X.—*On the Fossil Plants in the Ravenhead Collection in the Free Library and Museum, Liverpool.* By ROBERT KIDSTON, F.R.S.E., F.G.S. (Plates I. and II.)

(Read 16th July 1888.)

INTRODUCTION.

A copy of Mr MARRAT's paper "On the Fossil Ferns in the Ravenhead Collection" * having come into my hands, I was led to visit the Liverpool Free Public Museum in 1886, and again in 1887, with the object of examining this interesting collection, and while doing so I received every assistance from Mr THOMAS J. MOORE, the Curator, and Mr F. P. MARRAT, to whom I take this opportunity of expressing my indebtedness for the many kindnesses I received while studying the Ravenhead plants. I have further the pleasure of acknowledging the privilege accorded me by the Museum Committee, through the kind offices of the Rev. H. H. HIGGINS, which allowed me to have a number of specimens sent to Stirling, where I could more advantageously examine them than in the Museum, where the literature of the subject is limited.

The history of the Ravenhead Collection has already been given by the Rev. H. H. HIGGINS† and by Mr MARRAT in his paper "On the Fossil Ferns in the Ravenhead Collection." I may, however, briefly say here, that the specimens were collected by the Rev. H. H. HIGGINS, chiefly from the shales associated with some upright stems of fossil trees immediately below the lower of the two Ravenhead Coals. A few specimens may also have been collected from the shales between the two Ravenhead Coals, or in the shales that overlie them, but these form a small proportion of the collection.

The section from which the fossils were collected was exposed while making a cutting on the Huyton and St Helens Railway, which passed through the Middle Coal Measures, at Ravenhead near St Helens, South Lancashire.

Mr G. H. MORTON, F.G.S., author of the *Geology of the Country around Liverpool*, has most kindly favoured me with the following sketch of the Geology of the South-West Lancashire Coal Measures. Mr MORTON's intimate knowledge of the geology of this district, and his reliable work on the subject, are already known to geologists, and I feel confident that the geological description with which he has favoured me will add much to the value of this paper.

The Coal Measures of South-West Lancashire rest on the Millstone Grit, which is exposed in three restricted areas, viz.,—Knowsley Park, Grimshaw Delf, and Parbold and

* *Abstract of Proc. of the Liverpool Geol. Soc.*, 13th session, 1871–72, p. 97, 1872 (Plates).

† *Proc. Liverpool Nat. Field Club* for the year 1870–1871, and *Abstr. of Proc. of the Liverpool Geol. Soc.*, 13th session, 1871–1872, p. 94, 1872.

the Harrock Hills, as shown on the maps of the Geological Survey. The general succession of the Coal Measures shows the following subdivisions in the neighbourhood of Prescott, St Helens, and Wigan:—

Upper Coal Measures.

Middle or Productive Coal Measures.

Lower Coal Measures.

The *Lower Coal Measures* contain a greater proportion of sandstone strata than the other two subdivisions, and form the highest and most conspicuous ground; the *Middle or Productive Coal Measures* contain nearly all the coal seams that are of sufficient thickness to be worth working; while the *Upper Coal Measures* are of little economic importance. These subdivisions are principally the result of observations by Professor EDWARD HULL, F.R.S., who originally surveyed the district for the Geological Survey thirty years ago, though it had been described long before by the late Mr E. W. BINNEY, F.R.S., to whom geologists are so much indebted for his valuable and long-continued researches in the Lancashire Coal Field. The succession of the coal seams and the thickness of the strata between them have been known for a long period, this information having been gradually obtained from the sinking of shafts and working the coals during the last one hundred years, but some of the most reliable details are given in the "Sections of Shafts sunk in the Middle Coal Measures of Prescott, St Helens, Wigan, and Burnley," by Messrs C. E. DE RANCE, F.G.S., and A. STRAHAN, B.A., F.G.S., published by the Geological Survey.

FIG. 1.—Section through the Coal Measures at Prescott.

The above section (fig. 1) along four miles of country from north to south, with Prescott in the centre, exhibits in regular sequence the nearest development of the Coal Measures in the country around Liverpool, and shows the subdivisions described. This threefold succession is common to the whole of the Lancashire Coal Field, which was all formed under the same general conditions, but it has been since broken up by faults, and denuded to such an extent that the subdivisions appear at the surface in separate areas, and the whole is frequently covered by the overlying Triassic strata which extend over a large portion of Lancashire and Cheshire.

LOWER COAL MEASURES.

These overlies the *Millstone Grit*, and form the lowest subdivision of the Coal Measures. They have been called the *Gannister Series*, a provincial term, alluding to the hard siliceous beds which often form the floor of the few coal seams they contain. The formerly well-known Huyton Quarry* was worked in strata in this subdivision, and the hard grey flagstones occur in other parts of the Coal Field, and form some of the highest beds, as at Upholland, where they occur at the east end of the tunnel.

All traces of the quarry have now been covered up, but forty years ago a good section of the strata was exposed, and 50 feet of grey micaceous flagstones, with some 6 feet of shale near the top, formed an anticlinal arch parallel with the railway, with the beds dipping to the east and west. The surfaces of many of the beds were beautifully ripple-marked, and tracks of Annelids were abundant. Some curious casts, supposed to have been those of the burrows of bivalves, and *Calamites Cistii*, Brongt., were of common occurrence. The strata exposed in the quarry were more fully shown in the railway cutting from Huyton to St Helens, about 200 yards farther north, where the grey flagstones were found to be 60 feet thick, with 10 feet of shale and a thin bed of coal (1 foot 6 inches) over them. The beds were found to dip at various angles to the south-east, and included some that were worked below the bottom of the old quarry. Shales and flagstones, with the seams of coal known as "Mountain Mines," occur at a considerable depth below the Huyton flagstones, which are 240 feet below *Little Delf Coal* at the base of the *Middle Coal Measures*.

The Lower Coal Measures are continued at the surface from Huyton Quarry to the east of Prescott over a large area about Hurst House and the Hazels. Another area, forming the eastern portion of Knowsley Park, belongs to the same subdivision. Near Hag Delf, in the Park, a little east of the Stand Quarry, a bed of coal (2 feet 4 inches), one of the "Mountain Mines," occurs, and is said to have been worked about a hundred years ago. The old pit banks remain, and traces of iron smelting occur at the same place; but trees have grown over the spot, and little is known as to when the coal and ironstone were worked. The highest beds occur along the eastern boundary of the Park, particularly about Trap Wood, where flagstones and shales have been exposed, though little can be seen of them now, and much less of the strata in the Park generally than when explored in 1862.

There is a considerable area, several square miles, of the Lower Coal Measures between Prescott and Parbold; and the Liverpool and Yorkshire Railway presents a fine section of them at Pimbo Lane Station, which was originally described by Mr BINNEY, who found here *Goniatites Listeri* and *Aviculopecten papyraceus*, fossils characteristic of the horizon. The beds are exposed in a deep cutting, and consist of black shales, micaceous

* A Station on the Liverpool and Manchester Railway.

flaggy sandstones, and two or three thin beds of coal. To the south of Pimbo Lane is Billinge Hill, where there are quarries in the sandstone near the Beacon, which is on the highest ground, 593 feet above Ordnance datum. Probably, in consequence of the predominating sandstones, the subdivision forms an elevated district, and good sections of the strata are of frequent occurrence. In the *Geology of Wigan*,* Professor HULL gives a section through the Lower Coal Measures at Billinge, which shows the thickness of the successive beds, and that they are altogether 1881 feet thick. There are six beds of coal, the *Upper Mountain Mine* being 2 feet, and the *Lower Mountain Mine* being 2 feet 8 inches thick, with four intermediate seams, much too thin to be worked. In a sandstone quarry near the top of Billinge Hill, *Calamites*,† *Bothrodendron*, and *Lepidodendron* have been found.

MIDDLE OR PRODUCTIVE COAL MEASURES.

The *Middle Coal Measures* form the most important subdivision, economically considered, for they contain all the valuable beds of coal. They extend from near Huyton and south of St Helens, many miles to the north-east, forming two projections, bounded on each side by the Trias, a few miles to the east of Liverpool. Although there are many quarries and small exposures where they may be seen, there is no important section showing a great thickness of the beds and the relative position of the various shales, sandstones, and coal seams. The whole of the strata between the *Lyon's Delf Coal* at the top, and the *Little Delf Coal* or *Arley Mine* at the bottom, are considered to constitute the subdivision.

The Middle Coal Measures at Prescott are the nearest to Liverpool, and may be adopted as a scale for comparison with those at St Helens and Wigan, and the coal seams at each of these places have been correlated with those on the same horizon, though they are usually known by different names, which were originally given to them before it was possible to ascertain their relative position in the Coal Field. The following General Section, compiled from the *Geological Survey Memoirs*, is the final result of observations extending over many years.

