PHILOSOPHICAL TRANSACTIONS OF THE ROYAL SOCIETY B BIOLOGICAL SCIENCES

Correlation and Palaeontology of the Coal Measures in East Glamorganshire

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Phil. Trans. R. Soc. Lond. B 1929 **217**, 91-153
doi: 10.1098/rstb.1929.0003

III. *Correlation and Palæontology of the Coal Measures in East Glamorganshire.*

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Communicated by Dr. P. F. Kendall, *F.R.S.*

(Received May 20,—Read June 30, 1927.)

(Plates 34–40.)

Contents.

The following Paper gives the results of an investigation of the Flora and Fauna associated with the various coal seams in a part of the South Wales Coalfield.

An account of the ecology of some of the lower seams was given in 'Quart. Jl. Geol. Soc.,' vol. 77, 1921, and a preliminary list of the species recorded from the Westphalian and lower part of the Staffordian Measures was given, in 1920, to the Manchester Institution of Mining Engineers ('Transacts.,' vol. 59, Part III).

I. Distribution of the Coal Seams. (See Locality Plan.)

The district with which this paper is concerned covers about 30 square miles in the eastern part of Glamorganshire, and includes the triangular area between Merthyr Tydfil in the North to Llantrisant in the South, a distance of 14 miles, and to Gilfach Goch in the West. The geological structure of the area is described in the 'Memoirs of the Geological Survey.'*

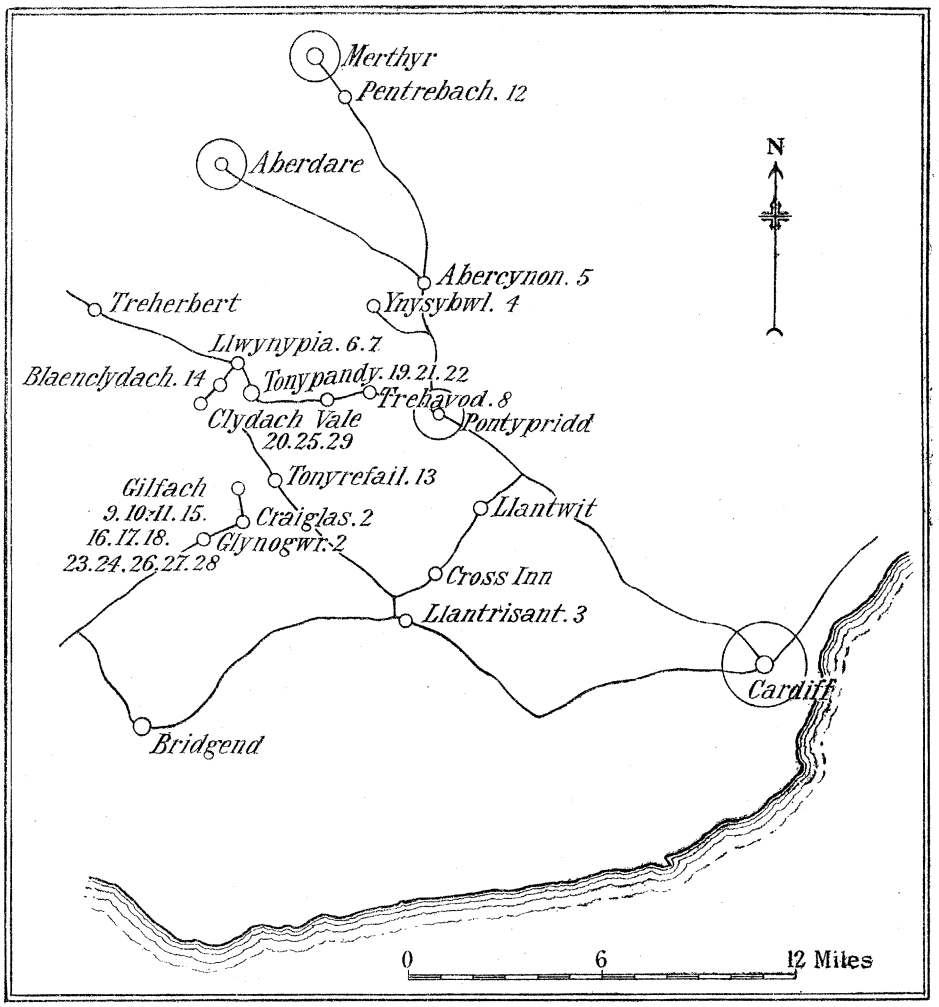
At Gilfach Goch, the well-known anticline that runs eastward to Pontypridd divides the area into two distinct troughs or synclines. In the southern trough, seams have been worked at Beddau, Cross Inn, Castellau, Trefyrig (Tonyrefail), Craiglas (Gilfach

* "The Geology of the South Wales Coalfield." "The Country around Merthyr Tydfil." "The Country around Pontypridd," by A. Strahan and others.

 [Published January 2, 1929.]

Goch) and Glynogwr. In the northern trough, seams have been worked at Gilfach Goch, Clydach Vale, Llwynypia, Penygraig, Tonyrefail (Gelligron), Ynysybwl (Upper), Abercynon and Merthyr Tydfil.

The southern trough, with its steep dips from the anticlinal ridge, brings in the Upper Pennant Series (or Radstockian), containing in descending order the numbers 1, 2, and 3 Llantwit Seams, the number 3 Llantwit Seam being the base of the Radstockian Series. The seams worked on the north side of the anticline belong, some to the Lower Pennant Series or Staffordian and others to the White Ash Series (or Westphalian). The base of the Lower Pennant (or Staffordian) is placed by the writer at the horizon of the well-known No. 3 Rhondda Seam, and this is confirmed by Dr. KIDSTON in his latest classification of the coal seams, contained in a list forwarded to the writer in March, 1924.



Coal Seams, Locality Plan.

Eighteen seams occur in the White Ash Series (or Westphalian), namely (in ascending order): Gellideg, Five Feet or (Seven Feet) Middle Yard, Upper Yard, or (Bute) Lower Nine Feet, Nine Feet, Six Feet, Four Feet, Four Feet Rider, Two Feet Nine,

Three Coals (B), Lower Gorllwyn, Gorllwyn, Lower Pentre, Pentre, Abergorky, Hafod and Hafod Rider Seams. Eight seams occur in the Staffordian Series, namely (in ascending order): No. 3 Rhondda, Three Coals (A), No. 2 Rhondda, Fforest Fach, No. 1 Rhondda, No. 1 Rhondda Rider, Cefn Glas and Daran Ddu Seams. Three seams are found in the Radstockian Series and are persistent in the limited area in which the series is still preserved, while the underlying White Ash or Westphalian Series extend to the lowest coal seam, the Gellideg.

The lithology of the measures shows 90 per cent. sandstone in the Radstockian and Staffordian Series, with the Westphalian Series in marked contrast, consisting of shale to the extent of about 80 per cent. The total thickness of strata in the three groups is about 1,150 yards, of which the 29 coal seams examined make altogether 103 feet thickness of coal.

TABULATION OF COAL SEAMS WITH LOCALITIES.

Horizon No.	Name.	Localities (where examined).
Westphalian or White Ash Series :—		
29	Gellideg Seam or Lower Five Feet Seam or No. 3 Yard Seam.	No. 3 Pit, Cambrian Collieries, Clydach Vale.
28	Five Feet Seam or Seven Feet Seam	Britannic Colliery, Gilfach Goch.
27	Middle Yard Seam or No. 2 Yard Seam	Britannic Colliery, Gilfach Goch.
26	Upper Yard or Bute Seam	Britannic Colliery, Gilfach Goch.
25	Lower Nine Feet Seam	No. 2 Pit, Cambrian Collieries, Clydach Vale.
24	Nine Feet Seam	Trane Colliery, Gilfach Goch.
23	Six Feet Seam	Trane Colliery, Gilfach Goch.
22	Four Feet Seam	Nantgwyn Colliery, Penygraig.
21	Upper Four Feet Seam or Rider Seam	Nantgwyn Colliery, Penygraig.
20	Two Feet Nine Seam	No. 1 Pit, Cambrian Collieries, Clydach Vale.
19	"Three Coal" Seam (B) or Upper Two Feet Nine Seam, or No. 1 Yard Seam.	Pandy Pit, Penygraig.
18	Lower Gorllwyn Seam	Trane Colliery, Gilfach Goch.
17	Upper Gorllwyn Seam	Trane Colliery, Gilfach Goch.
16	Lower Pentre Seam	Trane Colliery, Gilfach Goch.
15	Pentre Seam or Upper Pentre Seam	Trane Colliery, Gilfach Goch.
14	Abergorky Seam	Blaenclydach Colliery, Clydach Vale.
13	Hafod Seam	Gelli Gron Drift, Tonyrefail.
12	Hafod Rider Seam	Hills Plymouth Collieries, Merthyr. Level.
Staffordian or Lower Pennant Series :—		
11	No. 3 Rhondda Seam	Glamorgan Colliery, Gilfach Goch.
10	Three Coals Seam (A)	Glynogwr Colliery, Gilfach Goch.
9	No. 2 Rhondda Seam	Dinas Main Level, Gilfach Goch.
8	Fforest Fach Seam	Hafod Rhondda Colliery, Hafod.
7	No. 1 Rhondda Seam	Llwynypia Level, Glamorgan Collieries, Llwynypia.
6	No. 1 Rhondda Rider Seam	Llwynypia Level, Glamorgan Collieries, Llwynypia.
5	Cefn Glas or Red Ash Seam	Carn Colliery Level, Abercynon.
4	Daran Ddu Seam or Penygroes Seam	Mynachdy Level, Ynysybwl.
Radstockian or Upper Pennant Series :—		
3	No. 3 Llantwit Seam	Old Coal Pit, Cross Inn, and Old Coal Pit, Castellau, near Llantrisant.
2	No. 2 Llantwit Seam	Glynogwr, Graiglas, and Trefyrig Levels.
1	No. 1 Llantwit Seam	Beddau Drift, near Dowlais Inn.

Remarks on Seams.

The coal seams met with in the Glamorganshire Coal Measures fall into three distinct types, namely: the "Regional," "Split" and "Local" types. The "Regional" type of seam is one that persists over a wide area; the "Split" type is a sub-division of another seam; the "Local" type is confined to a limited area.

Westphalian Series.

Gellideg Seam.—A "Split" type of seam, probably the true parent of the Five Feet Seam. It is not present beneath the Five Feet Seam throughout the area.

Five Feet Seam.—A "Regional" type of seam, of real value as a starting-point, to correlate the coal seams in an ascending order.

Middle Yard Seam.—A "Regional" type of seam, very thin in section; in many places it thins out to a mere "Rider," and is of no value as a means of correlation.

Upper Yard or Bute Seam.—A "Regional" type of seam well known over a wide area, and of value for purposes of correlation.

Lower Nine Feet Seam.—A "Split" type of seam from which the Nine Feet Seam branches off.

Nine Feet Seam.—A "Regional" type of seam and is well known to be of value in the correlation of the Glamorganshire coal seams.

Six Feet Seam.—Another "Regional" type of seam, and like the Nine Feet Seam, is of value for purposes of correlation.

Four Feet Seam.—Another "Regional" type of seam and of similar importance to the previous seam for purposes of correlation.

Four Feet Rider Seam.—A "Split" type of seam dividing itself from the Four Feet, its parent seam.

Two Feet Nine Seam.—A "Regional" type of seam well known over a wide area and of importance for the correlation of coal seams.

"*Three Coals*" *Seam* (*B*).—A "Split" type of seam branching off from the Two Feet Nine, which is a parent seam.

Lower Gorllwyn Seam.—A thin seam probably of a "Local" type—appearing here and there as a workable seam or as a thin Rider seam, being entirely absent from other places and of no value for purposes of correlation.

Gorllwyn Seam.—A thin seam of a "Regional" type and of no value for purposes of correlation.

Lower Pentre Seam.—This seam lies very close to the Pentre Seam at Gilfach Goch. Probably it is the parent of the Pentre Seam above. It is absent from numerous places, but where found is a "Split" type of seam.

Pentre Seam.—A "Regional" type of seam and very reliable for purposes of correlation.

Abergorky Seam.—A "Regional" type of seam and is very thin in many localities.

Hafod Seam.—Another " Regional " type of seam. Although the seam itself becomes attenuated in numerous places within the area under observation, it is rather a well-known seam, and is of considerable value for correlating purposes.

Hafod " Rider " Seam.—The Hafod Rider belongs to the " Split " type of seam, its parent seam being the Hafod.

Staffordian Series.

No. 3 *Rhondda Seam.*—A " Regional " type of seam and is most reliable for purposes of correlation.

" Three Coals " Seam (A).—This coal seam is somewhat persistent. The writer has examined the seam *in situ*, in Glynogwr Drift, Gilfach Goch, Pentre (Rhondda), and also above the No. 3 Rhondda Seam near Hills Plymouth Collieries, Merthyr, yet when the seam is sought in other areas it is found to exist merely as a thin " rider " seam or to have died out altogether. All that can be stated with safety is that the " Three Coals " Seam (A) does exist between the No. 3 Rhondda and No. 2 Rhondda Seams in certain localities, and that at each of the three localities mentioned it shows three well-defined coals with dirt partings. The seam cannot be said to be of a " Regional " type, and in all probability is a " Local " type of seam.

No. 2 *Rhondda Seam.*—A " Regional " type of seam, well known over a wide area similar to the No. 3 Rhondda Seam.

Fforest Fach Seam.—A " Split " type of seam, the No. 2 Rhondda being its parent seam.

No. 1 *Rhondda Seam.*—Although thin appears to be of a " Regional " type.

No. 1 *Rhondda Rider Seam.*—Appears to belong to the " Split " type of seam and to divide off somewhere near the Llwynypia area from the No. 1 Rhondda seam, which is, in all probability, the parent seam.

Cefn Glas Seam.—A " Local " type of seam and does not persist over a wide area.

Daran Ddu Seam.—This seam is the uppermost horizon in the Staffordian Series and is of a " Regional " type. It is very regrettable that the seam is known by so many names. In the Llantrisant area it is known as the " Pencœdcæ " Seam and the " Penygroes " Seam, and at Ynysybwl as the " Daran Ddu " Seam.

Radstockian Series.

No. 3 *Llantwit Seam.*—A " Regional " type of seam; it appears to persist without dying out or subdividing. Within this limited area the upper coal measures have escaped denudation.

No. 2 *Llantwit Seam.*—This is another " Regional " type of seam, with its area more limited than the No. 3 Llantwit Seam.

No. 1 *Llantwit Seam.*—Also a " Regional " type of seam and even more limited in its area than the No. 2 Llantwit Seam.

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Summarising the above, the Westphalian Series contains eleven seams of " Regional " type, six seams of " Split " type and one of " Local " type. The " Regional " type of seams are the Five Feet Seam, Middle Yard Seam, Upper Yard or Bute Seam, Nine Feet Seam, Six Feet Seam, Four Feet Seam, Two Feet Nine Seam, Gorllwyn Seam, Pentre Seam, Abergorky Seam and Hafod Seam. The " Split " type of seams are the Gellideg Seam, Lower Nine Feet Seam, Four Feet Rider Seam, Three Coals Seam (B), Lower Pentre Seam and the Hafod Rider Seam. The only " Local " type is the Lower Gorllwyn Seam.

The Staffordian Series contains four seams of the " Regional " type, two seams of the " Split " type and two of the " Local " type. The " Regional " type are the No. 3 Rhondda Seam, No. 2 Rhondda Seam, No. 1 Rhondda Seam and Daran Ddu Seam. The " Split " type are the Fforest Fach Seam and No. 1 Rhondda Rider Seam. The " Local " type are the Three Coals Seam (A) and Cefn Glas Seam.

The Radstockian Series contains three " Regional " type of seams, namely: the No. 1, 2 and 3, Llantwit. Thus of the 29 coal seams examined, eighteen are " Regional " in character, eight are of the " Split " type and three of the " Local " type.

TABLE giving number, name, thickness, position, lineal extent or area and lithological composition of each horizon in ascending order. (See Chart I—Section.)

No. of Horizon.	Name of Horizon.	Thickness of Horizon in feet.	Position of Horizon from Top of Coal Seam where Fossils were obtained.	Lineal Extent or Area of Horizon.	Lithological Composition of Horizon.
29	Gellideg Seam or Lower Five Feet Seam or No. 3 Yard Seam	6	3 to 9 feet from top of coal seam	1,000 yards	Arenaceous shale.
28	Five Feet Seam or Seven Feet Seam	10	2 to 12 feet from top of coal seam	2,000 yards	Argillaceous shale.
27	Middle Yard Seam or No. 2 Yard Seam	7	5 to 12 feet from top of coal seam	400 yards	Argillaceous shale.
26	Upper Yard Seam or Bute Seam	6	6 to 12 feet from top of coal seam	760 yards	Arenaceous shale.
25	Lower Nine Feet Seam.	5	3 to 8 feet from top of coal seam	800 yards	Arenaceous shale.
24	Nine Feet Seam . . .	10	4 to 14 feet from top of coal seam	2 acres	Argillaceous shale.
23	Six Feet Seam	6	6 to 12 feet from top of coal seam	15 acres	Argillaceous shale.
22	Four Feet Seam . . .	6	3 to 9 feet from top of coal seam	1,200 yards	Carbonaceous shale.
21	Upper Four Feet Seam or Rider Seam	6	From top of coal seam .	10 yards	Carbonaceous shale.
20	Two Feet Nine Seam .	10	4 to 14 feet from top of coal seam	1,000 yards	Carbonaceous shale.
19	Three Coals Seam (B), or Upper Two Feet Nine Seam or No. 1 Yard Seam	9	From top of coal seam .	35 yards	Argillaceous shale.

TABLE giving number, &c. (continued).

No. of Horizon.	Name of Horizon.	Thickness of Horizon in feet.	Position of Horizon from Top of Coal Seam where Fossils were obtained.	Lineal Extent or Area of Horizon.	Lithological Composition of Horizon.
18	Lower Gorllwyn Seam .	6	From top of coal seam .	12 yards	Arenaceous shale.
17	Upper Gorllwyn Seam .	6	From top of coal seam .	300 yards	Arenaceous shale.
16	Lower Pentre Seam . .	6	From top of coal seam .	40 yards	Argillaceous shale.
15	Pentre Seam or Upper Pentre Seam	10	4 to 14 feet from top of coal seam	1,200 yards	Argillaceous shale.
14	Abergorky Seam . . .	8	From top of coal seam .	1,000 yards	Argillaceous shale.
13	Hafod Seam	7	From top of coal seam .	300 yards	Arenaceous shale.
12	Hafod "Rider" Seam .	8	From top of coal seam .	6 yards	Argillaceous shale.
11	No. 3 Rhondda Seam .	9	From top of coal seam .	3,000 yards	Argillaceous shale.
10	Three Coals Seam (A) .	4	From top of coal seam .	30 yards	Argillaceous shale.
9	No. 2 Rhondda Seam .	8	From top of coal seam .	3,000 yards	Argillaceous shale.
8	Fforest Fach Seam . .	7	From top of coal seam .	80 yards	Arenaceous shale.
7	No. 1 Rhondda Seam .	5	From top of coal seam .	100 yards	Argillaceous shale.
6	No. 1 Rhondda "Rider" Seam	5	From top of coal seam .	50 yards	Arenaceous shale.
5	Cefn Glas Seam	6	From top of coal seam .	300 yards	Carbonaceous shale.
4	Daran Ddu or Penygroes Seam	8	From top of coal seam .	1,200 yards	Arenaceous shale.
3	No. 3 Llantwit Seam . .	4	From top of coal seam .	300 yards	Argillaceous shale.
2	No. 2 Llantwit Seam . .	4 at Trefyrig, Tontrefail	From top of coal seam .	60 yards	Arenaceous shale.
		4 at Craiglas, Gilfach Goch	From top of coal seam .	150 yards	Argillaceous shale.
		10 at Glyn-ogwr	From top of coal seam .	350 yards	Carbonaceous shale.
1	No. 1 Llantwit Seam . .	15	From 50 to 65 feet from top of coal seam	34 yards	Argillaceous shale.

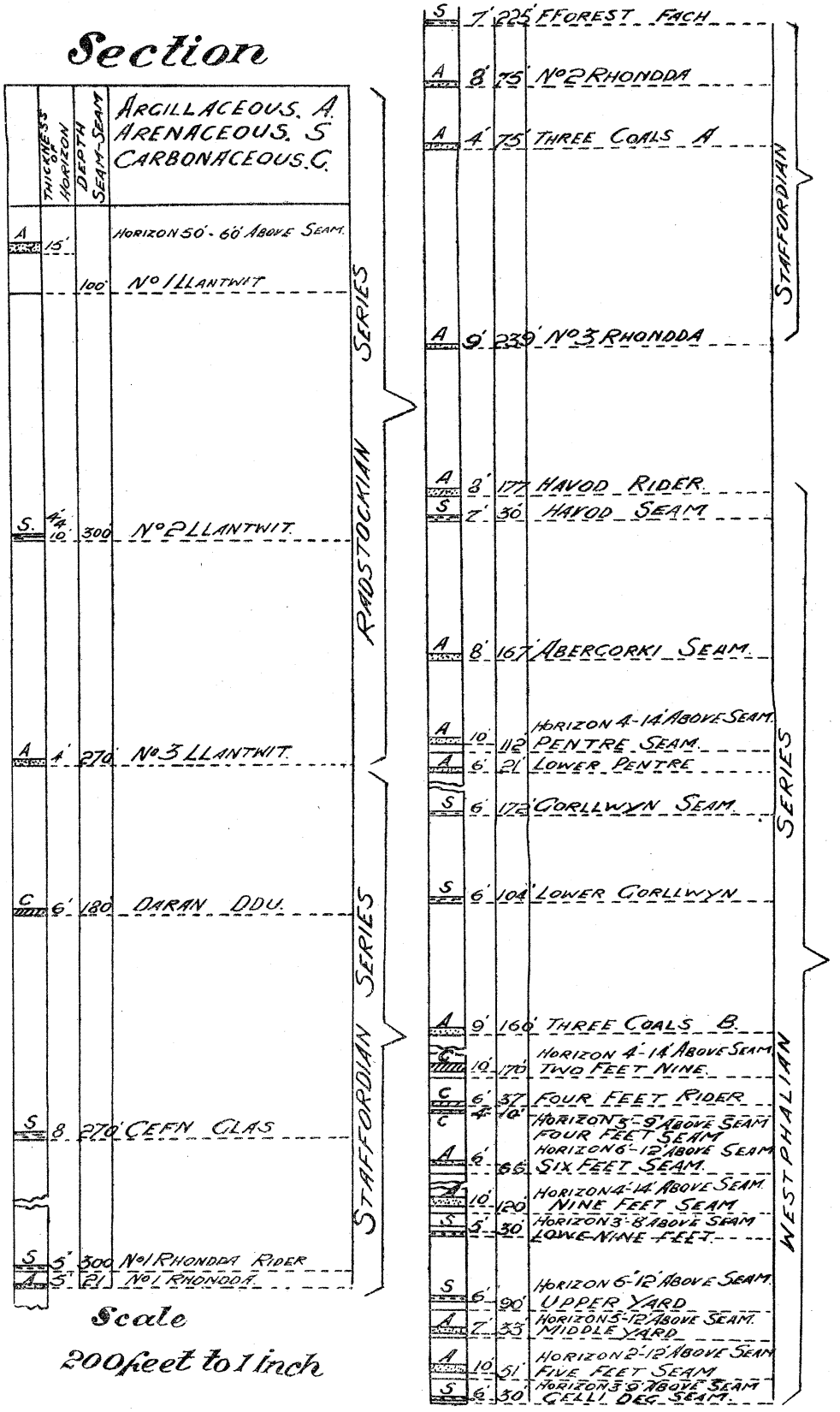

Chart I.—Section.

