VIII. *On the Fossil Flora of the Forest of Dean Coalfield (Gloucestershire), and the Relationships of the Coalfields of the West of England and South Wales.*

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[Plates 11–13.]

Contents.

1. *Introduction.*

The Forest of Dean lies in a somewhat out-of-the-way corner of Gloucestershire, West of the Severn, and is bounded on the North-west by Herefordshire, and on the West and South by Monmouthshire and the Wye. The nearest coalfield is to the North, where a small area of Upper Carboniferous rocks occurs at Newent, also in Gloucestershire. The Bristol and Radstock coalfields lie some little distance to the South, and still further to the West is the great basin of South Wales. The Forest of Dean is remarkable for the simplicity of the structure of the Carboniferous area. As is well known, the basin is the most symmetrical in England, the beds, very little disturbed by faulting or folding, having, for the most part, a very regular outcrop. From the mining point of view, the entire absence of fire-damp and the consequent use of naked lights below ground, as is also the case in the Radstock coalfield, is remarkable.

The Coal Measures, which occupy an area of about 16,700 acres, overlie beds which have long been spoken of as Millstone Grits, and these, with the Carboniferous Limestone, form the elevated rim of the field, except for a short distance in the South-east,

where the Coal Measures overstep both the so-called Millstone Grits and the Carboniferous Limestone (see p. 269). The latter has a much less regular distribution than the "Millstone Grits," and a considerable development of the Limestone series is found to the North and West of the Forest, and this is continuous with a long tongue of Lower Carboniferous stretching South to Chepstow, and then South-west in the direction of Newport.

It is only proposed to discuss here the general geology of the Forest,* in so far as may be necessary in connection with the study of the distribution of the fossil plants in the Upper Carboniferous rocks of the area. It may be pointed out, however, that this was one of the earliest of British coalfields to be described geologically, and that our present knowledge rests mainly on the memoirs of BUCKLAND and CONYBEARE,† published in 1824, of MACLAUGHLAN‡ in 1840, and especially on that of DE LA BECHE,§ which appeared in 1846. Geological maps of the Forest are included in the two first-mentioned papers, and the 1-inch Geological Survey Maps (XLIII S.W. and XLIII S.E. and also a small part of XXXV) were published about 1855, or perhaps earlier. SOPWITH, in 1835, published a series of 16 engraved plans of the coal seams and iron mines, and a large and well-known model of the coalfield was also made by him in 1841. Examples of this model may be seen at the Jermyn Street Museum, and at the Sedgwick Museum, Cambridge.

So far as I am aware, the district has not been surveyed more recently, nor have the Upper Carboniferous rocks since attracted any special attention. The most important of the more recent notices of the beds in the Forest is that by HOSKOLD,‖ published in 1892. Other brief mentions have also been made by BUCKMAN,¶ NICHOLLS,** BINKS,†† MOORE,‡‡ THOMPSON,§§ and RICHARDSON.‖‖

The Upper Carboniferous rocks fall naturally into a higher, productive series, and a lower, unproductive series. It will be necessary here to consider the succession in each case. That of the productive series, from which the plants described here have been obtained, is shown in the following table.¶¶

These beds fall naturally into three divisions, in accordance with the relation of the

* The Forest of Dean has long been the property of the Crown, in whom the mining rights are also vested. Nearly the whole of the area occupied by Carboniferous rocks is as densely forested to-day as it has been for many centuries past.

† BUCKLAND and CONYBEARE ('24).

‡ MACLAUGHLAN ('40).

§ DE LA BECHE ('46).

‖ HOSKOLD ('92).

¶ BUCKMAN ('57).

** NICHOLLS ('58).

†† BINKS ('02).

‡‡ MOORE ('03).

§§ THOMPSON ('07).

‖‖ RICHARDSON ('07).

¶¶ The unproductive series will be considered in Section 5, p. 266.

outcrops of the seams. The highest, or First Division, contains two seams, the Upper and Lower Woorgreens coals, and these lie isolated in the centre of the basin, and are separated by 348 feet of barren strata from the coals of the Second Division. The latter consists of a group of eight, closely associated seams (208 feet of strata in all), the outcrops of which are very regular, and parallel to one another. The Third Division consists of six coals, more widely separated, and with outcrops more irregular and less nearly parallel than those of the Second Division. This division is 833 feet in thickness, and is separated by 42 feet of barren rock from the Second Division. It rests directly upon the "Millstone Grits," except in one small portion of the field. The names of the seams are shown in the following table :—

Diagrammatic Vertical Section of the Upper Carboniferous Rocks of the Forest of Dean.*

(Not to Scale.)

First Division 78 feet	Shale and rock 17 yards	
	1 foot 2 inches	Upper Woorgreens Coal.
	Rock 8 yards	
	1 foot 8 inches	Lower Woorgreens Coal.
348 feet of barren Measures	Sandstones, shales, etc. 116 yards	
Second Division 208 feet	1 foot 3 inches	Crowdelf Coal.
	Shales 8 yards	
	1 foot 9 inches	Twenty Inch or Smith Coal.
	Underclay 3 feet 7 inches	
	1 foot 3 inches	Foot Coal.
	Shale and stone 11 yards	

* Abridged from Plate 8 of the 'Report of the Royal Commission on Coal Supplies,' see LEWIS ('05).

Second Division 208 feet *contd.*	2 feet 1 inch	Lowery Coal.
	Shale and stone 16 yards	
	1 foot 7 inches	Starkey Coal.
	Shale 4 yards	
	1 foot 8 inches	Rockey Coal.
	Shale and stone 14 yards	
	1 foot	Breadless Coal.
	Shale 11 yards	
	1 foot 11 inches	Churchway High Delph Coal.
42 feet of barren Measures	Rock and shale 14 yards	
Third Division 833 feet	1 foot 6 inches	No Coal.
	Rock and shale 17 yards	
	1 foot 9 inches	Brazzilly Coal.
	Greystone and shale 119 yards	
	2 feet 1 inch	Yorkley Coal.
	Grey rock 51 yards	
	1 foot 9 inches	Wittington Coal.

Third Division 833 feet *contd.*	Grey rock, etc. 44 yards	
	4 feet 3 inches	Coleford High Delph Coal.
	Rock 42 yards	
	3 feet	Trenchard Coal.*
	"Millstone Grits" ? 600 feet	

As will be seen from this table, the associated rocks of the seams of the First and Second Divisions are essentially argillaceous, and in them plant remains are abundant. As we pass downwards, however, through the Third Division, and especially below the Yorkley Coal, the arenaceous beds increase in importance, and not only form the roofs of the lowest coals, but by far the greater part of the thickness of the sediments separating the seams, while argillaceous beds are of very rare occurrence. Consequently fossil plants are much more difficult to obtain from this division than from beds higher in the series.

With the help of some of my pupils at Cambridge, I have spent some time in the Forest during each of the last five years in forming as complete a collection of fossil plants as possible from this coalfield. It has been found that specimens can be obtained from each of the three divisions. The coals of the First Division are only worked at Woorgreens Colliery, but since this pit does not mine those of the Second Division, the origin of the specimens to be obtained at the waste heap there is accurately fixed.

All the larger collieries in the Forest, such as Trafalgar, Foxe's Bridge, New Fancy, Lightmoor, and Crump Meadow, work the coals of the Second Division, but not those of the first or third. Several seams, usually four or more, the exact number and identity varying in different cases, are worked at each colliery. Owing to the thinness of the seams, enormous quantities of the rocks between them have to be brought to the surface, and are thrown on vast and high waste-heaps. The sandstones and shales there are of course very much mixed, and it is naturally impossible to correlate them with the coals with which they were originally associated. For this reason the coals and the intervening rocks of the Second Division are here treated as if they formed one vast seam, and since they are naturally closely associated, this is a satisfactory way of dealing with the difficulty, for the present purpose.

The Third Division is very disappointing as a collecting ground for fossil plants,

* Total thickness of the Productive Series (to base of Trenchard Coal), 1509 feet.

owing to the predominance of arenaceous sediments. Fortunately the Yorkley Seam has a shale roof, and still more fortunately, from a collector's point of view, this seam is worked alone at two pits, Park Gutter and Flour Mill, belonging to the Princess Royal Colliery Company. The waste heap of Park Gutter pit has yielded many excellent specimens, which give us a good idea of the flora of the higher beds of the Third Division.

I have spent a great deal of time to no purpose in trying to obtain fossil plants from the Coleford High Delph and Trenchard, the two lowest seams, at different workings. The roof always proved to be a coarse sandstone, without any indications of plant remains. Fortunately, however, Mr. JOHN MORRIS, the Manager of Lydbrook Colliery, which works the former coal, very kindly interested himself in this matter. When, in April, 1909, the unexpected event occurred, almost unheard of previously in the Forest, of a bed of shale of very limited extent being discovered above the seam, he very kindly communicated with me, and saved as much as possible of the material, from which I was able to unearth a number of species of interest. These remain the only well-preserved specimens I have been able to obtain from the Coleford High Delph coal. I would express my sincere thanks to Mr. MORRIS for his valuable services in this and other matters.

I would also here record my thanks to many who have assisted me in the field. I am especially indebted to my friend Mr. D. G. LILLIE, B.A., of St. John's College, Cambridge, now Biologist to Captain Scott's Expedition in the Antarctic, who has accompanied me on three of my visits to the Forest, and has entered most enthusiastically into the laborious work of collecting the specimens. Mr. M. P. PRICE, B.A., and Mr. W. R. PRICE, B.A., both of Trinity College, have also rendered me much assistance by placing their special knowledge of the Forest and of the collieries at my disposal, which has been of great value. Mr. LILLIE and Mr. W. R. PRICE have also very kindly presented the specimens which they personally collected to the Sedgwick Museum, Cambridge.

I also gratefully acknowledge the help and influence of Mr. W. FORSTER BROWN, the Deputy Gaveller of the Forest, who, through the Chief Clerk of the Crown Office at Coleford, Mr. T. A. LLEWELLYN, has aided my work in many directions. I would especially express my thanks to Mr. LLEWELLYN for the constant kindness and courtesy which I have received at his hands, and for the personal trouble he has taken to aid this work.

To the Managers of the various collieries, and especially to Mr. FRANK BRAIN of the Trafalgar, and to Mr. C. COOKE of the Princess Royal Collieries, I return my thanks for permission to collect at the collieries, and for the kindness and sympathy which they invariably extended to me during my visits to the Forest. I have also to acknowledge my indebtedness for grants from the Royal Society Government Grant Committee, whereby part of the expenses of the field work were defrayed.

2. *Previous Records.*

It has been known for nearly a hundred years past that well-preserved plant remains occur in the Upper Carboniferous rocks of the Forest of Dean. There is no evidence, however, that any attempt has been made hitherto to undertake a thorough examination of the fossil flora of this coalfield, or to examine the vertical distribution of the plants in detail. Excellent specimens from the Forest are to be found in many collections, notably those in the Sedgwick Museum (Cambridge), the Natural History Museum, and the Jermyn Street Museum. Few, if any, of these examples, however, are accompanied by labels stating the exact locality, with the seam or division, from which they were derived, and thus they are of comparatively little value as evidence of the distribution of the flora in this coalfield.

The earliest figured specimens from the Forest are those described by LINDLEY and HUTTON* as *Hippurites longifolia*, and now known by the name *Calamocladus equisetiformis* (Schloth.).

In none of the earlier descriptions of the coalfield are any fossil plants mentioned by name. In 1858, however, NICHOLLS† included, in his description of the Forest, a list of 33 species drawn up by Mr. R. GIBBS. This was no doubt an amateur's effort to further a knowledge of this flora, and a number of the species were, as we should expect, wrongly determined, and thus the list at the present day is of little interest or value. Among the plants recorded, no doubt correctly, are those known as :—

Calamocladus equisetiformis (Schloth.).
Annularia radiata Brongn.
Lepidodendron dichotomum Sternb.
Neuropteris macrophylla Brongn.
Pecopteris miltoni (Artis.).
Pecopteris arborescens (Schloth.).
Pecopteris (*Dactylotheca*) *plumosa* (Artis.).

In 1886 KIDSTON‡ recorded from this coalfield the following species, which are preserved in the British Museum (Natural History) collection. I have added their registered numbers in the following list :—

Annularia radiata Brongn.§
A. stellata (Schloth.) [No. 39,323].
Dictyopteris brongniarti Gutbier.§

* LINDLEY and HUTTON ('35), vol. 3, Pl. CXC and CXCI.

† NICHOLLS ('58), p. 251.

‡ KIDSTON ('86).

§ After careful search, I have been unable to find any specimens of this species labelled "Forest of Dean."

Alethopteris lonchitica (Schloth.).*
A. serli (Brongn.) [No. 39,089].
Lonchopteris rugosa Brongn. [No. 52,674].
Pecopteris arborescens (Schloth.) [No. 52,674].
P. oreopteridea (Schloth.) [No. 39,324].†
P. miltoni (Artis.) [Nos. 52,674 and V. 884].

Curiously enough, among the large collection which I have gathered together from the Forest, I have found no examples of *Lonchopteris*, *Dictyopteris*, *Alethopteris lonchitica*, *A. serli* or *Pecopteris oreopteridea*, and only one example of *Annularia stellata*.

Dr. KIDSTON‡ has also since recorded *Pecopteris polymorpha* Brongn. from the Forest of Dean.

3. *The Fossil Flora.*

None of the species collected from the Forest of Dean appear to be new, and the majority are already well known from other British coalfields. Descriptions are, therefore, only given in cases where there appear to be special reasons for so doing. No attempt has been made to construct a complete synonymy in any case, but references to figures of the type and a few other important illustrations of the species are given in each instance. The relative abundance or rarity of occurrence, which is a matter of great importance in estimating the horizon, is indicated by the list of localities at which the plants were observed, the numbers referring to the specimens now incorporated in the Carboniferous Plant Collections of the Sedgwick Museum, Cambridge, where they may be consulted.

EQUISETALES.

CALAMITES Suckow, 1784.

1. *Calamites varians* Sternb. Plate 13, figs. 15 and 16.

1833. *Calamites varians*, STERNBERG, 'Vers. Darstell. Flora Vorwelt,' vol. 2, Part 7–8, p. 50, Plate 12.
1876. *Calamites Goepperti*, WEISS, 'Abhandl. Geol. Specialk. Preuss. u. Thüring. Staat.,' vol. 2, Part 1, p. 127, Plate 17, fig. 2.
1884. *Calamites* (*Calamitina*) *varians*, WEISS, *ibid.*, vol. 5, Part 2, pp. 62, 69; Atlas, Plate 1, fig. 1; Plate 16*a*, figs. 7 and 8; Plate 25, fig. 2.
1886. *Calamophyllites Goepperti*, ZEILLER, 'Flore foss. Bass. houill. Valenciennes,' p. 363, Plate 57, fig. 1.

* The two specimens (No. V. 3) labelled *Alethopteris lonchitica* (Schloth.) are, I think, probably referable to *A. davreuxi* (Brongn.).

† This specimen is perhaps *Pecopteris polymorpha* Brongn., though the nervation is not very clearly seen.

‡ KIDSTON ('88), p. 373.

1889. *Calamitina* (*Calamites*) *varians*, var. *inconstans*, KIDSTON, 'Trans. Roy. Soc. Edinb.,' vol. 35, Part 2, p. 398, Plate 1, figs. 1, 1A.

Distribution :—? *External Surface.*—Second Division—New Fancy Colliery, No. 1723.

Pith-cast.—Second Division, Trafalgar Colliery, No. 1464.

Description.—The specimen showing the external surface of this or some closely similar species, Plate 13, fig, 15, exhibits portions of four internodes of varying length, separated by three nodes. Above one of the nodes two branch scars are seen. The surface of the bark is smooth, though finely striated longitudinally.

The excellent example of the pith-cast of this species collected at Trafalgar Colliery, part of which is figured on Plate 13, fig. 16, closely resembles that described by Dr. KIDSTON in 1889 (see synonymy), now in the Liverpool Museum. It shows 22 internodes of varying length. Above the fifth node from the broken lower end of the specimen, there is a row of four small branch scars, distant from one another (Plate 13, fig. 16). Then follow eleven internodes without branch scars, and at the seventeenth node, not shown in the figure, another row of three branch scars is seen, above which four further internodes occur without branch scars.

2. *Calamites ramosus* Artis.

1825. *Calamites ramosus*, ARTIS, 'Antidil. Phytol.,' Plate 2.

1831. *Calamites nodosus*, LINDLEY and HUTTON, 'Fossil Flora,' vol. 1, Plate 15.

1884. *Calamites* (*Eucalamites*) *ramosus*, WEISS, 'Abhandl. Geol. Specialk. Preuss. u. Thuring. Staat.,' vol. 5, Part 2, p. 98, Plate 2, fig. 3; Plate 5, figs. 1, 2; Plate 6; Plate 7, figs. 1, 2, 4; Plate 9, figs. 1, 2; Plate 10, fig. 1; Plate 20, figs. 1, 2.

Distribution :—Second Division—Park End Colliery, No. 1964.

3. *Calamites suckowi* Brongn.

1828. *Calamites Suckowi*, BRONGNIART, 'Hist. Végét. foss.,' p. 124, Plate 14, fig. 6; Plate 15, figs. 1–6; Plate 16, figs. 2–4.

1884. *Calamites* (*Stylocalamites*) *Suckowi*, WEISS, 'Abhandl. Geol. Specialk. Preuss. u. Thüring. Staat.,' vol. 5, Part 2, p. 129; Plate 2, fig. 1; Plate 3, figs. 2, 3; Plate 4, fig. 1; Plate 17, fig. 4; Plate 27, fig. 3.