The section given on the opposite page shows that the Middle Coal Measures are thinner at Prescott than at St Helens, where the coal seams are at greater distances from each other, while at Wigan there is a still greater expansion of the series. It also shows the equivalent of each coal seam at Prescott, St Helens, and Wigan; as, for example, that the *Tenlands Coal* at Prescott becomes the *Ravenhead Coals* at St Helens, and the *Wigan 5-feet Mine* at Wigan; and that the *Little Delf Coal* at the two former places becomes the *Arley Mine*, or *Orrell 4-feet* at the latter place. The succession of the coal seams could only have been ascertained from the records obtained in sinking

* *Memoirs of the Geological Survey.*

† The Liverpool Museum contains specimens of *Calamites Suckowii* and *Bothrodendron* (decorticated) from this locality.
—R. K.

the shafts of pits, and from borings, though there are many places where the outcrops of beds of coal may be seen at the surface and the associated strata examined.

In 1870 the *Ravenhead Higher Coal* and the *Ravenhead Main Delf Coal* at Thatto Heath, were both exposed during the construction of the Huyton and St Helens Railway, though when it was finished the sides of the cutting were levelled, and traces of the coal seams almost obliterated. The following is a section of the strata (fig. 2), and the locality will always be of local interest on account of the numerous fossil plants that have been obtained there through the patient industry of the Rev. H. H. HIGGINS, who fortunately resided so near the place that he was able to visit it almost daily for several months.

FIG. 2.—Coal Measures at Ravenhead, St Helens. (Scale, 12 inches to 1 mile in length.)

The position of the coal seams is shown on the sketch (fig. 2), and that of a remarkable line of trunks of trees in the position in which they originally grew, usually about 4 or 5 feet high from the roots upwards, and about 8 feet below the Ravenhead Main Coal. It was principally in the black shales and in ironstone nodules below the coal seam and below the trees that the plant remains were found, and the number of species collected within such a restricted space was extraordinary. The collection when completed was presented by the Rev. H. H. HIGGINS to the Liverpool Free Public Library and Museum, where it is known as the "Ravenhead Collection." Two wings of an orthopterous insect, *Protophasmidæ*, from the same beds as the plants, are also preserved in the collection.

In the *Geology of Wigan*, Professor HULL describes several sections where coal seams might be seen cropping out at the surface, but that of the Ince 7-feet Coal, in a cliff above Leyland Mill, nearly two miles north of the railway station, is the only one that is now well exposed, and may be seen from the road with a series of associated shales and sandstones. The Middle Coal Measures may be seen to advantage in a large quarry on the south-west of St Helens, where Messrs DOULTON & Co. obtain clay for making bricks and tiles; the strata are here nearly 118 feet in thickness. The highest beds consist of sandstone, with a great series of shales and thin sandstones below, and three thin seams of coal about the middle. They are all above the

Rushy Park Coal, which is about 200 feet below the lowest beds visible. Plant remains are numerous in the shales, and on one side of the quarry two upright trunks of trees are exposed.

In the Middle Coal Measures there are a few species of Mollusca,—*Anthrocosia robusta* being the most common; they usually occur in thick bands and extend a considerable distance from one coal pit to another, particularly a band above and another below the *Rushy Park Coal*. Fish remains also occur in many localities, but direct search has not been made for them, though there is little doubt that the scales and teeth of small species would be found of common occurrence, and those of *Cœlacanthus*, *Gyrolepis*, and *Platysomus* have been already recorded from several localities.

UPPER COAL MEASURES.

These consist of red and purple shales, clays, and sandstones when seen within 200 or 300 feet from the surface, probably coloured by the infiltration of ferruginous water from the overlying Permian or Trias, but of black shales and grey sandstones where brought up during borings and the sinking of shafts. The first exposure is in the cutting of the Liverpool and Manchester Railway, between Rainhill and Marshall's Cross stations, and the strata are principally of a red colour. They may occasionally be seen in small openings about the reservoirs south of St Helens, but as there are no coal

FIG. 3.—Permian or Trias on Coal Measures, Haydock. (Scale, 1 inch to 6 feet.)

seams of sufficient thickness to be worth working, and the strata of little economic importance, they are seldom exposed. At Collin's Green and Bold, shafts have been sunk through the base of the Trias and the whole of the Upper Coal Measures into the Middle Coal Measures beneath, and both have afforded accurate sections and proved the thickness of the strata at these two places, which are about a mile apart. Mr A. STRAHAN, in the *Geology of Prescott* (2nd edition), gives the details of each section, and the débris from the shafts still remains on the surface. The strata consist of various shales and sandstones, with a red stain for some distance below the surface, but as the depth increases they gradually present the usual black and grey coloured shales. In both the Collin's Green and Bold sections there are numerous thin beds of coal, varying from 1 to 24 inches in thickness. A shaft was sunk at Haydock a few

years ago, passing through the Trias for 101 feet into the Upper Coal Measures, but did not reach any coal seams. At the end of a heading 327 feet from the surface, the Permian or Trias was found resting unconformably on the Upper Coal Measures, as shown in fig. 3.

These important sections prove the thickness of the subdivision to be about 1200 feet, and that in any future sinking or boring through the Trias for the purpose of obtaining coal, the occurrence of that amount of unproductive strata may be expected before the productive Coal Measures are reached.

SYNOPSIS OF SPECIES.*

Calamariæ.

Calamites, Suckow.

Group I.—**Calamitina**, Weiss (*Emend.*), 1884, *Steinkohlen Calamarien*, part ii. p. 59.†

Calamitina (Calamites) varians, Sternb., var. **inconstans**, Weiss,
Pl. I. figs. 1, 1a.

Calamites (Calamitina) varians inconstans, Weiss, *Steinkohlen-Calamarien*, part ii. pp. 62 and 69, pl. xvi. a, figs. 7, 8; pl. xxv. fig. 2, 1884.

Calamites varians, Sternb., *Vers.*, ii. p. 50, pl. xii. (cast).

Cyclocladia major, Feistmantel (*not* L. & H. (!), (in part), *Vers. d. böhm. Ablager.*, Abth. i. pl. i. fig. 8.

Calamitina Göpperti, Weiss. (*not* Ettingshausen), *Steinkohlen Calamarien*, part i. pl. xvii. figs. 1, 2, 1876.

Description.—Internodes broader than long, faintly striate, periods of six to fourteen non-branch-bearing nodes between each verticil of branch-scars; branch-scars oval, approximate, with a more or less central circular cicatrice; the internode at the base of the period is the shortest, the next succeeding internodes have generally a slight increase in their length, but sometimes their increase in length is irregular, the uppermost one is generally the longest; leaf-scars contiguous or slightly distant, transversely oval or sub-triangular.

Remarks.—The only specimen of this species in the collection is shown natural size on Pl. I. fig. 1, and measures about 32 cm. in length. It shows two complete and

* In the Ravenhead collection are several ferns which are specifically distinct from any included in this list, but are too fragmentary for any satisfactory determination.

† In *Abhandl. z. geol. special-karte v. Preussen u. Thüringischen Staaten*, Band v. part ii.

two incomplete periods. The lengths of the internodes entering into the composition of the specimen are as follow :—

		mm.	
Period incomplete.	Internode 1	8·50	
	" 2	5	
	" 3	6·50	
	" 4	5·50	
	" 5	4·50	
	" 6	5	
	" 7	3	
	" 8	4	
	" 9	3·50	
	" 10	3	
	" 11	3	
Period complete.	" 12	7	Node with branch-scars.
	" 13	6	
	" 14	8·50	
	" 15	8	
	" 16	8	
	" 17	7·50	
	" 18	7·50	
	" 19	7	
	" 20	5	
	" 21	4·50	
	" 22	4	
Period complete.	" 23	3·50	
	" 24	7·50	Node with branch-scars.
	" 25	8	
	" 26	11	
	" 27	12	
	" 28	12·50	
	" 29	12	
	" 30	11·50	
	" 31	11	
	" 32	10·50	
	" 33	8·50	
Period incomplete.	" 34	9·50	
	" 35	6·50	
	" 36	5	
	" 37	9·50	Node with branch-scars.
	" 38	19	
	" 39	22·50	
	" 40	17	

321·50 mm.

I am not certain that the full width of the specimen is shown at any part. On the right-hand side the true margin of the fossil is seen, on the left, from the manner in which the matrix has splintered off, it is difficult to decide as to whether the full

width of the stem is preserved, though it possibly may be at the two parts marked with a +.

