DEVONIAN SPORES FROM OUTER TRØNDELAG, NORWAY

KEITH C. ALLEN


Rock samples for palynological study were collected from a number of localities in outer Trøndelag. From these samples, poorly preserved but identifiable spores were obtained from three localities. Those from small islands north of Tristein indicate an Emsian age equivalent, those from Døsvik on Ørlandet a probable Lower Devonian age, and those from an island west of Storfosna a probable Emsian or Eifelian age equivalent.

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Samples for palynological study were collected by the author from Hitra, Døsvik and along a road section near Bjugn in Ørlandet, Storfosna and islands west of Storfosna, and from the Tristein island region north-west of Vallersund (Fig. 1). Samples collected by S. Siedlecki from Hitra and from Løvøya south of Smøla in southernmost outer Trøndelag were also prepared. In none of these samples were the spores well-preserved, most being highly carbonised. Those from the small islands north of Tristein produced the best spores, but identifiable spores were also obtained from an island west of Storfosna and from Døsvik. Samples from the road section near Bjugn produced a few simple spores, which gave no clear indication of their age. Several samples prepared from Hitra, mostly from member D of the Hitra Formation (Siedlecka & Siedlecki 1972: 3), yielded dark apparently organic remains, but no spores.

Preparation of samples

The extraction of the spores followed the usual palynological techniques, employing warm hydrofluoric acid, dilute hydrochloric acid, and Schulze's reagent. Samples were not treated with a weak alkaline solution, as this tended to further darken the spores. Residues were mounted in Clearol, and after drying, in D.P.X. mountant.

All figured specimens are housed in the Palaeobotanical Collection, Department of Botany, University of Bristol, England, and are referred to by a preparation slide number, followed by 'east-west' and 'north-south' mechanical stage readings, and then by a rock specimen number (e.g. NOR 5/11, 58.9 99.6, N31). The stage readings are from a Leitz Orthoplan Microscope serial no. 715334 in the Department of Botany, University of Bristol.
The Tristein region
Rock samples were collected from lenses of fine grey sandstones and siltstones within the reddish conglomerate sequence, on four small islands north of Tristein (Fig. 1). The samples contained an abundance of *Hyenia ramosa* (Høeg) mostly as impression material. The samples are all from about the same stratigraphical horizon, and form part of a single assemblage.

Vogt (1929) recorded fossil plants from some islands north of Tristein, which were referred to *Psilophyton princeps* by Halle. Høeg (1945) collected and identified *Psilophyton* sp. and *Hyenia ramosa* from several skerries near Tristein. It is clear that both Høeg’s samples and those collected by the author are from about the same horizon, though Høeg’s samples were red rather than grey. Based on the presence of *Hyenia*, Høeg indicated a Middle Devonian age for these beds. Later, Høeg (1966) suggested that *Psilophyton* sp. may be *Thursophyton*, and again indicated a Middle Devonian age. Nilsen (1973) suggested that this outcrop probably represents a separate Devonian basin slightly younger than that further south in this area.

