 16B, 230-240 ft., 12657/3, 240 x 1080, 38196
- Polypodiidites* sp.
- Figure 28. 16B, 360-370 ft., 7076/A1, 232 x 1002, 38197
- Figure 29. 16B, 200-210 ft., 12654/3, 186 x 1071, 38198
- Umbosporites callosus* Newman, 1965
- Figure 30. 16A, 50-60 ft., 12551/3, 350 x 1021, 38199
- Laevigatosporites ovatus* Wilson and Webster, 1946
- Figure 31. 16B, 240-250 ft., 12658/3, 286 x 1034, 38200
- Reticuloidosporites* sp.
- Figure 32. 16B, 290-300 ft., 12663/3, 146 x 1141, 38201
- Abietineaepollenites* sp.
- Figure 33. 16A, 0-10 ft., 12546/3, 462 x 1019, 38202
- Figure 34. 16B, 300-310 ft., 12664/3, 250 x 1085, 38203
- Podocarpidites multesimus* (Bolkhovitina) Pocock, 1962
- Figure 35. 16A, 60-70 ft., 12552/3, 488 x 1132, 38204
- Figure 36. 16B, 300-310 ft., 12664/3, 435 x 1180, 38205
- Cedripites cretaceus* Pocock, 1962
- Figure 37. 16A, 40-50 ft., 12550/3, 200 x 1142, 38206
- Alisporites bilateralis* Rouse, 1959
- Figure 38. 16A, 60-70 ft., 12552/3, 491 x 1205, 38207

Plate 14

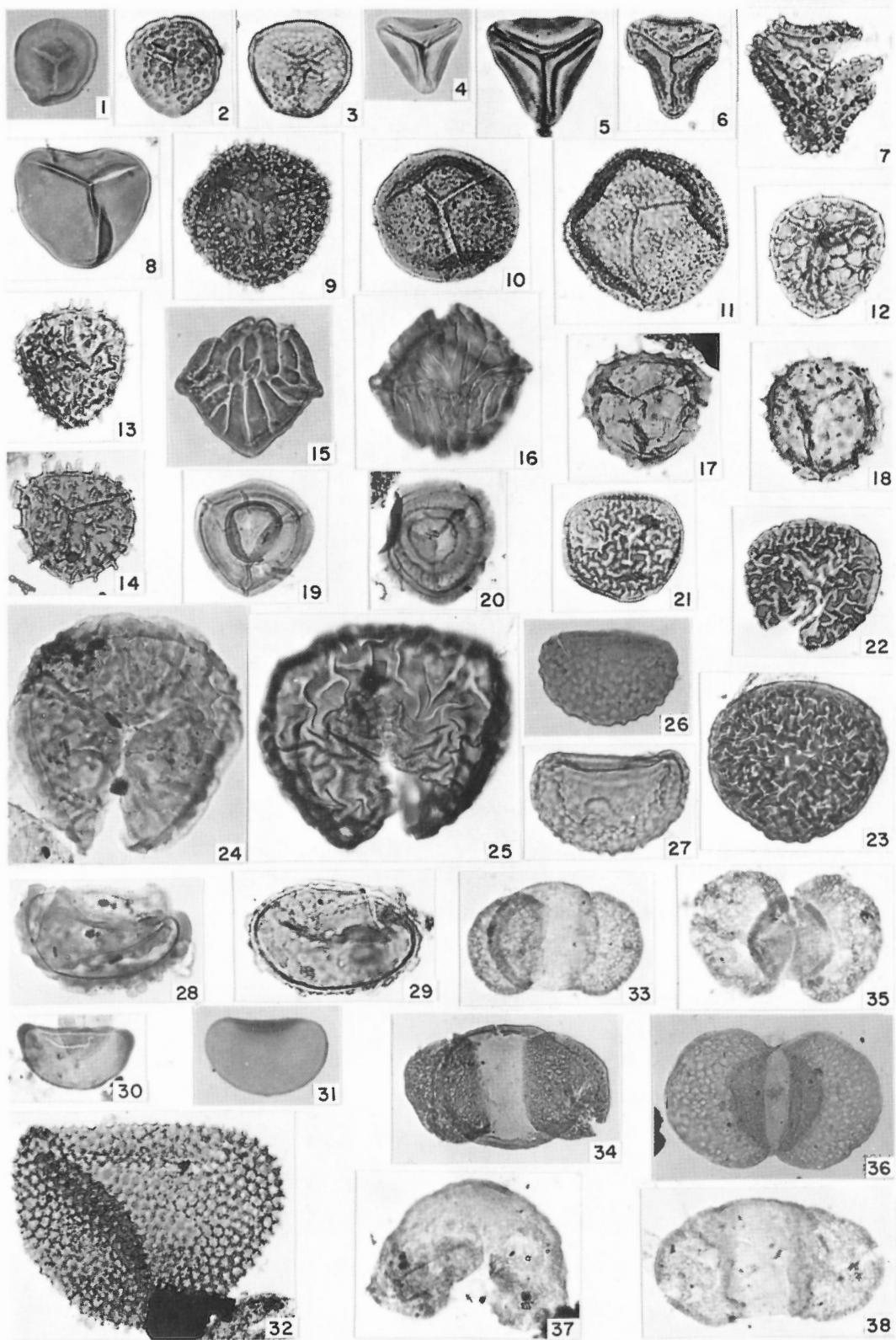


PLATE 15
(Figures 1-12, x500; Figures 13-20, x1,000)

Podocarpidites biformis Rouse, 1957

- Figure 1. 16B, 170-180 ft., 12651/3, 387 x 1010, 38208
Figure 2. 16B, 10-20 ft., 12623/4, 146 x 1209, 38209

Piceapollenites sp. 1

- Figure 3. 17A, 80-90 ft., 6932/A2, 354 x 1056, 38210

Piceapollenites sp. 2

- Figure 4. 16B, 290-300 ft., 12663/3, 206 x 1212, 38211

Phyllocladidites microreticulatus Brenner, 1963

- Figure 5. 16A, 40-50 ft., 12550/3, 137 x 1208, 38212
Figure 6. 16A, 50-60 ft., 12551/3, 337 x 1031, 38213

Phyllocladidites inchoatus (Pierce) Norris, 1967

- Figure 7. 16B, 300-310 ft., 12664/3, 359 x 1167, 38214
Figure 8. 16A, 40-50 ft., 12550/3, 131 x 1080, 38215

Cycadopites nitidus (Balme) Norris, 1969

- Figure 9. 16A, 270-280 ft., 12590/3, 354 x 1092, 38216

Taxodiaceae pollenites hiatus (Potonié) Kremp, 1949

- Figure 10. 16A, 40-50 ft., 12550/3, 380 x 1210, 38217
Figure 11. 16B, 100-110 ft., 12632/3, 423 x 1103, 38218

Cerebropollenites mesozoicus (Couper) Nilsson, 1958

- Figure 12. 16A, 40-50 ft., 12550/3, 160 x 1116, 38219

Wodehouseia jacutense (Samoilovitch) Samoilovitch, 1967

- Figure 13. 16B, 350-360 ft., 7075/A2, 340 x 1046, 38220
Figure 19. 16B, 280-290 ft., 12662/3, 321 x 1146, 38221

