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PALYNOLOGICAL EVIDENCE FOR THE AGE OF THE LOWER PALAEOZOIC ROCKS OF SLIEVE AUGHTY, COUNTIES CLARE AND GALWAY

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ABSTRACT

The Lower Palaeozoic sequence of Slieve Aughty is divided into five formations and evidence from rare graptolites and poorly preserved acritarchs is used to date them as follows Toberelatan Formation, Upper Llandeilo - Lower Caradoc, *gracilis* (? *peltifer*) Zone, Caher Hill Formation, ? Upper Llandeilo to Lower Caradoc, *peltifer* (? *gracilis*) Zone, Gortnagleav Formation, undated (? Mid-Caradoc to ? Late Llandovery), Derryfadda Formation, Late Llandovery (? *crispus* Zone) to ? Upper Wenlock, Killanena Formation, Late Llandovery to ? Upper Wenlock.

Correlation with the adjacent inliers of Slieve Bernagh, Broadford Mountains, Cratloe Hills and Slieve Arra is suggested

1. Introduction

Slieve Aughty is situated in the west of central Ireland about 35km south-east of Galway (Fig 1). The area lies within sheets 115, 124 and 125 of the one inch Geological Survey maps.

The only detailed account of the area was published by Kinahan (1863, 1865) who divided the rocks into the 'Llandeilo' and 'Bala' of the 'Lower Silurian'. Revised maps were published by Kilroe in 1901 and the strata were assigned by him to the 'Lower Silurian' ('Bala') and Upper Silurian (Llandovery). Subsequent maps and references placed the strata in the Ordovician and Silurian (e.g Harper 1948, Cocks *et al* 1971).

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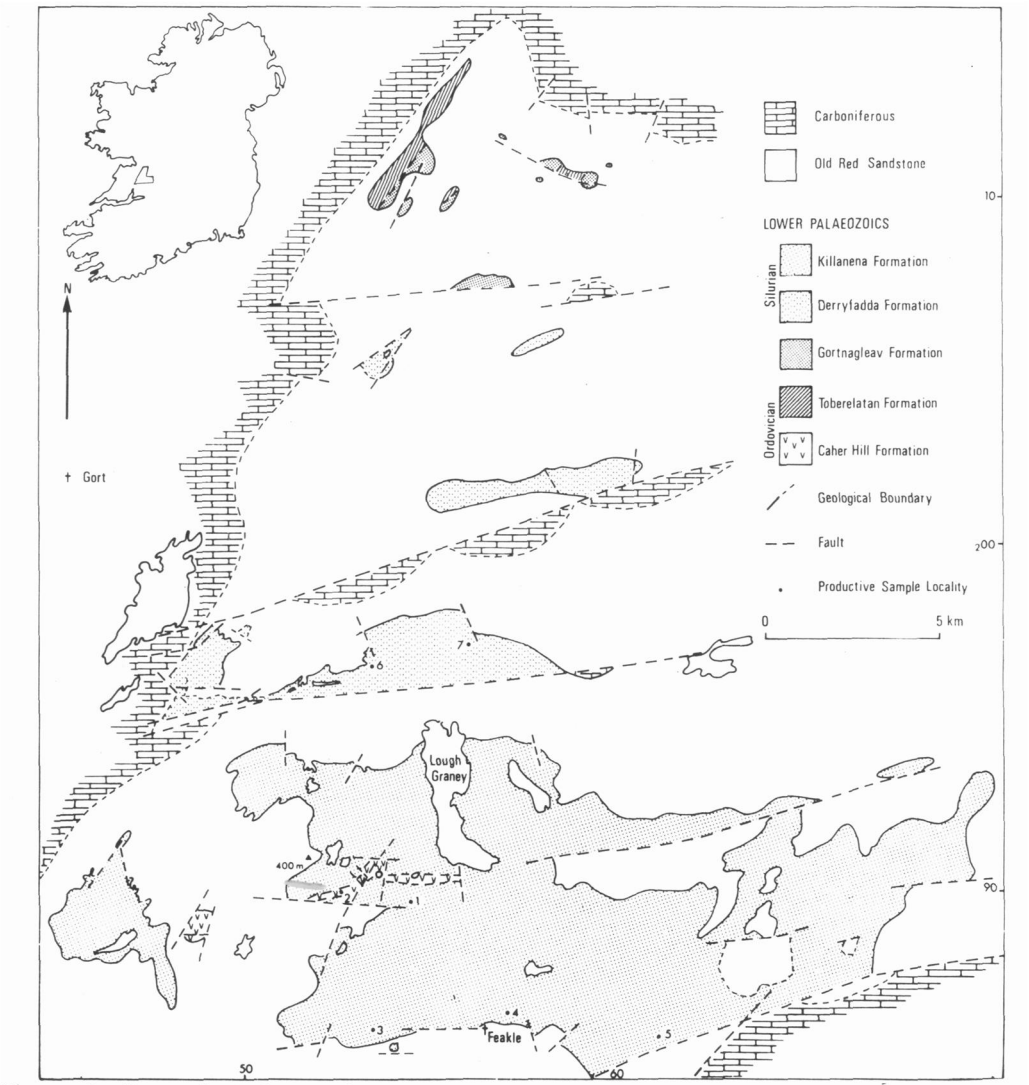

