LOWER CARBONIFEROUS (TOURNAISIAN) MIOSPORES AND MEGASPORES FROM BREEDON CLOUD QUARRY, LEICESTERSHIRE

by

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Summary

Thin shale seams within the dolomite of Breedon Cloud Quarry have been found to contain dispersed miospores and megaspores. An assemblage from the southeast face is reported and a Tournaisian age suggested for it.

Introduction

A line of five small structurally disturbed inliers of Carboniferous Limestone extends north-northwest from the northwestern corner of Charnwood Forest; from south to north these are Grace Dieu, Osgathorpe, Barrow Hill, Breedon Cloud and Cloud Hill. Text-figure 1 gives the locations. The last two are being quarried at the present time.

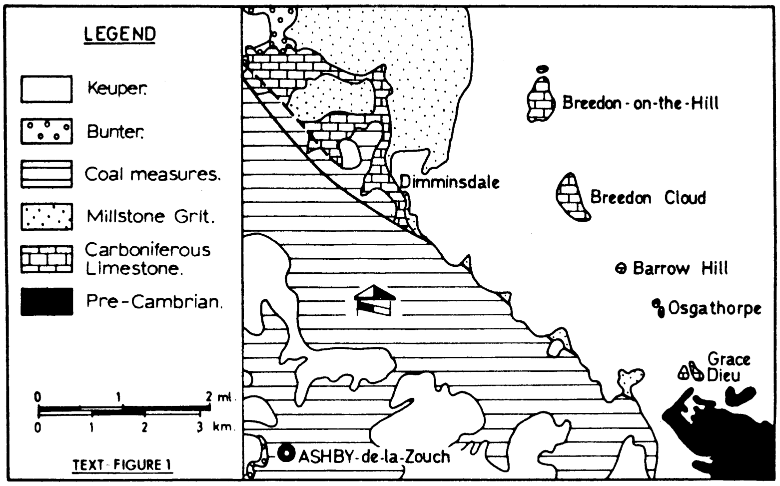
The most recent account of Breedon Cloud Quarry is given by Mitchell and Stubblefield (1941a, b). Owing to continued excavation, the shape of the exposure has changed. Text-figure 2 compares part of their sketch map with another drawn in 1970. The Massive Bedded Dolomite is the lowest formation of the sequence described by them. The dolomite exposed at the presently disused southeastern face of the quarry is identified with this, the strike being roughly perpendicular to the present face. The dip is from 80^{o} to near vertical, higher than that observed by Mitchell and Stubblefield. A group of thin, lenticular bands of clay and shale was first noticed by one of us (P.G.L.) and the dolomite was later found to be interspersed throughout with such clastic horizons. Text-figure 3 shows the disposition of shale bands in the southeastern face. The present note mentions only spores recovered from the central group of shale bands. Spores have also been extracted from other bands in the same face, and from bands in the southwestern face, and from the dolomite itself.

Fauna

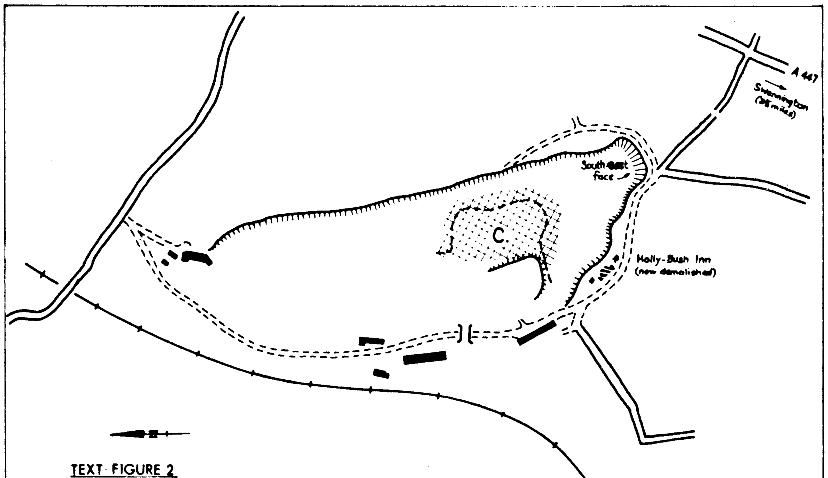
Mitchell and Stubblefield (1941a) suggest that the Massive Bedded Dolomite is older than thought by Parsons (1918). They describe a fauna of casts of brachiopods, thought to be early Visean in age. The identifications are tentative comparisons rather than firm determinations.