Azonia fabacea Samoilovitch, 1961

- Figure 14. 16B, 80-90 ft., 12630/3, 422 x 1203, 38222

Wodehouseia gracile (Samoilovitch) Pokrovskaya, 1966

- Figure 15. 16B, 200-210 ft., 12654/3, 374 x 1107, 38223
Figure 16. 16B, 330-340 ft., 7073/A1, 281 x 1097, 38224

Singularia aculeata Samoilovitch, 1961

- Figure 17. 16B, 310-320 ft., 12665/3, 317 x 1197, 38225

Wodehouseia spinata Stanley, 1961

- Figure 18. 16B, 230-240 ft., 12657/3, 300 x 1161, 38226

Wodehouseia fimbriata Stanley, 1961

- Figure 20. 16B, 310-320 ft., 12665/5, 317 x 1041, 38227

Plate 15

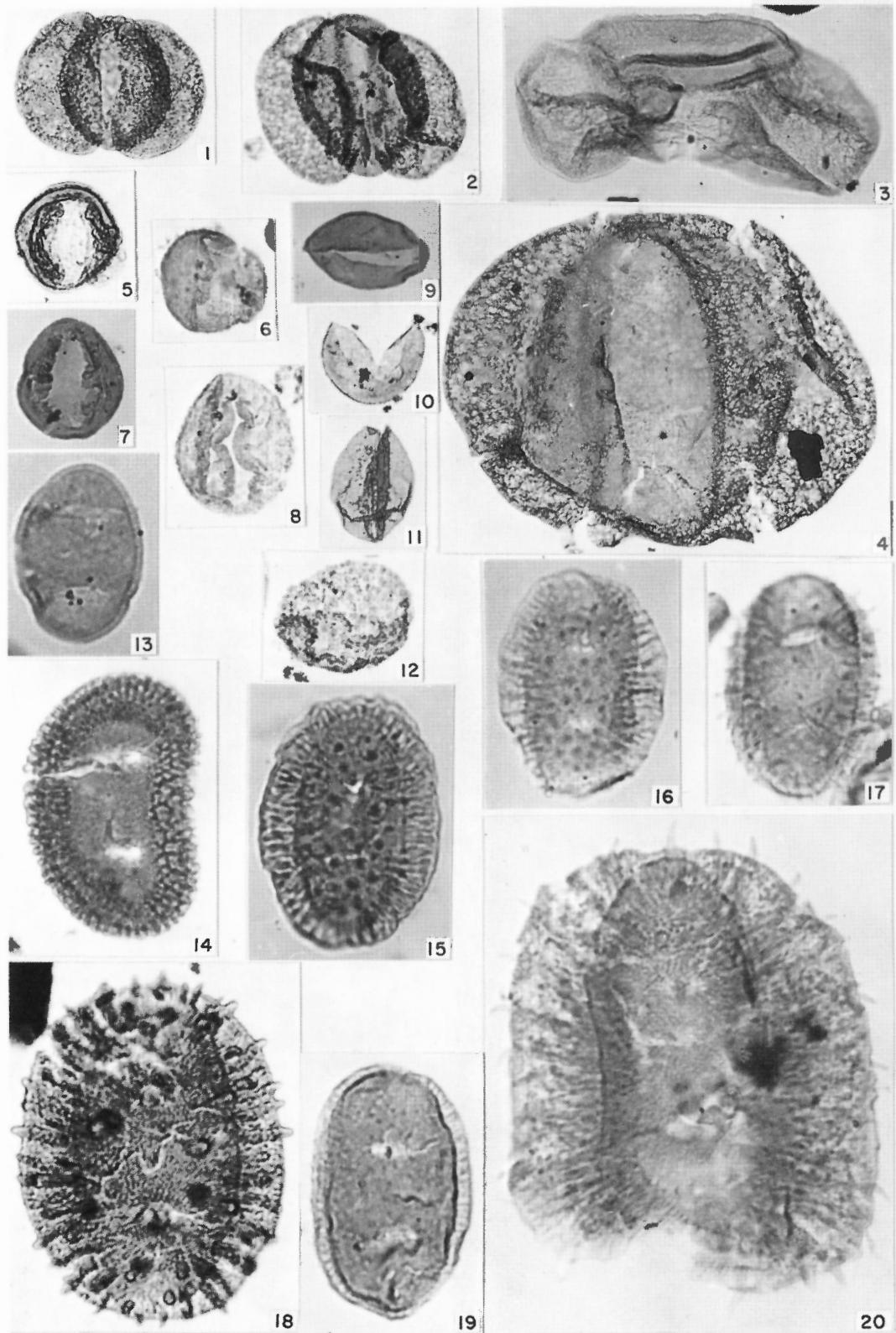


PLATE 16
(all figures x1,000)

Loranthacites sp. 2

- Figure 1. 16B, 60-70 ft., 12628/3, 422 x 1024, 38228
Figure 2. 16B, 40-50 ft., 12626/3, 366 x 1050, 38229

Loranthacites sp. 3

- Figure 3. 16B, 80-90 ft., 12630/3, 367 x 1178, 38230
Figure 4. 16B, 130-140 ft., 12635/3, 379 x 1126, 38231

Anacolosidites sp.

- Figure 5. 16B, 260-270 ft., 12660/3, 416 x 1080, 38232
Figure 6. 16B, 310-330 ft., 12665/3, 446 x 1087, 38233
Figure 7. 16B, 180-190 ft., 12652/3, 390 x 1044, 38234