Fig. 1 – Outline geological map of Slieve Aughty inliers, showing collecting localities referred to in the text and in Table 1.

The area was mapped by one of the present authors (G.T.E.) resulting in the setting up of five formations as follows:

		North	South
Silurian	—	Derryfadda Formation >2,500m	Killanena Formation >3,000m
		Gortnagleav Formation >650m	
Ordovician	—	Toberelatan Formation c.120m	Caher Hill Formation c.670m

The distribution of these divisions is shown in Fig. 1. Detailed descriptions of the formations are outside the scope of the present paper and only a brief summary of each formation is given here.

2. Lithostratigraphy

TOBERELATAN FORMATION

This formation consists of interbedded grey and black cherts, siltstones, mottled siltstones, shales and occasional thin tuffaceous horizons. A poorly preserved graptolite fauna of *gracilis* (? *peltifer*) Zone age is present in the shales.

CAHER HILL FORMATION

These rocks, which are in fault contact with the Killanena Formation, consist of basic tuffs and agglomerates, basaltic and trachytic lavas and grey cherts and shales. Graptolites belonging to the *peltifer* or top *gracilis* Zone are present in the shales.

GORTNAGLEAV FORMATION

The rocks of this unfossiliferous formation (green, thinly bedded mudstone, siltstone, mottled siltstone, greywacke sandstone and minor thin lavas) are faulted against the Toberelatan Formation. The sandstones are generally fine grained but a few medium to coarse grained beds are found near the top of the formation.

DERRYFADDA FORMATION

This thick (> 2,500m) formation consists of green, medium to coarse grained proximal turbidites interbedded with siltstones and mudstones. Granule grade conglomerate forms the channelled bases to some of the thicker bedded turbidite units.

Structurally the beds young north, dip south and are transected by a number of strike faults. Graptolites of a low *griestoniensis* Zone age have been found in banded siltstones at one locality (Loc. 7, Fig. 1).

KILLANENA FORMATION

These rocks are generally thinner bedded and finer grained than those of the Derryfadda Formation and consist of fine to medium grained, grey-green greywackes with interbedded laminated and cross-laminated fine sandstone, siltstone and mudstone. The beds, inverted to the north, contain a number of slump features and strike faults. Macrofossils are absent. Old Red Sandstone, faulted against the Derryfadda Formation in the north, outcrops between it and the Killanena Formation. The fault is interpreted as a probable Lower Palaeozoic strike fault reactivated in post-Carboniferous times and is taken tentatively as the structure which separates the two formations.

The scarcity of macro-fossils especially from the last three formations prompted the search for microfossils which might provide the means for dating this poorly fossiliferous sequence Palynological methods have been used with considerable success for dating thick unfossiliferous sequences elsewhere in Ireland (e g Downie and Tremlett 1968, Gardiner and Vanguestaine 1971, Bruck, Potter and Downie 1974, Colthurst and Smith, 1977)

3. Palynology

Samples for palynological processing were collected from a scatter of Lower Palaeozoic outcrops in the Slieve Aughty area Suitable lithologies (grey siltstones and mudstones) are not commonly found, twenty-six samples altogether were prepared by standard techniques and of these only eight yielded useful microfossils Solution of the

TABLE 1 – Lithology, locality and preparation method for eight productive samples from the Lower Palaeozoic rocks of Slieve Aughty