II. Ecology: The Floral Assemblages. See Chart II (Ecology); Table C, Sheets 1–9 (Groups) and Table A, Sheets 1–6 (Horizons).

Westphalian or White Ash Series.—Records have been taken of 229,801 plants from the eighteen Westphalian coal seams examined. Eleven horizons shown that the class Equisetales dominates the other individual classes. The two classes Filicales and Pteridosperms and the Lycopodiales dominate on three horizons, while the class Cordaitales is superior in number on the lowest horizon but one, namely, horizon 28.

Staffordian or Lower Pennant Series.—A total of 111,666 records of plants was made from eight horizons. It is found that the class Filicales and Pteridosperms preponderates over the individual classes on four horizons. The class Equisetales dominates on two horizons only, and the class Lycopodiales and Cordaitales are each superior in number in one horizon, thus clearly establishing the ascendancy of the Filicales and Pteridosperms in the middle group of the Coal Measures.

Radstockian or Upper Pennant or Llantwit Series.—From the three horizons of this Series there was a total yield of 48,516 plants, and each individual horizon showed that towards the close of the Carboniferous times, the Filicales and Pteridosperms held the field over the other classes of plants. It will be seen by comparing the three groups together, that the lowest or Westphalian shows the Equisetales dominant, whereas the middle or Staffordian group and the upper group or Radstockian show the dominance of the Filicales and Pteridosperms.

Taking the whole Coal Measures from the bottom to the top with an assemblage of 389,983 plants, the class Equisetales dominates on 13 horizons, the Filicales and Pteridosperms on 10 horizons, the Lycopodiales on 4 horizons, while the class Cordaitales, being the least, is dominant on 2 horizons only.

Having shown the position of the different classes of plants, stating their relative dominance to one another, it will be well here to show the position of the dominant genus within each class on the various horizons, from an ecological standpoint. The number of examples and the percentage of each genus recorded are given in tables, so that detailed discussion is unnecessary. A few of the main conclusions are referred to in the following notes.

Westphalian Series.

Equisetales.—The genus Asterophyllites dominated on 12 of the 18 horizons examined; the Calamites dominated on 4 horizons and Myrophyllites on 2 horizons.

Sphenophyllales.—The genus Sphenophyllum—the only one belonging to this class—appeared on 12 horizons. This genus was not present at all on 6 of the 18 horizons of the Westphalian Series.

Lycopodiales.—It was found that the genus Lepidodendron dominated on 13, Sigillaria on 3 and Stigmaria on 2 of the 18 horizons of the series.

Filicales and Pteridosperms.—The genus Neuropteris dominated on 15 horizons. The three genera, Mariopteris, Sphenopteris and Alethopteris dominated on 1 horizon each, which equal 18 horizons.

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Cordaitales.—The Cordaite leaves were the sole representative of this class. The class Cordaitales was present on all the 18 horizons examined in the Westphalian Series.

Staffordian Series.

Equisetales.—The eight horizons of the Staffordian Series showed the genus Asterophyllites dominant.

Sphenophyllales.—Sphenophyllum was found present in 7 horizons; 1 horizon failed to show its appearance.

Lycopodiales.—The genus Lepidodendron dominated on 4 of the 8 horizons, Sigillaria on 3 and Lepidophyllum on 1 only.

Filicales and Pteridosperms.—The genus Neuropteris dominated on the 8 horizons of the series.

Cordaitales.—Cordaite leaves dominated on the 8 horizons.

Radstockian Series.

Equisetales.—The genus Asterophyllites dominated on the 3 horizons.

Sphenophyllales.—The genus Sphenophyllum was found in the 3 horizons.

Lycopodiales.—The 3 genera, Lepidodendron, Sigillaria and Lepidophyllum dominated on one horizon each.

Filicales and Pteridosperms.—The genus Neuropteris dominated on the 3 horizons.

Cordaitales.—Cordaite leaves dominated on the 3 horizons.

Taking the three groups, the Westphalian, Staffordian and Radstockian Series together, the different genera within their respective classes show the following behaviour in their dominance one over the other.

Equisetales.—The genus Asterophyllites dominates on 23 horizons, Calamites on 4 horizons, Myrophyllites on 2 horizons—total, 29 horizons.

Sphenophyllales.—The genus Sphenophyllum appears on only 22 of the 29 horizons examined.

Lycopodiales.—The different genera within this class showing a dominance over the other genera are Lepidodendron, occurring on 18 horizons, Sigillaria on 7 horizons, Lepidophyllum and Stigmaria on 2 horizons each.

Filicales and Pteridosperms.—The genus Neuropteris appears dominant in no less than 26 horizons, while Alethopteris, Sphenopteris and Mariopteris show their dominance on 1 horizon each.

Cordaitales.—Cordaite leaves appear on 29 horizons, and are nearly the sole representative of this class.

Summarising the above it becomes quite clear that the Asterophyllites, or branch foliage of the Calamites, were present in far greater number than the parent stems, or Calamites.

The genus Sphenophyllum was absent from no fewer than 7 horizons. In the class Lycopodiales the genus Lepidodendron shows a clear preponderance in number. The genus Neuropteris persisted from the base to the uppermost horizons and failed to dominate only on 3 horizons.

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TABLE A.—The Distribution of a Single Genus of Plants as related to the Genera of Plants of each Horizon.

Sheet No. 1.—Horizons I to XXIX. Equisetales.

Horizon No.	Calamites.		Asterophyllites.		Calamo-cladus.		Annularia.		Calamite Leaves.		Calamite Phragma.		Myro-phyllites.		Pinularia.		Calamite Cones.		Calamite Bulbil.		Palæ-stachya.		Total Plants in a Class.		Total Plants of different Classes.
	Plants.	Per cent.	Plants.	Per cent.	Plants.	Per cent.	Plants.	Per cent.	Plants.	Per cent.	Plants.	Per cent.	Plants.	Per cent.	Plants.	Per cent.	Plants.	Per cent.	Plants.	Per cent.	Plants.	Per cent.	Plants.	Per cent.	
I	459	*3·06*	1,668	*11·11*	—	—	13	*0·08*	—	—	5	*0·03*	1,058	*7·05*	406	*2·66*	8	*0·05*	—	—	—	—	3,617	*24·05*	15,006
II	661	*4·42*	3,599	*24·00*	—	—	503	*3·36*	—	—	—	—	246	*1·64*	387	*2·58*	50	*0·33*	—	—	—	—	5,446	*36·42*	14,951
III	427	*2·30*	2,531	*13·63*	—	—	236	*1·27*	—	—	—	—	955	*5·14*	96	*0·51*	26	*0·14*	—	—	—	—	4,271	*21·93*	18,559
IV	498	*2·92*	1,617	*9·48*	—	—	375	*2·20*	—	—	—	—	1,206	*7·07*	52	*0·30*	—	—	—	—	—	—	3,748	*21·98*	17,045
V	203	*3·05*	1,558	*23·45*	—	—	2	*0·03*	—	—	—	—	1	*0·01*	—	—	—	—	—	—	—	—	1,764	*26·55*	6,643
VI	4,000	*29·35*	5,154	*37·82*	—	—	1,597	*4·72*	—	—	64	*0·47*	1,036	*7·60*	4	*0·03*	231	*1·79*	—	—	—	—	12,086	*88·62*	13,626
VII	2,191	*11·55*	3,763	*19·96*	—	—	269	*1·41*	—	—	17	*0·09*	603	*3·18*	8	*0·04*	18	*0·09*	1	*0·005*	—	—	6,870	*36·24*	18,959
VIII	1,419	*6·77*	2,585	*12·33*	—	—	294	*1·40*	—	—	7	*0·03*	1,399	*6·67*	8	*0·03*	117	*0·55*	1	*0·004*	—	—	5,830	*27·83*	20,951
IX	345	*8·70*	612	*15·40*	92	*2·30*	186	*4·60*	18	—	8	*0·20*	336	*8·40*	47	*1·08*	1	*0·02*	—	—	7	*0·19*	1,652	*41·60*	3,975
X	3,614	*15·03*	4,353	*17·64*	—	—	37	*0·15*	—	—	6	*0·02*	1,929	*7·81*	11	*0·04*	24	*0·09*	—	—	—	—	9,974	*40·42*	24,672
XI	433	*7·5*	787	*13·40*	146	*2·50*	184	*3·10*	11	—	11	*0·20*	583	*10·60*	73	*1·20*	6	*0·11*	—	—	24	*0·4*	2,258	*39·00*	5,792
XII	2,718	*14·34*	5,000	*26·38*	—	—	—	—	—	—	—	—	298	*1·52*	—	—	396	*2·08*	—	—	—	—	8,417	*44·42*	18,949
XIII	3,176	*21·58*	8,898	*60·30*	5	*0·03*	—	—	—	—	—	—	243	*1·64*	—	—	3	*0·02*	—	—	—	—	12,325	*83·73*	14,721
XIV	87	*2·10*	2,172	*48·40*	1	*0·02*	3	*0·07*	—	—	—	—	1,169	*28·60*	—	—	2	*0·04*	—	—	—	—	3,434	*84·30*	4,074
XV	406	*7·30*	765	*10·10*	91	*1·10*	37	*0·71*	—	—	—	—	138	*2·50*	1	*0·01*	6	*0·10*	—	—	—	—	1,444	*26·04*	5,545
XVI	5,290	*17·50*	4,941	*16·34*	—	—	1,034	*3·42*	—	—	3	*0·009*	2,973	*9·83*	9	*0·03*	13	*0·04*	—	—	—	—	14,263	*47·18*	30,228
XVII	757	*3·43*	12,710	*57·59*	—	—	11	*0·05*	—	—	—	—	7,272	*32·96*	—	—	—	—	—	—	—	—	20,750	*94·03*	22,069
XVIII	95	*0·38*	266	*1·07*	—	—	—	—	—	—	—	—	2	*0·008*	—	—	—	—	—	—	—	—	363	*1·47*	24,812
XIX	186	*0·67*	10,557	*37·87*	—	—	—	—	—	—	—	—	6,013	*24·41*	—	—	3	*0·01*	—	—	—	—	16,759	*60·12*	27,874
XX	78	*5·50*	6	*0·4*	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	84	*5·99*	1,402
XXI	41	*3·71*	403	*36·53*	—	—	—	—	—	—	—	—	240	*2·18*	—	—	—	—	—	—	—	—	684	*62·02*	1,103
XXII	1,724	*1·07*	5,679	*4·81*	—	—	—	—	—	—	—	—	720	*6·09*	—	—	3	*0·02*	—	—	—	—	8,126	*68·71*	11,806
XXIII	209	*2·91*	2,600	*37·10*	—	—	—	—	—	—	2	*0·03*	43	*0·55*	—	—	—	—	—	—	—	—	2,854	*40·70*	7,004
XXIV	620	*10·80*	2,111	*36·60*	—	—	1	*0·01*	—	—	4	*0·07*	190	*3·30*	—	—	—	—	—	—	—	—	2,925	*50·90*	5,745
XXV	554	*2·64*	6,055	*28·86*	—	—	—	—	—	—	—	—	7,793	*37·17*	—	—	—	—	—	—	—	—	14,402	*68·66*	20,973
XXVI	863	*18·50*	389	*8·40*	—	—	2	*0·04*	—	—	—	—	154	*3·20*	—	—	40	*0·86*	—	—	4	*0·08*	1,452	*31·30*	4,639
XXVII	1,816	*30·50*	2,161	*36·30*	27	*0·50*	—	—	—	—	11	*0·20*	274	*4·60*	—	—	3	*0·05*	—	—	—	—	4,292	*72·19*	5,946
XXVIII	310	*16·90*	161	*8·80*	13	*0·70*	6	*0·30*	—	—	—	—	40	*2·20*	—	—	8	*0·50*	—	—	—	—	566	*30·69*	1,831
XXIX	1,000	*4·53*	3,108	*14·09*	—	—	—	—	—	—	—	—	4,627	*20·95*	—	—	1	*0·004*	—	—	—	—	8,736	*39·61*	22,056

Table A (continued).

Sheet No. 2. Sphenophyllales.

Horizon No.	Sphenophyllum.		Total Plants in a Class.		Total Plants of different Classes.
	Plants.	Per cent.	Plants.	Per cent.	
I	26	*0·18*	26	*0·18*	15,006
II	743	*4·98*	743	*4·98*	14,951
III	158	*0·85*	158	*0·85*	18,559
IV	35	*0·20*	35	*0·20*	17,045
V	—	—	—	—	—
VI	1	*0·01*	1	*0·01*	13,626
VII	356	*1·87*	356	*1·87*	18,959
VIII	701	*3·35*	701	*3·35*	20,951
IX	264	*6·64*	264	*6·64*	3,975
X	141	*0·57*	141	*0·57*	24,672
XI	61	*1·05*	61	*1·05*	5,792
XII	46	*0·24*	46	*0·24*	18,949
XIII	4	*0·03*	4	*0·03*	14,721
XIV	17	*0·40*	17	*0·40*	4,074
XV	361	*6·49*	361	*6·49*	5,545
XVI	2,816	*9·33*	2,816	*9·33*	30,228
XVII	7	*0·03*	7	*0·03*	22,069
XVIII	—	—	—	—	24,812
XIX	3	*0·02*	3	*0·02*	27,874
XX	—	—	—	—	1,402
XXI	2	*0·18*	2	*0·18*	1,103
XXII	208	*1·76*	208	*1·76*	11,806
XXIII	—	—	—	—	7,004
XXIV	—	—	—	—	5,745
XXV	20	*0·12*	20	*0·12*	20,973
XXVI	—	—	—	—	4,639
XXVII	11	*0·19*	11	*0·19*	5,946
XXVIII	—	—	—	—	1,831
XXIX	4	*0·02*	4	*0·02*	22,056

PHILOSOPHICAL TRANSACTIONS OF THE ROYAL SOCIETY B BIOLOGICAL SCIENCES

PHILOSOPHICAL TRANSACTIONS OF THE ROYAL SOCIETY B BIOLOGICAL SCIENCES

Table A (continued).

Sheet No. 3. Lycopodiales.

Horizon No.	Lepidodendron.		Sigillaria.		Bothrodendron.		Ulodendron.		Pinakodendron (?)		Asolanus.		Lepidophloios.		Lepidophyllum.		Stigmaria.		Lepidostrobus.		Sigillariostrobus.		Lepidocystis.		Total Plants in a Class.		Total Plants.
	Plants.	Per cent.	Plants.	Per cent.	Plants.	Per cent.	Plants.	Per cent.	Plants.	Per cent.	Plants.	Per cent.	Plants.	Per cent.	Plants.	Per cent.	Plants.	Per cent.	Plants.	Per cent.	Plants.	Per cent.	Plants.	Per cent.	Plants.	Per cent.	
I	1,357	*9·04*	179	*1·19*	2	*0·01*	1	*0·005*	—	—	—	—	1	*0·005*	189	*1·19*	—	—	204	*1·35*	—	—	—	—	1,933	*12·88*	15,006
II	27	*0·18*	11	*0·07*	—	—	—	—	2	*0·01*	—	—	2	*0·01*	169	*1·13*	1	*0·005*	25	*0·17*	3 (?)	*0·02*	—	—	240	*1·63*	14,951
III	215	*1·15*	506	*2·72*	27	*0·14*	—	—	—	—	9	*0·05*	11	*0·06*	200	*1·07*	5	*0·003*	73	*0·39*	—	—	—	—	1,046	*5·63*	18,559
IV	121	*0·71*	68	*0·39*	5	*0·02*	—	—	3	*0·01*	—	—	5	*0·02*	199	*1·10*	21	*0·12*	30	*0·17*	—	—	—	—	452	*2·65*	17,045
V	2,183	*32·86*	262	*3·94*	2	*0·03*	—	—	—	—	—	—	3	*0·04*	2	*0·03*	1	*0·01*	5	*0·07*	—	—	—	—	2,458	*36·85*	6,643
VI	7	*0·05*	4	*0·02*	—	—	—	—	—	—	—	—	—	—	6	*0·04*	2	*0·01*	—	—	—	—	—	—	19	*0·14*	13,626
VII	84	*0·44*	613	*3·29*	6	*0·03*	—	—	—	—	—	—	14	*0·07*	18	*0·09*	26	*0·14*	10	*0·05*	—	—	—	—	771	*4·06*	18,959
VIII	27	*0·12*	132	*0·63*	—	—	—	—	—	—	—	—	—	—	9	*0·04*	3	*0·01*	8	*0·03*	—	—	—	—	179	*0·85*	20,951
IX	29	*0·72*	20	*0·50*	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	49	*1·27*	3,975
X	181	*0·73*	11	*0·04*	—	—	—	—	—	—	29	*0·11*	—	—	22	*0·09*	6	*0·02*	22	*0·09*	—	—	5	*0·02*	276	*1·00*	24,672
XI	4	*0·07*	9	*0·15*	—	—	—	—	—	—	—	—	—	—	—	—	1	*0·017*	—	—	—	—	—	—	14	*0·25*	5,792
XII	601	*3·17*	1,126	*5·94*	—	—	—	—	—	—	—	—	54	*0·28*	379	*2·00*	12	*0·06*	43	*0·22*	—	—	—	—	2,215	*11·70*	18,949
XIII	420	*2·85*	15	*0·10*	—	—	—	—	—	—	—	—	—	—	9	*0·06*	216	*1·46*	22	*0·15*	—	—	—	—	682	*4·63*	14,721
XIV	9	*0·21*	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	9	*0·21*	4,074
XV	1,141	*20·57*	127	*2·47*	18	*0·32*	—	—	—	—	—	—	1	*0·01*	458	*8·25*	173	*3·12*	233	*4·20*	—	—	—	—	2,151	*38·71*	5,545
XVI	459	*1·51*	472	*1·56*	—	—	—	—	—	—	322	*1·06*	—	—	128	*0·42*	159	*0·52*	4	*0·01*	—	—	10	*0·03*	1,554	*5·14*	30,228
XVII	8	*0·03*	19	*0·08*	—	—	—	—	—	—	—	—	—	—	13	*0·05*	2	*0·009*	1	*0·004*	—	—	—	—	43	*0·19*	22,069
XVIII	7,876	*31·78*	1,495	*6·02*	—	—	—	—	—	—	—	—	1	*0·004*	—	—	1,116	*4·45*	1,550	*6·20*	—	—	—	—	12,038	*48·51*	24,812
XIX	3,808	*13·66*	225	*0·80*	—	—	—	—	—	—	—	—	2	*0·007*	859	*3·08*	63	*0·23*	1,265	*4·53*	—	—	—	—	6,222	*22·32*	27,874
XX	647	*46·14*	142	*10·12*	—	—	—	—	—	—	—	—	—	—	16	*1·14*	128	*9·12*	2	*0·14*	—	—	—	—	935	*66·69*	1,402
XXI	123	*11·15*	9	*0·17*	—	—	—	—	—	—	—	—	3	*0·27*	54	*4·89*	6	*0·54*	22	*1·99*	—	—	—	—	217	*19·67*	1,103
XXII	661	*5·60*	39	*0·33*	—	—	—	—	—	—	—	—	54	*0·45*	4	*0·03*	197	*1·67*	160	*1·35*	—	—	—	—	1,085	*9·19*	11,806
XXIII	17	*0·24*	10	*0·14*	—	—	—	—	—	—	—	—	—	—	—	—	—	—	5	*0·07*	—	—	—	—	32	*0·45*	7,004
XXIV	141	*2·4*	14	*0·24*	—	—	—	—	—	—	—	—	—	—	—	—	14	*0·24*	27	*0·47*	—	—	—	—	196	*3·40*	5,745
XXV	3,132	*14·93*	24	*0·11*	—	—	—	—	—	—	—	—	2	*0·009*	43	*0·20*	—	—	457	*2·14*	—	—	—	—	3,658	*17·44*	20,973
XXVI	434	*9·3*	19	*0·4*	—	—	—	—	—	—	—	—	—	—	—	—	4	*0·10*	34	*0·80*	—	—	—	—	491	*10·60*	4,639
XXVII	1	*0·01*	28	*0·49*	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	29	*0·50*	5,946
XXVIII	3	*0·16*	1	*0·05*	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	4	*0·21*	1,831
XXIX	200	*90*	8	*0·03*	—	—	—	—	—	—	—	—	7	*0·03*	15	*0·06*	139	*0·63*	7	*0·03*	—	—	—	—	376	*1·70*	22,056

PHILOSOPHICAL TRANSACTIONS OF THE ROYAL SOCIETY B BIOLOGICAL SCIENCES

Table A (continued).