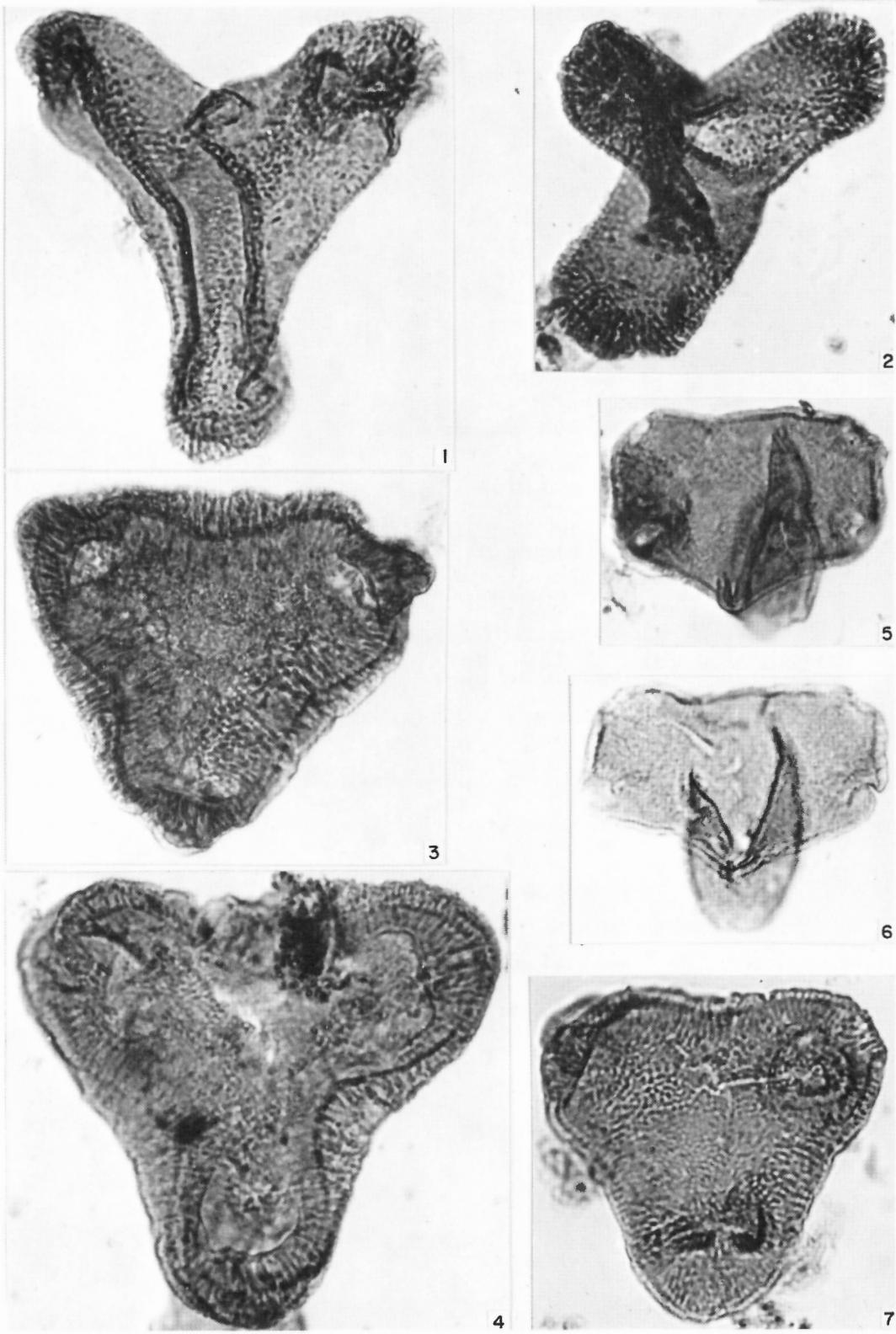


PLATE 17
(all figures x1,000)

Expressipollis sp. 1

- Figure 1. 16B, 200-210 ft., 12654/3, 432 x 1061, 38235
Figure 2. 16B, 200-210 ft., 12654/3, 327 x 1153, 38236

Anacolosidites sp.

- Figure 3. 16B, 300-310 ft., 12664/3, 315 x 1095, 38237

Loranthacites sp. 1

- Figure 4. 16B, 40-50 ft., 12626/3, 360 x 1057, 38238
Figure 5. 16B, 170-180 ft., 12651/3, 257 x 1132, 38239

Loranthacites pilatus Mchedlishvili, 1961

- Figure 6. 16B, 310-320 ft., 12665/3, 279 x 1178, 38240
Figure 7. 16B, 390-400 ft., 7079/A3, 115 x 1057, 38241

Expressipollis sp. 2

- Figure 8. 16B, 160-170 ft., 12650/3, 316 x 1049, 38242

Orbiculapollis globosus (Chlonova) Chlonova, 1961

- Figure 9. 16B, 40-50 ft., 12626/3, 415 x 1081, 38254
Figure 10. 16B, 280-290 ft., 12662/3, 207 x 1168, 38243
Figure 11. 16B, 220-230 ft., 12656/3, 431 x 1152, 38244

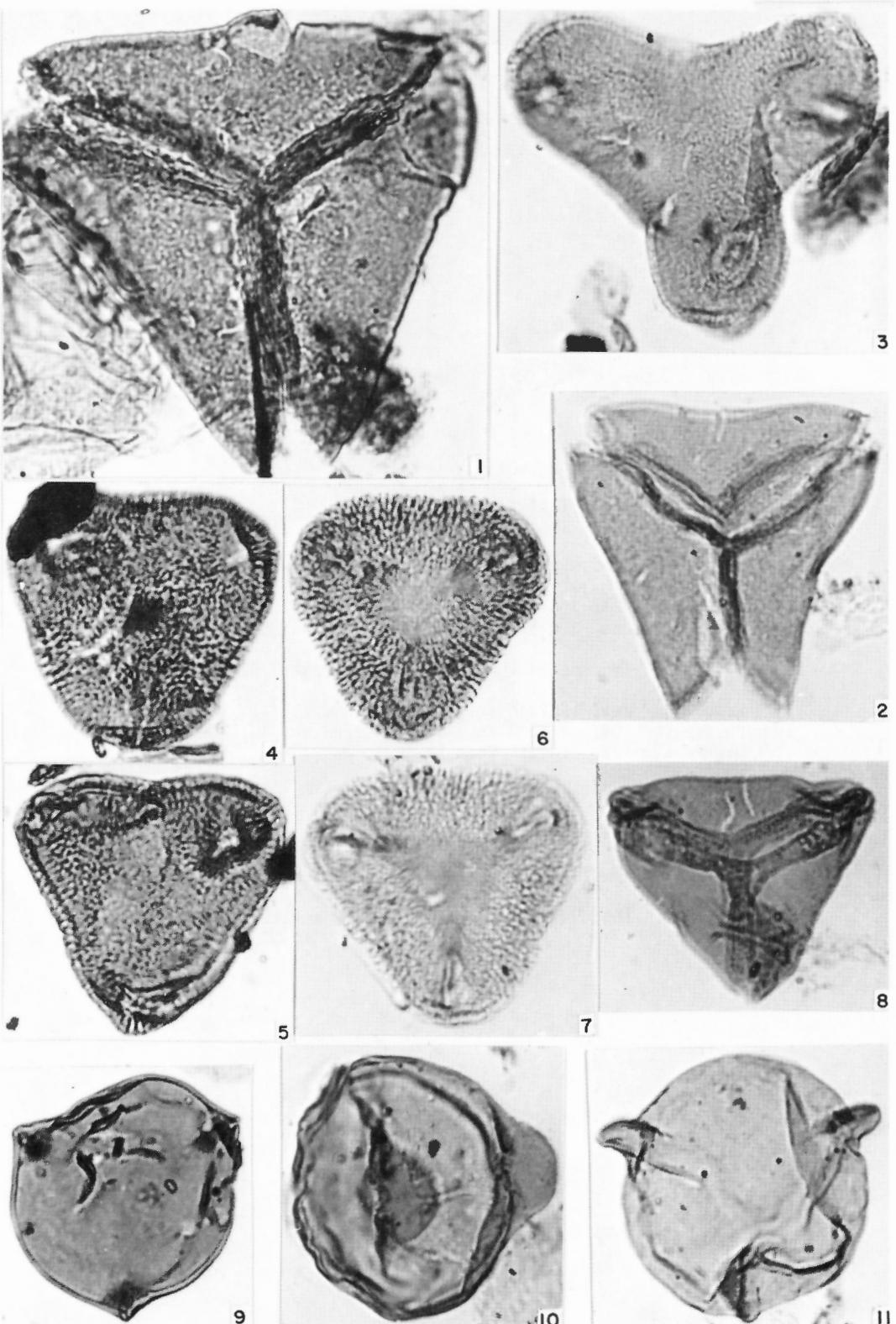


PLATE 18
(all figures x1,000)

