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STRATIGRAPHIC PALYNOLOGY OF THE UPPER DEVONIAN-LOWER CARBONIFEROUS SUCCESSION IN NORTH DEVON, SOUTHWEST ENGLAND

by

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(5 figures, 1 table and 1 plate)

ABSTRACT.- A detailed palynological investigation has been undertaken of the Upper Devonian and Lower Carboniferous succession in the Barnstaple area of north Devon, southwest England. The succession consists of the marginal marine Baggy Formation which passes upwards conformably into the marine Pilton Formation. Age determinations are based on twelve moderate to well preserved miospore assemblages. The assemblages are assigned to the miospore zonation scheme of Higgs *et al.* (1988) which was established for the late Devonian and Tournaisian rocks of Southern Ireland. The Baggy Formation ranges in age from the uppermost Devonian LL-LE Biozones, while the Pilton Formation shows a change in the palynoflora from uppermost Devonian LN Biozonal age to Basal Carboniferous VI Biozonal age. The Devonian-Carboniferous Boundary has been accurately located in the Upper Pilton Formation at Fremington Pill.

1.- INTRODUCTION

The uppermost Devonian and lowermost Carboniferous succession in north Devon, southwest England has been well documented by Goldring (1956, 1970, 1971) and Williams (1970); their stratigraphical nomenclature is used in this account. The succession records a gradual deepening of the sedimentary environments and a decrease in the sedimentation rate. The general succession in the area is shown in Table 1. The two stratigraphical units investigated in this study are the Baggy Formation (Goldring, 1970), which represents a marginal marine sequence and the conformably overlying Pilton Formation (Goldring, 1970), which was deposited under more open and deeper marine conditions. The Pilton Formation has been divided into two members; a lower arenaceous member and a upper argillaceous member (Goldring, 1955,1970; Williams 1970). Both the Baggy and Pilton Formations are well exposed in a number of coastal and inland sections in the Barnstaple area.

For the purpose of this study, twelve samples were collected from the Baggy and Pilton Formations along two coastal exposures at Croyde Bay/Baggy Point and at Fremington Pill (Fig. 1). The latter section is of particular importance, since it was at this locality that Sedwick and Murchison (1842) originally defined the boundary between the Devonian and Carboniferous systems. The samples were obtained from grey, dark grey and black mudstones and grey, mud streaked siltstones. These were processed using standard palynological preparation techniques; Concentrated hydrochloric acid and 49% hydrofluoric acid were used to remove carbonates and silicates respectively, and the samples were sieved using a 20µm sieve cloth. Because of the high level of maturity and carbonisation of the organic residues, oxidation of the miospore exines required. This was carried out using standard Schultze Solution. Oxidation times varied for each sample and necessitated an initial oxidation of two hours in Schultze Solution, followed by a further twenty to twenty-four hours in fresh solution. Permanent strew mounts of the of the oxidised residues were made using

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Table 1.- Generalised stratigraphical succession in north Devon.

Carboniferous	Brigantian	Rubble Hills Formation	Codden Hill Group
	Asbian	Hearson Formation	
	Chadian-Holkerian	Tawstock Formation	
	Courceyan	Landkey Formation	
		Pilton Formation	
Devonian	Famennian	**Baggy Formation**	
		Upcott Beds	
		Pickwell Down Sandstone	
		Morte Slates	
	Givetian-Frasnian	Ilfracombe Beds	
	?Eifelian	Hangman Grits	
	Emsian	Lynton Beds	

Cellusize as a dispersal agent and Evalcite as a cold mounting medium. These slides are stored in the Palynology Collection, Department of Geology, University College Cork.