Formation	Preparation No Locality (Fig. 1) Grid Reference	Lithology and Preparation
Killanena	115 Loc 1 R 15491899	Lith. Black slate Prep HF, HCl, 2.5 hr Schulze, Min sep., short centrifuging
	79 Loc 3 R15331862	Lith Dark grey crenulated silty shale Prep HCl, HF, Min sep
	75 Loc 4 R15761871	Lith. Tough, dark grey, silty slate Prep. HCl, HF, HCl, Min. sep.
	78 Loc. 4 R15761871	Lith Dark grey silty slate Prep HCl, HF, HCl, 2.5 hr Schulze, Min sep , short centrifuging
	113 Loc. 5 R16231860	Lith. Cleaved grey siltstone Prep HF, HCl, 2 5 hr Schulze, Min sep , short centrifuging
Derryfadda	116 Loc 6 R15361966	Lith Dark grey shale Prep HF, HCl, 2.5 hr Schulze, Min sep , short centrifuging
	117 Loc. 7 R15651972	Lith Thinly interbedded green and grey siltstone Prep. HF, HCl, short centrifuging
Caher Hill	83 Loc 2 R15291902	Lith Slightly crenulated grey shale Prep. HCl, HF, HCl, 1 hr Schulze, Min. sep., short centrifuging

TABLE 2 – Distribution of palynomorph taxa identified in eight palynological preparations

Taxa	Preparation no.	115	83	75	116	117	113	78	79
ACRITARCHA	Loc. no. (Fig.1)	1	2	4	6	7	5	4	3
ACANTHOMORPHITAE									
Ammonidium Lister						2			?1
Baltisphaeridium echinodermum St.&Will.						1			
B. nanum (Downie) emend. Lister			3			2			1
B. pilar Cramer									1
Diexallophasis Loeblich						1			1
Goniosphaeridium dentatum (Timofeev)		3							
G. sp. indet.		9							
Micrhystridium bacilliferum (Defl.)			6						
M. campoae Stock. & Will.		1							
M. eatonenseDownie			6						
M. nannacanthum Defl.		2	3				1		
M. parinconspicuum Defl.		12	24			4		1	
M. parveroquesi Stock. & Will.					1				
M. robustum Downie			2						
M. stellatum Defl.		15	9					1	1
Micrhystridium indet.		6							1
Multiplicisphaeridium digitatum (Eis.)		?							
M. indet.		4							
Priscogalea Deunff em.Rasul restr.		6							
Vulcanisphaera Deunff		3							
POLYGONOMORPHITAE									
Polygonium Vavrdova		3							
Striatotheca Burmann		1							
Veryhachium lairdii (Defl.)		2							
V. trisulcum Deunff		1						1	1
SPHAEROMORPHITAE									
Leiosphaeridia		+	+					+	
Lophosphaeridium Tim.emend. Lister		3			2				
L. citrinum Downie								2	1
L. parverarum Stock. & Will.			8		1				
NETROMORPHITAE									
Deunffia Downie					?1	8	14		
Domasia limaciforme (Stock. & Will.)						12			
D. trispinosa Downie						16	9		
Leiofusa spp. indet.						7	3		
Leiovalia Eisenack			3						
DIACROMORPHITAE									
Acanthodiacrodium spp. indet.		8	4						
A. sp. 1		1							
A. constrictum (Deunff)			1						
A. convexum Timofeev		1	1						
A. ignoratum (Deunff)		7	1						
A. cf. ubui Martin		1							
Coryphidium Vavrdova		2							
Lophodiacrodium Timofeev		2							
HERKOMORPHITAE									
Cymatiogalea Dff em.Dff,Gor.& Raus.		1							
C. cf.cristata(Downie)		1							
Stelliferidium Dff, Gorka & Rauscher		3							
Subgroup uncertain									
Moyeria uticaensis Thusu								15	2
MIOSPORES									
Ambitisporites avitus Hoffmeister				?	?6	1	5	4	6
A. dilutus (Hoffmeister)								8	4
CHITINOZOA									
Lagenochitina Eisenack					1				
Conochitina Eisenack							1	1	

rock matrix in hydrochloric and hydrofluoric acids, with a second treatment with hydrochloric acid to clear resulting fluoride crystals, was followed variously by oxidation in nitric acid or Schulze's solution (HNO_3 + $KClO_3$), heavy liquid (zinc bromide solution) separation of remaining minerals, and short centrifuging Permanent strew mounts, made with Clearcol and Depex on glass slides, are deposited in the Geology Museum, Trinity College, Dublin. Table 1 shows the lithology and locality for each of the productive samples, and gives a summary of the preparation method used in each case