Orbiculapollis sp. 2

- Figure 1. 16B, 230-240 ft., 12657/3, 306 x 1091, 38245
Figure 2. 16B, 300-310 ft., 12664/3, 399 x 1087, 38246

Triprojectus magnus (Mchedlishvili) Stanley, 1970

- Figure 3. 16B, 130-140 ft., 12635/3, 420 x 1147, 38247
Figure 4. 16B, 230-240 ft., 12657/3, 285 x 1049, 38248
Figure 5. 16B, 200-210 ft., 12654/3, 474 x 1053, 38249

Triprojectus sp. 2

- Figure 6. 16B, 310-320 ft., 12665/3, 456 x 1041, 38250

Aquilapollenites aucellatus Srivastava, 1969c

- Figure 7. 16B, 200-210 ft., 12654/3, 135 x 1141, 38251

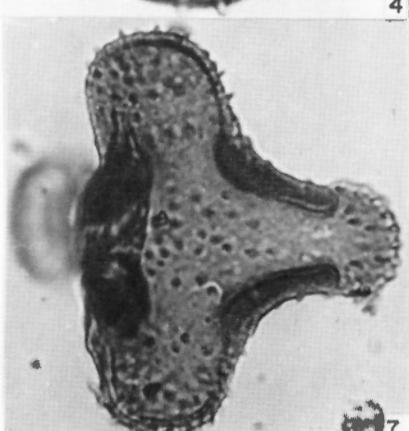
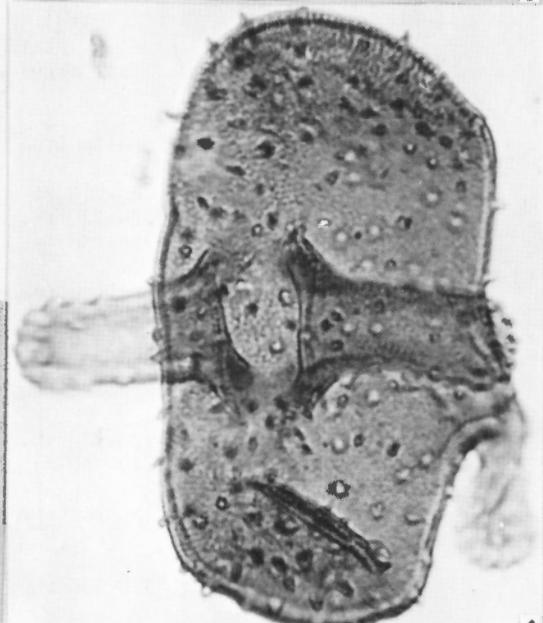
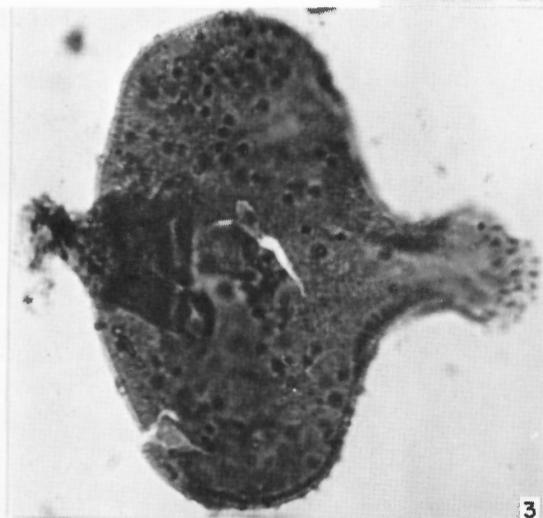
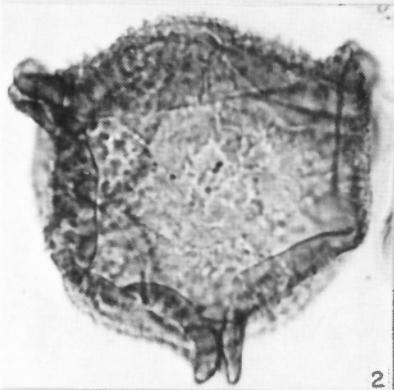


PLATE 19
(all figures x1,000)

Aquilapollenites asper Mcchedlishvili, 1961

- Figure 1. 16B, 200-210 ft., 12654/3, 295 x 1177, 38252
Figure 2. 16B, 220-230 ft., 12656/3, 377 x 1096, 38253
Figure 3. 16B, 220-230 ft., 12656/3, 377 x 1096, 38253

Aquilapollenites aucellatus

- Figure 4. 16B, 200-210 ft., 12654/3, 432 x 1129, 38256

Aquilapollenites quadrilobus Rouse, 1957

- Figure 5. 16B, 120-130 ft., 12634/3, 272 x 1116, 38257
Figure 6. 16B, 240-250 ft., 12658/3, 310 x 1146, 38258