I at first regarded this specimen as the type of a new species, chiefly on account of the subtriangular leaf-scars, but before raising it to that rank I forwarded a sketch of the plant to Dr WEISS, Berlin, who kindly examined it, and now informs me that he believes the "Ravenhead" specimen cannot be separated from *Calamitina varians*, var. *inconstans*. He further states that he has observed the subtriangular form of the leaf-scars on other specimens, and he believes it to be the result of pressure, which has brought about a slight distortion.

Calamitina (Calamites) varians, Sternb., var.

Calamites varians, Sternb., *Vers.*, ii. p. 50.

Calamitina (Calamites) approximatus, Brongt.

Calamites approximatus, Brongt. (in part), *Hist. d. végét. foss.*, p. 133, pl. xxiv. figs. 2, 3, 4, 5.

Group II.—**Eucalamites**, Weiss, 1884, *Steinkohlen Calamarien*,
part ii. p. 96.

Eucalamites (Calamites) ramosus, Artis.

Calamites ramosus, Artis, *Antedil. Phyt.*, pl. ii.

Calamites (Eucalamites) ramosus, Weiss, *Steinkohlen Calamarien*, part ii. p. 98, pl. ii. fig. 3; v. figs. 1, 2 vi.; vii. figs. 1, 2; viii. figs. 1, 2, 4; ix. figs. 1, 2; x. fig. 1; xx. figs. 1, 2.

Calamites (Eucalamites) ramosus, Kidston, *Trans. Roy. Soc. Edin.*, vol. xxxiii. p. 341.

Calamites nodosus, L. & H., *Fossil Flora*, vol. i. pls. xv., xvi.

As foliage:—

Annularia radiata, Brongt., *Prodrome*, p. 156.

Group III.—**Stylocalamites**, Weiss, 1884, *Steinkohlen Calamarien*,
part ii. p. 119.

Stylocalamites (Calamites) Suckowii, Brongt.

Calamites Suckowii, Brongt., *Hist. d. végét. foss.*, p. 124 (pl. xiv. fig. 6 ?), pl. xv. figs. 1-6; pl. xvi. figs. 2, 3, 4 (fig. 1 ?).

Calamites Suckowii, Geinitz, *Vers. d. Steinkf. in Sachsen.*, p. 6, pl. xiii. figs. 1-6.

Calamites Suckowii, Weiss., *Steinkohlen Calamarien*, part i. p. 123, pl. xix. fig. 1, 1876; part ii. p. 129, pl. ii. fig. 1; pl. iii. figs. 2, 3; pl. iv. fig. 1; pl. xxvii. fig. 3 (1884).

Calamites Suckowii, Zeiller, *Flore foss. du bassin houiller de Valenciennes*, p. 333, pl. liv. figs. 2, 3; pl. lv. fig. 1.

Stylocalamites (Calamites) undulatus, Sternb.

- Calamites undulatus*, Sternb., *Vers.*, i. fasc. 4, p. xxvi.; *Vers.*, ii. p. 47, pl. i. fig. 1 (pl. xx. fig. 8?).
Calamites undulatus, Brongt., *Hist. d. végét. foss.*, p. 127, pl. xvii. figs. 1-4.
Calamites undulatus, Sauveur, *Végét. foss. d. terr. houiller de la Belgique*, pl. v. figs. 1-3; pl. viii. fig. 1.
Calamites undulatus, Zeiller, *Flore foss. du bassin houiller de Valenciennes*, p. 338, pl. liv. figs. 1 and 4.
(?) *Calamites decoratus*, Brongt. (in part), *Hist. d. végét. foss.*, p. 123, pl. xiv. figs. 3, 4.
Calamites (Stylocalamites) Suckowii, var. *undulatus*, Weiss, *Steinkohlen Calamarien*, part ii. pp. 129, 134, 135, pl. xvii. fig. 4.
Calamites cannaeformis, Roehl (not Schlotheim) (in part), *Foss. Flora d. Steink. Form. Westph.*, p. 12, pl. ii. fig. 3. (In *Palæont.*, vol. xviii.)
Calamites inæquus, Achepohl., *Niederrh. Westfäl. Steinkohl.*, p. 114, pl. xxxiv. fig. 15.
Calamites duplex, Achepohl., *Niederrh. Westfäl. Steinkohl.*, p. 135, pl. xli. fig. 11.

Remarks.—I previously regarded *Calamites undulatus*, Sternb., as a varietal form—probably of *Calamites Suckowii*, Brongt.—but now believe it to be a distinct species. *Calamites undulatus* is most easily distinguished from *Calamites Suckowii* by the ribs being undulate (but this character may be removed by pressure), and by their terminating at the nodes in sharp triangular points—not being rounded, as in *Calamites Suckowii*.

Stylocalamites (Calamites) Cistii, Brongt.

- Calamites Cistii*, Brongt., *Hist. de végét. foss.*, p. 129, pl. xx.
Calamites Cistii, Zeiller, *Flore foss. du bassin houiller de Valenciennes*, p. 342, pl. lvi. figs. 1, 2.

Calamocladus, Schimper.

Calamocladus equisetiformis, Schloth., sp.

- Calamocladus equisetiformis*, Schimper, *Traité d. paléont. végét.*, vol. i. p. 324, pl. xxii. figs. 1-3.
Asterophyllites equisetiformis, Zeiller, *Flore foss. du bassin houiller de Valenciennes*, p. 368, pl. lviii. figs. 1-7.
Casuarinites equisetiformis, Schloth., *Flora d. Vorwelt*, p. 30, pl. i. figs. 1, 2; pl. ii. fig. 3.

Calamocladus grandis, Sternb., sp.

- Calamocladus grandis*, Schimper, *Traité d. paléont. végét.*, vol. i. p. 325.
Asterophyllites grandis, Zeiller, *Flore foss. du bassin houiller de Valenciennes*, p. 376, pl. lix. figs. 4-7.
Bechera grandis, Sternb., *Vers.*, i. fasc. 4, p. xxx. pl. xlix. fig. 1.

Calamocladus lycopodioides, Zeiller, sp.

- Asterophyllites lycopodioides*, Zeiller, *Flore foss. du bassin houiller de Valenciennes*, Atlas, pl. lix. figs. 1, 2 (1886); Text, p. 380 (1888).

SPHENOPHYLLÆ.

Sphenophyllum, Brongt.

Sphenophyllum cuneifolium, Sternb., sp.

- Sphenophyllum cuneifolium*, Zeiller, *Flore foss. du bassin houiller de Valenciennes*, p. 413, pl. lxii. fig. 1; pl. lxiii. figs. 1-10 (includes varieties).
Rotularia cuneifolia, Sternb., *Vers.*, i. p. 33, pl. xxvi. figs. 4a, 4b.

FILICACEÆ.

Sphyropteris, Stur, 1883.

Sphyropteris, Stur, *Morph. u. Syst. d. Culm. u. Carbon Farne*, p. 23 (in lxxxviii. vol. *Sitzb. d. k. Akad. d. Wissensch.*, 1 Abth.).

Sphyropteris, Stur, *Carbon Flora*, vol. i. p. 16.

Sphyropteris, Zeiller, *Flore foss. du bassin houiller de Valenciennes*, p. 31, fig. 17.

Description.—Sporangia free, exannulate, globular or hemispherical, placed in rows on oblique, levated bands, which are borne on a narrow membranous expansion, terminating the pinnæ and pinnules, and placed at right angles to them. Sporangia walls composed of elongated cells, which diverge from a terminal depression (pore?).

Remarks.—This peculiar genus is represented in the Ravenhead Collection by a single, but fortunately well-preserved specimen, of *Sphyropteris obliqua*, Marrat, sp. (= *Sphyropteris Crépini*, Stur). This example gives some additional information in regard to the structure of the sporangia. These are globular or perhaps hemispherical, as they seem to be attached by a base whose width is equal to the diameter of the sporangia, the cells of whose walls radiate from a central depression (Pl. I. figs. 3c and 3d). This central depression is too constant to be accidental, and I can only explain it by supposing it to be an apical pore for the dissemination of the spores, similar to what occurs in the fossil genus *Urnatopteris* and in the recent genus *Danæa*.

Sphyropteris obliqua, Marrat, sp.

Pl. I. figs. 3, 3a, 3b, 3c, 3d.

Sphenopteris obliqua, Marrat, *Proc. Liverpool Geol. Soc.*, Session 13, 1871–72, p. 99, pl. ix. fig. 3, 1872.

Sphyropteris Crépini, Stur, *Morph. u. Syst. d. Culm. u. Carbon Farne*, p. 24, fig. 6c, 1883.

Sphyropteris Crépini, Stur, *Carbon Flora*, vol. i. p. 18, pl. xxxix. figs. 1, 1a.; text, fig. 6c, p. 16, 1885.