The resulting organic residues were poor in palynomorphs, some samples yielded no organic residue at all The best yields, and best preserved acritarchs, came from a sample taken from a graptolite locality (Loc 7, Fig 1). All productive samples however were notable for yielding acritarchs and acritarch fragments of small size only (predominantly less than 30 microns) This could reflect either sorting during deposition or subsequent tectonic and metamorphic destruction of the larger cysts, or possibly an original absence of larger cysts.

Although the numbers of acritarchs found were small, their diversity was relatively high in some cases, and as many as possible have been identified or compared with previously described taxa in Table 2 It should be noted that the identifications are based on very low numbers of specimens which are often incomplete or otherwise poorly preserved The stratigraphical significance of the acritarch assemblages is discussed below Too few chitinozoa were recognised to be of any assistance in dating the assemblages A representative selection of the stratigraphically significant palynomorphs is illustrated in Plate I.

4. Discussion of palynological results

4.1 Toberelatan Formation

The one sample processed from this formation yielded no usable microfossils.

4.2 Caher Hill Formation

One sample was processed from this unit (preparation 83) and it yielded relatively well-preserved acritarchs These are, however, of rather little stratigraphic significance, comprising mainly simple acanthomorphs, predominantly of small size. Several species of *Micrhystridium* can be distinguished on the basis of size, shape and density of spines A few *Acanthodiacrodium* spp are present and, although more characteristic of Tremadoc to Llanvirn assemblages, they need not be inconsistent with the Llandeilo to Lower Caradoc age indicated by the graptolites for this formation Three specimens have been referred to *Leiovalia,* which is particularly characteristic of the late Ordovician

4.3 Gortnagleav Formation

Four samples from this formation were all completely unproductive We have, therefore, no palaeontological evidence for the age of this unit

4.4 Derryfadda Formation

Of six samples processed, two (preparations 116 and 117) yielded microfossils Preparation 116 contains very few recognisable palynomorphs, but these include a few

probable trilete miospores of *Ambitisporites* type. This is a genus which has been recorded elsewhere in Ireland from strata of early and mid Wenlock age (Smith 1975, Colthurst and Smith, 1977). Its first appearance in the Welsh Borderland is in the upper Llandovery (Fronian Stage, P. J. Hill, unpublished results).

Preparation 117 (Loc. 7, Fig. 1) contains a highly diagnostic assemblage characterised by *Deunffia* and *Domasia*. These two acritarch genera are restricted to strata of late Llandovery to Wenlock age. Hill (1974) has published detailed ranges for species of both genera in the type Llandovery area and in the Welsh Borderland. The species of *Domasia* (Pl. I, figs. 11, 12) identified here ranges from the Fronian Stage into the early Wenlock, but *Deunffia* does not occur in any abundance until the latest (Telychian) stage of the Llandovery. The acritarch assemblage in this preparation therefore indicates a late Llandovery (Telychian) to early Wenlock (Sheinwoodian) age. This is confirmed by the presence of graptolites at the collecting locality for preparation 117; they indicate a low *griestoniensis* Zone (Telychian) age.

4.5 Killanena Formation

This formation includes the greatest proportion of suitable lithologies for palynology. Thirteen samples were processed and five of these were productive. Four (preparations 75, 78, 79 and 113) give a consistent mid-Silurian date, but one (preparation 115) contains an assemblage of Tremadoc or Arenig age. Reasons for supposing that the latter have been reworked are given below.

Preparation 75 resembles preparation 116 from the Derryfadda Formation by containing very little apart from a few probable miospores, suggesting an Upper Llandovery or later age.