Preparation procedures

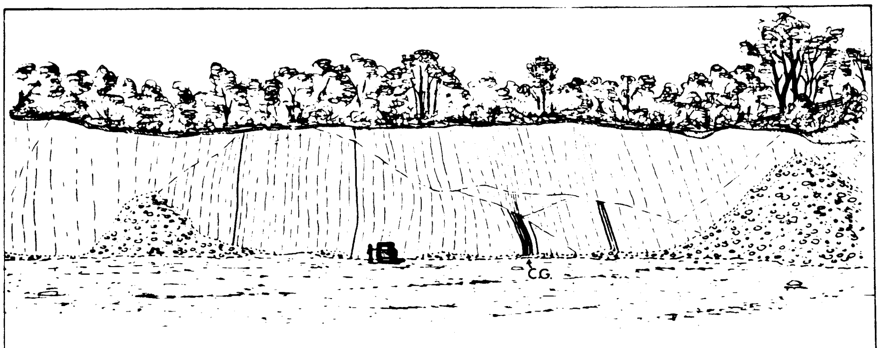
The samples were not crushed, but roughly crumbled, and then disaggregated and cleared of dolomite and calcite by warming with concentrated HCl. Treatment with HF to clear silicates was also necessary. Oxidation with Schulze's solution was brief.



TEXT-FIGURE 1



TEXT-FIGURE 2
Outline shape of exposure at Breedon Cloud.
C = 1941 exposure of Massive Bedded Dolomite



TEXT-FIGURE 3
View of South-east face, Breedon Cloud.
C.G. = central group of shale bands in dolomite

The residues were sieved at BS80. The coarse fractions were scanned in water. Megaspores were picked out and single-mounted in Canada Balsam. Megaspores are those spores larger than the arbitrary size threshold of 200 microns diameter: in practice these constitute the spores large enough to be handled individually under the low-power binocular microscope. Spores of this size mainly represent megaspores (potential female gametophytes) of the lycopods such as *Lepidodendron*.

The fine fractions were strew-mounted in glycerine jelly for miospore counting, and single-mounts of particular miospores were made from smears for photography. Miospores are those spores smaller than the arbitrary size threshold of 200 microns diameter. They represent microspores (potential male gametophytes) of heterosporous plants such as the lycopods, and also isospores (which develop directly into both female and male gametophytes) of homosporous plants such as many ferns.

The age of the spore assemblage

Table 1 gives a list of the taxa identified so far, together with a chart of the ages of published records, taken from the references given. It is readily seen that the greatest concentration of all previous records is in the Tournaisian, with a lesser concentration both below in the Famennian and above in the Visean. British records show a less symmetrical distribution, with more in the Visean than the Famennian, though still most in the Tournaisian. The imbalance is partly accounted for by the assemblage from the Menai Straits (Hibbert and Lacey 1969), which is all recorded as S_2 - D_1 age, although it is thought by Hibbert and Lacey to contain reworked Tournaisian elements.