Description.—Fronde tripinnate, pinna alternate, lanceolate; pinnules broadly oval, uppermost almost simple or slightly dentate, lower divided into 4–6 truncate lobes, which are occasionally notched; veins indistinct, but apparently one enters each lobe. Sporangia as described above, and placed on obliquely elevated bands, which are situated on linear membranous expansions placed at right angles to the extremities of the pinnules or terminating the pinnæ.

Remarks.—Pl. I. fig. 3a, gives an enlarged view of an ultimate pinna, magnified five times. Two of the pinnules and the apex of the pinna each bear one of the linear sporangial expansions. At fig. 3b, one of these sporangial bands is shown enlarged $7\frac{1}{2}$ times. The left half of the band was not so well preserved as the right half, and on it the sporangia were a good deal displaced, but on the right and better preserved portion three elevated ridges are clearly shown, on two of which are borne three sporangia each, and on the terminal one two have been developed. Their number may, however, vary.

There is no recent genus with which *Sphyropteris* can be compared in the arrangement of its sporangia and the peculiarly developed sporangial band. In the structure of the individual sporangia, however, they are clearly shown to be *Marattiaceous*, and in their apparently opening by a terminal pore, they show some similarity to the sporangia of the recent *Danæa*.

Sphyropteris Crépini, Stur, does not appear to differ in any character from *Sphyropteris obliqua*, Marrat, sp.

Zeilleria, Kidston.

Zeilleria delicatula, Sternb., sp.

Zeilleria delicatula, Kidston, *Quart. Jour. Geol. Soc.*, vol. xl. p. 592, pl. xxv.

Zeilleria delicatula, Kidston, *Catal. Palæoz. Plants*, p. 66.

Sphenopteris delicatula, Sternb., *Vers.*, i. fasc. ii. p. 30, pl. xxvi. fig. 5; fasc. iv. p. xvi.

Sphenopteris, Brongt.

Sphenopteris Sauveurii, Crépin.

Sphenopteris Sauveurii, Crépin, *Bull. Soc. Roy. Bot. de Belgique*, vol. xix. part ii. p. 17.

Sphenopteris Sauveurii, Crépin, *ibid.*, vol. xx. part ii. p. 26.

Sphenopteris Sauveurii, Zeiller, *Flore foss. d. bassin houill. d. Valenciennes*, p. 79, pl. ix. fig. 6.*

Sphenopteris trifoliolata, Artis, sp.

Sphenopteris trifoliolata, Brongt., *Prodrome*, p. 51.

Filicites trifoliolatus, Artis, *Antedil. Phyt.*, pl. xi.

Remark.—For notes on *Sphenopteris trifoliolata*, see the following species.

Sphenopteris Marratii, Kidston, n. sp.,

Pl. II. figs. 1, 2.

Sphenopteris-Gymnogrammides, *Proc. Liverpool Nat. Field Club for 1870-71*, frontispiece, fig. 1, 1871.

Sphenopteris trifoliolata, Marrat (*not* Artis), *Proc. Liverpool Geol. Soc.*, Session 13, 1871-72, p. 98, 1872.

Description.—Frond bi- or tripinnate, pinnæ linear lanceolate, alternate; pinnules small, of firm texture, opposite or alternate, obovate, obcordate, or trilobate; the pinnules towards the base of the pinnæ stalked, the uppermost pinnules sessile or attached by a wide pedicle-like contraction of the pinnule. Main rachis of primary (?) pinnæ or frond (?) moderately thick, the other rachis thin. Venation not shown.

Remarks.—There is no more difficult class of fossils to determine accurately than the small pinnuled *Sphenopterids*, and it is only after a good deal of consideration that I have come to the conclusion that a new specific name must be applied to the two specimens given on Pl. II. figs. 1, 2.

Sphenopteris Marratii appears to me to be altogether different from *Sphenopteris*

* A full synonymy is given here by M. ZEILLER of this much-confused and many-named species.

trifoliolata, Artis, sp., with which it had been previously identified. In this latter species the pinnules are much larger and characteristically trilobate, and the plant has a different mode of growth,—the importance of these characters, though difficult to describe adequately in words, are very obvious when actual specimens of the two plants are compared. The type figure of *Sph. trifoliolata* * is a very characteristic drawing of the plant, and shows the differences more clearly than can be pointed out in a written description.

In Pl. II. fig. 1, the pinnæ have an almost linear outline, while in *Sphenopteris trifoliolata* they are more deltoid. Some of the pinnules of *Sphenopteris Marratii*, especially on the upper pinnæ, are trilobate (fig. 1*b*), but on the lower pinnæ, where the trilobate pinnules are characteristic in *Sph. trifoliolata*, they do not occur on *Sph. Marratii*, or only very rarely.

Fig. 2 is from another small specimen of the same species, and shows portions of two pinnæ, evidently belonging to a lower part of the frond than that from which fig. 1 has been derived. It is laxer in its growth, the ultimate pinnæ and pinnules are more distant, but still possess the same characters as those of fig. 1.

The pinnules at the base of the pinnæ are often notched or obcordate, those higher on the pinnæ obovate. The terminal pinnules are blunt, and frequently lobed. The number of pinnules on the ultimate pinnæ varies according to the position of the pinnæ on the frond.

Fig. 1 is probably the terminal portion of a frond, though it may be only the termination of a primary lateral pinna.

Sphenopteris Marratii may possibly be the same plant as that figured by STUR as *Sphenopteris trifoliolata*,† but in the absence of enlarged drawings of the pinnules of his fern, one cannot be certain of their identity. One point, however, is certain, that the fern named *Diplothmema trifoliolatum*, Artis, sp., by STUR, is not that plant.

Of the references STUR gives for *Sphenopteris trifoliolata*, Artis, sp., only that to ARTIS' figure is correct. The *Sphenopteris numularia* figured by ANDRÆ,‡ and the *Sphenopteris trifoliolata* given by BRONGNIART,§ not being referable to ARTIS' species. In fact, *Sphen. trifoliolata*, Artis, sp., seems to be very much misunderstood on the Continent.

Since preparing the catalogue of Palæozoic Plants in the British Museum, I have had considerable opportunities of examining specimens of *Sphen. trifoliolata*, and now think that none of the figures issued under this name by ANDRÆ,|| ROEHL,¶ or BRONGNIART** belong to that plant.

* *Antedil. Phyt.*, pl. xi.

† *Carbon Flora*, p. 346, pl. xix. figs. 1-4 (*Diplothmema trifoliolatum*).
Vorwelt Pflanzen, pl. xi.

§ *Hist. d. végét. foss.*, pl. liii. fig. 3.

|| *Vorwelt Pflanzen*, pl. ix. figs. 2-4.

¶ *Foss. Flora d. Steink. Form. Westph.*, pl. xvi. figs. 3 and 16.

** *Hist. d. végét. foss.*, pl. liii. fig. 3.

ZEILLER, in his admirable work on the *Flore foss. d. bassin houill. d. Valenciennes*, gives, on his pl. i. figs. 1–4, drawings of a fern he identifies as *Sphenopteris trifoliolata*, Artis, sp. None of these figures are, however, according to my view, referable to the true *Sph. trifoliolata*, but to *Sph. obtusiloba*. Though the pinnules of some of ZEILLER's figures show a trilobate segmentation, they are much more solid, and altogether want the light and diffuse appearance of the pinnules of *Sph. trifoliolata*. I also fear that the union of *Sph. numularia* with *Sph. trifoliolata*, as proposed by ZEILLER, is inadmissible. I am led to this conclusion from the examination of specimens of *Sph. trifoliolata* from the same horizon as that from which the type was procured, and therefore do not think that I can be mistaken in the characters of the true plant.

Sphenopteris Marratii approaches very closely to *Sphenopteris* (*Diplothemema*) *avoldensis*, Stur,* but seems to differ from it in the pinnæ and pinnules being more obtuse, and according to the description of *Sphen. avoldensis*, Stur, sp., it must have been of more delicate texture. Dr STUR here again gives no enlarged drawings of the segmentation of his species, without which a satisfactory comparison of these small pinnuled *Sphenopterids* is almost impossible.

I have pleasure in naming the Ravenhead species after Mr MARRAT, who was the first to publish a list of the Ravenhead ferns.

Sphenopteris obtusiloba, Brongt.

Sphenopteris obtusiloba, Brongt., *Hist. d. végét. foss.*, p. 204, pl. liii. fig. 2.

Sphenopteris obtusiloba, Zeiller, *Flore foss. d. bassin houill. d. Valenciennes*, p. 65, pl. iii. figs. 1–4; pl. iv. fig. 1; pl. v. figs. 1, 2 (exclude syn. *Sph. grandifrons*, Sauv.).

Sphenopteris irregularis, Sternb., *Vers.*, ii. p. 63, pl. xvii. fig. 4.

