PALYNOLOGY AND STRATIGRAPHY OF THE MUCH WENLOCK LIMESTONE FORMATION OF DUDLEY, CENTRAL ENGLAND.

by

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Summary

Acritarchs, chitinozoa and miospores have been studied from 18 samples collected stratigraphically from the Silurian Coalbrookdale Formation, Much Wenlock Limestone Formation and Elton Formation at Wren's Nest Hill, Dudley, West Midlands, Central England. All the palynomorphs are of low thermal maturation and are in general very well preserved. The acritarchs show a high taxonomic diversity. In addition, the lithostratigraphy of the Much Wenlock Limestone Formation is revised to include a Lower Quarried Limestone Member, a Nodular Member and an Upper Quarried Limestone Member.

Introduction

The Silurian rocks of Central England have long been known for their very well preserved macrofossils, particularly trilobites; the microfossils, including the organic walled acritarchs and chitinozoa, and hard conodonts and ostracods, are also particularly well preserved. Most of the fossil groups contain species rarely recorded elsewhere.

The main exposures of the Much Wenlock Limestone Formation in Central England occur in the Wren's Nest Inlier, just to the northwest of Dudley, where there are several disused quarries that provided the localities sampled. Butler (1938) described in detail the stratigraphy of the area, referring to the Much Wenlock Limestone Formation as the Wenlock Limestone or "Dudley" Limestone.

Several distinct groups of acritarch assemblages can be recognised; as the proportion of sphaeromorph acritarchs increase, so the species diversity of the assemblages tends to decrease.

Sample Details

The stratigraphical location of samples is recorded on text-fig. 1. The samples are described in stratigraphical order, WN1 at the base.

1. The codes (5Y 5/2) are rock colors according to the USGS color chart.

WN 1.	Light olive grey calcareous silty mudrock, 5Y 5/2, Coalbrookdale Formation, 1.5m from top of formation, Butler loc. 10.
WN 2.	Light olive grey calcareous mudrock, 5Y 5/1, Basement Beds, base of Butler unit a, Much Wenlock Limestone Formation, loc. 10.
WN 3.	Light olive grey silty limestone, 5Y 6/1, Basement Beds, middle of Butler unit b, Much Wenlock Limestone Formation, loc. 10.
WN 4.	Light olive grey silty limestone, 5Y 6/1, Basement Beds, Butler unit c, Much Wenlock limestone Formation, loc. 10.
WN 15.	Light grey limestone, N7, 'reef', 1.5m from base of Lower Quarried Limestone Member, Much Wenlock Limestone Formation, loc. 30
WN 16.	Medium grey limestone, N5, 'bedded', 2.0m from base of Butler unit d, Much Wenlock Limestone Formation, loc. 30.
WN 27.	Medium grey crinoidal limestone, N5, middle Butler unit d, Much Wenlock Limestone Formation, loc. 29.
WN 28.	Medium grey silty mudrock, N5, interbed between Butler units d and e, Much Wenlock Limestone

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pp. 31-40, 1 text-fig., plate 5-7.

Formation, loc. 29.

WN 19. Medium grey limestone, N5, Butler unit h, Much Wenlock Limestone Formation, loc. 30.

WN 5. Medium light grey silty limestone, N6, 2m from base of Nodular Member, Butler unit i, Much Wenlock Limestone Formation, loc. 8.

WN 6. Olive grey soft calcareous silty mudrock, SY 4/1, base Butler unit n, Nodular Member, Much Wenlock Limestone Formation, loc. 8.

WN 7. Medium grey silty limestone, N5, near base of Butler unit q, Nodular Member, Much Wenlock Limestone Formation, loc. 10.

WN 8. Medium grey silty limestone, N5, middle of Butler unit q, Nodular Member, Much Wenlock Limestone Formation, loc. 10.

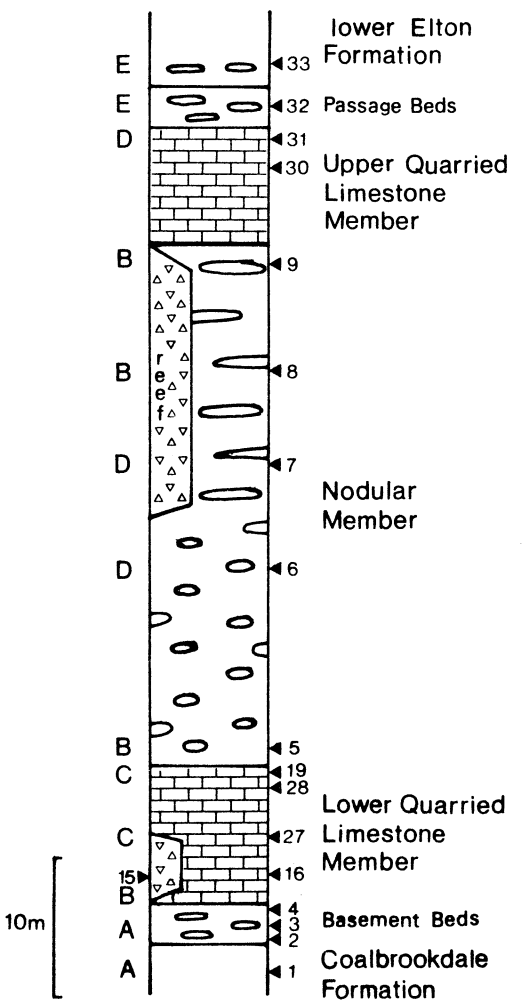
WN 9. Light olive grey silty limestone, 5Y 5/1, middle Butler unit r, Nodular Member, Much Wenlock Limestone Formation, loc. 10.

