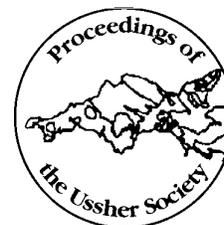


PALYNOLOGICAL EVIDENCE CONCERNING THE AGE OF THE HYNER SHALE AND GURRINGTON SLATE FORMATIONS IN THE NEWTON ABBOT AREA, SOUTH DEVON.



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Palynomorph assemblages obtained from a well-dated horizon in the Hyner Shale Formation (Famennian/Tournaisian), are compared using scanning electron microscopy (SEM), and transmitted light microscopy techniques. The floral lists obtained independently, reveal a high proportion of identifications common to both, but with the larger assemblage coming from the SEM sample. It is suggested that this imbalance is a direct result of the oxidation techniques used to produce translucent images from coalified miospores. This distinctive assemblage was compared with that obtained from an horizon of comparable age, but contrasting fades, developed within the Gurrington Slate Formation. The palynomorph assemblages, from both the Hyner Shale and Gurrington Slate Formations of south Devon confirm a late Famennian or earliest Carboniferous age. The appearance of miospores only previously recorded from the Carboniferous within both formations is consistent with the presence of the Devonian/Carboniferous boundary at this lithostratigraphic level (Selwood *et al.*, 1985). The ostracod and SEM palynomorph biostratigraphies broadly correlate, allowing palynomorph age determinations within the region to be used with greater confidence.

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INTRODUCTION

Progress in the Upper Palaeozoic stratigraphy of south-west England has been hampered by the lack of a site-specific biostratigraphy. Macrofossils, conodonts and ostracods have proven useful but are facies dependent. Extensive areas of the 'slate belt' are without effective biostratigraphic control.

This paper forms part of a larger study aimed at the creation of a palynostratigraphy for south-west England. For reasons elaborated by Dean (1989a), conventional palynology reliant upon transmitted light techniques has largely failed, due to the relatively high metamorphic grade of the sediments. To overcome this problem, the coalified palynomorphs recovered have been examined using a SEM. It was therefore necessary to compare the results obtained using both techniques, independently.

Whiteley (1983), recorded a palynomorph assemblage from a well-dated horizon in the middle Teign Valley, within a road cutting at grid reference [SX 8380 8470], using transmitted light techniques. This locality was re-sampled (BS8850), and the organic fraction obtained examined under the SEM.

To test the usefulness of the assemblage obtained, the results were compared with those from a horizon of similar age (Selwood *et al.*, 1985), but contrasting fades, in the Gurrington Slate Formation [SX 7920 7059], the sample (BS8856), being recovered from the base of a small road-side quarry.

Samples for SEM analysis were processed using conventional palynological techniques. Hydrofluoric acid was used to digest the silicates, and zinc bromide to remove the heavy minerals. The resulting organic fractions were variably coalified, and examined using a SEM, as described by Dean (1989a). As SEM specimens cannot be preserved, the images in Plate 1 are held as photographic negatives in the Palaeontological collections of the British Geological Survey, Keyworth, Nottingham.

STRATIGRAPHY

The Hyner Shale Formation crops out north of Newton Abbot, within the Teign Valley succession, (Figure 1). It consists of hard, dark blue or bluish green shales and mudstones. In upward succession it passes conformably into the Trusham Shale. Towards the top of the Hyner Shale Formation a series of calcareous nodule bands and calcareous shales, along with a siltstone horizon, yield a rich fauna of macrofossils and ostracods from

the late Famennian *hemisphaerica-dichotoma* biozone, (Selwood *et al.*, 1985). This level yields the rich palynomorph assemblage described here.