Sphenopteris trifoliolata, Zeiller (not Artis), *Flore foss. d. bassin houill. d. Valenciennes*, p. 75, pl. i. figs. 1–4. (Ref. in part.)

Remarks.—See notes appended to *Sphenopteris trifoliolata*.

Sphenopteris mixta, Schimper.

Sphenopteris mixta, Schimper, *Traité d. paléont. végét.*, vol. i. p. 382, 1869.

Sphenopteris mixta, Zeiller, *Flore foss. d. bassin houill. d. Valenciennes*, p. 95, pl. xii. fig. 3, 1886.

Sphenopteris mixta, Lesquereux, *Geol. Survey of Illin.*, vol. iv. p. 409, pl. xv. fig. 7, 1870.

Sphenopteris mixta, Lesquereux, *Coal Flora*, vol. i. p. 276 (pl. liv. figs. 1–3 (?)).

Sphenopteris rigida (?), Lesquereux (not Brongt.), *Geol. Survey of Illin.*, vol. ii. p. 435, pl. xxxix. figs. 5, 6.

Sphenopteris (*Aneimioides*) (?) *pulchra*, Marrat, *Proc. Liverpool Geol. Soc.*, Session 13, 1871–72, p. 101, pl. viii. fig. 1.

Remarks.—In the Ravenhead Collection is a small specimen which I refer to this species. It appears to be similar to the fern figured under this name by ZEILLER in his *Flore foss. d. bassin houill. d. Valenciennes*. In the description of his specimen he mentions that the inferior surface of the pinnules is entirely covered with adpressed hairs. A similar structure occurs on the Ravenhead example, but is on the upper surface of the pinnules.

* *Carbon Flora*, vol. i. p. 345, pl. xxiv. fig. 6.

Mr LACOE has kindly sent me a specimen of *Sph. mixta*, labelled as from the "Sub-carboniferous of Clinton, Mo." This series is below the Millstone Grit, and therefore from a much lower horizon than that from which the British example originates. I have compared our plant most carefully with Mr LACOE's specimen of *Sphenopteris mixta*, and in nervation and pinnule cutting it agrees entirely, and although the example sent me by Mr LACOE does not show the adpressed hairs, yet the surface of the pinnules have a roughened appearance, suggestive of the presence of hairs. LESQUEREUX, in the original description of *Sph. mixta*, which he then identified as *Sphen. rigida*, Brongt. (?), says, "in our specimens the surface of the leaves is evidently rugose, as if it had been originally squamose or hairy."* In his latest description in the *Coal Flora*† he says, "surface smooth or polished," but at the same time gives his *Sphen. rigida* (Lesqx., not Brongt.) as a synonym to *Sphen. mixta*. ZEILLER thinks it probable that the fern LESQUEREUX figures in the *Coal Flora* may not belong to *Sphen. mixta*, Schimper, but be a distinct species. On this question, in the absence of American specimens similar to those figured in the *Coal Flora*, I cannot enter.

The Lancashire fossil has been named *Sphenopteris pulchra* by Mr MARRAT in his list of the Ravenhead Ferns, but it does not differ in any point from *Sphenopteris mixta*, Schimper, as far as I understand this species.

***Sphenopteris coriacea*, Marrat.**

Pl. I. figs. 4, 4a, 4b.

Sphenopteris coriacea, Marrat, *Proc. Liverpool Geol. Soc.*, Session 13, 1871-72, p. 98, pl. ix. figs. 1-2, 1872.

Description.—Fronde ; pinnæ alternate, ovate-lanceolate, main rachis thick; pinnules crowded on lower pinnæ, more distant on upper ones, contracted at the base, deltoid or lanceolate, coriaceous, basal pinnules divided into oblong lobes, the basal lobe much developed and directed towards the base of the pinna, and again divided into oblong simple or lobed segments; in these pinnules the basal lobe is not much less than the other part of the pinnule. Upper pinnules oblong, and divided into 5-9 simple or lobed teeth; terminal lobe blunt, and not enlarged. Veins immersed, obscure.

***Sphenopteris Footneri*, Marrat.**

Pl. II. figs. 3, 3a, 3b.

Sphenopteris Footneri, Marrat, *Proc. Liverpool Geol. Soc.*, Session 13, 1871-72, p. 101, pl. viii. figs. 2, 3, 1872.

Description.—Fronde tripinnate or decompose; rachis winged, flexuous; pinnæ alternate, narrow deltoid; pinnules oblong, of delicate texture, and divided into 3-7 blunt segments, these in turn bear 2-4 blunt teeth, into each of which extends a vein;

* *Geol. Survey of Illin.*, vol. iv. p. 436.

† Page 276.

the terminal lobe of the pinnule usually consists of two blunt equal lobes separated by a sinus. The pinnules become confluent on the upper pinnæ, and on the upper portion of the lower pinnæ. Veins distinct, flexuous.

Remarks.—This description is founded on the specimen figured here,—one of Mr MARRAT'S types,—and on another specimen in my collection from the Middle Coal Measures, Claycross, Derbyshire, given me by Dr PEGLER, Stonebroom.

Fig. 3 shows portion of a pinna, probably from the basal part of a frond. My Claycross specimen seems to show a portion of a frond near the apex. In that figured the pinnules are free, and attached to a broad winged rachis; in the Claycross example the pinnules are confluent on the greater number of the pinnæ, like those on the apical portion of the pinna given at 3*b*. The venation is firm and distinct, and when the limb of the pinnule has been subjected to any decay before fossilisation, little more than the veins are preserved.

This species is closely related to *Sphenopteris gracilis*, Brongt.,* from Newcastle-on-Tyne, especially as figured by ZEILLER,† and will likely require to be united with it, but as probably at an early date I may have further facilities for examining additional specimens, I meantime retain Mr MARRAT'S name for the Ravenhead fern, though strongly of opinion that the plant should be referred to *Sphenopteris* (*Renaultia*) *gracilis*, Brongt.

I have hitherto been unable to ascertain to which species BRONGNIART'S *Sphenopteris gracilis* really referred, and it is only since seeing M. ZEILLER'S figures that it has occurred to me that the *Sphenopteris Footneri*, Marrat, is most probably the *Sphen. gracilis* of Brongniart.

Sphenopteris spinosa, Göppert.

Sphenopteris spinosa, Göpp., *Gatt. d. foss. Pflanzen*, Lief 3-4, p. 70, pl. xii.

Sphenopteris spinosa, Zeiller, *Flore foss. d. bassin houill. d. Valenciennes*, p. 135, pl. xv. figs. 1-3.

Remarks.—The specimens are all very fragmentary.

Sphenopteris furcata, Brongt.

Sphenopteris furcata, Brongt., *Hist. d. végét. foss.*, p. 179, pl. xlix. figs. 4, 5.

Diplothemema furcatum, Stur, *Carbon Flora*, vol. i. p. 299, pl. xxviii. figs. 2, 3.

Diplothemema furcatum, Zeiller, *Flore foss. d. bassin houill. d. Valenciennes*, p. 147, pl. iv. figs. 5, 6; pl. v. fig. 4.

Sphenopteris multifida, Lindley & Hutton.

Sphenopteris multifida, L. & H., *Fossil Flora*, vol. ii. pl. cxxiii.

Remarks.—In the *Quart. Jour. Geol. Soc.*, vol. xl. p. 594, and in my *Catalogue of Palæozoic Plants*, p. 65, I have united this species with *Urnatopteris tenella*, Brongt.,

* *Hist. d. végét. foss.*, p. 197, pl. liv. fig. 2.

† *Flore foss. d. bassin houill. d. Valenciennes*, p. 94, pl. iv. figs. 2, 3.

sp. Though not yet quite certain as to the true characters of the plant which was named *Sphenopteris multifida* by LINDLEY and HUTTON, I believe that the fragments here recorded under this name are referable to that species; and if I am correct in this supposition, *Sphenopteris multifida*, L. & H., cannot be united with *Urnatopteris tenella*, Brongt., sp.

Sphenopteris Sternbergii, Ett., sp.

Asplenites Sternbergii, Ettingshausen, *Steinkf. v. Radnitz.*, p. 42, pl. xx. figs. 2, 3, and 4 (pars).

Pecopteris Sternbergii, Schimper, *Traité d. paléont. végét.*, vol. i. p. 525.

Alethopteris Sternbergii, Kidston, *Catal. Palæoz. Plants*, p. 138.

Sphenopteris Sternbergii, Zeiller, *Flore foss. d. bassin houill. d. Valenciennes*, p. 128, pl. ix. fig. 5; pl. xxxviii. fig. 6.

Neuropteris, Brongt.

Neuropertis heterophylla, Brongt.

Neuropteris heterophylla, Brongt., *Hist. d. végét. foss.*, p. 243, pl. lxxi.; pl. lxxii. fig. 2.