Sheet No. 4. Filicales and Pteridosperms.

Horizon No.	Neuropteris.		Sphenopteris.		Alethopteris.		Pecopteris.		Mariopteris.		Crossotheca.		Eremopteris.		Coronopteris.		Odontopteris.		Rachis of Fern or Fernlike Plants.		Cyclopteris.		Trigonocarpus.		Seeds (?)		Total Plants in a Class.		Total Plants of different Classes.
	Plants.	Per cent.	Plants.	Per cent.	Plants.	Per cent.	Plants.	Per cent.	Plants.	Per cent.	Plants.	Per cent.	Plants.	Per cent.	Plants.	Per cent.	Plants.	Per cent.	Plants.	Per cent.	Plants.	Per cent.	Plants.	Per cent.	Plants.	Per cent.	Plants.	Per cent.	
I	6,530	*43·51*	44	*0·29*	239	*1·59*	100	*0·60*	26	*0·16*	—	—	2	*0·02*	—	—	—	—	2,101	*14·01*	156	*1·03*	116	*0·77*	2	*0·02*	9,316	*62·08*	15,006
II	4,124	*27·55*	676	*4·52*	21	*0·14*	1,173	*7·81*	407	*2·72*	—	—	15	*0·10*	32	*0·21*	—	—	1,762	*11·11*	22	*0·81*	12	*0·08*	58	*0·39*	8,402	*5·61*	14,951
III	7,026	*37·85*	858	*4·62*	207	*1·11*	1,508	*8·12*	94	*0·50*	—	—	3	*0·01*	18	*0·09*	112	*0·60*	2,336	*12·58*	92	*0·49*	30	*0·16*	12	*0·06*	12,296	*66·14*	18,559
IV	7,324	*42·90*	76	*0·44*	29	*0·16*	163	*0·95*	46	*0·26*	—	—	—	—	—	—	147	*0·86*	2,965	*17·33*	72	*0·42*	90	*0·52*	7	*0·04*	10,919	*64·09*	17,045
V	16	*0·24*	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	776	*11·68*	—	—	—	—	1	*0·01*	793	*11·93*	6,643
VI	1,290	*9·46*	1	*0·07*	—	—	—	—	4	*0·02*	—	—	—	—	—	—	—	—	169	*1·16*	35	*0·25*	—	—	—	—	1,499	*11·01*	13,626
VII	2,949	*15·55*	37	*0·19*	70	*0·37*	2	*0·01*	1	*0·005*	—	—	—	—	—	—	3	*0·01*	906	*4·77*	34	*0·17*	1	*0·005*	9	*0·04*	4,009	*21·15*	18,959
VIII	8,212	*39·20*	63	*0·30*	—	—	42	*0·20*	2	*0·009*	—	—	—	—	—	—	—	—	2,136	*10·19*	293	*1·39*	—	—	9	*0·04*	10,757	*51·35*	20,951
IX	1,050	*26·30*	127	*3·18*	—	—	20	*0·56*	10	*0·28*	31	*0·80*	—	—	—	—	—	—	161	*4·03*	28	*0·75*	—	—	—	—	1,427	*35·90*	3,975
X	7,790	*31·17*	501	*2·03*	36	*0·14*	275	*1·11*	126	*0·51*	2	*0·008*	9	*0·03*	—	—	1	*0·004*	3,911	*15·85*	—	—	1	*0·004*	6	*0·02*	12,693	*51·40*	24,672
XI	756	*13·08*	654	*11·20*	—	—	28	*0·48*	58	*1·00*	3	*0·05*	41	*0·70*	—	—	—	—	790	*13·60*	11	*0·20*	—	—	—	—	2,251	*40·50*	5,792
XII	3,492	*18·42*	71	*0·37*	56	*0·29*	—	—	311	*1·64*	—	—	—	—	—	—	—	—	3,749	*19·78*	25	*0·13*	1	*0·005*	3	*0·01*	7,708	*40·68*	18,949
XIII	179	*1·21*	4	*0·02*	—	—	—	—	8	*0·05*	—	—	—	—	—	—	—	—	1,093	*7·35*	1	*0·006*	—	—	15	*0·10*	1,300	*8·83*	14,721
XIV	66	*1·37*	10	*0·22*	4	*0·08*	—	—	26	*0·63*	—	—	2	*0·40*	—	—	—	—	105	*2·56*	1	*0·03*	—	—	—	—	214	*5·20*	4,074
XV	23	*0·41*	17	*0·30*	86	*1·50*	11	*0·20*	—	—	—	—	—	—	—	—	—	—	413	*7·40*	1	*0·01*	—	—	—	—	551	*9·70*	5,545
XVI	5,447	*18·01*	652	*2·15*	—	—	—	—	2	*0·006*	—	—	—	—	5	*0·01*	—	—	4,989	*16·14*	61	*0·20*	—	—	46	*0·15*	11,202	*37·05*	30,228
XVII	599	*2·71*	11	*0·04*	—	—	1	*0·004*	5	*0·02*	—	—	—	—	—	—	—	—	616	*2·79*	—	—	—	—	12	*0·05*	1,244	*5·63*	22,069
XVIII	16	*0·06*	1	*0·004*	—	—	4	*0·01*	—	—	—	—	—	—	—	—	—	—	1,367	*5·47*	—	—	—	—	18	*0·07*	1,388	*5·60*	24,812
XIX	3,345	*12·35*	3	*0·01*	22	*0·08*	—	—	12	*0·04*	—	—	—	—	—	—	—	—	1,070	*3·48*	1	*0·003*	—	—	—	—	4,471	*16·04*	27,874
XX	19	*1·30*	—	—	—	—	—	—	3	*0·20*	—	—	—	—	—	—	—	—	2	*0·13*	—	—	—	—	—	—	24	*1·50*	1,402
XXI	22	*2·00*	—	—	1	*0·09*	—	—	2	*0·18*	—	—	—	—	—	—	—	—	147	*1·32*	3	*0·27*	1	*0·09*	5	*0·46*	181	*16·40*	1,103
XXII	688	*5·82*	2	*0·01*	24	*0·20*	3	*0·02*	7	*0·06*	—	—	—	—	—	—	—	—	1,209	*10·24*	3	*0·02*	1	*0·005*	—	—	1,937	*17·31*	11,806
XXIII	2,964	*42·30*	4	*0·06*	10	*0·14*	1	*0·01*	43	*0·55*	—	—	—	—	—	—	—	—	28	*0·40*	57	*0·80*	—	—	—	—	3,107	*44·30*	7,004
XXIV	1,573	*27·40*	6	*0·14*	21	*0·36*	6	*0·14*	—	—	—	—	—	—	—	—	—	—	11	*0·19*	5	*0·04*	—	—	—	—	1,622	*28·30*	5,745
XXV	1,136	*5·41*	52	*0·21*	11	*0·05*	—	—	52	*0·24*	—	—	2	*0·009*	—	—	—	—	1,106	*5·27*	1	*0·004*	1	*0·004*	23	*0·11*	2,384	*11·36*	20,973
XXVI	941	*20·20*	36	*0·77*	—	—	—	—	28	*0·69*	—	—	—	—	—	—	—	—	872	*18·80*	13	*0·06*	—	—	4	*0·08*	1,884	*40·80*	4,639
XXVII	232	*3·90*	331	*5·90*	2	*0·05*	—	—	—	—	—	—	—	—	—	—	—	—	970	*16·30*	—	—	—	—	1	*0·01*	1,536	*26·50*	5,946
XVIII	114	*6·20*	40	*2·20*	183	*10·00*	—	—	31	*1·60*	—	—	—	—	—	—	—	—	69	*3·70*	8	*0·40*	—	—	8	*0·40*	453	*24·60*	1,831
XXIX	8,027	*36·34*	49	*1·12*	249	*1·12*	—	—	—	—	—	—	—	—	—	—	—	—	3,594	*15·34*	77	*0·34*	2	*0·009*	11	*0·05*	12,009	*54·45*	22,056

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Table A (continued).

Sheet No. 5. Cordaitales.

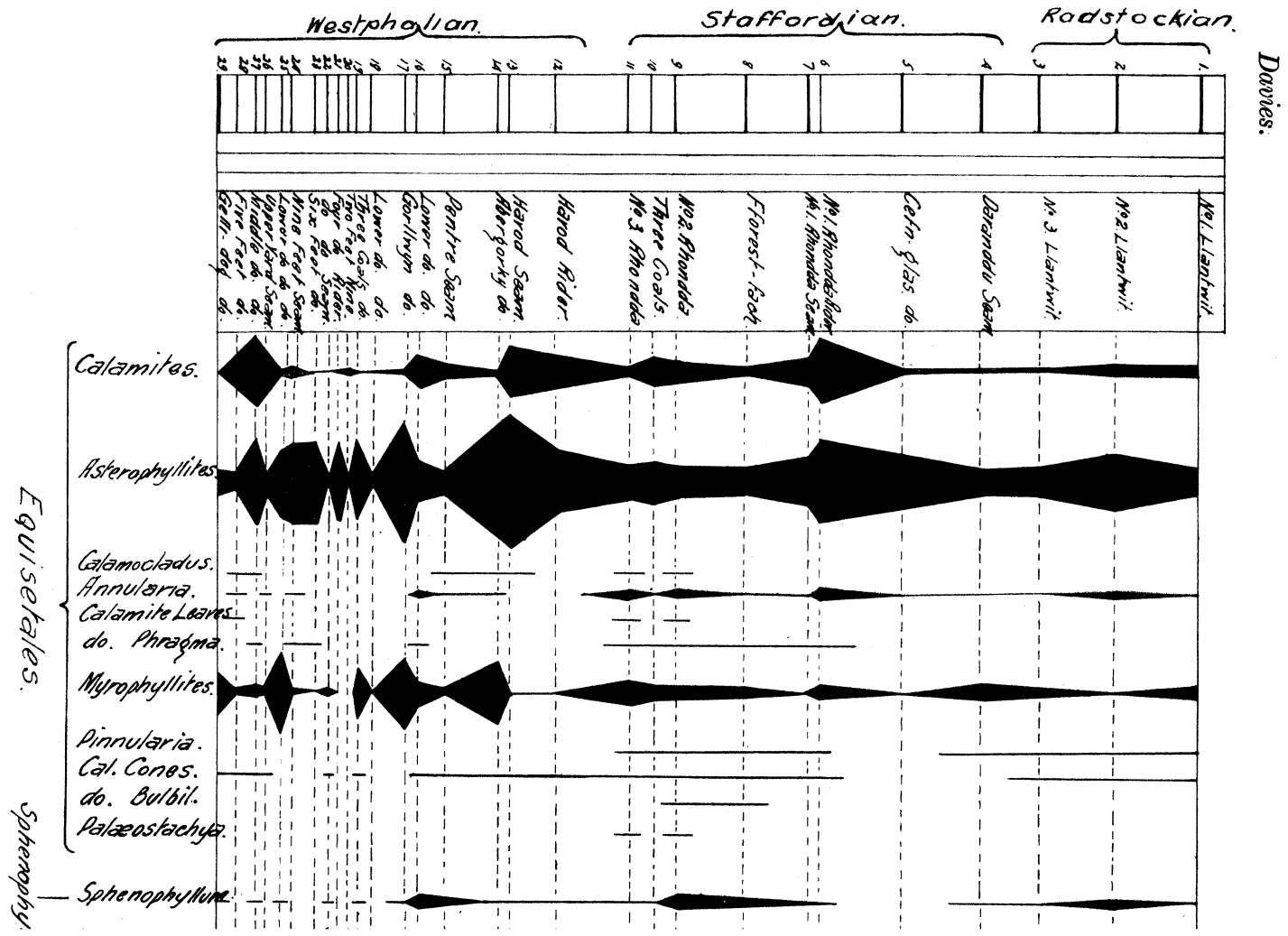
Horizon No.	Cordaite Leaves.		Cordaianthus.		Artisia (pith cast).		Samaropsis.		Polyptero-spermum.		Seeds.		Total Plants in a Class.		Total Plants.
	Plants.	Per cent.	Plants.	Per cent.	Plants.	Per cent.	Plants.	Per cent.	Plants.	Per cent.	Plants.	Per cent.	Plants.	Per cent.	
I	113	*0·75*	1	*0·006*	—	—	—	—	—	—	Ribbed	—	114	*0·76*	15,006
II	107	*0·71*	—	—	1	*0·006*	3	*0·02*	—	—	type.	*0·06*	120	*0·81*	14,951
III	778	*4·19*	—	—	—	—	9	*0·04*	1	*0·005*	5+4 Platis-permic.	—	788	*5·34*	18,559
IV	1,890	*11·08*	—	—	1	*0·005*	—	—	—	—	—	—	1,891	*11·08*	17,045
V	1,618	*24·35*	—	—	10	*0·15*	—	—	—	—	—	—	1,628	*24·60*	6,643
VI	21	*0·15*	—	—	—	—	—	—	—	—	—	—	21	*0·15*	13,626
VII	6,910	*36·44*	13	*0·07*	—	—	30	*0·15*	—	—	—	—	6,953	*36·68*	18,959
VIII	3,366	*16·11*	10	*0·04*	—	—	108	*0·51*	—	—	—	—	3,484	*16·62*	20,951
XI	553	*13·92*	—	—	1	*0·03*	29	*0·73*	—	—	—	—	583	*14·68*	3,975
X	1,577	*6·35*	—	—	2	*0·008*	9	*0·03*	—	—	—	—	1,588	*6·61*	24,672
XI	1,085	*18·8*	—	—	5	*0·08*	10	*0·17*	—	—	17	*0·29*	1,117	*19·3*	5,792
XII	563	*2·96*	—	—	—	—	—	—	—	—	—	—	563	*2·96*	18,949
XIII	397	*2·62*	4	*0·02*	9	*9·06*	—	—	—	—	—	—	410	*2·78*	14,721
XIV	384	*9·42*	—	—	1	*0·03*	2	*0·04*	—	—	13	*0·32*	400	*9·81*	4,074
XV	1,027	*18·60*	—	—	2	*0·03*	1	*0·01*	—	—	8	*0·14*	1,038	*18·70*	5,545
XVI	393	*2·37*	—	—	—	—	—	—	—	—	—	—	393	*2·37*	30,228
XVII	25	*0·12*	—	—	—	—	—	—	—	—	—	—	25	*0·12*	22,069
XVIII	6,312	*25·43*	1,859	*7·49*	—	—	2,852	*11·49*	—	—	—	—	11,023	*44·42*	24,812
XIX	412	*1·48*	—	—	—	—	7	*0·02*	—	—	—	—	419	*1·50*	27,874
XX	335	*23·80*	—	—	2	*0·13*	—	—	—	—	2	*0·13*	359	*24·06*	1,402
XXI	19	*1·73*	—	—	—	—	—	—	—	—	—	—	19	*1·73*	1,103
XXII	447	*3·77*	1	*0·005*	2	*0·01*	—	—	—	—	—	—	450	*3·81*	11,806
XXIII	1,006	*14·20*	—	—	—	—	—	—	—	—	5	*0·70*	1,011	*14·20*	7,004
XXIV	984	*17·10*	—	—	1	*0·01*	1	*0·01*	—	—	16	*0·28*	1,002	*17·44*	5,745
XXV	502	*2·39*	—	—	4	*0·02*	3	*0·01*	—	—	—	—	509	*2·42*	20,973
XXVI	809	17·2	—	—	2	*0·04*	1	*0·02*	—	—	—	—	812	*17·26*	4,639
XXVII	78	*1·30*	—	—	—	—	—	—	—	—	—	—	78	*1·30*	5,946
XXVIII	810	*44·20*	—	—	2	*0·10*	—	—	—	—	—	—	812	*44·30*	1,831
XXIX	930	*4·21*	—	—	1	*0·01*	—	—	—	—	—	—	931	*4·22*	22,056

Table A (continued).

Sheet No. 6. Showing the Distribution of a Single Class of Plants as related to the Different Classes of Plants on each of the 29 Horizons.

Horizon No.	Equisetales.		Sphenophyllales.		Lycopodiales.		Filicales and Pteridosperms.		Cordaitales.		Total Plants of Different Classes.
	Plants.	Per cent.	Plants.	Per cent.	Plants.	Per cent.	Plants.	Per cent.	Plants.	Per cent.	
I	3,617	*24·05*	26	*0·18*	1,933	*12·89*	9,316	*62·09*	114	*0·79*	15,006
II	5,446	*36·42*	743	*4·98*	240	*1·60*	8,402	*56·19*	120	*0·81*	14,951
III	4,271	*21·93*	158	*0·85*	1,046	*5·63*	12,296	*66·25*	788	*5·34*	18,559
IV	3,748	*21·98*	35	*0·20*	452	*2·65*	10,919	*64·09*	1,891	*11·08*	17,045
V	1,764	*26·50*	—	—	2,458	*37·00*	793	*11·90*	1,628	*24·6*	6,643
VI	12,086	*88·69*	1	*0·01*	19	*0·14*	1,499	*11·01*	21	*0·15*	13,626
VII	6,870	*36·24*	356	*1·87*	771	*4·06*	4,009	*21·15*	6,953	*36·68*	18,959
VIII	5,830	*27·83*	701	*3·35*	179	*0·85*	10,757	*51·35*	3,484	*16·62*	20,951
IX	1,652	*41·56*	264	*6·64*	49	*1·23*	1,427	*35·89*	583	*14·68*	3,975
X	9,974	*40·42*	141	*0·57*	276	*1·14*	12,693	*51·47*	1,588	*6·47*	24,672
XI	2,258	*39·00*	61	*1·05*	14	*0·24*	2,342	*40·43*	1,117	*19·28*	5,792
XII	8,417	*44·42*	46	*0·24*	2,215	*11·70*	7,708	*40·68*	563	*2·96*	18,949
XIII	12,325	*83·73*	4	*0·03*	682	*4·63*	1,300	*8·83*	410	*2·78*	14,721
XIV	3,434	*84·29*	17	*0·41*	9	*0·22*	214	*5·23*	400	*9·83*	4,074
XV	144	*26·04*	361	*6·51*	2,151	*38·79*	551	*9·93*	1,038	*18·73*	5,545
XVI	14,263	*47·18*	2,816	*9·33*	1,554	*5·14*	11,202	*37·05*	393	*1·30*	30,228
XVII	20,750	*94·03*	7	*0·03*	43	*0·19*	1,244	*5·63*	25	*0·12*	22,069
XVIII	363	*1·47*	—	—	12,038	*48·51*	1,388	*5·60*	11,023	*44·42*	24,812
XIX	16,759	*60·12*	3	*0·02*	6,222	*22·32*	4,471	*16·04*	419	*1·50*	27,874
XX	84	*5·99*	—	—	935	*66·69*	24	*1·71*	359	*25·61*	1,402
XXI	684	*62·02*	2	*0·18*	217	*19·67*	181	*16·40*	19	*1·73*	1,103
XXII	8,126	*68·71*	208	*1·76*	1,085	*9·19*	1,937	*17·31*	450	*3·03*	11,806
XXIII	2,854	*40·75*	—	—	32	*0·45*	3,107	*44·36*	1,011	*14·44*	7,004
XXIV	2,926	*50·93*	—	—	196	*3·41*	1,621	*28·19*	1,002	*12·47*	5,745
XXV	14,402	*68·66*	20	*0·12*	3,658	*17·44*	2,384	*11·36*	509	*2·42*	20,973
XXVI	1,452	*31·30*	—	—	491	*10·59*	1,884	*40·61*	812	*17·50*	4,639
XXVII	4,292	*72·19*	11	*0·19*	29	*0·48*	1,536	*25·83*	78	*1·30*	5,946
XXVIII	562	*30·69*	—	—	4	*0·22*	453	*24·74*	812	*44·35*	1,831
XXIX	8,736	*39·61*	4	*0·02*	376	*1·70*	12,009	*54·45*	931	*4·22*	22,056