Preparations 78 and 79 (Locs. 4 and 3 respectively, Fig. 1) contain slightly more miospores than any of the other assemblages. The miospores are probably of two species of *Ambitisporites* (Pl. I, figs. 14, 15); they occur together with rare acanthomorph acritarchs and specimens of the distinctive acritarch *Moyeria*. This as yet monotypic genus was described by Thusu (1973) from New York State, from beds which he suggested on the basis of the palynomorphs are of similar age to the 'Wenlock Shale' (now the Buildwas and Coalbrookdale Formations; Bassett *et al.* 1975) of the Welsh Borderland. The specimens found in preparations 78 and 79 are mostly incomplete, but range in size between 21 and 36 microns, and show the characteristic criss-cross spiral striae of *Moyeria* (Pl. I, figs. 15-18). There is some resemblance also to *Eupoikilofusa cabottii* Cramer (e.g. Cramer 1970, Pl. IV, figs. 66, 67), but this species, which is known from late Llandovery to early Wenlock strata, is very much larger than *Moyeria*. The stratigraphical range of *Moyeria* is unknown as it has not been described previously from outside its type locality and a late Llandovery or early Wenlock age would be consistent with the available evidence from preparations 78 and 79.

Preparation 113 contains a *Deunffia-Domasia* assemblage similar to that discussed for the Derryfadda Formation and likewise indicates a Telychian to Sheinwoodian age.

Preparation 115 has yielded a very distinctive assemblage of acritarchs of Tremadoc and/or Arenig age, which conflicts with the provenance of the sample from which it came. Particularly characteristic is the association of diacromorphs with acritarchs of the *Priscogalea-Cymatiogalea-Stelliferidium* group. (*Priscogalea* is herein used in the sense of

Rasul (1974), but restricted to exclude forms referable to *Stelliferidium* Deunff, Gorka & Rauscher) The diacromorphs are represented principally by species of *Acanthodiacrodium* (Pl I, figs 2, 4) but also by *Lophodiacrodium* (Pl I, fig 3) and *Coryphidium* (Pl I, fig 6) Abundant and varied *Acanthodiacrodium* are found in rocks of Tremadoc age (e g Rasul and Downie 1974), and although the genus ranges into the Ordovician, all the species recognised here were first described from Tremadoc assemblages *Coryphidium* on the other hand is generally taken to be restricted to Arenig assemblages (e g Rauscher 1974). *Priscogalea, Cymatiogalea* and *Stelliferidium* (Pl I, figs 1, 7, 8) are also characteristically Tremadoc, but range into Arenig and possibly later strata The species identified here (*S simplex* and *C cristata*) are probably indicative of the Tremadoc (Rasul 1974) Of the acanthomorphs in preparation 115, *Vulcanisphaera* (Pl I, fig. 5) is restricted to Tremadoc and earlier assemblages, while abundant and varied *Micrhystridium* and *Goniosphaeridium* are probably more characteristic of Arenig and later assemblages The few polygonomorphs found are known elsewhere from both Tremadoc and Arenig assemblages, except for *Striatotheca* which is restricted to the Arenig and Llanvirn Series.

Preparation 115 appears therefore to contain an assemblage of mixed Tremadoc and Arenig aspect, it is possible from the available data from well-dated material elsewhere that all the taxa found could occur together around the Tremadoc-Arenig series boundary However, as the otherwise Silurian date for the Killanena Formation suggests that the entire assemblage is reworked, its precise age is of less importance

Reworking of late Cambrian and early Ordovician acritarchs is widespread in the British Isles, and has been recorded in assemblages of later Ordovician and Silurian age in Wales and the Welsh Borderland (Dr. C. Downie and others, University of Sheffield, unpublished results) and in Ordovician and Silurian assemblages from the Slievenamon inlier, Co Tipperary (Colthurst and Smith 1977)

5. Stratigraphical implications

Despite the small number of productive samples (eight from twenty-six) the presence of datable palynomorphs and macrofossils from all but one formation has added considerably to the knowledge of the age of the Lower Palaeozoic strata of Slieve Aughty The ages of the Toberelatan and Caher Hill Formations have been determined from their graptolite assemblages Palynomorph evidence from the Caher Hill Formation does not conflict with the graptolite fauna obtained from the same unit

The presence of medium to coarse grained turbiditic sandstones within the upper part of the undated Gortnagleav Formation points to lithological similarity with the Derryfadda Formation. Thus, for at least the top part of the Gortnagleav Formation, a late Llandovery age is suggested The presence of grey shales however (especially near its base) and thin lava flows suggests lithological comparison with the Toberelatan and Caher Hill Formations and a possible mid-Caradoc age for the lower part of the Gortnagleav Formation may be suggested.