Neuropteris heterophylla, Zeiller, *Flore foss. d. bassin houill. d. Valenciennes*, p. 261, pls. xliii. and xliv.

Neuropteris Loshii, Brongt., *Hist. d. végét. foss.*, p. 242, pl. lxxii. fig. 1; pl. lxxiii.

Cyclopteris trichomanoides, Brongt., *Hist. d. végét. foss.*, p. 217, pl. lxi. bis, fig. 4.

Neuropteris tenuifolia, Schlotheim, sp.

Neuropteris tenuifolia, Brongt., *Hist. d. végét. foss.*, p. 241, pl. lxxii. fig. 3.

Neuropteris tenuifolia, Zeiller, *Flore foss. d. bassin houill. d. Valenciennes*, p. 273, pl. xlvi. fig. 1.

Filicites tenuifolius, Schloth., *Petrefactenkunde*, p. 405, pl. xxii. fig. 1.

Neuropteris gigantea, Sternberg.

Neuropteris gigantea, Sternb., *Vers.*, i. fasc. 4, p. xvi.

Neuropteris gigantea, Brongt., *Hist. d. végét. foss.*, p. 240, pl. lxix.

Osmunda gigantea, Sternb., *Vers.*, i. fasc. 2, pp. 33 and 36, pl. xxii.

Neuropteris macrophylla, Brongt.

Neuropteris macrophylla, Brongt., *Hist. d. végét. foss.*, p. 235, pl. lxv. fig. 1.

Neuropteris macrophylla, Kidston, *Trans. Roy. Soc. Edin.*, vol. xxxiii. p. 354, pl. xxi. fig. 2; pl. xxii. figs. 2, 3.

Neuropteris dentata, Lesquereux.

Pl. II. fig. 5.

Neuropteris dentata, Lesqx., *Geol. of Pennsylv.*, 1858, p. 859, pl. v. figs. 9, 10.

Neuropteris dentata, Lesqx., *Coal Flora*, vol. i. p. 82, pl. v. figs. 7, 8.

Nephropteris denticulata, Marrat, *Proc. Liverpool Geol. Soc.*, p. 104, 1871-72.

(Unnamed), Higgins, *Proc. Liverpool Nat. Field Club*, frontispiece, fig. 13, for year 1871-72.

Description.—Pinnules ovate, obtuse, truncate, or subcordate at the base, irregularly lacerate-dentate, the clefts occasionally extending some distance inwards from the margin. Veins dichotomous, flabellate, slightly arched in passing to the border, thin, close.

Remarks.—This species is only represented by a single pinnule, but it agrees so completely with LESQUEREUX's description and figure that I have no doubt that the Ravenhead specimen is identical with LESQUEREUX's species.

Neuropteris dentata is one of a group of Neuropterids whose pinnules have dentate or ciliate margins, and whose relationship to each other is not yet clearly made out. They usually occur in a very fragmentary condition.

In my paper on the Fossil Flora of the Radstock Series, I have given three figures of what I believe to be the *Neuropteris fimbriata*, Lesqx.*

HEER describes two species which are very closely related to these, viz., *Neuropteris* (*Cyclopteris*) *lacerata* and *Neuropteris* (*Cyclopteris*) *ciliata*,† which perhaps should be referred to one or other of the American species.

Odontopteris, Brongt.

Odontopteris Reichiana, Gutbier.

Odontopteris Reichiana, Gutbier, *Vers. d. Zwick. Schwarzk.*, p. 65, pl. ix. figs. 1, 2, 3, 5, 7; pl. x. fig. 13.

Odontopteris Reichiana, Weiss, *Foss. Flora d. jüngst. Stk. u. Rothl.*, p. 32, pl. i. figs. 3–9.

Odontopteris neuropteroides, Marrat (not Roemer, not Lesqx.), *Proc. Liverpool Geol. Soc.*, Session 13, 1871–72, p. 107, pl. vii. figs. 1, 2.

? *Odontopteris Britannica*, Gutbier.

Odontopteris Britannica, Gutbier, *Vers. d. Zwick. Schwarzk.*, p. 68, pl. ix. figs. 8–11.

Odontopteris Britannica, Weiss, *Foss. Flora d. jüngst. Stk. u. Rothl.*, p. 45, pl. i. fig. 2.

Mariopteris, Zeiller.

Mariopteris muricata, Schloth., sp.

Mariopteris muricata, Zeiller, *Flore foss. d. bassin. houill. d. Valenciennes*, p. 173, pl. xx. figs. 1–4; pl. xxi. fig. 1; pl. xxii. figs. 1, 2; pl. xxiii. fig. 1 (includes var. *nervosa*).

Pecopteris muricata, Brongt., *Hist. d. végét. foss.*, p. 352, pl. xcv. figs. 3, 4; pl. xcvi.

Filicites muricatus, Schloth., *Flora d. Vorwelt*, pp. 52 and 55, pl. xii. figs. 21 and 23.

Pecopteris nervosa, Brongt., *Hist. d. végét. foss.*, p. 297, pl. xciv.; pl. xcv. figs. 1, 2.

Remarks.—Specimens of the typical form and of *Pec. nervosa*, Brongt., which is only a variety of *Mariopteris* (*Pecopteris*) *muricata*, are contained in the collection.

Pecopteris, Brongt.

? *Pecopteris Miltoni*, Artis, sp.

Pecopteris Miltoni, Kidston, *Trans. Roy. Soc. Edin.*, vol. xxxiii. p. 374.

Filicites Miltoni, Artis, *Antedil. Phyt.*, pl. xiv.

Dactylothea, Zeiller.

Dactylothea plumosa, Artis, sp.

Filicites plumosa, Artis, *Antedil. Phyt.*, pl. xvii.

* *Trans. Roy. Soc. Edin.*, vol. xxxiii. p. 361, pl. xxi. figs. 3, 4, 1888.

† *Flora fossilis Helvetiæ*, p. 17, pl. vi. figs. 17 and 24.

Remarks.—I have previously placed *Dactylothea dentata*, Brongt., sp., with this fern as a variety of it, and this view may be correct; but it must be noted that *Dactylothea plumosa*, Artis, sp., is the only form I have hitherto met with in the Middle Coal Measures, where it would appear *Dactylothea dentata* is either absent or very rare.

It is perhaps better to leave the relationship of *Dactylothea dentata* and *Dactylothea plumosa* to each other an open question till the subject has been more fully investigated.*

Alethopteris, Sternberg.

Alethopteris lonchitica, Schloth., sp.

Pecopteris lonchitica, Brongt., *Hist. d. végét. foss.*, p. 275, pl. lxxxiv. figs. 1–7; pl. cxxviii.

Alethopteris lonchitica, Zeiller, *Flore foss. d. bassin houill. d. Valenciennes*, p. 225, pl. xxxi.

Filicites lonchiticus, Schloth., *Flora d. Vorwelt*, p. 55, pl. xi. fig. 22.

Alethopteris lonchitica, Schloth., sp., var. *decurrens*, Artis, sp.

Alethopteris decurrens, Zeiller, *Flore foss. d. bassin houill. d. Valenciennes*, p. 221, pl. xxxiv. figs. 2, 3; pl. xxxv. fig. 1; pl. xxxvi. figs. 3, 4.

Filicites decurrens, Artis, *Antedil. Phyt.*, pl. xxi.

Pecopteris Mantelli, Brongt., *Hist. d. végét. foss.*, p. 278, pl. lxxxiii. figs. 3, 4.

Pecopteris Mantelli, Lindley & Hutton, vol. ii. pl. cxlv.

Pecopteris heterophylla, Lindley & Hutton, *Foss. Flora*, vol. i. pl. xxxviii.

Remarks.—ZEILLER treats *Filicites decurrens*, Artis, as a distinct species, but I am much more inclined to regard it as a variety of *Alethopteris lonchitica*, Schloth., sp.

Alethopteris Serlii, Brongt.

Pecopteris Serlii, Brongt., *Hist. d. végét. foss.*, p. 292, pl. lxxxv.

Rhacophyllum, Schimper.

Rhacophyllum crispum, Gutbier, sp., forma *lineare*, Gutbier, sp.

Fucoides crispus, Gutbier, *Vers. d. Zwick. Schwarzk.*, p. 13, pl. i. fig. 11; pl. vi. fig. 18.

Rhacophyllum Lactuca, Schimper, *Traité d. paléont. végét.*, vol. i. p. 684; pl. xlvi. fig. 1; pl. xlvii. fig. 1 (fig. 2 ?); vol. iii. p. 524.

Fucoides linearis, Gutbier, *Vers. d. Zwick. Schwarzk.*, p. 13, pl. i. figs. 10, 12.