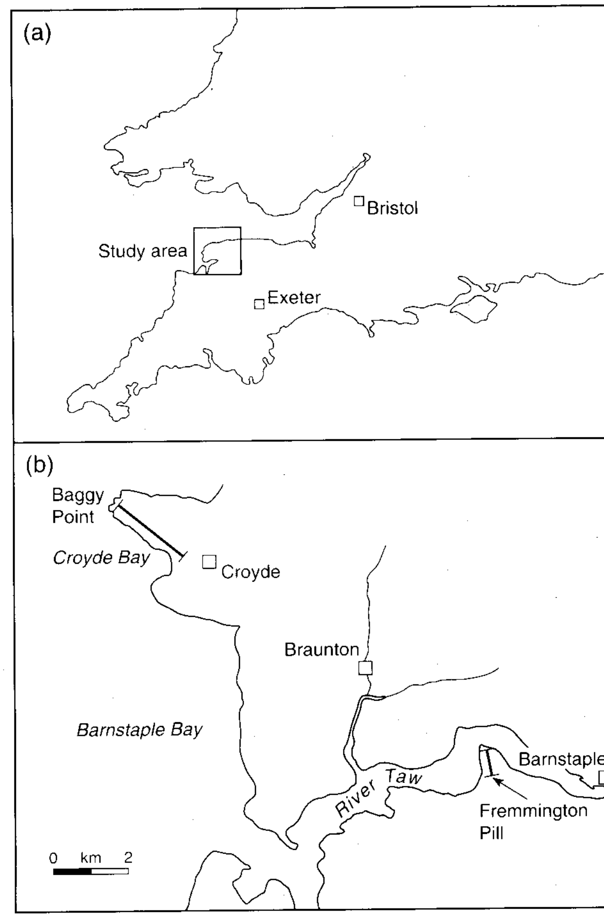

Fig. 1.- (a) Map of SW Britain showing locations of present study and previous work.
(b) Geographical locations of the two sections in north Devon investigated in this study.

2 .- STRATIGRAPHY AND SEDIMENTOLOGY

2 .1.- THE BAGGY FORMATION

Croyde Bay is located along the west coast of north Devon, approximately 26km northwest of Barnstaple (Fig. 1(b)). At this locality the succession is continuous from the Baggy Formation through to the overlying Lower Pilton Formation. The Baggy Formation is completely exposed along the high cliffs on the north side of the bay at Baggy Point - from which the formation has derived its name (Ussher & Champernowne, 1879). The beds dip to the south and are comformably overlain by the Lower Pilton Formation. The latter is repeated by folding on the southern side of the bay. The thickness of the Baggy Formation at Croyde Bay was estimated by Williams to be approximately 427m. However, in a later publication Goldring (1971) modified this thickness to 440m.

The base of the Baggy Formation is exposed just north of Baggy Point, approximately 1.5km northwest of Croyde Beach. The contact with the underlying Upcott Beds is marked by a distinct lithological and colour change (Williams, 1970). The grey and buff coloured sandstones of the lowermost Baggy Formation have a sharp contact with the purple and grey coloured mudstones of the uppermost Upcott Beds. The boundary between the Baggy Formation and Lower Pilton Formation is gradational and has been arbitrarily placed by Goldring (1956) at the top of a massive sandstone which immediately overlies a local contemporaneous slump (which he termed the '*Grand Slump*'). Williams (1970) however, placed the boundary at the top of the slump itself, arguing that based on conodont evidence, it proved a more practical boundary.

The Baggy Formation consist for the most part of dark grey shales, siltstones and thin sandstones. Goldring (1971) indicated that these lithologies constituted a particular group of rock types which formed a backround for the entire sequence in the Baggy Formation. Goldring estimated that in the lower part of the formation this group accounted for approximately 40% of the succession, whereas in the upper part, near the boundary with the overlying Pilton Formation, these lithologies were more abundant forming approximately 70% of the sequence. This lithological assemblage is also characterised by the widespread occurrence of the U-shaped burrows of the trace fossil *Diplocraterion yoyo.* Apart from the lithologies described above, the Baggy Formation also consists of thick massive and cross-bedded buff coloured sandstones. Most of these sandstones occur in the lower part of the formation, especially around Baggy Point. Some rare thin conglomerates and rare fossiliferous limestones are also present, the latter occur as thin lenses within thinly bedded shales and sandstones. The limestones are more abundant at the top of the formation, close to the boundary with the Pilton Formation.

Goldring (*op. cit.*) recognised a number of separate and distinct sedimentological facies types in the Baggy Formation, which he interpreted as being indicative of both marine and non-marine environments. Goldring saw little evidence of cyclicity of the facies and he suggested that the Baggy Formation could be interpreted as representing "a transgressive sequence of shallow water marine and delta-like sediments".

2. 2.- THE PILTON FORMATION

The Pilton Formation is stratigraphically subdivided into two members, the Lower and Upper Pilton Formation. The name 'Pilton' was first proposed by Phillips (1841) following his work on the Palaeozoic fossils in the Cornwall, north Devon and west Somerset regions. The Lower Pilton Formation is well exposed along the excellent coastal section on the northern side of Croyde Bay, while the Upper Pilton Formation is best exposed in the Fremington Pill section, located along the southern bank of the River Taw, 1km north of Fremington Railway Station, approximately 7km west of Barnstaple (Fig. 1). Much of this section is weathered and covered by tidal mud, however, the boundary between the Devonian and Carboniferous Systems is exposed and was identified by Goldring (1970) using macrofaunal evidence. The contact between the Pilton Formation and the succeeding Landkey Formation is transitional and is not well exposed. Intermittent outcrops of the transition are seen at Rumsan villiage, 4km south of Barnstaple and in a stream section along Hannaford Brook, approximately 10km southeast of Barnstaple (Jackson, 1991).

