COMPRESSION STRUCTURES IN THE LOWER CARBONIFEROUS MIOSPORE *DICTYOTRILETES ADMIRABILIS* PLAYFORD

by G. CLAYTON

ABSTRACT. Specimens of the dispersed miospore species *Dictyotriletes admirabilis* Playford 1963 are described from large spore masses obtained from the Lower Carboniferous of eastern Scotland. *D. admirabilis* is transferred to the genus *Punctatisporites* (Ibrahim) Potonié and Kremp 1954, and compression of sporangial masses is suggested as the mechanism by which the characteristic indentations in the exine were formed.

Dictyotriletes admirabilis was first described by Playford in 1963 from the Horton Group (Mississippian) of eastern Canada. Subsequently a similar but smaller form was recorded by Butterworth and Spinner (1967) from the Lower Carboniferous of north-west England.

Spore masses containing *D. admirabilis* were found in one coal sample by Dr. E. G. Spinner (*pers. comm.* 1970) during an investigation of the Viséan megaspores of East Lothian, Scotland. The sample from which the spore masses were obtained was a thin coal from depth 32 ft 8 in in the Institute of Geological Sciences' Skateraw (1969) bore-hole, East Lothian. This horizon is approximately two feet below the Mid Skateraw Limestone in the Lower Limestone Group, which in this area is considered to be Upper Viséan in age (Wilson *pers. comm.* in Spinner 1969). Further investigation of the same sample has resulted in the isolation of several more spore masses of the same type, and the isolation of individual spores from some of these masses. The sample was also prepared by standard techniques for dispersed miospores.

SAMPLE PREPARATION

The coal was crushed into small pieces approximately 1 cm in diameter, treated with Schulze solution for 12 hours, washed until neutral, rinsed rapidly with 2% potassium hydroxide solution, and washed again until neutral. The residue was then sieved at 100 B.S. mesh size, and the spore masses picked from the remaining coarse fraction. The spore masses were broken down into small clusters or single spores by repeated treatment with fuming nitric acid for approximately 1 minute, washing until neutral, then application of ultrasonic vibration for approximately 5 seconds. Selected specimens were mounted for scanning electron microscope investigation, and the remaining spores were mounted in glycerine jelly.

The same sample was also prepared by standard dispersed miospore techniques, and permanent scatter mounts using cellosize and Canada balsam were made. All figured specimens are housed in the Micropalaeontology Collection of the University of Sheffield Geology Department. Specimens mounted for scanning electron microscopy are denoted by 'SEM' after the collection reference number. Representative specimens are also deposited in the Institute of Geological Sciences, Leeds.

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SYSTEMATIC DESCRIPTIONS

Spore masses containing *D. admirabilis*

Plate 27, fig. 2

Description. Seven specimens were recorded ranging from 500 to 900 μm in longest diameter. All are irregular in shape and are flattened. The constituent miospores are well preserved, and are in close contact with each other. Tapetal material is irregularly distributed between the spores as small spheres up to 8 μm in diameter. The affinity of these spore masses is unknown.

Anteturma SPORITES H. Potonié 1893
Turma TRILETES (Reinsch) Dettmann 1963
Suprasubturma ACAMERATITRILETES Neves and Owens 1966
Subturma AZONOTRILETES (Luber) Dettmann 1963
Infraturma LAEVIGATI (Bennie and Kidston) Potonié and Kremp 1954
Genus PUNCTATISPORITES (Ibrahim) Potonié and Kremp 1954

Type species. *Punctatisporites punctatus* Ibrahim 1933.

Punctatisporites admirabilis (Playford) comb. nov.

Plate 27, figs. 1, 3, 4, 6, 7

1963 *Dictyotriletes admirabilis* Playford p. 29, pl. viii, figs. 5–7.
?1967 *Dictyotriletes admirabilis* Butterworth and Spinner, pl. 2, fig. 16.

Holotype. Playford 1963, pl. viii, fig. 5; Horton Group, Nova Scotia (GSC loc. 6400).

Dimensions. 64 (75) 91 μm, 61 specimens, spore mass B.