Remarks.—The specimens agree with the *Fucoides linearis*, Gutbier, which is most probably only a variety of *Fucoides crispus*, Gutbier.

The fossil figured by Mr MARRAT as “Rootstock of a Fern”† is a fragment of *Rhacophyllum*, and what has been mistaken for “paleæ or chaffy scales” are stainings in the matrix, and not an organic substance.

Megaphyton, Artis.

Megaphyton frondosum, Artis.

Megaphyton frondosum, Artis, *Antedil. Phyt.*, pl. xx.

* Since this was written, I believe I have evidence to show that “*dentata*” is most probably only a variety of *Filicites plumosa*, Artis.—April 1889.

† *Proc. Liverpool Geol. Soc.*, Session 13, 1871–72, pl. i. fig. 2, 1872.

LYCOPODIACEÆ.

Lepidodendron, Sternberg.

Lepidodendron Sternbergii, Brongt.

Lepidodendron Sternbergii, Brongt., *Prodrome*, p. 85.

Lepidodendron dichotomum, Sternb. (in part), *Vers.*, i. fasc. i. pp. 19 and 23, pls. i., ii. (excl. pl. iii.); *Vers.*, ii. p. 177, pl. lxviii. fig. 1.

Lepidodendron dichotomum, Zeiller, *Flore foss. d. bassin houill. d. Valenciennes*, pl. lxvii. fig. 1.

Lepidodendron aculeatum, Sternb.

Lepidodendron aculeatum, Sternb., *Vers.*, i. fasc. i. pp. 20 and 23, pl. vi. fig. 2; pl. viii. fig. 1B; fasc. ii. p. 25, pl. xiv. figs. 1-4; fasc. iv. p. 10.

Lepidodendron aculeatum, Zeiller, *Flore foss. d. bassin houill. d. Valenciennes*, p. 435, pl. lxv.

Lepidodendron Haidingeri, Ettingshausen.

Lepidodendron Haidingeri, Ettings., *Steinkf. v. Radnitz*, p. 55, pls. xxii. and xxiii.

Remarks.—The collection contains several specimens of this species, of which I had previously only seen a single example from Shale over “Hughes’ Vein,” Cwmburla Colliery, near Swansea, which was collected by Mr LEWIS, Swansea.

Lepidostrobus, Brongt.

Lepidostrobus variabilis, L. & H.

Lepidostrobus variabilis, L. & H., *Fossil Flora*, vol. i. pls. x. and xi.

(?) Lepidostrobus Olryi, Zeiller.

Lepidostrobus Olryi, Zeiller, *Flore foss. d. bassin houill. d. Valenciennes*, p. 502, pl. lxvii. fig. 1.

Lepidostrobus Geinitzii, Schimper.

Lepidostrobus Geinitzii, Schimper, *Traité d. paléont. végét.*, vol. ii. p. 62 (excl. syn. *L. comosus*, L. & H.).

Lepidostrobus Geinitzii, Zeiller, *Flore foss. d. bassin houill. d. Valenciennes*, p. 501, pl. lxxxvi. fig. 2.

Lepidostrobus variabilis, Geinitz (not L. & H.), *Vers. d. Steinkf. in Sachsen*, pl. ii. figs. 1, 3, 4.

Lepidostrobus variabilis, Roehl (not L. & H.) (in part), *Foss. Flora d. Steink. Form. Westph.*, pl. vii. fig. 2.

Lepidostrobus variabilis, Feistmantel (not L. & H.) (in part), *Vers. d. böhm. Kohlenab.*, pls. xliii. and xliv.

Lepidophloios, Sternberg.

Lepidophloios carinatus, Weiss.

Lepidophloios carinatus, Weiss, *Foss. Flora d. jüngst. Stk. u. d. Rothl.*, p. 155.

Lepidophloios carinatus, Kidston, *Catal. Palæoz. Plants*, p. 172.

Halonia, L. & H.**Halonia regularis, L. & H.**

Halonia regularis, L. & H., *Fossil Flora*, vol. iii. pl. ccxxviii.

Remarks.—*Halonia regularis* is merely the decorticated fruiting branch of a *Lepidophloios*.

Lepidophyllum, Brongt.**Lepidophyllum lanceolatum, Brongt.**

Lepidophyllum lanceolatum, L. & H., *Fossil Flora*, vol. i. pl. vii. figs. 3, 4.

Bothrodendron, Lindley & Hutton.**Bothrodendron minutifolium, Boulay, sp.**

Bothrodendron minutifolium, Zeiller, *Bull. Soc. Géol. de France*, 3^e sér. vol. xiv. p. 176, pl. ix. figs. 1, 2, 1885.

Bothrodendron minutifolium, Zeiller, *Flore foss. d. bassin houill. d. Valenciennes*, p. 491, pl. lxxiv. figs. 2–4, 1888.

Bothrodendron minutifolium, Zeiller, *Végét. foss. du terr. houill. de la France (Extrait du Tome IV. de l'explantion de la carte géol. de la France)*, p. 117, 1879.

Bothrodendron minutifolium, Kidston, *Trans. Geol. Soc. Glasgow*, vol. viii. p. 65.

Rhytidodendron minutifolium, Boulay, *Le terr. houil. du nord de la France et ses végét. foss.*, p. 39, pl. iii. figs. 1 and 1 bis, 1876.

Rhytidodendron minutifolium, Renault, *Cours d. botan. foss.*, Deuxième Année, p. 52, pl. xii. figs. 1, 2, 1882.

Lycopodium carbonaceum, O. Feistmantel, *Vers. d. böhm. Kohlenab.*, Abth. ii. p. 9, pl. i. figs. 1 and 2 (named on plate *Lycopodites lycopodioides*), 1875.

Lycopodites selaginoides, Roehl (not Sternb.) (in part), *Foss. Flora d. Steink. Form. Westph.*, p. 144, pl. vii. fig. 3, 1869.

Lycopodites carbonaceus, Zeiller, *Flore foss. d. bassin houill. d. Valenciennes*, p. 495, pl. lxxiv. fig. 1.

Remarks.—In a previous paper,* while recording this species from Lancashire, I called attention to the error I made in uniting *Bothrodendron* with *Sigillaria discophora*, König, sp.†

At Pl. II. fig. 6, is given a figure of a plant which was originally named *Lycopodium carbonaceum* by FEISTMANTEL. The same fossil has been figured more recently by ZEILLER (*loc. cit.*) under the name of *Lycopodites carbonaceus*, O. Feistm., sp. I have fully satisfied myself, from the examination of foliage branches of *Bothrodendron minutifolium*, which were associated with stems bearing the characteristic marks of the species, that the *Lycopodium carbonaceum* of O. FEISTMANTEL has been founded on foliage branches of *Bothrodendron minutifolium*. Although small branches of this Lycopod, bearing the foliage, are not uncommon, yet owing to the dense manner in

* *Geol. Soc. Glasgow*, vol. iii. p. 65.

† See *Annals and Mag. Nat. Hist.*, vol. xvi. p. 251, 1885. *Note.*—Since this paper was written I have seen specimens of *Bothrodendron punctatum*, L. & H., as well as of *Bothrodendron minutifolium*, from the Lower Coal Measures, Kilmarnock, Ayrshire.

which the leaves clothe the stem, it is seldom that one finds examples which show the form of the leaves clearly. In the specimen I figure they are well shown at the point marked with a +, and are enlarged five times at fig. 6a. The leaves are linear lanceolate, single nerved, and taper to a sharp point. I have little doubt, however, that their form will vary somewhat on different parts of the plant.

Sigillaria, Brongt.

Sigillaria tessellata, Brongt.

Sigillaria tessellata, Brongt., *Hist. d. végét. foss.*, p. 436, pl. clvi. fig. 1 (?); pl. clxii. figs. 1-4.

Sigillaria tessellata, Zeiller, *Flore foss. d. bassin houill. d. Valenciennes*, p. 561, pl. lxxxv. figs. 1-9; pl. lxxxvi. figs. 1-6.

Sigillaria mamillaris, Brongt., var. abbreviata, Weiss.

Sigillaria mamillaris, Brongt., var. *abbreviata*, Weiss, *Foss. Flora d. jüngst. Stk. u. d. Rothl.*, p. 165, pl. xv. figs. 1, 2.

Sigillaria Arzinensis, Corda.

Pl. I. fig. 2.

Sigillaria Arzinensis, Corda, *Flora Protogæa*, p. 29, pl. lix. fig. 12 (figure inverted).

Sigillaria Arzinensis, Goldenberg, *Flora Saræpont. foss.*, Heft ii. p. 44, pl. x. fig. 14.

Sigillaria Arzinensis, Kimball, *Flora from the Apalachian Coal Field*, p. 16, pl. i. fig. 5.