The thickness of the Lower Pilton Formation at Croyde Bay was estimated by Williams (1970) to be approximately 450m. Goldring (1956) believed that a further 53m was assignable to the Lower Pilton Formation before the junction with the Upper Pilton Formation, thus giving a total thickness of 503m for the Lower Pilton Formation. With regard to the Upper Pilton Formation, both Williams (*op cit.*) and Goldring (*op cit.*) found it difficult to determine precisely the thickness. However, Goldring tentatively suggested a total thickness of approximately 320m for the Upper Pilton Formation, but admitted that the estimations were not completely accurate. In a subsequent publication Goldring (1970) proposed a total thickness of 600-700m for the entire Pilton Formation.

The Lower Pilton Formation at Croyde Bay consist mainly of thinly bedded sandstones (<30cm thick) and mudstones which are brown or grey in colour (Williams 1970), and beds of fine calcareous sandstone up to 1.5m thick (Goldring, 1970). These thicker sandstones, which are distinctive of the Lower Pilton Formation, tend to occur in groups up to 10m thick and are separated by shale intercalations. Throughout the Lower Pilton Formation, thin lenses and bands of crinoidal fossiliferous limestones occur. These limestones are blue-grey in colour, generally less than 30cm thick and are often decalcified (Williams,1970). The fauna in the Pilton Formation is more varied and less restricted than that of the underlying Baggy Formation (Goldring, 1970). Edmonds *et al.* (1985) also noted a gradual decrease in sand content from the Baggy Formation upwards through the Lower Pilton Formation. Associated with this decrease there is an overall increase of the cherty bands and nodules. South of the beach at Croyde Bay two thin tuff bands are present. The tuffs are creamy-white in colour and form excellent lithological marker horizons at this locality, unfortunately however, they cannot be traced inland.

In the Upper Pilton Formation relatively few of the thicker calcareous sandstone units occur; where present, they rarely exceed a thickness of 1m. The Upper Pilton Formation consists dominantly of dark grey mudstones in which occasional fossil lenticles and cherty nodules and bands are present (Williams, 1970). Some thin (<60cm) limestone bands occur at a few horizons in the Upper Pilton Formation. These limestones contain abundant crinoid debris but are very impure containing considerable amounts of shale (Goldring, 1970).

The Pilton Formation therefore seems to have been deposited in more open marine conditions, below the level of wave activity (Williams, 1970). The sharp decrease in sand grade at the Lower/Upper boundary of the Pilton Formation probably indicates a further deepening of the which can be correlated with the Lower Carboniferous marine transgression (Goldring, *op cit.*).

CARBONIFEROUS	TOURNAISIAN	IVORIAN	*Schopfites claviger - Auroraspora macra* CM Biozone
			Spelaeotriletes pretiosus - Raistrickia clavata PC Biozone
		HASTARIAN	*Spelaeotriletes balteatus - Rugospora polyptycha* BP Biozone
			Kraeuselisporites hibernicus - Umbonatisporites distinctus HD Biozone
			Vallatisporites verrucosus - Retusotriletes incohatus VI Biozone
DEVONIAN	FAMENNIAN (PARS.)		*Retispora lepidophyta - Verrucosisporites nitidus* LN Biozone
			Retispora lepidophyta - Hymenozonotriletes explanatus LE Biozone
			Retispora lepidophyta - Knoxisporites literatus LL Biozone

Fig. 2.- Late Devonian and Tournaisian miospore zonation scheme of Higgs *et al.* (1988).

3.- PREVIOUS PALYNOLOGICAL WORK

Over the past 20 years little palynological work has been attempted on the Upper Devonian-Lower Carboniferous succession in north Devon. Dolby (1970a, 1970b) undertook a preliminary palynological study of the Baggy and Pilton Formations and results of this study were also published in Austin *et al.* (1970). Higgs *et al.* (1988) reinterpreted the miospore assemblages recorded by Dolby and suggested that the assemblages from the Baggy Formation should be assigned to the LL Biozones, whilst those from the Lower Pilton Formation should be assigned to the LE Biozone. The stratigraphical positions of Dolby's samples are illustrated in Fig. 3.

4.- NEW PALYNOLOGICAL DATA

Twelve productive samples have been obtained in this study from the Upper Devonian and Lower Carboniferous succession in north Devon. The miospore assemblages recorded have been assigned to the miospore zonation scheme of Higgs *et al.* (1988) which is summarised in Fig. 2. The samples were collected at various levels throughout the Baggy and Lower Pilton Formations and from the basal part of the Upper Pilton Formation from sections at Croyde Bay/Baggy Point and at Fremington Pill (Fig. 1). The aim of this work is to establish a palynostratigraphic database for the two formations, and hence accurately place the boundary between the Devonian and Carboniferous Systems. The composition of the miospore assemblages obtained from the samples are outlined below, and the occurrence of the various miospore taxa recorded is illustrated in Fig. 5.