PHILOSOPHICAL TRANSACTIONS OF THE ROYAL SOCIETY B BIOLOGICAL SCIENCES



PHILOSOPHICAL TRANSACTIONS OF THE ROYAL SOCIETY B BIOLOGICAL SCIENCES

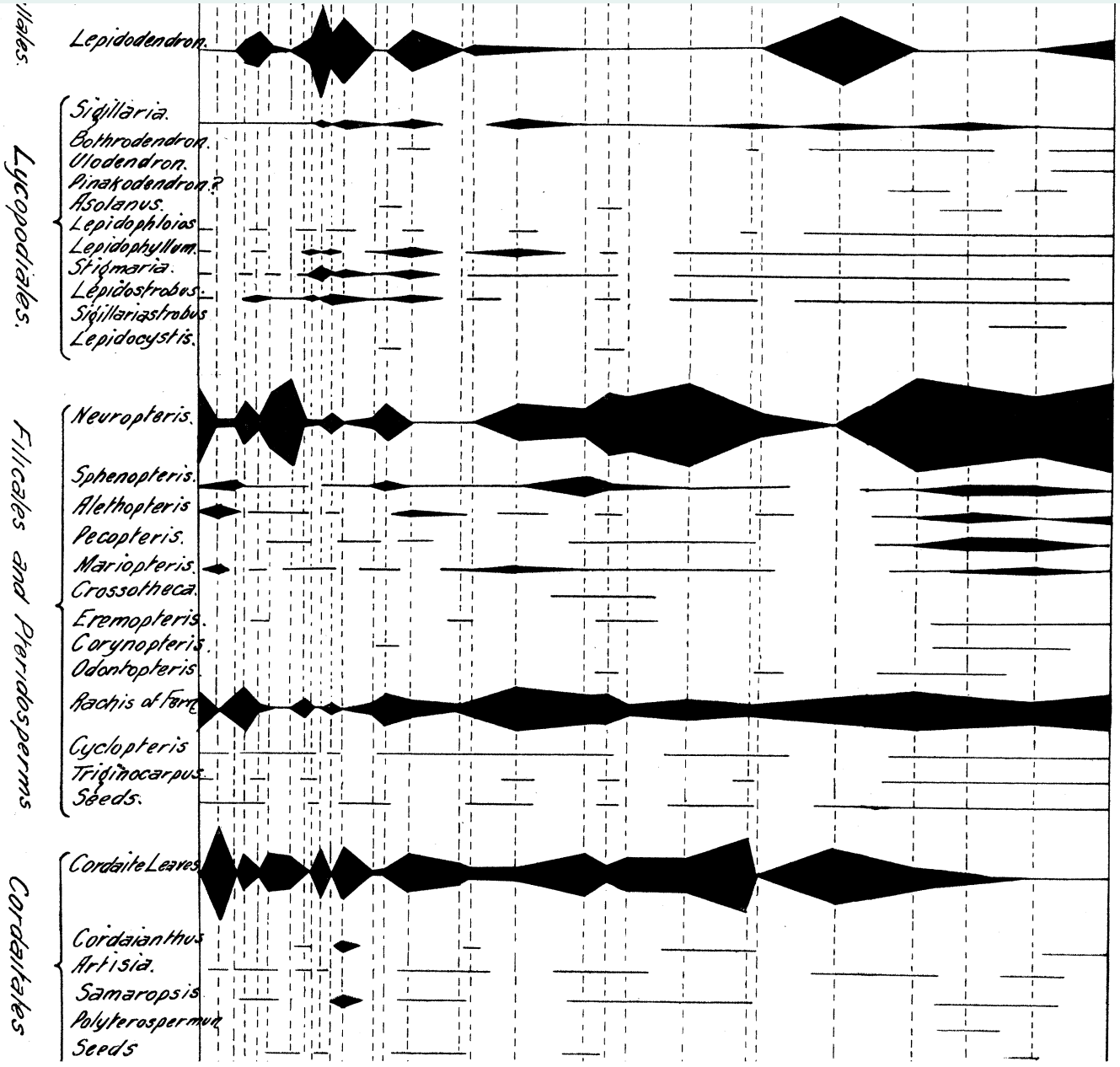
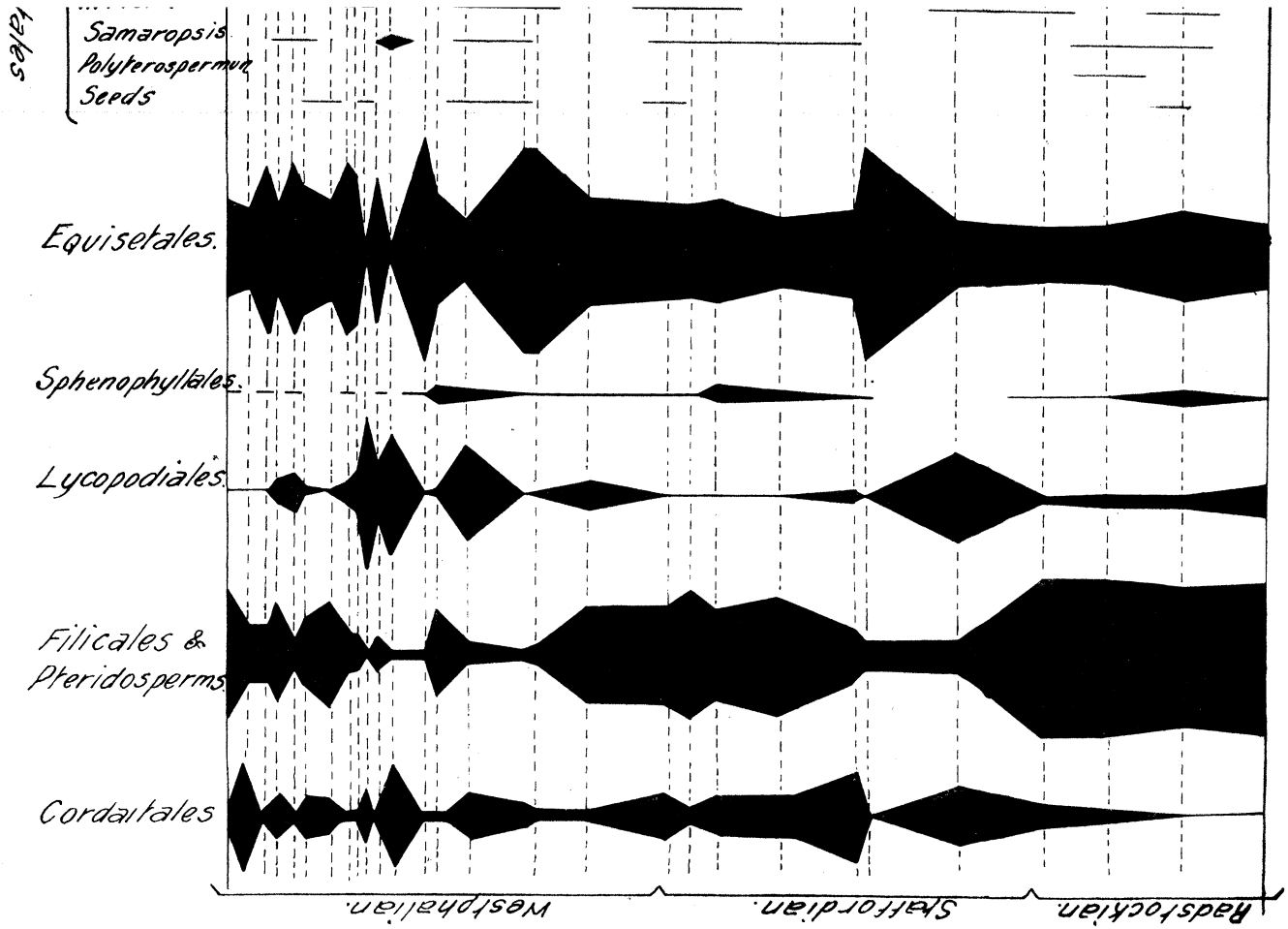


Chart II.—Ecology.

PHILOSOPHICAL TRANSACTIONS OF THE ROYAL SOCIETY B BIOLOGICAL SCIENCES



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III. Flora—Tabulation of Species. (See Chart III.)

The following is a complete list of the species and the various horizons at which each species was found.

(W = Westphalian; S = Staffordian; R = Radstockian.)

Class Equisetales.

Genus Equisetites.

E. rugosus (Geinitz), hor. 16 (W), hor. 11 (S).

Genus Calamites.

C. Suckowi (Brongt), hor. 29–26–25–23–19–17–13 (W), hor. 11–9–8–4 (S), hor. 3–2–1 (R).
C. ramosus (var. *rugosus*), (Kidston and Jongmans), hor. 28–15 (W), hor. 9 (S).
C. cisti (Brongt), hor. 26–14 (W), hor. 9 (S), hor 3–1 (R).
C. (*cf.*) *cisti* (Brongt), hor. 3–1 (R).
C. palæceus (Stur.), hor. 15 (W).
C. carinatus (Sternbg.), hor. 29–28–27–25–24–12 (W), hor. 10–9–8–7–6 (S), hor. 3–2 (R).
C. undulatus (Sternbg.), hor. 29–28–27–24–23–22–19–18–15–13 (W), hor. 11–10–9–8 (S).
C. (*cf.*) *carinatus* (var. *rugosus*) (Kidston and Jongmans), hor. 10–7–4 (S).
C. (*cf.*) *undulatus* (Sternbg.), hor. 10 (S), hor. 3 (R).
C. carinatus (var. *rugosus*) (Kidston and Jongmans), hor. 8–7 (S).
C. ramosus (Weiss), hor. 7 (S).
C. semicircularis (Weiss), hor. 15 (W), hor. 8 (S).
C. approximatus (Brongt), hor. 8 (S).
C. Sachsei (Stur.), hor. 27 (W), hor. 11–8 (S).
C. Scheutzeiformis (Kidston and Jongmans), hor. 9 (S).
C. Scheutzeiformis (forma *Waldenburgensis*) (Kidston and Jongmans), hor. 23–16 (W), hor. 11 (S).
C. Gopperti (Ettinghausen), hor. 27 (W).
C. (*cf.*) *palæceus* (Stur.), hor. 2 (R).
C. verticillatus (Lind and Hutt), hor. 12 (W).
Calamites (rhizomes), hor. 6 (S), hor. 1 (R).
Calamites sp. indet. 20 horizons (W–S–R).

Genus Asterophyllites.

A. longifolius (Sternbg.), hor. 27 (W), hor. 11 (S).
A. equisetiformis (Schloth.), hor. 28–27–26–17–15 (W), hor. 11–10–9–7–6–4 (S), hor. 3–2–1 (R).
A. chæræformis (Sternbg.) (formerly known as *Calamocladus chæræformis*), hor. 28–27–26–17–15–14 (W), hor. 11–9 (S).

CLASS EQUISETALES (continued).

Genus Asterophyllites (continued).

A. radiata (*vera*) (BRONGT), hor. 11–9 (S), hor. 2 (R).
A. grandis (ZEILLER), hor. 14 (W).
A. (*cf.*) *Dumasi* (ZEILLER), hor. 13 (W).
Asterophyllites sp. indet. 10 horizons (W–S).

Genus Annularia.

A. galioides (LIND and HUTT), hor. 16 (W), hor. 11 (S).
A. sphenophylloides (ZENKER), hor. 14 (W), hor. 7–6 (S), hor. 1 (R).
A. stellata (SCHLOTH.), hor. 15 (W), hor. 4 (S), hor. 3–1 (R).
A. radiata (*vera*) (BRONGT), hor. 28–27–16–14–12 (W), hor. 11–9–8–7–6–4 (S), hor. 3–2 (R).
A. radiata (AUCTT.), hor. 28–27–17–15 (W), hor. 11–10–9–8–6–4 (S), hor. 2 (R).
A. (*cf.*) *stellata* (SCHLOTH.), hor. 3–2 (R).
A. ramosa (WEISS), hor. 27 (W), hor. 9 (S).
A. spicata (GUTBIER), hor. 16 (W).
Annularia sp. indet. 9 horizons (W–S–R).
Phragma of Calamites, hor. 24–16 (W), hor. 8–7–6 (S).
Foliage of *Calamites palæceus* (STUR.), hor. 29–15 (W), hor. 2 (R).
Calamite leaves, hor. 28 (W).
Calamite stem leaves, hor. 11 (S).

Genus Myrophyllites.

M. gracilis (ARTIS), hor. 28–27–15 (W), hor. 11–10–9–8–7–6 (S).
Myrophyllites sp. indet. 14 horizons (W–S–R).
(*cf.*) *Myrophyllites* sp. 3 horizons (S).

Genus Pinnularia.

P. capillacea (LIND and HUTT), hor. 15 (W), hor. 11–10–9–8–7–6½ (S), hor. 2–1 (R).
P. columnaris (ARTIS), hor. 29–28–16 (W), hor. 9–6–4 (S).

Genus Calamostachys.

Calamostachys sp. indet. hor. 8 (S).

Genus Palæostachya.

P. elongata (PRESL.), hor. 22 (W).
P. gracillima (WEISS), hor. 8–7–6 (S).
Palæostachya sp. indet. (WEISS), hor. 14 (W), hor. 11 (S).

CLASS EQUISETALES (continued).

Genus Macrostachya.

Macrostachya sp. indet., hor. 1 (R).
Calamite cones sp. indet. 7 horizons (W).
Cones of *Asterophyllites equisetiformis*, hor. 26 (W), hor. 9 (S), hor. 1 (R).
Calamite bulbil sp. (bulbous cone), hor. 27 (W), hor. 8–7 (S).
Megaspores of Calamites, hor. 3 (E).

Class Equisetales—Summary.

Equisetites (stems) 1, Calamite stems 21, Calamite branch foliage, Asterophyllites type 7, Annularia type 9, Calamite stem foliage 3, Calamite phragma 1, Calamite root organ—Myrophyllites type 3, Pinnularia 2, Calamite cones 8, Calamite megaspores 1. Total, 56.

CLASS SPHENOPHYLLALES.

Genus Sphenophyllum.

S. emarginatum (BRONGT), hor. 11–10–9–8–7–6–4 (S), hor. 3–2–1 (R).
S. cuneifolium (STERNBG.), hor. 28–27–24–23–22–17–16–15–14–12 (W), hor. 11–9 (S).
S. trichomotosum (STUR.), hor. 10–9 (S).
S. cuneifolium (forma *saxifragæfolium*) (STUR.), hor. 22–16 (W).
S. majus (BRONN.), hor. 17–14 (W), hor. 9 (S).
S. (*cf.*) *longifolium* (GERMAR.), hor. 7 (S), hor. 2–1 (R).
S. (*cf.*) *papilionaceum* (GRAND EURY) (*Sphen. Thoni*, MOHR in JUNGMAN), hor. 7 (S), hor. 2–1 (R).
Sphenophyllum sp. indet. 15 horizons (W–S–R).

Class Sphenophyllales—Total, 8 species.

CLASS LYCOPODIALES.

Genus Lepidodendron.

L. (*cf.*) *lanceolatum* (LESQX.), hor. 1 (R).
L. Wortheni (LESQX.), hor. 3–2 (R).
L. (*cf.*) *aculeatum* (STERNBG.), hor. 13 (W), hor. 3 (S).
L. aculeatum (STERNBG.), hor. 29–24–23–20–18–15–13–12 (W), hor. 11–9 (S).
L. fusiforme (CORDA), hor. 4 (S), hor. 3 (R).
L. obovatum (STERNBG.), hor. 24–22–15 (W), hor. 7 (S).
L. rimosum (STERNBG.), hor. 23 (W), hor. 11–7 (S).
L. simile (KIDSTON), hor. 15–13–12 (W), hor. 11–10–9 (S), hor. 1 (R).
L. ophiurus (BRONGT), hor. 24–19–15 (W), hor. 9 (S).
L. (*cf.*) *simile* (KIDSTON), hor. 13 (W).

Class Lycopodiales (continued).

Genus Lepidodendron (continued).

L. dissetum (Sauveur), hor. 23–15 (W), hor. 11 (S).
L. acutum (Presl.), hor. 26–15 (W).
L. loricatum (Arber), hor. 5–4 (S), hor. 3 (R).
L. (*cf.*) *aculeatum* (Sternbg.), hor. 3 (R).
L. Gaudryi (Renault), hor. 12 (W).
L. Jarackewski (Zeiller), hor. 12 (W).
L. lanceolatum (Lesqx.), hor. 3 (R).
L. (*cf.*) *ophiurus* (forma *dilatata*) (Lind and Hutt), pro. sp. hor. 12 (W).
Lepidodendron (twigs) indet. hor. 29 (W), hor. 3 (R).
Lepidodendron sp. (Knorria state), hor. 26–12 (W), hor. 9 (S).
Lepidodendron (small Lycopod branches), hor. 25 (W).
Lepidodendron sp. indet. 21 horizons (W–S–R).

Genus Sigillaria.

S. (*cf.*) *discophora* (Kœnig), hor. 1 (R).
S. (*cf.*) *tesselata* (Brongt), hor. 23–22–20 (W), hor. 9–7–5–4 (S), hor. 2 (R)
S. (*cf.*) *reniformis* (Brongt), hor. 7 (S).
S. (*cf.*) *nudicaulis* (Boulay), hor. 7 (S).
S. camptotoenia (Wood), hor. 23 (W), hor. 10 (S).
S. lœvigata (Brongt), hor. 28–23 (W), hor. 7 (S).
S. Schlotheimi (Brongt), hor. 9 (S).
S. Walchi (Sauveur), hor. 11 (S).
S. mammilaris (Brongt), hor. 28–26–23–16–15 (W.)
S. mammilaris (forma *Dournaisii*) (Brongt), hor. 26 (W).
S. elongata (Brongt), hor. 16–15 (W).
S. (*cf.*) *elongata* (Brongt), hor. 16 (W).
S. rugosa (Brongt), hor. 28 (W).
S. ovata (Sauveur), hor. 11 (S).
S. elegans (Brongt), hor. 23 (W).
S. scutellata (Brongt), hor. 23 (W).
S. nudicaulis (Boulay), hor. 11 (W).
S. tesselata (Brongt), hor. 23 (W), hor. 8–7–4 (S), hor. 2 (R).
S. Boblayi (Brongt), nor. 7 (S).
Sigillaria sp. (decorticated), hor. 16 (W), hor. 11–7 (S).
Sigillaria (pith cast), hor. 28–23 (W).
Sigillaria sp. indet. 10 horizons (W–S–R).

Genus Ulodendron.

Ulodendron sp. indet., hor. 15 (W).

CLASS LYCOPODIALES (continued).

Genus Bothrodendron.

B. punctatum (LIND and HUTT), hor. 28–23 (W).
Bothrodendron sp. indet., hor. 5 (S), hor. 3 (R).

Genus Lepidophloios.

L. laricinus (STERNBG.), hor. 11–9–7–6 (S).
L. acerosus (LIND and HUTT), hor. 24–12 (W).
(*cf.*) *Lepidophloios* sp. indet., hor. 7 (S).
Lepidophloios sp. indet., 7 horizons (W–S–R).

Genus Asolanus.

A. camptotœnia (WOOD), hor. 24–16–15 (W), hor. 11–10–9 (S), hor. 3 (R).

Genus Halonia.

H. regularis (LIND and HUTT), hor. 29–15 (W).
H. tortuosa (LIND and HUTT), hor. 29 (W).

Genus Lepidophyllum.

L. aculeatum (STERNBG.), hor. 17 (W), hor. 9 (S).
L. majus (BRONGT), hor. 16 (W), hor. 1 (R).
L. acuminatum (LESQX.), hor. 4 (S), hor. 1 (R).
L. lanceolatum (BRONGT), hor. 29–24–19–17–12 (W), hor. 6–4 (S), hor. 3–2 (R).
L. intermedium (LIND and HUTT), hor. 7 (S).
L. (*cf.*) *lanceolatum* (LIND and HUTT), hor. 2 (R).
L. (*cf.*) *acuminatum* (LESQX.), hor. 7 (S).
L. anthemis (KŒNIG), hor. 19–12 (W).
L. Moyseri (ARBER), hor. 4 (S).
L. Campbellianum (LESQX.), hor. 12 (W).
L. Morrisianum (LESQX.), hor. 19 (W).
Lepidophyllum indet., hor. 2 (R).
Lepidophyllum sp. indet., 20 horizons (W–S–R).

Genus Sigillariophyllum.

S. bicarinatum (LIND and HUTT), hor. 18 (W), hor. 9–8–7 (S), hor. 1 (R).
Sigillariophyllum sp. indet., 4 horizons (W–S–R).
(*cf.*) Sigillarian leaves, indet., 4 horizons (W–S–R).
Sigillarian leaves, indet., 2 horizons (W–R).

CLASS LYCOPODIALES (continued).

Genus Stigmaria.

S. reticulata (GÖPPERT), hor. 15 (W).
S. ficoides (STERNBG.), hor. 29–28–26–24–22–21–20–19–18–17–16–15–13–12 (W), hor. 11–10–8–7–5–4 (S), hor. 3–2–1 (R).
S. minuta (GÖPPERT) (pro-var.), hor. 22–12 (W).
Stigmaria n. sp. (not yet determined), hor. 13 (W).
Stigmaria sp. indet., 8 horizons (W–S–R).
Stigmaria sp. indet. (variety), hor. 24 (W).

Genus Stigmariaopsis.

S. anglica (KIDSTON), hor. 16–12 (W).

Genus Lepidostrobus.

L. triangularis (ZEILLER), hor. 19–14 (W).
L. ophiurus (BRONGT), hor. 19 (W).
L. anthemis (KŒNIG), hor. 25–24–20–19–18–15–14 (W), hor. 4 (S).
L. minor (GOODE), hor. 3–2 (R).
L. brevifolius (ARBER) (non LESQX.) hor. 3 (R).
Lepidostrobus sp. indet., 25 horizons (W–S–R).
Transverse section of *Lepidostrobus*, hor. 20 (W).

Genus Sigillariostrobus.

Sigillariostrobus sp. indet., hor. 8 (S), hor. 2 (R).
(*cf.*) Sigillarian cone, hor. 7 (S).
Sigillarian stem with cone scars, hor. 11 (S).
Sporangia of Sigillarian cone, hor. 8 (S).
Megaspores of Lycopods, hor. 2 (R).

Genus Lepidocystis.

L. fraxiniformis (LESQX.), hor. 12 (W), hor. 11–8 (S).
L. vesicularis (LESQX.) hor. 16 (W).
Lepidocystis sp. indet., hor. 16–12 (W), hor. 1 (R).
Sporangia of Lycopods, hor. 25 (W).

Genus Bothrostrobus.

Bothrostrobus sp. indet., hor. 12 (W).

Class Lycopodiales—Summary.

Lepidodendron 22 sp., Sigillaria 22 sp., Ulodendron 1 sp., Bothrodendron 2 sp., Lepidophloios 4 sp., Asolanus 1 sp., Halonia 2 sp., Lepidophyllum 13 sp., Sigillariophyllum, 4 sp., Stigmaria 7 sp., Lepidostrobus 7 sp., Sigillariostrobus 4 sp., Bothrostrobus 1 sp., Lepidocystis 3 sp., Megaspores of Lycopods 1, Sporangia of Lycopods 1.

Total, 95 sp.

Class Filicales and Pteridosperms.

Genus Neuropteris.