Cropping out to the west of Newton Abbot, the Gurrington Slate Formation comprises an unknown thickness of purple and green slates,

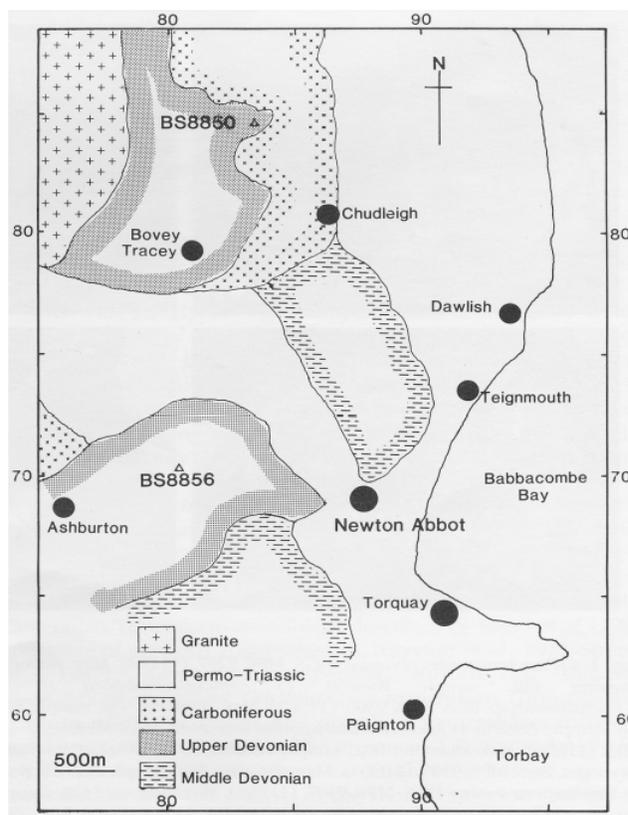


Figure 1: Regional geology and sample localities.