1886–8. *Calamites Suckowi*, ZEILLER, 'Flore foss. Bassin. houill. Valenciennes,' p. 333, Plate 54, figs. 2, 3; Plate 55, fig. 1.

Distribution :—Second Division—Trafalgar Colliery, No. 1634.

4. *Calamites undulatus?* Sternb.

1826. *Calamites undulatus*, STERNBERG, 'Vers. Darstell. Flora Vorwelt,' vol. 2, Part 5–6, p. xxvi; Part 7–8, p. 47, Plate 1, fig. 2.

1828. *Calamites undulatus*, Brongniart, 'Hist. Végét. foss.,' p. 127, Plate 17, figs. 1–4.

1886–8. *Calamites undulatus*, Zeiller, 'Flore foss. Bassin. houill. Valenciennes,' p. 338, Plate 54, figs. 1 and 4.

Distribution:—Second Division—Trafalgar Colliery, No. 1463.

5. *Calamites* sp.

Distribution:—Second Division—Crump Meadow Colliery, No. 1713.

CALAMOCLADUS Schimper, 1869.

Calamocladus equisetiformis (Schlotheim).

1804. ——— Schlotheim, 'Flora Vorwelt,' p. 30, Plate 1, figs. 1, 2; Plate 2, fig. 3.

1820. *Casuarinites equisetiformis*, Schlotheim, 'Petrefactenk.,' p. 397.

1836. *Hippurites longifolia*, Lindley and Hutton, 'Fossil Flora,' vol. 3, Plates 190 and 191.

1886–8. *Asterophyllites equisetiformis*, Zeiller, 'Flore foss. Bassin. houill. Valenciennes,' p. 368, Plate 58, figs. 1–7.

Distribution:—First Division—Woorgreens Coal, Woorgreens Colliery, Nos. 1461, 1725, 1942.

Second Division—Trafalgar Colliery, No. 1462; New Fancy Colliery, Nos. 1451, 1453, 1688, 1716; Foxe's Bridge Colliery, No. 1719; Park End Colliery, No. 1946.

Third Division—Yorkley Coal, Park Gutter Colliery, No. 1714.

ANNULARIA Sternberg, 1821.

1. *Annularia radiata?* (Brongn.).

1822. *Asterophyllites radiatus*, Brongniart, 'Sur. Class. Végét. foss.,' p. 235, Plate 13, figs. 7a, 7b.

1832. *Asterophyllites foliosa*, Lindley and Hutton, 'Fossil Flora,' vol. 1, Plate 25, fig. 1.

1886–8. *Annularia radiata*, Zeiller, 'Flore foss. Bass. houill. Valenciennes,' p. 394, Plate 59, fig. 8; Plate 61, figs. 1 and 2.

Distribution:—Second Division—New Fancy Colliery, No. 1718; Foxe's Bridge Colliery, No. 1949.

Remarks.—Only two, not very perfect, examples, which recall *A. radiata* rather than *A. stellata* (Schloth.) have been collected.

2. *Annularia stellata* (Schloth.).

1804. ———— Schlotheim, 'Flora Vorwelt,' p. 32, Plate 1, fig. 4.
1820. *Casuarinites stellatus*, Schlotheim, 'Petrefactenk.,' p. 397.
1886–8. *Annularia stellata*, Zeiller, 'Flore foss. Bass. houill. Valenciennes,' p. 398, Plate 61, figs. 3–6.

Distribution :—Third Division—Coleford High Delph Coal, Lydbrook Colliery, No. 2099.

3. *Annularia sphenophylloides* (Zenker).

1833. *Galium sphenophylloides*, Zenker, 'Neues Jarhb.,' p. 398, Plate 5, figs. 6–9.
1869. *Annularia sphenophylloides*, Schimper, 'Traité Paléont. végét.,' vol. 1, p. 347, Plate 17, figs. 12 and 13.
1886–8. *Annularia sphenophylloides*, Zeiller, 'Flore foss. Bass. houill. Valenciennes,' p. 388, Plate 60, figs. 5–6.

Distribution :—First Division—Woorgreens Coal, Woorgreens Colliery, No. 1948.
Second Division—Park End Colliery, No. 1636.

4. *Annularia galioides* (L. and H.).

1832. *Asterophyllites galioides*, Lindley and Hutton, 'Fossil Flora,' vol. 1, Plate 25, fig. 2.
1848. *Annularia microphylla*, Sauveur, 'Végét. foss. Terr. houill. Belgique,' Plate 69, fig. 6.
1886–8. *Annularia microphylla*, Zeiller, 'Flore foss. Bass. houill. Valenciennes,' p. 392, Plate 60, figs. 3–4.
1893. *Annularia galioides*, Kidston, 'Trans. Roy. Soc. Edinburgh,' vol. 37, p. 317, Plate 2, figs. 4, 4a.

Distribution :—First Division—Woorgreens Coal, Woorgreens Colliery, Nos. 1787, 1788.

CALAMOSTACHYS Schimper, 1869.

Calamostachys tuberculata (Sternberg). Plate 13, fig. 17.

1826. *Bruckmannia tuberculata*, Sternberg, 'Vers. Darstell. Flora Vorwelt,' vol. 2, Part 5–6, p. xxix, Plate 45, fig. 2.
1876. *Stachannularia tuberculata*, Weiss, 'Abhandl. Geol. Specialk. Preuss. u. Thüring. Staat.,' vol. 2, Part 1, p. 17; Plate 1, figs. 2–4; Plate 2, figs. 1–3, 5; Plate 3, figs. 3–10 and 12.

Distribution :—Second Division—Foxe's Bridge Colliery, Nos. 1943–45.
Third Division—Coleford High Delph Coal, Lydbrook Colliery, Nos. 2101–2.

MACROSTACHYA Schimper, 1869.

1. *Macrostachya infundibuliformis* (Brongn.). Plate 13, figs. 19–20.

1828. *Equisetum infundibuliformis*, BRONGNIART, 'Hist. Végét. foss.,' p. 119, Plate 12, figs. 14, 15.

1869. *Macrostachya infundibuliformis*, SCHIMPER, 'Traité Pal. végét.,' vol. 1, p. 333, Plate 23, figs. 15–17.

1876. *Macrostachya infundibuliformis*, WEISS, 'Abhandl. K. Geol. Specialk. Preuss. u. Thüring. Staat.,' vol. 2, p. 71; Plate 6, figs. 1–4; Plate 18, figs. 1, 3, 4.

Distribution:—Second Division—Trafalgar Colliery, Nos. 1727, 1970.
Third Division—Yorkley Coal, Park Gutter Colliery, Nos. 1726, 1728.

Description.—Several good examples of this plant, which is comparatively rare in Britain, have been obtained, of which that on Plate 13, fig. 19, shows the external features of the cone. As is usually the case, the upper part of each whorl of the united bracts has been broken off irregularly. This cone measures over 16 cm. in length and 3 cm. across. The large size of these cones, in comparison with those of other fructifications attributed to Calamites, is one of their most striking features. The example figured on Plate 13, fig. 20, is 20 cm. long and 3·2 cm. in breadth, and, like the last, is incomplete, neither the base nor the apex being seen. The external surfaces of the broken whorls of sporophylls are seen above, while below, the axis of the cone, with its short internodes, is clearly shown. Unfortunately, however, neither of these specimens permits us to add anything to what is already known of the organisation of *Macrostachya*.

2. *Macrostachya* ? sp.

Distribution:—First Division—Woorgreens Coal, Woorgreens Colliery, No. 1633.
Second Division—Trafalgar Colliery, No. 1940. New Fancy Colliery, No. 1639.
Third Division—Coleford High Delph Coal, Lydbrook Colliery.

Remarks.—These examples are probably referable to *Macrostachya infundibuliformis* (Brongn.), but are either too fragmentary or imperfectly preserved to be specifically determined.

SPHENOPHYLLALES.

SPHENOPHYLLUM Brongniart, 1822.

1. *Sphenophyllum emarginatum* Brongn.

1822. *Sphenophyllites emarginatus*, BRONGNIART, 'Class. Végét. foss.,' pp. 234, 239, Plate 13, figs. 8A, 8B.

1869. *Sphenophyllum emarginatum*, SCHIMPER, 'Traité Pal. végét.,' vol. 1, p. 339, Plate 25, figs. 15–17.

1886–8. *Sphenophyllum emarginatum*, Zeiller, 'Flore foss. Bass. houill. Valenciennes,' p. 409, Plate 64, figs. 3–5.

Distribution:—Second Division—New Fancy Colliery, No. 1720; Foxe's Bridge Colliery, No. 1952; Park End Colliery, Nos. 1950, 1951.

Third Division—Yorkley Coal, Park Gutter Colliery, Nos. 1548, 1599, 1602, 1690; Coleford High Delph Coal, Lydbrook Colliery, No. 2104.

2. *Sphenophyllum majus* (Bronn). Plate 11, fig. 5.

1828. *Rotularia major*, Bronn, in Bischoff, 'Krytogam. Gewächse.,' pp. 89, 131, Plate 13, figs. 2a, 2b.

1868. *Sphenophyllum longifolium*, Roehl, 'Palæontogr.,' vol. 18, p. 31, Plate 4, fig. 14.

1886–8. *Sphenophyllum majus*, Zeiller, 'Flore foss. Bass. houill. Valenciennes,' p. 420, Plate 64, figs. 1, 2.

Distribution:—Third Division—Yorkley Coal, Park Gutter Colliery, Nos. 1941, 1947.

Pteridospermeæ and Filicales.

SPHENOPTERIS Brongniart, 1822.

1. *Sphenopteris neuropteroides* (Boulay). Plate 13, fig. 21.

1876. *Pecopteris neuropteroides*, Boulay, 'Terr. houill. Nord France,' p. 32, Plate 2, fig. 6–6 *bis*.

1886–88. *Sphenopteris neuropteroides*, Zeiller, 'Flore foss. Bass. houill. Valenciennes,' p. 70, Plate 2, figs. 1–2a.

1909. *Sphenopteris neuropteroides*, Arber, 'Quart. Journ. Geol. Soc.,' vol. 65, p. 29, Plate 1, fig. 8.

Distribution:—First Division—Woorgreens Coal, Woorgreens Colliery, Nos. 1973, ? 1786, ? 1975.

Second Division—Trafalgar Colliery, No. 1577.

Third Division—Yorkley Coal, Park Gutter Colliery, Nos. 1588, 1615, 1733, 1745, 1783, 1785, 1968, 1974, 1977.

2. *Sphenopteris* (*Renaultia*) *chærophylloides* (Brongn.).

1835–36. *Pecopteris chærophylloides*, Brongniart, 'Hist. Végét. foss.,' p. 357, Plate 125, figs. 1, 2.

1883. *Renaultia chærophylloides*, Zeiller, 'Ann. Sci. Nat.,' Ser. 6, vol. 16, pp. 185, 208, Plate 9, figs. 16, 17.

1885. *Hapalopteris typica*, Stur, 'Abhandl. K. K. Geol. Reichsanst.,' vol. 11, Part I, pp. 27, 46, Plate 42, figs. 3, 4, and text-fig. 8 on p. 27.

1886–8. *Sphenopteris* (*Renaultia*) *chærophylloides*, ZEILLER, 'Flore foss. Bass. houill. Valenciennes,' p. 90, Plate 11, figs. 1, 2.

Distribution:—First Division—Woorgreens Coal, Woorgreens Colliery, Nos. 1597 and ?1779.

Remarks.—After a careful examination of these specimens, which also show some resemblance to *S.* (*Renaultia*) *footneri*, Maratt, I have arrived at the conclusion that they are probably identical with *S.* (*Renaultia*) *chærophylloides* (Brongn.). I believe I have also collected examples of the latter species in the Radstock coalfield, at Kilmerston Colliery (No. 1715 in the Sedgwick Museum, Cambridge).

MARIOPTERIS Zeiller, 1879.

1. *Mariopteris muricata* (Schloth.).

1804. ————, SCHLOTHEIM, 'Flora der Vorwelt,' pp. 54, 55, Plate 12, figs. 21 and 23.

1820. *Filicites muricatus*, SCHLOTHEIM, 'Petrefactenk.,' p. 409.

1832. *Pecopteris muricata*, BRONGNIART, 'Hist. Végét. foss.,' p. 352, Plate 95, figs. 3, 4, Plate 97.

1886–8. *Pecopteris muricata*, ZEILLER, 'Flore foss. Bass. houill. Valenciennes,' p. 173, Plate 22, fig. 2.

Distribution:—Second Division—Crump Meadow Colliery, No. 1782; New Fancy Colliery, No. 1584; Lightmoor Colliery (Starkey Coal), No. 1631.

Third Division—Yorkley Coal, Park Gutter Colliery, Nos. 1547, 1576, 1579.

2. *Mariopteris latifolia* ? (Brongn.).

1828. *Sphenopteris latifolia*, BRONGNIART, 'Hist. Végét. foss.,' p. 205, Plate 57, figs. 1, 5.

1886–8. *Mariopteris latifolia*, ZEILLER, 'Flore foss. Bass. houill. Valenciennes,' p. 161, Plate 17, figs. 1, 2; Plate 18, fig. 1.

Distribution:—Third Division—Yorkley Coal, Park Gutter Colliery, No. 1599.

NEUROPTERIS Brongniart, 1822.

1. *Neuropteris scheuchzeri* Hoffm.

1826. *Neuropteris Scheuchzeri*, HOFFMANN, in KEFERSTEIN'S 'Teutschland geognost. geol. dargestellt.,' vol. 4, p. 156, and Plate 1B, figs. 1–4.

1886–8. *Neuropteris Scheuchzeri*, ZEILLER, 'Flore foss. Bass. houill. Valenciennes,' p. 251, Plate 41, figs. 1–3.

1888. *Neuropteris Scheuchzeri*, KIDSTON, 'Trans. Roy. Soc. Edinburgh,' vol. 33, Part II, p. 356, Plate 23, figs. 1–2.

Distribution:—Second Division—Trafalgar Colliery, Nos. 1980, 1632; also at New Fancy Colliery and Park End Colliery.

Third Division—Park Gutter Colliery, No. 1806; Flour Mill Colliery, Nos. 1526, 1578.

2. *Neuropteris macrophylla ?* Brongn. Plate 11, fig. 4.

1828. *? Neuropteris macrophylla*, Brongniart, 'Hist. Végét. foss.,' p. 235, Plate 65, fig. 1.

1888. *Neuropteris macrophylla*, Kidston, 'Trans. Roy. Soc. Edinburgh,' vol. 33, Part II, p. 354, Plate 21, fig. 2; Plate 22, figs. 2, 3.

Distribution :—Second Division—Trafalgar Colliery, No. 1988; Foxe's Bridge Colliery, Nos. 1717, 1978.

Third Division—Yorkley Coal, Park Gutter Colliery, Nos. 1722, 1811; Flour Mill Colliery, No. 1604; Coleford High Delph Coal, Lydbrook Colliery, ? No. 2094.

3. *Neuropteris ovata* Hoffm. Plate 11, fig. 9.

1826. *Neuropteris ovata*, Hoffmann, in Keferstein's 'Teutschland geognost. geol. dargestellt.,' vol. 4, p. 158, Plate 1B, figs. 5, 6, 7.

1888. *Neuropteris ovata*, Kidston, 'Trans. Roy. Soc. Edinburgh,' vol. 33, Part II, p. 359, Plate 22, fig. 1.

1909. *Neuropteris ovata*, Zalessky, 'Mém. Com. Geol. St. Petersburg,' N.S., Livr. 50, Plates 1, 2; Plate 3, figs. 1, 2; ? Plate 4.

Distribution :—First Division—Woorgreens Coal, Woorgreens Colliery, ? No. 1972.

Second Division—Trafalgar Colliery, Nos. 1632, 1807; Park End Colliery, Nos. 1628, 1629, 1630; Foxe's Bridge Colliery, Nos. 1812, 1814, 1978, 1989; New Fancy Colliery, Nos. 1802, 1803, 1805, 1818; Lightmoor Colliery, Nos. 1635, ? 1638, 1631 (Starkey Coal); Speechhouse Colliery, No. 1550.

Third Division—Yorkley Coal, Park Gutter Colliery, Nos. 1806, ? 1810, 1809, 1811, 1813; Coleford High Delph Coal, Lydbrook Colliery, Nos. 2095, 2097, 2098.

4. *Neuropteris rarinervis* Bunb.

1847. *Neuropteris rarinervis*, Bunbury, 'Quart. Journ. Geol. Soc.,' vol. 3, p. 425, Plate 22.

1879. *Neuropteris rarinervis*, Lesquereux, 'Coal Flora Pennsyl.,' p. 109, Atlas, Plate 15, figs. 2, 2A, and 3.

1886–8. *Neuropteris rarinervis*, Zeiller, 'Flore foss. Bass. houill. Valenciennes,' p. 268, Plate 45.

Distribution :—Second Division—New Fancy Colliery, No. 1627.

5. *Neuropteris* (*Cyclopteris*) *fimbriata* Lesq.

1858. *Neuropteris dentata*, Lesquereux, in Roger's 'Geol. Report Pennsyl.,' vol. 2, Part II, p. 859, Plate 5, figs. 11, 12.

1880. *Neuropteris fimbriata*, Lesquereux, 'Coal Flora Pennsyl.,' vol. 1, p. 81, Plate 5, figs. 1–6.

1888. *Neuropteris fimbriata*, KIDSTON, 'Trans. Roy. Soc. Edinburgh,' vol. 33, Part II, p. 361, Plate 21, figs. 3–5.

Distribution:—Second Division—Trafalgar Colliery, Nos. 1784, ? 1984, 1985. Third Division—Coleford High Delph Coal, Lydbrook Colliery, No. 2098.

6. *Neuropteris* (*Cyclopteris*) sp.

