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Carboniferous palynology of the East Dron Borehole: a preliminary report

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Carboniferous palynology of the East Dron Borehole: a preliminary report

M H Stephenson

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Summary

This preliminary report describes palynological analysis of 20 samples from the interval 221.69-25.68m in the East Dron Borehole, Fife (NO 1360 1572). The borehole was sampled for palynology in the early 1970s by Dr R. Neves of the University of Sheffield, and more recently by BGS staff for ostracods. The slides made at the University of Sheffield have only recently (Jan 2002) been recovered and these and new slides made from samples taken for ostracods form the basis for this report.

The sequence yielded a relatively large number of rich assemblages whose preservation is notably better than those of the Glenrothes Borehole and approximately similar to those at the Heads of Ayr coastal section, though 5 samples from the lowest part of the borehole (221.69-203.24m) were barren. CM Biozone (Tn3c; latest Tournaisian) assemblages are present from 189.4m to the top of the studied section.

Detailed ostracod data is available between 72.29m and 24.35m and this indicates that brackish or quasi-marine conditions dominated within this section (Williams 2002).

On the basis of this and earlier studies, and other published information on the Spilmersford, Birnieknowes and Cockburnspath sections, a preliminary correlation for the MVS Ballagan Formation is suggested (Fig. 2). 'Upper Ballagan' assemblages from the Heads of Ayr are not present in Glenrothes and East Dron, hence it could be argued that younger parts of the Ballagan Formation are present in the Heads of Ayr section. Even younger parts of the Ballagan Formation are present, however, in the Spilmersford and Birnieknowes boreholes where Pu Biozone (earliest Viséan) assemblages have been recorded.

Table 1 presents sections in which CM/Pu Biozone assemblages have been identified from the Ballagan Formation, but most are poorly known biostratigraphically. It is recommended that a number of these be further sampled for palynology and ostracods with a view to:

- further developing biostratigraphical subdivision of the CM Biozone,
- cross referenced investigations of the CM-Pu (approximately the Tournaisian- Viséan) boundary.

1 Introduction

This preliminary report records the results of palynological analysis of 20 samples from the East Dron Borehole, Fife (NGR NO 1360 1572). The borehole was sampled for palynology in the early 1970s by Dr R. Neves of the University of Sheffield, and more recently by BGS staff for ostracods. The slides made at the University of Sheffield have only recently (Jan 2002) been recovered and these and new slides made from samples taken from ostracods form the basis for this report. The objective of the study is to investigate the potential for high precision correlation within the Ballagan Formation in the Midland Valley of Scotland, following detailed work at the Heads of Ayr section, Ayrshire (Stephenson et al. in press, *Scottish Journal of Geology*) and on the Glenrothes Borehole (Stephenson 2002).

It is envisaged that further palynological work will be carried out on this borehole since this study has shown relatively good preservation (certainly better than that seen in the Glenrothes Borehole). Ostracod studies cover only the upper part of the borehole, and further studies lower in the succession are planned. A later report will describe the biostratigraphy of this borehole in more detail.

Slides recovered from Sheffield University do not at present have an MPA number, but will be registered as a priority.

2 Description of assemblages

Fig. 1 illustrates the ranges of palynomorphs and gives details of ostracod occurrence in the studied section.

2.1 SAMPLES MPA 50818 TO 50814

Depths 221.69m to 203.24m

These assemblages contain very little organic matter and therefore no age determination can be given.

2.2 SHEFFIELD UNIVERSITY CODE 4455

Depth 189.4m

The sample yielded a rich organic residue consisting mainly of black equant and elongate fragments of probable land plant origin and well preserved yellowish-brown palynomorphs in equal measure. The palynological assemblage contained:

Acanthotriletes cf. *hacquebardii*

Apiculiretusispora fructicosa

Auroraspora cf. *macra*

Baculatisporites fusticulus

Camptotriletes sp.

Cf. *Murospora* sp.

Cf. *Savitrissporites* sp.

Cf. *Vestispora* sp.

Colatisporites spp.