Streel (1966, 1969) discusses early Tournaisian assemblages of the Dinant Basin and of Russia and the Ardenno-Rhine region. Sullivan (1964a) and Neves and Dolby (1967) show that English assemblages of similar age have many similar palynological characteristics to those of these areas. Thus the absence at Breedon Cloud of such important and widely distributed taxa as *Hystricosporites*, *Lophozonotriletes rarituberculatus*, *Hymenozonotriletes lepidophytus* and *H.pusillites* is taken to argue against an early Tournaisian age. *Knoxisporites* in association with *Corbulispora* is regarded by Streel as characteristic of Tn1b and Tn2a, but this association is not found at Breedon Cloud. Nor is the *Dictyotriletes trivialis/H. explanatus* association present, which in Belgium marks the top of Tn1b and in Russia an equivalent horizon. Importance in the Breedon assemblage described here thus attaches to the records of spores known from the Tournaisian of Spitsbergen (e.g. *Verrucosisporites gobbettii*, *Lophozonotriletes dentatus*) and from Canada (e.g. *Dictyotriletes submarginatus*, *Spinozonotriletes conspicuus* and *Grandispora* sp.). While the assemblage is not comparable in detail with any one previously described assemblage, such records give confidence of a Tournaisian age, with some probability of Middle Tournaisian.

Notes on the taxa quoted

Verrucosisporites gobbettii Playford. Our material resembles pl. 80, fig. 4 of Playford (1962) rather than pl. 80, figs. 1 - 3 in which the ornament appears coarser.

cf. *Lophotriletes macrotuberculatus* Kedo. Both figure and description of Kedo (1963) agree with our material, but in our spores the ornament is restricted to the distal face, a feature not mentioned by Kedo. *Verrucosisporites* sp. of Balme and Hassell (1962) has a smooth proximal face and similar ornament to our material.

cf. *Raistrickia corynoges* Sullivan. We have only two examples of this species, which have a comparatively low ornament consisting of mixed baculae and coni. Comparison is made with pl. 25, fig.8 of Sullivan (1968) rather than with figs. 6, 7 in which the ornament is higher.

TABLE 1

Stratigraphic distribution of taxa found in the Breedon Cloud assemblage

TAXON	REFERENCES	U.FAM	TOURNAISIAN	VISEAN
Miospores:-				
Leiotriletes ornatus Ishchenko	6,7,8,9,10,11,15	———	– – –	– – –
Punctatisporites solidus Hacquebard	5,12		– – –	
P. irrasus Hacquebard	5,6,10,12,16	———	– – –	
P. glaber (Naumova) Playford	2,4,6,7,8,11	– – –	– – –	
Calamospora microrugosa (Ibrahim) S.W.B.	1,2,6,7,8,11	– – –	– – –	– – –
Retusotriletes incohatus Sullivan	2,4,10,15,16	———	———	– – –
Verrucosisporites gobbettii Playford	11		– – –	
cf. *Lophotriletes macrotuberculatus* Kedo	1,8	– – –	– – –	
cf. *Raistrickia corynoges* Sullivan	14,16		———	
Convolutispora labiata Playford	6,11			– – –
C. usitata Playford	11			– – –
C. vermiformis Hughes and Playford	6,11		– – –	
Dictyotriletes submarginatus Playford	12		– – –	
cf. *D. magnus* Naumova ex Kedo	8		– – –	
cf. *Reticulatisporites crassa* Winslow	17	– – –	– – –	
cf. *R. textilis* Balme and Hassell	1,16	– – –	———	
Lophozonotriletes dentatus Hughes and Playford	11		– – –	
cf. *L. triangulatus* (Ishchenko) Hughes and Playford	7,11		– – –	
Spinozonotriletes conspicuus Playford	12		– – –	
Grandispora sp. cf *Pustulatisporites pretiosus* Playford	12,14		– – –	
Perotrilites magnus Hughes and Playford	6,11,12,16		———	– – –
Megaspores:-				
Lagenicula sp.	2,3,9,17	———	———	———
Setosisporites cf. *hirsutus* var. *brevispinosa* (Zerndt) Potonié and Kremp	2,3,13,17		———	– – –
Triletes aff. *catenulatus* var. *marginatus* Winslow	17		– – –	

Solid lines represent British occurrences; broken lines represent other occurrences.