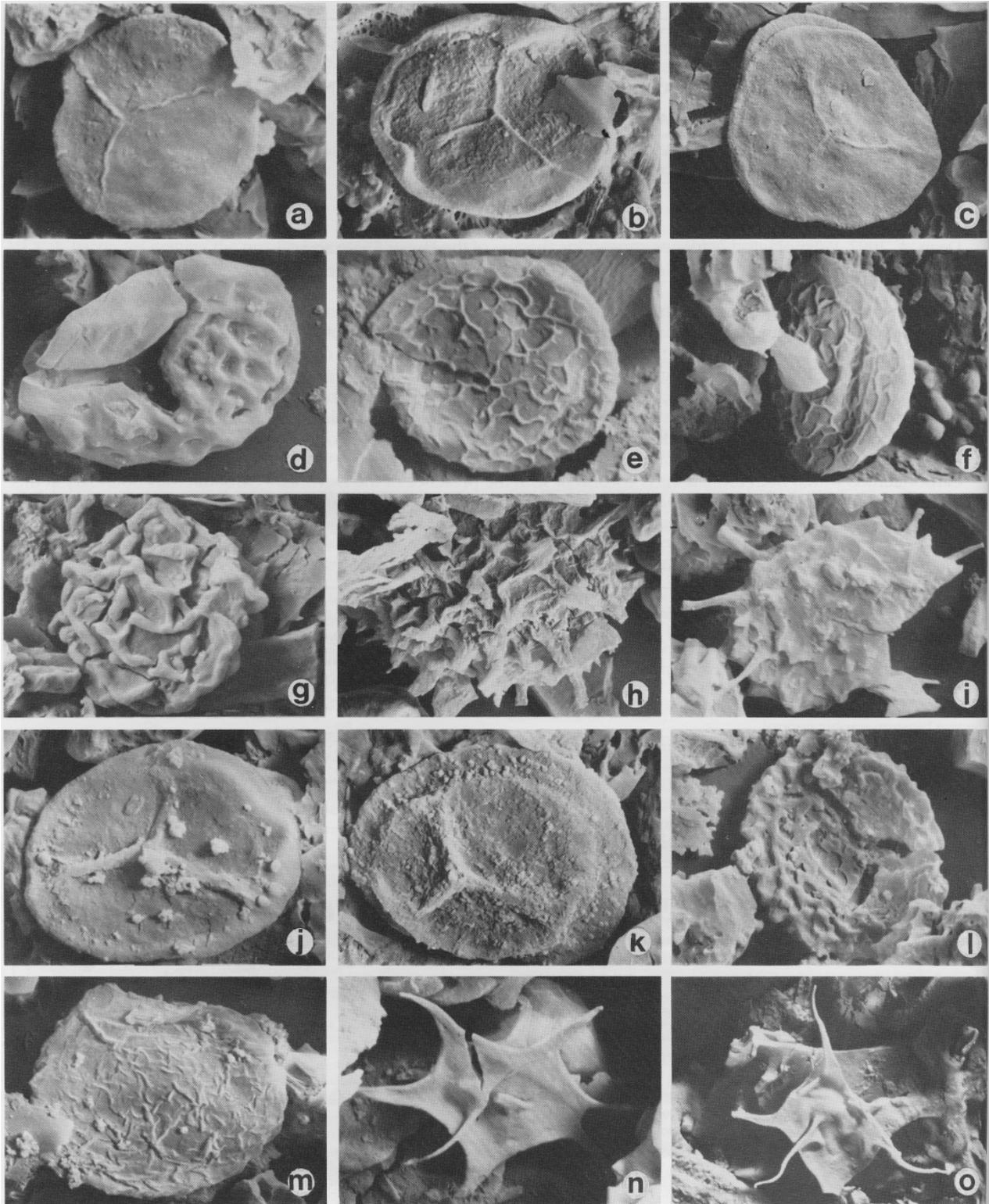


Plate 1. a) *Punctatisporites obliquus*. BGS. MPK 9297. (114B4). Max. diameter 32 μ , sample BS8850. b) *Retusotriletes incohatus*. BGS. MPK 9298. (114C6). Mm diameter 44 μ , sample BS8850. c) ?*Apiculiretusispora* sp. BGS. MPK 9299. (114E6). Max. diameter 42 μ , sample BS8850. d) *Dicyotriletes* sp. BGS. MPK 9300. (116C3). Max. diameter 55 μ , sample BS8856. e) *Microreticulatisporites araneum*. BGS. MPK 9301. (115E3). Max. diameter 28 μ , sample BS8856. f) *Microreticulatisporites araneum*. BGS. MPK 9302. (175E1). Max. diameter 27 μ , sample BS8850. g) *Corbulispora cancellata*. BGS. MPK 9303. (115B6). Max. diameter 80 μ , sample BS8850. h) *Raistrickia macrura*. BGS. MPK 9304. (114C3). Max. diameter 65 μ , sample BS8850. i) *Raistrickia* cf. *corynoges*. BGS. MPK 9305. (116D4). Max. diameter 38 μ , sample BS8856. j) *Auroraspora asperella*. BGS. MPK 9306. (118E4). Max. diameter 44 μ , sample BS8856. k) *Auroraspora macra*. BGS. MPK 9307. (113A6). Max. diameter 42 μ , sample BS8850. l) *Cristatisporites meneradezii*. BGS. MPK 9308. (117G1). Max. diameter 37 μ , sample BS8856. m) *Velamisporites* sp. BGS. MPK 9309. (118F1). Max. diameter 63 μ , sample BS8856. n) *Micrhystridium stellatum*. BGS. MPK 9310. (115C6). Max. diameter 48 μ , sample BS8850. o) *Veryhachiuna arcarium*. BGS. MPK 9311. (114B5). Max. diameter 37 μ , sample BS8850.

flanked by grey slates to the north-west and south-east. Faunas are irregularly distributed and often poorly preserved; they are dominated by juvenile bivalves and planktonic ostracods ranging from middle Frasnian to possibly early Tournaisian in age. For comparative purposes a locality was selected which yielded a fauna of comparable age to that of the Teign Valley (Selwood *et al.*, 1985), the sediments here being characteristic representatives of the ostracod slate facies extensively developed in Famennian times.

PALYNOLOGY

Hyner Shale Formation

Whiteley (1983) described a microflora from the Hyner Shale Formation that was dominated by the following genera; *Auroraspora*, *Grandispora*, *Punctatisporites*, *Retusotriletes* and *Verrucosisorites*. All were identified in the subsequent SEM study, but not the fragments of large bifurcate spores he described. Whiteley recorded the following taxa;

Auroraspora sp.

Grandispora sp.

Punctatisporites sp.

Punctatisporites irrasus Hacquebard 1957

Retusotriletes sp.

Retusotriletes incohatus Sullivan 1964

Retusotriletes cf. planus Dolby and Neves 1970

Retispora lepidophyta (Kedo) Playford 1976

Verrucosisorites sp.

Verrucosisorites nitidus (Naumova) Playford 1964

SEM analysis, undertaken during the present study, also recorded *Retusotriletes incohatus* and *Verrucosisorites nitidus*. In addition other forms given only generic status by Whiteley could be more accurately identified by SEM analysis, these being; *Auroraspora macro* Sullivan 1968 and *Grandispora cf. cornuta* Higgs 1975.