Convolutispora major

Convolutispora vermiformis

Cyclogranisporites sp.
Discernisporites sullivanii
Discernisporites sullivanii
Endoculeospora gradzinskii
Grandispora echinata
Grandispora melvinii
Knoxisporites hederatus
Knoxisporites literatus
Knoxisporites spp.
Kraeuselisporites hibernicus
Latosporites spp.
Murospora cf. *aurita*
Retusotriletes incohatus
Rugospora granulatipunctata
Rugospora polyptycha
Schopfites claviger
Schopfites delicatus
Spelaeotriletes pretiosus
Spelaeotriletes tuberosus
Verrucosisporites nitidus

2.2.1 Interpretation

The presence of *Schopfites claviger* and *Auroraspora macra* suggests that this sample can be assigned to the Tn3c (latest Tournaisian) CM Biozone of Clayton et al. (1977). The assemblage is most like those of the 'lower Ballagan' at the Heads of Ayr, Ayrshire (Stephenson et al., in press).

2.3 MPA 50813

188.76m

The sample yielded a rich organic residue consisting mainly of black equant and elongate fragments of probable land plant origin, and well preserved yellowish-brown palynomorphs in equal measure. The palynological assemblage contained:

Auroraspora cf. *macra*
Auroraspora macra
Baculatisporites fusticulus
Colatisporites spp.
Convolutispora spp.
Corystisporites costatus
Cyclogranisporites sp.
Grandispora cf. *echinata*
Knoxisporites spp.
Leiotriletes sp.
Murospora cf. *aurita*
Plicatispora scoleophora
Punctatisporites spp.
Retusotriletes incohatus
Retusotriletes spp.
Rugospora minuta
Rugospora polyptycha
Rugospora sp.
Schopfites claviger

Spelaeotriletes tuberosus
Stenozonotriletes sp.
Verrucosisporites cf. *nitidus*
Verrucosisporites nitidus

2.3.1 Interpretation

The presence of *Schopfites claviger* and *Auroraspora macra* suggests that this sample can be assigned to the Tn3c (latest Tournaisian) CM Biozone of Clayton et al. (1977).

2.4 SHEFFIELD UNIVERSITY CODE 4453

180.44m

The sample yielded a residue of mainly black or brown fragments, sheet cellular material and rare, poorly preserved palynomorphs including common *Leiosphaeridia* spp., *Retusotriletes* sp and *Auroraspora* cf. *macra*.

2.4.1 Interpretation

The relative abundance of specimens of probable aquatic algal origin suggests similarity with ‘algal assemblages’ described from the Glenrothes Borehole (Stephenson 2002).

2.5 SHEFFIELD UNIVERSITY CODE 4452

176.60m

The sample yielded a residue of mainly black or brown fragments, sheet cellular material and rare, poorly preserved palynomorphs including common *Leiosphaeridia* spp., *Schopfites claviger*, *Colatisporites* spp., *Retusotriletes* sp. *Botryococcus* sp, and *Grandispora echinata*.

2.5.1 Interpretation

The relative abundance of specimens of probable aquatic algal origin suggests similarity with the ‘algal assemblages’ described from the Glenrothes Borehole (Stephenson 2002). The presence of *Schopfites claviger* and the position of the sample with respect to others with diagnostic assemblages suggests that the assemblages is CM Biozone age.

2.6 SHEFFIELD UNIVERSITY CODE XXXX

172.5m

The sample yielded a rich organic residue consisting mainly of black equant and elongate fragments of probable land plant origin and well preserved yellowish-brown palynomorphs in equal measure. The palynological assemblage contained:

Apiculiretusispora fructicosa
Auroraspora cf. *macra*
Auroraspora corporiga
Auroraspora sp.
Baculatisporites fusticulus
Cf. *Brevitriletes* sp.
Cincturasporites convolutus
Colatisporites spp.
Convolutispora circumvallata
Convolutispora finis
Convolutispora major

Convolutispora mellita
Convolutispora spp.
Crassispora trychera
Diducites poljessicus
Endoculeospora gradzinskii
Grandispora echinata
Knoxisporites spp.
Plicatispora scolecophora
Retusotriletes incohatus
Retusotriletes spp.
Rugospora granulatipunctata
Rugospora polyptycha
Rugospora spp.
Spelaeotriletes spp.
Spelaeotriletes tuberosus
Stenozonotriletes sp.
Verrucosisporites nitidus

2.6.1 Interpretation

The presence of *Schopfites claviger* and *Auroraspora macra* suggests that this sample can be assigned to the Tn3c (latest Tournaisian) CM Biozone of Clayton et al. (1977).