Index to authors:- 1, Balme and Hassell 1962, 2, Butterworth and Spinner 1967. 3, Chaloner 1966, 4, Doubinger and Rauscher 1966, 5, Hacquebard 1957, 6, Hibbert and Lacey 1969, 7, Ishchenko 1958. 8, Kedo 1963, 9, Mortimer and Chaloner 1967, 10, Neves and Dolby 1967, 11, Playford 1963. 12, Playford 1964, 13, Spinner 1969, 14, Sullivan 1964a, 15, Sullivan 1964b, 16, Sullivan 1968, 17, Winslow 1962.

cf. *Dictyotriletes magnus* Naumova ex Kedo. Our material conforms with this species in the width and distribution of the muri, and in their height as seen in profile at the equator. Other described species, however, are close to *D. magnus*. For instance, *Reticulatisporites cancellatus* (Waltz) Playford, in which the muri are less tall, and *Archaeozonotriletes multiplicabilis* Kedo, in which they are taller. Both these morphographically similar species are restricted to the Tournaisian, as is *D. magnus*.

cf. *Reticulatisporites crassa* Winslow. Our spore resembles *R. crassa* in having a loose distal reticulum. However the structure of the equatorial feature conforms with *Reticulatisporites*, *sensu* Neves 1964, whereas that of *R. crassa* in the figures of Winslow (1962) conforms with *Knoxisporites*, *sensu* Neves 1964. Our spore resembles *R. margarethae* (Hughes and Playford) Neves in the arrangement of the ornament and structure of the equatorial feature, but lacks the diagnostic frilled border at the amb and at the edges of the muri.

Grandispora sp., of *Pustulatisporites pretiosus* Playford. In our material spores referred to this taxon show variation in the degree of separation of the exine layers and also in the size and density of the distal ornament. An example of each extreme is figured (pl. 1, figs. 13, 14). Comparison is made with those specimens of *P. pretiosus* which Playford (1964) records as having a mesosporoid. Our figure 14 also resembles pl. 2, figs. 12, 13 of Sullivan (1964a), referred by him to *Spinozonotriletes balteatus* Playford.

Lagenicula sp. We have a number of small (240 - 580 μ, 13 specimens) spores showing the relatively large apical prominence of this genus, and a subdued ornament ranging from small (5 μ) pila and gemmae to irregular granules. A general comparison may be made with *L. rugosa* of the Upper Carboniferous, or, more closely, with the Frasnian *L. paulispinosa*. However, some specimens show small protusions at the extremities of the rays as in the Lower Carboniferous *Lagenoisporites angulatus* (Zerndt) Pontonié and Kremp. These spores do not appear to be referable to any previously described species.

Setosisporites cf. *hirsutus* var. *brevispinosa* (Zerndt) Potonié and Kremp. Our spores (240 - 450 μ, 20 specimens) have the small, constricted apical prominence on which Spinner (1969) places emphasis as the principal feature of this genus. We assign our material to this variety, which being based on material observed by reflected light, is more broadly defined, rather than to *S. pseudoreticulatus* Spinner, which it also clearly resembles. But it is conceded that all the megaspores show some signs of attrition and crystal growth damage, and that an absolute distinction from *S. pseudoreticulatus* would require better material.

Triletes aff. *catenulatus* var. *marginatus* Winslow. These megaspores (240 - 475 μ, 24 specimens) resemble Winslow's variety in their size and in having an irregular ornament of small gemmae and pila, which in the equatorial region become taller and there fuse and anastomose to form an irregular equatorial feature. In this way they somewhat resemble *Zonalesporites sensu lato* of Spinner (1965). The small size of the spores and irregular character of the equatorial feature is however closer to this variety than to any *Zonalesporites*. *Triletes catenulatus* Winslow (comprising three varieties) shows a wide range of sculpture and of development of the apical prominence. The lack of an apical prominence separates our spores from most of Winslow's specimens of this variety, although in her pl. 5, fig. 8 (proximo-distal compression) no prominence is evident.