It is possible that the forms illustrated by Whiteley (1983), as *Retusotriletes* sp. and *Verrucosisorites* sp. may well be nonspecific with *Retusotriletes famenensis* Naumova 1953 and *Corbulispora cancellata* (Waltz) Bharadwaj and Venkatachala 1961 respectively, both recorded in the subsequent SEM study. This would leave only *Retusotriletes cf. planus* and *Retispora lepidophyta*, unidentified in the SEM study. The complete SEM floral list comprises;

?*Apiculiretusispora* sp.

Auroraspora corporiga Higgs, Clayton and Keegan 1988

Auroraspora macra Sullivan 1968

Calamospora sp.

Corbulispora cancellata (Waltz) Bharadwaj and Venkatachala 1961

Crassispora sp.

Dictyotriletes sp.

?*Geminospora* sp.

Grandispora cf. cornuta Higgs 1975

?*Knoxisporites* sp.

Leiotriletes sp.

Microreticulatisporites araneum Higgs, Clayton and Keegan 1988

Punctatisporites obliquus Kosanke 1950

Punctatisporites springsurensis Playford 1978

Raistrickia macrura (Luber) Dolby and Neves 1970

Retusotriletes famenensis Naumova 1953

Retusotriletes incohatus Sullivan 1964

Verrucosisorites nitidus (Naumova) Playford 1964

Of the taxa identified to specific level only *Auroraspora macra*, with a first occurrence in the late Frasnian, and *Grandispora cf. cornuta*, reported from the middle Famennian, are known from rocks older than late Famennian.

Three taxa have previously been reported only from the Carboniferous, one of these, *Auroraspora corporiga*, is potentially significant in that it is previously recorded only from the Tournaisian of Ireland. The others, *Punctatisporites springsurensis*, and *Punctatisporites obliquus*, are of less significance, the former being previously reported only from Australia, and the latter widely believed to be a compressional artefact.

Raistrickia macrura, *Microreticulatisporites araneum*, and *Grandispora cf. cornuta*, have not previously been reported from sediments younger than early to middle Tournaisian.

The acritarchs are the only palynomorph representatives of the marine environment. The presence of four acritarch genera, *Lophosphaeridium*, *Michhystridium*, *Unellium*, and *Veryhachium*, within the SEM sample, is more indicative of the Devonian; acritarchs are rare in the Carboniferous of Great Britain.

Two long-ranging acritarch species were recovered from this sample, *Michhystridium stellatum* Deflandre 1945, and *Veryhachium lairdii* (Deflandre) Deunff 1954. *Lophosphaeridium granulosum* Staplin 1961, was originally described from the Frasnian of North America, but is known from younger deposits, (Dean 1991). The remaining species are stratigraphically more useful, *Veryhachium arcarium* Wicander and Loeblich 1977 is of late Frasnian-late Famennian age, and *Unellium winslowae* Rauscher 1969, is only definitely known from the late Devonian, with one dubious report from the late Givetian. In south Devon *Unellium winslowae* is restricted to the Famennian, (Dean 1991).

When the miospore and acritarch information is combined with the ostracod data, a definite late Famennian age can be inferred, confirming the previous stratigraphic information (Selwood *et al.*, 1985), and Whiteley's (1983) determination.

Gurrington Slate Formation

This assemblage is dominated by miospores, including the long ranging taxa, *Leiotriletes simplex* Naumova 1953 and *Retusotriletes cf. psychovii* Naumova 1953. As with the Hyner Shale sample, the majority of miospores recorded are known from previous studies to range from the middle to late Famennian into the early Tournaisian. Those with a first occurrence in the middle Famennian are: *Auroraspora solisortus* Hoffmeister, Staplin and Malloy 1955, and *Grandispora cf. cornuta*. Taxa with a first occurrence in the late Famennian are more abundant, they are; *Leiotriletes* sp. A Higgs, Clayton and Keegan 1988, *Retusotriletes incohatus*, *Microreticulatisporites araneum*, *Auroraspora asperella* (Kedo) Van Der Zwan 1980, and *Cristatisporites menendezii* (Menendez and Azcuy) Playford 1978.