WN 30. Medium light grey limestone, N6, 1.0m from base of Butler unit t, upper limestone, Much Wenlock Limestone Formation, loc. 24.

WN 31. Medium grey silty limestone, middle Butler unit u, upper limestone, Much Wenlock Limestone Formation, loc. 24.

WN 32. Olive grey calcareous silty mudrock, 5Y 5/3, top of Butler unit v, Passage Beds, Much Wenlock Limestone Formation, loc. 24.

WN 33. Light olive grey silty mudrock, 5Y 5/1, 0.5m above top of Butler unit w, Elton Formation, loc. 24.



Text-fig. 1. Stratigraphical location of the samples

Palynology

Dorning (1981a, 1981b) has outlined the stratigraphical distribution of acritarchs and chitinozoa in the Wenlock of the Welsh Basin. The environmental distribution of Silurian acritarchs is presented in Dorning (1981c), and the general distribution of microfossils on the Welsh Basin shelf is detailed in Aldridge *et al.* (1981). Eisenack recorded acritarchs and chitinozoa from two spot samples from the Much Wenlock Limestone Formation of Dudley (Eisenack, 1977, 1978).

Table 1, lists the palynomorphs that have been recorded from the Much Wenlock Limestone Formations and see plates 5, 6 and 7:

ACRITARCHS

Ammonidium microcladum (Downie) Lister 1970
Ammonidium waldronense (Tappan and Loeblich) Dorning 1981
Cymatiosphaera octoplana Downie 1959
Cymatiosphaera pavimenta (Deflandre) Deunff 1958
Cymbosphaeridium eurnes (Cramer and Diez) Dorning 1981
Cymbosphaeridium gueltaense (Jardiné *et al.*) Dorning 1981
Dactylofusa neaghae Cramer 1970
Dateriocradus polydactylus Tappan and Loeblich 1971
Dateriocradus tribrachiata (Lister) Dorning 1981
Dictyotidium amydrum (Tappan and Loeblich) Diéz and Cramer 1977
Dictyotidium dictyotum (Eisenack) Eisenack 1955
Dictyotidium stenodictyum Eisenack 1955
Diexallophasis denticulata–granulatisphinosa group
Duvernayspaera aranaides Cramer 1964
Eisenackidium wenlockensis Dorning 1981
Electoriskos aurora Loeblich 1970
Estiastra granulata Downie 1963
Eupoikilofusa filifera (Downie) Dorning 1981
Eupoikilofusa striatifera (Cramer 1970
Florisphaeridium sp
Helosphaeridium pseudodictyum Lister 1970
Hoglintia ancyrea (Cramer and Diéz) Dorning 1981
Gloeocapsamorpha sp
Leiofusa banderillae Cramer 1964
Leiofusa parvitatis Loeblich 1970
Leptobrachion arbusculiferum (Downie) Dorning 1981
Lophosphaeridium citrinum Downie 1963
Lophosphaeridium sp
Melikeriopalla wenlockia Dorning 1981
Micrhystridium inflatum (Downie) Lister 1970
Wrensnestia ornata Dorning 1981
Micrhystridium intonsurans (Lister) Dorning 1981
Micrhystridium spp.
Multiplicisphaeridium arbusculum Dorning 1981
Multiplicisphaeridium cladum Downie 1963
Multiplicisphaeridium eltonensis Dorning 1981
Multiplicisphaeridium triangulatum (Downie) Dorning 1981
Multiplicisphaeridium variabile (Lister) Dorning 1981
Multiplicisphaeridium wrensnestensis Dorning 1981
Nanocyclopis sp.
Navifusa scrutilla Cramer and Diéz 1972
Onondagella sp.
Oppilatala insolita (Cramer and Diéz) 1981
Oppilatala ramusculosa (Deflandre) Dorning 1981
Psenotopus chondrocheus Tappen and Loeblich 1971
Pteropermella foveolata Lister in Dorning 1981
Pulvinosphaeridium pulvinellum Eisenack 1954
Quadratitum fantasticum Cramer 1964
Salopidium granuliferum (Downie) Dorning 1981
Salopidium wenlockensis (Downie) Dorning 1981
Schismatosphaeridium sp
Tunisphaeridium parvum Deunff and Evitt 1968
Tylotopalla robustispinosa (Downie) Eisenack, Cramer and Diéz 1973
Tylotopalla wenlockia 1968
Umbellaspheridium sp
Veryhachium rhomboidium Downie 1959
Veryhachium trispinosum (Eisenack) Cramer 1964 group
Veryhachium wenlockium Downie 1959 group
Visbysphaera dilatispinosa Downie 1963
Visbysphaera wenlockia (Thusu) Dorning 1963
Visbysphaera sp

CHITINOZOA

Ancyrochitina ancyrea (Eisenack) Eisenack 1955
Ancyrochitina gutnica Laufeld 1974
Ancyrochitina primitiva Eisenack 1964
Conochitina aff. *elegans* Eisenack 1931
Conochitina pachycephala Eisenack 1964
Conochitina tuba Eisenack 1932
Desmochitina acollaris Eisenack 1959
Linochitina cingulata (Eisenack) Eisenack 1968
Sphaerochitina aff. *dubia* 1968.