The palynomorphs obtained from the Derryfadda Formation (Locs 6, 7) agree with the low *griestoniensis* Zone age obtained from the graptolites of Loc 7. The beds of the formation young to the north structurally but it has not been proved that this is true stratigraphically For instance, in the Lower Palaeozoic strata of the Southern Uplands

of Scotland and in the Longford-Down Massif, strike faults separate a succession of units within each of which the beds young to the north, but the sedimentary pile as a whole youngs to the south (Phillips, Stillman and Murphy 1976). Small scale strike faults down-throwing to the south have been observed but their presence on a large scale has not been proved due to the repetitive lithologies and lack of marker horizons within the formation. In any case, at least 300m and probably 600m of strata outcrop stratigraphically below Locality 6 (Fig. 1) and this part of the formation may be of an earlier (? *crispus* Zone) age.

The late Llandovery or early Wenlock age for the Killanena Formation suggests that it is, in part at least, equivalent in age to the Derryfadda Formation. The two formations are interpreted as being probable lateral facies equivalents; the Derryfadda Formation being composed largely of proximal turbidites while both proximal and distal turbidites are present in the Killanena Formation. The palynomorphs have been obtained from the lowest exposed part of the formation. The presence of strike faults (cf. Derryfadda Formation) and the fact that the base is not seen, however, suggests that there may be parts of the formation older than the late Llandovery - early Wenlock.

6. Correlation and conclusions

The results allow more confident speculation than was previously possible on the relationships of the inlier to adjacent Lower Palaeozoic sequences.

A provisional correlation of the rocks of the adjacent inliers of Slieve Bernagh, Broadford Mountains, Cratloe Hills, and Slieve Arra (Weir 1962, 1973, 1975; Rickards and Archer 1969) is presented (Table 3). Further investigation of these areas is currently being conducted by Dr. A. Flegg of the Irish Geological Survey and a more precise correlation of these rocks must await his revised lithological descriptions.

Rocks of the *gracilis* and *peltifer* Zones are present at Tomgraney in Slieve Bernagh (Rickards and Archer 1969) and in the Belvoir Group of the Broadford Mountains (Weir 1962, 1973). Weir described the presence of ashy sandstones of probable *gracilis* Zone age in the Broadford Mountains which suggests lithological correlation with the Caher Hill Formation.

The *wilsoni, clingani, linearis* and *complanatus* Zones are represented in the Ballyvorgal Group of the Broadford Mountains (Weir 1962, 1973). The *acuminatus, vesiculosus* and *turriculatus* Zones are present at Tomgraney (Rickards and Archer 1969). Mottled siltstone and shale of *crispus* Zone age have been recorded from elsewhere in Slieve Bernagh by Dr. A. Flegg (pers. comm.) who considers that the *gracilis* to *crispus* Zones are represented in rocks of mudstone or shale facies. Mottled siltstones occur in both the Toberelatan and Gortnagleav Formations. In the former the sediments are associated with grey and black cherts and shales; in the latter the association is green and grey siltstones and shale. A similar association is seen in Slieve Bernagh. The grey and green siltstone and shale association are of a *crispus* Zone age and this may suggest a similar age for the Gortnagleav Formation.

The earliest turbidites in Slieve Bernagh and Broadford Mountains (Cloontra and Broadford Groups) appeared within the *crispus* Zone and continued into the late Wenlock (Weir 1962, 1973, 1975). In the Lough Acanon (Phillips and Skevington 1968)

TABLE 3 – Suggested correlation of Lower Palaeozic formations of Slieve Aughty with standard stratigraphical scale, and with neighbouring areas