Additionally the Gurrington Slate assemblage also contains representatives of *Punctatisporites ferquensis* Taugourdeau-Lantz 1960, which is restricted to the late Devonian, and the following taxa that are more characteristic of the Carboniferous; *Punctatisporites obliquus*, *P. springsurensis*, and *Raistrickia cf. corynoges* Sullivan 1968.

Miospores recorded to generic level only in the assemblage include; *Densosporites* sp., *Dictyotriletes* sp., *Hymenozonotriletes* sp., *Leiotriletes* sp., and *Velamisporites* sp.

The only element of the marine taxa identified to specific level is the late Frasnian to late Famennian acritarch *Gorgonisphaeridium elongatum* Wicander 1974.

As with the Hyner Shale sample, much of the spore content could equally be of late Famennian or early Carboniferous age. Such elements would be consistent with a position close to the Devonian/Carboniferous boundary, known to occur within the Gurrington Slate Formation, (Selwood *et al.*, 1985). There is only sufficient miospore data to indicate an age of probable late Famennian to early Tournaisian age. The ostracod and macrofossil evidence is more precise, placing the horizon within the *hemisphaerica-dichotoma* biozone of the late Famennian.

Though definitive zonal taxa are largely absent, an association, particularly with the assemblages described from Ireland, (Higgs *et al.*, 1988), can be recognized. The following miospore taxa were all recovered in this study and are all typical of the late Famennian/Tournaisian assemblage described by Higgs *et al.* (1988), and some of previous zonal schemes, (Clayton *et al.*, 1977, Streef *et al.*, 1987); *Auroraspora asperella*, *Auroraspora solisortus*, *Corbulispora cancellata*, *Cristatisporites menendezii*, *Grandispora cf. cornuta*, *Microreticulatisporites araneum*, *Retusotriletes incohatus*, and *Verrucosisorites nitidus*. The presence of *Retispora lepidophyta sensu stricto*, the zonal taxon for north-west Europe, was not confirmed by the SEM analysis in the Hyner Shale; interestingly this taxon is also absent in much of south Devon and north Cornwall (Dean, 1991).

CONCLUSIONS

The SEM study of palynomorphs from the Hyner Shale Formation confirms that it is possible to identify both spores and acritarchs without relying solely upon conventional transmitted light techniques. However, SEM analysis will not stand as a fully established taxonomic technique, until detailed taxonomic descriptions are published, (Dean, in prep.). The assemblages from the Hyner Shale and Gurrington Slate Formations are similar in broad terms, but not identical. To a degree, the presence of palynomorphs appears independent of facies.

The greater variety and size of the assemblage examined by SEM microscopy may be indicative of the extreme oxidation techniques employed in the original research (Whiteley, 1983), or it may be a result of sampling slightly lower in the Hyner Shale section, Suggested by the absence of *Retispora lepidophyta*. The level of preservation appears considerably better in the SEM (non oxidised) sample.

The palynological data indicates a late Famennian - early Tournaisian age for both localities, supporting the previous stratigraphic information in Selwood *et al.* (1985). The marine environment of deposition is confirmed; though the small proportion of marine species contrasts with the assemblage described by Dean (1989b), from the marine, basinal grey slates of east Cornwall.

The ostracod and palynomorph assemblages are proven, at this stratigraphic level, to produce similar, relatively compatible age determinations. The absence of appropriate palynomorph zonal taxa makes reference to established zonal schemes difficult, however, a number of associated stratigraphically useful miospores do occur and certain similarities can be seen, particularly with the succession in Ireland, Higgs *et al.* (1988).

The SEM study produced as much information, with the exception of the important *Retispora lepidophyta* (Kedo) Playford 1976, as the previous transmitted light study, and allowed, in some cases more accurate identifications to be made. More importantly it was possible to attempt an age determination without recourse to transmitted light microscopy.

The presence of a similar assemblage to that from the Hyner Shale,

within a different facies, provides a useful test for the SEM technique within the Palaeozoic 'slate belt'.

It is hoped that when combined with data from south-Devon and north Cornwall, described by Dean, (1991), and with work continuing in north Cornwall, it may eventually be possible to erect regional assemblage zones, or at the very least, characteristic associations, ranging from the Emsian into the early Carboniferous (Dean, in prep.).

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