N. Scheuchzeri (Hoffm.), hor. 23–19–14 (W), hor. 11–10–5–4 (S), hor. 3–2–1 (R).
N. ovata (Hoffm.), hor. 5–4 (S), hor. 3–2–1 (R).
N. (*cf.*) *ovata* (Hoffm.), hor. 4 (S), hor. 3–2–1 (R).
N. rarinervis (Banbury), hor. 28–26–23–16–12 (W), hor. 11–9–7–6–4 (S), hor. 3–2–1 (R).
N. obliqua (Brongt), hor. 28–22–14 (W), hor. 11–8–4 (S), hor. 1 (R).
N. flexuosa (Sternbg.)? hor. 23 (W), hor. 3–2–1 (R).
N. (*cf.*) *flexuosa* (Sternbg.), hor. 3–2 (R).
N. fimbriata (Lesqx.), hor. 3–2–1 (R).
N. (*cf.*) *macrophylla* (Brongt), hor. 26 (W), hor. 2 (R).
N. (*cf.*) *rarinervis* (Banbury), hor. 3–2 (R).
N. lonchitica (Brongt), hor. 9 (S).
N. (*cf.*) *tenuifolia* (Schloth.), hor. 8–7 (S).
N. tenuifolia (Schloth.), hor. 29–28–26–25–24–21–19–16–15–12 (W), hor. 11–10–9 (S).
N. heterophylla (Brongt), hor. 29–28–27–26–25–24–23–22–19–18–17–13–12 (W), hor. 11–10–9–8–7–6–4 (S).
N. (*cf.*) *callosa* (Lind and Hutt), hor. 23 (W), hor. 11–9–6 (S).
N. gigantea (Sternbg.), hor. 26–25–23–20–19 (W), hor. 11 (S).
N. gigantea (falcate form) (Sternbg.), hor. 23–20–19–14 (W), hor. 11–9 (S).
N. obtusifolia (Kidston), hor. 9 (S).
N. pseudogigantea (Potonie), hor. 22–20–19–18 (W).
N. grangeri (Brongt), hor. 27 (W).
N. camptophylla (Gothan and Jong), hor. 28 (W).
N. (*cf.*) *fimbriata* (Lesqx.), hor. 2 (R).
N. gibbosa (Lesqx.), hor. 10 (S).
N. (*cf.*) *microphylla* (Brongt), hor. 6 (S).
(*cf.*) *N. Missouriensis* (Lesqx.), hor. 8 (S).
Neuropteris sp. indet., 13 horizons (W–S–R).

Genus Sphenopteris.

S. neuropteroides (Boulay), hor. 19 (W), hor. 11–4 (S), hor. 3–2 (R).
S. (*cf.*) *neuropteroides* (Boulay), hor. 6–4 (S), hor. 2 (R).
S. obtusiloba (Brongt), hor. 28–23–14 (W), hor. 11–9 (S).
S. renaultia (with fructification) (Zeiller), hor. 9 (S).
S. obtusifolia (Brongt), hor. 9 (2S).
S. amœna (Stur.), hor. 9 (S).
S. artemisiæfolioides (Crepin), hor. 11 (S).
S. (*renaultia*) *chœrœphylloides* (Brongt), hor. 11 (S).
S. Cœmansi (Andræ), hor. 11 (S).
S. obtusiloba (forma *convexiloba*) (Schimper), hor. 11 (S).

Class Filicales and Pteridosperms (continued).

Genus Sphenopteris (continued).

S. (*cf.*) *latifolia* (Brongt), hor. 11 (S).
S. Conwayi (Lind and Hutt), hor. 11 (S).
S. rotundifolia (Andræ), hor. 11 (S).
S. Sauveri (Crepin), hor. 26–23 (W).
S. Andræana (Roehl), hor. 23 (W).
S. Sturi (Gothan), hor. 27 (W).
S. Laurenti (Andræ), hor. 23 (W).
S. nummularia (Gutbier), hor. 27 (W).
S. (*Palmopteris*) *Sturi* (Gothan), hor. 27 (W).
S. (*cf.*) *trifolialata* (Artis), hor. 9 (S).
S. pecopteroides (Kidston), hor. 2 (R).
S. integra (Andræ), hor. 2 (R).
S. striata (Gothan), hor. 12 (W), hor. 10 (S).
Stems of *S. Hoeninghausi* (Brongt), hor. 28 (W).
Sphenopteris sp. indet. (with fructification), hor. 9 (S).
Sphenopteris sp. indet., 14 horizons (W–S–R).

Genus Pecopteris.

(*cf.*) *P. unita* (Brongt), hor. 2 (R).
P. (*Asterotheca*) *miltoni* (Artis), hor. 11–4 (S), hor. 3–2–1 (R).
P. (*cf.*) (*Asterotheca*) *miltoni* (Artis), hor. 8–6 (S), hor. 3–2 (R).
P. (*cf.*) (*Asterotheca*) *arborescens* (Schloth.) ? hor. 23 (W), hor. 9 (S), hor. 2–1 (R).
P. Volkmanni (Sauveur), hor. 28 (W), hor. 11–9 (S).
P. Cyathea (Brongt), hor. 10–4 (S), hor. 3–2–1 (R).
P. miltoni (Brongt), hor. 15 (W).
P. muricata (with fructification) (Schloth.), hor. 23 (W).
P. (*Asterotheca*) *Cyathea* (Schloth.), hor. 2 (R).
P. (*cf.*) *lepidorachis* (Brongt), hor. 10–4 (R).
Pecopteris sp. indet., 9 horizons (W–S–R).
(*cf.*) *Pecopteris* sp. indet., 1 horizon (S).
P. unita (Brongt), hor. 2 (R).

Genus Eupecopteris.

E. Camerontensis (Kidston), hor. 3 (R).
E. Bucklandi (Brongt), hor. 3 (R).
Eupecopteris sp. indet., 5 horizons (S–R).

Genus Asterotheca.

A. oreopteridia (Schloth.), hor. 3 (R).

CLASS FILICALES AND PTERIDOSPERMS (continued).

Genus Mariopteris.

M. muricata (forma *nervosa*) (LIND and HUTT), hor. 23 (W), hor. 9 (S), hor. 3 (R).
M. acuta (BRONGT), hor. 28–27–15 (W), hor. 11 (S), hor. 1 (R).
M. muricata (SCHLOTH.), hor. 28–26–25–24–23–22–21–19–17–15–14–13–12 (W), hor. 11–10–9–6 (S), hor. 1 (R).
M. (*cf.*) *latifolia* (BRONGT), hor. 11 (S).
M. Daviesi (n. sp.) (KIDSTON), hor. 4 (S), hor. 3–2–1 (R).
M. (*cf.*) *acuta* (BRONGT), hor. 28–27–15 (W), hor. 11 (S).
Mariopteris sp. indet., 11 horizons (W–S–R).
**M. hirta* (STUR.), hor. 15 (W).
**M. nobilis* (ACHEPOHL), hor. 11 (S).
**Mariopteris* sp. (C), hor. 10 (S).

Genus Dactylotheca.

Dactylotheca sp. ? indet., hor. 9 (S).

Genus Linopteris.

L. (*cf.*) *munsteri* (EICHWALD), hor. 4 (S).
L. munsteri (EICHWALD), hor. 28–16–14 (W), hor. 11–4 (S).
L. obliqua (BUNBURY), hor. 10 (S).

Genus Crossotheca.

C. Crepini (ZEILLER), hor. 16 (W).
C. Hœninghausi (EICHWALD), hor. 28 (W).
C. Boulayi (with fructification) (KIDSTON), hor. 28 (W), hor. 11 (S).
C. Boulayi ? (ZEILLER), hor. 11–9 (S).
C. sagitta (ZEILLER), hor. 10 (S).

Genus Corynepteris.

C. coralloides (GUTBIER), hor. 11 (S).
C. Sternbergi (ETTING), hor. 28 (W), hor. 3 (R).

Genus Dolerophyllum.

D. pseudopeltatum (GRAND EURY), hor. 28–12 (W).
Dolerophyllum sp. indet., 6 horizons (S–R).
(*cf.*) *Dolerophyllum* sp. indet., 4 horizons (S–R).

Genus Odontopteris.

O. Lindleyana (STERNBG.), hor. 4 (S), hor. 3–2–1 (R).
O. Conwayi (LIND and HUTT), hor. 11 (S).

* Omitted from Chart.

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Class Filicales and Pteridosperms (continued).

Genus Alloiopteris.

A. Sternbergi (Etting), hor. 3 (R).
A. (*Corynepteris serrula*) (Lesqx.), hor. 11 (S).
Alloiopteris sp. indet., 1 horizon (R).

Genus Alethopteris.

A. Serli (Brongt), hor. 11 (S), hor. 2–1 (R).
A. Grandini (Brongt), hor. 2 (R).
A. aquilina (Schloth.), hor. 7–4 (S).
A. lonchitica (Schloth.), hor. 28–27–19–12 (W), hor. 11–9–7 (S).
A. integra (Gothan), hor. 11–9 (S).
A. decurrens (Artis), hor. 28–26–25–24–23–15 (W).
A. gracillima (Boulay), hor. 22 (W).
A. valida (Boulay), hor. 26 (W).
A. pseudoaquilina (Potonie), hor. 3 (R).
Alethopteris sp. indet., 6 horizons (W–S–R).

Genus Eremopteris.

E. artemisiæfolia ? (Sternbg.), hor. 24 (W), hor. 11 (S).
Eremopteris sp. indet., 1 horizon (W).

Genus Cyclopteris.

Cyclopteris (Gutbier), hor. 11 (S).
Cyclopteris sp. indet., 16 horizons (W–S–R).
(*cf.*) *Cyclopteris* sp. indet., 1 horizon (S).

Genus Aphlebia.

A crispa (Gutbier), hor. 15 (W).
A. (*cf.*) *crispa* (Gutbier), hor. 16 (W).
A. (*cf.*) *anomala* (Brongt), hor. 16 (W).
Aphlebia sp. indet., 3 horizons (W–S–R).

Genus Renaultia.

A. chærœphylloides (Brongt), hor. 16 (W), hor. 10–7 (S).

Genus Spiropteris.

Spiropteris sp., hor. 10 (S).

Genus Scolecopteris.

S. (*Acitheca*) *polymorpha* (Brongt), hor. 3 (R).

Genus Zeilleria.

Z. avoldensis (Stur.), hor. 28–26 (W).

Genus Ptychocarpus.

P. unita (Brongt), hor. 2 (R).

CLASS FILICALES AND PTERIDOSPERMS (continued).

Genus (*cf.*) *Caulopteris.*

(*cf.*) *Caulopteris* sp. indet., hor. 7 (S).

Rachis of Ferns or Fern-like Plants.

19 horizons (W–S–R).

Genus Triginocarpus.

T. oblongus (LIND and HUTT), hor. 11 (S).
T. Parkinsoni (BRONGT), hor. 28–22–12 (W).
Triginocarpus sp. indet., 9 horizons (W–S–R).

Genus Lagenospermum.

Lagenospermum sp. indet. (?), hor. 22 (W).

Genus Neurospermum.

N. tunicatum (GÖPP and BERG), hor. 3 (R).
(*cf.*) *N. tunicatum* (GÖPP and BERG), hor. 2 (R).

Genus Polypterocarpus.

P. ornatus (ARBER), hor. 19 (W), hor. 11 (S).
Polypterocarpus sp. indet., hor. 2 (R).

Genus Carpolithus.

C. Cordei (associated with *Neuropteris Scheuchzeri*), hor. 4 (S), hor. 1 (R).
C. perpusillus (LESQX.), hor. 2 (R).
Carpolithus sp. (allied with *C. perpusillus* (LESQX.), hor. 4, hor. 3–2 (R).

Genus Holeospermum.

H. multistriatum (PRESL.), hor. 4 (S).
Holeospermum sp. indet., hor. 2 (R).

Genus Microspermum.

Microspermum sp. indet., hor. 2 (R).

Genus Diplotmema.

**D. Sturi* (GOTHAN), hor. 27 (W).

Seeds (?) (probably Pteridospermous).

16 horizons (W–S–R).

Class Filicales and Pteridosperms.—Summary.

Stems 2 ; Fronds and Scale Leaves 124 ; Seed Organs 15.

Total, 141.

* Omitted from Chart.

CLASS CORDAITALES.

Genus Cordaites.

C. palmæformis (GÖPPERT), hor. 12 (W), hor. 7–4 (S).
C. (*cf.*) *palmæformis* (GÖPPERT), hor. 2–1 (R).
C. borassifolius (STERNBG.), hor. 9–8–4 (S), hor. 3 (R).
C. (*cf.*) *borassifolius* (STERNBG.), hor. 3 (R).
C. (*Dorycordaites*) *palmæformis* (GÖPPERT), hor. 27–26–15 (W), hor. 3 (R).
C. principalis (GERMAR), hor. 28–17–13 (W), hor. 9–8–7 (S), hor. 3 (R).
Cordaites sp. indet., 22 horizons (W–S–R).

Genus Poa-cordaites.

P. microstachys (GOLD), hor. 2 (R).
(*cf.*) *Poa-cordaites* sp. indet., 1 horizon (R).

Genus Hysterites.

H. cordaites (GRAND, EURY), hor. 2 (R).

Genus Artisia.

A. approximata (BRONGT), hor. 28–26–13 (W), hor. 11–9–7 (S).
A. transversa (ARTIS), hor. 9–4 (S).
Artisia sp. indet., 6 horizons (W–S–R).

Genus Cordaianthus.

C. Volkmanni (ETTING), hor. 18 (W).
Cordaianthus sp. indet., 6 horizons (W–S–R).

Genus Samaropsis.

S. Meachami (KIDSTON), hor. 15 (W), hor. 9–8 (S).
S. pseudo-fluitans (DAWSON), hor. 14 (W).
S. cambrica n. sp. hor. 8–7 (S).
Samaropsis sp. indet., 11 horizons (W–S–R).

Genus Cordaicarpus.

C. Cordai (GEINITZ), hor. 28–25–16 (W).
Cordaicarpus sp. indet., 3 horizons (S–R).

Genus Cordaicladus.

Cordaicladus sp. indet., 2 horizons (S).

Seeds (?) (probably belonging to *Cordaitales*).

6 horizons (W–S–R).

Class Cordaitales.—Summary.

Foliage 10, Pith cast 3, Ovulate Shoots 2, Seeds 8.

Total, 23.

Summary of Species.

	Species.
Equisetales	56
Sphenophyllales	8
Lycopodiales	95
Filicales and Pteridosperms	141
Cordaitales	23
Total	323
Species new to the South Wales Coalfield	83

Species new to Britain :—

Equisetites rugosus (Schimper).
Asterophyllites (*cf.*) *dumasi* (Zeiller).
Lepidophyllum sp. (in Dr. Kidston's collection).
Lepidophyllum sp. (still unnamed).
Lepidophyllum campbellianum (Lesqx.).
Neuropteris (*cf.*) *camptophylla* (Jongmans and Gotham).
Neuropteris gibbosa (Lesqx.).
Sphenopteris integra (Andræ).
Sphenopteris andræana (Roehl.).
Sphenopteris cœmansi (Andræ).
Dolerophyllum pseudopeltatum (Grand Eury).
Lagenospermum sp.
(*cf.*) *Caulopteris* sp.
Hysterites cordaites (Grand Eury).
Specimens No. 1179, 1180, 1181, 1185 (in Dr. Kidston's collection, still unnamed).
Mariopteris nobilis (Achepohl).
Mariopteris sp. (C).
Diplotmema Sturi (Gothan).

Total, 18.

New Species recorded for the first time :—

Stigmaria n. sp. (No. 11173) (in Dr. Kidston's collection).
Mariopteris Daviesi n. sp. (Kidston).
Samaropsis Cambrica n. sp. (Kidston).

Total, 3.

(See Tabulation of Species—Chart III.)

REMARKS ON SPECIES.

Class Equisetales.

Genus Calamites.

C. Suckowi (Brongt).—This species appears intermittently on 7 horizons in the Westphalian Series, and on 3 horizons in the Staffordian Series. Each horizon of the Radstockian Series shows its appearance.

C. ramosus (var. *rugosus*) (Kidston and Jongmans).—This species appears twice only in the Westphalian Series, and once in the Staffordian Series.

C. cisti (Brongt).—This species appears twice in the Westphalian Series, once in the Staffordian Series and twice again in the Radstockian Series.

C. carinatus (Sternbg.).—This species is found on 7 horizons in the Westphalian Series, on 5 horizons in the Staffordian Series, and on 2 horizons in the Radstockian Series.

C. undulatus (Sternbg.).—This species shows itself on 10 horizons in the Westphalian Series and 4 horizons in the Staffordian Series—the four lowest—after which it disappears altogether. *Calamites species* (indeterminable) is a common occurrence in the whole range from the base to the top of the Coal Measures.

General Remarks.—From the foregoing it will be seen that the two species *C. Suckowi* (Brongt) and *C. carinatus* (Sternbg.) have the longest range in time. Both commence in the lowest horizon in the Westphalian Series and persist upward to the top of the Radstockian Series. *C. undulatus* (Sternbg.), as previously stated, is limited in its range, being confined to the Westphalian Series and the lower half of the Staffordian Series. All the other species in the foregoing list can be considered to be, on the whole, very limited in time and scarce in number.

Genus Asterophyllites.

A. equisetiformis (Schloth.).—This species appears on 5 different horizons in the Westphalian Series, on 6 horizons in the Staffordian Series, and on each of the 3 horizons of the Radstockian Series, commencing its range at the lowest horizon but one in the Coal Measures and extending upwards to the uppermost horizon.

Genus Annularia.

Annularia is best represented by *A. Sphenophylloides* (Zenker), *A. radiata* (*vera*) (Brongt) and *A. radiata* (Auctt.). Each of these species has a long range in time from near the base of the Westphalian Series to the Radstockian Series.

Genus Myrophyllites.

M. gracilis (Artis) is well represented on the various horizons of the Westphalian and Staffordian Series, but Myrophyllites sp. without specific determination occur in each of the three groups or series.

Genus Pinnularia.

P. columnaris (Artis).—This species also appears with an extended range in the Westphalian and Staffordian Series.

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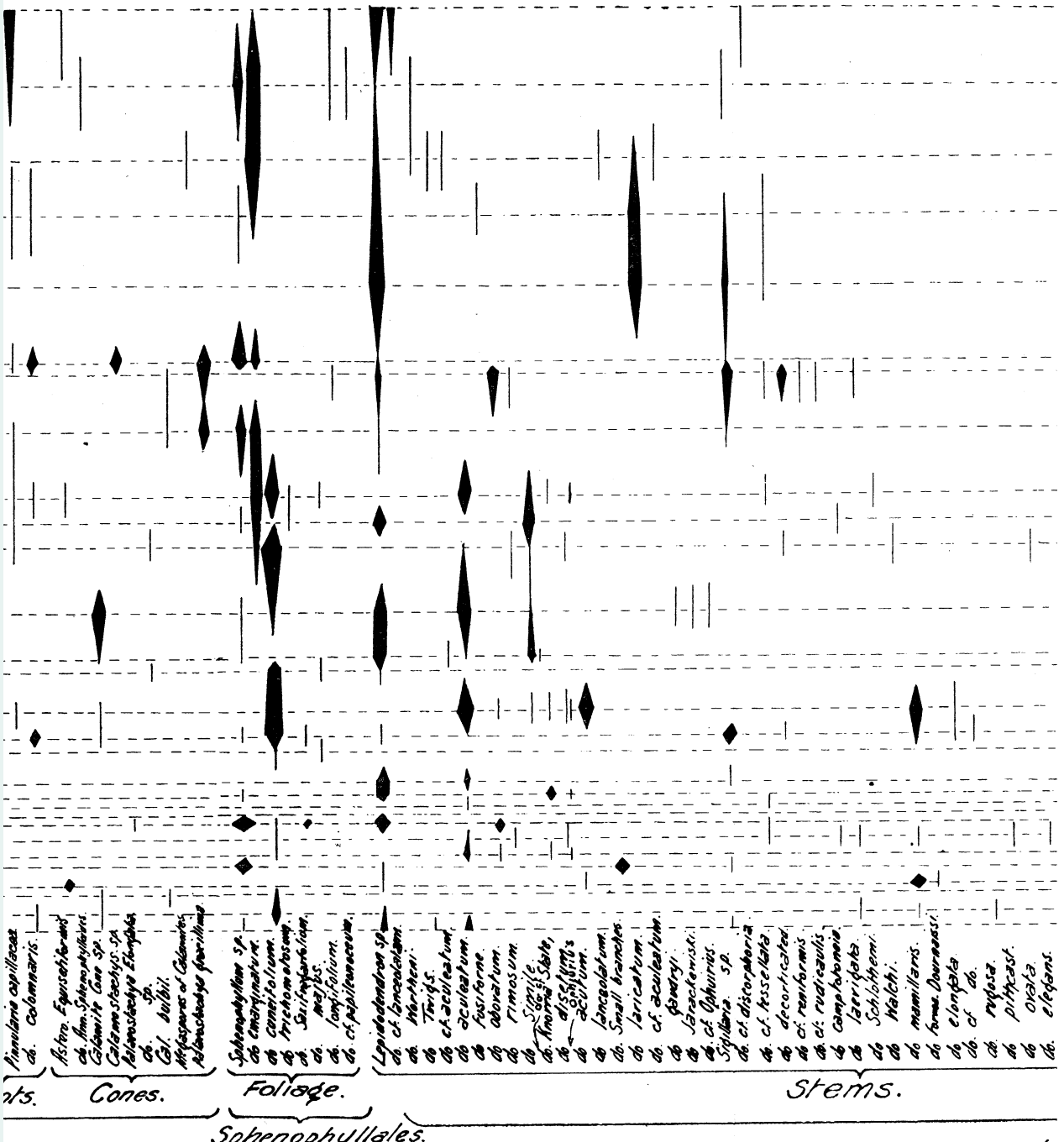
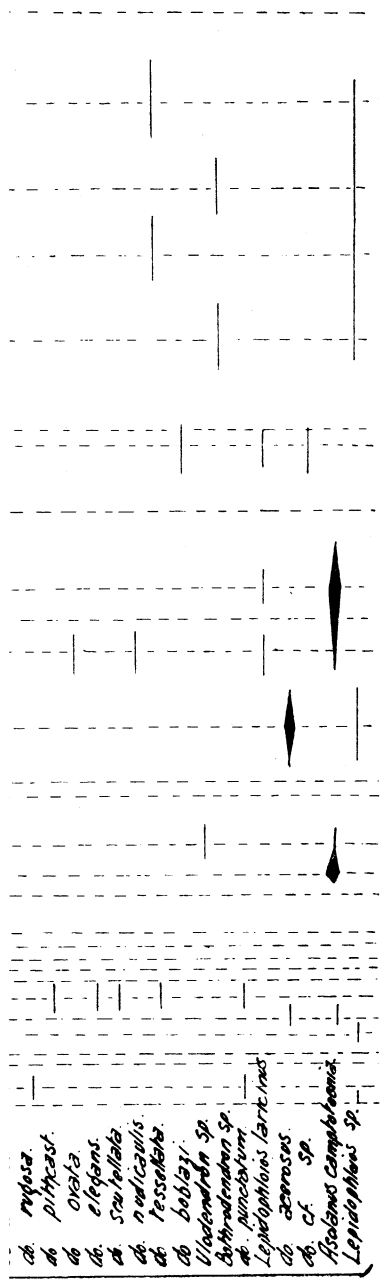
Davies.