MIOSPORES

Ambitisporites dilutus (Hoffmeister) Richardson and Lister 1969

Taxonomic references for the acritarchs can be found in Cramer 1979 and Dorning 1981a, and for the chitinozoa, Laufeld 1974.

The stratigraphical distribution of selected acritarchs and chitinozoa is presented in text-fig. 2. Well established records from the Coalbrookdale Formation of the Welsh Borderland are shown as an arrow on the left margin, and records from the lower Elton Formation as an arrow to the right.

Some acritarch species range thoughout most samples from the top Coalbrookdale Formation to the base of the Elton Formation; *Diexallophsis* spp., *Leiosphaeridia* spp., *Micrhystridium intonsurans*, *Veryhachium trispinosum* and *Veryhachium wenlockium* are common, long ranging acritarchs; *Cymatiosphaera octoplana, Eupoikilofusa filifera, Leiofusa parvitatis, Onondagella* sp., *Pterospermella foveolata* are long ranging acritarchs that are not always found in large numbers.

Palynomorph assemblages

Some acritarch species are only recorded from the lowest samples, and are considered to have a top of range at about this stratigraphical level: *Cymatiosphaera pavimenta, Salopidium wenlockensis, Tylotopalla robustispinosa, Tylotopalla wenlockia,* and *Visbysphaera wenlockia*. Some species are only recorded in the highest samples, and are considered to have a base of range at about this stratigraphical level: *Multiplicisphaeridium eltonensis,* and *Psenotopus chondrocheus*.

Some acritarch species are recorded in both the lowest and highest samples, but not in the bulk of the Much Wenlock Limestone Formation: *Ammonidium waldronense, Eupoikilofusa striatifera, Helosphaeridium pseudodictyum, Salopidium granuliferum*. These species are considered to be distributed with greater abundance in environments that produced the calcareous mudrock of the Coalbrookdale and Elton Formations. The distribution is not apparently due to the high carbonate content of the rocks, but due to the environment of deposition, as adjacent samples with differing carbonate composition are known to contain similar assemblages, but of different abundances, the numbers per gram of rock reflecting the dilution at a rate depending on the carbonate percentage present.

Some acritarch species are only recorded from the main part of the Much Wenlock Limestone Formation: *Dictyotidium amydrum, Dictyotidium dictyotum, Dictyotidium stenodictyum, Estiastra granulata, Multiplicisphaeridium wrensnestensis, Pulvinosphaeridium pulvinellum* and *Wrensnestia ornata*. These species are considered to favour one or more of the environments that are reflected in the limestone deposition of the Much Wenlock Limestone Formation.

The acritarch assemblages in the samples can be placed into groups of similar composition, apparently reflecting different environments of deposition. Percentages quoted are of the total acritarchs.

Assemblage group 1: Species diversity 25–35 distinctive taxa. Two taxa are dominant, *Leiosphaeridia* 25–35%, *Micryhstridium intonsurans* 10–25%, together forming 40–50%. Other common taxa are *Ammonidium waldronense, Dieallophasis* spp., *Oppilatala ramusculosa, Veryhachium wenlockium* and *Veryhachium trispinosum*. Samples WN1, WN2 and WN3 are in this assemblage group. It is of note that several taxa show a progressive increase or decrease in abundance from WN1 through WN2 to WN3, which are three adjacent samples at about the base of the Much Wenlock Limestone Formation. This may reflect a changing environment, heralding the onset of the limestone deposition.

	WN1	WN2	WN3
Salopidium granuliferum	6%	8%	13%
Ammonidium waldronense	1%	2%	4%
Veryhachium wenlockium	9%	12%	15%
Veryhachium trispinosum	1%	5%	6%
Diexallophasis spp.	16%	12%	6%
Oppilatala ramusculosa	4%	3%	2%
Helosphaeridium pseudodictyum	3%	2%	1%
Muraticavea wenlockia	4%	2%	1%

Care has to be taken in interpretation of this data, as increasing percentage abundance may reflect a greater tolerance threshold for a different environment, rather than a preference for that environment. Sample WN28 is similar in many respects to this group, except that *Micrhystridium* forms 48% of the total. Samples WN32 and WN33 are also similar in many respects to this assemblage group, except that *Diexallophasis* forms 32–37%, and the species diversity is lower at 22–24 distinctive species.

Assemblage group 2 : Species diversity 18–25 distinctive taxa. Two taxa are dominant, *Leiosphaeridia* 28–60%, *Micryhstridium intonsurans* 6–35%, together forming 60-70%. *Salopidium granuliferum* is recorded at 1% or less. Samples WN4, WN16, WN5, WN8, WN9 are in this group.

Assemblage group 3 : *Leiosphaeridia* dominates at 65–90% of the total. Species diversity varies widely, but is typically between 12 and 25 distinctive species. *Pulvinosphaeridium, Estiastra* and/or *Hogklintia* forms a significant part of the non sphaeromorph taxa, for example in WN27, WN19 *Pulvinosphaeridium* occurs at 2–3%, and in WN9 *Estiastra granulata* forms 7% and *Hogklintia ancyrea* 2%. Samples WN27, WN19, WN6, WN7, WN9 and WN31 are in this group.