Distribution:—Second Division—Lightmoor Colliery, No. 1631 (Starkey Coal). Third Division—Yorkley Coal, Flour Mill Colliery, No. 1976.

ODONTOPTERIS Brongniart, 1822.

Odontopteris sp.

Distribution:—Second Division—Trafalgar Colliery, No. 1983. Third Division—Yorkley Coal, Flour Mill Colliery, No. 1578.

ALETHOPTERIS Sternberg, 1826.

1. *Alethopteris aquilina* (Schloth.). Plate 11, fig. 2.

1804. ———— SCHLOTHEIM, 'Flora Vorwelt,' p. 35, Plate 5, fig. 8.
1820. *Filicites aquilina*, SCHLOTHEIM, 'Petrefactenk.,' p. 405.
1828. *Pecopteris aquilina*, BRONGNIART, 'Hist. Végét. foss.,' p. 284, Plate 90.
1869. *Alethopteris aquilina*, SCHIMPER, 'Traité Pal. Végét.,' vol. 1, p. 556, Plate 30, figs. 8–10.

Distribution:—Second Division—Trafalgar Colliery, Nos. 1600, 1620; New Fancy Colliery, No. ? 1621.

2. *Alethopteris grandini* (Brongniart). Plate 11, fig. 1.

1828. *Pecopteris grandini*, BRONGNIART, 'Hist. Végét. foss.,' p. 286, Plate 91, figs. 1–4.
1886–8. *Alethopteris grandini*, ZEILLER, 'Flore foss. Bass. houill. Valenciennes,' p. 237, Plate 38, figs. 1, 2.

Distribution:—Second Division—New Fancy Colliery, Nos. 1619 and ? 1791. Third Division—Yorkley Coal, Park Gutter Colliery, No. 1594.

3. *Alethopteris davreuxi ?* (Brongniart). Plate 11, fig. 8.

1828. *Pecopteris Davreuxi*, BRONGNIART, 'Hist. Végét. foss.,' p. 279, Plate 88.
1848. *Pecopteris Davreuxi*, SAUVEUR, 'Végét. foss. Terr. houill. Belgique,' Plate 42, figs. 2, 3.
1886–8. *Alethopteris Davreuxi*, ZEILLER, 'Flore foss. Bass. houill. Valenciennes,' p. 228, Plate 32.

Distribution:—Second Division—Trafalgar Colliery, Nos. 1965, 1966; Crump Meadow Colliery, No. 1794; New Fancy Colliery, Nos. 1790, 1792, 1795; Park End Colliery, ? No. 1607.

PECOPTERIS Brongniart, 1822.

1. *Pecopteris miltoni* (Artis).

1825. *Filicites Miltoni*, ARTIS, 'Antediluv. Phytology,' Plate 14.

1835. *Pecopteris abbreviata*, BRONGNIART, 'Hist. Végét. foss.,' vol. 1, p. 337, Plate 115, figs. 1–4.

1886–8. *Pecopteris* (*Asterotheca*) *abbreviata*, ZEILLER, 'Flore foss. Bass. houill. Valenciennes,' p. 186, Plate 24.

1888. *Pecopteris Miltoni*, KIDSTON, 'Trans. Roy. Soc. Edinburgh,' vol. 33, p. 374, and text-figs. 2–5A.

Distribution:—First Division—Woorgreens Coal, Woorgreens Colliery, No. 1801.

Second Division—Lightmoor Colliery, No. 1524; Trafalgar Colliery, Nos. 1800, 1990; New Fancy Colliery, Nos. 1525, 1532.

Third Division—Yorkley Coal, Flour Mill Colliery, Nos. 1523, 1526; Coleford High Delph Coal, Lydbrook Colliery, ? No. 2103.

2. *Pecopteris polymorpha* Brongn. Plate 11, fig. 7.

1828. *Pecopteris polymorpha*, BRONGNIART, 'Hist. Végét. foss.,' p. 331, Plate 113.

1828. *Pecopteris miltoni* (*non* Artis), BRONGNIART, *ibid.*, p. 333, Plate 114, figs. 2, 7.

1877. *Pecopteris polymorpha*, GRAND' EURY, 'Mém. Flore Carbon. Loire,' p. 74, Plate 8, figs. 10, 11.

1878. *Pecopteris polymorpha*, ZEILLER, 'Végét. foss. terr. houill.,' p. 91, Plate 169, figs. 1–3.

Distribution:—First Division—Woorgreens Coal, Woorgreens Colliery, Nos. 1583, 1585, 1586, 1587, 1797, 1799, 1958, 1961.

Second Division—Trafalgar Colliery, Nos. 1632, 1769, ? 1780, ? 1798, ? 1963; Park End Colliery, ? 1962; New Fancy Colliery, Nos. 1568, 1793; Foxe's Bridge Colliery, No. (?) 1612; Lightmoor Colliery, ? 1544, 1582.

Third Division—Yorkley Coal, Park Gutter Colliery, No. 1789; Coleford High Delph Coal, Lydbrook Colliery, ? No. 2107.

3. *Pecopteris arborescens* (Schloth.). Plate 11, fig. 3.

1804. ———— SCHLOTHEIM, 'Flora Vorwelt,' p. 41, Plate 7, fig. 11; Plate 8, figs. 13, 14.

1820. *Filicites arborescens*, SCHLOTHEIM, 'Petrefactenk.,' p. 404.

1833–4. *Pecopteris arborescens*, BRONGNIART, 'Hist. Végét. foss.,' vol. 1, p. 310, Plate 102, figs. 1, 2; Plate 103, figs. 2, 3.

1890. *Pecopteris* (*Asterotheca*) *arborescens*, ZEILLER, 'Bass. houill. et perm. d'Autun et d'Épinac,' fasc. 2, Part I, p. 43, Plate 8, fig. 1.

Distribution:—Third Division—Yorkley Coal, Park Gutter Colliery, No. 1979; Coleford High Delph Coal, Lydbrook Colliery, Nos. 2096, 2106.

4. *Pecopteris* (*Dactylotheca*) *plumosa* (Artis).

1825. *Filicites plumosus*, Artis, 'Antedil. Phytology,' p. 17, Plate 17.
1836. *Pecopteris plumosa*, Brongniart, 'Hist. Végét. foss.,' p. 348, Plates 121, 122.
1836. *Pecopteris delicatula*, Brongniart, *ibid.*, p. 349, Plate 116, fig. 6.
1896. *Dactylotheca plumosa*, Kidston, 'Trans. Roy. Soc. Edinburgh,' vol. 38, Part II, p. 205, Plates 1–3.

Distribution:—Third Division, Yorkley Coal, Park Gutter Colliery, Nos. 1548, 1981.

Semina Incertæ Sedis.

TRIGONOCARPUS Brongniart, 1828.

Trigonocarpus nœggerathi (Sternberg).

1826. *Palmacites Nœggerathi*, Sternberg, 'Vers. Darstell. Flora Vorwelt,' vol. 1, Part IV, p. xxxv, Plate 55, figs. 6, 7.
1886–8. *Trigonocarpus Nœggerathi*, Zeiller, 'Flore. foss. Bass. houill. Valenciennes,' p. 649, Plate 94, figs. 8–11.
1888. *Trigonocarpus Nœggerathi*, Kidston, 'Trans. Roy. Soc. Edinburgh,' vol. 33, Part II, p. 403, Plate 23, fig. 3.

Distribution:—Second Division—Trafalgar Colliery, Nos. 1666, 1668, 1684, 1730, 1735, 1739, 1741, 1742, 1743, 1744.

Lycopodiales.

LEPIDODENDRON Sternberg, 1820.

1. *Lepidodendron lanceolatum* Lesquereux. Plate 12, fig. 14.

1879–80. *Lepidodendron lanceolatum*, Lesquereux, 'Coal Flora Pennsylvan.,' p. P. 369, Plate 63, figs. 3–5.
1888. *Lepidodendron lanceolatum*, Kidston, 'Trans. Roy. Soc. Edinburgh,' vol. 33, Part II, p. 394, Plate 27, fig. 5; Plate 28, figs. 3, 4.

Distribution:—First Division—Woorgreens Coal, Woorgreens Colliery, Nos. 1617, 1662, 1679, 1779.

Second Division—Lightmoor Colliery, Nos. 1622, 1624, 1625; Park End Colliery, No. 1986.

2. *Lepidodendron aculeatum* Sternb.

1820. *Lepidodendron aculeatum*, Sternberg, 'Vers. Darstell. Flora Vorwelt,' vol. 1, Part I, pp. 20, 23, Plate 6, fig. 2; Plate 8, fig. 1b.
1886–8. *Lepidodendron aculeatum*, Zeiller, 'Flore foss. Bass. houill. Valenciennes,' p. 435, Plate 65, figs. 1–7.
1903. *Lepidodendron aculeatum*, Arber, 'Quart. Journ. Geol. Soc.,' vol. 59, p. 7, Plate 1, fig. 4.

1904. *Lepidodendron aculeatum*, ZALESSKY, 'Mém. Com. Géol. St. Petersburg,' N.S., Livr. 13, p. 3, Plate 1, figs. 1–6, 12; Plate 2, fig. 2.

Distribution:—Second Division—Trafalgar Colliery, No. 1504.
Third Division—Yorkley Coal, Park Gutter Colliery, No. 1956.

3. *Lepidodendron wortheni* Lesquereux.

1866. *Lepidodendron Wortheni*, LESQUEREUX, 'Geol. Surv. Illinois,' vol. 2, p. 452, Plate 44, figs. 4, 5.

1879–80. *Lepidodendron Wortheni*, LESQUEREUX, 'Coal Flora Pennsylvan.,' vol. 2, p. P. 388, Plate 64, figs. 8, 9.

1886–8. *Lepidodendron Wortheni*, ZEILLER, 'Flore foss. Bass. houill. Valenciennes,' p. 467, Plate 71, figs. 1–3.

1903. *Lepidodendron Wortheni*, ARBER, 'Quart. Journ. Geol. Soc.,' vol. 59, p. 12, Plate 2, fig. 6.

Distribution:—Second Division—New Fancy Colliery, No. 1626.
Third Division—Yorkley Coal, Park Gutter Colliery, ? No. 1548.

4. *Lepidodendron dichotomum* Sternberg. Plate 11, fig. 6.

1820. *? Lepidodendron dichotomum*, STERNBERG, 'Vers. Darstell. Flora Vorwelt,' Part I, p. 23, Plates 1 and 2; Part 7 (1838), p. 177, Plate 68, fig. 1.

1886–8. *Lepidodendron dichotomum*, ZEILLER, 'Flore foss. Bass. houill. Valenciennes,' p. 446, Plate 67, fig. 1.

1903. *Lepidodendron dichotomum*, ARBER, 'Mem. and Proc. Manchester Lit. and Phil. Soc.,' vol. 48, No. 2, p. 20, Plate 1, figs. 1, 2.

1904. *Lepidodendron dichotomum*, ZALESSKY, 'Mém. Com. Géol. St. Petersburg,' N.S., Livr. 13, p. 9, Plate 2, figs. 3, 5, 6; Plate 3, figs. 3, 5, 7–12; Plate 4, fig. 11.

Distribution:—Second Division—Trafalgar Colliery, No. 1953.
Third Division—Yorkley Coal, Flour Mill Colliery, No. 1645, 1681; Park Gutter Colliery, No. 1644.

HALONIA L. and H., 1833.

Halonia sp.

Distribution:—Second Division—Trafalgar Colliery, No. 1618.

Remarks.—This is a small portion of what was apparently a biseriate Halonial branch.

LEPIDOPHYLLUM Brongniart, 1828.

1. *Lepidophyllum majus* Brongniart.

1822. *Filicites* (*Glossopteris*) *dubius*, BRONGNIART, 'Class. Végét. foss.,' p. 232, Plate 13, fig. 4.

1828. *Lepidophyllum majus*, Brongniart, 'Prodr. Hist. Végét. foss.,' p. 87.
1834. *Lepidophyllum trinerve*, Lindley and Hutton, 'Fossil Flora,' vol. 2, Plate 152.
1855. *Lepidophyllum majus*, Geinitz, 'Verstein. Steinkohlenform. Sachsen,' p. 37, Plate 2, fig. 5.
1870. *Lepidophyllum majus*, Schimper, 'Traité Pal. végét.,' vol. 2, p. 72, Plate 61, fig. 8 ; ? Plate 64, fig. 9.

Distribution:—Second Division—New Fancy Colliery, No. 1746.

2. *Lepidophyllum brevifolium* Lesquereux.

1858. *Lepidophyllum brevifolium*, Lesquereux, in Rogers, 'Geol. of Pennsyl.,' vol. 2, Part II, p. 876, Plate 17, fig. 6.
1879–80. *Lepidophyllum brevifolium*, Lesquereux, 'Coal Flora Pennsyl.,' p. P. 447, Plate 69, fig. 33.
1888. *Lepidophyllum sp.*, Kidston, 'Trans. Roy. Soc. Edinburgh,' vol. 33, Part II, p. 395, Plate 27, figs. 7A, 7B.

Distribution:—Third Division—Yorkley Coal, Park Gutter Colliery, No. 1969.

Remarks.—The specimens from Radstock figured by Kidston (see above) were regarded as allied to *L. brevifolium* Lesq., but apparently there appeared to him to be some doubt as to their identity with Lesquereux's plant. I have examined other examples from Radstock and the Forest of Dean, and, while these exhibit among themselves some small variation in size and shape, they appear to me to agree very well with Lesquereux's figure, and I have therefore attributed them provisionally to his species.

3. *Lepidophyllum* sp.

Distribution:—Third Division—Yorkley Coal, Flour Mill Colliery, No. 1982.

LEPIDOPHLOIOS Sternberg, 1833.

cf. *Lepidophloios laricinus* Sternberg.

1820. *Lepidodendron laricinum*, Sternberg, 'Vers. Darstell. Flora Vorwelt,' vol. 1, Part I, p. 23, Plate 11, figs. 2–4.
1833. *Lepidofloyos laricinum*, Sternberg, *ibid.*, vol. 1, Parts 5–6, p. xiii.
1893. *Lepidophloios laricinus*, Kidston, 'Trans. Roy. Soc. Edinburgh,' vol. 37, Part III, p. 555, Plate 1, fig. 4, 4A ; Part II, Plate 8, 8A, 8B.

Distribution:—Third Division—Yorkley Coal, Flour Mill Colliery, No. 1683.

LEPIDOSTROBUS Brongniart, 1828.

Lepidostrobus sp.

Distribution:—Second Division—Trafalgar Colliery, Nos. 1749, 1750 ; Foxe's Bridge Colliery, Nos. 1748, 1751.

SIGILLARIA Brongniart, 1822.

1. *Sigillaria lævigata* Brongniart.

1828. *Sigillaria lævigata*, BRONGNIART, 'Hist. Végét. foss.,' p. 471, Plate 143.
1886–8. *Sigillaria lævigata*, ZEILLER, 'Flore foss. Bass. houill. Valenciennes,' p. 519, Plate 78, figs. 1–4.
1888. *Sigillaria lævigata*, KIDSTON, 'Trans. Roy. Soc. Edinburgh,' vol. 33, Part 2, p. 398, Plate 28, fig. 5.

Distribution:—Second Division—Trafalgar Colliery, No. 1503; New Fancy Colliery, No. 1659; Lightmoor Colliery, No. 1651; Crump Meadow Colliery, No. 1721.

2. *Sigillaria elongata* Brongniart. Plate 12, fig. 13.

1824. *Sigillaria elongata*, BRONGNIART, 'Ann. Sci. Nat.,' vol. 4, p. 33, Plate 2, figs. 3, 4.
1836. *Sigillaria elongata*, BRONGNIART, 'Hist. Végét. foss.,' p. 473, Plates 145 and 146, fig. 2.
1870. *Sigillaria elongata*, SCHIMPER, 'Traité Pal. Végét.,' vol. 2, p. 91, Plate 68, fig. 8.
1886–8. *Sigillaria elongata*, ZEILLER, 'Flore foss. Bass. houill. Valenciennes,' p. 545, Plate 81, figs. 1–9.

Distribution:—Second Division—Trafalgar Colliery, No. 1954; Park End Colliery, No. 1957; New Fancy Colliery, No. ? 1663.

3. *Sigillaria rugosa* Brongniart.

1836. *Sigillaria rugosa*, BRONGNIART, 'Hist. Végét. foss., p. 476, Plate 144, fig. 2.
1848. *Sigillaria rugosa*, SAUVEUR, 'Végét. foss. Terr. houill. Belgique,' Plate 58, fig. 1.
1879–80. *Sigillaria marginata*, LESQUEREUX, 'Coal Flora Pennsyl.,' p. P. 498, Plate 71, fig. 5.
1886–8. *Sigillaria rugosa*, ZEILLER, 'Flore foss. Bass. houill. Valenciennes,' p. 551, Plate 80, figs. 1–5.

Distribution:—Second Division—New Fancy Colliery, Nos. 1669, 1671, 1675, 1724; Foxe's Bridge Colliery, No. 1747.

4. *Sigillaria trigona* Sternberg. Plate 12, fig. 11.

1820. *Lepidodendron trigonum*, STERNBERG, 'Vers. Darstell. Flora Vorwelt,' vol. 1, Part I, p. 21, Plate 9, fig. 1.
1833. *Favularia trigona*, STERNBERG, *ibid.*, Parts V and VI, p. xiii.

1887. *Sigillaria trigona*, WEISS, 'Abhandl. K. Preuss. Geol. Landesanst.,' vol. 7, pp. 262–279, Plate 11 (5), fig. 54.

1894. *Sigillaria trigona*, KIDSTON, 'Trans. Manchester Geol. Soc.,' vol. 22, p. 11, text-fig. on p. 11.

Distribution:—Second Division—New Fancy Colliery, No. 1752.

