

The type Ludlow Series: Biostratigraphy - spores

Most of the Ludlow Series is currently assigned to the *Synorisporites libycus-Lophozonotriletes? poecilomorphus* Assemblage Biozone of Richardson & McGregor (1986). The reference section for the base of the zone is a subsurface section in Libya (Richardson & McGregor 1986, p. 9), but an accessory reference section is situated 6.4 km SW of Ludlow.

In south Wales, the *libycus-poecilomorphus* Biozone has been divided into four sub-biozones (Burgess & Richardson 1995), as follows.

Chelinospora obscura Assemblage Sub-Biozone (lowest)
Stellatispora inframurinata var. *cambrensis* Assemblage Sub-Biozone
Apiculiretusispora? asperata Assemblage Sub-Biozone
Stellatispora inframurinata var. *inframurinata* Assemblage Sub-Biozone (highest)

Only the *Stellatispora inframurinata* var. *cambrensis* Sub-Biozone has been recognized in the type Ludlow area (Burgess & Richardson 1995, p. 31), possibly because many diagnostic forms from south Wales were described recently, long after Richardson & Lister's (1969) account of the spores from the type area. Application of the south Wales biozones to the type area will probably require revision of the spore assemblages from the latter.

In south Wales, the *libycus-poecilomorphus* Biozone succeeds the *Scylaspora downiei-Concentricosporites saggitarius* Assemblage Biozone. The *downiei-saggitarius* Biozone is considered to span the Wenlock-Ludlow boundary (Burgess & Richardson 1995). The *libycus-poecilomorphus* Biozone is succeeded by the *Synorisporites tripapillatus-Apiculiretusispora spicula* Assemblage Biozone of Prídolí age (Richardson & McGregor 1986; Burgess & Richardson 1995).

Burgess, N.D. & Richardson, J.B. 1995. Late Wenlock to early Prídolí cryptospores and miospores from south and southwest Wales, Great Britain. *Palaeontographica Abteilung B*, **236**, 1-103.
Richardson, J.B. & Lister, T.R. 1969. Upper Silurian and lower Devonian spore assemblages from the Welsh Borderland and south Wales. *Palaeontology*, **12**, 201-252.
Richardson, J.B. & McGregor, D.C. 1986. *Silurian and Devonian spore zones of the Old Red Sandstone continent and adjacent areas*. Geological Survey of Canada, Bulletin **364**, 79 pp.

See: [Apiculiretusispora? asperata](#) Assemblage Sub-Biozone, [Chelinospora obscura](#) Assemblage Sub-Biozone, [Scylaspora downiei - Concentricosporites saggitarius](#) Assemblage Biozone, [Stellatispora inframurinata](#) var. *cambrensis* Assemblage Sub-Biozone, [Stellatispora inframurinata](#) var. *inframurinata* Assemblage Sub-Biozone, [Synorisporites libycus - Lophozonotriletes? poecilomorphus](#) Assemblage Biozone, [Synorisporites tripapillatus-Apiculiretusispora spicula](#) Assemblage Biozone.

See also '[Distribution of spore taxa in the Ludlow Series](#)' for the composition of floras from each zone and subzone.

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***Scylaspora downiei-Concentricosporites saggitarius* Assemblage Biozone**

Microflora

Burgess & Richardson (1995) defined the *Scylaspora downiei-Concentricosporites saggitarius* Biozone in the Rumney Borehole of south Wales, based on the appearance of the trilete miospores *Scylaspora downiei* Burgess & Richardson and *Concentricosporites saggitarius* Rodriguez.

S. downiei is restricted to the *downiei-saggitarius* Biozone in the Rumney Borehole, although the nomenclatural note of Burgess & Richardson (1995, p. 34) implies that it may range higher, into the lower Devonian *Emphanisporites micromatus-Streelispota newportensis* Biozone.

Concentricosporites saggitarius ranges through the overlying *Synorisporites libycus* - *Lophozonotriletes? poecilomorphus* Biozone into the lower part of the Prídolí Series.

