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AN ALBIAN SPORE-POLLEN MICROFLORA ASSOCIATED WITH A FISSION TRACK DATE IN THE OTWAY BASIN, VICTORIA

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ABSTRACT

A spore-pollen microflora from a shale bed in the Otway Group at Spout Creek (Otway Basin, Victoria) is assigned to the Crybelosporites striatus Zone. A fission track date of 108±15 Ma obtained from a sandstone immediately underlying the shale bed falls within the Early Cretaceous, and possibly latest Aptian. This age is not incompatible with faunal evidence from Queensland for an early Albian age of the microflora. A few dinoflagellates and acritarchs found in the microflora cannot be dated. Believed to be mostly nonmarine, they suggest a lacustrine to fluvial and probably nearshore enviroment for the Spout Creek shale bed.

INTRODUCTION

On 29 September 1989 Dr. Mart Idnurm (BMR) kindly collected 5 samples for palynological examination from a 2.4m thick shale bed exposed along the Ocean Road at Spout Creek, Victoria (latitude 38°33's, longitude 144°02'e). The location of the shale bed is shown in Figure 1, and the samples are specified in Table 1. The shale bed rests directly, and possibly unconformably, on coarsely crossbedded arenites (M. Idnurm, oral comm.), and the two sedimentary units are part of the Otway Group in the Otway Basin.

The shale bed yielded a spore-pollen assemblage sufficiently species-diverse to be dated. A fission track date established for the underlying arenites provides an opportunity to tie the spore-pollen biostratigraphy of the Otway Basin with the Cretaceous absolute time scale.

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FIGURE 1.
The Otway and Great Artesian Basins (stippled) and location of Spout Creek shale bed

METHODS

Treatment of the rock samples followed standard BMR laboratory procedures. After crushing, they were washed in diluted HCl, boiled in concentrated HF for 60 minutes, and washed again in diluted HCl, to remove silicates and carbonates. The residue was briefly washed in warm KOH and cold HNO_3 (both diluted), and the last fraction of sediment removed by heavy liquid separation.

The organic residue was washed in sodium hexametaphosphate $[Na(PO_3)Na_2O]$, and amorphous organic detritus removed by sieving (10 μ mesh cloth). The remaining residue is kept permanently in alcohol. Two slides were made up from each residue. The fossils, stained with safranine, are mounted in PVC, and coverslips attached with canada balsam. The list of species in Table 1 is obtained from a full scan of both slides from each sample.

THE SPORE-POLLEN MICROFLORA

Characteristics

In view of their close vertical spacing (see Table 1) the five samples analysed are taken to be coeval. Microfloral assemblages recovered from them are closely comparable in appearance and species composition. No statistical analysis was attempted in view of the relatively large number of uncertain identifications.

Appearance: The organic residue extracted from the sediment contains abundant coarse plant tissue fragments and carbon particles, and fine amorphous («sapropelic») debris. The slides contain relatively few spores and pollen, whose (pre-staining) colour ranges from light to dark brown. Deep weathering probably accounts for a preservational bias towards the group of tough trilete spores, thin-walled saccate and inaperturate grains being mostly very poorly preserved.

Species composition: The microflora includes high fractions of bisaccate forms (common *Alisporites* and very few *Podocarpidites*). Inaperturate types (*Araucariacites*, *Callialasporites*) were not uncommon in several slides. The group of trilete (fern) spores dominates, the most common components being *Baculatisporites*, *Ceratosporites*, *Lycopodiumsporites*, and *Cyathidites*. Several bryophites are present in minute fractions. A few pollen grains of angiosperm affinity were found in several slides, and their presence is compatible with records of angiosperm pollen in coeval and older horizons of the Gippsland and Great Artesian Basins (Dettmann, 1986; Burger, 1988).

The presence in some assemblages of several spore types which have been described from the latest Triassic and Early Jurassic of the Clarence-Moreton and Surat Basins in Queensland confirms earlier observations (Burger, 1987, not discussed here) of the existence of strata of that age in the Otway Basin region.

Biostratigraphic affinity

The Spout Creek microflora is placed in Dettmann & Playford's (1969) spore-pollen biostratigraphy for eastern Australia on the presence of *Crybelosporites striatus* and the apparent absence of *Coptospora paradoxa* (see Fig. 2). This zonal interval has been identified in every Cretaceous sedimentary basin in eastern and central Australia. Defined first as the Crybelosporites striatus Subzone by Dettmann & Playford, it was elevated to zonal level by Helby et al. (1987).