Assemblage group 4: Species diversity very low, *Leiosphaeridia* totally dominates. *Gloeocapsamorpha* is often also present. Preservation is sometimes poor, probably due to a high oxygen potential at the time of deposition. Samples WN15 and WN30 are in this group. Low numerical abundance, high sphaeromorph percentage abundance assemblages have been recorded from reef limestones in the Welsh Borderlands and by D.G. Bell (pers.comm.) from Wenlock Edge.

Most of the chitinozoa recorded occur throughout the late Wenlock; *Ancyrochitina ancyrea* and *Conochitina* spp. were common throughout the section, but their abundances varied widely from sample to sample. *Ancyrochitina primitiva* appears to occur more frequently in the limestones than the calcareous mudrock. Both *Linochitina cingulata* and *Desmochitina accollaris* only occur in the lowest samples; it is probable they are close to the top of their ranges.

Only one miospore species was recorded. *Ambitisporites dilutus* together with other *Ambitisporites* species are by far the most common species recorded from the Wenlock. In the samples studied, the percentage abundance was always lower than 1% of the total palynomorphs. This suggests that the Wren's Nest Inlier was at some distance from land supporting miospore producing vegetation.

Lithostratigraphy

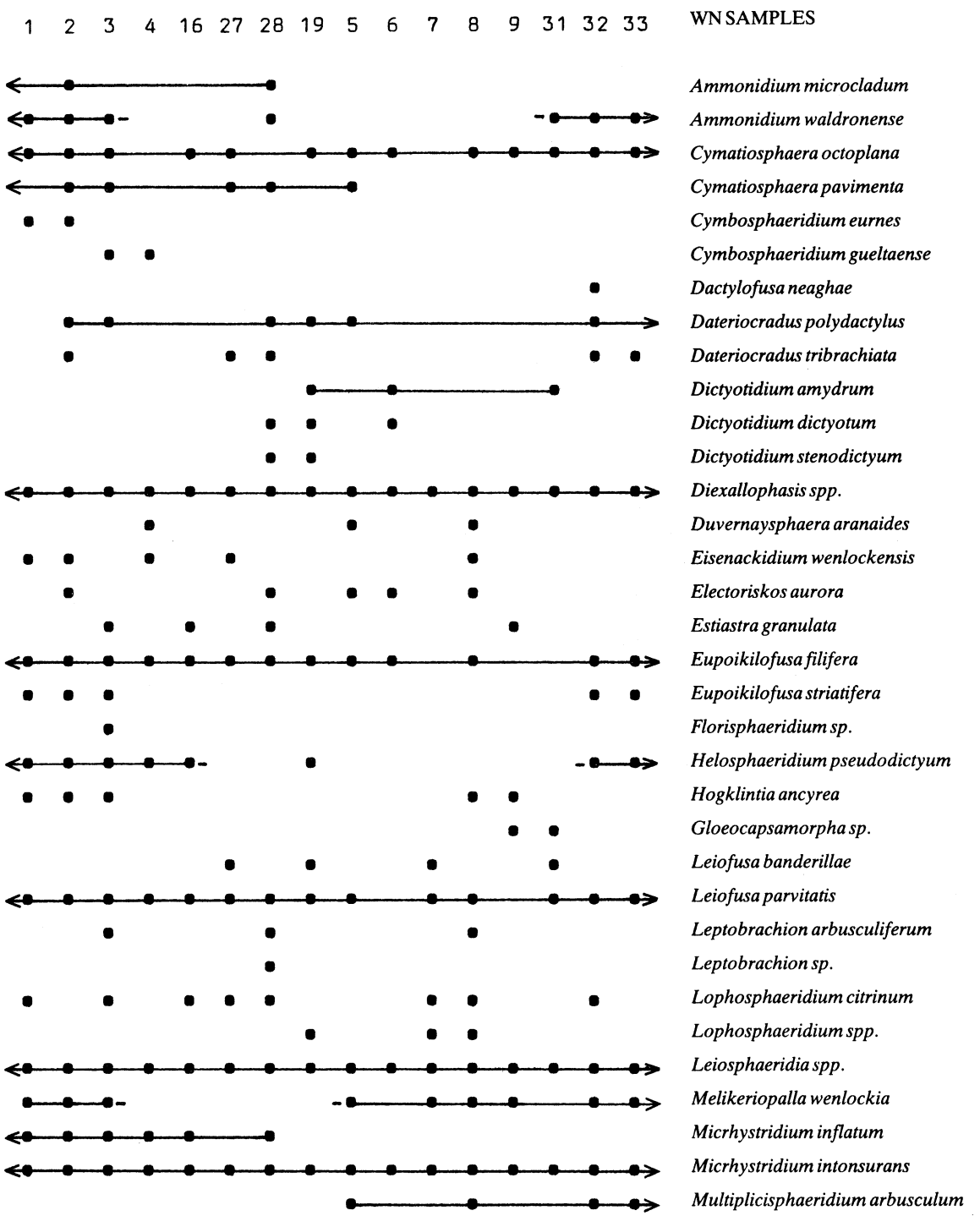
The stratigraphy of the type Wenlock Series in Shropshire has been revised by Bassett *et al.* (1975). The lithostratigraphical units used by Butler (1938) in describing the Wren's Nest Inlier do not conform in format to current nomenclature, and are revised:

Butler, 1938	**Dorning, this paper**
Lower Ludlow Shale	Elton Formation
Wenlock Limestone	Much Wenlock Limestone Formation
Wenlock Shale	Coalbrookdale Formation

Three members can be recognised in the Much Wenlock Limestone Formation in the Wren's Nest Inlier:

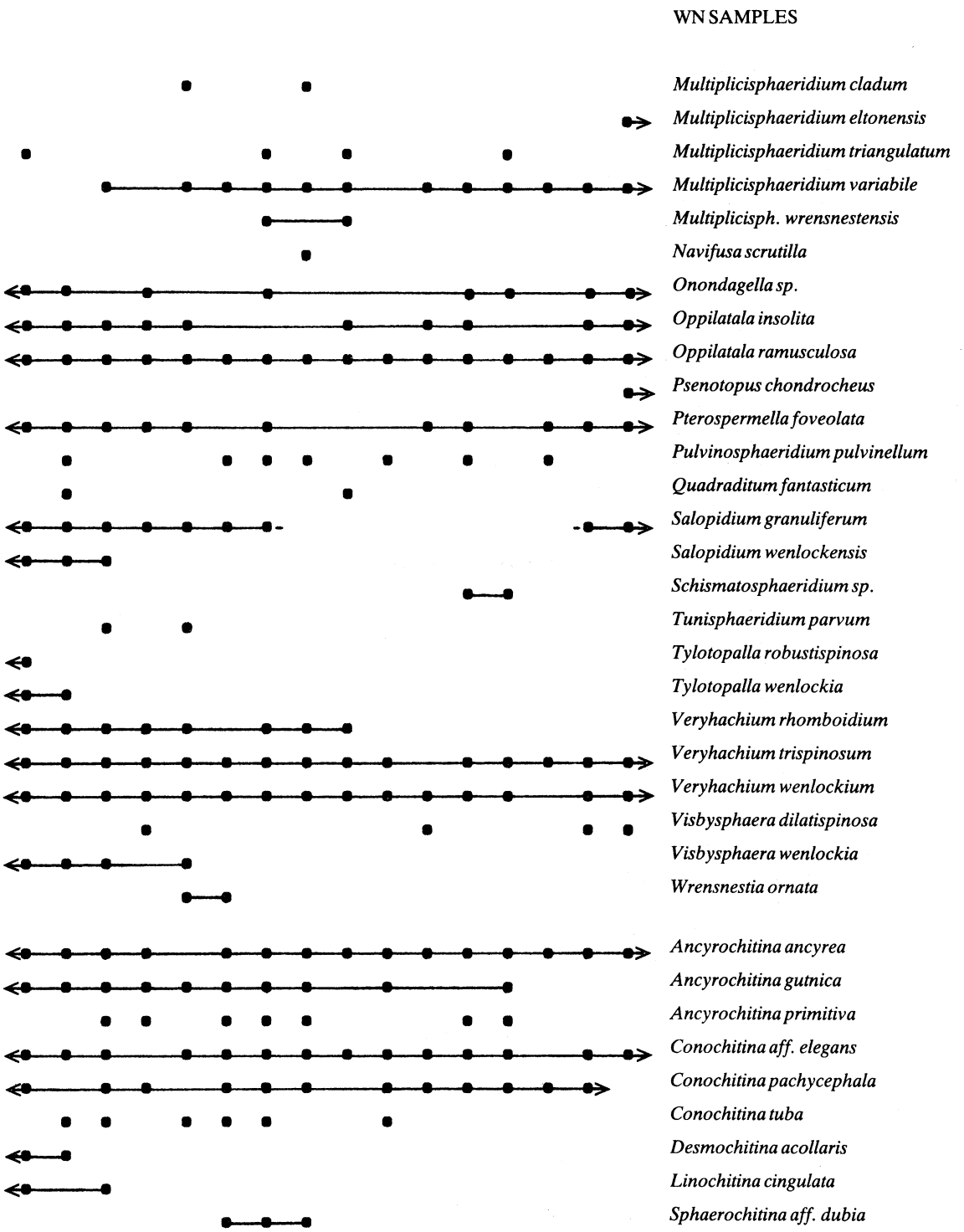
Butler, 1938	**Dorning, this paper**
Upper Quarried Limestone	Upper Quarried Limestone Member
Nodular Beds	Nodular Member
Lower Quarried Limestone	Lower Quarried Limestone Member

The Birmingham Siltstone Formation (Hurst, 1975) was proposed for the apparently Wenlock part of the Lower Elton Beds. As formations are lithostratigraphical units, they cannot be limited by the chronostratigraphy; the Birmingham Siltstone Formation is therefore considered superfluous.



Text-fig 2: Stratigraphical distribution of selected acritarchs and chitinozoa, Wenlock Limestone Formation.