4.1.- CROYDE BAY

Of the miospore assemblages recorded, six are from the Baggy and Lower Pilton Formations exposed on the north side of Croyde Bay, and from an outcrop in the centre of Croyde Beach. The geographic and stratigraphic positions of the samples collected from this section are shown in Fig. 3.

***Retispora lepidophyta - Knoxisporites literatus* (LL) Biozone**

The lowermost sample, CR 4, was obtained from a grey mudstone, immediately north of Baggy Point, approximately 20m above the base of the Baggy Formation. The sample yielded a diverse and well preserved miospore assemblage which is assigned to the LL Biozone. The assemblage is dominated by *Retispora lepidophyta* (approximately 40%) and the *Diducites* group (25%). The zonal species *Knoxisporites literatus* accounts for approximately 4.5% of the asemblage.

CR 9 was collected from a dark grey mudstone from an outcrop along a cliffside path, approximately 40m below the top of the Baggy Formation. A diverse and abundant miospore assemblage was recorded and the sample is assigned to the LL Biozone. *Retispora lepidophyta* and *Rugospora radiata* dominate the assemblage, accounting for approximately 37% and 14% (respectively) of the overall composition. Other abundant taxa include *Crassispora catenata* (9%), *Diducite*s versabilis (8%) and *Knoxisporites literatus* (5%).

***Retispora lepidophyta - Hymenozonotriletes explanatus* (LE) Biozone**

The lowest recorded LE Biozonal assemblage was obtained from sample CR 10 which was collected from a level approximately 6m below the Grand *Slump* (the upper boundary of the Baggy Formation).