Chart



t III.—Tabulation of Species.



Lycopodiales

[Continued on Plate 36.]

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PHILOSOPHICAL TRANSACTIONS OF THE ROYAL SOCIETY B BIOLOGICAL SCIENCES

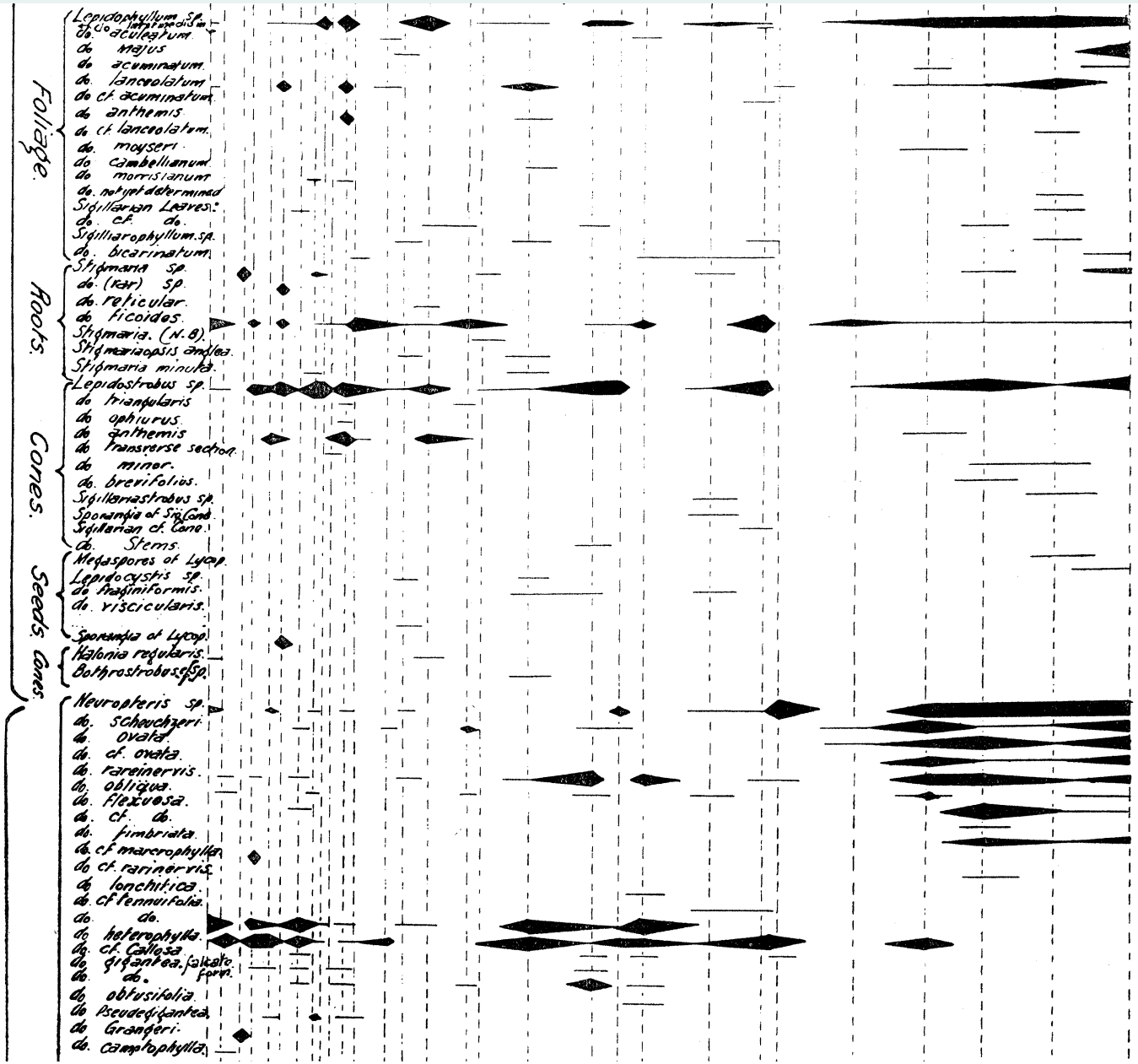
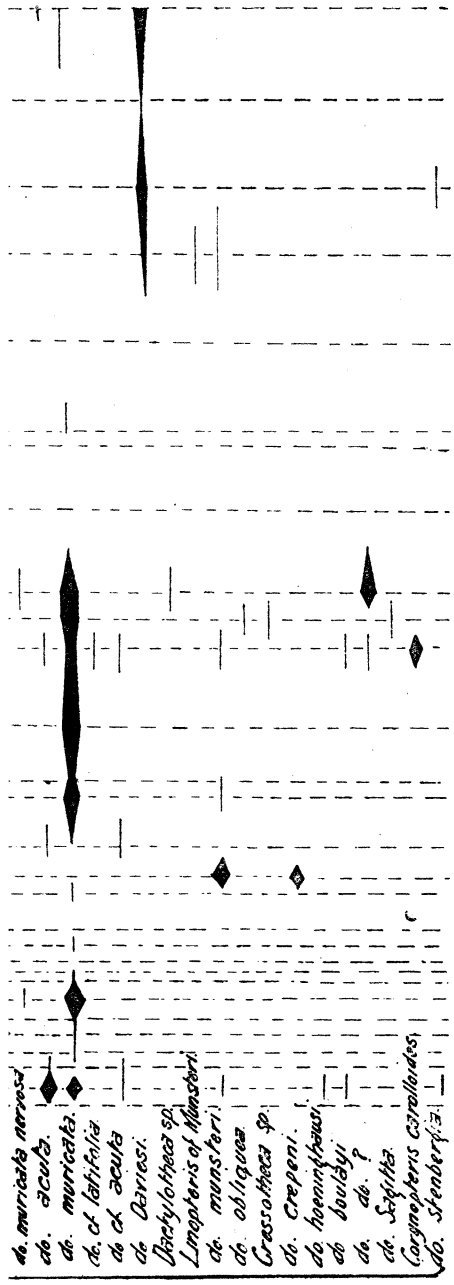


Chart III (continued).



Pteridosperms.

[Concluded on Plate 37.]

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PHILOSOPHICAL TRANSACTIONS OF THE ROYAL SOCIETY B BIOLOGICAL SCIENCES

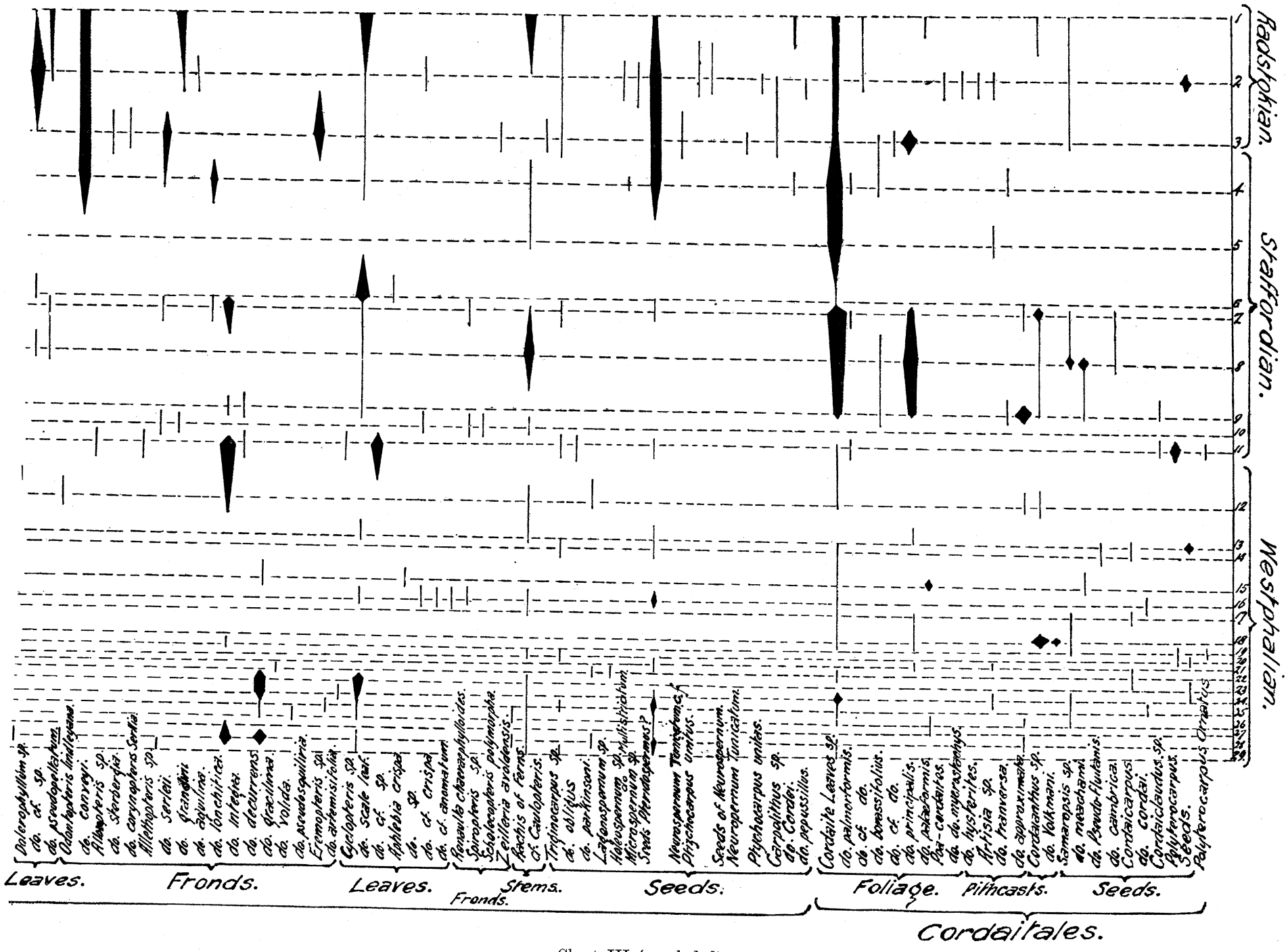

Chart III (concluded).

Calamite Cones.—Cones not specifically determined appear in each of the groups or series, from the base of the Coal Measures to the top horizon but one, namely, the No. 2 Llantwit Seam.

Class Sphenophyllales.

Genus Sphenophyllum.

Of the different species belonging to the Genus Sphenophyllum, the two species *S. cuneifolium* (Sternbg.) and *S. emarginatum* (Brongt) have the longest range in time. The former commences near the base of the Westphalian Series and passes upward to the third horizon above the base of the Staffordian Series, namely, the No. 2 Rhondda Seam. The latter appears at the base of the Staffordian Series and continues upwards to the top of the Radstockian Series.

Class Lycopodiales.

Genus Lepidodendron.

Lepidodendron species (not specifically determined) has been found from the base of the Westphalian Series to the top of the Radstockian Series. Of the genus Lepidodendron, the species most frequently met with is *L. aculeatum* (Sternbg.). It appears on the lowest horizon, namely, the Gelli Deg Seam, and afterwards shows itself in no less than 7 horizons of the Westphalian Series. It dies out in the ninth horizon, the third from the base of the Staffordian Series.

The other species that occur in the Westphalian Series and terminate in the Staffordian Series, dying out in the No. 2 Rhondda Seam, are *L. simile* (Kidston) and *L. ophiurus* (Brongt). There is one other species *L. dissetum* (Sauveur) that dies out on the eleventh horizon, namely, the No. 3 Rhondda Seam. *L. acutum* (Presl.) is confined to the Westphalian Series. Species limited to the Radstockian Series are *L. Wortheni* (Lesqx.) and *L.* (*cf.*) *lanceolatum* (Lesqx.).

Genus Sigillaria.

The species common to the different horizons of the Westphalian and Staffordian groups are *S. tesselata* (Brongt), *S. camptotœna* (Wood) and *S. lævigata* (Brongt).

The species belonging to the Westphalian Series are *S. elongata* (Brongt), *S.* (*cf.*) *elongata* (Brongt), *S. elegans* (Brongt), *S. mammilaris* (forma *dournaissi* (Brongt)), *S. scutellata* (Brongt) and *S. rugosa* (Brongt).

The species limited in their range to the top of the Staffordian Series are *S.* (*cf.*) *reniformis* (Brongt) ; *S. reniformis* (Brongt), *S.* (*cf.*) *nudicaulis* (Boulay) ; *S. Schlotheimi* (Brongt) ; *S. walchi* (Sauveur) and *S. ovata* (Sauveur).

The species belonging to the Radstockian Series alone are *S.* (*cf.*) *discophora* (Kœnig) and *S.* (*cf.*) *tesselata* (Brongt).

Genus Lepidophyllum.

Lepidophyllum sp. indet. has been found to occur in most of the horizons of the Westphalian, Staffordian and Radstockian Series.

The species known as *L. lanceolatum* (Brongt) is found to have the longest range in time, because it appears at the very base of the Westphalian Series and it afterwards occurs here and there on various horizons until it reaches the uppermost horizon but one, the No. 2 Llantwit Seam in the Radstockian Series.

Class Filicales and Pteridosperms.

Genus Neuropteris.

Species belonging to the genus Neuropteris are found from the base of the Westphalian Series to the top of the Radstockian Series. Of the species that permitted specific determination, *N. Scheuchzeri* (Hoffman) is found to appear first in horizon 23, *i.e.*, the Six Feet Seam, Westphalian Series, and it afterwards shows its presence here and there to the uppermost horizon in the Radstockian Series, thus showing a long range in time.

N. rarinervis (Bunbury) also shows a long range in time, commencing at the lowest horizon in the Westphalian Series and extending upwards on the different horizons to the uppermost but two in the Radstockian Series, *i.e.*, the No. 3 Llantwit Seam.

N. obliqua (Brongt) commences from horizon 28, *i.e.*, the Five Feet Seam, in the Westphalian Series. It appears less frequently than *N. rarinervis* (Bunbury) on the various horizons, but extends to the uppermost horizon of the Radstockian Series, *i.e.*, the No. 1 Llantwit Seam.

N. tenuifolia (Schlotheim) is persistent in the Westphalian Series almost throughout, but it shows a comparatively limited range in time, disappearing from all horizons above No. 2 Rhondda Seam, *i.e.*, horizon 9 in the Staffordian Series.

N. gigantea (Sternbg.) and *N.* (*cf.*) *gigantea* (Sternbg.) both extend from the Westphalian Series upwards into the Staffordian Series to horizon 9, but they are not evident in the higher horizons.

N. heterophylla (Brongt) extends from the very base of the Westphalian Series to horizon 4 of the Staffordian Series, *i.e.*, the Darran Ddu Seam.

The uppermost horizons show species that are not found in the lower portion of the Staffordian and Westphalian Series, and are represented by *N.* (*cf.*) *ovata* (Hoffm.), *N. ovata* (Hoffm.), *N. flexuosa* (Sternbg.) and *N. fimbriata* (Lesqx.).

Genus Sphenopteris.

The species belonging to the genus Sphenopteris occur rather infrequently throughout the three different series of Coal Measures. *S. obtusiloba* (Brongt) appears near the base of the Westphalian Series on three different horizons. It afterwards passes upwards into the Staffordian and shows itself on 2 horizons, disappearing altogether above horizon 9, *i.e.*, the No. 2 Rhondda Seam.

It will be observed by reference to the list of species and their horizons that a number of species are confined to a single group, either the Westphalian, Staffordian or Radstockian Series, and it is concluded that certain species of the genus Sphenopteris are limited in their range in time.

Genus Pecopteris.

Pecopteris species are found as low in the Series as horizon 28, *i.e.*, the Five Feet Seam in the Westphalian Series, the lowest horizon but one. The Westphalian Series shows a poor distribution of the species. They rapidly increase in number in the Staffordian Series and finally reach their zenith in the 3 horizons of the Radstockian Series.

The species known as *P. miltoni* (Brongt) has the longest range, extending from near the base of the Westphalian Series and isolated here and there to the uppermost horizon but one in the Radstockian Series.

Genus Mariopteris.

Of the eight species belonging to the Genus Mariopteris, *M. acuta* (Brongt) appears to have a limited range. It commences to show itself in horizon 28, *i.e.*, the lowest horizon but one of the Westphalian Coal Series. Thence it passes upwards appearing infrequently in the different horizons.

M. muricata (Schlotheim) has the longest range. It appears on horizon 28 in the Westphalian Series and is found on most horizons of this series. It also shows itself on 4 horizons in the Staffordian Series, but is only evident once in the uppermost horizon of the Radstockian Series. Taking the three groups together, the Westphalian, Staffordian and Radstockian Series, it appears on no fewer than 18 horizons.

Genus Alethopteris.

A. lonchitica (Schlotheim) has the longest range. It extends from near the base of the Westphalian Series, horizon 28, upwards to horizon 7 in the Staffordian Series. It only appears here and there.

A. decurrens (Artis) is confined to the Westphalian Series, where it shows itself on 6 different horizons.

Possibly it would be well to mention that the species belonging to the Genus Alethopteris, *A. Serli* (Brongt) appears once on the lowermost horizon in the Staffordian Series and does not appear again until it occurs on horizon 2 and horizon 1 in the Radstockian Series. Here it is very common.

Class Cordaitales.

Genus Cordaites.

The leaves of Cordaites, sp. indet., have been found to occur on almost every horizon from the base of the Westphalian to the top of the Radstockian Series. It appears that *C. principalis* (Germar) has the longest range. It first shows itself near the middle of the Westphalian Series and occurs very irregularly until it reaches the base of the Radstockian Series. *C. borassifolius* (Sternbg.) is limited to the Staffordian and Radstockian Series.

IV. Divergence and Convergence of Species.

Remarks and General Remarks.

(See Chart IV and Table B, showing Divergence and Convergence of Species.)

Introduction. (See Table.)

The divergence shows the increasing number of occurrences of any species relative to the genus on the horizons dealt with. The convergence shows the decreasing number of any species. The table referred to above shows the number of times the species has occurred in the various horizons.

Calamites.—The Westphalian Series, on the whole, shows fewer species on the individual horizons than the Staffordian or Radstockian Series. The number of different species is greatest in the Staffordian Series, attaining its maximum at the No. 2 Rhondda Seam. The Radstockian Series shows more uniformity in number of species throughout.

Asterophyllites.—The number of species throughout the different horizons is few. It appears from the evidence that the greatest number occurs at the base of the Staffordian Series, namely, the No. 3 Rhondda Seam.

Annularia.—The species belonging to the Genus Annularia were at their zenith in the Staffordian Series; they decrease in number in the Westphalian Series below and also in the Radstockian Series above. Further, it is of interest that the species belonging to the Genus Annularia increase in number when the species belonging to the Genus Asterophyllites decrease in number, thus pointing to the gradual displacement of Asterophyllites by Annularia in the two upper Series, viz., the Radstockian and Staffordian.

Sphenophyllum.—The individual species belonging to this genus are few in number. Not more than four species occur in the Westphalian and Staffordian Series, and even fewer in the Radstockian.

Lepidodendron.—The greatest number of species occur in the Westphalian and Radstockian Series. In the Hafod Rider Seam and the No. 3 Llantwit Seam seven species more are shown.

Sigillaria.—The species belonging to the Genus Sigillaria seem to be rather sudden in their appearance and disappearance. They are not so constant throughout the several horizons as the various species of Lepidodendron. It will be observed that in the Westphalian Series, two horizons yield eight and five species respectively. The maximum numbers which occur in the Staffordian Series are seven and four respectively. The zenith of the development of different species of the Genus Sigillaria appears in the Westphalian Series at the Six Feet Seam.

Neuropteris.—The species belonging to the Genus Neuropteris show an extraordinary persistence; each individual horizon from the base of the Coal Measures to the top gives evidence of its presence in varying numbers.