Many other spores range through the zone, from the underlying *Artemopyra brevicosta-Hispanaediscus verrucatus* Biozone into the overlying *libycus-poecilomorphus* Biozone. These include *Ambitisporites avitus* Hoffmeister, *Ambitisporites dilutus* (Hoffmeister) Richardson & Lister, *Archaeozonotriletes chulus* var. *chulus* (Cramer) Richardson & Lister, *Archaeozonotriletes chulus* var. *nanus* Richardson & Lister, *Artemopyra radiata* (Strother) Burgess & Richardson, *Cheilotetras caledonica* Wellman & Richardson, *Chelinospora rumneyi* Burgess & Richardson, *Chelinospora vermoluta* Burgess & Richardson, *Hispanaediscus lamontii* Wellman, *Hispanaediscus verrucatus* (Cramer) Burgess & Richardson, *Insolisporites bassettii* Burgess & Richardson, *Laevolancis divellomedia* (Chibrikova) Burgess & Richardson, *Laevolancis plicata* Burgess & Richardson, *Synorisporites* cf. *libycus*, Richardson & Ioannides and *Tetrahedraletes medinensis* var. *medinensis* Strother & Traverse.

Hispanaediscus rugulatus Burgess & Richardson and *Velatitetras cristata* Burgess & Richardson also range upwards from the *brevicosta-verrucatus* Biozone, but have their last appearances in the *downiei-saggitarius* Biozone.

Burgess, N.D. & Richardson, J.B. 1995. Late Wenlock to early Prídolí cryptospores and miospores from south and southwest Wales, Great Britain. *Palaeontographica Abteilung B*, **236**, 1-103.

See: [Distribution of spore taxa in the Ludlow Series, *Scylaspora downiei-Concentricosporites saggitarius* Assemblage Biozone - Occurrence.](#)

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[Author: SGM]

***Scylaspora downiei-Concentricosporites saggitarius* Assemblage Biozone**

Occurrence

The zone is known only from the Rumney Borehole of south Wales, where it occurs in the uppermost Cae Castell Formation and the lower part of the Hill Gardens Formation.

Burgess & Richardson (1995) considered the *downiei-saggitarius* Biozone to span the Wenlock-Ludlow boundary, occurring in rocks inferred to be of latest *ludensis* and early *nilssoni* Biozone age. The *downiei-saggitarius* Biozone is equivalent to the upper part of the ‘*Emphanisporites*’ cf. *protophanus*-cf. *Synorisporites verrucatus* Biozone of Richardson & McGregor (1986).

Burgess, N.D. & Richardson, J.B. 1995. Late Wenlock to early Prídolí cryptospores and miospores from south and southwest Wales, Great Britain. *Palaeontographica Abteilung B*, **236**, 1-103.

Richardson, J.B. & McGregor, D.C. 1986. *Silurian and Devonian spore zones of the Old Red Sandstone continent and adjacent areas*. Geological Survey of Canada, Bulletin **364**, 79 pp.

See: [Holostratigraphical chart, *Scylaspora downiei-Concentricosporites saggitarius* Assemblage Biozone - Microflora.](#)

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***Synorisporites libycus*-*Lophozonotriletes?* *poecilomorphus* Assemblage Biozone**

Microflora

Characteristic species listed by Richardson & McGregor (1986) include cf. *Brochotriletes* sp. A of Richardson & Ioannides (1973), *Emphanisporites neglectus* Vigran, '*E.*' *protophanus* Richardson & Ioannides, '*E.*' cf. *protophanus*, *Lophozonotriletes?* *poecilomorphus* Richardson & Ioannides, cf. *Synorisporitesowntonensis* Richardson & Lister, *Synorisporites libycus* Richardson & Ioannides, *S.* cf. *verrucatus* Richardson & Ioannides and *Tetraletes variabilis* Cramer.

Other species recorded from the zone include (Richardson & McGregor 1986, fig. 4) *Ambitisporites avitus* Hoffmeister, *A. dilutus* (Hoffmeister) Richardson & Lister, *Archaeozonotriletes chulus* var. *chulus* (Cramer) Richardson & Lister, *A. chulus* var. *nanus* Richardson & Lister, ?*A.* [*Laevolancis*] *divellomedium* Chibrikova, *Retusotriletes abundo* Rodriguez, *R. warringtonii* Richardson & Lister and *Tetrahedraletes medinensis* Strother & Traverse.