	GRAPTOLITE ZONES	Slieve Aughty North	Slieve Aughty South	Slieve Bernagh	Broadford Mountains	Cratloe Hills	Slieve Arra
WENLOCK	*ludensis*			Craglea and Moylussa Groups	Craglea and Moylussa Groups	Craglea and ?Moylussa Groups	Craglea and Moylussa Groups
	lundgreni						
	ellesae			c. 6,000 m	c. 6,000 m	c. 1,326 m	?
	linnarssoni	?---?	?---?				
	rigidus						
	murchisoni			Broadford Group c. 2,000 m	Broadford Group c. 2,000 m	Broadford Group c. 650 m	Broadford Group c. 2,000 m
	centrifugus	Derryfadda Formation	Killanena Formation				
LLANDOVERY	*crenulata*	c. 2,500 m	c. 3,000 m				
	griestoniensis	?---?	?---?	Mottled siltstone ? ?	Cloontra Group c. 300 m		
	crispus						
	turriculatus						
	maximus			Grey shale Fm. 79 m			
	sedgwicki						
	convolutus			faulted contact		not seen	not seen
	gregarius				faulted contact		
	cyphus						
	vesiculosus			Graptolitic shale Fm. 122 m			
	acuminatus						
	persculptus	? Gortnagleav Formation 650 m (age uncertain)	faulted contact				
ASHGILL	? *anceps*						
	complanatus			faulted contact	Ballyvorgal Group 74 m		
	linearis						
					non-sequence		
CARADOC	*clingani*			mottled siltstones and chert	Ballyvorgal Group 46 m		
	wilsoni	faulted contact					
	peltifer	?---?	?---?	C. peltifer Beds	Belvoir Group c. 580 m		
LLANDEILO	?---?	Toberelatan Formation c. 120 m	Caher Hill Fm. c. 670 m				
	gracilis			N. gracilis Beds 110 m			

and Shercock-Aghnamullen districts (O'Connor 1975) of the Longford-Down massif, turbidites arrived much earlier, in the *acuminatus* Zone Although Slieve Aughty was probably located about mid-way between these areas during the Lower Palaeozoic there is no stratigraphic evidence to suggest that turbidites arrived earlier than the *linspus* Zone

The Broadford, Craglea and Moylussa Groups which can be extended into Slieve Aira (Dr A Flegg, pers comm) are composed of conglomerates, greywackes, banded mudstones, siltstones and slates (Weir 1962) Although conglomerates and thick slates are apparently absent from the Slieve Aughty sucession the beds of the Killanena and Derryfadda Formations do have certain lithological similarities to those of the Broadford Group (feldspathic greywackes, banded mudstones and grits) and possible correlation is suggested Weir (1975) states that the late Wenlock conglomerates (Craglea Group) have been derived from the south-east while Dr A Flegg (pers comm) considers the sediments to have come from the northern quadrants A similar, northerly derivation occurs in Slieve Aughty and conglomerates could, therefore, be expected to be found there also. Microconglomerates do occur in the Derryfadda Formation and conglomerates could be present in the large exposure gaps If they do not occur it could mean that there is no equivalent to the Craglea Group in Slieve Aughty and that late Wenlock sediments are absent

The Moylussa Group, consisting of thick banded mudstone, overlies the Craglea Group A comparative lithology is not present in Slieve Aughty which again might suggest that late Wenlock sediments are absent or that a different facies was being deposited in the late Wenlock. As all suitable lithologies were sampled it is unlikely that further palynological work will provide the means for dating the upper parts of the Derryfadda and Killanena Formations.