In the Westphalian Series, the greatest number of species is in the Six Feet Seam, which shows no fewer than eight species. The Staffordian Series shows eight species

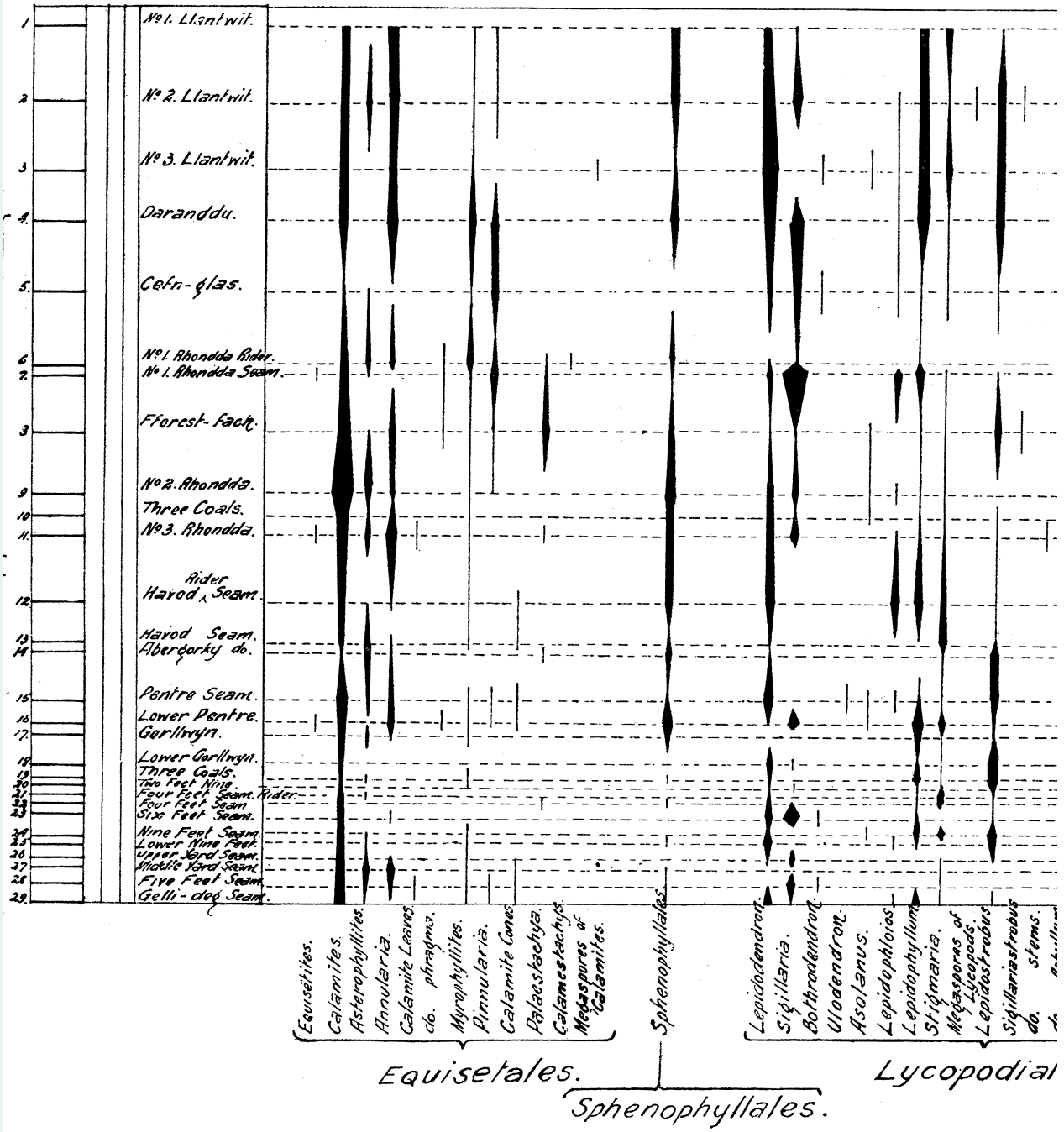

Chart IV.—Div

ergence and Convergence of Species.

PHILOSOPHICAL TRANSACTIONS OF THE ROYAL SOCIETY B BIOLOGICAL SCIENCES

on the No. 3 Rhondda Seam and seven species each on the No. 2 Rhondda and Daran Ddu Seams. However, the Radstockian Series shows the highest number of species, the No. 3 Llantwit Seam, the No. 2 Llantwit Seam and the No. 1 Llantwit Seam, yielding nine, eight and eight species respectively.

From the evidence obtained it becomes apparent that the number of species increases upwards in the Groups, the Staffordian Series showing a greater number than the Westphalian and the Radstockian showing a marked increase on the Staffordian Series.

It can safely be stated that the Genus Neuropteris was very persistent in type, and also that it gave a good instance of an increasing number of species in an ascending order.

Sphenopteris.—The Westphalian Series shows that the species belonging to the Genus Sphenopteris were few in number. The Staffordian Series shows the maximum, particularly at the base of the series. The species occur again in decreasing number in the Radstockian Series, thereby showing that the greatest development of species occurred during the Staffordian Series time.

Alethopteris.—The maximum number of species belonging to the Genus Alethopteris is found in the No. 3 Rhondda Seam in the Staffordian Series. This is somewhat significant, because it will be remembered that the same result appeared with the Genus Sphenopteris on the same horizon. The genus is rather persistent throughout the Westphalian, Staffordian and Radstockian Series and shows itself on each horizon.

Pecopteris.—From the evidence obtained, it becomes apparent that the development of species of the Genus Pecopteris was greatest towards the close of the Carboniferous times, *i.e.*, in the Radstockian Series, and becomes less and less as we proceed downward through the Staffordian and Westphalian Series.

Mariopteris.—The maximum development of species of the Genus Mariopteris occurs in the Staffordian Series; it commences dominating at the No. 3 Rhondda Seam, the base of the Staffordian Series. The species belonging to the Mariopteris are persistent from the base to the top of the Coal Measures.

General Remarks.

Priority for persistency must be given to the species belonging to the Genus Neuropteris, because every individual horizon has been represented by one or more species. The second position must be given to the Genus Sphenopteris and the Genus Mariopteris; these are represented in 22 different horizons and are absent from 7 horizons only. The Genus Alethopteris takes the third place, its species occurring on 19 horizons, with no trace on 10 horizons. The fourth position for persistency is taken by the Genus Pecopteris, which is represented on 13 of the 29 horizons.

Cordaites.—Cordaites ranged from the base to the top of the local Coal Measures and was present on 24 out of the 29 horizons.

PHILOSOPHICAL TRANSACTIONS OF THE ROYAL SOCIETY B BIOLOGICAL SCIENCES

TABLE B showing the Divergence and Convergence of the Different Genera of Plants in each of the 29 Horizons of the East Glamorgan Coalfield.

Genus.	Radstockian.			Staffordian Series.								Westphalian Series.																			
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29
	No. 1 Llantwit Seam.	No. 2 Llantwit Seam.	No. 3 Llantwit Seam.	Daran Ddu Seam.	Cefn Glas Seam.	No. 1 Rhondda Rider Seam.	No. 1 Rhondda Seam.	Fforest Fach Seam.	No. 2 Rhondda Seam.	Three Coals Seam A.	No. 3 Rhondda Seam.	Hafod Rider Seam.	Hafod Seam.	Abergorky Seam.	Pentre Seam.	Lower Pentre Seam.	Gorllwyn Seam.	Lower Gorllwyn Seam.	Three Coals Seam B.	Two Feet Nine Seam.	Upper Four Feet Seam.	Four Feet Seam.	Six Feet Seam.	Nine Feet Seam.	Lower Nine Feet Seam.	Upper Yard Seam.	Middle Yard Seam.	Five Feet Seam.	Gellideg Seam.
Equisetites . .	—	—	—	—	—	—	1	—	—	—	1	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—
Calamites . . .	4	4	6	3	1	3	4	5	9	5	4	3	3	1	4	2	2	2	3	1	1	2	3	2	3	3	4	3	4
Asterophyllites .	1	2	1	1	1	2	1	1	3	1	4	1	2	2	2	—	2	—	1	—	1	—	—	1	1	1	3	2	1
Annularia . . .	2	4	3	4	1	3	—	2	3	1	3	1	1	2	2	4	1	—	—	—	—	—	—	—	—	1	3	2	—
Calamite Leaves	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—
Calamite Phragma	—	—	—	—	—	1	1	1	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	1	—	—	—	—	—
Myrophyllites . .	1	1	1	2	1	2	1	1	1	1	1	1	1	—	1	1	1	—	1	—	—	—	—	1	1	1	1	1	1
Pinnularia . . .	1	1	—	2	—	2	—	1	2	1	1	—	—	—	1	1	—	—	—	—	—	—	—	—	—	—	—	1	1
Calamite Cones .	—	—	—	—	—	—	—	—	—	—	—	1	1	—	1	1	—	—	—	—	—	—	—	—	—	—	1	1	1
Palætachya . .	—	—	—	—	—	1	1	2	—	—	1	—	—	1	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—
Calamastachys .	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Megaspores of Calamites . .	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Sphenophyllales .	3	4	1	2	—	2	1	2	4	3	2	2	1	2	1	3	2	—	1	—	—	3	1	1	1	—	1	1	1
Lepidodendron .	3	2	7	3	2	1	3	1	4	2	4	7	5	1	6	1	—	2	2	1	1	2	3	1	4	1	—	1	3
Sigillaria . . .	1	2	—	3	2	1	7	1	2	1	4	—	—	—	2	5	—	1	—	1	—	1	8	—	1	2	—	3	1
Bothrodendron .	—	—	1	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	1	—
Ulodendron . .	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Asolanus . . .	—	—	1	—	—	—	—	—	1	1	1	—	—	—	1	1	—	—	—	—	—	—	—	1	—	—	—	—	—
Lepidophloios .	—	1	1	1	1	—	2	—	1	—	1	2	—	—	—	—	—	—	—	—	—	—	—	1	1	—	—	—	1
Lepidophyllum .	3	4	2	4	1	1	3	1	1	1	1	4	1	—	1	2	2	1	4	—	1	1	1	2	1	—	—	—	2
Stigmaria . . .	2	1	2	1	1	—	1	1	1	1	1	2	3	1	2	3	1	1	1	1	2	3	—	2	—	1	1	1	1
Megaspores of Lycopods . .	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Lepidostrobus .	1	2	3	2	1	—	1	2	—	1	1	1	1	2	2	1	1	2	4	3	1	1	1	2	2	1	—	1	1
Sigillariostrobus .	—	1	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Sigillaria Stems .	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Sigillariophyllum	1	1	—	—	—	—	2	1	1	—	—	1	—	—	—	1	—	1	—	—	—	—	—	—	—	—	—	—	—
Bothrostrobus .	—	—	—	—	—	—	—	1	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Lepidocystis . .	—	—	—	—	—	—	—	2	—	—	2	2	—	—	—	2	—	—	—	—	—	—	—	—	—	—	—	—	2
Halonia	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Sporangia of Lycopods . .	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—

Sigillarian Cone	—	—	—	—	—	—	1	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Neuropteris	8	8	9	7	2	4	4	5	7	5	8	4	1	3	2	3	1	2	7	2	1	5	8	2	6	5	2	5	4
Sphenopteris	1	5	2	3	—	1	2	1	6	2	9	2	1	1	—	1	1	1	1	—	—	—	4	—	1	1	3	2	1
Alethopteris	1	2	2	2	—	—	3	—	2	1	3	1	—	—	1	—	—	—	1	—	—	2	1	1	1	2	1	2	—
Pecopteris	4	8	6	3	—	1	1	3	2	3	3	—	—	—	1	—	1	1	—	—	—	—	2	—	—	—	—	1	—
Eupecopteris	1	1	1	1	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Mariopteris	3	2	2	2	—	2	1	1	2	2	4	2	1	1	3	—	1	—	1	1	1	1	2	1	2	1	2	3	—
Eremopteris	—	—	—	—	—	—	—	—	—	—	3	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Dactylotheca	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Spiropteris	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Holeospermum	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Dolerophyllum	2	2	1	—	—	1	1	2	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Crossotheca	—	—	—	—	—	—	—	—	1	2	2	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	2	—
Caulopteris	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Linopteris	—	—	—	2	—	—	—	—	—	1	1	—	—	1	—	1	—	—	—	—	—	—	—	—	—	—	—	1	—
Eremopteris	—	—	1	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	1	1	—	—	—	—
Renaultia	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—
Zileria	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	1	—
Aphlebia	—	1	—	—	—	—	—	—	—	1	—	—	—	—	1	3	—	—	—	—	—	—	—	—	—	—	—	—	—
Corynepteris	—	—	1	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—
Lagenospermum	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—
Odontopteris	1	1	1	1	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Rachis of Ferns and Fernlike Plants	1	1	—	1	1	—	1	1	—	1	—	1	1	—	—	1	1	—	—	1	—	—	1	1	1	1	1	1	1
Microspermum	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Cyclopteris	1	1	1	1	—	2	1	1	1	—	1	—	1	—	—	1	—	—	—	—	—	—	1	1	1	1	—	1	1
Scolecopteris	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Triginocarpus	1	1	1	—	—	—	1	—	—	—	2	1	—	1	—	—	—	—	—	1	—	1	—	—	1	—	—	1	1
Asterotheca	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Seeds	2	6	3	2	—	—	1	—	—	—	1	—	1	1	—	1	—	—	—	—	1	—	—	1	1	1	1	1	1
Neurospermum	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Alleiopteris	—	—	2	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Cordaite Leaves	1	2	4	3	1	1	3	3	3	—	1	2	1	1	2	1	2	2	—	1	—	1	—	1	1	2	1	1	1
Poa Cordaites	—	2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Artisia	—	1	—	1	1	—	1	—	2	—	1	—	1	—	—	—	—	—	—	1	—	—	—	1	1	1	—	1	1
Hysterites of Cordaites	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Samaropsis	1	1	1	—	—	—	2	3	1	—	—	—	—	1	1	—	1	1	1	—	—	—	—	—	1	1	—	—	—
Cordaicarpus	1	—	—	—	—	—	—	—	—	—	1	—	—	1	—	2	—	—	—	—	—	1	1	—	1	—	—	1	—
Cordianthus	—	—	—	—	—	—	1	1	1	—	—	—	1	—	—	—	—	2	—	—	—	—	—	—	—	—	—	—	—
Polypterocarpus	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	1	1	—	—	—	—	—	—	—	—	—
Seeds	—	1	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	1	—	—	1	1	—	—	—	—	—
Carpolithus	1	—	1	1	—	—	—	—	—	—	1	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	1	—
Cordaicladus	—	—	—	—	—	—	—	—	1	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—

V. Fauna.

Tabulation of Species and their Horizons.

(See Chart V, showing Distribution of Species.)

Annelida.

Class Chætopoda. Genus Spirorbis. Spirorbis sp. hor. 11–9 (S). Worm burrows, hor. 28 (W).

Arthropoda.

Class Arachnida? Order: Xiphosura. *Family:* Belinuridæ. *Genus Prestwichia* (Woodward). Prestwichia sp., hor. 11 (S).

Class Insecta. Genus Archimylacris (Scudder). *A.* (*Etoblattina*) *woodwardi* (Bolton) (type), hor. 9 (S). Archimylacris sp. (no specific determination made), hor. 17 (W), hor. 10–9 (S). *Genus Dictyoneura* sp. (Goldenberg). *Order:* Palæodictyoptera (Goldenberg) (Handlirsch). *Family:* Dictyoneuridæ (Handlirsch), hor. 25 (W). *Genus Fayolia.* (*c.f*) Fayolia, sp., hor. 2 (R).

Mollusca.

Class Lamellibranchia:—

Genus Carbonicola (M'Coy).

C. turgida (Brown), hor. 25–22–21 (W).
C. ovalis (Martin), hor. 25–22–21 (W).
C. aquilina (Sowerby), hor. 29–22–21–18 (W).
C. (*cf.*) *robusta* (Sowerby), hor. 24 (W).
C. sub-constricta (Sowerby), hor. 21 (W).
C. acuta (Sowerby) (var. *rhomboidalis*) (W. Hind), hor. 20 (W).
C. similis (Brown), hor. 20 (W).
Carbonicola sp. indet., hor. 17 (W), hor. 10–4 (S).

Genus Anthracomya (Salter).

A. modiolaris (Sowerby), hor. 26–25–20 (W).
A. (*cf.*) *modiolaris* (Sowerby), hor. 19 (W).
A. adamsi (Salter), hor. 22 (W).
A. phillipsi (Williamson), hor. 19 (W).
A. senex (Salter), hor. 22 (W).
A. wardi (Salter), hor. 21–20 (W), hor. 4 (S).
A. williamsoni (Brown), hor. 29 (W).
Anthracomya sp. indet., hor. 17 (W).

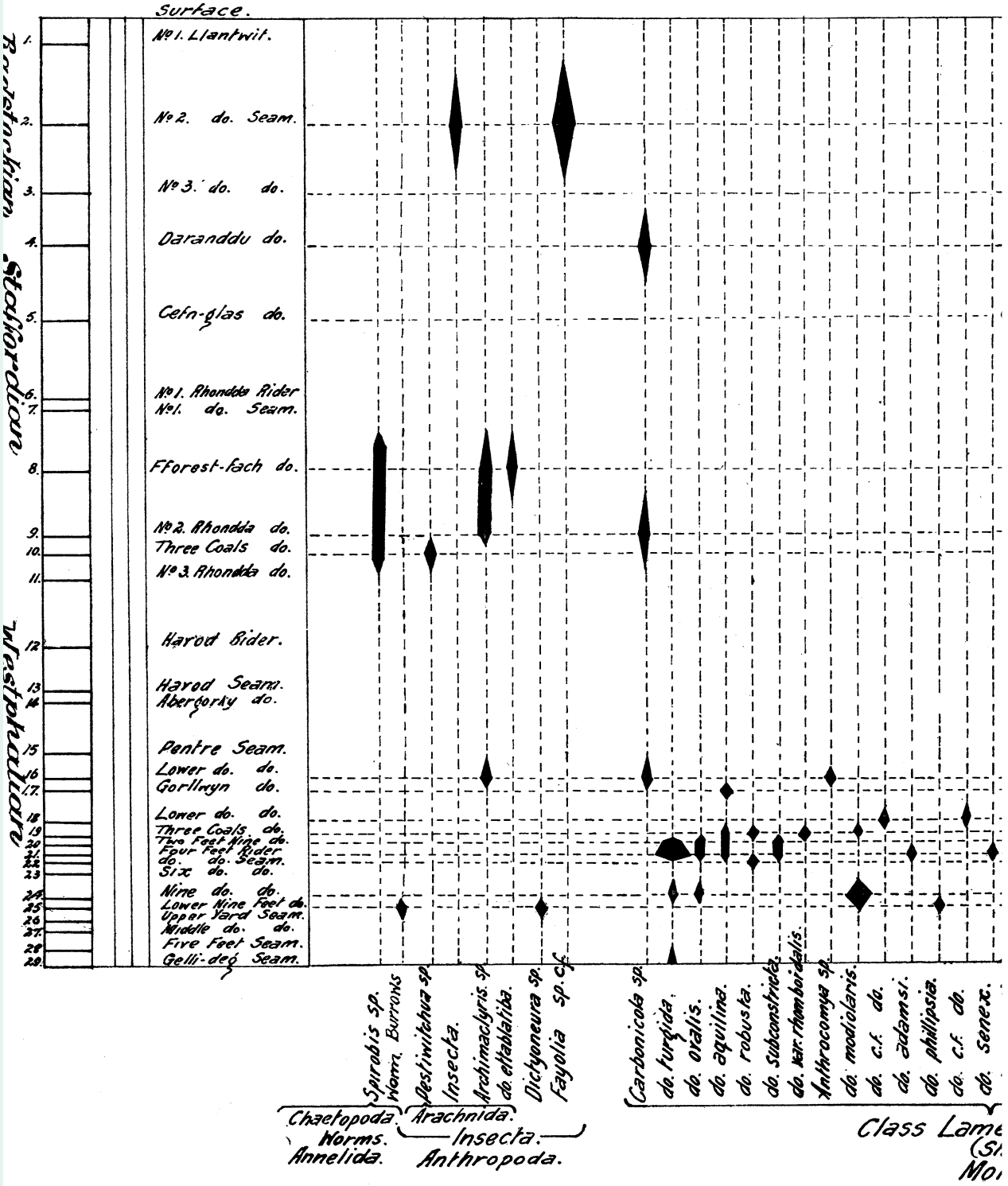

Chart V.—Tabulation of (Fauna) Species.

pecies.

Mollusca (continued).

Class Lamellibranchia (continued)—

Genus Naiadites (Dawson).

N. quadrata (Sowerby), hor. 25 (W).
N. modiolaris (Sowerby), hor. 25–22 (W).
N. triangularis (Sowerby), hor. 25–22 (W).
N. (*cf.*) *quadrata* (Sowerby), hor. 26 (W).
Naiadites sp. indet., hor. 21 (W).

Vertebrata (*Actinopterygii*).

Class Pisces, family *Palæoniscidæ. Genus Elonichthys: E. semistriatus* (Traquair), hor. 26 (W) (fish scale).

Order: Crossopterygii. Genus Strepsodus. S. sauroides (Binney), hor. 25 (W) (fish scale).

Genus Palæoxyris (*Vetacapsula*) (*cf.*) *Johnsoni* (Kidston). Palæoxyris sp., hor. 21 (W).

Notes on the Distribution of Carbonicola. Anthracomya and Naiadites.

Genus Carbonicola.—The different species which were specifically determined are limited in their range to the Westphalian Series and become numerous in two horizons, namely, the Four Feet and Four Feet "Rider" Seams. No fewer than six species occur between these two horizons, which are only separated by about 10 feet of a dark argillaceous shale. The genus is unusually abundant in the Two Feet Nine Seam—in a dark carbonaceous band replete with shells. No fewer than 78 were recorded from a small slab of shale, 12 inches long, 9 inches wide and 6 inches in depth.

Genus Anthracomya.—Few specimens of Anthracomya were found in the Westphalian Series, but they became particularly numerous in the Cefn Glas Seam of the Staffordian Series, where a dark band of shale occurs which is literally covered with their crushed shells. The band which lies directly on top of the coal seam is from 5 to 6 feet in thickness and of a dark carbonaceous character.

Genus Naiadites.—The Genus Naiadites has been found only in the Westphalian Series. In spite of close examination no specimen was found in the Staffordian or Radstockian Series.

General Remarks on the Lamellibranchs.

The three genera Carbonicola, Anthracomya and Naiadites have been found to occur together in the Lower Nine Feet Seam, which is almost the lowest horizon in the whole series. There is no evidence from the material available to indicate that Carbonicola preceded the other two genera. It is strange that no trace of any one of these genera has been found in the Radstockian Series.

VI. Deductions.

(See Chart VI at end, showing (*a*) Assumed land surface and sea floor; (*b*) Species of Plants of the different horizons; (*c*) Species of Plants of the different groups; (*d*) Lithological character of the Coal Measures.)

Changes in the Character of Seams.

Whether the coal seam itself belongs to the "Regional," "Split" or "Local" type, its mode of division varies from place to place. A coal seam may lack any dividing plane at one locality while at another it may be divided into two or more parts. Again, the division within the coal seam may be a clean bedding plane with little, if any, definite parting of clod, shale or rashes. This parting is often found dying away and then the two divisions of the coal seam coalesce forming a complete seam. Also, the bedding plane just referred to may form a parting by the gradual "wedging" in of clod, rashes, shale or sandstone. These dirt partings vary in thickness in small distances.

The process of thickening sometimes progresses so far that the seam is finally divided and in this manner becomes what has been termed the "Split" type of seam. How often the process of the "splitting" of an individual seam may occur is not known. The number of seams encountered in shaft-sections between any two known horizons certainly varies from place to place. This is due partly to the sub-division of the seams and partly to the incoming of "Rider" Seams.