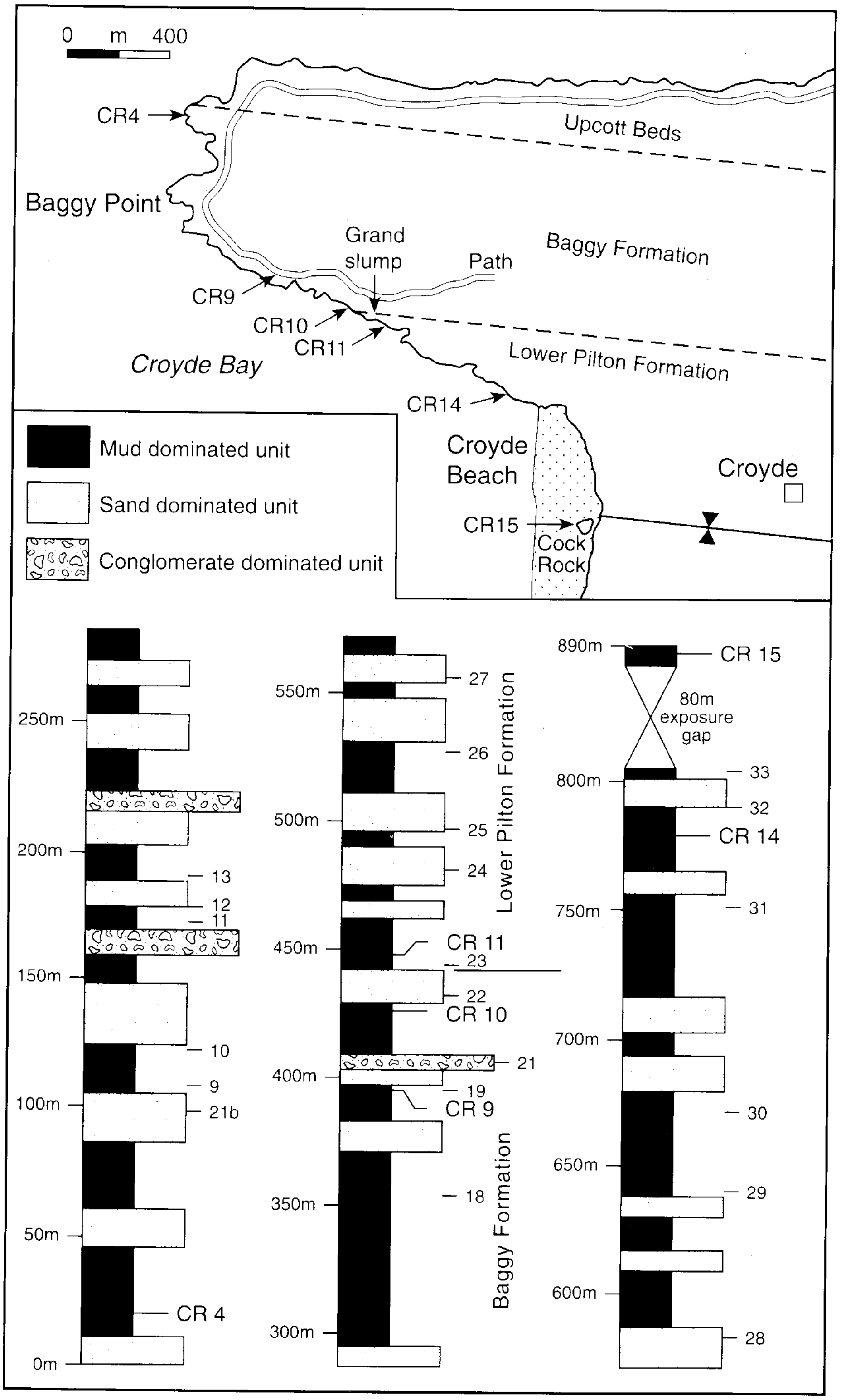

Fig. 3.- Geographical and stratigraphical positions of samples obtained from the Croyde Bay section in this investigation and by Dolby (1970a, 1970b). CR4-CR15 : Samples investigated in this study; 21b-33 : SamplesDolby (1970a, 1970b).

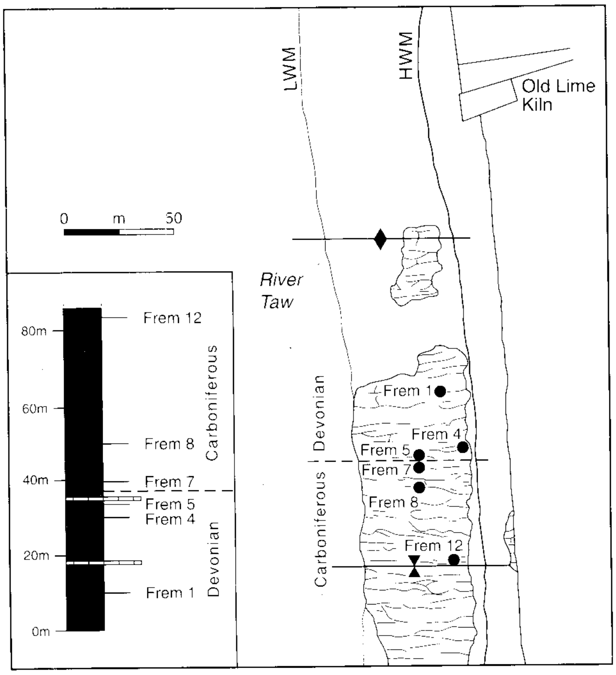

Fig. 4.- Locations of samples collected from the section at Fremington Pill, north Devon.A well preserved and compositionally diverse miospore assemblage was obtained, and among the most common miospore taxa present are *Retispora lepidophyta* (35-40%), *Diducites* spp. (13-15%), *Vallatisporites hystricosus* (7%) and *Crassispora catenata* (5%). *Hymenozonotriletes explanatus* is rare forming only approximately 1.5% of the assemblage. The rare occurrence of this zonal miospore taxon suggests that the sample may lie close to the base of the LE Biozone.

Sample CR 11 was obtained from the base of the Lower Pilton Formation, approximately 8m above the *Grand Slump*. The sample yielded a typical and diverse LE miospore assemblage, dominated again by *Retispora lepidophyta* which formed approximately 45% of the assemblage. Other miospore taxa that are common include *Vallatisporites hystricosus* (10%), *Vallatisporites pusillites* (8%) and *Raistrickia variabilis* (8%). *Hymenozonotriletes explanatus* was again quite rare (3%).

The highest LE miospore assemblage recorded in this section is from sample CR 14, collected from a dark grey mudstone approximately 335m above the base of the Lower Pilton Formation, some 30m below the top of the exposed section on the north side of the beach. The zonal species *Retispora lepidophyta* and *Hymenozonotriletes explanatus* are the most abundant species present, forming approximately 45% and 13% of the assemblage. The assemblage also contains significant amounts of the taxa *Rugospora radiata* (10%), *Densosporites spitzbergensis* (7%) and *Diducites* spp. (10%). The species *Vallatisporites verrucosus* first appears in this assemblage.

Retispora lepidophyta - Verrucosisporites *nitidus* (LN) Biozone

A single LN miospore assemblage was obtained from the Lower Pilton Formation at Croyde Bay. The sample (CR 15) was collected at Cock Rock, which is situated in the centre of Croyde Beach near the core of a major syncline. The sample yielded a fairly diverse but rather poorly preserved miospore assemblage, dominated by the zonal species *Retispora lepidophyta* and *Verrucosisporites nitidus* which account for an estimated 25% and 13% respectively of the miospore assemblage. Other common taxa include *Diducites* spp. (15%), *Cymbosporites minutus* (6%) and *Hymenozonotriletes explanatus* (5%).