Except for cf. *Synorisporitesowntonensis*, which appears at the base of the zone and is restricted to its lower part, all these taxa range through the zone, extending a little way above and below (Richardson & McGregor 1986, fig. 4). *Apiculiretusispora synorea* Richardson & Lister appears within the zone, and *Amicosporites splendidus* Cramer appears at its top.

In the Ludlow area, where *Synorisporites libycus* and *Lophozonotriletes?* *poecilomorphus* have not been found, the biozone is based on the incoming of trilete miospores with murornate sculpture such as cf. *S.owntonensis* (Richardson & Edwards 1989, p. 219).

Synorisporites cf. *libycus* and *Lophozonotriletes?* *poecilomorphus* both occur in south Wales, where the base of the zone is located at the appearance of *L.?* *poecilomorphus* in the Rumney Borehole (Burgess & Richardson 1995, text-fig. 6).

Burgess, N.D. & Richardson, J.B. 1995. Late Wenlock to early Prídolí cryptospores and miospores from south and southwest Wales, Great Britain. *Palaeontographica Abteilung B*, **236**, 1-103.

Richardson, J.B. & Edwards, D. 1989. Sporomorphs and plant megafossils. In Holland, C.H. & Bassett, M.G. (eds) *A global standard for the Silurian System*. National Museum of Wales, Geological Series No. **9**, Cardiff. 216-226.

Richardson, J.B. & McGregor, D.C. 1986. *Silurian and Devonian spore zones of the Old Red Sandstone continent and adjacent areas*. Geological Survey of Canada, Bulletin **364**, 79 pp.

See: [Distribution of spore taxa in the Ludlow Series, *Synorisporites libycus*-*Lophozonotriletes?* *poecilomorphus* Assemblage Biozone - Occurrence.](#)

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***Synorisporites libycus-Lophozonotriletes? poecilomorphus* Assemblage Biozone**

Occurrence

Most of the Ludlow Series is currently assigned to the *Synorisporites libycus-Lophozonotriletes? poecilomorphus* Assemblage Zone (of Richardson & McGregor 1986).

The reference section for the base of the zone is in BP borehole B2-34, in the Ghadames Basin of Libya, but an accessory reference section is located in the upper part of the Lower Elton Formation (Richardson & McGregor 1986, p. 9), at the junction of Elton Lane with the track to Evenhay Farm, 800 m SE of Elton village and 6.4 km SW of Ludlow. The locality description (Richardson & McGregor 1986) suggests that the base of the zone in the accessory section coincides with sample LD53 of Richardson & Lister (1969), from grid reference [SO 4619 7025]. The microflora from that sample is distinguished from underlying assemblages by the presence of cf. *Synorisporites downtonensis* Richardson & Lister, a spore identified by Richardson & McGregor (1986) as being characteristic of the *libycus-poecilomorphus* Biozone. The stratigraphical position of the accessory reference section implies correlation with a level in the *Neodiversograptus nilssoni* Graptolite Biozone, which extends from the base of the Lower Elton Formation into the Middle Elton Formation.

Richardson & McGregor (1986, p. 9) considered the *libycus-poecilomorphus* Biozone to be represented by spore microfloras from the Middle Elton, Bringewood, Leintwardine and Whitcliffe formations of Shropshire, based on data from Richardson & Lister (1969) and unpublished information.

In south Wales, the *libycus-poecilomorphus* Biozone has been divided into four sub-biozones (Burgess & Richardson 1995). In upwards succession, these are the *Chelinospora obscura* Assemblage Sub-Biozone, the *Stellatispora inframurinata* var. *cambrensis* Assemblage Sub-Biozone, the *Apiculiretusispora? asperata* Assemblage Sub-Biozone, and the *Stellatispora inframurinata* var. *inframurinata* Assemblage Sub-Biozone. Only the *Stellatispora inframurinata* var. *cambrensis* Assemblage Sub-Biozone has been recognized outside south Wales, being present in the Upper Elton Formation of the Millichope-Diddlebury area in Shropshire, and in the Lower Bringewood Formation of the Ludlow type area.