Aquilapollenites formosus Srivastava and Rouse,
1970

- Figure 7. 16B, 310-320 ft., 12665/3, 089 x 1042, 38259

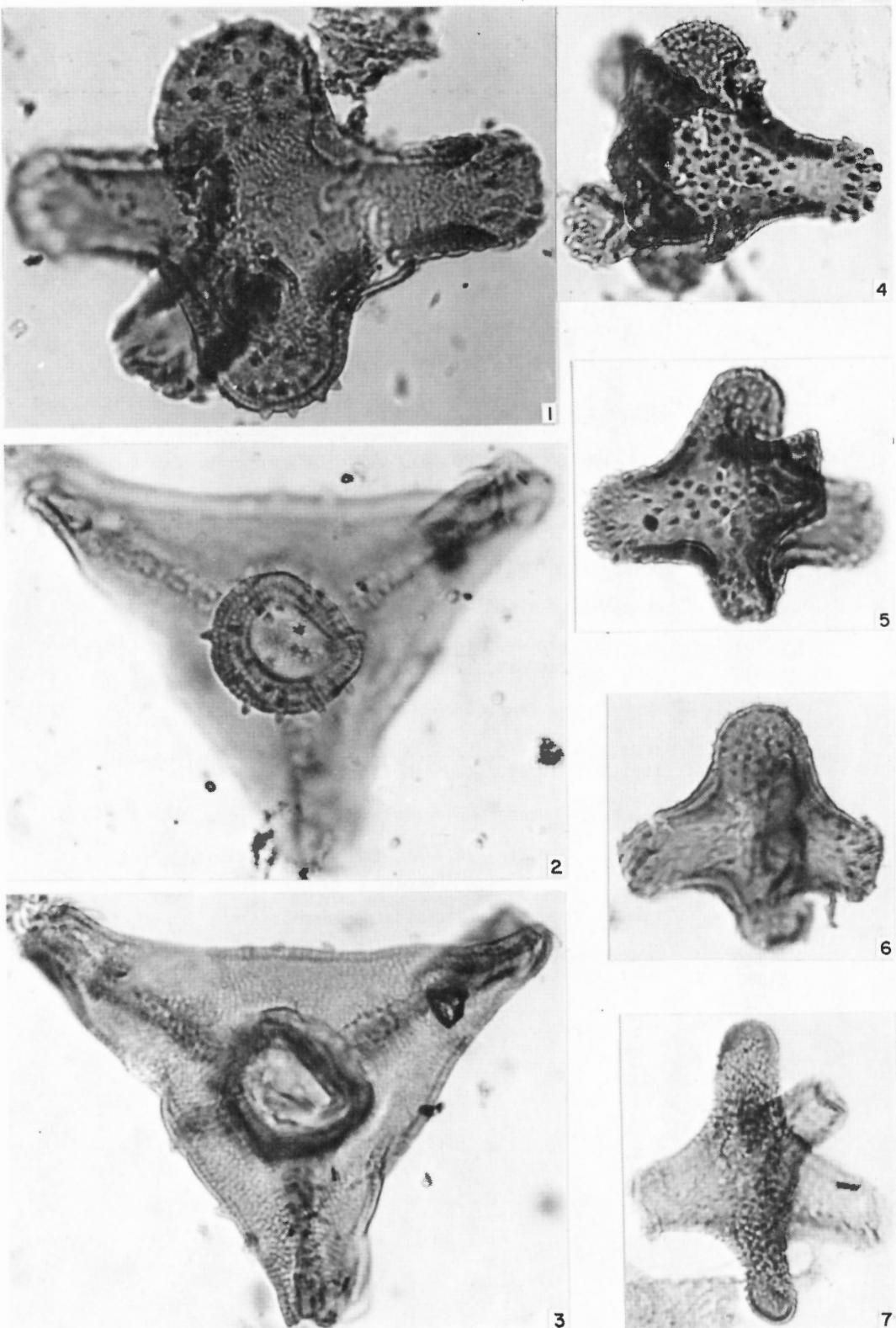


PLATE 20
(all figures x1,000)

Aquilapollenites asper

Figure 1. 16B, 90-100 ft., 12631/3, 184 x 1085 Interference
Contrast, 38260

Aquilapollenites formosus

Figure 2. 16B, 290-300 ft., 12663/3, 226 x 998, 38261

Mancicorpus senonicum Mchedlishvili, 1961

Figure 3. 16B, 390-400 ft., 7079/A3, 102 x 1085, 38262
Figure 4. 16B, 230-240 ft., 12657/3, 141 x 1008, 38263

Mancicorpus trapeziforme Mchedlishvili, 1961

Figure 5. 16B, 230-240 ft., 12657/3, 179 x 1000, 38264
Figure 6. 16B, 300-310 ft., 12664/3, 370 x 990, 38265

Integricorpus venustus (Srivastava) Stanley, 1970

Figure 7. 16B, 340-350 ft., 7074/A1, 195 x 1182, 38266
Figure 8. 16B, 400-410 ft., 7080/A1, 173 x 1020, 38267

Integricorpus clarireticulatus Samoilovitch, 1965

Figure 9. 16B, 280-290 ft., 12662/3, 147 x 1054, 38268
Figure 10. 16B, 240-250 ft., 12658/3, 459 x 1017, 38269

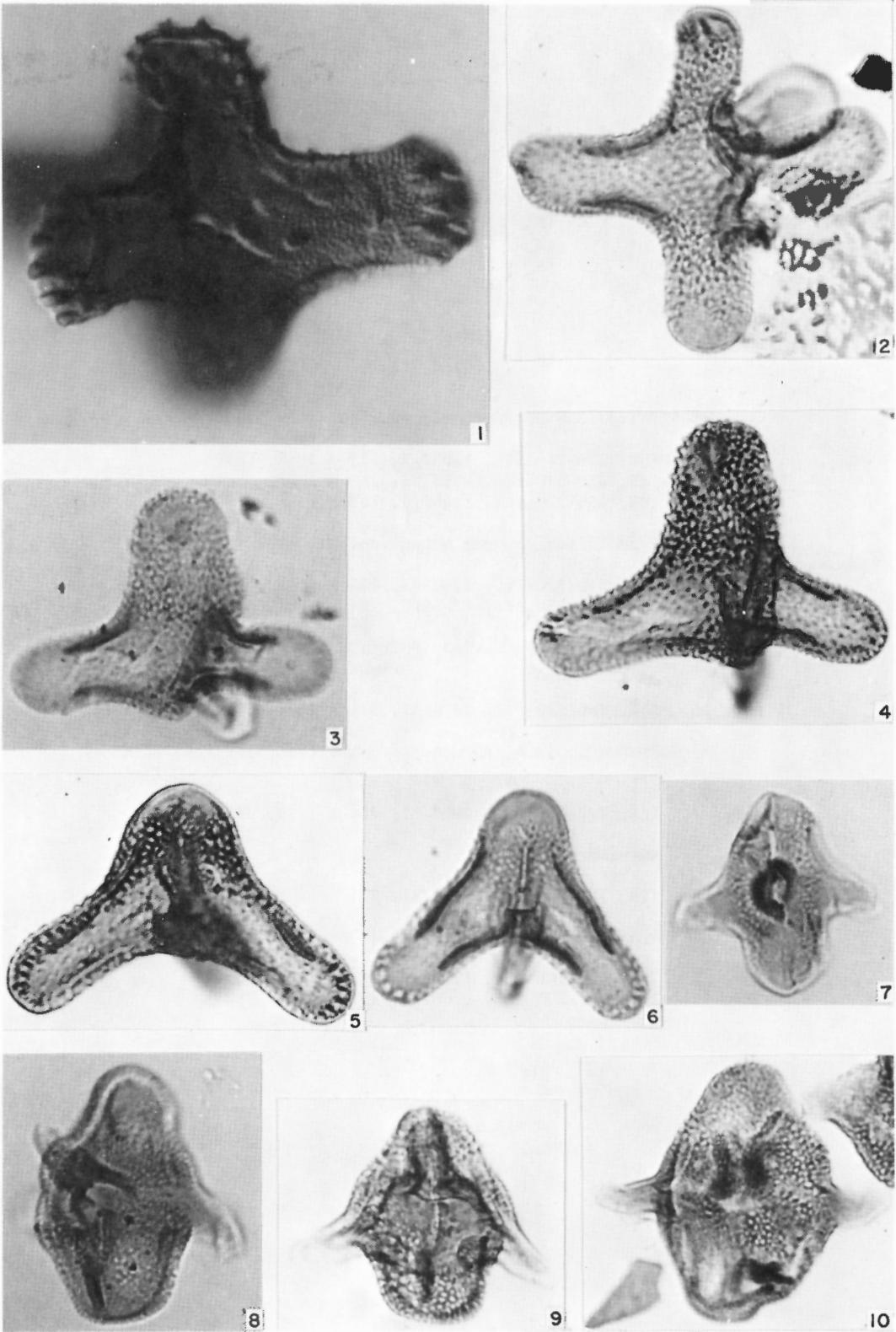


PLATE 21
(all figures x1,000)

Integricorpus (*Integricorpus* sp. 1 of Samoilovitch, 1967)

- Figure 1. 16B, 230-240 ft., 12657/3, 239 x 1068, 38270
Figure 2. 16B, 230-240 ft., 12657/3, 239 x 1068, 38270
Figure 3. 16B, 260-270 ft., 12660/3, 133 x 1165, 38271

Syncolpites porosus Mchedlishvili, 1961

- Figure 4. 16B, 310-320 ft., 12665/3, 405 x 1179, 38272
Figure 5. 16B, 210-220 ft., 12655/3, 264 x 1001, 38273

Callistopollenites radiostriatus (Mchedlishvili)
Srivastava, 1969d

- Figure 6. 16B, 360-370 ft., 7076/A1, 374 x 1174, 38274

Erdtmanipollis procumbentiformis (Samoilovitch) Krutzsch,
1966

- Figure 7. 16B, 370-380 ft., 7077/A1, 406 x 1119, 38275

Mancicorpus sp.