Microfloral assemblage
Twenty-seven of the thirty-one species shown in Table 1 were recorded from the Tristein region. The abundance of each species is expressed as a figure out of a count of 200 specimens. Where a species was not recorded in the count, it is marked with an X. All species are illustrated in Figs. 2–4.
<table>
<thead>
<tr>
<th>Age (where restricted)</th>
<th>Spore species</th>
<th>The Tristien region</th>
<th>Øsvik west of Storfosna</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lower Devonian</td>
<td><em>Leiotriletes pagius</em> Allen</td>
<td>3</td>
<td></td>
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<tr>
<td></td>
<td><em>Calamospora atava</em> (Naumova)</td>
<td>20</td>
<td></td>
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<tr>
<td></td>
<td>Retusotriletes dubiosus McGregor</td>
<td>2</td>
<td>x</td>
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<tr>
<td></td>
<td>Retusotriletes psychovii Naumova</td>
<td>22</td>
<td>x</td>
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<tr>
<td></td>
<td><em>Apiculiretusispora plicata</em> (Allen) Stree</td>
<td>67</td>
<td>x</td>
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<tr>
<td></td>
<td><em>Apiculatisporites perpusillus</em> (Naumova) McGregor</td>
<td>4</td>
<td>x</td>
</tr>
<tr>
<td>Emsian</td>
<td><em>Dibolisporites wetteldorfensis</em> Lanninger</td>
<td>14</td>
<td>x</td>
</tr>
<tr>
<td>Emsian</td>
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<td>1</td>
<td></td>
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<tr>
<td>Emsian</td>
<td><em>cf. Procoronaspora ambigua</em> Butterworth and Williams</td>
<td>1</td>
<td></td>
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<tr>
<td>Emsian</td>
<td><em>Verrusosisporites devonicus</em> McGregor</td>
<td>13</td>
<td>x</td>
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<tr>
<td>Emsian and</td>
<td><em>Brochotrites sp.</em></td>
<td>2</td>
<td></td>
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<tr>
<td>Siegenian</td>
<td>Dictyotriletes emsiensis* (Allen) McGregor</td>
<td>1</td>
<td></td>
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<tr>
<td>Emsian and</td>
<td><em>Dictyotriletes sp.</em></td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>Siegenian</td>
<td><em>Emphanisporites rotatus</em> (McGregor) McGregor</td>
<td>x</td>
<td></td>
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<tr>
<td>Lower Devonian</td>
<td><em>Acinosporites munstereifeliensis</em> (Franke) Streel</td>
<td>13</td>
<td>x</td>
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<tr>
<td></td>
<td><em>Geminospora sp.</em></td>
<td>3</td>
<td></td>
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<tr>
<td>Emsian and</td>
<td><em>Craspedispora craspeda</em> Allen</td>
<td>1</td>
<td></td>
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<tr>
<td>Siegenian</td>
<td><em>Stenozonotriletes incessus</em> Allen</td>
<td>x</td>
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<tr>
<td>Lower Eifelian to</td>
<td><em>Rhabdosporites cymatilis</em> Allen</td>
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<tr>
<td>Siegenian</td>
<td><em>Rhabdosporites langii</em> (Eisenack) Richardson</td>
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<td>x</td>
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<td><em>Rhabdosporites parvulus</em> Richardson</td>
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<td></td>
<td>Perotrilites sp.</td>
<td>15</td>
<td>x</td>
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<td></td>
<td>Punctatisporites sp.</td>
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<tr>
<td>dominantly Middle</td>
<td><em>Dibolisporites echinaceus</em> (Eisenack) Richardson</td>
<td>x</td>
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<tr>
<td>Devonian</td>
<td><em>Hystricosporites sp.</em></td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>dominantly Middle</td>
<td><em>Grandispora sp.</em></td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>Devonian</td>
<td></td>
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</tbody>
</table>
Notes on selected species
The species mentioned here are indicated with an asterisk in Table 1.

**Calanspora pannucea** Richardson. – I have followed McGregor (1973) in separating this species from *Calamospora atava* (Naumova) McGregor, on size difference. In *C. pannucea*, the darkened central area often extends over half the proximal surface.

**Apiculiretusispora plicata** (Allen) Streel. – This is the most common species in the Tristein Region assemblage. It shows a wide size range (40–150 µ). The ornament is sometimes very small, and in such cases unless studied under oil, resembles *Retusotriletes*. Two specimens have a small papilla on each of the three contact areas.

**Apiculatisporites perpusillus** (Naumova) McGregor. – The author follows McGregor (1973: 24) in separating this species from *Granulatisporites newportensis* Chaloner and Streel on the basis that it lacks interradial papillae.

**Dibolisporites wetteldorfensis** Lanninger. – One of the more common species, it usually has a larger ornament in the equatorial region, especially in the interradial areas (Fig. 2, N). This species is recorded from the Emsian of Germany by Lanninger 1968 and the Emsian (Battery Point, Lower Assemblage) of Canada by McGregor 1973.

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Fig. 2.
All photographs \( \times 500 \) unless otherwise stated; from unretouched negatives.

A,B. **Leiotriletes pagius** Allen. A. Proximal surface; NOR 2/13,59.7 98.4, N33. B. Broken specimen showing azonate nature of the exine; NOR 2/24, 54.7 103.3 N33.
C. **Calamospora atava** (Naumova) McGregor. Proximal surface; NOR 2/13, 49.8 110.3, N33.
D. **Calamospora pannucea** Richardson. NOR 2/20, 40.1 100.1, N33.
E. **Retusotriletes dubiosus** McGregor. Proximal surface; NOR 15/1, 50.1 105.4, N28.
I. **Apiculatisporites perpusillus**. Chaloner & Streel. Distal surface; NOR 5/2, 47.4 106.6, N31.
K. **Anapiculatisporites grandispinus** (Naumova) Schultz. Distal surface; NOR 2/2, 47.4 98.7, N33.
L. cf. **Procoronaspora ambiguа** Butterworth & Williams. Proximal surface; NOR 2/10, 30.6 98.6, N33.
M,N. **Dibolisporites wetteldorfensis** Lanninger. M. Distal surface; NOR 2/10, 47.6 102.2, N33. N. Proximal surface; NOR 2/21, 38.3 97.5, N 33. Both specimens show larger ornament in the equatorial interradial area.
O-Q. **Converrucosisporites minor** (Schultz) comb. nov. O. Equatorial surface; NOR 5/2, 38.8, 108.2, N31. P. The same X1000. Q. Distal surface (X 1,000) showing verrucae which are often angled as seen in surface view, and having a denser exine in the angles. NOR 2/21, 45.6 108.0, N33.
Fig. 2.