Description. Spores radial, trilete. Amb circular to oval or rounded polygonal. Trilete mark often indistinct. Suturae straight, normally accompanied by low, membranous folds of the exine bordering the suturae, length one half to two thirds of spore radius. Exine approximately 3 μm thick, finely scabrate. The spores are preserved in large masses, in polar, oblique and lateral compressions. The spore exine is affected by several large, shallow, partially superimposed depressions, which, in clusters of spores, can often be seen to affect two or more adjacent spores. In transmitted light individual depressions are normally seen as either relatively light or dark areas, depending on the focus, separated from each other and from non-depressed areas by well-defined arcuate boundaries. In the scanning electron microscope these arcuate markings, described by Playford (1963, p. 29) as 'thread-like muri' are seen to be low crests between adjacent depressions, or separating depressions from relatively high, non-depressed areas. The radius of curvature of the depressions is never greater than the maximum observed spore radius. Peripheral folding is common.

EXPLANATION OF PLATE 27

Figs. 1–4, 6, 7. *Punctatisporites admirabilis* (Playford) comb. nov. 1, ML849 SEM, ×500. 2, ML850 SEM, spore mass; approx. ×100. 3, ML851, showing abortive spore, ×400. 4, 6, 7, ML852–854, ×400.
Fig. 5. *P. planus* Hacquebard, ML 855; ×400.

Remarks. D. admirabilis was assigned by Playford (1963) to the genus *Dictyotriletes* (Naumova) Potonié and Kremp 1954 on the basis of the presence of muri forming a reticulum. This genus was later emended by Smith and Butterworth (1967). Examination of Playford's illustration of the holotype together with scanning electron microscope studies of the Scottish material have however clearly shown that the reticulate appearance of this species is formed by partially superimposed depressions in the spore exine, and not muri sensu Smith and Butterworth (1967, p. 116). This species is therefore transferred to *Punctatisporites* as it is a laevigate form, and does not possess muri in the accepted sense (Smith and Butterworth 1967, p. 116) as projecting thickenings of the exine.

Comparison. P. admirabilis comb. nov. is very similar to *P. planus* Hacquebard 1957, except for the presence of the prominent arcuate markings in the former species.

Punctatisporites planus Hacquebard 1957

Plate 27, fig. 5

Dimensions. 58 (70) 89 μm, 50 specimens, dispersed miospore preparation.

Description. Radial trilete miospores. Amb circular to oval. Non-polar compressions common. Trilete mark often indistinct. Suturae straight, often accompanied by low, membranous folds of the exine bordering the suturae, length one half to two thirds of spore radius. Exine finely scabrate, approximately 3 μm thick. Folding rare.

Previous records. Hacquebard 1957 (coal) and Playford 1963 from the Horton Group (Mississippian) of Nova Scotia.

DISCUSSION

In many clusters of *P. admirabilis* the arcuate markings can be traced across several spores, in some cases almost completing a full circle (Pl. 27, fig. 6). The size and distribution of the depressions are consistent with their having been formed by compression against neighbouring spores, which may also have caused some separation of the spores from the tetrad state. The common peripheral folding in this species was probably caused by the spores 'spreading' against each other normal to the axis of compression.

The presence of indentations on both surfaces of the flattened spores irrespective of their post-compressional orientation suggests that the depressions were formed during compaction of the enclosing sediment, rather than by growth of the spores in the restricted volume of the sporangium during maturation. If the latter mode of formation was the case, the depressions would be restricted to the distal surface of the spores, with the attendant development of such specialized proximal surface features as clearly defined contact areas, due to the close mutual contact of the spores within their tetrads. The spores would also be expected to be present in all cases in the dispersed miospore preparation. The presence of *P. admirabilis* in the dispersed miospore preparations described by Playford (1963), and Butterworth and Spinner (1967) may be accounted for by the break up of spore masses during oxidation, as Playford figures one cluster of specimens.

The similarity between *P. admirabilis* and *P. planus* in all aspects except the depressions in the former species is interpreted by the author as indicating the probable derivation of *P. admirabilis* from spores referable to the morphographic species *P. planus* by an unusual mode of fossilization. This interpretation is supported by the mutual exclusion of these species in the spore masses, and in the dispersed miospore preparation. The specimen of *P. admirabilis* figured by Butterworth and Spinner (1967, pl. 2, fig. 16) is somewhat smaller than the lower limit of either the size range recorded for this species by Playford, or that of the specimens from the Skateraw sample. *P. debilis* Hacquebard 1957, the only species of *Punctatisporites* recorded by Butterworth and Spinner from the sample containing *P. admirabilis* is proportionately smaller than *P. planus*, and its size range covers the diameter of the specimen figured by these workers. This provides some substantiation for the hypothesis that the characteristic exine deformation of *P. admirabilis* is not a primary structure, but is produced during fossilization, and could therefore be duplicated in many other morphographic species under suitable conditions.