The absence of densospores

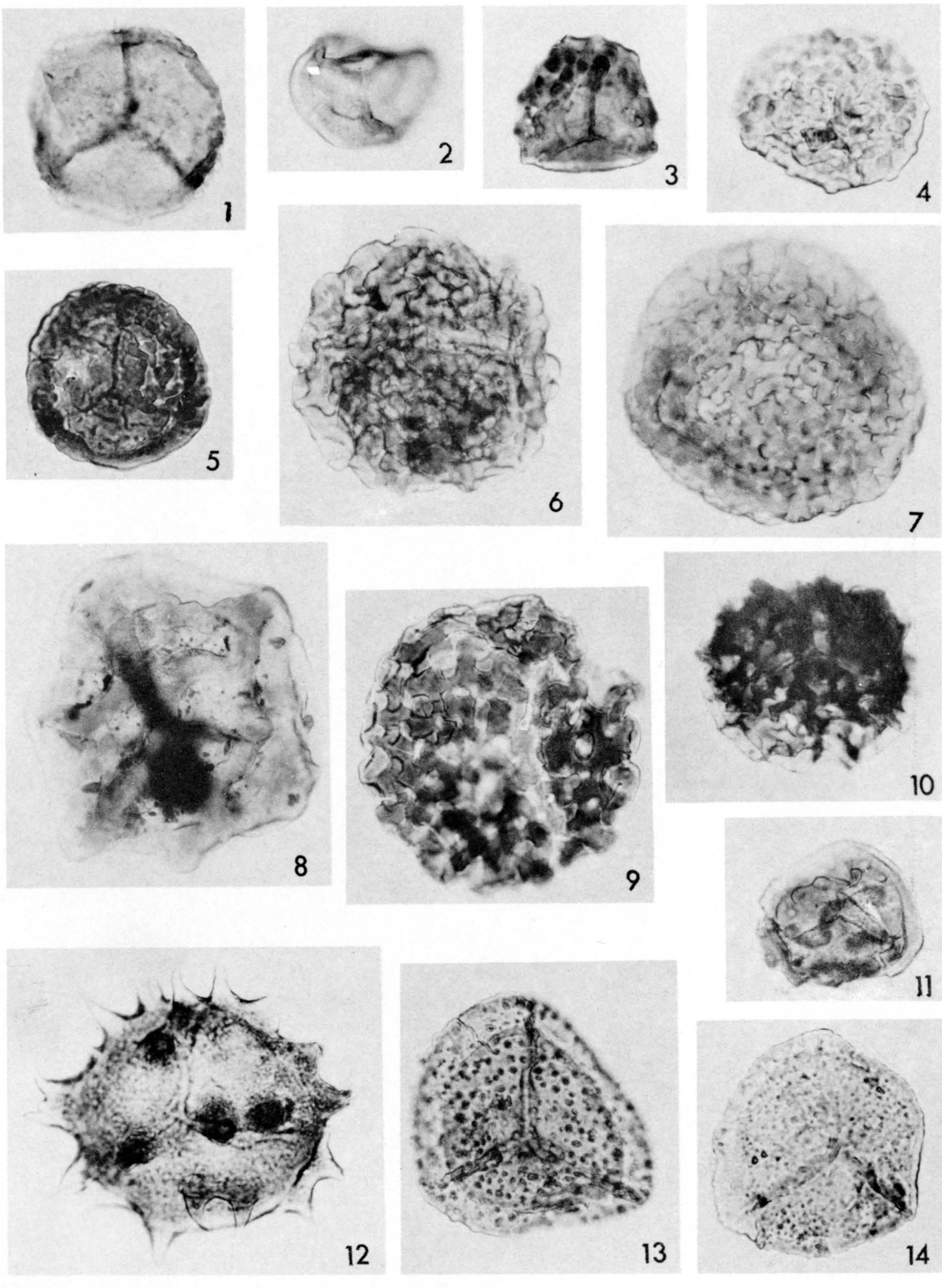
Densospores (that is the genus *Densosporites* and similar forms), known to represent the microspores of several lycopods, are among the most frequently encountered of Carboniferous small spores. However, no densospores have been found among the miospores in the present material. This feature of the assemblage is in common with several of the assemblages with