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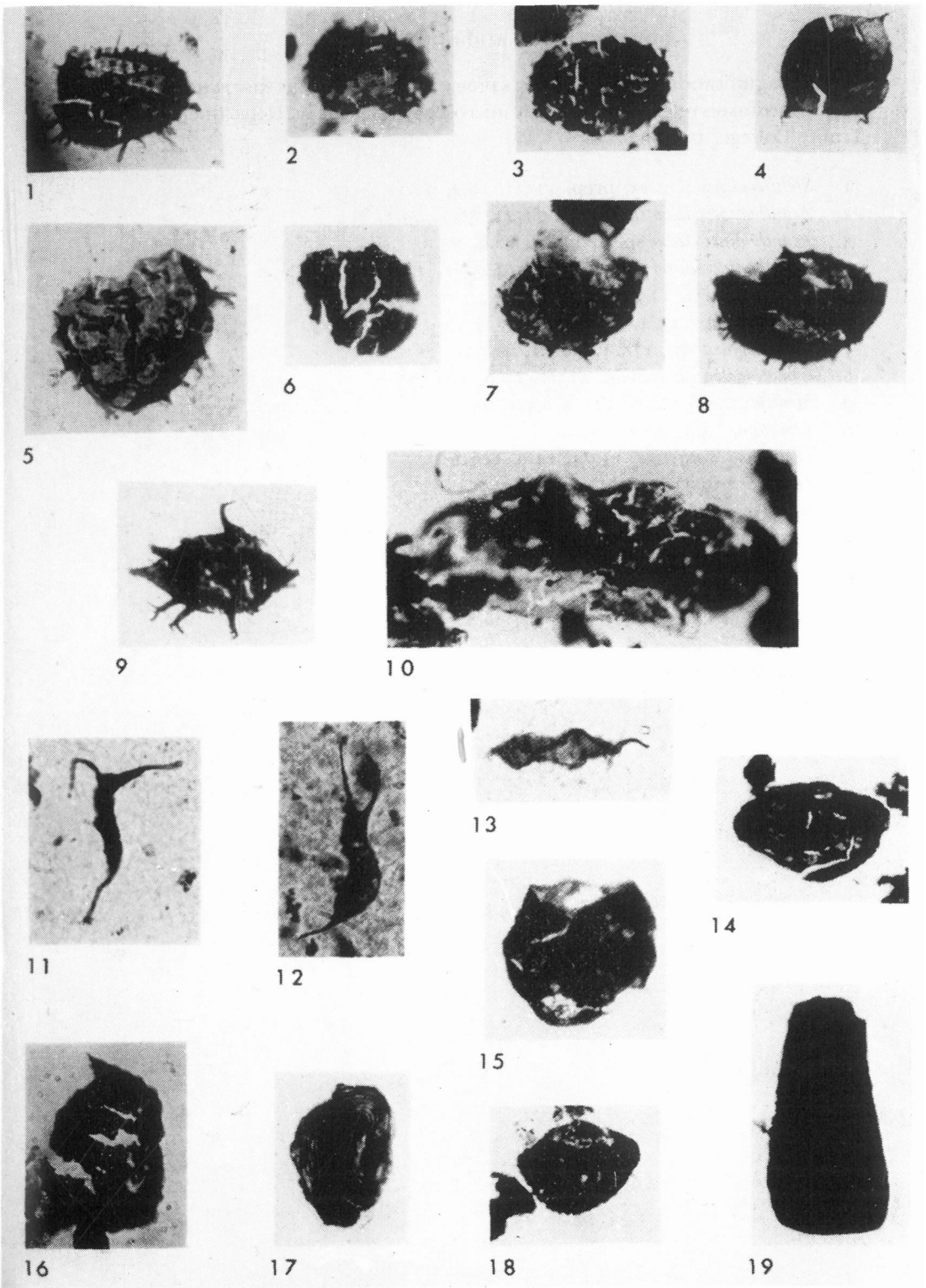

Explanation of Plate I

All magnifications approximately x1000 except where otherwise stated. Mechanical stage coordinates refer to Leitz Dialux microscope no 860412, Department of Geology, Trinity College, Dublin.

1. *Stelliferidium simplex,* prep 115/1, 16 2, 92 1
2. *Acanthodiacrodium ignoratum,* 115/1, 36 1, 99 5.
3. *Acanthodiacrodium* sp. 1, 115/4, 28.2, 95 9.
4. *Acanthodiacrodium convexum,* 115/4, 37.2, 101.3.
5. *Vulcanisphaera,* 115/1, 33.9, 102.2.
6. *Coryphidium,* 115/4, 33.8, 103.3.
7. *Cymatiogalea* sp., 115/4,4, 27.1, 91.5.
8. *Cymatiogalea* cf. *cristata,* 115/1, 22 8, 107.5
9. *Multiplicisphaeridium,* 115/4, 34.1, 95.8
10. *Leiovalia,* 83/1, 48.3, 107.9
11. *Domasia limaciforme,* 117/4, 24.0, 106.2
12. *Domasia trispinosa,* 117/5, 63.0, 94 5.
13. *Leiofusa,* 117/4, 57.1, 108 3
14. *Ambitisporites avitus,* 78/8, 53.7, 103.8
15. *Ambitisporites* (tetrad), 78/8, 58.0, 102 9.
16. *Moyeria* cf *uticaensis,* 78/8, 26.3, 104 6.
17. *Moyeria* cf. *uticaensis,* 79/2, 43.2, 96 8.
18. *Moyeria* cf. *uticaensis,* 78/8, 52.8, 100.8.
19. *Conochitina,* 78/8, 45 9, 101.1, x700.