The postulated criteria for the generation of *P. admirabilis* style of exine deformation in miospores can be summarized:

1. Preservation of spores in clusters or perhaps even whole sporangia, rather than as dispersed individuals.
2. A thick exine relative to the spore diameter, which would be indented by the surrounding spores, rather than simply folded during compression.
3. A relatively smooth exine which would allow contact with the adjacent spores over a large surface area, unimpeded by projecting ornament.

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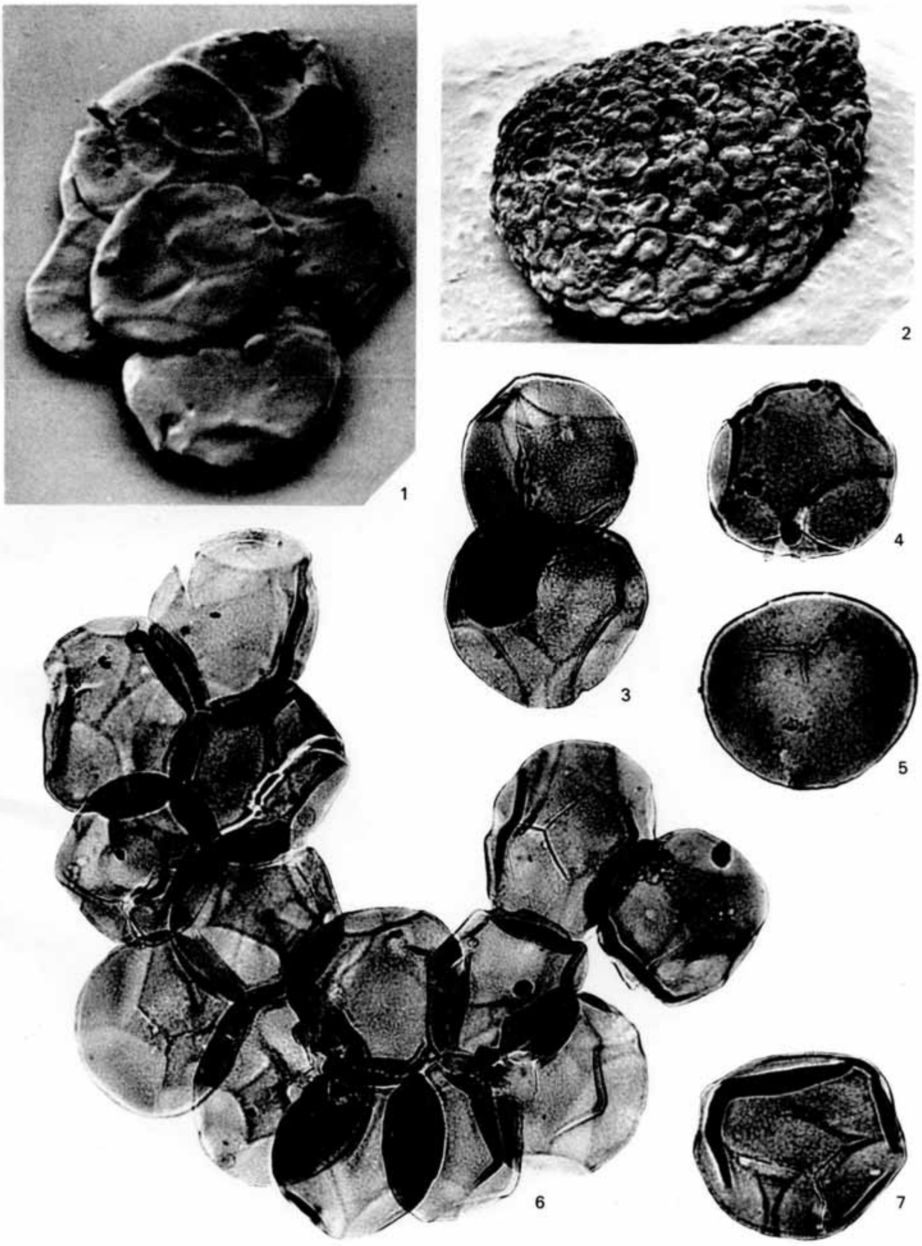

CLAYTON, Lower Carboniferous miospore