EXPLANATION OF PLATE 29

Figs. 1, 2.	*Retusotriletes incohatus* Sullivan. 1, Proximal view. 2, Oblique view of another specimen, showing thickening where rays meet curvaturae.
Fig. 3	cf *Lophotriletes macrotuberculatus* Kedo.
Fig. 4	*Verrucosisporites gobbettii* Playford.
Fig. 5	*Dictyotriletes submarginatus* Playford.
Fig. 6	*Convolutispora labiata* Playford.
Fig. 7	*Convolutispora usitata* Playford.
Fig. 8	cf *Reticulatisporites crassa* Winslow.
Fig. 9	cf *Reticulatisporites textilis* Balme and Hassell.
Fig. 10	cf *Dictyotriletes magnus* Naumova ex Kedo.
Fig. 11	*Lophozonotriletes dentatus* Hughes and Playford.
Fig. 12	*Spinozonotriletes conspicuus* Playford.
Figs 13, 14	Grandispora sp. cf *Pustulatisporites pretiosus* Playford.

All magnifications x 500.

Plate 29



which comparison may be made (Russian, Canadian and English). Nonetheless it is surprising in view of the presence of *Setosisporites* megaspores. Grebe (1966) collects instances of the association of densospores with *Setosisporites*, and Chaloner (1958) shows that *Densosporites* sp. and ***S. hirsutus*** are the microspores and megaspores respectively of the same cone. Bharadwaj (1959) gives another similar instance. The present find of *Setosisporites* shows some new features but this hardly offers an explanation for the absence among the miospores of *Densosporites*, (or another genus of similar morphology such as *Radiizonates*, *Cingulizonates* or *Cristatisporites*) which would have been confidently expected to be present.

Megaspores in a Carboniferous Limestone environment

The occurrence of Carboniferous megaspores is generally associated with coal seams or at least more or less autochthonous accumulations of plant material. Only rarely are they encountered in a marine environment, though an instance has been described by one of us (Chaloner 1954). In the present material, the megaspores occur in an argillaceous rock which lacks other plant remains larger than the miospores, and which in turn forms part of a dominantly carbonate sequence. The presence of megaspores is presumably to be correlated with the proximity of the locality to the southern shore of the Widmerpool Gulf (Ford 1968, fig. 14): the site was perhaps only two or three miles from contemporaneous land. Megaspores and miospores are less destructible than most other plant material, but megaspores are less likely than miospores to be transported far from their source plants, on account of their larger size. Thus it is possible to envisage the land with a soil or swamp surface where aerobic decay would attack plant material. The megaspores in such a situation could be transported into the Gulf by water, along with the argillaceous material forming the shale bands, following exceptional rainstorms.

Comparison with the Hathern Borehole

The miospore assemblage from Breedon Cloud has some features in common with the assemblage reported by Llewellyn *et al.* (1969) from the Anhydrite Series in the Hathern No. 1 Borehole. There are also differences, and the Hathern assemblage is regarded as early to mid-Tournaisian in age, that is, probably a little older than that at Breedon Cloud. Further work is in progress on the assemblages from both localities.

Conclusions

This brief account has aimed to show the intrinsic and stratigraphic interest of the spore assemblage obtained from shale within the Massive Bedded Dolomite of the Breedon Cloud Quarry. Dispersed megaspores and miospores have been found: the miospores indicate a Middle Tournaisian age: *Setosisporites* occurs without the expected accompaniment of densospores: the presence of megaspores has some bearing on considerations of contemporary palaeogeography.