2.7 SHEFFIELD UNIVERSITY CODE 4444

140.44m

The sample yielded a rich organic residue consisting mainly of black equant and elongate fragments of probable land plant origin, sheet cellular material and moderately preserved yellowish-brown palynomorphs in equal measure. The palynological assemblage contained:

Apiculiretusispora fructicosa
Auroraspora cf. *macra*
Auroraspora corporiga
Auroraspora macra
Baculatisporites fusticulus
Cf. *Savitrissporites* sp.
Colatisporites spp.
Convolutispora circumvallata
Convolutispora major
Convolutispora mellita
Convolutispora spp.
Crassispora trychera
Crassispora trychera
Cyclogranisporites sp.
Discernisporites micromanifestus
Discernisporites sullivanii
Foveosporites sp.
Knoxisporites spp.
Kraeuselisporites hibernicus
Latosporites sp.
Leiotriletes sp.
Murospora spp.
Punctatisporites spp.
Retusotriletes incohatus

Schopfites claviger
Spelaeotriletes microspinosus
Spelaeotriletes tuberosus
Stenozonotriletes spp.
Verrucosisporites gibberosus

2.7.1 Interpretation

The presence of *Schopfites claviger* and *Auroraspora macra* suggests that this sample can be assigned to the Tn3c (latest Tournaisian) CM Biozone of Clayton et al. (1977).

2.8 MPA 50812

The sample contained very little organic matter.

2.8.1 Interpretation

No age determination can be given.

2.9 SHEFFIELD UNIVERSITY CODE 4439

116.25m

The sample yielded a rich organic residue consisting mainly of black equant and elongate fragments of probable land plant origin, sheet cellular material and moderately preserved yellowish-brown palynomorphs in equal measure. The palynological assemblage contains:

Acanthotriletes persibus
Anaplanisporites centrosus
Apiculiretusispora fructicosa
Auroraspora cf. *macra*
Auroraspora corporiga
Auroraspora macra
Baculatisporites fusticulus
Camptotriletes prionotus
Cf. *Murospora* sp.
Cf. *Palambages* sp.
Cincturasporites convolutus
Colatisporites spp.
Convolutispora major
Convolutispora mellita
Convolutispora sp. A Ioannides
Convolutispora tessellata
Corbulispora cancellata
Corystisporites costatus
Crassispora trychera
Discernisporites sullivanii
Grandispora cf. *echinata*
Knoxisporites literatus
Knoxisporites spp.
Kraeuselisporites hibernicus
Latosporites spp.
Leiosphaeridia spp.
Plicatispora scolecophora
Punctatisporites spp.

Retusotriletes incohatus
Rugospora granulatipunctata
Rugospora polyptycha
Rugospora spp.
Schopfites claviger
Schopfites delicatus
Spelaeotriletes pretiosus
Vallatisporites sp.

2.9.1 Interpretation

The presence of *Schopfites claviger* and *Auroraspora macra* suggests that this sample can be assigned to the Tn3c (latest Tournaisian) CM Biozone of Clayton et al. (1977).

2.10 SHEFFIELD UNIVERSITY CODE 4433

94.12m

The sample yielded a sparse residue of black fragments and rare, poorly preserved palynomorphs including *Leiosphaeridia* sp., *Retusotriletes* sp. and *Chomotriletes* sp..

2.10.1 Interpretation

No age determination can be given. The relative abundance of specimens of probable aquatic algal origin suggest similarity with the ‘algal assemblages’ described from the Glenrothes Borehole (Stephenson 2002).

2.11 MPA 50811

The sample yielded a rich organic residue consisting mainly of black equant and elongate fragments of probable land plant origin and well preserved yellowish-brown palynomorphs in equal measure. The palynological assemblage contained:

?*Deusilites* sp.
Auroraspora cf. *macra*
Auroraspora macra
Baculatisporites fusticulus
Colatisporites spp.
Convolutispora spp.
Corystisporites costatus
Diducites sp.
Discernisporites micromanifestus
Grandispora cornuta
Grandispora echinata
Knoxisporites spp.
Latosporites sp.
Plicatispora scoleophora
Punctatisporites spp.
Retusotriletes incohatus (including the monolete form)
Rugospora spp.
Schopfites claviger
Schopfites delicatus
Spelaeotriletes cf. *microspinosus*
Spelaeotriletes cf. *pretiosus*
Spelaeotriletes cf. *tuberosus*

Stenozonotriletes sp.
Verrucosisporites gibberosus
Verrucosisporites nitidus
Verrucosisporites sp.