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Anapiculatisporites grandispinus (Naumova) Schultz. – This species is recorded from the Emsian of West Germany by Schultz 1968. Streel (1967) records Anapiculatisporites sp. C. a similar spore, from the Emsian of Belgium, cf. Procoronaspora ambigua resembles P. ambigua Butterworth and Williams, but the Norwegian spores, although having a larger ornament in the interradial equatorial region, also have a small ornament radially. This would also appear to be the case in Schultz’s specimens.

Verrucosisporites devonicus McGregor. – The Norwegian specimens have a smaller size range than that recorded by McGregor in Canada from rocks of Emsian age. Also, the proximal surface is never flat or laevigate.

Brochotriletes sp. – Too few specimens are present for specific designation. They appear to be intermediate between McGregor’s Brochotriletes robustus and Brochotriletes sp. B.

Acinosporites munstereifeliensis (Franke) Streel. – This is the largest spore in this assemblage, ranging from 80–180 μ (there are some unidentifiable fragments of spores reaching 220 μ). In some specimens, the bases of the biform ornament do not anastomose, and the specimens could be included within Dibolisporites. In overmacerated specimens, a closely appressed intexine can be seen. The illustration of Retusotriletes antiquus Kedo in Lanning 1968 (pl. 20, fig. 22) appears similar.

Geminospora sp. – Too few specimens are present, to erect a new species. It differs from Geminospora traverica Reigel, in having a verrucate ornament.

Age of the assemblage
A number of points suggest an Emsian age equivalent for this assemblage.

Fig. 3.
All photographs × 500 unless otherwise stated; from unretouched negatives.
A,B. Verrucosisporites devonicus McGregor. A. Lateral view; NOR 5/11, 52.4 105.4, N31. B. Lateral view, showing smaller ornamentation on the proximal surface, a feature of about half the specimens; NOR 5/11, 58.9 99.6, N31.
C. Brochotriletes sp. Distal surface; NOR 5/2, 403 109.5, N31.
D. Dictyotriletes emsiensis (Allen) McGregor. Distal surface; NOR 2/19, 51.5 96.0 N33.
E,F. Dictyotriletes sp. E. Distal surface; NOR 5/17, 46.4 93.4, N31. F. The same ×1,000, showing the low, narrow reticulate ornament.
I. Emphanisporites robustus McGregor. Proximal surface; NOR 17/5, 26.3 95.4, N33.
J. Acinosporites munstereifeliensis (Franke) Streel K. Typical large dark specimen;
K,L. Acinosporites munstereifeliensis (Franke) Streel. K. Typical large dark specimen; NOR 2/34, 34.7 93.8, N33. L. Showing ornament separating from the rest of the exine in the lower part of the photograph; NOR 2/7, 61.3 111.5, N33.
Fig. 3.

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The overall species list includes several species found only in the Emsian or Lower Devonian (see Table 1). Both *Craspedispora craspeda* Allen and *Dictyotriletes emsiensis* (Allen) McGregor have to date been found only in the Emsian and Siegenian. In the Norwegian specimens of *D. emsiensis*, the muri in the equatorial region form a distinct 'zone' (Fig. 3, D), unlike those from Spitsbergen (Allen 1965) and Canada (McGregor 1973). *Procoronaspora* sp. is recorded by McGregor et al. 1970, from the Stooping River and Sextant Formation in Canada; by Jardine and Yapandjian 1968 from the Emsian of the Sahara (McGregor 1970: 47); and by Konior and Turnau 1973 from probable Emsian rocks of Poland.