Description.—The specimen figured on Plate 12, fig. 11, is no doubt nearly allied to *S. mamillaris* Brongn., though, as regards the shape of the leaf scar, it is quite distinct from the typical examples of that variable species, occurring in Britain. The apical angle of the scar is rounded, and the upper lateral margins, on each side, are markedly concave, so that the whole outline of the scar is somewhat pyriform in shape. So far as one can judge from STERNBERG'S somewhat rough figure of his example from Radnitz in Bohemia, this specimen agrees with his *S. trigona*, and a comparison with the much clearer figures given by WEISS and KIDSTON confirms this conclusion. So far as I am aware this species has only been previously recorded from Britain from the Middle Coal Measures of Lancashire. The leaf-base, below the scar, has a faint vertical median ridge, with a very faint, oblique, lateral ridge on either side, the latter traversed by fine oblique striæ, slanting in the opposite direction to the lateral ridges.

5. *Sigillaria tessellata* (Steinh.). Plate 12, fig. 12.

1818. *Phytolithus tessellatus*, STEINHAUER, 'Trans. Amer. Phil. Soc.,' N.S., vol. 1, p. 295, Plate 7, fig. 2.

1836–37. *Sigillaria tessellata*, BRONGNIART, 'Hist. Végét. foss.,' p. 436, Plate 156, fig. 1, Plate 162, figs. 1–4.

1886–8. *Sigillaria tessellata*, ZEILLER, 'Flore foss. Bass. houill. Valenciennes,' p. 561, Plate 85, figs. 1–9, Plate 86, figs. 1–6.

1887. *Sigillaria fossorum*, WEISS, 'Abhand. K. Preuss. Geol. Landesanst.,' vol. 7, p. 254, Plate 9 (3), figs. 25–32.

Distribution:—Second Division—New Fancy Colliery, Nos. 1672–3.

Remarks.—This specimen (Plate 12, fig. 12) appears to be distinct from *S. cumulata* Weiss, recorded by KIDSTON in 1905, from the Radstock coalfield. It is probably one of the numerous varieties of *S. tessellata*, perhaps approximating very closely to *S. fossorum* Weiss, which I regard merely as a variety of that species.

6. *Sigillaria brardi*, Brongn., var. *denudata* Gœppert. Plate 12, fig. 10.

1822. *Clathraria Brardii*, BRONGNIART, 'Class. Végét. foss.,' p. 222, Plate 12, fig. 5.

1865. *Sigillaria denudata*, GOEPPERT, 'Palæontogr.,' vol. 12, p. 200, Plate 34, fig. 1.

1893. *Sigillaria mutans*, var. *denudata*, WEISS, 'Abhandl. K. Preuss. Geol. Landesanst.,' N.F., vol. 2, p. 92, Plate 8, fig. 39.

1896. *Sigillaria Brardi*, KIDSTON, 'Proc. Roy. Phys. Soc. Edinburgh,' vol. 13, p. 237, Plate 7, figs. 1, 1c.

Distribution:—Second Division—Trafalgar Colliery, No. 1967.

CORDAITALES.

CORDAITES, Unger, 1850.

Cordaites angulosostriatus, Grand' Eury. Plate 13, fig. 18.

1877. *Cordaites angulosostriatus*, GRAND' EURY, 'Mém. Flore Carbon. Loire,' p. 217, Plate 19.

1878. *Cordaites angulosostriatus*, ZEILLER, 'Végét. foss. Terr. houill.,' p. 144, Plate 175, figs. 2, 3.

1881. *Cordaites angulosostriatus*, RENAULT, 'Cours. Bot. foss.,' vol. 1, p. 90, Plate 12, fig. 3.

Distribution:—Second Division—Foxe's Bridge Colliery, Nos. 1731, 1736, 1738, 1955, 1962; Trafalgar Colliery, Nos. 1593, 1732, 1734, 1740; New Fancy Colliery, ? No. 1592; Lightmoor Colliery, No. 1631 (Starkey Coal).

Third Division—Coleford High Delph Coal, Lydbrook Colliery, Nos. 2093, 2098, 2100.

4. *The Upper Coal Measure Horizon.*

We have now to compare the floras of the three divisions (see p. 234) of the Upper Carboniferous rocks of the Forest of Dean. The following table gives a list of the species here recorded, and the vertical distribution of each in the Forest:—

TABLE I.—The Vertical Distribution of Species in the Forest of Dean.

(X = rare; XX = moderately abundant; XXX = very abundant.)

Species.	First Division (Highest) Woorgreens Coals.	Second Division Coals.	Third Division.	
			Yorkley Seam.	Coleford High Delph Seam.
EQUISETALES.				
Calamites varians Sternb.	—	X		
C. ramosus Artis	—	X		
C. suckowi Brongn.	—	X		
C. undulatus ? Sternb.	—	X		
Calamocladus equisetiformis (Schloth.)	XXX	XXX	X	
Annularia radiata ? (Brongn.)	—	X		
A. stellata (Schloth.)	—	—	—	X
A. sphenophylloides (Zenker)	X	X		
A. galioides (L. and H.)	X			
Calamostachys tuberculata (Sternb.)	—	XX	—	X
Macrostachya infundibuliformis (Brongn.)	?	XX	X	?

TABLE I—*continued.*

Species.	First Division (Highest) Woorgreens Coals.	Second Division Coals.	Third Division.	
			Yorkley Seam.	Coleford High Delph Seam.
SPHENOPHYLLALES.				
Sphenophyllum emarginatnm Brongn.	—	XXX	XXX	X
S. majus (Bronn)	—	—	X	
PTERIDOSPERMEÆ AND FILICALES.				
Sphenopteris neuropteroides (Boulay).	X	X	XXX	
S. (*Renaultia*) *chærophylloides* (Brongn.)	X			
Mariopteris muricata (Schloth.)	—	XX	XX	
M. latifolia ? (Brongn.)	—	—	X	
Neuropteris scheuchzeri Hoffm.	—	XX	XX	
N. macrophylla Brongn.	—	XX	XX	?
N. ovata Hoffm.	?	XXX	XXX	XXX
N. rarinervis Bunb.	—	X		
N. (*Cyclopteris*) *fimbriata* Lesq.	—	XX	—	X
Alethopteris aquilina (Schloth.)	—	XX		
A. grandini (Brongn.)	—	X	X	
A. davreuxi (Brongn.)	—	XXX		
Pecopteris miltoni (Artis)	X	XXX	XXX	?
P. polymorpha Brongn.	XXX	XXX	X	?
P. arborescens ? (Schloth.)	—	—	X	X
P. (*Dactylotheca*) *plumosa* (Artis)	—	—	X	
SEMINA INCERTÆ SEDIS.				
Trigonocarpus nœggerathi (Sternb.)	—	XXX		
LYCOPODIALES.				
Lepidodendron lanceolatum Lesq.	XXX	XXX		
L. aculeatum Sternb.	—	X	X	
L. wortheni Lesq.	—	X	?	
L. dichotomum Sternb.	—	X	XX	
Lepidophloios cf. *L. laricinus* Sternb.	—	—	X	
Lepidophyllum majus Brongn.	—	X		
L. brevifolium Lesq.	—	—	X	
Sigillaria lævigata Brongn.	—	XX		
S. elongata Brongn.	—	XX		
S. rugosa Brongn.	—	XXX		
S. trigona Sternb.	—	X		
S. tessellata (Steinh.)	—	X		
S. brardi Brongn., var. *denudata* Gœpp.	—	X		
CORDAITALES.				
Cordaites angulosostriatus Grand' Eury	—	XXX	—	XX

The number of records from the seams of the First and Third Divisions is naturally less than that from the coals of the Second Division. The plants from the First Division were obtained from two seams only, worked at a single colliery, those from the Third, from two seams, worked at three pits, whereas those from the Second Division were collected at many large collieries, each working several coals.

Comparing the flora of the First Division with that of the Second, we find that all the species recorded above are common to the two, except :—

Annularia galioides (L. and H.),
Sphenopteris (*Renaultia*) *chærophylloides* (Brongn.),

both of which are rare, and represented only by two specimens in each case. The commonest species of the First Division are :—

Calamocladus equisetiformis (Schloth.).
Pecopteris polymorpha (Brongn.).
Lepidodendron lanceolatum Lesq.

All of these are also abundant in the Second Division.

There appears to be no essential difference between the flora of the Woorgreens coals and that of the Second Division, and the horizon of the former is undoubtedly the same as that of the latter.

Turning next to the Third Division, we find that the following species have not been obtained from the higher beds :—

Annularia stellata (Schloth.).
Sphenophyllum majus (Bronn).
Mariopteris latifolia ? (Brongn.).
Pecopteris arborescens (Schloth.).
P. (*Dactylotheca*) *plumosa* (Artis).
Lepidophloios, cf. *L. laricinus* Sternb.
Leipidophyllum brevifolium Lesq.

The most abundant plants in the Third Division are :—

Sphenophyllum emarginatum Brongn.
Sphenopteris neuropteroides (Boul.).
Neuropteris ovata Hoffm.
Pecopteris miltoni (Artis).

These are also frequent in the Second Division, except *Sphenopteris neuropteroides* (Boul.).

From a comparison of the floras of the three Divisions we thus arrive at the conclusion that they are practically identical, and that the palæobotanical horizon is undoubtedly the same in each case. This horizon is unmistakeably that known to the palæobotanist as the Upper Coal Measures, and we have thus arrived at the

important deduction, which it was one of the particular objects of this work to determine, that *the whole of the productive coal measures of the Forest of Dean belong to one horizon, the Upper Coal Measures*. This conclusion is in entire agreement with the opinion expressed by Dr. KIDSTON* many years ago, though the fact that no other horizon is represented among the productive series had not hitherto been proved, nor had the vertical distribution of the flora been previously worked out in detail.

We will now compare the fossil flora of the Forest of Dean with the Upper Coal Measure floras as developed elsewhere in Britain.

TABLE II.—The Distribution of the Forest of Dean Species in other Coalfields.

Forest of Dean Species.	Radstock and Farrington Series, Somerset.†	Farrington Series, Bristol.‡	Other British Upper Coal Measure Floras.§
EQUISETALES.			
Calamites varians Sternb.	X		
C. ramosus Artis	X	X	
C. suckowi Brongn.	X	X	X
C. undulatus ? Sternb.	—	—	X
Calamocladus equisetiformis (Schloth.)	X	—	X
Annularia radiata ? (Brongn.)	—	?	X
A. stellata (Schloth.)	X	X	X
A. sphenophylloides (Zenker)	X	X	X
A. galioides (L. and H.)	—	—	—
Calamostachys tuberculata (Sternb.)	X		
Macrostachya infundibuliformis (Brongn.)	X		
SPHENOPHYLLALES.			
Sphenophyllum emarginatum Brongn.	X	X	X
S. majus (Bronn).	—	—	—
PTERIDOSPERMEÆ AND FILICALES.			
Sphenopteris neuropteroides (Boul.)	X	X	X
S. (*Renaultia*) *chærophylloides* (Brongn.)	X‖		
Mariopteris muricata (Schloth.)	X	X	X
M. latifolia ? (Brongn.)	—	—	—
Neuropteris scheuchzeri Hoffm.	X	X	X
N. macrophylla Brongn.	X	X	
N. ovata Hoffm.	X	X	X
N. rarinervis Bunb.	X	—	X

* KIDSTON ('94[1]), p. 214; ('94[2]), p. 570.

† KIDSTON ('88).

‡ KIDSTON ('88), LILLIE ('10).

§ In either South Wales, KIDSTON ('94[2]); the Midland Counties, KIDSTON ('05); or Canonbie, KIDSTON ('03).

‖ Collected by the Author, previously unrecorded, see p. 246.

TABLE II—*continued.*

Forest of Dean Species.	Radstock and Farrington Series, Somerset.	Farrington Series, Bristol.	Other British Upper Coal Measure Floras.
PTERIDOSPERMEÆ AND FILICALES—*contd.*			
N. (*Cyclopteris*) *fimbriata* Lesq.	X		
Alethopteris aquilina (Schloth.)	X	—	X
A. grandini (Brongn.)	X	—	X
A. davreuxi (Brongn.)	X		
Pecopteris miltoni (Artis)	X	X	X
P. polymorpha Brongn.	X	X	
P. arborescens (Schloth.)	X	X	X
P. (*Dactylotheca*) *plumosa* (Artis)	X	X	
SEMINA INCERTÆ SEDIS.			
Trigonocarpus nœggerathi (Sternb.)	X	X	
LYCOPODIALES.			
Lepidodendron lanceolatum Lesq.	X	X	
L. aculeatum Sternb.	X		
L. wortheni Lesq.	X		
L. dichotomum Sternb.	—	—	—
Lepidophloios cf. *L. laricinus* Sternb.	?		
Lepidophyllum majus Brongn.	X	X	
L. brevifolium Lesq.	X		
Sigillaria lævigata Brongn.	X		
S. elongata Brongn.	—	X	
S. rugosa Brongn.	—	—	—
S. trigona Sternb.	—	—	—
S. tessellata (Steinh.)	—	—	X
S. brardi Brongn., var. *denudata* Gœpp.	—	—	—
CORDAITALES.			
Cordaites angulosostriatus Grand' Eury	X	X	X

From this table we see that there is a very marked agreement between the flora of the Forest of Dean and the Upper Coal Measure floras of other British coalfields. On the other hand, the following species, here recorded from the Forest, have not previously been obtained from the Upper Coal Measures :—

Annularia galioides (L. and H.).
Sphenophyllum majus (Bronn).
Mariopteris latifolia ? (Brongn.).
Lepidodendron dichotomum Sternb.
Sigillaria rugosa Brongn.
S. trigona Sternb.
S. brardi Brongn. var. *denudata* Gœpp.

Of these, *Annularia galioides* (L. and H.), *Lepidodendron dichotomum* Sternb., *Sigillaria rugosa* Brongn., and *S. brardi* Brongn., have been already recorded elsewhere from the lower horizons of the Transition Coal Measures and the Middle Coal Measures, and now, from a still higher horizon, in the Forest. On the other hand, *Sphenophyllum majus* Bronn, and *Mariopteris latifolia* (Brongn.), have not apparently been previously found above the Middle Coal Measures, while *Sigillaria trigona* Sternb. is very rare in Britain on that horizon.

A more detailed comparison of the flora of the Forest with that of the Upper Coal Measures of Radstock and Bristol, the nearest coalfields to the South, is of interest, for, as will be seen from the following table, there are considerable differences in detail between them. This list contains all the recorded species from the three coalfields :—

TABLE III.—The Comparative Distribution of the Floras of the Forest of Dean, Radstock and Bristol Coalfields.

Species.	Forest of Dean.	Upper Coal Measures, Radstock.	Upper Coal Measures, Bristol.
EQUISETALES.			
Calamites varians Sternb.	X	X	
C. suckowi Brongn.	X	X	X
C. ramosus Artis	X	X	X
C. undulatus Sternb.	?	—	
C. cannæformis Schloth.	—	X	
C. cisti Brongn.	—	X	X
C. cruciatus Weiss	—	X	
Calamocladus equisetiformis (Schloth.)	X	X	
Annularia stellata (Schloth.)	X	X	X
A. radiata (Brongn.)	?	—	?
A. sphenophylloides (Zenker)	X	X	X
A. galioides (L. and H.)	X	—	
Calamostachys tuberculata (Sternb.)	X	X	
Macrostachya infundibuliformis (Brongn.)	X	X	
SPHENOPHYLLALES.			
Sphenophyllum emarginatum Brongn.	X	X	X
S. majus (Bronn)	X	—	
PTERIDOSPERMEÆ AND FILICALES.			
Sphenopteris neuropteroides (Boulay)	X	X	X
S. (Renaultia) chærophylloides (Brongn.)	X	—	
S. tenuifolia Gutbier	—	X	
S. geniculata Germ. and Kaulf.	—	X	
S. grandini (Gœpp.)	—	X	
S. macilenta, L. and H.	—	X	
S. woodwardi Kidst.	—	X	
S. cristata (Brongn.)	—	X	
S. ovatifolia Lillie	—	—	X

TABLE III—*continued.*

Species.	Forest of Dean.	Upper Coal Measures, Radstock.	Upper Coal Measures, Bristol.
PTERIDOSPERMEÆ AND FILICALES—*continued.*			
Ptychocarpus oblongus Kidst.	—	X	
Schizostachys sphenopteroides Kidst.	—	X	
Macrosphenopteris lindsæoides Kidst.	—	X	?
Mariopteris muricata (Schloth.)	X	X	X
M. nervosa (Brongn.)	—	X	
M. latifolia (Brongn.)	?	—	
Neuropteris scheuchzeri Hoffm.	X	X	X
N. macrophylla Brongn.	X	X	X
N. flexuosa Sternb.	—	X	X
N. ovata Hoffm.	X	X	X
N. rarinervis Bunb.	X	X	
N. (Cyclopteris) fimbriata Lesq.	X	X	
Dictyopteris münsteri (Eichw.).	—	X	
Odontopteris lindleyana Sternb.	?	X	
Alethopteris aquilina (Schloth.)	X	X	
A. grandini (Brongn.)	X	X	
A. davreuxi (Brongn.)	X	X	
A. lonchitica (Schloth.).	—	X	X
A. serli (Brongn.)	—	X	X
Pecopteris miltoni (Artis)	X	X	X
P. polymorpha Brongn.	X	X	X
P. oreopteridia (Schloth.)	—	X	X
P. arborescens (Schloth.)	X	X	X
P. (Dactylotheca) plumosa (Artis).	X	X	X
P. candolliana Brongn.	—	X	
P. asper? Brongn.	—	X	
P. pennæformis Brongn.	—	X	
P. unita Brongn	—	X	
P. villosa Brongn.	—	X	
P. cisti Brongn.	—	X	
P. bucklandi Brongn.	—	X	
P. pteroides Brongn.	—	X	X
P. crenulata Brongn.	—	X	X
P. lamuriana Heer	—	X	
P. pinnatifida (Gutb.)	—	X	
Dicksoniites pluckeneti (Schloth.)	—	X	
Corynepteris erosa (Gutbier)	—	X	
Rhacophyllum crispum (Gutb.)	—	X	X
R. filiciforme (Gutb.)	—	X	
R. goldenbergi Weiss	—	X	X
R. spinosum Lesq.	—	X	X
Schizopteris lactuca Presl.	—	—	X
Megaphyton frondosum Artis	—	X	
M. elongatum Kidst.	—	X	
Caulopteris primæva L. and H.	—	X	
C. anglica Kidst.	—	X	
C. macrodiscus (Brongn.)	—	X	X
SEMINA INCERTÆ SEDIS.			
Trigonocarpus nœggerathi (Sternb.)	X	X	X
? T. dawesii L. and H.	—	X	