2.11.1 Interpretation

The presence of *Schopfites claviger* and *Auroraspora macra* suggests that this sample can be assigned to the Tn3c (latest Tournaisian) CM Biozone of Clayton et al. (1977).

2.12 SHEFFIELD UNIVERSITY CODE 4423

55.25m

The sample yielded a rich organic residue consisting mainly of black equant and elongate fragments of probable land plant origin and well preserved yellowish-brown palynomorphs in equal measure. The palynological assemblage contained:

Acanthotriletes cf. *hacquebardii*
Acanthotriletes persibus
Apiculiretusispora fructicosa
Auroraspora cf. *macra*
Auroraspora corporiga
Auroraspora macra
Baculatisporites fusticulus
Camptotriletes prionotus
Cincturasporites convolutus
Colatisporites spp.
Convolutispora finis
Convolutispora major
Convolutispora mellita
Convolutispora spp.
Crassispora trychera
Discernisporites sullivanii
Grandispora echinata
Grandispora melvinii
Grandispora sp.
Knoxisporites hederatus
Knoxisporites literatus
Knoxisporites literatus
Knoxisporites spp.
Knoxisporites triangularis
Latosporites sp.
Latosporites spp.
Murospora cf. *aurita*
Plicatispora scolecophora
Punctatisporites spp.
Raistrickia corynoges
Raistrickia minor
Retusotriletes incohatus
Rugospora granulatipunctata
Rugospora polyptycha
Schopfites claviger
Schopfites delicatus
Stenozonotriletes sp.

Verrucosisporites gibberosus
Verrucosisporites nitidus

2.12.1 Interpretation

The presence of *Schopfites claviger* and *Auroraspora macra* suggests that this sample can be assigned to the Tn3c (latest Tournaisian) CM Biozone of Clayton et al. (1977).

2.13 MPA 50810

The sample yielded a very sparse residue of black fragments and extremely rare, poorly preserved palynomorphs including *Leiosphaeridia* sp. and *Convolutispora* sp.

2.13.1 Interpretation

No age determination can be given.

2.14 MPA 50809

The sample yielded a residue of mainly black fragments and extremely rare, poorly preserved palynomorphs including *Retusotriletes* sp. and *Convolutispora* sp..

2.14.1 Interpretation

No age determination can be given.

2.15 SHEFFIELD UNIVERSITY CODE 4417

31.62m

The sample yielded a rich residue of mainly elongate black and brown fragments (some clearly of woody tissue) and rare, poorly preserved palynomorphs including *Retusotriletes* sp., *Colatisporites* spp., *Punctatisporites* sp., *Schopfites claviger*, *Auroraspora macra*, *Leiosphaeridia* sp., *Discernisporites* cf. *micromanifestus*, *Spelaeotriletes microspinosus*, *Corystisporites costatus* and *Camptotriletes* sp., *Auroraspora corporiga* and *Rugospora granulatipunctata*.

2.15.1 Interpretation

The presence of *Schopfites claviger* and *Auroraspora* cf. *macra* suggests that this sample can be assigned to the Tn3c (latest Tournaisian) CM Biozone of Clayton et al. (1977).

2.16 SHEFFIELD UNIVERSITY CODE 4411

25.68m

The sample yielded a residue of mainly black fragments and rare, poorly preserved palynomorphs including *Retusotriletes* sp., *Convolutispora* sp., *Colatisporites* spp., *Punctatisporites* sp., *Schopfites claviger*, *Auroraspora* cf. *macra* and *Leiotriletes* sp.

2.16.1 Interpretation

The presence of *Schopfites claviger* and *Auroraspora* cf. *macra* suggests that this sample can be assigned to the Tn3c (latest Tournaisian) CM Biozone of Clayton et al. (1977).