4.2.- FREMINGTON PILL

The remaining six samples investigated from the Devonian-Carboniferous transition sequence in north Devon were obtained from the lower 80m of the poorly exposed section at Fremington Pill. It was not possible to place these samples on a measured lithological log as unfortunately none was available at that time. However, by measuring from a disused lime kiln on the northern end of the section, the samples were accurately located on a detailed geological map which was kindly supplied to the author by Dr. R. Goldring. It is not certain whether the exposed section contains the boundary between the Lower and Upper Pilton Formation, although Williams (1970) regarded this exposure as being "essentially an Upper Pilton locality". Nonetheless, the exposure at Fremington Pill is extremely important as it was at this locality that Goldring (1970) first identified the Devonian-Carboniferous boundary in north Devon. The geographical locations of the samples are shown in Fig. 4 and accompanying this figure is a generalised lithological log indicating the relative positions of the collected samples.

Retispora lepidophyta - Verrucosisporites nitidus (LN) Biozone

Three of the miospore assemblages recorded are assigned to the LN Biozone. The lowest of these, sample Frem 1, was obtained from a brown-grey mudstone at the base of the continuous exposure, approximately 122m south of the old lime kiln. The sample yielded a diverse and well preserved miospore assemblage in which both zonal species, *Retispora lepidophyta* and *Verrucosisporites nitidus* are present. It is therefore assigned to the LN Biozone. The assemblage is dominated by *R.*

Miospore Taxa / Sample	CR 4	CR 9	CR 10	CR 11	CR 14	CR 15	Frem 1	Frem 4	Frem 5	Frem 7	Frem 8	Frem12
Apiculiretusispora fructicosa		●			●	●	●	●	●			
Auroraspora asperella							●					
Auroraspora curvatura	●											
Auroraspora macra	●	●	●	●	●		●	●		●		●
Auroraspora solisortus				●	●			●	●	●	●	
Bascaudaspora collicula	●		●		●	●	●			●	●	
Calamospora liquida					●						●	
Convolutispora caliginosa		●			●	●			●		●	
Convolutispora major										●	●	
Corbulispora cancellata		●			●				●			
Crassispora catenata	●	●	●	●	●		●		●			
Cymbosporites minutus	●		●	●	●	●	●	●	●			
Cyrtospora cristifer							●	●			●	●
Densosporites spitzbergensis				●		●			●			
Diducites mucronatus	●		●	●	●	●	●	●	●			
Diducites plicabilis	●		●	●	●	●		●				
Diducites poljessicus		●		●	●	●						
Diducites versabilis	●	●	●	●	●	●		●	●			
Discernisporites micromanifestus	●		●			●			●			
Emphanisporites rotatus						●			●			
Endoculeospora gradzinskii	●	●	●	●	●		●	●	●			●
Grandispora cornuta		●			●			●	●			
Grandispora echinata					●							
Hymenozonotriletes explanatus			●	●	●	●	●	●	●			
Knoxisporites literatus	●	●			●				●			
Lophozonotriletes concentricus	●	●	●	●	●		●	●	●		●	
Lophozonotriletes curvatus	●		●	●	●	●	●		●	●	●	
Plicatispora scolecophora							●	●			●	●
Punctatisporites irrasus	●	●		●			●		●	●		
Punctatisporites minutus	●		●	●	●	●	●	●	●	●	●	●
Punctatisporites planus										●	●	●
Pustulatisporites dolbii		●		●	●	●	●		●			
Raistrickia minor	●	●		●	●				●			
Raistrickia variabilis		●		●	●	●			●			●
Retispora lepidophyta	●	●	●	●	●	●	●	●	●			
Retusotriletes crassus		●	●			●						●
Retusotriletes incohatus	●	●	●	●	●	●	●	●	●	●	●	●
Retusotriletes planus					●	●	●			●	●	
Retusotriletes triangulatus	●	●	●		●							
Rugospora radiata		●	●	●	●		●					
Rugospora granulatipunctata		●					●			●		
Spelaeotriletes crenulatus	●	●	●	●	●	●	●		●	●	●	
Spelaeotriletes? cumulus							●		●			●
Spinozonotriletes saurotus		●	●		●							
Tumulispora malevkensis									●			●
Vallatisporites hystricosus	●		●	●	●		●		●			
Vallatisporites pusillites	●	●		●	●	●						
Vallatisporites verrucosus					●					●		
Velamisporites caperatus							●	●	●			
Verrucosisporites nitidus						●	●	●	●	●	●	●
Verrucosisporites oppressus							●	●			●	
Verrucosisporites scurrus	●	●	●	●		●	●	●		●	●	●

Fig. 5.- Composition of the miospore assemblages recorded in this study.

lepidophyta (33%), *Crassispora catenata* (10%), *V. nitidus* (10%), *Vallatisporites hystricosus* (7%) and Hymenozonotriletes explanatus (6%). The first appearance of *Cyrtospora cristifer* is recorded in this assemblage.

Sample Frem 4 was collected from a grey mudstone 26m above Frem 1, approximately 148m south of the disused lime kiln. The assemblage recorded is rather poor and limited in diversity although the majority of the characteristic miospore taxa are present. The assemblage is dominated by the two zonal forms *Retispora lepidophyta* and *Verrucosisporites nitidus*. These account for approximately 26% and 12% of the assemblage, respectively.

