SYNOPSIS

Mississippian microspore assemblages are strongly affected by floral provincialism, resulting in major compositional differences between the various regions in the Northern Hemisphere. Nevertheless, six major palynological events can be recognized which may be relevant to the correlation of the Mississippian. In ascending order, these are: 1-the extinction of *Retipores leptophyta* approximately at the Devonian/Carboniferous boundary, 2-the first appearance of *Spelorastites precolus* in the middle Tournaisian, 3-the first appearance of *Lycopores paullii* (uppermost Tournaisian - basal Viséan), 4-the first appearance of *Tripartites venatus* (upper Viséan), 5-the first appearance of monosaccate pollen (lowermost Namurian), and 6-the extinction of *Tripartites venatus* and *Rosapora* spp. (lower Namurian - Ems). Limited, independent, biostratigraphic control suggests that the six events are essentially synchronous over considerable distances.

INTRODUCTION

The establishment of floral provinces during the Early Mississippian resulted in major differences among microspore assemblages of similar age from the various regions of the Northern Hemisphere (SULLIVAN, 1965, 1967; CLAYTON 1985). The Lower Mississippian *Vallatisporites* Microflora has been recognized in the Midcontinent U.S.A., Atlantic Canada, Western Europe, southern and central Poland, the Donets Basin, Tibet and northern China. The broadly contemporaneous *Lophosporites ramosus* Microflora encompassed western Canada, Spitsbergen, Bear Island, northern Poland and the northwestern parts of the U.S.S.R. The *Vallatisporites* and *Lophosporites* microfloras are succeeded in the same regions by the Upper Mississippian *Geinitzapis* and *Vallatisporites* microfloras, respectively. The latter microflora also occurs in the Canadian Arctic Archipelago.

A very different Mississippian microflora, the *Spelorastites balticus* Microflora, was described from North America and the Middle East (CLAYTON, 1985), though its name should now be changed to the *Aarapisites adhemarii* Microflora, following the erection of this taxon by LOBOZIAK et al. (1986) to accommodate spores which had previously been incorrectly assigned to *Spelorastites balticus*. The Mississippian Kazakhian microflora is poorly known, and is not considered further here.

In the following discussion of significant events in the Mississippian, emphasis is placed on the *Vallatisporites* and *Geinitzapis* microfloras. Events which can be recognized within these microfloras may permit correlation of the Dinantian and lower Namurian regional stages of Western Europe, and of sequences in Atlantic Canada, Eastern Europe, Tibet and central China with Mississippian reference sections once the latter have been studied in sufficient detail.

This paper briefly outlines the main changes in palynological associations through the Mississippian in Europe, North Africa and North America, based mainly on detailed investigations in Canada, Western Europe, Poland and North Africa. The locations of the sections discussed are shown in Fig. 1. Many of the palynological events described are first appearances of species rather than genera or supergeneric groupings, and are subjective in nature. They are described in the following section in ascending stratigraphic order.

PALYNOLOGICAL EVENTS

1. Extinction of *Retipores leptophyta* (KEDO) PLAYFORD. This event, which can be recognized worldwide and appears to be totally independent of facies, is one of the most prominent breaks in the Upper Palaeozoic microspore succession. Other taxa which disappear at this...
level include Vallisneriopsis hystrix (WINSLOW) BYYSHEVA, HIGGS & STREELE. 1984. In Western Europe, the disappearance of R. lapidophyta appears to be more or less coincident with the Baltic/Finnmarkian boundary (PAPROTH & STREELE, 1972; BYYSHEVA et al., 1984; HIGGS & STREELE, 1984). In other regions, independent biostratigraphic control is more limited, or totally absent, but there is nothing to suggest that the timing of this event differs substantially in age from Europe.

2. First appearance of Spolenoleites praecox (PLAN- FORD) NEVES & BELT emend. UTING. In Western Europe, Spolenoleites praecox first appears in the middle Tournaissian (CLAYTON et al., 1978). The taxon also appears in Atlantic Canada in sections dated as middle or possibly upper Tournaissian (UTING, 1987; UTING, KEPPIE & GILES, 1989) and in the Kinderhookian/Lower Osagean of the midcontinental United States (COLEMAN & CLAYTON, 1987).

In northern Poland, S. praecox first appears in deposits assigned to the middle Tournaissian (TURNAU, 1975; 1976; CLAYTON & TURNAU, in press). In North Africa, the first appearance of S. praecox immediately follows the disappearance of R. lapidophyta, suggesting a condensed section in the uppermost part of the lower Tournaissian and in the lower middle Tournaissian, though independent dating is lacking (LOHRZIAK & CLAYTON, 1988; COQUEL & LATRUCHE, 1989).