- Figure 8. 17A, 150-160 ft., 6938/A1, 271 x 1068, 38276

Cranwellia sp.

- Figure 9. 16B, 190-200 ft., 12653/3, 221 x 1096, 38277
Figure 10. 16B, 280-290 ft., 12662/3, 453 x 1214, 38278

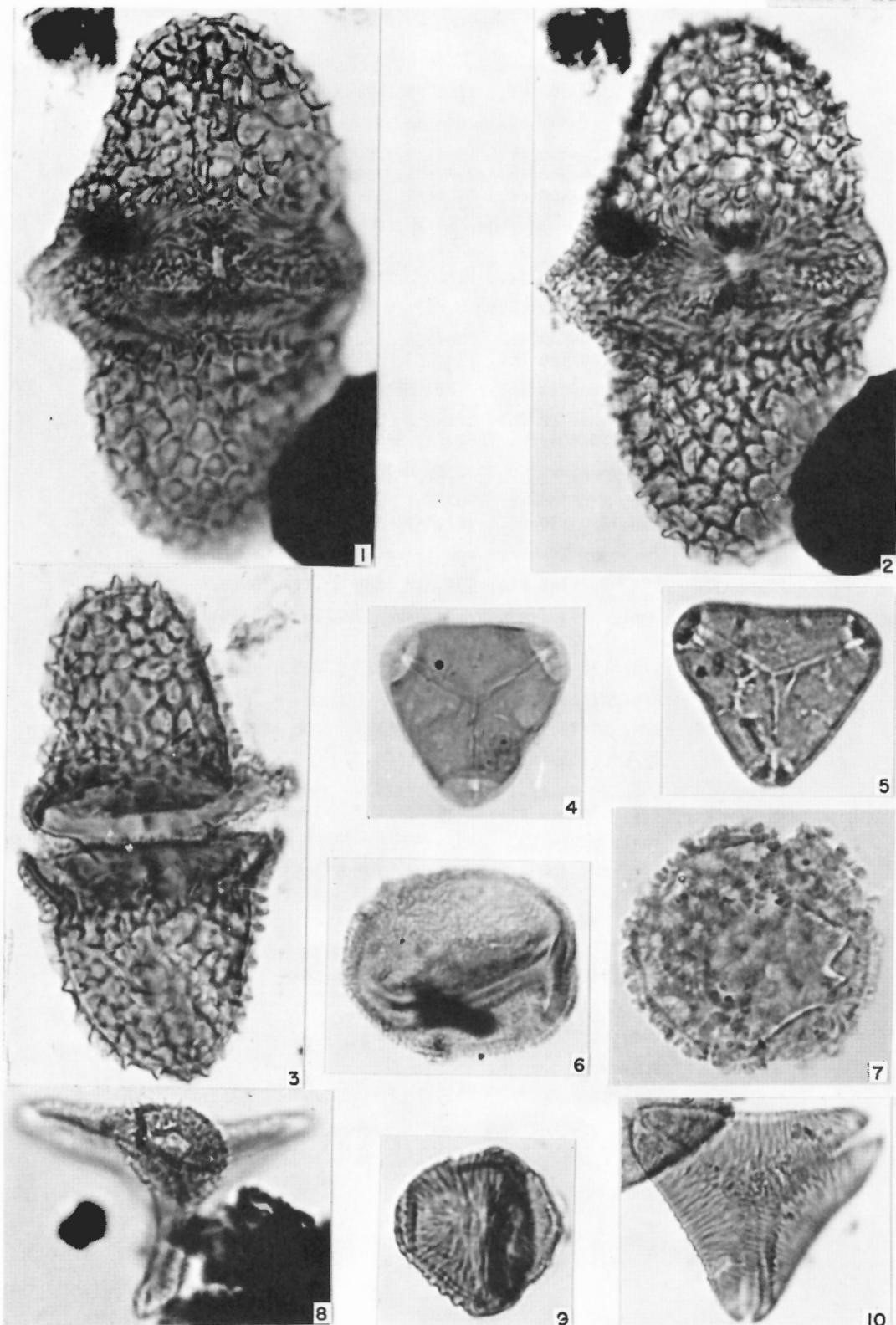


PLATE 22
(all figures x1,000)

Cranwellia sp.

Figure 1. 16B, 280-290 ft., 12662/3, 471 x 1067, 38279

Extratribporopollenites sp. 2

Figure 2. 16B, 300-310 ft., 12664/4, 320 x 1057, 38280

Figure 3. 16B, 370-380 ft., 7077/A1, 368 x 1191, 38281

Figure 4. 16B, 340-350 ft., 7074/A1, 316 x 1020, 38282

Extratribporopollenites sp. 1

Figure 5. 16B, 370-380 ft., 7077/A1, 281 x 1126, 38283

Figure 6. 16B, 260-270 ft., 12660/3, 394 x 1145, 38284

Tripoporopollenites sp. 3

Figure 7. 16B, 290-300 ft., 12663/3, 102 x 1076, 38285

Figure 8. 16B, 180-190 ft., 12652/3, 395 x 1079, 38286

Tetraporites sp. 1 (cf. *Extratribporopollenites* sp.)

Figure 9. 16B, 270-280 ft., 12661/3, 212 x 1048, 38287

Figure 10. 16B, 70-80 ft., 12629/3, 285 x 1040, 38288

Tetraporites sp. 2 (cf. Haloragaceae)

Figure 11. 16B, 320-330 ft., 7072/A1, 249 x 1061, 38289

Figure 12. 16B, 340-350 ft., 7074/A1, 150 x 1011, 38290

Tripoporopollenites sp. 1 (cf. *Betula*)

Figure 13. 17A, 200-205 ft., 6943/A2, 380 x 1114, 38291

Paraalnippollenites confusus (Zaklinskaia) Hills and Wallace, 1969

Figure 14. 17A, 150-160 ft., 6938/A2, 357 x 1130, 38292

Alnipollenites sp.

Figure 15. 17A, 30-40 ft., 6929/A2, 303 x 1070, 38293

Myricipites sp.