The highest LN Biozonal assemblage recorded is from sample Frem 5, which was obtained 50cm below a thin limestone bed approximately 152.2m south of the lime kiln. The sample yielded a diverse and abundant miospore assemblage (approximately 30 species) typical of the LN Biozone. Among the most commonly occurring taxa in the assemblage are the zonal species *Retispora lepidophyta* (44%) and *Verrucosisporites nitidus* (9%). Other abundant forms include *Diducites* versabilis (13%), *Tumulispora malevkensis* (8%) and *Corbulispora cancellata* (7%).

***Vallatisporites verrucosus* - *Retusotriletes incohatus* (VI) Biozone**

In all, three VI Biozonal assemblages were obtained from samples collected from the succeeding 50m of the Pilton Formation. Sample Frem 7 is from a grey mudstone 4.7m above the previously mentioned thin limestone bed, approximately 156.9m south of the lime kiln. This sample yielded a poor and compositionally restricted (approximately 14 species) miospore assemblage. The assemblage is composed primarily of simple laevigate forms. Notably the index species *Retispora lepidophyta* is absent as are *Vallatisporites hystricosus* and species of the *Diducites* complex. The sample is therefore assigned to the basal Carboniferous VI Biozone. The assemblage is dominated by the genera *Retusotriletes* and *Punctatisporites* which account for 35% and 26% of the miospore content, respectively.

Sample Frem 8 was obtained from a dark grey mudstone approximately 166.8m south of the disused lime kiln. The miospore assemblage is also poor and limited in composition and is again assigned to the VI Biozone. The assemblage is dominated by the genus *Retusotriletes* (40%) and the taxon *Verrucosisporites nitidus* (11.5%).

The highest VI assemblage obtained in this section is from sample Frem 12. This was collected from a thick mudstone unit 35.5m above sample Frem 8, approximately 202.3m south of the lime kiln. Again the miospore assemblage is poorly preserved, limited in composition and typical of a VI Biozonal assemblage. The assemblage is dominated by the laevigate genera *Punctatisporites* and *Retusotriletes* which form approximately 28% and 23% of the assemblage, respectively.

5.- CONCLUSIONS

1. This present study records the detailed sequence of the miospore biozones from the Baggy and Pilton Formations in the north Devon area. In particular, it provides an accurate placement of the Devonian-Carboniferous boundary at Fremington Pill.

2. This new data shows that the Baggy Formation ranges in age from the Upper Devonian ('Strunian') LL - LE Biozones, with the lowermost LE Biozonal assemblage recorded from a level approximately 6m below the top of the Baggy Formation . The Lower Pilton Formation at Croyde Bay ranges in age from the LE Biozone to the base of the LN Biozone.

3. The samples investigated from the Upper Pilton Formation at Fremington Pill show a change in the palynoflora from Uppermost Devonian LN Biozonal age to Basal Carboniferous VI Biozonal age. The Devonian-Carboniferous boundary can therefore be located within a 5.6m interval between samples Frem 5 and Frem 7. This interval corresponds well with initial positioning of the boundary by Goldring (1970) using macrofaunal evidence.

An attempt was made to further refine the boundary. A fresh sample was obtained from the thin limestone bed which lies between the two critical samples. This was sent for micropalaeontological analysis to Dr. Roland Dreesen. Unfortunately, the conodonts recorded were stratigraphically long ranging and not diagnostic.