THE MICROPHYTOPLANKTON FLORA

Characteristics

The microplankton flora, although very scarce, includes both dinoflagellates and acritarchs whose (pre-staining) colour ranges from almost colourless to medium brown. The acritarchs are mostly smooth-walled (Leiosphaeridia, Sigmopollis, Fromea, Nummus) and only very few spinose types (Veryhachium, Micrhystridium) were found. The dinoflagellate assemblage includes proximate, mostly acavate cysts. Several forms are as yet unfamiliar to the author and may perhaps represent new genera.

Biostratigraphic affinity

The acritarchs identified are widely distributed in the Early Cretaceous of eastern Australia but give no clue as to the biostratigraphic affinity of the microflora. The dinoflagellate flora includes Early Cretaceous forms but is only slightly less uninformative. Leiosphaeridia? perthensis has been reported only from Western Australia (Backhouse, 1988). The brackish/freshwater species Batiacasphaera macrogranulata also occurs in the Great Artesian Basin (Morgan, 1980; Burger, 1988). Full upper range extensions of these species are not yet certain.

By themselves, the other species (Cassiculosphaeridia magna, Circulodinium colliveri, Muderongia tetracantha) do not indicate a specific zonal interval in Helby et al.'s (1987) dinoflagellate biostratigraphy for Australia. Morgan (1980), Burger (1986, 1988) and Helby et al. (1987) reported the youngest known occurrence of M. tetracantha from the Muderongia tetracantha Zone in central and northeastern Australia. The presence of a single specimen of that species in assemblage MFP-9164 might suggest an upper age limit for the Spout Creek flora comparable to that indicated by the spores and pollen (see Fig. 2).

AGE OF SPOUT CREEK MICROFLORA

By the absence of marine faunas the Otway Group has been dated latest Jurassic to Early Cretaceous on its megaflora, spores, and pollen grains (Douglas et al., 1976). Evidence from molluscs and foraminifera in the Great Artesian Basin date the Crybelosporites striatus Spore-pollen Zone as well as the Muderongia tetracantha Dinoflagellate Zone early Albian (Day, 1969; Haig, 1979; Burger, 1980; Helby et al., 1987). On somewhat negative evidence Morgan (1980) and Helby et al. took the lower limit of the C. striatus Zone in the Great Artesian Basin to be latest Aptian.

Evidence from invertebrate faunas and dinoflagellates from the Great Artesian and Otway Basins strongly suggests the late Albian and Cenomanian spore-pollen zones to be approximately time-parallel, but it is not known to which extent (if at all) the C. striatus Zone may be diachronous in eastern Australia. The Spout Creek shale bed is thus dated most probably early Albian.