3. First appearance of Lycopora puzilla (IBRAHIM) SOMERS, Lycopora puzilla and morphologically related species of the same genus were microspores produced by the arborescent lycopod Lepidodendron. The first appearance of Lycopora puzilla is undoubtedly one of the most significant events in terms of Mississippiian plant evolution.

The species first appears at, or close to, the Tournaissian/Viséan boundary in the British Isles (NEVES et al., 1972; CLAYTON et al., 1978), and in the uppermost Tournaissian in the Doneus Basin of the U.S.S.R. (OWENS et al., 1978). Macrofossil and microfossil correlation of the successions in these regions with the Belgian stratotype is, however, extremely tenuous. L. puzilla is present in strata dated as early Viséan in the Baltic islands of Finland, Denmark (BERTSELS et al., 1972) and Rügen, Germany (BURRENIG, 1975). In northern Poland, it first appears in sections poorly dated as early Viséan, though in this region its initial occurrences are very rare (TURNAU, 1978). The first appearance of L. puzilla in Spitsbergen is in rocks which lack any stratigraphically diagnostic faunas (PLAYFORD, 1962, 1963). Lycopora puzilla is not present in reasonably diverse microspore assemblages from the lower Osagean of Kentucky (COLEMAN & CLAYTON, 1987), but was recorded from the upper Osagean (Kerekuk Kostkum equivalent) of Tennessee (HOROZITZ et al., 1979).

The first species appears at the base of the Barnama Formation in Nysllmark, Tibet, which is dated on faunal evidence as late Tournaissian to early Viséan (GAO, 1985). In Gansu Province, northern China, L. puzilla first occurs in the lowermost Viséan (GAO, 1985).

In Atlantic Canada, L. puzilla first appears in rocks of late middle to late Viséan age, though these are separated from the underlying late Tournaissian by an hiatus or by red beds lacking palynostratigraphy (UTING, 1987; UTING, KEPPIE & GILES, 1989). It occurs commonly in the late Viséan of western Canada and the Canadian Arctic (BAMBER et al., 1989; UTING, JACHOWICZ & JACHOWICZ, 1989). In western Canada this species has also been recorded in early to middleViséan rocks (BRAMAN & HILLS, 1977; RICHARDS et al., in press), although early Viséan beds in this region have yet to be studied in detail.

In North Africa, the first appearance of L. puzilla was considered by MASSA et al. (1980), COQUEL et al. (1988), LOHRZIAK & CLAYTON (1988) and COQUEL & LATRUCHE (1989) to occur only in the late Viséan. However, there is no reliable palynological evidence to prove the existence of middle Viséan strata in this region.

4. First appearance of Tripartita retusa SCHEMEL. Tripartita retusa appears to be restricted geographically to the Grandapis Microflora, but its first appearance is nevertheless considered significant since it may enable correlation between the Middlecontinent U.S.A., Western Europe, Doneus Basin and Gansu, China. The species first appears at the base of the late Viséan Baltic Stage in Scotland and northern England (CLAYTON et al., 1978). Other taxa which typically first appear with T. retusa are Protosporites franciscanus (SCHEMEL) SMITH & BUTTERWORTH, R. knosisi BUTTERWORTH & WILLIAMS, Grandapis spinosus HOFFMEISTER, STAPLIN & MALLOY, and Seripteporites mar (BUTTERWORTH & WILLIAMS) SMITH & BUTTERWORTH. In the Wawas–Loblon area, T. retusa and R. franciscus first appear in the late Viséan, though older Carboniferous rocks are absent (KIMBIEC, 1979, 1986).

In Atlantic Canada Grandapis spinosus appears in rocks believed to be late Viséan (UTING, 1987). Protosporites francisc anus occurs in the late Viséan of western Canada and the Canadian Arctic (BAMBER et al., 1989; UTING, JACHOWICZ & JACHOWICZ, 1989).

5. First appearance of monosaccate pollen. The Dinarid/Silesian boundary cannot easily be recognized on palynological evidence in Europe, since no taxa consistently appear or disappear precisely at the boundary. However, several taxa do appear sporadically in basal Namurian sections including Cratonipora costarkel (POTONIE & CREMP) BANDARADAW, Centrimedusites satun- nei (IBRAHIM) SCHOFF, WILSON & BENTALL, Protopiptopites larinicornus NIEVES et al. and the monosaccate pollen Florinites sp. and Podozacoeporida elegans (WIL- SON & COE) WILSON & VENKATA CHALAM. Of these, the monosaccate pollen taxa are considered the most significant, since they first appear at broadly com- parable stratigraphic levels (lower Namurian or lower Serpukhovian) in both the European and Russian stratigraphic successions.
REFERENCES


BIRTELS, F. (1972) A Lower Carboniferous microflora from the Órerød No. 1 borehole, Island of Fälster, Denmark.—Danmarks Geol. Undersøgelse, 11 Fasc.: 1-76, 24 pl.