3 Preliminary correlation of the MV Ballagan Formation

A brief literature survey shows that CM Biozone assemblages have been recovered from the Ballagan Formation in the sections shown in Table 1. In a few sections, the Ballagan Formation extends into the younger Pu Biozone (earliest Viséan, Clayton et al. 1977).

Table 1 Survey of CM Biozone assemblages in the MVS

Borehole/Section	Location	Depth range of CM assemblages	Author	Remarks
Spilmersford BH	NT 45706902	3013-2628'	Neves & Ioannides (1974) Neves et al. (1973)	Transition to Pu Biozone present
Birnieknowes BH	NT 758732	1276-1096'	Clayton (1971), Neves et al. (1973)	Transition to Pu Biozone present
Cockburnspath outcrop	Pease Bay, Berwickshire	Outcrop	Clayton (1971), Neves et al. (1973)	
Edinburgh outcrop	Edinburgh area	Outcrop	Neves et al. (1973)	
Heads of Ayr outcrop	Ayrshire	Outcrop	Stephenson et al. (in press), Sullivan (1968)	
Glenrothes BH	NO 2561 0314	205-316.95m	Turner (1995), Stephenson (2002)	
East Dron BH	NO13601572	25.68-189.4m	Stephenson (this study), Browne (1980)	
New Farm A	NO 25662296	10-40m	McLean, D. & Neves, R. (2001), Browne (1980)	
Newburgh B	NO23201852	30-60m approx.	Browne (1980)	Transition to Pu Biozone present
West Dron	NO1348 1614	3-45m	Browne (1980)	
Mains of Errol	NO23802190	20-45m	Browne (1980)	
Oxroad Bay outcrop	Nr. Tantallon Castle	Outcrop	Bateman & Scott (1990); Scott et al. (1984)	
Blairmulloch BH	NS 56050 28200	212.1-124.65m	Abusham (Unpub. PhD Thesis 2000)	Transition to Pu Biozone present
Loch Humphrey Burn outcrop	Kilpatrick Hills	Outcrop	Scott et al. (1984)	Transition to Pu Biozone present

On the basis of palynological information given on the Spilmersford BH (NT 45706902), the Birnieknowes BH (NT 758732) and outcrop from the Cockburnspath area (see Neves & Ioannides 1974, Neves et al. 1973 and Clayton 1971), a correlation with the East Dron and Glenrothes boreholes is suggested in Fig. 2. The palynological details on other sections shown in the table are too brief to allow them to be included in the diagram.

It should be noted that the 'Upper Ballagan' assemblages (i.e. assemblages from a probable high position in the CM Biozone) at the Heads of Ayr do not appear to be present in Glenrothes and East Dron, hence it could be argued that younger parts of the Ballagan Formation are present in the Heads of Ayr section. From the brief details given by see Neves & Ioannides (1974), Neves

et al. (1973) and Clayton (1971), it is not possible to discern whether ‘Upper Ballagan’ assemblages are present in the CM Biozone component of the Ballagan Formation at Spilmersford, Birnieknowes and Cockburnspath.

The youngest part of the Ballagan Formation in the MVS appears to be present in the Spilmersford and Birnieknowes boreholes where Pu Biozone assemblages have been recorded by Neves & Ioannides (1974), Neves et al. (1973) and Clayton (1971). A single Pu Biozone Ballagan Formation assemblage also appears to be present in Newburgh B BH (NO23201852, see Browne 1980).

4 Further work

Many of the sections referred to in Table 1 have not been studied to a level which allows detailed correlation. It is recommended that a number of these be sampled for palynology and ostracods with a view to:

- developing biostratigraphical subdivision of the CM Biozone,
- cross referenced investigations of the CM-Pu (approximately the Tournaisian- Viséan) boundary.