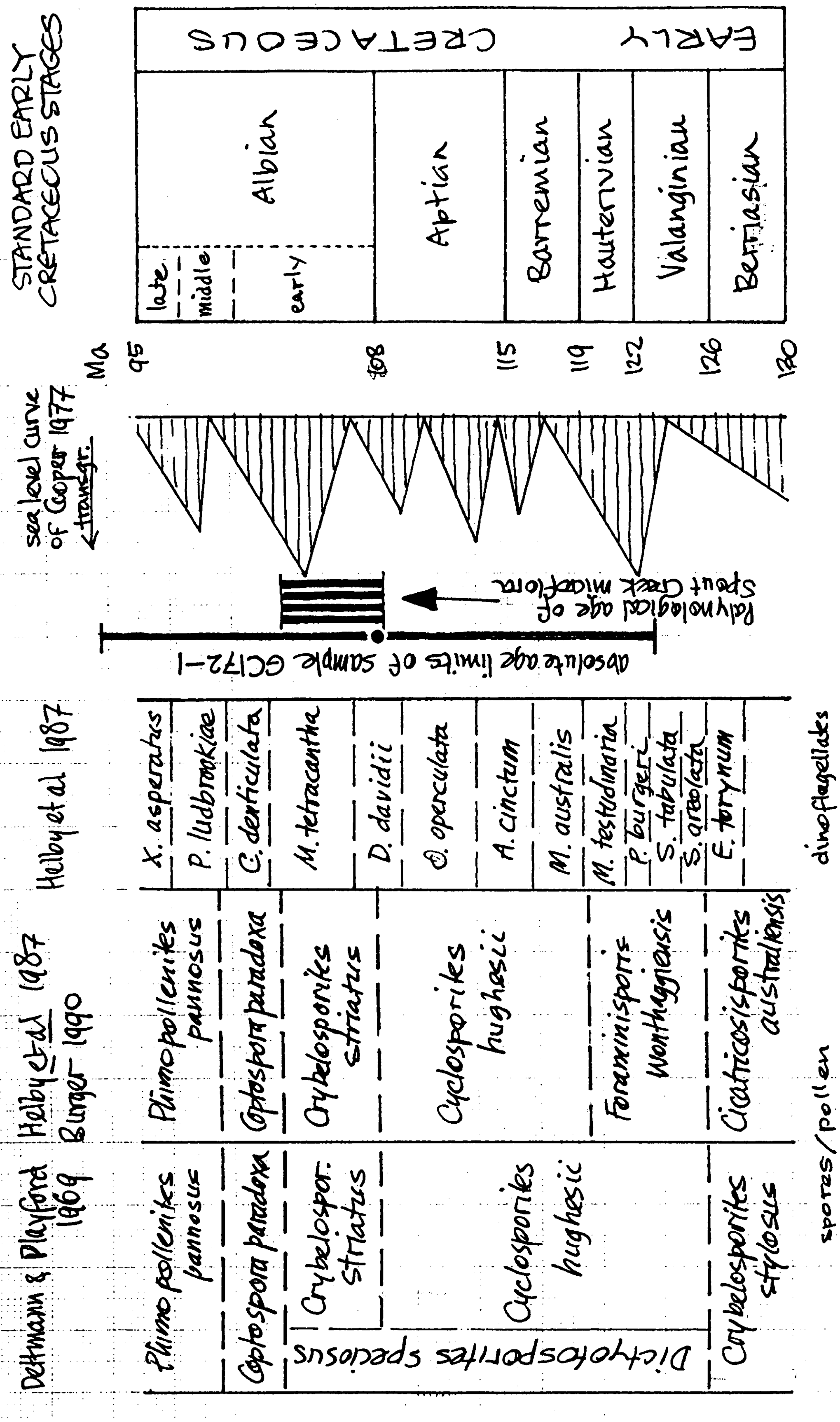

FIGURE 2: Biostratigraphic zonal schemes referred to in text and their ties to the Spout Creek flora and fission track dating

Gleadow & Duddy (1981) calculated an age of 126-103 Ma for the Otway Group on sphene and apatite fission track analyses from the central Otway Basin. This age span includes the Valanginian to earliest Albian in the Cretacous time scale of Kennedy & Odin (1982) and Hallam et al. (1985), which is proposed as the standard scale for Australia (Burger, 1990).

Based on fission track analysis on zircons, Green (1989) dated a sample (GC172-1) from 4.5 m below the base of the Spout Creek shale bed as (one s.d.) 107.9±7.4 Ma. This means a two s.d. age of 108±15 Ma, which spans the latest Valanginian to earliest Cenomanian. A 108 Ma age coincides with the Aptian-Albian boundary and is compatible with 108-?101 Ma for the Spout Creek microflora deduced from the spore-pollen evidence alone (Fig. 2). Duddy's estimation of 110-115 Ma for the strata at Spout Creek (see Idnurm, 1985, p. 404) seems therefore too old. A refined fission track or zircon age determination may provide a firmer age for the lower limit of the C. striatus Zone.

PALAEOENVIRONMENT

In the Spout Creek microflora Batiacasphaera macrogranulata and ?Batiacasphaera sp. are the most common dinoflagellates, and the first is likely a freshwater/brackish form (Morgan, 1976). Muderongia tetracantha, Cassiculosphaeridia magna, Circulodinium colliveri, and Leiosphaeridia? perthensis are known chiefly from marine sediments (Morgan, 1980; Burger, 1980, 1988; Helby et al, 1987; Backhouse, 1988), and are very rare at Spout Creek. The equally rare unidentified dinocysts are of unknown affinity. Most acritarchs are environmentally nonselective, but Veryhachium and Micrhystridium may be brackish water forms (Burger, 1980).

This evidence indicates that the Spout Creek shale bed was probably deposited in a coastal lake or swamp, which at times was mixed with seawater. Such an environment agrees with Douglas et al.'s (1976) description of a predominantly fluvial origin for the Otway Group.

Frakes et al. (1987) suggested that the sea first entered the Otway Basin through rift valleys in the late Albian. The presence of marine fossils at Spout Creek indicates that the sea had much earlier access to the basin (presumably via the same rift valleys), and is linked with an early Albian high eustatic sea level, which gave rise to a marine transgression in the Great Artesian Basin.