Burgess, N.D. & Richardson, J.B. 1995. Late Wenlock to early Prídolí cryptospores and miospores from south and southwest Wales, Great Britain. *Palaeontographica Abteilung B*, **236**, 1-103.

Richardson, J.B. & Lister, T.R. 1969. Upper Silurian and lower Devonian spore assemblages from the Welsh Borderland and south Wales. *Palaeontology*, **12**, 201-252.

Richardson, J.B. & McGregor, D.C. 1986. *Silurian and Devonian spore zones of the Old Red Sandstone continent and adjacent areas*. Geological Survey of Canada, Bulletin **364**, 79 pp.

(continued...)

***Synorisporites libycus-Lophozonotriletes? poecilomorphus* Assemblage Biozone -Occurrence
(continued)**

See: *Apiculiretusispora? asperata* Assemblage Sub-Biozone, *Chelinospora obscura* Assemblage Sub-Biozone, Holostratigraphical chart, *Stellatispora inframurinata* var. *cambrensis* Assemblage Sub-Biozone, *Stellatispora inframurinata* var. *inframurinata* Assemblage Sub-Biozone, *Synorisporites libycus-Lophozonotriletes? poecilomorphus* Assemblage Biozone - Microflora.

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***Chelinospora obscura* Assemblage Sub-Biozone**

Microflora

The base of the *Chelinospora obscura* Sub-Biozone is defined by the first appearance of *Chelinospora obscura* Burgess & Richardson, *Emphanisporites? concentricus* Burgess & Richardson or *Lophozonotriletes? poecilomorphus* Richardson & Ioannides. In the Rumney Borehole, south Wales, the base of the subzone (and the *libycus-poecilomorphus* Biozone) is placed at the first appearance of *L.? poecilomorphus*, below the first appearances of *C. obscura* and *E.? concentricus*. In the Rumney River section, where *L.? poecilomorphus* appears above *C. obscura* in the upper part of the subzone, and *E.? concentricus* appears in the overlying *Stellatispora inframurinata* var. *cambrensis* Sub-Biozone, the base of the subzone is placed at the first appearance of *Chelinospora obscura*.

Spores recorded from the zone include: *Ambitisporites avitus* Hoffmeister, *Ambitisporites dilutus* (Hoffmeister) Richardson & Lister, *Archaeozonotriletes chulus* var. *chulus* (Cramer) Richardson & Lister, *Archaeozonotriletes chulus* var. *nanus* Richardson & Lister, *Artemopyra radiata* (Strother) Burgess & Richardson, *Cheilotetras caledonica* Wellman & Richardson, *Chelinospora obscura*, *Chelinospora rumneyi* Burgess & Richardson, *Chelinospora vermoluta* Burgess & Richardson, *Concentricosisporites sagittarius* Rodriguez, *Emphanisporites? concentricus*, *Hispanaediscus lamontii* Wellman, *Hispanaediscus verrucatus* (Cramer) Burgess & Richardson, *Insolisporites anchistinus* Burgess & Richardson, *Insolisporites bassettii* Burgess & Richardson, *Laevolancis divellomedia* (Chibrikova) Burgess & Richardson, *Laevolancis plicata* Burgess & Richardson, *Lophozonotriletes? poecilomorphus*, *Synorisporites* cf. *libycus* Richardson & Ioannides and *Tetrahedraletes medinensis* var. *medinensis* Strother & Traverse (data from Burgess & Richardson 1995).

Except for *Hispanaediscus verrucatus* and *Insolisporites anchistinus*, all these species range into the overlying *Stellatispora inframurinata* var. *cambrensis* Assemblage Sub-Biozone.

Burgess, N.D. & Richardson, J.B. 1995. Late Wenlock to early Prídolí cryptospores and miospores from south and southwest Wales, Great Britain. *Palaeontographica Abteilung B*, **236**, 1-103.

See: [Chelinospora obscura Assemblage Sub-Biozone - Occurrence, Distribution of spore taxa in the Ludlow Series.](#)

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***Chelinospora obscura* Assemblage Sub-Biozone**

Occurrence

The *Chelinospora obscura* Sub-Biozone is represented in the Hill Gardens Formation of the Rumney Borehole and Rumney River sections in south Wales. Burgess & Richardson (1995, p. 31) considered it to correlate with the uppermost *nilssoni*, *scanicus*, and possibly the lowermost *incipiens* graptolite biozones.