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Fig. 1 Summary of the biostratigraphy of the East Dron Borehole

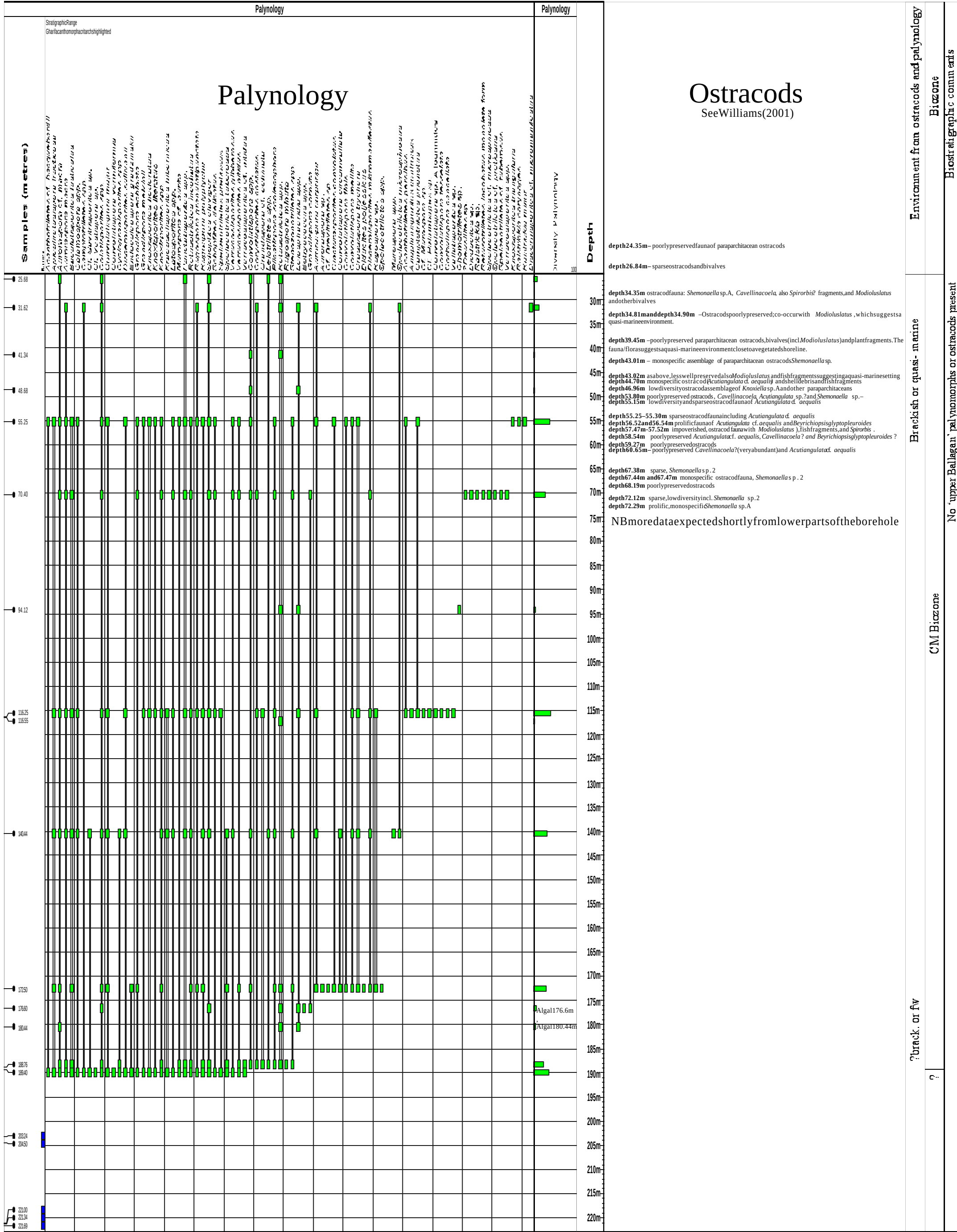


Fig. 2 Correlation of the Ballagan Formation across the MVS, including Cockburnspath/Spilmersford. Thicknesses approximate.