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TABLE 1
Samples and plant microfossils from the Spout Creek shale bed

The samples, identified by a BMR Palynological Register number (MFP), were collected as follows (M. Idnurm, pers. comm.):

Sample MFP-9164 from 220 cm below top of shale bed
Sample MFP-9163 , 150 cm , , , , ,
Sample MFP-9162 , 100 cm , , , , ,
Sample MFP-9161 , 55 cm , , , , ,
Sample MFP-9160 , 17 cm , , , , ,

SPORES AND POLLEN GRAINS	9164	9163	9162	9161	9160
Aequitriradites spinulosus				x	
Aequitriradites verrucosus	?				x
Angiosperm pollen grains (indetermin.)		x	x		?
Alisporites grandis	x	x		x	
Alisporites similis	x	x	x	x	x
Araucariacites australis	x	x	?	?	x
Araucariacites fissus	?	?			?
Asteropollis asteroides		?		x	?
Baculatisporites comaumensis	x	x	x	x	x
Bisaccate pollen grains (indetermin.)	x	x	x		x
Callialasporites dampieri		?	?		
Callialasporites trilobatus	x		x	x	
Ceratosporites equalis	x	x	x	x	x
Cicatricosisporites australiensis	x	x	x	x	x
Cicatricosisporites spp. (indetermin.)			x	x	x
Classopollis spp.	x	x	x	x	
Clavatipollenites cf. *C. hughesii*			x	x	
Concentrisporites hallei		?		x	x
Contignisporites cooksoniae	x				
Cooksonites variabilis					x
Couperisporites tabulatus	?				
Crybelosporites berberioides					?
Crybelosporites punctatus	?				
Crybelosporites striatus	x	x	x	x	x
Crybelosporites stylosus		?		?	
Cyathidites australis	x			x	x
Cyathidites minor	x	x	x	x	x
Dictyotosporites complex	?			x	x
Dictyotosporites filosus			?		
Dictyotosporites speciosus	x		x	x	x

TABLE 1 (cont'd)

Foraminisporis asymmetricus	?		x		x
Foraminisporis dailyi				x	
Foraminisporis wonthaggiensis					?
Foveosporites canalis				x	
Gleicheniidites circinidites				x	
Inaperturopollenites turbatus	x		?	x	?
Klukisporites scaberis			?		
Leptolepidites major		x			
Leptolepidites verrucatus	x	x	x		x
Lycopodiumsporites austroclavatidites	x	x	x	x	x
Lycopodiumsporites circolumenus	x	x	x	x	x
Lycopodiumsporites nodosus			f	x	x
Lycopodiumsporites rosewoodensis		x	x	?	x
Microcachryidites antarcticus	x	x	x	x	
Monosulcites minimus	x		x	x	x
Neoraistrickia truncata					x
Osmundacidites dubius	x	?	?		
Osmundacidites mollis		?			
Osmundacidites wellmanii			x	x	x
Peromonolites (Brenner 1963) sp.		?			
Perotrilites sp. (indetermin.)		x	x		
Podocarpidites ellipticus			x	x	?
Polycingulatisporites densatus	x			x	
Rugubivesiculites sp. (indetermin.)	x				
Stereisporites antiquasporites	x	x	x	x	x
Stereisporites pocockii	x				
Stoverisporites lunaris	x				
Triporoletes sp. (indetermin.)	?		?		
Velosporites triquetrus	x	x			?
Vitreisporites pallidus		x			x

	9164	9163	9162	9161	9160
DINOFLAGELLATE CYSTS					
Batiacasphaera macrogranulata	x	x	x	x	
Batiacasphaera sp.		x	x		x
Cassiculosphaeridia magna	x	?		?	x
Circulodinium colliveri	x		x	x	
Circulodinium? sp. A		x	x		
Circulodinium? sp. B		x	x		
Circulodinium? sp. C		x	x		
Eucladinium? sp.		x			
Leiosphaeridia? perthensis	?	x	x	x	x
Muderongia tetracantha		x			
Palaeotetradinium? sp.	x	x	x		
Other undetermined forms	x	?	x	x	
ACRITARCHS					
Fromea fragilis	x				
Leiosphaeridia spp.	x	x	x	x	x
Micrhystridium spp.		x			x
Nummus monoculatus	?	x			x
Sigmopollis cf. S. hispidus	x	?	x	x	x
Veryhachium reductum		x		x	