Figure 16. 16B, 70-80 ft., 12629/3, 185 x 1084, 38294

Figure 17. 17A, 100-110 ft., 6933/A1, 267 x 1085, 38295

Kurtzzipites sp.

Figure 18. 16B, 290-300 ft., 12663/3, 171 x 1153, 38296

Figure 19. 16B, 290-300 ft., 12663/3, 193 x 997, 38297

Momipites sp.

Figure 20. 17A, 25-30 ft., 6928/A1, 269 x 1178, 38298

Figure 21. 16B, 380-390 ft., 7078/A1, 145 x 1084, 38299

cf. Juglandaceae

Figure 22. 16B, 60-70 ft., 12628/3, 301 x 1091, 38300

Proteacidites sp. 1

Figure 23. 16B, 190-200 ft., 12653/3, 330 x 1113, 38301

Proteacidites thalmanni Anderson, 1960

Figure 24. 17A, 130-140 ft., 6936/A1, 348 x 1078, 38303

Plate 22

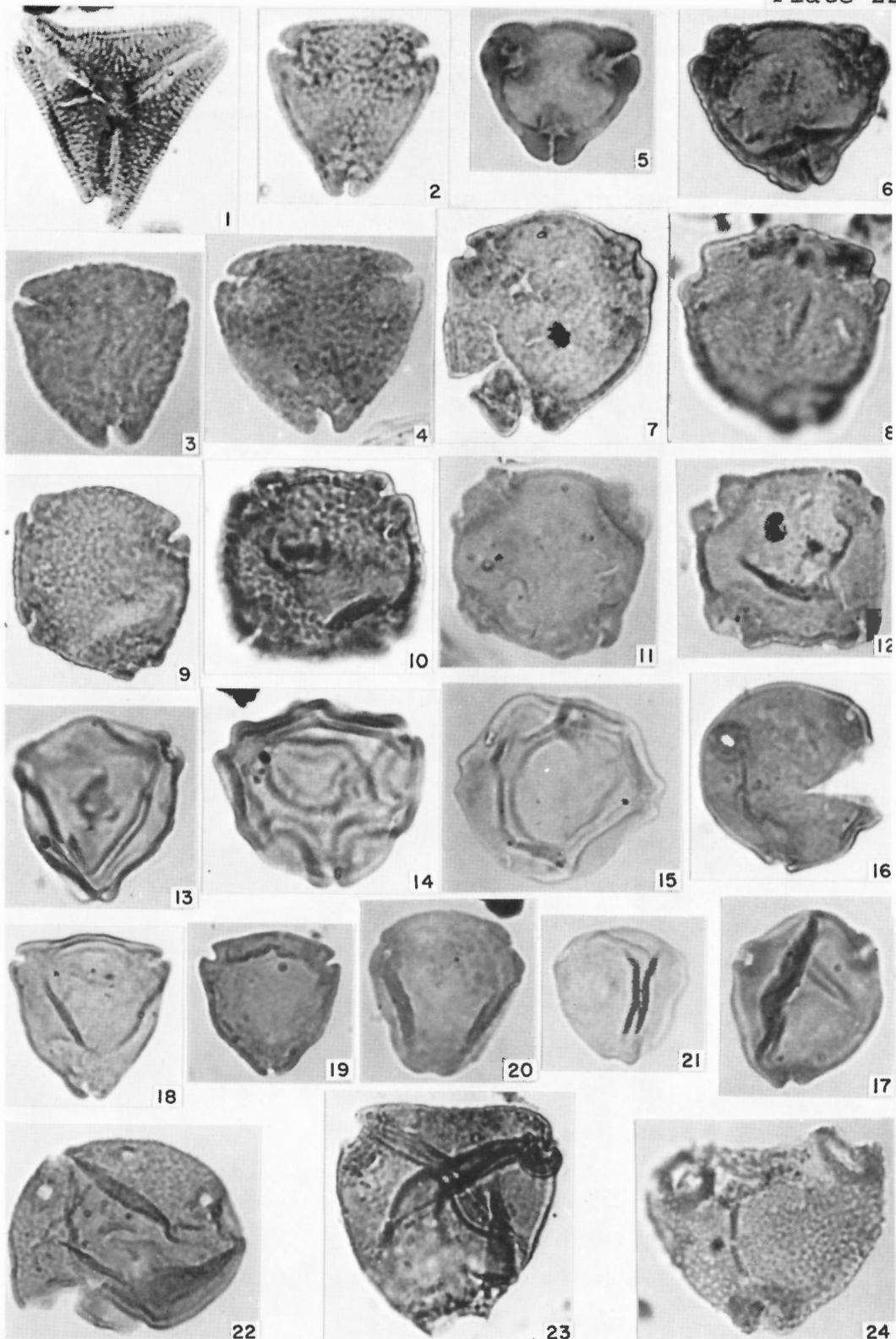


PLATE 23
(all figures x1,000)

cf. *Proteacidites* sp.

Figure 1. 16B, 290-300 ft., 12663/3, 394 x 1022, 38304

Proteacidites sp. 1

Figure 2. 16B, 270-280 ft., 12661/3, 272 x 1006, 38305

Triporopollenites sp. 4

Figure 3. 16B, 350-360 ft., 7075/A2, 143 x 1100, 38306

Proteacidites thalmanni

Figure 4. 16B, 320-330 ft., 7072/A1, 270 x 1148, 38307

Triporopollenites sp. 2

Figure 5. 16A, 70-80 ft., 12553/3, 418 x 1051, 38308

Tricolpites sp. 3

Figure 6. 16A, 20-30 ft., 12548/3, 375 x 1165, 38309

Trifossapollenites ellipticus Rouse, 1957

Figure 7. 16A, 0-10 ft., 12546/3, 302 x 1054, 38310

Tricolpites sp. 5

Figure 8. 16A, 100-110 ft., 12556/4, 333 x 1135, 38311

Figure 9. 16B, 10-20 ft., 12623/4, 312 x 1118, 38312

Figure 10. 16A, 40-50 ft., 12550/3, 232 x 1132, 38313

Figure 17. 16B, 10-20 ft., 12623/4, 309 x 1117, 38314

Tricolpites sp. 4

Figure 11. 16A, 40-50 ft., 12550/3, 184 x 1053, 38315

Tricolpites sp. 12

Figure 12. 17A, 80-90 ft., 6932/A2, 259 x 1092, 38316

Tricolpites sp. 2

Figure 13. 16B, 0-10 ft., 12622/4, 472 x 1144, 38317

cf. *Fibulapollis* sp.