———(1977) Palynological division of the Namurian of


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AUSTRALIAN LOWER CARBONIFEROUS MOSPORES RELEVANT TO EXTRA-GONDWANAN CORRELATIONS: AN EVALUATION

Geoffrey PLAYFORD

ABSTRACT

In this Australian-based survey of globally distributed Early Carboniferous (Mississippian) mospores, a number of taxa are identified, in terms of their consistency of stratigraphic appearance or disappearance, as being of actual or potential significance in correlating Southern Hemisphere strata beyond the Gondwana realm. The exit of Rhipidophytes (REDO) PLAYFORD 1976 appears to be a ubiquitous palyno-event, consistently marking the Devonian—Carboniferous boundary. Within the Mississippian, the ranges of the following are regarded as chronologically significant in both Northern and Southern Hemispheres: Dikosporites distinctus (CLAYTON) PLAYFORD 1976, D. acutaurea (NEVILLE) PLAYFORD & SATTERTHWAIT 1986, Triculatiosporites spp., Diatomosporites verrucosus, Car- dinalisporites papillosus (NAUMOVA) PLAYFORD & SATTERTHWAIT 1985, Xeropinerosites naumovae (BULANIN) DOUSINGER & RAUSCHER 1966, Rastericula zierckeana (SULLIVAN) PLAYFORD & SATTERTHWAIT 1986, Tornasporites auratauriculatus (LUBER) PLAYFORD n. comb., Betulaeites mikelinae (NEVILLE) PLAYFORD 1978, and Walporgia polia (HOFFMEISTER, STAPLIN & MALLOY) SMITH & BUTTERWORTH 1967. The palyno- logical data are suggestive of floral regionalism during the Early Carboniferous, while still providing evidence of cosmopolitan distribution of some elements of the spore-producing land vegetation. In the systematic section of the paper, the widespread, lowermost Visean species Hydropitys expansus (LUBER) is newly combined with Indoraminia TIWARI 1964, and several other new combinations are instituted. The new sporo-plagiogamous genus Umbroisporeites HIBBERT & LACEY 1969 is reaffirmed as a junior synonym of Dikosporites RICH- ARDSON 1965.

INTRODUCTION

This paper was originally solicited by the Chairman of the SCCS Lower Carboniferous/Mississippian Boundaries Working Group (Dr. Paul BRENCLE) as a survey of palynomorph taxa that occur in Southern Hemisphere Lower Carboniferous (Mississippian) strata and offer scope for international correlation (i.e., of and within that interval). The focus of the paper is on Australian palynomorphs, inevitably so because very little has been forthcoming from the older parts of the Carboniferous System elsewhere in the Southern Hemisphere. Moreover, the palynomorphs discussed are entirely mosspores. Many of the Australian sequences that have been studied palynologically are of marine origin (and hence dated on independent faunal grounds), but their acritarch content is minimal in comparison with the pro- fuse mosspore component. Megaspores, too, are rare occurrence (PLAYFORD, 1986b).

In the systematic section, the taxonomy and morphological characteristics of 23 widely distributed mosspore taxa (all but two of specific rank) are reviewed and illustrated on Plates 2-4: complete synonomy listings (or references to same) are provided, together with distribution (geographic/stratigraphic) summaries for each of the taxa. Figs. 1 and 2 depict known vertical ranges of the mosspore taxa in Australian and Northern Hemisphere deposits, respectively. A selection of species that are not certainly known outside the Australian Lower Carboniferous is illustrated on Plate 1 to emphasize the predominantly endemic complexion of the Aus- tralian palynomorph fauna.

The combination of attributes that places spores—pollen palynomorphs at the forefront of stratigraphically important microfossil assemblages in the correlation of both continental and nearshore marine sedimentary rocks, needs no reiteration here. So far as the Australian Lower Carboniferous is concerned, mosspores are well-established as zonal indices, particularly in western and northern Europe, in the So- viet Union, and in North America. In Australia, Carboniferous palynological studies were inaugurated appreciably later (BALME, 1960) than in the Northern Hemisphere, but have since progressed considerably.