Sigillaria Arzinensis, Schimper, *Traité d. paléont. végét.*, vol. ii. p. 93.

Description.—Ribs arched, separated by straight furrows; leaf-scars ovate, lateral angles distinct but not very prominent; cicatricules slightly above the centre, the two lateral straight or slightly lunate, diverging, the central punctiform. On the ribs, extending from one leaf-scar to another, is a longitudinal band of very fine punctato-granulate markings, and immediately above the leaf-scars are fine transverse corrugations. Subepidermal surface longitudinally striate.

Remarks.—The surface ornamentations of the ribs of this species are very delicate, and unless the specimens are in a fine state of preservation they would not likely be shown. I have indicated the appearance they present at Pl. I. fig. 2a. Above the scars the ornamentation is more pronounced, and assumes the form of fine transverse lines which bend round the upper end of the leaf-scar. On account of imperfect preservation, I can easily understand that this species will more frequently be found with a smooth bark, and in this condition it would be difficult to distinguish it from *Sigillaria ovalis*, Lesqx.,* which may, perhaps, be only a form of *Sigillaria Arzinensis*, Corda.

Stigmaria, Brongt.

Stigmaria ficoides, Sternb., sp.

Stigmaria ficoides, Brongt., *Class. d. végét. foss.*, p. 9, pl. i. fig. 7.

Stigmaria ficoides, L. & H., *Fossil Flora*, vol. i. pls. xxxi.-xxxvi.

Variolaria ficoides, Sternb., *Vers.*, i. fasc. i. pp. 22 and 24, pl. xii. figs. 1-3.

* *Coal Flora*, vol. ii. p. 495, pl. lxxi. figs. 7, 8.

Stigmaria rimosa, Goldenberg.

Stigmaria rimosa, Goldenb., *Flora Saræp. foss.*, Heft iii. p. 15 pl. xii. figs. 3–6 (named *Stigmaria abbreviata* on plate).

Cordaites, Unger.**Cordaites principalis**, Germar, sp.

Cordaites principalis, Zeiller, *Flore foss. d. bassin. houill. d. Valenciennes*, p. 629, pl. xciii. fig. 3, pl. xciv. fig. 1.

Flabellaria principalis, Germar, *Vers. v. Wettin u. Löbejun*, p. 55, pl. xxiii.

Antholithus, Brongt.**Antholithus**, sp.**Sternbergia**, Artis.**Sternbergia approximata**, Brongt.

Sternbergia approximata, Brongt., *Prodrome*, p. 137.

Sternbergia approximata, L. & H., *Fossil Flora*, vol. iii. pls. cccxiv., cccxv.

Remarks.—For notes on *Sternbergia*, see remarks under *Araucaroxylon* and *Sternbergia* in the *Catal. of Palæoz. Plants in the British Museum*, pp. 220, 221.

Trigonocarpus, Brongt.**Trigonocarpus Noeggerathi**, Sternb., sp.

Pl. II. fig. 4.

Palmacites Noeggerathi, Sternb., *Vers.*, i. fasc. 4, p. xxxv. pl. lv. figs. 6, 7.

Trigonocarpus Noeggerathi, Brongt., *Prodrome*, p. 137.

Trigonocarpus Noeggerathi, Zeiller, *Flore foss. d. bassin houill. d. Valenciennes*, p. 649, pl. xciv. figs. 8–11 (excl. ref. Lindley & Hutton).

Trigonocarpus Noeggerathi, Kidston, *Trans. Roy. Soc. Edin.*, vol. xxxiii. p. 403, pl. xxiii. fig. 3.

Trigonocarpus Noeggerathi, Kidston, *Catal. of Palæoz. Plants*, p. 216.

Palmacites dubius, Sternb., *Vers.*, i. fasc. 4, p. xxxv. pl. lviii. figs. 3a, b, c, d.

Remarks.—*Trigonocarpus Noeggerathi* has been confused with *Trigonocarpus Parkinsoni*, Brongt., by LINDLEY and HUTTON in their *Fossil Flora*, vol. ii. pl. clii^o. and vol. iii. pl. cxliii^b., and pl. ccxxii. figs. 2, 3, where they figure seeds of the latter under the name of the former, and their figures have unfortunately been given as a reference to *Trigonocarpus Noeggerathi* by several authors.

Trigonocarpus Noeggerathi is longer than *Trigonocarpus Parkinsoni*, the largest forms of the latter being seldom equal in size to the smallest specimens of the former, though in their length both species vary considerably. I do not know that *Trigono-*

carpus Noeggerathi is ever less than 2·5 cm., if so small; whereas the longest specimen of *Trigonocarpus Parkinsoni* that I have met with is 2·7 cm. long, but it was somewhat compressed. Of course, the diameter of *Trigonocarpus Parkinsoni* is proportionally smaller.

Trigonocarpi have three prominent and three very slightly raised ridges placed between the stronger ones, but it is only on well-preserved examples that the slightly raised ridges or keels are observable.

Of the two figures I have given of *Trigonocarpus Noeggerathi*, that in the *Trans. Roy. Soc. Edin.*, vol. xxxiii. part ii. pl. xxiii. fig. 3, represents the form named *dubius* by STERNBERG, which is, however, not specifically distinct from his *Trigonocarpus Noeggerathi*.

Trigonocarpus Parkinsoni, Brongt.

Trigonocarpus Parkinsoni, Brongt., *Prodrome*, p. 137.

Trigonocarpus Parkinsoni, Kidston, *Catal. of Palæoz. Plants*, p. 217.

Pinnularia, Lindley & Hutton.

Pinnularia capillacea, L. & H

Pinnularia capillacea, L. & H., *Fossil Flora*, vol. ii. pl. cxi.

Pinnularia capillacea, Kidston, *Catal. of Palæoz. Plants*, p. 58.

Stem.

"*Stem of a Fern*," Marrat, *Proc. Liverpool Geol. Soc.*, Session 13, 1871-72, pl. xi. fig. 1, 1872.

Remarks.—A figure of one of these fossils has been given by Mr MARRAT, who regarded them as fern stems. They possibly may belong to that group of fossils, but their state of preservation does not admit of a satisfactory determination. The stems bear spirally arranged obovate scars, which are considerably elevated in their upper part, but slope downwards towards their base, where they merge gradually into the stem, which is longitudinally striated.

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EXPLANATION OF PLATES.

PLATE I.

- Fig. 1. *Calamitina (Calamites) varians*, Sternb., var. *inconstans*, Weiss, nat. size.
 1a. Portion of the node showing leaf-scars $\times 5$.
- Fig. 2. *Sigillaria Arzinensis*, Corda, nat. size.
 2a. Leaf-scars and portion of rib enlarged 3 times, to show the surface ornamentation.
- Fig. 3. *Sphyropteris obliqua*, Marrat, sp., nat. size (type specimen).
 3a. Pinnule $\times 5$, showing the pinnule segmentation and three sporangial bands.
 3b. A sporangial band $\times 7\frac{1}{2}$, showing the sporangia placed on oblique elevated ridges.
 3c. A sporangium $\times 53$, showing the terminal depression (pore?) and the cell structure of the walls.
 3d. Another sporangium $\times 53$.
- Fig. 4. *Sphenopteris coriacea*, Marrat, nat. size (type specimen).
 4a, 4b. Two pinnules $\times 6$.

PLATE II.

- Fig. 1. *Sphenopteris Marratii*, Kidston, n. sp., nat. size.
 1a, 1b, 1c. Portions enlarged 5 times, to show the segmentation of the pinnules.
- Fig. 2. *Sphenopteris Marratii*, Kidston, n. sp., nat. size.
 2a. Pinnule $\times 5$.
- Fig. 3. *Sphenopteris Footneri*, Marrat, nat. size (one of the types).
 3a. Pinnule $\times 7\frac{1}{2}$, to show the segmentation and nervation.
 3b. Terminal portion of a pinna $\times 7\frac{1}{2}$.
- Fig. 4. *Trigonocarpus Noeggerathi*, Sternb., sp., nat. size.
- Fig. 5. *Neuropteris dentata*, Lesqx., nat. size. (The small stem underneath the pinnule has no connection with it.)
- Fig. 6. *Bothrodendron minutifolium*, Boulay, sp., nat. size. Small branches showing foliage.
 6a. Two leaves $\times 5$, from branchlet marked + on fig. 6.

Robt Kidston del.

Fig. 1. CALAMITINA (CALAMITES) VARIANS, Sternb. var. INCONSTANS, Weiss. Fig. 2. SIGILLARIA ARZINENSIS, Corda.

Fig. 3. SPHYROPTERIS OBLIQUA, Marrat, sp. Fig. 4. SPHENOPTERIS CORIACEA, Marrat.