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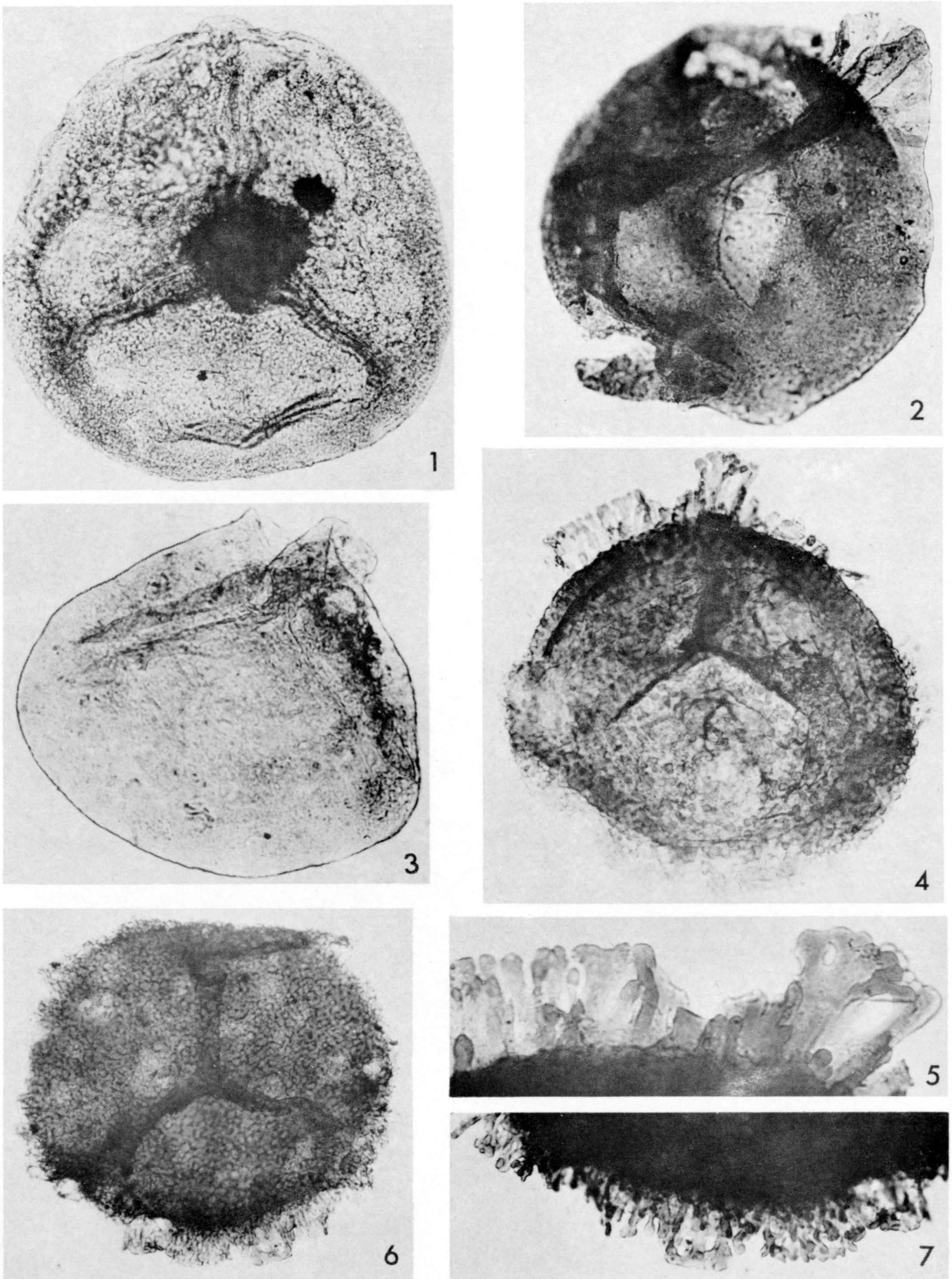
EXPLANATION OF PLATE 30

Figs. 1, 3	*Setosisporites* cf *hirsutus* var. *brevispinosa* (Zerndt) Potonié and Kremp. 1, Proximo-distal compression. 3, Lateral compression, open at apex. Both x 100.
Fig. 2	*Lagenicula* sp. x 100.
Figs. 4, 5	*Triletes* aff. *catenulatus* var. *marginatus* Winslow. 4, Detail of equatorial feature x 500. 5, Oblique compression x 200.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