TABLE III—*continued.*

Species.	Forest of Dean.	Upper Coal Measures, Radstock.	Upper Coal Measures, Bristol.
SEMINA INCERTÆ SEDIS—*continued.*			
Rhabdocarpus multistriatus (Presl.)	—	X	
Cardiocarpus gutbieri Gein.	—	X	
C. fluitans Dawson	—	X	
Carpolithus ovoideus Gœpp. and Berg.	—	X	
LYCOPODIALES.			
Lepidodendron lanceolatum Lesq.	X	X	X
L. aculeatum Sternb.	X	X	
L. wortheni Lesq.	X	X	
L. dichotomum Sternb.	X	—	
L. rhombicum (Sternb.).	—	X	
L. cf. *L. glincanum* Eichw.	—	—	X
Lepidophyllum majus Brongn.	X	X	X
L. brevifolium Lesq.	X	X	X
Lepidostrobus spinosus Kidst.	—	X	
Sigillaria lævigata Brongn.	X	X	
S. elongata Brongn.	X	—	X
S. rugosa Brongn.	X	—	
S. trigona Sternb.	X	—	
S. tessellata (Steinh.)	X	—	
S. cumulata Weiss	—	X	
S. brardi Brongn.	X	—	
S. major (L. and H.)	—	X	
S. serlii Brongn.	—	X	
S. m'murtriei Kidst.	—	X	
S. reniformis Brongn.	—	X	X
S. alternans (Sternb.)	—	X	
S. notata (Steinh.)	—	X	
S. voltzia Brongn.	—	—	X
Asolanus camptotænia Wood	—	X	
Omphalophloios anglica (Sternb.)	—	X	
Stigmaria ficoides (Sternb.).	X	X	X
CORDAITALES.			
Cordaites angulosostriatus Grand' Eury	X	X	X
Poacordaites microstachys (Goldenb.).	—	X	

Equisetales.—From this table we see that the representatives of the Equisetales are largely identical. In the Forest of Dean, Calamite pith-casts are as infrequent as at Radstock. *Calamites undulatus* Sternb., which is not found at Radstock or Bristol, is, however, known from the Upper Coal Measures elsewhere in Britain. On the other hand, *C. cruciatus* Weiss is very rare at Radstock, only two specimens being known.

Annularia galioides (L. and H.) is the most remarkable species new to this horizon.

Calamocladus equisetiformis (Schloth.) is the most frequent type of Calamite foliage in the Forest, where *Annularia stellata* (Schloth.) and *A. sphenophylloides* (Zenker), both of which are very abundant at Radstock, are very rare, only one specimen of the former, and two of the latter, having been collected. Several examples of the cones *Calamostachys tuberculata* (Sternb.) belonging to the same plant as the leaves *Annularia stellata* (Schloth.) have, however, been found.

The very interesting cone *Macrostachya infundibuliformis* (Brongn.) appears to be a little more frequent in the Forest than at Radstock, where it is very rare.

Sphenophyllales.—Passing to the Sphenophyllales, we find *Sphenophyllum emarginatum* Brongn. as abundant in the Forest as at Radstock. Two specimens of *S. majus* (Bronn) have also been obtained from the Forest, and this plant has apparently not been recorded elsewhere from the Upper Coal Measures.

Pteridospermeæ and Filicales.—Of the Sphenopterids, only one is common both to the Forest and to Radstock. *S. neuropteroides* (Boulay) is abundant in the former, but rare in the latter coalfield. The six other species of *Sphenopteris*, recorded from Radstock by KIDSTON, are all infrequent, four of them being very rare or known only from a single specimen. This is also the case as regards the records of the genera *Ptychocarpus*, *Schizostachys*, and *Macrosphenopteris*. On the other hand, the occurrence of *Sphenopteris* (*Renaultia*) *chærophylloides* (Brongn.) in the Forest is the only recorded instance of this species in the Upper Coal Measures in Britain. I believe I have also collected it from Radstock.

Mariopteris muricata (Schloth.) and *M. nervosa* (Brongn.) are stated to be very rare at Radstock. The former species is not infrequent in the Forest, where *M. latifolia* (Brongn.) may also occur.

The Neuropterids, on the other hand, correspond very closely, both as regards species and abundance. *N. scheuchzeri* Hoff., *N. macrophylla* Brongn., and *N. ovata* Hoffm., are all frequent, both at Radstock and in the Forest, while *N. rarinervis* Bunb. and *N.* (*Cyclopteris*) *fimbriata* (Lesq.) are much rarer in both coalfields. *Dictyopteris münsteri* (Eichw.) has been recorded by KIDSTON from Radstock, and another species *D. brongniarti* Gutb. from the Forest (see p. 240). *Odontopteris* occurs in both coalfields, though but very rarely, and the Forest species has not been determined.

As regards the Alethopterids, the most striking difference is the absence in my collections of any examples of *A. serli* and *A. lonchitica*, the former species being one of the commonest and most typical plants at Radstock. Dr. KIDSTON (see p. 240) has, however, recorded both species from the Forest, where they must be very rare. In the Forest of Dean, *A. davreuxi* (Brongn.) and *A. aquilina* (Schloth.) are the two commonest representatives of this genus, but while fairly abundant they are by no means so frequent as *A. serli* is at Radstock, where these two species are very rare. *A. grandini* (Brongn.) is rare in both coalfields.

The Pecopterids of the Forest, so far as the recorded species are concerned, agree very closely with those of the Radstock coalfield, with the important exception that *Pecopteris oreopteridea*, so abundant at Radstock, is probably unknown in the Forest, where its place is taken by *P. polymorpha* Brongn., which is very rare at Radstock. *Pec. arborescens* (Schloth.), another abundant Radstock species, is rare in the Forest, only three examples having been obtained from the Third Division.* *P. miltoni* (Artis) is abundant in both coalfields, though *P.* (*Dactylotheca*) *plumosa* (Artis), which is very frequent at Radstock, is rare in the Forest.

The other eleven species of *Pecopteris*, recorded by KIDSTON from Radstock, are unknown from the Forest, and so also is *Dicksoniites pluckeneti* (Schloth.). All of these, however, except *P. unita* Brongn., are very rare plants, only represented in Britain by a very few specimens.

Lycopodiales.—Turning next to the Lycopodiales, we find that the commoner species of *Lepidodendron* and *Lepidophyllum* occur in about equal abundance in both coalfields. In the case, however, of the Sigillarias, matters are very different. Seven of the species recorded from Radstock by KIDSTON are there very rare, and no examples of these, nor of *Asolanus camptotænia* Wood, have been met with in the Forest. The two commonest Radstock species are *S. cumulata* Weiss and *S. lævigata* Brongn., the latter alone being found in the Forest, where the other important species are *S. elongata* Brongn., *S. rugosa* Brongn. *S. tessellata* (Steinh.), *S. brardi* (Brongn.), and *S. trigona* Sternb. also occur in the Forest, where they are rare. These three species have not been found at Radstock.

Cordaitales.—The leaf *Cordaites angulosostriatus* Grand' Eury is as abundant in the Forest as at Radstock.

From this comparison of the floras of the Forest of Dean and Radstock coalfields, we see that while there is a general agreement, there are differences in detail, which are more marked than those which exist between the known floras of Radstock and Bristol (see Table III). These differences, however, do not appear to indicate any considerable disagreement as regards horizon, for, as we shall see, the percentage of essentially Stephanian plants present is approximately the same in each case. They are best explained as local variations in the distribution of the flora of the period.

As compared with the flora of the Upper Coal Measures (Upper Pennant) of South Wales,† of which, unfortunately, little is known at present, we find that five Forest of Dean species are there represented out of a total of eight recorded. Two of the three species occurring in South Wales, which are not included in my collections, have, however, been previously recorded by KIDSTON (see p. 240) from the Forest of Dean. They are *Alethopteris serli* (Brongn.) and *A. lonchitica*

* There is, however, a specimen of this species from the Second Division, at Trafalgar Colliery, in the Sedgwick Museum, Cambridge (No. 1216), which was presented by Mr. W. H. NORRIS in 1905.

† KIDSTON ('94[2]).

(Schloth.). *Neuropteris flexuosa* Sternb., abundant at Radstock and in South Wales, is apparently unrecorded from the Forest.

Lastly, we may institute a comparison with the scanty flora known from the Newent Coalfield,* lying but a short distance North of the Forest of Dean. Of the nine Newent species, two only, *Sphenopteris obtusiloba* Brongn. and *Pecopteris oreopteridea* (Schloth.), are unrepresented in my collections from the Forest, and of these the latter has been previously recorded by KIDSTON (see p. 240).

The flora of the Upper Coal Measure horizon is essentially Westphalian in type, though a considerable number of Stephanian species are present, as I have recently explained in another paper.† In the case of the Radstock flora, as recorded by Dr. KIDSTON, out of some 90 species, about 24 are essentially Stephanian plants, or 26·6 per cent. In the case of the Forest of Dean flora, as indicated by the following table, 11 essentially Stephanian species occur out of a total of 44, or 25 per cent. Table IV shows the distribution in time of the Forest of Dean species, all of which are known from the Westphalian. Some of them are essentially Stephanian plants, while others, essentially Westphalian, are also known to occur in the higher zone.

TABLE IV.—The Distribution in Time of the Forest of Dean Species.

Forest of Dean Species.	Essentially Westphalian.	Essentially Stephanian.	Also known from the Stephanian.
EQUISETALES.			
Calamites varians Sternb.	X		
C. ramosus Artis	X	—	X
C. suckowi Brongn.	X	—	X
C. undulatus Sternb.	X		
Calamocladus equisetiformis (Schloth.)	X	—	X
Annularia radiata (Brongn.)	X		
A. stellata (Schloth.)	—	X	
A. sphenophylloides (Zenker)	—	X	
A. galioides (L. and H.)	X		
Calamostachys tuberculata (Sternb.)	—	X	
Macrostachya infundibuliformis (Brongn.)	—	X	
SPHENOPHYLLALES.			
Sphenophyllum emarginatum Brongn.	X	—	X
S. majus (Bronn)	X	—	X
PTERIDOSPERMEÆ AND FILICALES.			
Sphenopteris neuropteroides (Boul.)	X		
S. (Renaultia) chærophylloides (Brongn.)	X		

* ARBER ('10).

† ARBER ('09), pp. 37–38.

TABLE IV—*continued.*

Forest of Dean Species.	Essentially Westphalian.	Essentially Stephanian.	Also known from the Stephanian.
PTERIDOSPERMEÆ AND FILICALES—*contd.*			
Mariopteris muricata (Schloth.)	X		
M. latifolia ? (Brongn.)	X		
Neuropteris scheuchzeri Hoffm.	X		
N. macrophylla Brongn.	X		
N. ovata Hoffm.	X	—	X
N. rarinervis Bunb.	X		
N. (*Cyclopteris*) *fimbriata* Lesq.	X		
Alethopteris aquilina (Schloth.)	X	—	X
A. grandini (Brongn.)	—	X	
A. davreuxi (Brongn.)	X		
Pecopteris miltoni (Artis)	X		
P. polymorpha Brongn.	—	X	
P. arborescens (Schloth.)	—	X	
P. (*Dactylotheca*) *plumosa* (Artis).	X	—	X
SEMINA INCERTÆ SEDIS.			
Trigonocarpus nœggerathi (Sternb.)	—	X	
LYCOPODIALES.			
Lepidodendron lanceolatum Lesq.	X		
L. aculeatum Sternb.	X		
L. wortheni Lesq.	X		
L. dichotomum Sternb.	X		
Lepidophloios laricinus Sternb.	X	—	X
Lepidophyllum majus Brongn.	—	X	
L. brevifolium Lesq.	? X		
Sigillaria lævigata Brongn.	X		
S. elongata Brongn.	X		
S. rugosa Brongn.	X	—	X
S. trigona Sternb.	?		
S. tessellata (Steinh.)	X	—	X
S. brardi Brongn.	—	X	
CORDAITALES.			
Cordaites angulosostriatus Grand' Eury	—	X	

5. *The "Millstone Grits" of the Forest of Dean.*

The Third Division (see table on p. 236) of the productive measures of the Forest is, as has been already pointed out, essentially an arenaceous series. The sandstones, especially those both above and below the Wittington Coal, are quarried on a large scale and exported from the Forest. They are much used for building purposes, the

reputation of the Forest of Dean Stone being considerable in the West of England. As has been shown here, these sandstones are of Upper Coal Measure age.

Below the Trenchard Coal, and above the Carboniferous Limestone, we also find arenaceous rocks, red in colour, with subsidiary beds of marl, limestone, and ironstone, and, near their base, conglomerates. The thickness of these beds no doubt varies locally. It is estimated at 299 feet by BUCKLAND and CONYBEARE,* 265 feet by DE LA BECHE,† 470 feet by WETHERED,‡ and 612–780 feet by HOSKOLD.§ In MUSHET'S section, quoted by BUCKLAND and CONYBEARE,‖ these beds are termed Millstone Grit, and the same term has also been applied to them by all those who have since written on the geology of this coalfield, and, except by MACLAUGHLAN, they have always been mapped as such.

It may be worth while to quote here the details of these strata as given in MUSHET'S section—

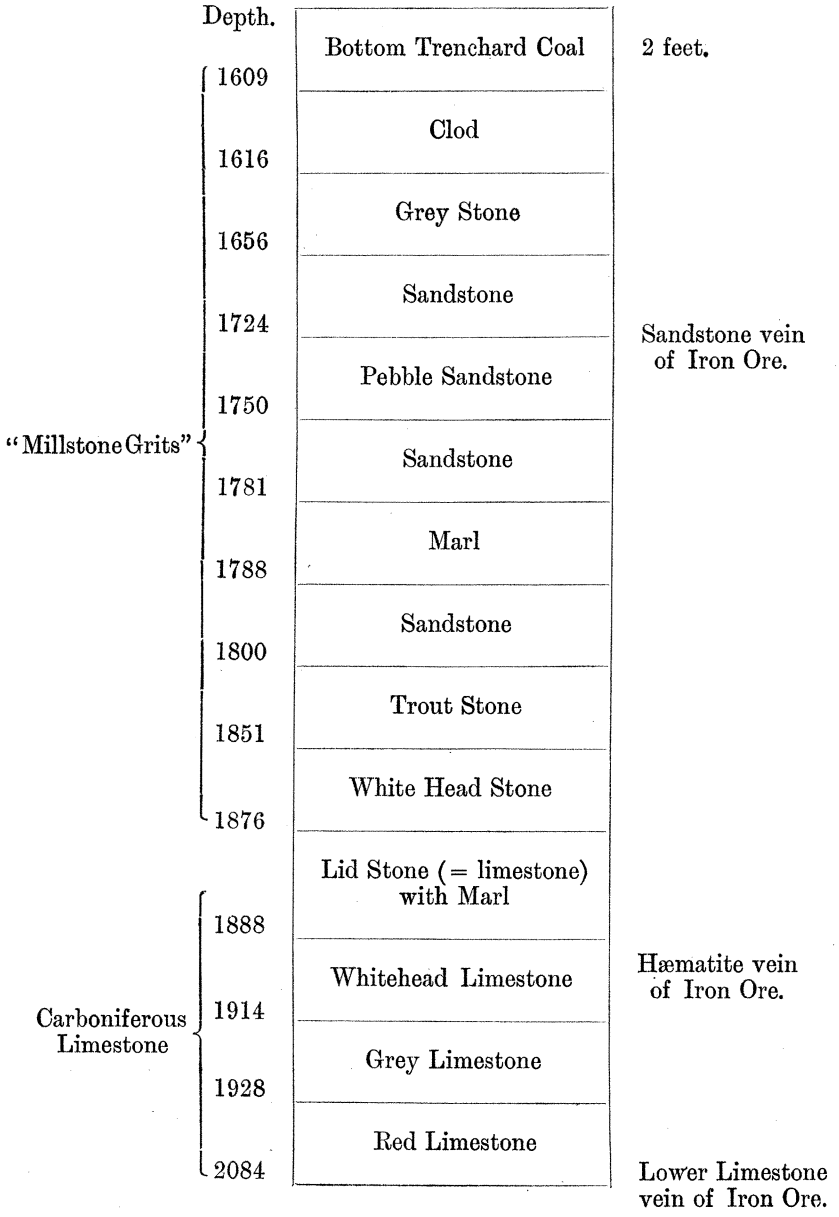
Lower Trenchard Coal.