Figure 14. 16B, 330-340 ft., 7073/A1, 261 x 1127, 38318

Tricolpites sp. 13

Figure 15. 16B, 330-340 ft., 7073/A1, 293 x 1168, 38319

Figure 16. 16B, 340-350 ft., 7074/A1, 343 x 1121, 38320

Triporopollenites sp. 5

Figure 18. 16B, 340-350 ft., 7074/A1, 220 x 1024, 38321

Tricolpites sp. 11

Figure 19. 17A, 120-130 ft., 6935/A2, 439 x 1056, 38322

Figure 20. 17A, 130-140 ft., 6936/A1, 264 x 1186, 38323

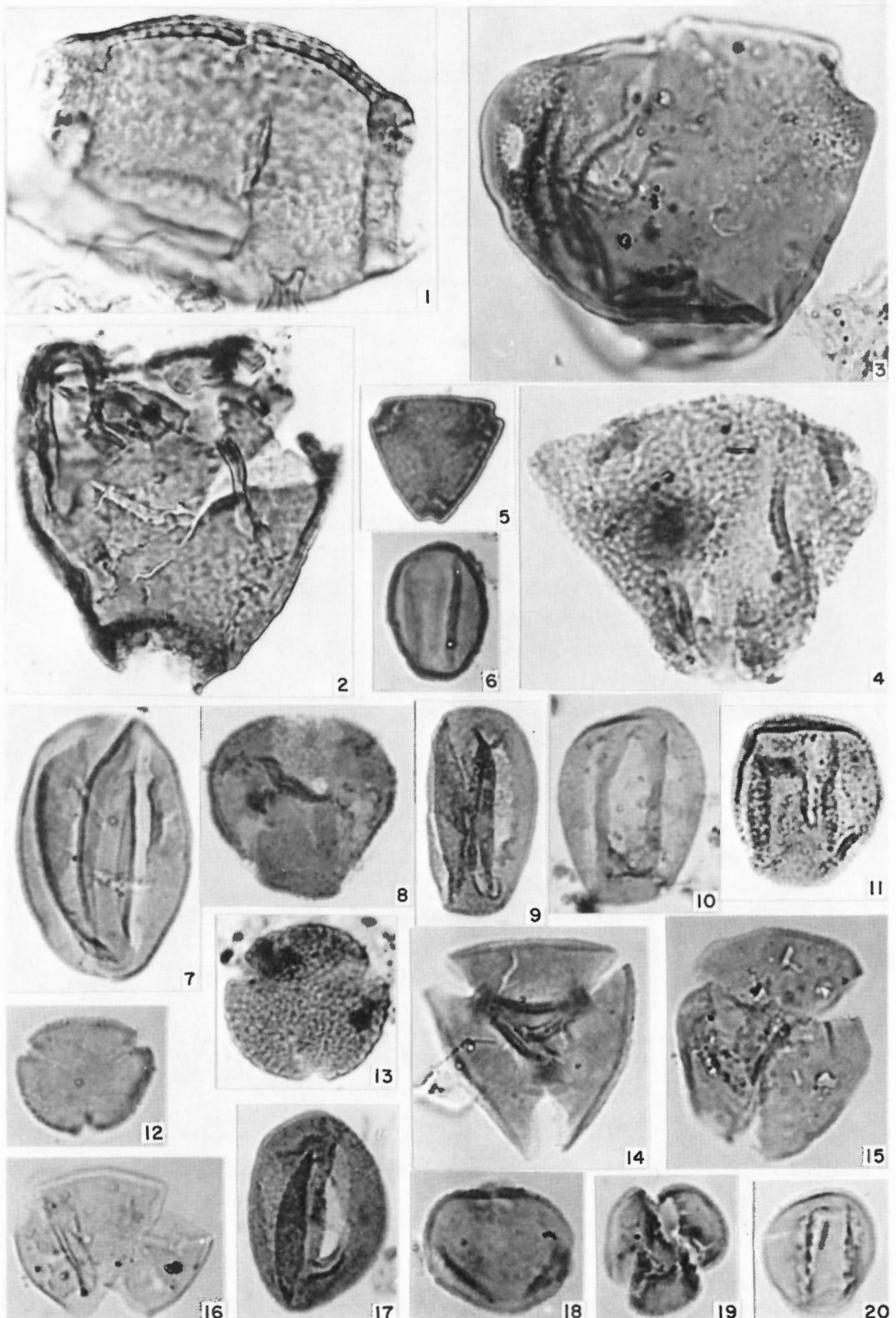


PLATE 24
(all figures x1,000)

Tricolpites sp. 8

Figure 1. 16B, 160-170 ft., 12650/3, 178 x 1167, 38324

Tricolpites sp. 6

Figure 2. 16A, 240-250 ft., 12587/3, 320 x 1021, 38325
Figure 8. 16A, 240-250 ft., 12587/3, 223 x 1125, 38326

Tricolpites sp. 3

Figure 3. 16B, 10-20 ft., 12623/4, 423 x 1085, 38327

Tricolpites sp. 7

Figure 4. 16B, 20-30 ft., 12624/3, 322 x 1103, 38328

Tricolpites sp. 2

Figure 5. 16B, 40-50 ft., 12626/3, 345 x 1007, 38329

Tricolpites sp. 9

Figure 6. 16B, 220-230 ft., 12656/3, 124 x 1107, 38330
Figure 9. 16B, 380-390 ft., 7078/A1, 244 x 1114, 38331
Figure 10. 16B, 380-390 ft., 7078/A1, 404 x 1066, 38332
Figure 13. 16B, 380-390 ft., 7078/A1, 165 x 1081, 38333

Tricolporopollenites sp. 1

Figure 11. 16B, 200-210 ft., 12654/3, 431 x 1109, 38334

Tricolpites sp. 13

Figure 7. 16B, 390-400 ft., 7079/A3, 332 x 1151, 38336

Tricolpites sp. 10

Figure 12. 16B, 320-330 ft., 7072/A1, 192 x 1127, 38337

Tricolporopollenites sp. 3

Figure 14. 16B, 260-270 ft., 12660/3, 207 x 1033, 38338

Tricolporopollenites sp. 5

Figure 15. 16B, 390-400 ft., 7079/A3, 341 x 1109, 38339

Figure 16. 17A, 120-130 ft., 6935/A2, 253 x 1035, 38340

Tricolporopollenites sp. 4

Figure 17. 16B, 270-280 ft., 12661/3, 460 x 1096, 38341

Tricolporopollenites sp. 7

Figure 18. 17A, 120-130 ft., 6935/A2, 369 x 1127, 38342

Tricolporopollenites sp. 6

Figure 19. 16B, 390-400 ft., 7079/A3, 370 x 1045, 38343

Tricolpites sp. 1

Figure 20. 16A, 30-40 ft., 12549/3, 425 x 1065, 38344

Figure 21. 16A, 120-130 ft., 12558/3, 453 x 1058, 38345

Arecipites columellus Leffingwell, 1970

Figure 22. 16B, 260-270 ft., 12660/3, 355 x 1136, 38346

Figure 23. 16B, 260-270 ft., 12660/3, 380 x 1030, 38347

Liliacidites complexus (Stanley) Leffingwell, 1970

Figure 24. 16B, 280-290 ft., 12662/3, 225 x 1099, 38348

Figure 25. 16B, 280-290 ft., 12662/3, 147 x 1054, 38349

Liliacidites sp.

Figure 26. 16B, 380-390 ft., 7078/A1, 115 x 1184, 38255

Figure 27. 16B, 400-410 ft., 7080/A1, 176 x 1125, 38302

Monosulcites sp.

Figure 28. 16B, 300-310 ft., 12664/3, 153 x 1196, 38335

Plate 24