Burgess, N.D. & Richardson, J.B. 1995. Late Wenlock to early Prídolí cryptospores and miospores from south and southwest Wales, Great Britain. *Palaeontographica Abteilung B*, **236**, 1-103.

See: [Chelinospora obscura Assemblage Sub-Biozone - Microflora, Holostratigraphical chart.](#)

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***Stellatispora inframurinata* var. *cambrensis* Assemblage Sub-Biozone**

Microflora

The base of the subzone is defined by the appearance of *Stellatispora inframurinata* var. *cambrensis* Burgess & Richardson. Species typical of the *Chelinospora obscura* Sub-Biozone persist through this subzone.

In addition to *Stellatispora inframurinata* var. *cambrensis*, spores recorded from the *cambrensis* Sub-Biozone include: *Ambitisporites avitus* Hoffmeister, *Ambitisporites dilutus* (Hoffmeister) Richardson & Lister, *Archaeozonotriletes chulus* var. *chulus* (Cramer) Richardson & Lister, *Archaeozonotriletes chulus* var. *nanus* Richardson & Lister, *Artemopyra radiata* (Strother) Burgess & Richardson, *Cheilotetras caledonica* Wellman & Richardson, *Chelinospora obscura* Burgess & Richardson, *Chelinospora rumneyi* Burgess & Richardson, *Chelinospora vermoluta* Burgess & Richardson, *Concentricosisporites saggitarius* Rodriguez, *Emphanisporites? concentricus* Burgess & Richardson, *Hispanaediscus lamontii* Wellman, *Insolisporites bassettii* Burgess & Richardson, *Laevolancis divellomedia* (Chibrikova) Burgess & Richardson, *Laevolancis plicata* Burgess & Richardson, *Lophozonotriletes? poecilomorphus* Richardson & Ioannides, *Synorisporites* cf. *libycus* Richardson & Ioannides and *Tetrahedraletes medinensis* var. *medinensis* Strother & Traverse.

With the exception of *Stellatispora inframurinata* var. *cambrensis*, all these species range from the *Chelinospora obscura* Sub-Biozone, and apart from *Hispanaediscus lamontii* and *Synorisporites* cf. *libycus*, all range into the overlying *Apiculiretusispora? asperata* Sub-Biozone. Data are from Burgess & Richardson (1995, text-figs 5-7).

Burgess, N.D. & Richardson, J.B. 1995. Late Wenlock to early Prídolí cryptospores and miospores from south and southwest Wales, Great Britain. *Palaeontographica Abteilung B*, **236**, 1-103.

See: [Distribution of spore taxa in the Ludlow Series, *Stellatispora inframurinata* var. *cambrensis* Assemblage Sub-Biozone - Occurrence.](#)

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[Author: SGM]

***Stellatispora inframurinata* var. *cambrensis* Assemblage Sub-Biozone**

Occurrence

The *Stellatispora inframurinata* var. *cambrensis* Sub-Biozone is represented in the upper part of the Hill Gardens Formation and the lower part of the Llanedeyrn Formation of the Rumney Borehole and Rumney River section, and in the upper part of the Black Cock Beds in the Sawdde Valley, all in south Wales (Burgess & Richardson 1995).

Burgess & Richardson (1995, p. 31), citing Richardson & Lister (1969), remarked that the *Stellatispora inframurinata* var. *cambrensis* Sub-Biozone was present in the Upper Elton Formation of the Millichope-Diddlebury area in Shropshire, and in the Lower Bringewood Formation of the Ludlow type area. The specimen figured by Richardson & Lister (1969, pl. 43, fig. 9), and placed in synonymy with *Stellatispora inframurinata* var. *cambrensis* by Burgess & Richardson (1995), is from the Lower Bringewood Formation at an unspecified location in the Welsh Borderland. Apart from this, it is unclear what evidence enables recognition of the *cambrensis* Sub-Biozone in the Ludlow area, especially as Richardson & Lister (1969, tables 1, 2) recorded *Archaeozonotriletes chulus* var. *inframurinus* (the basionym of *Stellatispora inframurinata*) from the Lower Elton Formation, and questionably from the Much Wenlock Limestone Formation.