Coalbrookdale Formation, lower Elton Formation



Text-fig. 2: (continued from p.36)

Explanation of Plate 5

1 *Ammonidium waldronense* WN1 K, H41/2
2 *Ammonidium microcladum* WN1 A, N39/2
3 *Oppilatala insolita* WN2 K, D40/0
4 *Veryhachium rhomboidium* WN1 K, Q34/1
5 *Visbysphaera* sp. WN 1 K, G33/4
6 *Cymbosphaeridium gueltaense* WN K, Q46/0
7 *Salopidium granuliferum* WN1 K Q40/3
8 *Micrhystridium inflatum* WN1 K, W37/1
9 *Helosphaeridium pseudodictyum* WN 1 K, M29/2
10 *Leiosphaeridia* sp. WN1 A, 037/4
11 *Lophosphaeridium* sp. WN1 A, 040/4
12 *Multiplicisphaeridium triangulatum* WN1 K, W38/0
13 *Lophosphaeridium* sp. WN1 K, W42/1
14 *Lophosphaeridium* sp. WN2 K, P33/0
15 *Nanocyclopia* sp. WN1 K, N33/0
16 *Muraticavea wenlockia* WN1 K, B39/1
17 *Cymatiosphaera octoplana* WN1 K, V43/3
18 *Visbysphaera wenlockia* WN1 K, H41/2

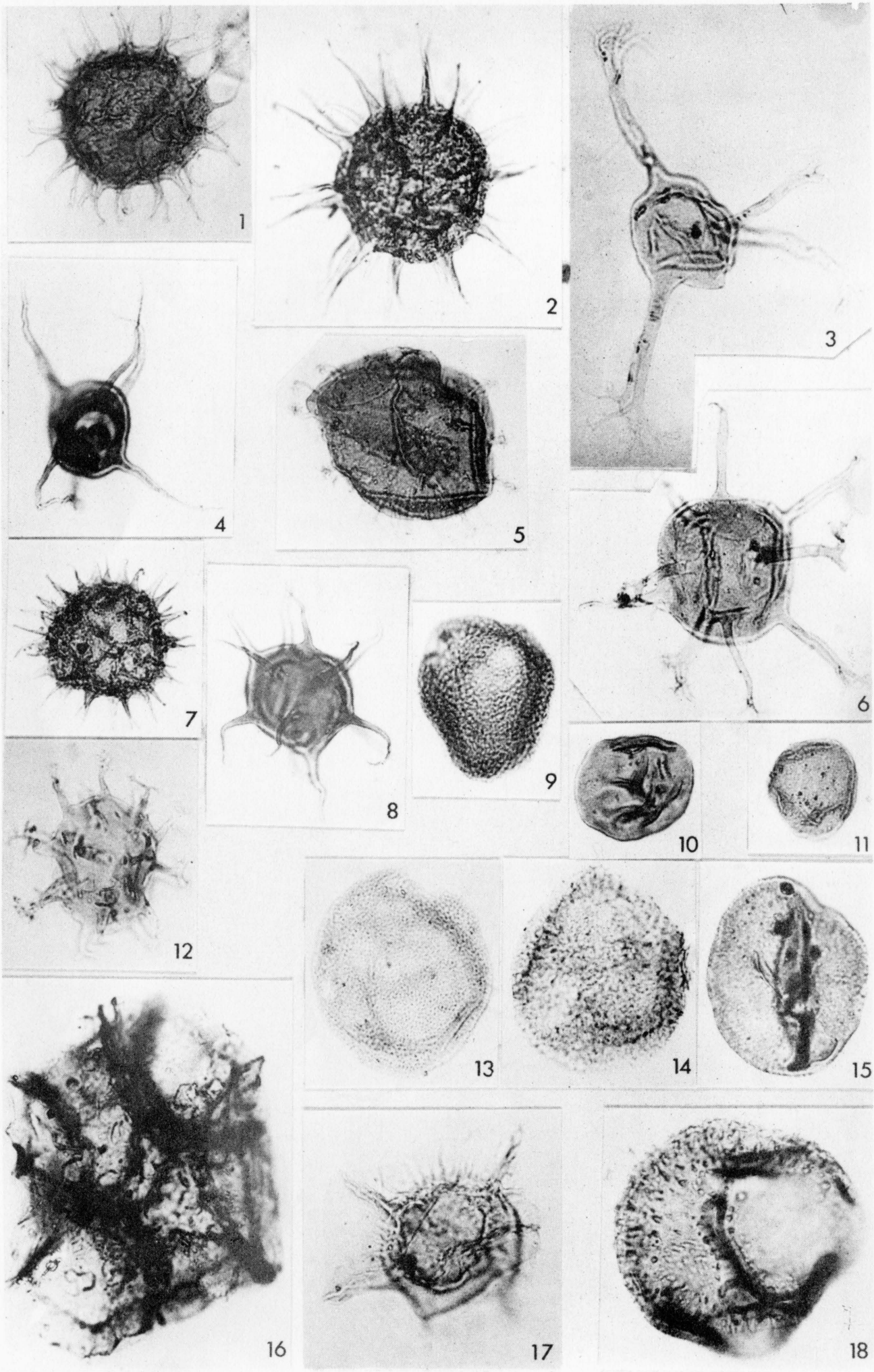
Explanation of Plate 6

1 *Oppilatala* cfr *ramusculosa* WN33 K, S41/0
2 *Diexallophasis* sp. WN33 K, T30/4
3 *Wrensnestia ornata* WN16 K, P38/0
4 *Pterospermella foveolata* WN33 K, E45/4
5 *Dictyotidium dictyotum* WN31 K, T33/3
6 *Dateriocradus polydactylus* Wn33 K, T42/3
7 *Eisenackidium wenlockensis* WN28 K, V29/2
8 *Multiplicisphaeridium eltonensis* WN33 K, M33/4
9 *Dictyotidium amydrum* WN19 K, M37/2
10 *Helosphaeridium* sp. WN33 K, L45/4
11 *Psenotopus chondrocheus* WN33 K, P35/4
12 *Schismatosphaeridium* sp.
13 *Visbysphaera dilatispinosa* WN33 K, Q28/2
14 *Ambitisporites dilutus* WN8 A, N43/3
15 *Gloecapsamorpha* sp. WN30 K, V36/1