There is a high proportion of both laevigate and apiculate retusoid forms, a common feature of the Lower Devonian, and especially the Emsian (Lanninger 1968: 159). There is also a tendency for the ornament to separate from the rest of the exine (Fig. 3, L), a common feature in Lower Devonian spores, and particularly in the Emsian (e.g. Streele 1964 (pl. 3, fig. 40) and McGregor 1973 (pl. 2, fig. 14)). Another characteristic which appears to be a quite common feature of upper Lower Devonian spores is a tendency for the ornament to be larger in the interradial equatorial region, not only in *Procoronaspora ambigua*, but also in *Dibolisporites wetteldorfensis*, *Acinosporites munstereifeliensis*, *Anapiculatisporites grandispinus*, and *Rhabdosporites parvulus*.

The only dominantly Middle Devonian spore which occurs, albeit rarely, in this assemblage is *Rhabdosporites langii* (Eisenack) Richardson. Its lowest published record is Eifelian (Richardson 1974), but Riegel (pers. comm.) finds *R. langii* in beds of Upper Emsian age in Germany, where there is good stratigraphic control. In terms of spore construction, the Norwegian material shows quite close comparison with Schultz's (1968) and Lanninger's (1968) Emsian assemblages, rather than with the more varied construction of Riegel's (1968, 1973) or Hamid's (1974) Eifelian assemblages, all from West Germany.

Døsvik, Ørlandet

Rock samples were collected from the coast just north-east of Døsvik (Fig. 1).
Fig. 4.
These were mostly hard, dark grey siltstones with occasional unidentifiable dichotomising stem fragments, from below the polymictic conglomerate (Richter 1949, 1958).

Vogt 1929 recorded plants from Døsvik, and these were later described by Høeg 1945 as *Psilophyton rectissimum* Høeg, *Hostimella* sp., and the sporangium of a psilophyte. On the basis of these plant remains, Høeg suggested very tentatively a Lower Devonian age. Later Høeg (1966) also recorded *Drepanophycus spinaeformis*, a Lower Devonian plant, from Døsvik.

Microfloral assemblage

The seven species recorded are shown in Table I.

Because of poor preservation, several of the specimens, particularly simple laevigate and apiculate forms, are difficult to identify. The spores which are identifiable also occur in the better preserved samples from the Tristein region. On the basis of the few species present a Lower Devonian age seems probable.

Island west of Storfosna

Samples were collected from well-bedded grey micaceous sandstones within the massive conglomerate sequence on a small island between Storslåttøy and Storfosna (Fig. 1). Small, unidentifiable, poorly preserved, unbranched stem axes were present.

Vogt 1924 recorded some fossil plants, which, according to his map (Vogt 1929: 60, fig. 4), would appear to be from Storslåttøy. However, no clear indication of the age was given, either here, or in subsequent publications (Richter 1949, 1958, Holtedahl 1960).

Microfloral assemblage

The nine species recorded are shown in Table I.

The presence of *Hystricosporites* sp., *Grandispora* sp., and *Rhabdosporites langii* (up to 240 μ, and more common than in the Tristein region) suggests an age slightly younger than that for the Tristein region, possibly an Eifelian age equivalent, and certainly not older than the Tristein sediments.

Conclusions

Firstly, a more exact age based on the microflora can now be given for the Devonian of the Tristein region, and west of Storfosna, with confirmation of a Lower Devonian age at Døsvik. Secondly, the rocks west of Storfosna are at least as young and probably younger than those in the Tristein region. Thirdly, the spore assemblage of the Tristein region indicates an Emsian age, and represents the oldest rocks from which *Hyenia* has yet been recorded. Though the author has not processed samples for palynological study from
the Nordfjord region, it would appear that the *Hyenia*-bearing sediments north of Tristein are older than the *Hyenia*-bearing rocks of the Nordfjord region, which are dated as Givetian on the fish fauna (Jarvik 1949). Fourthly, it is probable that the Devonian of the Tristein region and the Døsvik area are about the same age, and are at least both Lower Devonian. Fifthly, the youngest Devonian rocks in the north-east, south-west trending series of exposures from south of Smøla to Ørlandet, are as young and probably younger than those of the Tristein region, contrary to what is suggested by Nilsen (1973, 477). Finally, it is interesting to note that if the north-east, south-west trending Hitra sequence is late Ludlovian or possibly Downtonian, based on *Dictyocaris simoni* and eurypterid fragments (Reusch 1914, Størmer 1935), it has both to its south-west (Smøla, Peacock’s communication in Allen et al. 1967), and to its immediate north-east (present study – west of Storfosna) rocks of considerably younger age. It is unfortunate that neither the Hitra nor the Løvøya samples produced any spores.

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REFERENCES