		Fath.	ft.	ins.
(Millstone grit) No. 1	Fire-clay and coarse sharp red gritstone, or Farewell rock	5	0	0
	Red sandstone, with layers of red and white indurated marl, falling to pieces by exposure to the weather. It contains cobalt towards the bottom at Mitchell Dean	12	3	0
	Upper limestone Bed	5	0	0
	Pure siliceous red grit, with two beds of pudding stone	15	0	0

Nos. 142–160 of WILLIAM'S section, quoted by DE LA BECHE,¶ are called the Farewell Rock Series, overlying the Carboniferous Limestone Series. These strata are recorded as alternations of sandstone and marl, but no mention is made of any conglomerates or beds of iron ore.

The most detailed section which I have seen of these beds, especially as developed in the Mitcheldean area, is one which was lent to me by the Crown Office in Coleford. The portion relating to the "Millstone Grit" series is as follows :—

* BUCKLAND and CONYBEARE ('24), p. 289.
† DE LA BECHE ('46), p. 206.
‡ WETHERED ('83), p. 216.
§ HOSKOLD ('92), pp. 128–129.
‖ BUCKLAND and CONYBEARE ('24), p. 289.
¶ DE LA BECHE ('46), p. 206.



If we enquire what is the evidence for regarding the 267 feet of arenaceous sediments, as shown above, lying below the Trenchard Coal and above the Lid Stone, as the equivalents of the Millstone Grits of the North Midland coalfields, we find that it rests entirely on lithological grounds. It will be remembered that there was formerly a tendency, in the case of nearly all British coalfields, to map the basal sediments of the Upper Carboniferous sequence, whenever they have proved to be sandy or gritty, as Millstone Grits. The only true Millstone Grits are those beds which belong palæontologically to the basal portion of the Lower Coal Measures horizon. In recent years the suspicion that such mapping is sometimes unreliable has become more and more pronounced, especially where the lithology is the sole

basis of such conclusions. It seems to have been overlooked that the first phase in the initiation of an Upper Carboniferous sequence has commonly been the deposition of a considerable thickness of arenaceous rocks, without or with only a few thin seams of coal, and that the productive beds (above this series) have been laid down at different periods in Coal Measure time in different areas, as has been indicated on palæobotanical evidence.

The same conclusion also has recently been arrived at on other grounds. Dr. VAUGHAN* has shown that in the Mitcheldean area of the Forest, as well as at Bristol, the higher beds of Carboniferous Limestone age assume a Millstone Grit facies. It is therefore clear that, in the Forest of Dean, the so-called Millstone Grits overlie conformably the Carboniferous Limestone, and are in part of Lower Carboniferous age. It has been shown here that the Coleford High Delph seam belongs to the Upper Coal Measures, and that there is every reason to suppose that the Upper and Lower Trenchard Coals belong to the same horizon, though no fossil plants have been found associated with them. It is therefore clear that there must be an unconformity somewhere below the Trenchard Coal, and between it and the lower portion of the so-called Millstone Grits. Mr. DIXON† has recently discovered such an unconformity between the "Sweet Coals" of the Titterstone Clee Hills and the so-called Millstone Grits of that area, which, again, he regards as "much older than the rocks of that name which underlie Coal Measures elsewhere." In the Forest of Dean there is at present no evidence of such an unconformity, except in the South-eastern portion of the field, where, as is well known, the productive measures overstep the so-called Millstone Grits as well as the Lower Carboniferous rocks, from the Howbeach Valley southwards to Soilwell Farm.‡ In other parts of the coalfield there appear to be very few sections showing the junction of the Carboniferous Limestone and the sandstone series above, which at the present time, unlike the sandstones of the Third Division of the productive measures, are very little worked. Further, so far as I can ascertain, there are now no exposures to be found which exhibit the relationships of the productive measures and the so-called Millstone Grits below. Thus, if an unconformity exists below the Trenchard Coals, there is no direct evidence of it at the present time, but this may be well explained by the lack of sections in a region densely forested, and for the most part uninhabited except on the North and North-east boundaries. As the result of a rapid examination of the margin of this coalfield, the only evidence which I could discover, which may or may not bear on this question, occurs in the Mitcheldean area. At the northern end of Mitcheldean Meend enclosure, at Pingary's Tump, there are two pairs of small quarries, one close to and slightly to the South-west of the cottage, and the other pair a few yards further north. In these quarries the beds

* VAUGHAN ('05), pp. 252 and 199.

† DIXON ('11), p. 612.

‡ See HOSKOLD ('92), pp. 133–135.

in descending order are a thick pebble conglomerate, sandstones, and limestones, all dipping west. The conglomerates have been worked in one quarry of each pair, while the other quarry, at a lower level in each case, shows a sandstone bed overlying limestones. There appears to be a considerable difference in the dip of the sandstones as compared with that of the limestones in both quarries. On the other hand, until the area has been thoroughly mapped on a large scale, it will not be possible to determine the position of the beds seen in these quarries, either in relation to the Whitehead Limestone or to any other landmark in the series, and the observed difference in the dip of the beds is not in itself conclusive evidence of an unconformity.

I have not been able to obtain any fossil plants from the so-called Millstone Grits of the Forest. WETHERED* has, however, recorded a Lepidodendron "allied to *L. Griffithii* Brongn." from them at Drybrook. Thus their palæobotanical horizon remains unknown.

Reviewing the present evidence I am inclined to think that it will eventually prove that an unconformity exists a short distance below the Lower Trenchard Coal (see the table on p. 268) perhaps a little above the Sandstone vein of Iron Ore. In this case the greater portion of the Millstone Grits, so-called, will be found to be simply a sandy facies of the Carboniferous Limestone series, just as the lower beds have already been shown to be by Dr. VAUGHAN. I imagine that, in the Forest of Dean, the Upper Coal Measures rest unconformably on an ancient floor consisting for the most part of the higher sandy beds of the Carboniferous Limestone series, though, in some parts of the area, on Carboniferous Limestone of normal facies or even on Old Red Sandstone.

6. *The Relationships of the Forest of Dean Coalfield to the Coalfields of Bristol, Radstock, South Wales, and Newent.*

We now pass to a consideration of the relationships of the Forest of Dean to the Carboniferous tracts which occur to the North, South, and West.

The opinion has been frequently expressed that the Forest of Dean is an outlying portion of the South Wales coalfield. This view has been upheld by DE LA BECHE,† RAMSEY,‡ HOSKOLD,§ (who also concludes that the Forest was originally joined to the Bristol coalfield) and quite recently by GIBSON.‖ MUSHET¶ identified the Third Division of the productive series in the Forest with the Pennant Rock of Bristol, and

* WETHERED ('83), p. 215.
† DE LA BECHE ('46), p. 223.
‡ RAMSEY ('46), p. 303.
§ HOSKOLD ('92), pp. 124–5.
‖ GIBSON ('08), pp. 154, 156.
¶ See BUCKLAND and CONYBEARE ('24), p. 287.

Hoskold* has provisionally accepted the same view more recently. De la Beche† and others have correlated these beds with the "central sandstone series of the Pont y pool district" in South Wales, *i.e.*, the Pennant Grit. Gibson‡ states that a "thick mass of sandstone, comparable with the Pennant Sandstone of South Wales, lies between the Coleford Highdelf and a seam known as the Churchway Highdelf."

The evidence brought forward in this paper is entirely at variance with many of the conclusions previously expressed. The recent studies of the fossil floras of the plexus of Upper Carboniferous areas in the West of England and South Wales have served to show that the problem of tracing the original relationships of these tracts, now isolated in separate basins by earth movements, is far more complicated than was at one time imagined. At present many difficulties remain to be overcome, and it would appear to be unlikely that we shall understand fully the true relationships of these coalfields for some time yet, until further palæontological investigations and a broad study of the tectonics of the whole area have been completed. It may be well, however, to enumerate here some of the chief difficulties, unexplained at present.

The idea has long been prevalent that these detached basins at one time formed a continuous sheet of measures over the West of England and South Wales, and that their present deposition was due to the Armorican uplift, the axes of which traverse the South of England and Wales, from West to East.§ This theory was established on a sure footing by Godwin-Austin in his celebrated paper "On the Possible Extension of the Coal-Measures beneath the South-Eastern part of England," published in 1856. Further Godwin-Austin showed that, in theory, the main axis of elevation is prolonged across Southern England into France, Belgium, and Westphalia, and that the coalfields there are not only closely related to one another, but to those under discussion here. The same author also prophesied the discovery of other coalfields, east of the Forest of Dean and Somerset coalfields, beneath the Mesozoic rocks of the South of England, and this assumption has since been fully proved by the discovery in recent years of the Kent coalfield.

The theory that these coalfields once formed a continuous sheet does not necessarily imply that the beds of the now isolated basins belong to the same horizon in all cases. The author‖ has recently pointed out how, as we pass from Westphalia through Belgium, France and Kent to Somerset, higher and higher horizons appear towards the West. The Middle Coal Measure horizon is the highest represented on the Continent, so far as this chain of coalfields is concerned. In Kent, the Transition series appears, and, in Somerset and Bristol, Upper Coal Measures occur in addition.

So far no particular difficulty can be said to arise. But when we come to examine

* Hoskold ('92), pp. 127, 135, 142.
† De la Beche ('46), p. 202.
‡ Gibson ('08), p. 154.
§ Jukes-Browne ('11), p. 178, etc., fig. 29.
‖ Arber ('09), p. 37.

the mutual relationships of Upper Carboniferous rocks in Somerset, Gloucester, and South Wales we meet with the following difficulties.

In the Forest of Dean, as has been shown here, there is little doubt that the beds are wholly of Upper Coal Measure age, and that they probably rest unconformably on Lower Carboniferous deposits. In South Wales, not only are the Upper, Transition, and Middle Coal Measures well developed, as KIDSTON* has proved, but rocks mapped as Millstone Grits fringe the basin and overlie the Carboniferous Limestone. So far as I am aware, it has never been shown, on palæontological evidence, that these sandy, basal beds are the true equivalent of the Millstone Grits of the Midlands. Whether they are so or not, remains an open question. At any rate, apart from these beds, should they prove to be true Millstone Grits, the Lower Coal Measures are unrepresented, on the present evidence, in South Wales.

The succession of seams and the thickness of the beds in South Wales varies in different portions of the coalfield. In the Eastern (Monmouth) district the following is the general section :—†

	Horizon.
Upper Pennant Series 2–300 feet, with 3 coals Shales and Sandstones	= Upper Coal Measures.
Lower Pennant Series = Pennant Grit or Sandstone 800–1000 feet, with 9 coals Chiefly Sandstones	= Transition Coal Measures.
White Ash Series or Infra-Pennant 850–1600 feet, with 17 coals Chiefly Shales	= Middle Coal Measures.
Farewell Rock	

Thus, as regards the horizons represented, the South Wales coalfield differs entirely from the Forest of Dean, and for this reason alone it seems extremely improbable that the latter is really an outlier of the former. If this were the case, how are we to explain the absence of the Middle and Transition Coal Measures in the Forest ?

On the southern side of the Bristol Channel we find the great barren coalfield

* KIDSTON ('94[2]).

† See KIDSTON ('94[2]), p. 569 ; *cf.* also STRAHAN ('09), pp. 28–29.

of Devon and Cornwall, which is no doubt also related to the Armorican uplift, and is at present the only coalfield in Britain which is definitely known to lie to the south of the North Devon axis. Here the rocks belong to the Middle Coal Measure* horizon, and apparently rest directly on Lower Carboniferous sediments.

We turn next to the Radstock portion of the Somerset coalfield, lying between the Mendip and the South Wales axes. Here the general section is—

	Horizon.†
Radstock Series (Essentially argillaceous) 8 seams	Upper Coal Measures, 2000 feet.
Red Shales 130–250 feet	
Farrington Series (Essentially argillaceous) 8 seams	
Pennant Grit 2–4 coals	Unknown, 2000 feet.
New Rock Series (Essentially argillaceous) 18 or more seams	Transition Coal Measures, 2500 feet.
Vobster Series (Essentially argillaceous) 8 or more seams	
Millstone Grit (so-called)	Upper part unknown, lower part is Carboniferous Limestone. 1000 feet.
Carboniferous Limestone	

The succession in the Bristol district, separated from the Radstock area by the Kingswood anticline and fault, is similar, except that the Radstock series is absent

* Arber ('04) and ('07).

† Kidston ('88); see also McMurtrie ('02) for the succession.

and the red shales above the Farrington series are very thin. The Upper and Transition Coal Measure floras have been worked out by Dr. KIDSTON,* and, more recently, additions have been made to the former by Mr. LILLIE.†

A short distance to the North-east of the Forest of Dean, and separated from the Mitcheldean area by May Hill, there is a small tract of Upper Carboniferous rocks, of which very little is known. These beds rest on the Old Red Sandstones. An attempt‡ has been made recently to obtain fossil plants from this area, with but little success, for the coals have not been worked for many years past, and the coalfield is largely concealed beneath Mesozoic rocks. Exposures, either natural or artificial, are thus practically absent at present. So far as the limited flora, which includes *Pecopteris oreopteridia* (Schloth.), *P. arborescens* (Schloth.), *Neuropteris rarinervis* Bunb. and *Annularia radiata* Brongn., will permit of an opinion being expressed as to the horizon of the beds, their position certainly appears to be higher than the Middle Coal Measures, and to be equivalent either to the Upper or the Transition Coal Measures of Radstock and Bristol.

To the North of Newent, several small patches of Coal Measures§ form links in the chain connecting Newent with the Forest of Wyre and Coalbrookdale coalfields, these being the most southerly of the series of coal basins of the Welsh Borderland. The fossil floras of these areas are under examination, but the work will not be completed for some time yet. So far as it has progressed at the present time, it would certainly seem that the Newent area is more closely connected with the Wyre Forest than with the Forest of Dean.

These conclusions may be summarised in the following table :—

Horizon.	Forest of Dean.	Radstock and Bristol.	South Wales.	Newent.	Devon and Cornwall.
Upper Coal Measures . . .	Present	Present	Present	Present	Absent
Transition Coal Measures. .	Absent	Present	Present		Absent
Middle Coal Measures. . .	Absent	Absent	Present	? Absent	Present
Lower Coal Measures . . .	Absent	Absent	Absent	Absent	Absent
Millstone Grits	? Absent	? Present	? Present	Absent	Absent
Lower Carboniferous . . .	Present	Present	Present	Absent	Present

* KIDSTON ('88).
† LILLIE ('10).
‡ ARBER ('10).
§ GROOM ('10), p. 724.

From this brief summary it is obvious that, while the productive measures of the Forest of Dean are the equivalents of the Radstock and Farrington Series in Somerset and of the Upper Pennant Series of South Wales, there is no exact lithological correspondence between these coalfields. There appear to be no equivalents in the Forest of the New Rock and Vobster Series of Bristol and Radstock, nor of the Pennant Grit and Middle Coal Measures of South Wales. The horizon of the Pennant Grit of Somerset is unknown. It may be either Upper or Transition Coal Measures, and it is thus still an open question whether, if the former alternative should prove to be correct, the Third Division of the Forest may not be the representative in the Forest of the Pennant Grit of Bristol. As regards South Wales, however, the so-called "Millstone Grit" of the Forest is the only series there developed which could possibly be the equivalent of the Lower Pennant (= Transition Coal Measures), and, as has been emphasised already, part of these beds, and probably a very large part, belong to the Carboniferous Limestone.

This being the case, it appears to me to be futile at present to institute a closer comparison between the massive sandstone series of these three neighbouring coalfields. All that we can say at the present stage is that, in the Forest, this series is of Upper Coal Measure age, while in the eastern portion of South Wales it belongs to the Transition Coal Measures, and in the Bristol and Radstock coalfields the exact horizon is unknown, though it is not lower than the Transition Coal Measures. On the whole, it is clear that the correspondence between the Forest of Dean and the coalfields of Bristol and Radstock is much closer than with the South Wales.

It may perhaps be imagined that the present difficulties originate from the fact that the horizons, as determined by the fossil plants, are not sufficiently accurate to warrant a close comparison. Or it may be thought that the productive measures of these coalfields all belong to one horizon, and that we are dealing with floras of local distribution, and not with assemblages representing different stages in the evolution of Carboniferous vegetation. It would be out of place here to attempt to justify the existence of palæobotanical horizons, or the validity of the large amount of work which has been done, in recent years and in many lands, on the study of the vertical, as well as the lateral, distribution of Carboniferous plants. As a reply, however, to such a possible criticism, attention may be called to the fact that an essentially similar problem, and one quite independent of the palæobotanical evidence, is still unsolved in the Midlands. This is the relationship of the Southern Midland to the North Midland coalfields. The latter, comprising the basins of South Lancashire on the West, and Yorkshire, with extensions into Nottinghamshire and Derbyshire, on the East, are now very well known, both geologically and palæobotanically. The relationship of the one to the other, and of each to the Pennine uplift, is of the simplest, so much so that the chief seams on either side of the axis can be correlated. We find here Upper, Transition, Middle, and Lower Coal Measures, resting on true Millstone Grits and, below these, Lower Carboniferous marine deposits.

Some little distance to the South we find the Southern Midland fields of Warwickshire and South Staffordshire. There is reason to believe that these basins are also related to the Pennine uplift, and to the North Midland basins,* but since their geology and palæontology has been less thoroughly studied, the relationships are still far from clear. We find, however, that, in both fields, the Middle Coal Measures are the lowest horizon of the Upper Carboniferous represented, and that these rest, in Warwickshire directly on Cambrian, and in South Staffordshire on Silurian rocks. The Lower Coal Measures, Millstone Grits, and Carboniferous Limestones are here absent, which is, of course, a fact deduced from geological rather than palæobotanical observation. It is scarcely necessary to emphasise the fact that the problem to be solved here has much in common with that with which we are concerned in the West of England and South Wales.