Explanation of Plate 7

1 *Wrensnestia ornata* holotype. WN16 K, D41/2, MPK 2912
2 *Muraticavea wenlockia* WN1 K, M36/4
3 *Dictyotidium amydrum* WN19 K, T37/4
4 *Multiplicisphaeridium triangulatam* WN9 K, K32/4
5 *Nanocyclopia* sp. WN2 K, N39/0
6 *Multiplicisphaeridium wrensnestensis* WN28 K, W30/3
7 *Dactylofusa neaghae* WN32 K, G42/4
8 *Multiplicisphaeridium variabile* WN28 K, U30/3
9 *Tylotopalla* sp. WN33 K, 031/0
10 *Umbellasphaeridium* sp. WN3 K, Q35/2
11 *Lophosphaeridium citrinum* WN19 K, F34/4
12 *Dictyotidium* cf *amydrum* WN4 K, K45/0

All the figured material is in the reference collections of Pallab Research, Sheffield, except Plate 6, fig 3, and Plate 7, fig 1 which are housed at the I.G.S. Leeds.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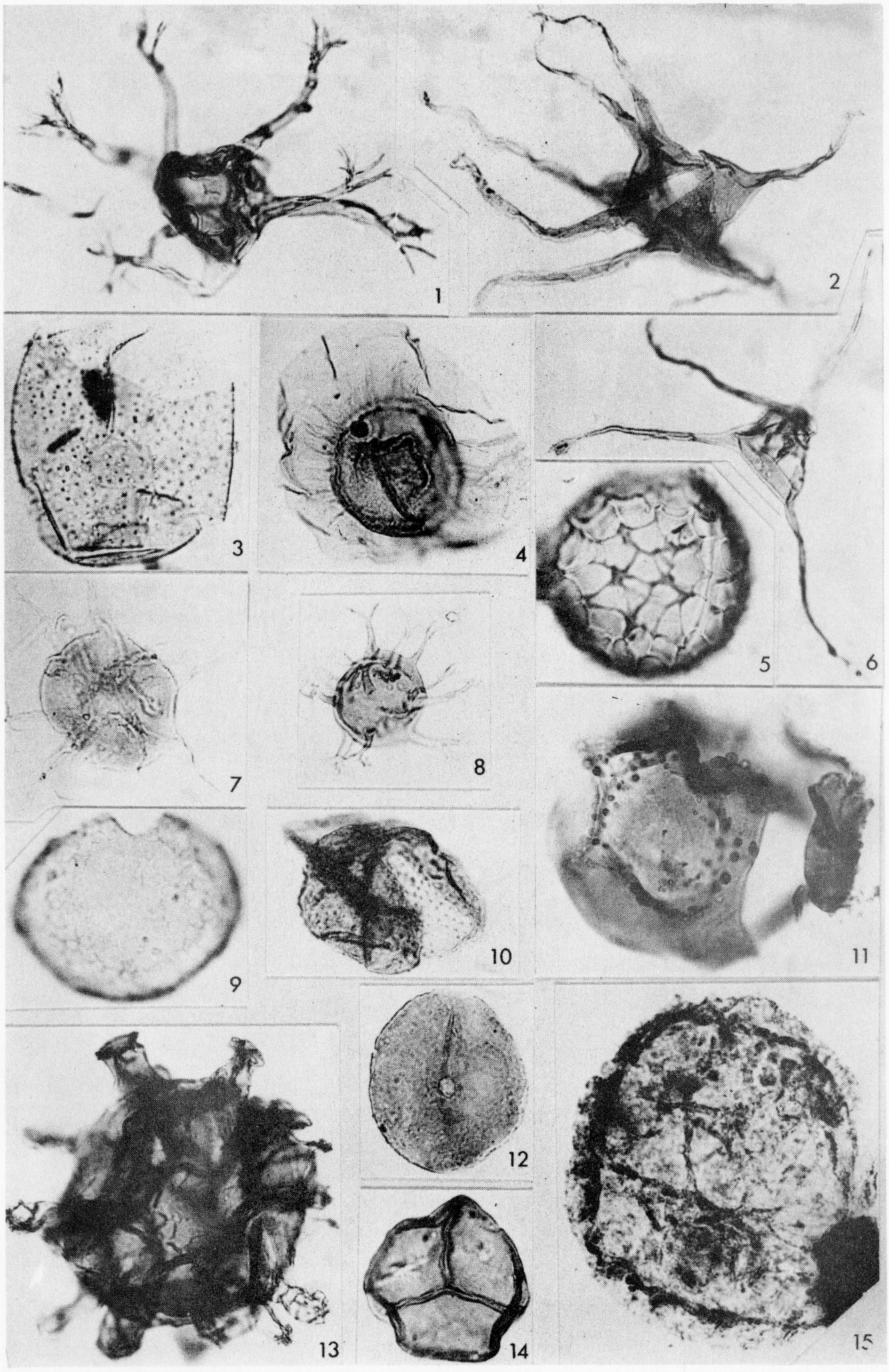
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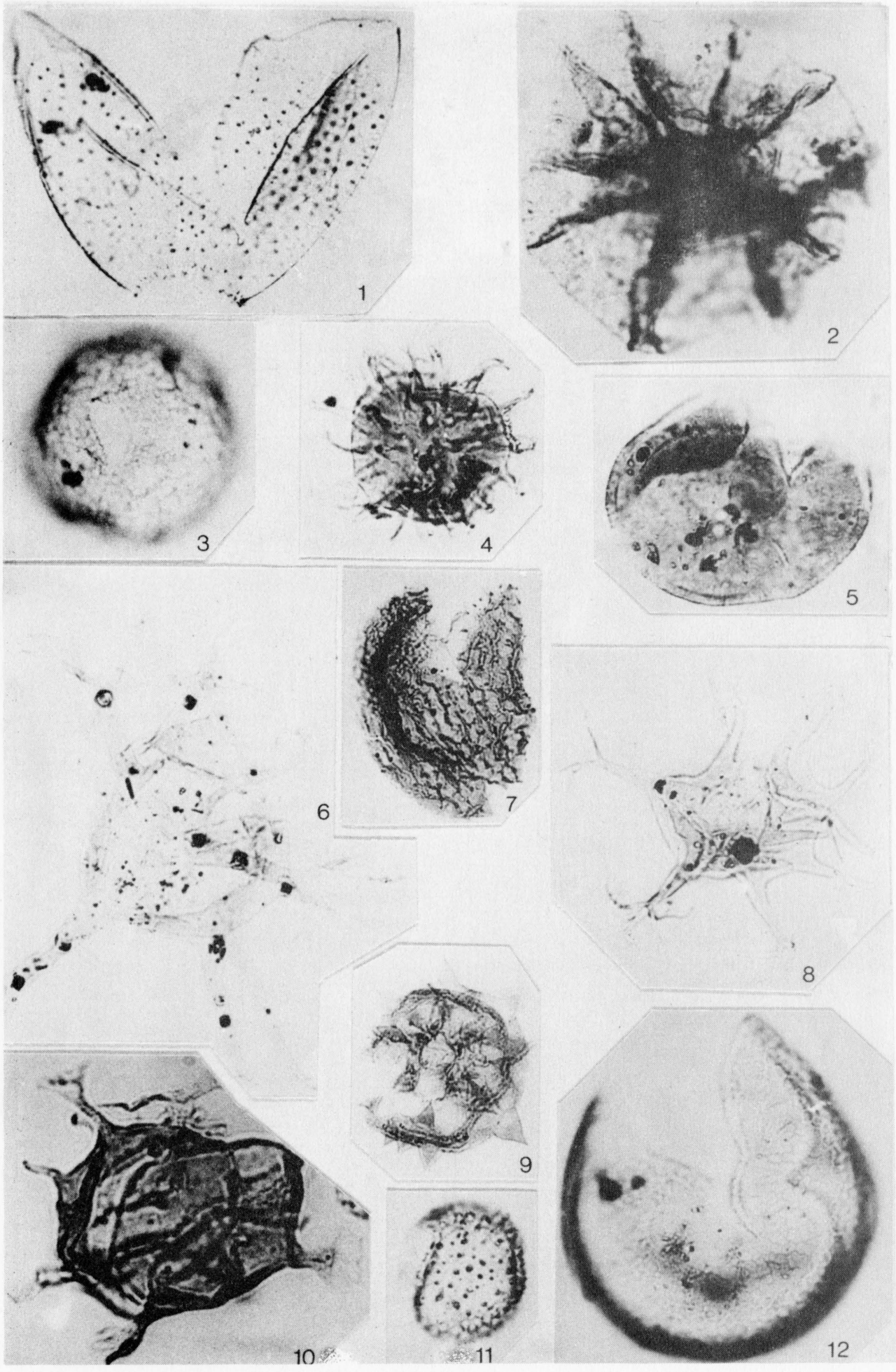
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Biostratigraphy

On lithostratigraphical evidence, the Much Wenlock Limestone Formation of the Wren's Nest Inlier can be readily correlated with the type area on Wenlock Edge. Several of the acritarchs recorded have top of ranges or bases of ranges within the samples studied. In correlation with the known acritarch ranges in the type area (Dorning 1981a), it is probable that limestone deposition began somewhat earlier in Central England, so that the base of the Much Wenlock Limestone Formation at Wren's Nest correlates somewhere near the top of the Coalbrookdale Formation in the type area. Bassett (1974) on the basis of macrofossils suggested that the base of the Much Wenlock Limestone in Central England occurred earlier in the Wenlock than in the type area. On the basis of the acritarch ranges, there is no indication that there is any significant time difference between the end of limestone deposition in Central England and the type area, and it is most unlikely that the Much Wenlock Limestone Formation in Central England extends into the Ludlow.

Acknowledgements

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