Burgess, N.D. & Richardson, J.B. 1995. Late Wenlock to early Prídolí cryptospores and miospores from south and southwest Wales, Great Britain. *Palaeontographica Abteilung B*, **236**, 1-103.

Richardson, J.B. & Lister, T.R. 1969. Upper Silurian and lower Devonian spore assemblages from the Welsh Borderland and south Wales. *Palaeontology*, **12**, 201-252.

See: [Holostratigraphical chart, *Stellatispora inframurinata* var. *cambrensis* Assemblage Sub-Biozone - Microflora.](#)

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[Author: SGM]

***Apiculiretusispora? asperata* Assemblage Sub-Biozone**

Microflora

The base of the subzone is defined by the appearance of *Apiculiretusispora? asperata* Burgess & Richardson.

In addition to *Apiculiretusispora? asperata*, spores recorded from the *asperata* Sub-Biozone include: *Ambitisporites avitus* Hoffmeister, *Ambitisporites dilutus* (Hoffmeister) Richardson & Lister, *Archaeozonotriletes chulus* var. *chulus* (Cramer) Richardson & Lister, *Archaeozonotriletes chulus* var. *nanus* Richardson & Lister, *Artemopyra radiata* (Strother) Burgess & Richardson, *Cheilotetras caledonica* Wellman & Richardson, *Chelinospora obscura* Burgess & Richardson, *Chelinospora rumneyi* Burgess & Richardson, *Chelinospora vermoluta* Burgess & Richardson, *Concentricosporites saggitarius* Rodriguez, *Emphanisporites? concentricus* Burgess & Richardson, *Insolisporites bassettii* Burgess & Richardson, *Laevolancis divellomedia* (Chibrikova) Burgess & Richardson, *Laevolancis plicata* Burgess & Richardson, *Lophozonotriletes? poecilomorphus* Richardson & Ioannides, *Stellatispora inframurinata* var. *cambrensis* Burgess & Richardson and *Tetrahedraletes medinensis* var. *medinensis* Strother & Traverse.

Except for *Apiculiretusispora? asperata*, all these species occur in the *Stellatispora inframurinata* var. *cambrensis* Sub-Biozone. All range into the overlying *Stellatispora inframurinata* var. *inframurinata* Sub-Biozone, except for *Artemopyra radiata* and *Emphanisporites? concentricus* which disappear close to the top of the *asperata* Sub-Biozone. Data are from Burgess & Richardson (1995, text-figs 6-7).

Burgess, N.D. & Richardson, J.B. 1995. Late Wenlock to early Prídolí cryptospores and miospores from south and southwest Wales, Great Britain. *Palaeontographica Abteilung B*, **236**, 1-103.

See: [Apiculiretusispora? asperata Assemblage Sub-Biozone - Occurrence, Distribution of spore taxa in the Ludlow Series.](#)

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[Author: SGM]

***Apiculiretusispora? asperata* Assemblage Sub-Biozone**

Occurrence

The *Apiculiretusispora? asperata* Sub-Biozone is represented by spore assemblages from the Llanedeyrn Formation of the Rumney Borehole, and the Black Cock Beds, Carn Powell Facies and Trichrûg Beds of the Sawdde Valley, all in south Wales (Burgess & Richardson 1995).

Burgess & Richardson (1995, p. 32) believed the *Apiculiretusispora? asperata* Assemblage Sub-Biozone to span the boundary between the *incipiens* and *leintwardinensis* graptolite biozones.

Burgess, N.D. & Richardson, J.B. 1995. Late Wenlock to early Prídolí cryptospores and miospores from south and southwest Wales, Great Britain. *Palaeontographica Abteilung B*, **236**, 1-103.

See: [Apiculiretusispora? asperata Assemblage Sub-Biozone - Microflora, Holostratigraphical chart.](#)

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[Author: SGM]

***Stellatispora inframurinata* var. *inframurinata* Assemblage Sub-Biozone**

Microflora

The base of the *Stellatispora inframurinata* var. *inframurinata* Sub-Biozone is defined by the appearance of the trilete miospore variety *Stellatispora inframurinata* var. *inframurinata* (Richardson & Lister) Burgess & Richardson and the hilate cryptospore *Hispanaediscus major* Burgess & Richardson.