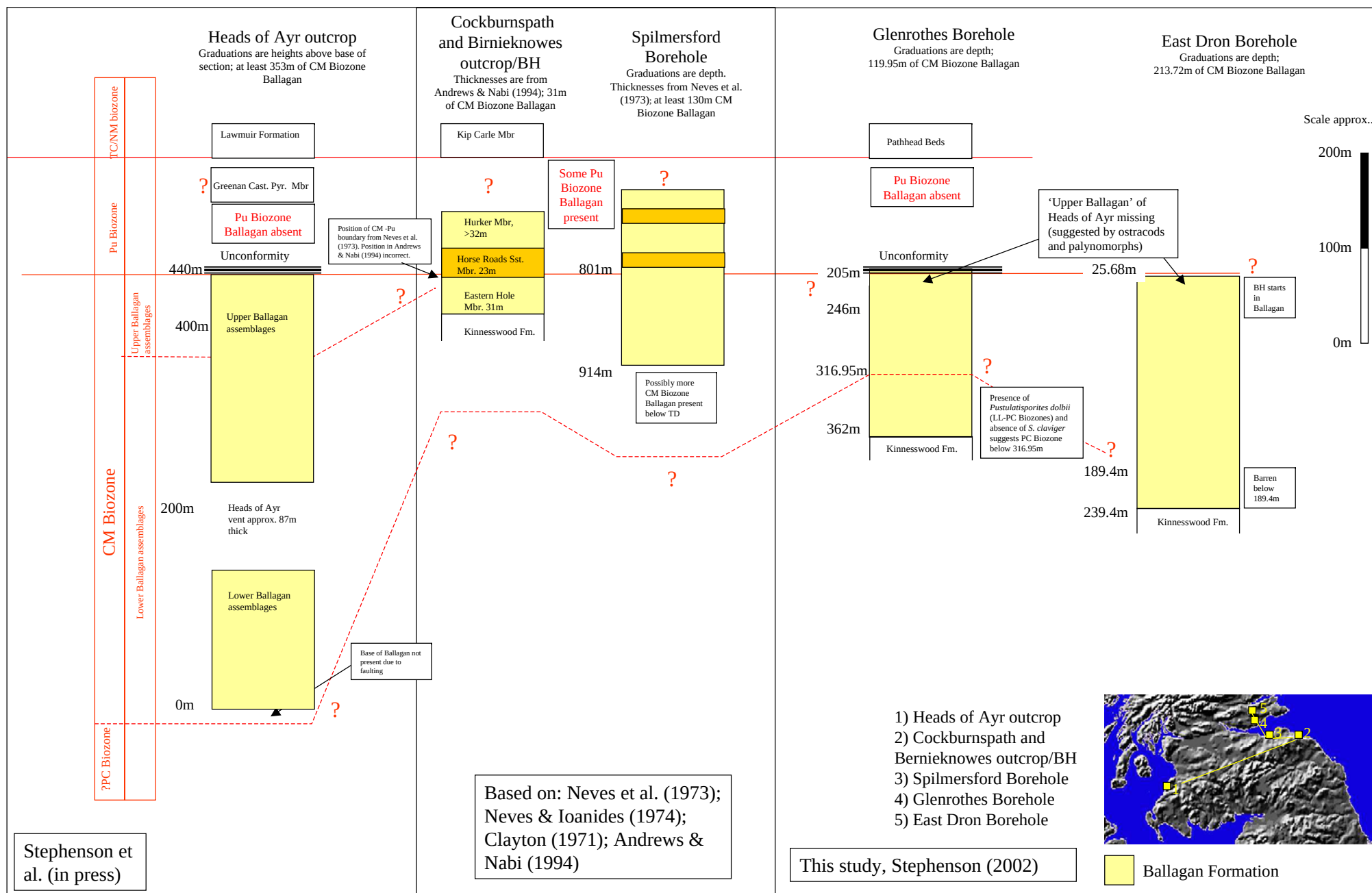
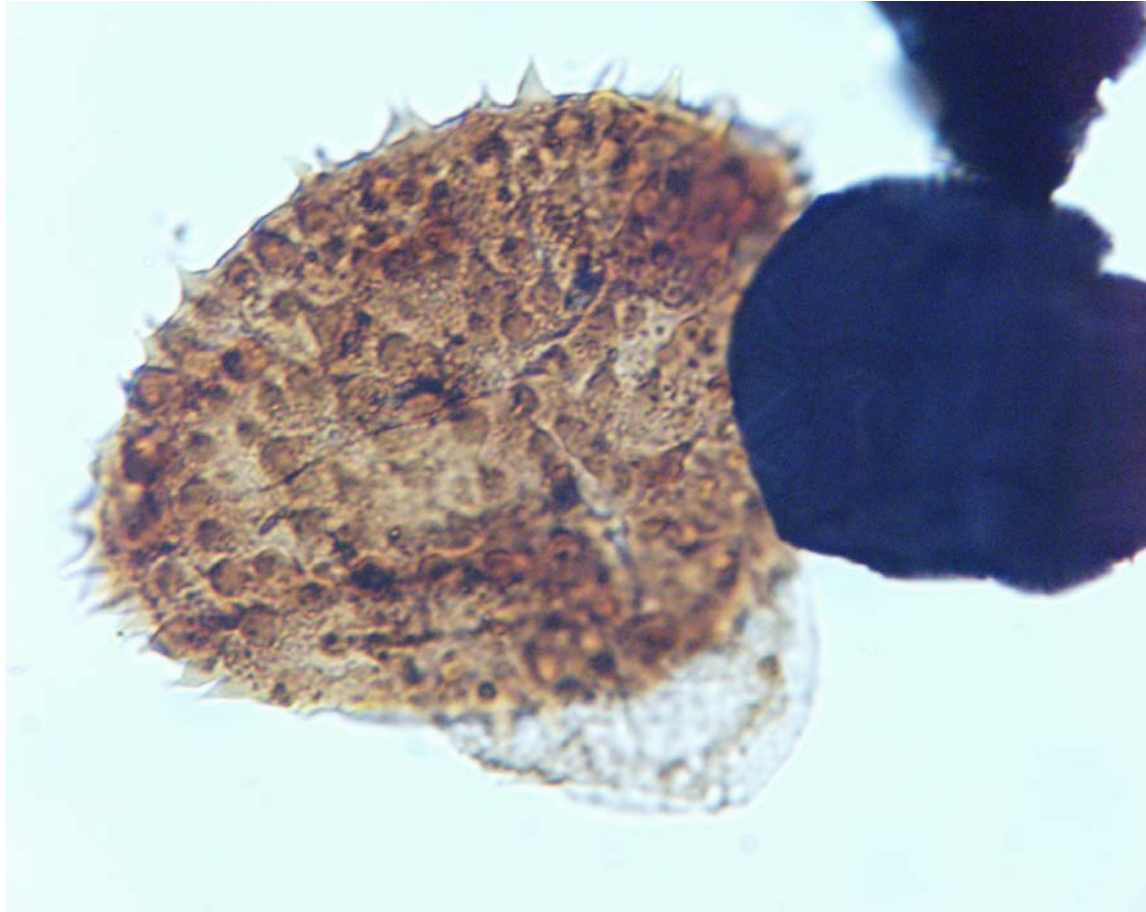
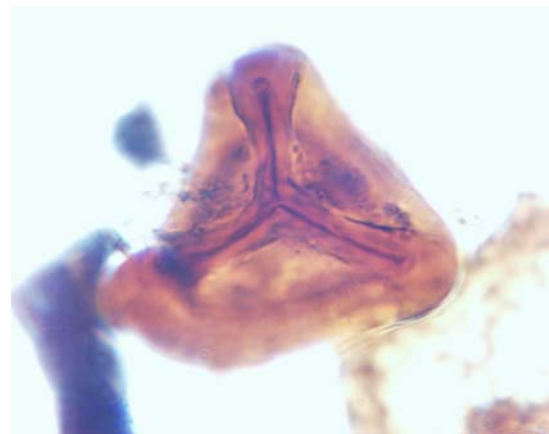
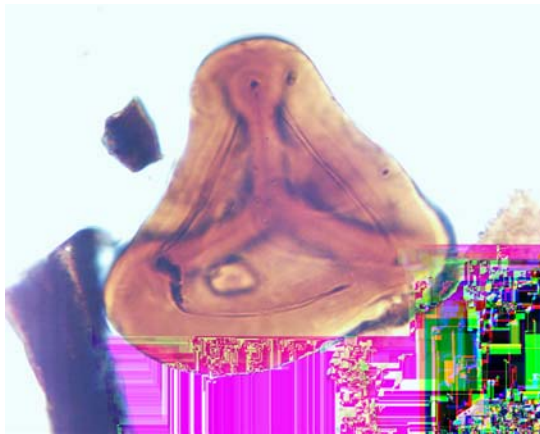


Plate 1 Taxa from East Dron Borehole



Acanthotriletes cf. *hacquebardii*, Slide 4423 (Sheffield University Code), depth 55.25m East Dron BH



Murospora cf. *aurita*, R31, Slide 4423 (Sheffield University Code), depth 55.25m East Dron BH; left distal, right proximal.