The tectonics of the districts under consideration here require much greater attention than has at present been devoted to them before the relationships of these coalfields can be made clear. It is, however, becoming obvious that, on the borders of Gloucester and Somerset, we have evidence of possibly three distinct sets of axes, and where three ways meet confusion is likely to arise. There are first of all the East and West axes of South Wales, the Mendips and North Devon, to which the coalfields of South Wales and of Devon and Cornwall, with their approximately East and West strike, are no doubt to be correlated. A second uplift, possibly subsidiary to, though connected with the Armorican uplift, with a direction roughly North and South, starting from the Mendips and approximating to the Valley of the Severn, is probably responsible for the Radstock and Bristol coalfields on the East, and the Forest of Dean on the West, the strike of these coalfields being also North and South. This is the view first put forward by Buckland and Conybeare† as early as 1824, and it is one with which I am in entire agreement. Next, we have the complex series of uplifts of the Welsh Borderland, stretching, as Murchison showed, from Shropshire through the Malverns, approximately North and South, with which the Welsh Borderland chain of coalfields may be associated. Where this axis ends to the southward is a disputed point. The Forest of Wyre coalfield certainly belongs to this system. The axis is continued further to the South in the Malvern Hills and May Hill. The Newent coalfield was regarded by Buckland and Conybeare as belonging to the same system as the Somerset, Bristol, and Forest of Dean coalfields. As I have already pointed out, I am inclined to think that it is more nearly related to the Welsh borderland chain. At the same time I have not been able to find any evidence that the Newent Coals are newer than those of the Forest of Dean, as Dr. Groom‡ has recently concluded in an able discussion of the tectonic problems of the southern portion of the Welsh Borderland. So far as our knowledge of the

* Lapworth ('08).

† Buckland and Conybeare ('24), p. 213 and map, Pl. 38.

‡ Groom ('10), p. 732.

lithology of the Borderland coalfields enables us to form any opinion, they appear to be very different from the basins of Radstock, Bristol, and the Forest of Dean, and I am therefore inclined provisionally to regard them as separate systems due to separate uplifts.

7. *Conclusions.*

Of the 44 species here described from the Forest of Dean coalfield none are new to Britain, though some are very rare fossils in this country. From a study of the vertical distribution of these plants, it has been shown that the three divisions of the productive measures all belong to one horizon, which is the Upper Coal Measures. Several species, including *Annularia galioides* (L. and H.), *Sphenophyllum majus* (Bronn), *Lepidodendron dichotomum* Sternb., as well as three species of *Sigillaria*, none of which have been previously known to occur above the Transition or Middle Coal Measures in Britain, are found in the Forest on a still higher horizon. As compared with the flora of the Radstock coalfield, that of the Forest of Dean shows many points of general agreement, though there are also differences in detail. Certain species which are abundant in one coalfield are rare in the other, and *vice versâ*. These differences are regarded as due to local variations in the distribution of the flora of the period.

The rocks between the productive measures and the Carboniferous Limestone are discussed, and reasons are advanced in support of the view that the Upper Coal Measures of the Forest of Dean overlie unconformably the so-called Millstone Grits, which are in reality the higher beds (of a sandy facies) of the Carboniferous Limestone. Owing to the general absence of sections, the unconformity has not, however, been demonstrated in the field. True Millstone Grits, Lower, Middle, and Transition Coal Measures appear to be absent in the Forest of Dean, so that the unconformity in question is of considerable importance.

The relationships of this coalfield to the neighbouring coalfields of the West of England and South Wales are discussed from the palæobotanical standpoint. It has been pointed out that the Forest of Dean exhibits no obvious relationship either to the South Wales or to the Radstock-Bristol coalfields. The massive sandstone facies of the productive measures, known as the Pennant Grits in South Wales, belong to a lower horizon than the corresponding beds in the Third Division of the Forest of Dean. There may be some correspondence between these beds and the so-called Pennant Grits of the Radstock-Bristol area, but until the palæobotanical horizon of the latter has been ascertained, the degree of correlation must remain doubtful. On the whole the agreement between these two coalfields is closer than that between South Wales and the Forest of Dean. The Radstock, Bristol, and Forest of Dean basins are believed to be related, not to the main axes of South Wales and the Mendips, but to a secondary, cognate uplift, stretching North and South, and approximating to the valley of the Severn. The Forest of Dean does not appear to have any special affinity to the Newent, Wyre Forest, Coalbrookdale, and other

coalfields of the Welsh Borderland series, which are regarded as forming a distinct chain of coalfields. In the case of the Forest of Dean it seems evident that the Lower Carboniferous rocks and Old Red Sandstones of the area remained elevated above sea level, and were denuded, until the beginning of Upper Coal Measure times, whereas in South Wales, and in Devon and Cornwall, depression set in, and the deposition of coal-bearing sediments began in Middle Coal Measure times, and in the Radstock-Bristol area in the Transition Coal Measure period. Thus, on the palæobotanical evidence, the relationships of the coalfields of the West of England and South Wales have proved to be more complex than has hitherto been supposed, and this appears to be due, in part at least, to the coincidence of three distinct axes of elevation in the neighbourhood of the Forest of Dean.

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EXPLANATION OF THE PLATES.

(All the specimens figured are in the Carboniferous Plant Collection, Sedgwick Museum, Cambridge, to which the numbers refer. The negatives were taken by the author; the prints are by Mr. Tams, Cambridge.)

PLATE 11.

Fig. 1.—*Alethopteris grandini* (Brongn.). From the Second Division, New Fancy Colliery. No. 1619. ×10/9.

Fig. 2.—*Alethopteris aquilina* (Schloth.). From the Second Division, at Trafalgar Colliery. No. 1620. Very slightly enlarged.

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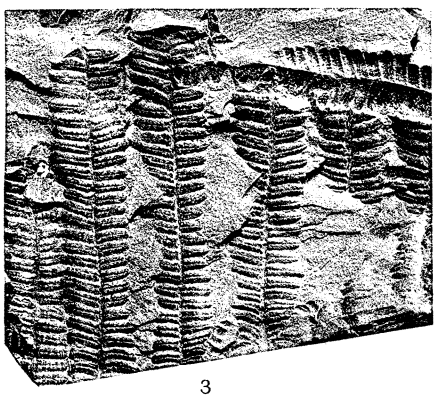

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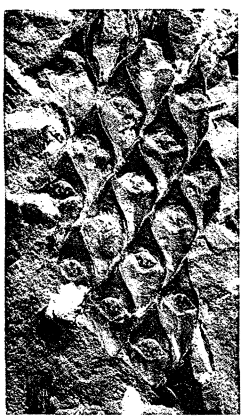

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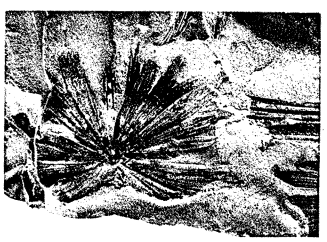

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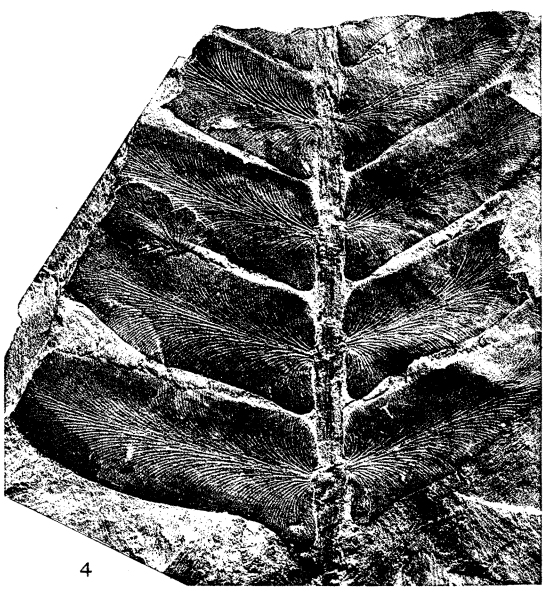

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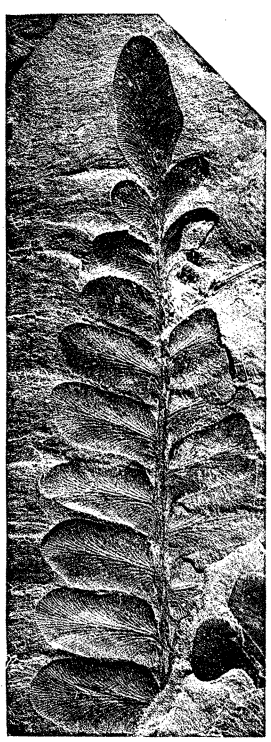

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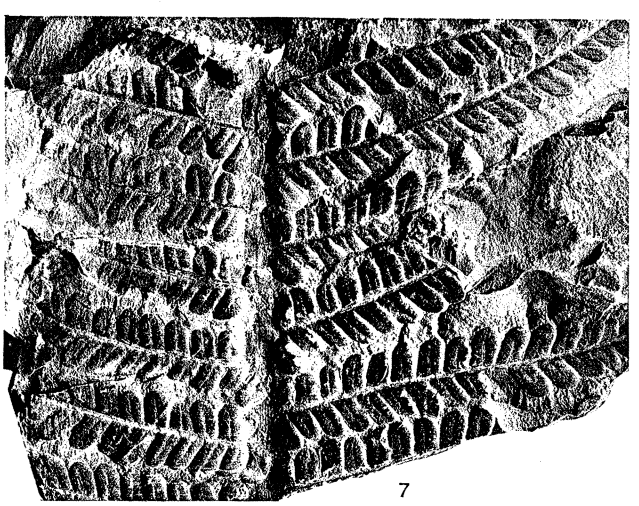

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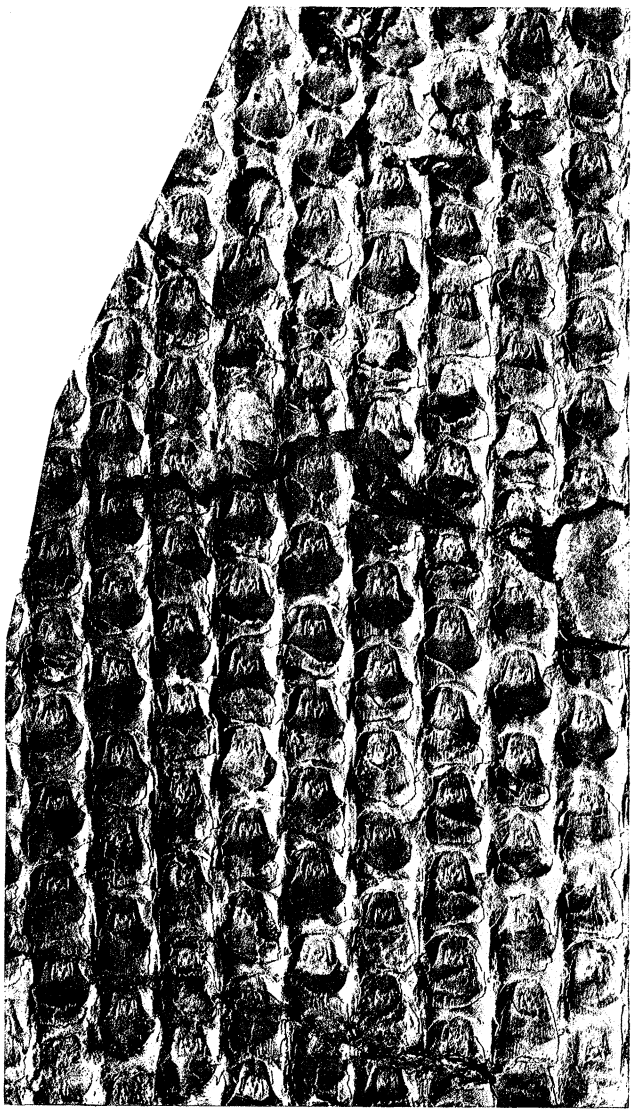
E.A.N.A., PHOTO.

FOSSIL PLANTS FROM THE FOREST OF DEAN COALFIELD.



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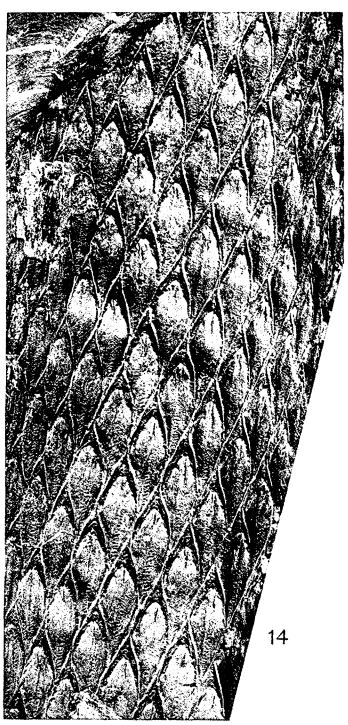

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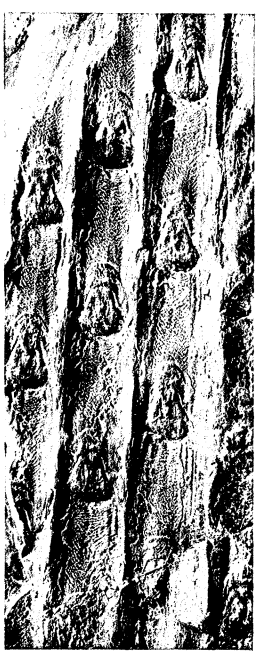

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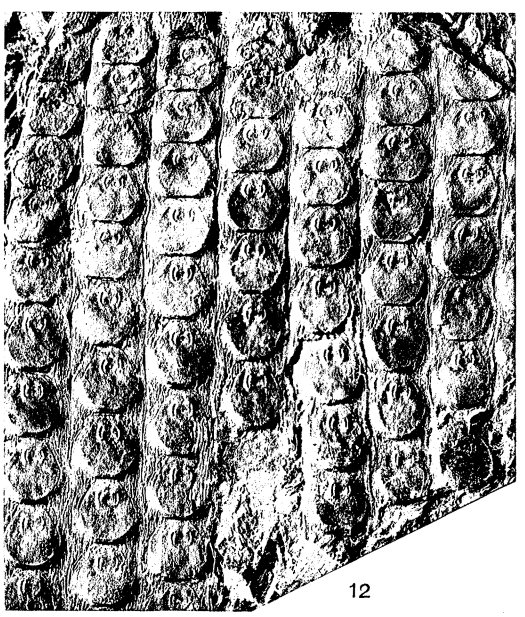

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E.A.N.A., PHOTO.

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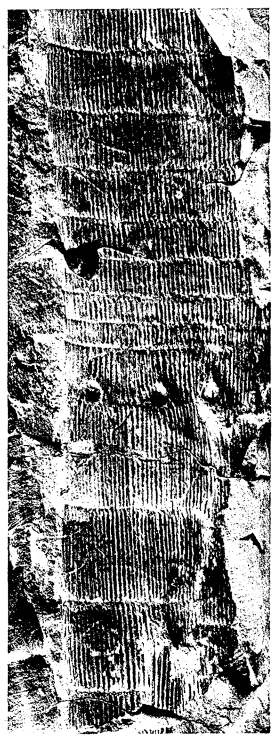

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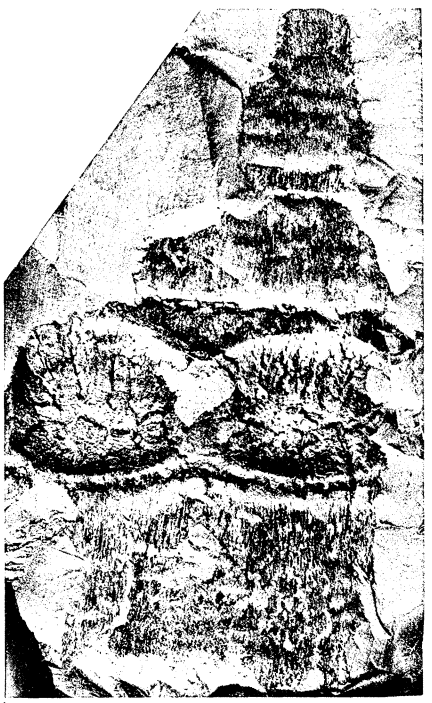

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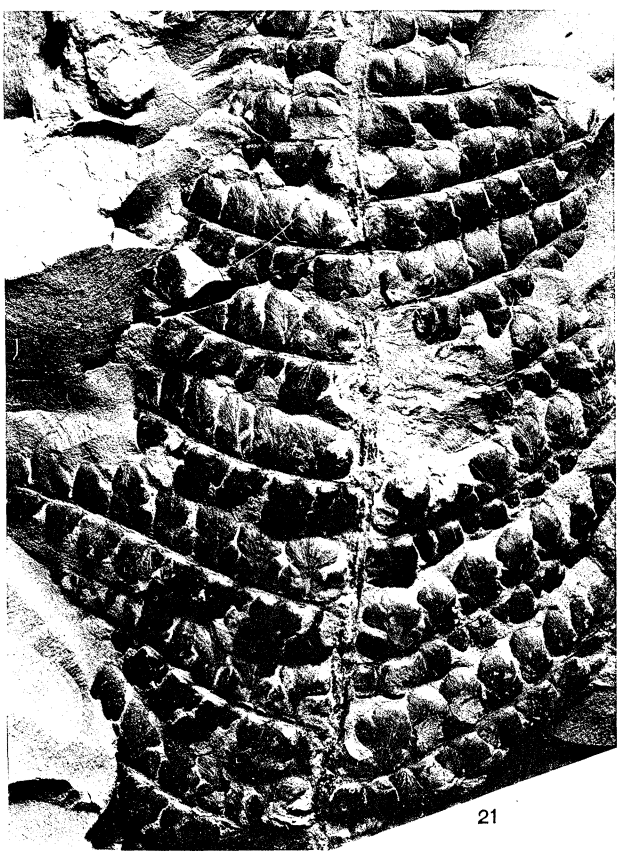

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Fig. 12.—*Sigillaria tessellata* (Steinh.). From the Second Division, New Fancy Colliery. No. 1673. ×7/6.