In addition to *Stellatispora inframurinata* var. *inframurinata* and *Hispanaediscus major*, spores recorded from the *inframurinata* Sub-Biozone include: *Ambitisporites avitus* Hoffmeister, *Ambitisporites dilutus* (Hoffmeister) Richardson & Lister, *Apiculiretusispora?* *asperata* Burgess & Richardson, *Archaeozonotriletes chulus* var. *chulus* (Cramer) Richardson & Lister, *Archaeozonotriletes chulus* var. *nanus* Richardson & Lister, *Cheilotetras caledonica* Wellman & Richardson, *Chelinospora obscura* Burgess & Richardson, *Chelinospora rumneyi* Burgess & Richardson, *Chelinospora vermoluta* Burgess & Richardson, *Concentricosisporites saggitarius* Rodriguez, *Emphanisporites* sp. A of Burgess & Richardson (1995), *Insolisporites bassettii* Burgess & Richardson, *Laevolancis divellomedia* (Chibrikova) Burgess & Richardson, *Laevolancis plicata* Burgess & Richardson, *Lophozonotriletes?* *poecilomorphus* Richardson & Ioannides, *Stellatispora inframurinata* var. *cambrensis* Burgess & Richardson, *Synorisporites* sp. D of Burgess & Richardson (1995) and *Tetrahedraletes medinensis* var. *medinensis* Strother & Traverse.

Except for *Emphanisporites* sp. A, *Hispanaediscus major*, *Stellatispora inframurinata* var. *inframurinata* and *Synorisporites* sp. D, all these species occur in the *Apiculiretusispora?* *asperata* Sub-Biozone.

Chelinospora obscura disappears in the lower part of the zone in the Rumney Borehole, and *Chelinospora rumneyi*, *Chelinospora vermoluta*, *Insolisporites bassettii* and *Archaeozonotriletes chulus* var. *nanus* at successively higher levels. *Concentricosisporites saggitarius* has a sporadic presence in the lower part of the zone, but reappears in the overlying *Synorisporites tripapillatus*-*Apiculiretusispora spicula* Biozone. The remaining taxa range into the highest productive sample of the *inframurinata* Sub-Biozone in the Rumney Borehole, while *Ambitisporites avitus*, *Ambitisporites dilutus*, *Archaeozonotriletes chulus* var. *chulus*, *Cheilotetras caledonica*, *Laevolancis divellomedia*, *Laevolancis plicata*, and *Tetrahedraletes medinensis* var. *medinensis* range higher, into the *tripapillatus*-*spicula* Biozone. Data are from Burgess & Richardson (1995, text-figs 6-7).

(continued...)

***Stellatispora inframurinata* var. *inframurinata* Assemblage Sub-Biozone - Microflora
(continued)**

Burgess, N.D. & Richardson, J.B. 1995. Late Wenlock to early Prídolí cryptospores and miospores from south and southwest Wales, Great Britain. *Palaeontographica Abteilung B*, **236**, 1-103.

See: [Distribution of spore taxa in the Ludlow Series, *Stellatispora inframurinata* var. *inframurinata* Assemblage Sub-Biozone - Occurrence.](#)

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***Stellatispora inframurinata* var. *inframurinata* Assemblage Sub-Biozone**

Occurrence

The *Stellatispora inframurinata* var. *inframurinata* Sub-Biozone is represented by spore assemblages from the Llanedeyrn Formation of the Rumney Borehole, and the uppermost part of the Trichrûg Beds, the Upper Cwm Clyd Beds and the Lower Roman Camp Beds of the Sawdde Valley section, all in south Wales (Burgess & Richardson 1995).

Burgess & Richardson (1995, p. 32) believed the *Stellatispora inframurinata* var. *inframurinata* Sub-Biozone to cover part of the *leintwardinensis* and *bohemicus* graptolite biozones. Burgess & Richardson (1995, text-fig. 8) depicted the top of the sub-biozone, which coincides with the top of the *libycus-poecilomorphus* Biozone, as correlating approximately with the top of the Ludlow Series in south Wales, being succeeded by the *Synorisporites tripapillatus*-*Apiculiretusispora spicula* Assemblage Biozone of Downton (Prídolí) age.