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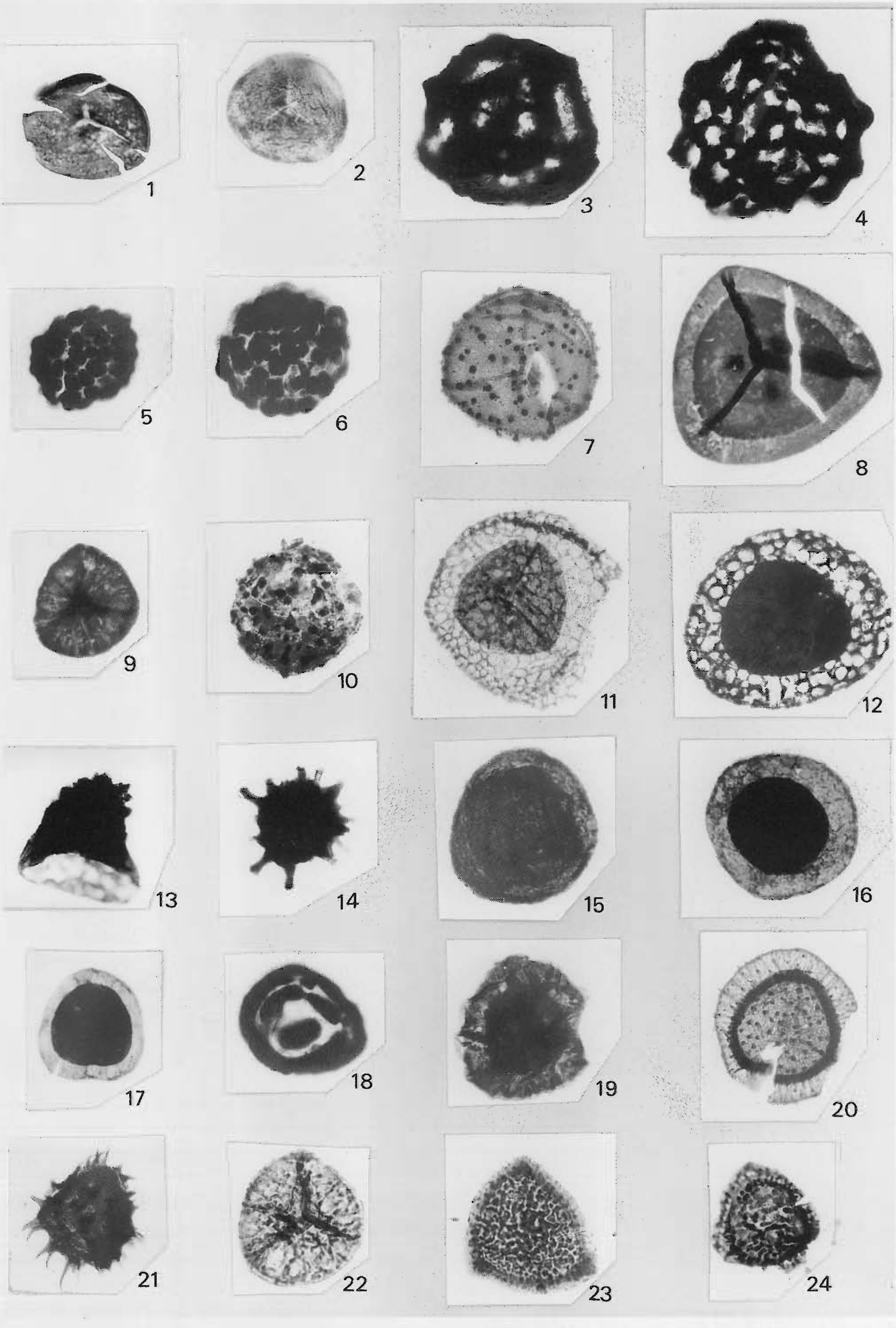
PLATE 1

All illustrations are at x 500 magnification, unless otherwise stated. Each specimen is referenced by: sample number, slide number (in parentheses) and slide co-ordinates. The latter obtained using an England finder. The palynological organic material was logged on a Nikon Optiphot microscope.

All figured specimens are housed in the Palynology Collection, Department of Geology, University College Cork, Ireland.

1.	*Retusotriletes triangulatus,*	CR 10 (1), J17/4	13.	*Cyrtospora cristifer,*	Frem 4 (2), L15/1
2.	*Plicatispora scolecophora,*	Frem 1 (1), V31/1	14.	*Raistrickia minor,*	CR 4 (2), Q35/3
3.	*Knoxisporites literatus,*	CR 9 (2), A28/1	15.	*Diducites poljessicus,*	CR 9 (1), O23/1
4.	*Corbulispora cancellata,*	CR 9 (2), B18/2	16.	*Diducites mucronatus,*	CR 4 (2), L9/4
5.	*Verrucosisporites nitidus,*	Frem 5 (1), A16/4	17.	*Auroraspora macra,*	CR 10 (2), S15/1
6.	*Verrucosisporites nitidus,*	Frem 1 (2), U10/2	18.	*Tumulispora malevkensis,*	Frem 5 (1), V16/3
7.	*Grandispora echinata,*	CR 14 (3), M9/4	19.	*Diducites versabilis,*	CR 4 (1), L27
8.	*Discernisporites micromanifestus,*	CR 4 (1), R15/4	20.	*Hymenozonotriletes explanatus,*	Frem 1 (1), P9/2
9.	*Emphanisporites rotatus,*	CR 15 (3), A26/2	21.	*Spinozonotriletes saurotus,*	CR 14 (1), S8/1
10.	*Pustulatisporites dolbii,*	Frem 5 (2), Q8/2	22.	*Rugospora radiata,*	CR 9 (3), R18/1
11.	*Retispora lepidophyta,*	CR 4 (1), Q28/1	23.	*Vallatisporites verrucosus,*	Frem 7 (1), Q21/3
12.	*Retispora lepidophyta,*	CR 10 (1), F24/2	24.	*Vallatisporites verrucosus,*	Frem 7 (1), R7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