Fig. 13.—*Sigillaria elongata* Brongn. From the Second Division, Park End Colliery. No. 1957. Nat. size.

Fig. 14.—*Lepidodendron lanceolatum* Lesq. From the Second Division, Park End Colliery. No. 1624. ×8/7.

Plate 13.

Fig. 15.—*Calamites? varians* Sternb. External surface of the stem. Second Division, New Fancy Colliery. No. 1723. Slightly reduced.

Fig. 16.—*Calamites varians* Sternb. Pith-cast. Second Division, Trafalgar Colliery. No. 1464. 2/3 nat. size.

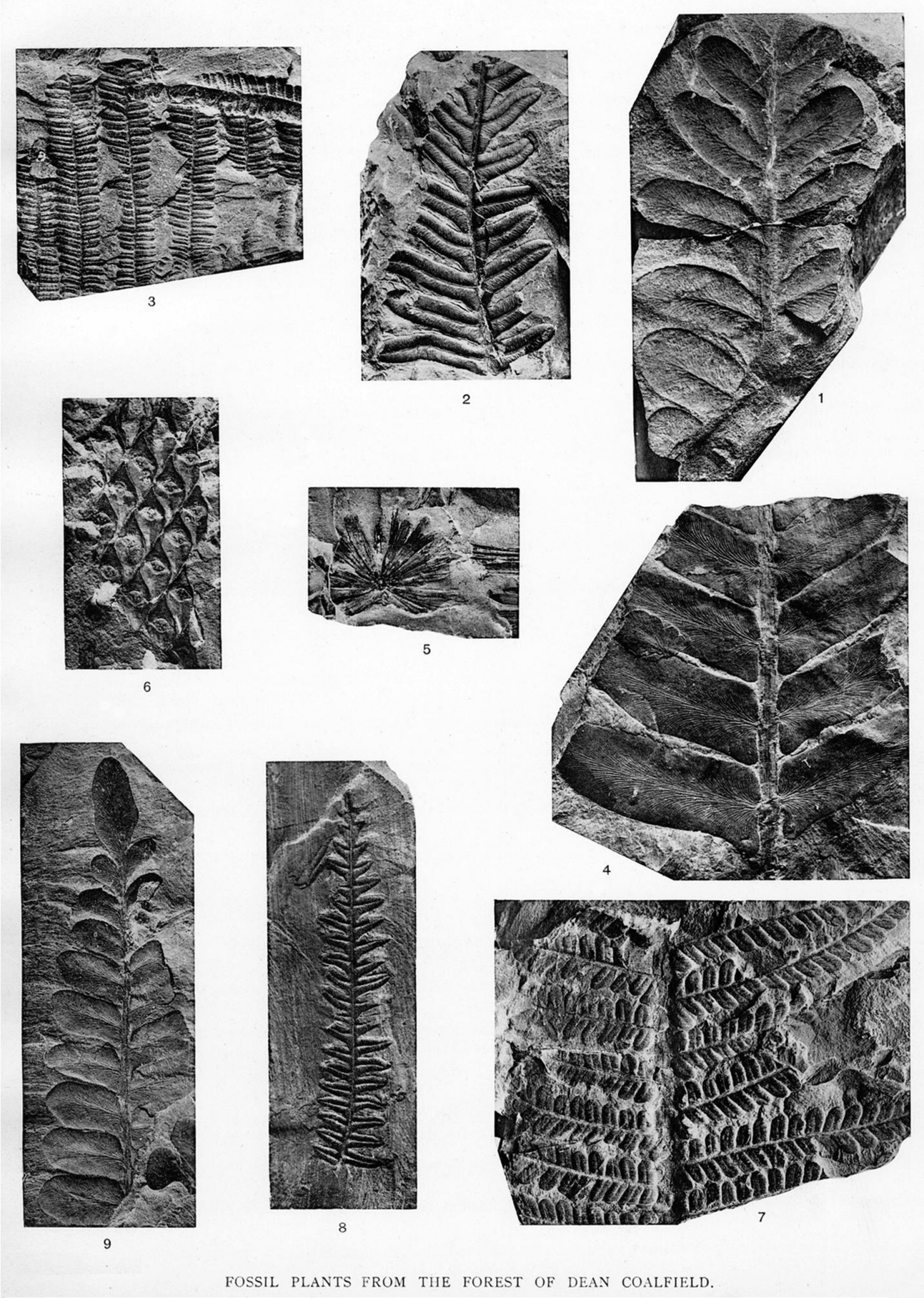
Fig. 17.—*Calamostachys tuberculata* (Sternberg). Second Division, at Foxe's Bridge Colliery. No. 1945. Slightly enlarged.

Fig. 18.—*Cordaites angulosostriatus* Grand' Eury. Second Division, Foxe's Bridge Colliery. No. 1736. Slightly reduced.

Fig. 19.—*Macrostachya infundibuliformis* (Brongn.). Second Division, Trafalgar Colliery. No. 1970. Slightly enlarged.

Fig. 20.—*Macrostachya infundibuliformis* (Brongn.). Second Division, Trafalgar Colliery. No. 1727. 2/3 nat. size.

Fig. 21.—*Sphenopteris neuropteroides* (Boul.). Yorkley Coal, Third Division, Park Gutter Colliery. No. 1968. ×6/5.



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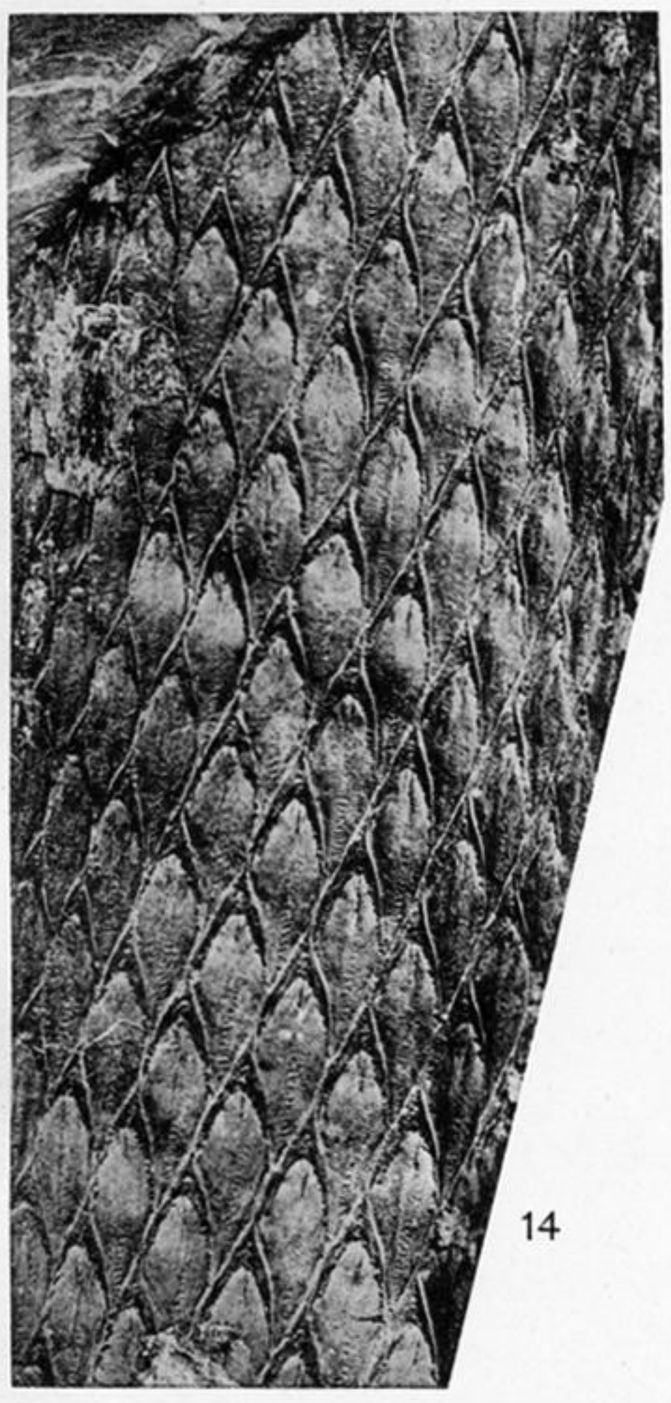

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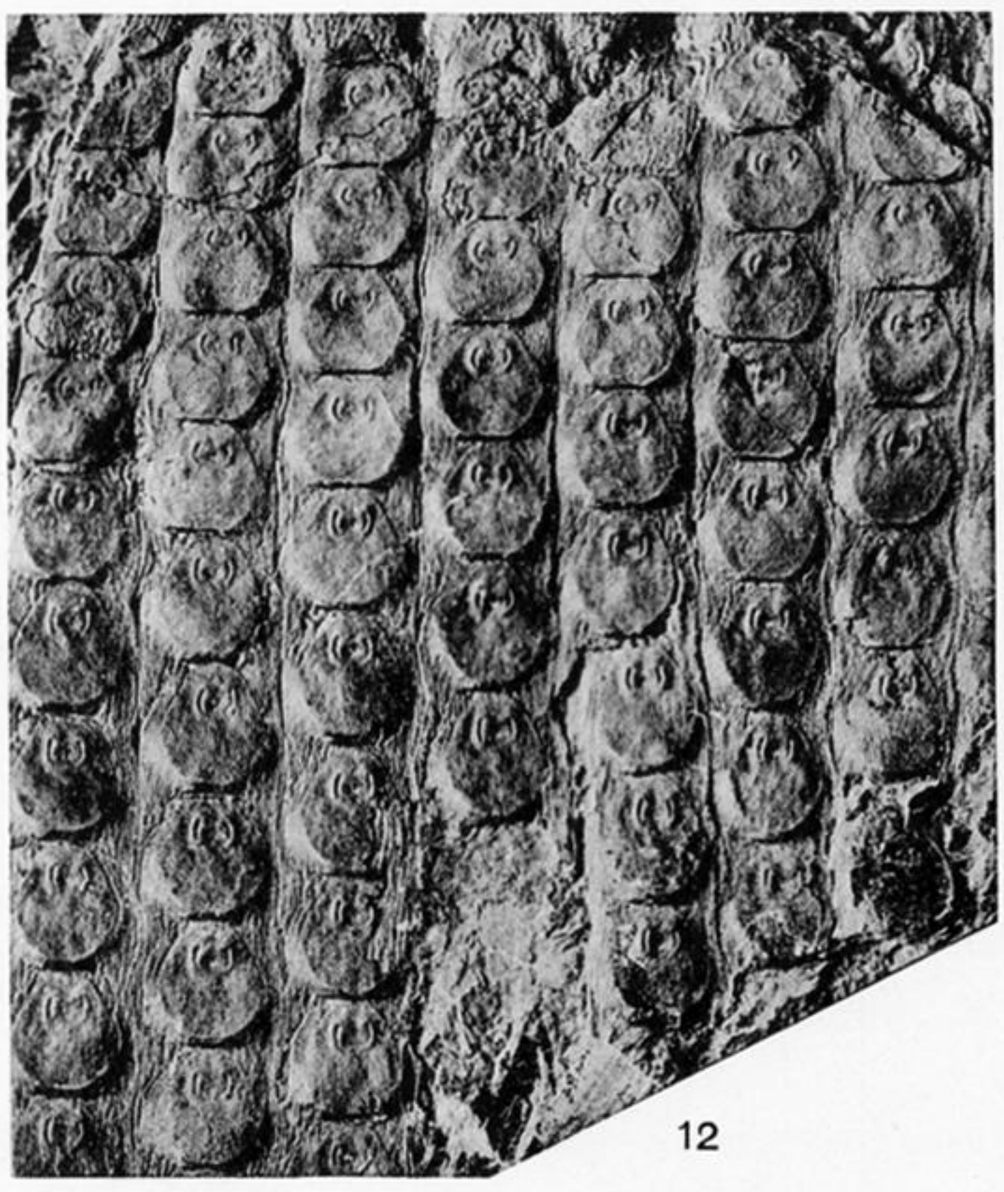

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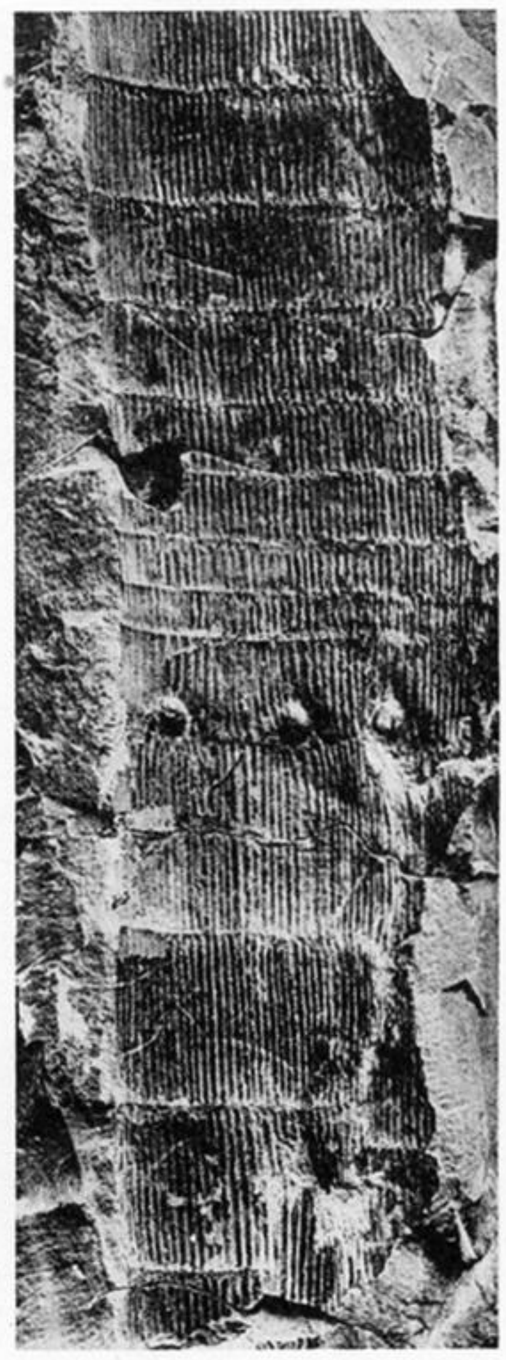

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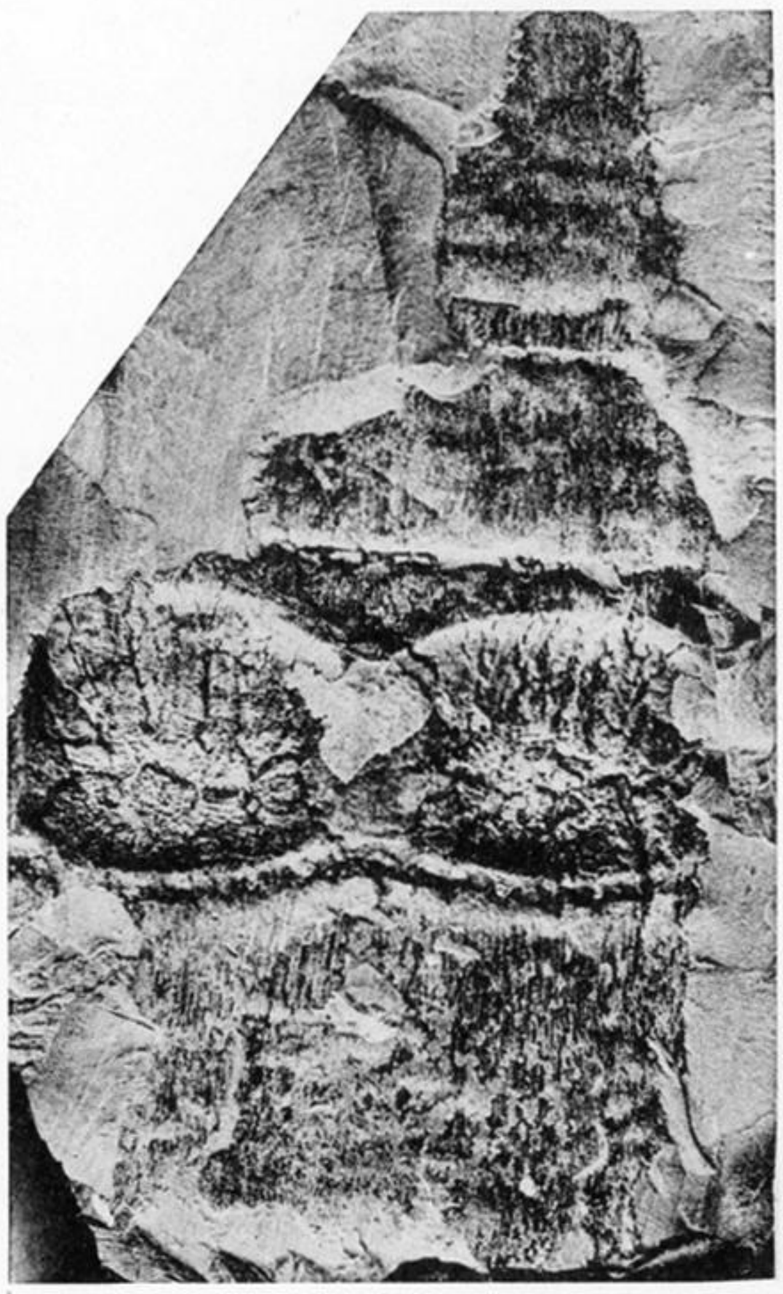

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