Burgess, N.D. & Richardson, J.B. 1995. Late Wenlock to early Prídolí cryptospores and miospores from south and southwest Wales, Great Britain. *Palaeontographica Abteilung B*, **236**, 1-103.

See: [Holostratigraphical chart, *Stellatispora inframurinata* var. *inframurinata* Assemblage Sub-Biozone - Microflora.](#)

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***Synorisporites tripapillatus*-*Apiculiretusispora spicula* Assemblage Biozone**

A marked increase in the diversity of spore microfloras occurs across the base of the Downton Castle Sandstone Formation in the Ludlow area. The increase in diversity is associated with morphological developments that include the appearance of tripapillate spores and distally sculptured (echinate, verrucate) patinate spores (Richardson & McGregor 1986, p.10; Richardson & Edwards 1989).

The increase in diversity is accompanied by an increase in spore abundance. Richardson & Lister (1969, pp. 202, 206, 207) noted that spores generally comprised less than 1% of Ludlow palynological assemblages, but that the percentage rose to 11% immediately above the base of the Ludlow Bone Bed Member (the lowest unit of the Downton Castle Sandstone), and to 70% 1.78-1.83 m above the base of the member (see also Bassett *et al.* 1982, table 1; White & Lawson 1989, fig. 98). Richardson & Rasul (1990, table 1) showed the percentage of spores to increase across the base of the Downton Castle Sandstone Formation and its equivalents, at several localities, in rocks of Ludlow shelf and basin margin facies. (See also: [The type Ludlow Series: Palynofacies](#)).

The change is apparent across the base of the Downton Castle Sandstone Formation in the vicinity of Ludford Corner (Richardson & Lister 1969, table 1; Bassett *et al.* 1982, table 2, reproduced as fig. 99 in White & Lawson 1989; [Whitcliffe Road section](#)). Spores from the Upper Whitcliffe Formation, 18.80 to 0.41 m below the base of the Downton Castle Sandstone Formation, comprise low diversity assemblages with a maximum of three species out of *Archaeozonotriletes chulus* var. *chulus* (Cramer) Richardson & Lister, *Retusotriletes* cf. *warringtoni* Richardson & Lister, *Retusotriletes* sp. A (of Richardson & Lister 1969) and *Stellatispora inframurinata* (Richardson & Lister) Burgess & Richardson. The lowest spore assemblage from the Downton Castle Sandstone Formation, 0-0.10 m above the base of the Ludlow Bone Bed Member, comprises *Apiculiretusispora spicula* Richardson & Lister, *Apiculiretusispora synorea* Richardson & Lister, *Archaeozonotriletes chulus* var. *chulus* (Cramer) Richardson & Lister, *Cymbosporites echinatus* Richardson & Lister, *Cymbosporites verrucosus* Richardson & Lister, *Laevolancis* cf. *divellomedia* (Chibrikova) Burgess & Richardson, ?*Perotriletes* sp. A (of Richardson & Lister 1969), *Retusotriletes* cf. *minor* Kedo, *Retusotriletes* sp. A (of Richardson & Lister 1969), *Stellatispora inframurinata*, *Synorisporites downtonensis* Richardson & Lister, *Synorisporites tripapillatus* Richardson & Lister and *Synorisporites verrucatus* Richardson & Lister, indicating the *Synorisporites tripapillatus*-*Apiculiretusispora spicula* Biozone.

(continued...)

Richardson & McGregor (1986, p. 9) placed the base of the *tripapillatus-spicula* Biozone immediately above the Ludlow Bone Bed, remarking that no spores had been recovered from the latter. This is presumed to mean the Ludlow Bone Bed in the strict sense, i.e. the lowest lenticular vertebrate sand in the succession (see '[Whitcliffe Road - lithostratigraphy](#)'), rather than the Ludlow Bone Bed Member (the lowest 0.3 m of the Downton Castle Sandstone Formation at Ludlow), since spores have been recorded from the member (e.g. by Richardson & Rasul 1990).

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See: [Distribution of spore taxa in the Ludlow Series, Holostratigraphical chart, Whitcliffe Road](#).

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