The "Local" type of seam is, no doubt, a "Rider" seam, which thickens locally until it becomes of workable thickness. Only three such workable local seams can be traced with certainty, namely, the Cefn Glas Seam, Three Coal Seams (A), and the Lower Gorllwyn Seam, and as these seams are quite local, they naturally do not appear in many of the shaft-sections.

Each individual coal seam varies in the number of its coal divisions and also in the nature of the division itself. The greatest possible care must therefore be taken not to be misled when attempting to correlate the coal seams. Further, the strata intervening between the seams also vary in thickness, and the roof that immediately overlies a coal seam may change. Each individual stratum dovetails out gently or abruptly, the result being that a seam at one locality is overlaid by a roof of clod, at another by shale and at another by sandstone. The writer has found this to occur over the well-known seams and within a limited area.

Owing to changes in the character of the strata between the seams and to the dovetailing of the strata that form the roof, it is easy to be misled when attempting to correlate the various seams. Therefore, owing to these difficulties in correlating the seams, the writer has assigned a definite number to each individual horizon, in order to make the stratigraphical position of the seam as clear as possible and also to facilitate comparison.

It is noteworthy that however much the seam itself or the overlying strata may

change, the flooring or underclay beneath the seam maintains its lithological character with remarkable constancy. Not a single instance is known of any change in the character of the floor. Moreover, although drifted fragments of stigmarian roots occur now and again in shales overlying the seams, not a single example of drifted plants has been observed in the underclay. Stigmarian roots and rootlets are often, but not always, present in abundance, but no portions of any drifted plants. This confirms the view previously held by the writer, that the growth *in situ* theory is the only one that fits with the overwhelming evidence in its favour.

If the *in situ* hypothesis, or formation on the spot, is accepted, then it becomes clear that each seam which is "Regional," without any "Split" seam branching from it, must, after its formation, have been entirely submerged, prior to the formation of a subsequent overlying seam. Again the "Split" type of seam furnishes an instance of local subsidence having occurred, a portion of the vegetation that originally formed a land-surface becoming submerged. After the infilling of the submerged area, a second growth occurs on the new land-surface and this re-unites itself with that portion of the vegetable land-surface that remained stationary and formed the parent coal seam.

The duration of time during which the "Split" type of coal seam is forming after dividing itself from the "Parent" coal seam, equals the time of formation of the "Parent" seam where it has not divided in itself. The Nine Feet is known over a wide area, whereas the Lower Nine Feet Seam is known only in a limited area and is the lowest division of the three coals that constitute the Nine Feet Seam in its normal condition. In this case we have a submergence of a portion of the land-surface with the vegetation forming the lower division of the Three Coals under water, while the unsubmerged still remains a vegetable land-surface and represents the Nine Feet Seam when complete. Sediments are laid down in due course over the submerged vegetation followed by the infilling of the depressed area. A new land-surface follows, which is again clothed with a vegetation uniting itself with the continuous vegetation of the unsubmerged land-surface which forms the complete Nine Feet Seam.

In other words the time taken to form the Nine Feet Seam (where it is found with its three coals as one complete seam) equals the time taken to form the Lower Nine Feet Seam *plus* the time of infilling the depressed area with sediments to form a new land surface, *plus* also the time taken to form the next seam, which consists of the middle and upper portion of the Nine Feet Seam itself. It is known that between the lower and middle divisions the "wedge" of strata comes in. The middle and upper divisions of the divided seam are about twice the thickness of the lower division of the seam, and it is reasonable to infer that the lower division of the Nine Feet Seam represents a shorter period of time in formation than do the middle and upper divisions.

As further examples may be cited the Four Feet Seam with its "Rider," namely, the Four Feet Rider Seam and also the Two Feet Nine Seam with its "Rider," namely,

the Three Coals Seam (B). The Four Feet Seam and the Two Feet Nine Seam are of the " Regional " type and are known to persist over a wide area, whereas the upper divisions of the Four Feet Seam and the Two Feet Nine Seam, namely, the Four Feet " Rider " Seam and the Three Coals Seam (B) are known only in a limited area. Each of these two " Rider " Seams dies out locally.

The " Local " type of coal seams could only have been formed here and there on plots of emerged land-surfaces, such as may have appeared from time to time. The " Local " seams are always thin, and the inference is that not only was the land-surface of limited extent, but the duration of time of growth was also limited.

Lithological Character of the Strata.

Lithologically the Upper Pennant or Radstockian Series have been found to consist of 90 per cent. sandstone and 10 per cent. shale and underclay. The same figures hold good for the Staffordian or Lower Pennant Series. The Westphalian or White Ash Series shows a preponderance of shales over the sandstone and fireclay added together, the shales making up about 80 per cent. the thickness of the whole group.

Considering the strata in ascending order, shales dominate from the lowest coal seam, the Gellideg, up to the Cock Shot Rock (a hard siliceous sandstone) above the Gorllwyn Seam. Above the Cock Shot Rock shales continue to dominate in the strata between the seams until the No. 3 Rhondda Seam is reached at the base of the Staffordian Series.

Afterwards sandstone predominates overwhelmingly up to No. 1 Llantwit Seam. A thick band of shale overlies the sandstone that follows immediately above the No. 1 Llantwit Seam, thus showing the shales again recur at the highest point of the Coal Measure sequence.

Briefly stated, the first *episode* of sediments forming shale exists from the base of the Coal Measures until the Gorllwyn Seam is reached, thus forming 600 feet or more of strata. A second brief *episode* of sandstone deposits forms a persistent band of light yellow siliceous sandstone, which is regional in character, and this band extends over a wide area, the thickness of the sandstone strata being about 34 feet. A third *episode* of sediments forming shale afterwards follows until the No. 3 Rhondda Seam is reached. The thickness of strata in this episode is about 600 feet.

A fourth *episode* of sediments forming sandstone occurs until the No. 1 Llantwit Seam is reached, the thickness of strata here being 2,075 feet. A fifth *episode* of sediments forming shale and of a very brief character occurs at the very top of the Coal Measures, the thickness of strata being about 15 feet.

Ecology of Plants.

Taking the evidence of the whole 29 horizons examined, it was found that not only did certain classes dominate over others, but also that a certain genus dominated in each individual class of plants. The other genera decreased in number on each horizon in each of the four alphabetic groups taken to record the plants. It is remarkable how

few were the instances when the rate of decrease in number of the different genera *within a class* failed to behave in the manner described.

The best test for proving the similarity of the plants at three widely different points on the same seam was made on the No. 2 Llantwit Seam. As already recorded (in Part I), the seam was examined at three different localities, namely, Trefyrig (near Tonyrefail), Graiglas (near Gilfach Goch) and Glynogwr. Although the shales themselves differed in character at each of the localities mentioned, the plants were found more or less constant, whether the aspect of the classes themselves was considered or the different genera within each individual class.

The distance between the two farthest points mentioned, namely, Trefyrig and Glynogwr, was five miles. Whether this constancy holds good in the behaviour of the flora over even greater distances is not known; no test has been made to prove the constancy of the dominance of the plants of a class over an extensive area.

Another interesting feature comes to light. It was found that whenever the plants belonging to the class Lycopodiales assumed dominance over the other classes, without any exception the Filicales and Pteridosperms became few in number among the other classes. Conversely, the Lycopodiales became few in number whenever the Filicales and Pteridosperms became dominant. On the other hand, the Equisetales and Cordaitales seemed to maintain a numerical constancy, however much the other classes of plants reacted upon each other.

When a certain class assumed a dominance it was found that various parts of the plants to which separate generic names have been applied were also abundant. For instance, if the Equisetales dominated the other classes there would be an abundance of Calamites (stems, branch, foliage), Calamite cones (organs of reproduction) and Myrophyllites or Pinnularia (the roots).

Again, when the class Lycopodiales was found dominating there was abundant evidence of the Lepidodendron (stems) with their twigs and foliage attached, and even the cones of Lepidostrobus in organic union with the terminal end of the twigs. If the Filicales and Pteridosperms were found dominating, then it was found that *only* certain genera asserted themselves in great numbers. For instance, Neuropteris, generally speaking, seems to be the strongest representative of this class nearly throughout. If any fern or fernlike plants were present at all, Neuropteris would always be well represented, but the genera Mariopteris, Pecopteris, Sphenopteris and Alethopteris might be well represented or absent altogether on certain horizons.

Whenever the seeds of the Trigonocarpus occur in great number Alethopteris is always present in abundance. The association of Trigonocarpus with Alethopteris has been observed by other workers. Strange to say, although a great number of seeds have been seen—and sometimes as many as six or eight examples have been observed on the surface of a single slab of shale—with the fronds of Alethopteris lying close to the seeds themselves, yet there is not a single instance of Trigonocarpus occurring in organic union with the fronds of Alethopteris.

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When plants of the class Cordaitales showed themselves to be numerous or dominating, the leaves of Cordaites and the ovulate shoots of Cordaianthus and the seed Samaropsis were found to be common. It may also be mentioned that the Lamellibranchia were always found in great number on horizons where the Lycopodiales were found numerous or rampant. The shales on these horizons are invariably dark and carbonaceous in character. Moreover, although dark and even black shales were a common feature on certain other horizons, with the plants of the class Lycopodiales few in number and with the other different classes dominating the Lycopodiales, it was then found that the shells, if present at all, were very rare.

The probable causes that contributed to the alteration in the balance of distribution of the different classes of plants may now be considered. It is a reasonable inference that if the physical conditions affecting growth remained unchanged at any spot, the balance of the different classes of plants would not be altered at all. If a change in the classes of plants is found, it may therefore be taken to indicate a change in the physical conditions. One of the most probable of such changes would be a change in the relative height of land-surface above sea-level. The evidence of the different horizons as to whether the relative height of land-surface above sea-level is a factor in the causation of changed growth of different classes of plants will therefore be examined.

It is conceded by many authorites that plants of the class Lycopodiales were suited for *wet ground* or *marshy conditions*, and that plants of the class Equisetales would flourish in *damp places*, and that plants of the class Cordaitales were probably suited more or less for *dry conditions*, and that the class Filicales and Pteridosperms were suited best for *dry land-surfaces*.

Very little is known of the condition of growth of the Sphenophyllales, except that the slender plant "climbed" on the larger stems of plants of other classes. The present investigation shows that the Sphenophyllales were hardly ever present in the shales when plants of the class Lycopodiales were dominant. On the other hand, they were found in good number when fern and fernlike plants were numerous.

If the association of the different classes has any significance, this would seem to indicate that the Sphenophyllales were a class of plants adapted for dry-land conditions. Again, if the probable conditions of growth of the different classes of plants were as stated, we can regard the Lycopodiales as a *wet flora*, and the ferns and fernlike plants as representing the *dry flora*, the Equisetales as *damp flora*, and Cordaitales with greater power of adaptation as suited for both damp and dry conditions of growth.

The fact, as already stated, was that the two classes Lycopodiales and Filicales and Pteridosperms were found to re-act one upon the other, that is, the one class being almost absent when the other classes became dominant, and also the second fact that the Equisetales and Cordaitales were not influenced in a marked manner, whichever of the two classes, namely, the Filicales and Pteridosperms or the Lycopodiales were dominant.

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The two classes Equisetales and Cordaitales seem to hold a position for growth between the two extremes of *wet* and *dry*, represented by the Lycopodiales on the one hand and the Filicales and Pteridosperms on the other. Consequently, whatever alteration occurred in the relative height of the land-surface above the water-level, the Equisetales and Cordaitales always managed to maintain their existence in considerable numbers. The type of land-surface that prevailed during the deposition of the different sediments that form the strata between the twenty-nine coal seams must have varied considerably from time to time to cause the variations in the flora.

When the Lycopodiales—wet flora—dominated, we may reasonably assume that swampy or marshy conditions prevailed. Again, if elevated land prevailed we should get a different flora suited to drier conditions, the result being that dry flora would, in this circumstance, dominate the wet flora.

It is well to be guarded here, for even though elevated and dry conditions prevailed over the mainland area, the wet flora would still fringe the rivers and mouths of the deltas, and would always be in the most favoured position for transport of the plants to the delta, while the dry flora would be in a less favoured position, being more remote from the banks of rivers and the margins of the deltas. Notwithstanding these odds against the entombment of the dry flora they have easily defeated the wet flora in their dominance in the 29 horizons. This shows quite clearly that the idea that the coal age was a period of swampy conditions is erroneous. If the condition that held good in the past is true, why is it that the dry flora, as an extreme on the one hand, is far more numerous than is the wet flora on the other hand ?

A cycle of elevated land-surfaces evidently did exist—produced by an uplift too rapid for erosion to keep pace with it. If the rate of erosion of land-surface kept pace with the rate of uplift, then elevated land-surfaces would become an impossibility. On the other hand, a submerging land-surface produced a cycle of swampy conditions which occurred now and again, showing that earth movements were occurring then as now.

As there was no fixed relative elevation of sea-level to land surface throughout, there was no fixed and even distribution of plants of different classes as a result. In a brief cycle of depression it would show the Lycopodiales in the ascendant, while an opposite cycle of upraised land producing elevations would cause the ferns and fernlike plants to become dominant, whereas physical conditions between the swampy conditions and elevated land would produce a dominance of the two classes Equisetales and Cordaitales. Intermediary or normal flora prevailed between the two extremes, namely, the Lycopodiales and the Filicales and Pteridosperms.

If the premises stated above are justified, an approximately even balance of the four classes of plants, the Equisetales, the Lycopodiales, the Filicales and Pteridosperms and the Cordaitales, would indicate swampy conditions limited in area, with a larger area of damp and slightly elevated land surface, and a still larger area of more elevated land surface. Such conditions would enable the Filicales and Pteridosperms, the least

favoured from the standpoint of transportation, to hold their own in balance of distribution among the other classes.

It will be well to show in tabular form the percentage of the different classes of plants for each individual horizon, and to indicate the probable physical aspect of the land surfaces from which the plants were derived.

HORIZON PERCENTAGES AND PHYSICAL CONDITIONS.

Horizon No.	Name of Seam.	Percentage Composition of Flora.	Probable Physical Conditions.
29	Gellideg	Equisetales . . . 39·61 per cent. Sphenophyllales . 0·02 ,, Lycopodiales . . 1·70 ,, Filicales and Pteridosperms . . 54·45 ,, Cordaitales . . . 4·22 ,,	A large extent of dry and uplands. Lycopodiales weak, indicating very limited area of swampy conditions.
28	Five Feet . . .	Equisetales . . . 30·34 per cent. Sphenophyllales . Nil. Lycopodiales . . 0·21 ,, Filicales and Pteridosperms . 24·46 ,, Cordaitales . . . 43·83 ,,	Conditions more or less similar to those of the previous stage—but the elevation perhaps not so great as indicated by the smaller percentage of Filicales and Pteridosperms.
27	Middle Yard . .	Equisetales . . . 72·96 per cent. Sphenophyllales . 0·18 ,, Lycopodiales . . 0·49 ,, Filicales and Pteridosperms . . 24·41 ,, Cordaitales . . . 1·35 ,,	Conditions closely allied to those of the Five Feet Seam. The Lycopodiales are rare and dry. Land vegetation is fairly strong in evidence.
26	Upper Yard (or Bute)	Equisetales . . . 31·30 per cent. Sphenophyllales . Nil. Lycopodiales . . 10·60 ,, Filicales and Pteridosperms . . 40·60 ,, Cordaitales . . . 17·50 ,,	A slight increase of dry land conditions. The fern and fern-like plants increase, accompanied by more swampy areas.
25	Lower Nine Feet	Equisetales . . . 68·66 per cent. Sphenophyllales . 0·12 ,, Lycopodiales . . 17·44 ,, Filicales and Pteridosperms . . 11·36 ,, Cordaitales . . . 2·42 ,,	A marked decrease of Filicales and Pteridosperms—and an increasing number of Lycopodiales suggest less elevated land and an increase of swampy areas.
24	Nine Feet . . .	Equisetales . . . 49·74 per cent. Sphenophyllales . Nil. Lycopodiales . . 3·33 ,, Filicales and Pteridosperms . . 27·55 ,, Cordaitales . . 17·03 ,,	Swampy areas less prevalent. Low altitudes of land surface favouring the damp flora, such as the Lycopodiales and probably the Cordaitales.

HORIZON PERCENTAGES AND PHYSICAL CONDITIONS (continued).

Horizon No.	Name of Seam.	Percentage Composition of Flora.	Probable Physical Conditions.
23	Six Feet	Equisetales . . . 39·34 per cent. Sphenophyllales . Nil. Lycopodiales . . 0·44 ,, Filicales and Pteridosperms . . 43·77 ,, Cordaitales . . . 14·15 ,,	A period of elevation of land surface. The fern and fern-like plants dominating the other classes of plants. Swampy areas restricted.
22	Four Feet . . .	Equisetales . . . 68·71 per cent. Sphenophyllales . 1·76 ,, Lycopodiales . . 9·19 ,, Filicales and Pteridosperms . . 17·31 ,, Cordaitales . . . 3·03 ,,	Lowland conditions with an increasing swampy area. The damp and wet Flora easily preponderate over the dry Flora due to a depression of land surface.
21	Four Feet "Rider"	Equisetales . . . 62·02 per cent. Sphenophyllales . 0·18 ,, Lycopodiales . . 19·67 ,, Filicales and Pteridosperms . . 16·40 ,, Cordaitales . . . 1·73 ,,	Lowland with damp conditions for growth still prevailing with an increased area of marshy conditions. Lycopodiales gaining in number.
20	Two Feet Nine .	Equisetales . . . 5·96 per cent. Sphenophyllales . Nil. Lycopodiales . . 66·38 ,, Filicales and Pteridosperms . . 1·70 ,, Cordaitales . . . 25·13 ,,	The inference here is that there was an extensive lowland surface with hugh marshes. The uplands were small in area, therefore the fern and fern-like plants were feeble, as the evidence shows.
19	Three Coals (B)	Equisetales . . . 60·12 per cent. Sphenophyllales . 0·02 ,, Lycopodiales . . 23·32 ,, Filicales and Pteridosperms . . 16·04 ,, Cordaitales . . . 1·50 ,,	Swampy conditions, becoming less in extent here. Lowland with damp places increasing and also an increase here and there in the amount of elevated land.
18	Lower Gorllwyn	Equisetales . . . 1·47 per cent. Sphenophyllales . Nil. Lycopodiales . . 48·51 ,, Filicales and Pteridosperms . . 5·60 ,, Cordaitales . . . 44·42 ,,	Dry and lowland conditions in wide areas. Also an extensive marshy land surface, as the Lycopodiales are strong in evidence.
17	Gorllwyn	Equisetales . . . 94·03 per cent. Sphenophyllales . 0·03 ,, Lycopodiales . . 0·19 ,, Filicales and Pteridosperms . . 5·63 ,, Cordaitales . . . 0·12 ,,	Damp and lowland surface with very few swamps and also with but slight elevations of surface. It will be observed the two extreme Floras (Wet and Dry Flora), namely, the Lycopodiales and Filicales and Pteridosperms are but feebly in evidence.

HORIZON PERCENTAGES AND PHYSICAL CONDITIONS (continued).

Horizon No.	Name of Seam.	Percentage Composition of Flora.	Probable Physical Conditions.
16	Lower Pentre	Equisetales . . . 47·18 per cent. Sphenophyllales . 9·33 ,, Lycopodiales . . 5·14 ,, Filicales and Pteridosperms . . 37·05 ,, Cordaitales . . . 1·30 ,,	Elevated land surfaces are now showing themselves with large stretches of lowland and with a considerable area of damp conditions.
15	Pentre	Equisetales . . . 25·99 per cent. Sphenophyllales . 6·49 ,, Lycopodiales . . 38·79 ,, Filicales and Pteridosperms . . 9·97 ,, Cordaitales . . . 18·68 ,,	Lowland surfaces with dry and damp areas and large bordering marshes. The elevated surfaces could not have been extensive because the fern and fernlike plants are weak in evidence.
14	Abergorky . . .	Equisetales . . 82·41 per cent. Sphenophyllales . 0·40 ,, Lycopodiales . . 0·21 ,, Filicales and Pteridosperms . . 5·13 ,, Cordaitales . . . 9·60 ,,	Wide and extensive lowland, with the major portion of its surface of a damp nature. Very few marshes and also very few elevations of surface.
13	Hafod	Equisetales . . . 83·70 per cent. Sphenophyllales . 0·03 ,, Lycopodiales . . 4·63 ,, Filicales and Pteridosperms . . 8·83 ,, Cordaitales . . . 2·78 ,,	The surface condition at this stage closely resembled the preceding one. There is evidence of a slight increase of swampy areas. The Lycopodiales are now increasing in number.
12	Hafod " Rider "	Equisetales . . . 44·42 per cent. Sphenophyllales . 0·24 ,, Lycopodiales . . 11·70 ,, Filicales and Pteridosperms . . 40·68 ,, Cordaitales . . . 2·96 ,,	A period of upraised land surface forming elevations to a marked degree. The lowland is damp in wide areas and bordered here and there by marshes.
11	No. 3 Rhondda .	Equisetales . . . 37·19 per cent. Sphenophyllales . 1·09 ,, Lycopodiales . . 0·25 ,, Filicales and Pteridosperms . . 42·13 ,, Cordaitales . . . 20·10 ,,	Elevated land surface still persisting with damp and dry areas on lowlands. The swampy areas must have been limited, hence the Lycopodiales being rarely in evidence.
10	Three Coals (A)	Equisetales . . . 40·42 per cent. Sphenophyllales . 0·57 ,, Lycopodiales . . 1·14 ,, Filicales and Pteridosperms . . 51·40 ,, Cordaitales . . . 6·47 ,,	Elevation of land surface occurring to a marked degree. The fern and fernlike plants are now rampant with a small area of swampy conditions. The Lycopodiales are very feebly in evidence.

HORIZON PERCENTAGES AND PHYSICAL CONDITIONS (continued).

Horizon No.	Name of Seam.	Percentage Composition of Flora.	Probable Physical Conditions.
9	No. 2 Rhondda .	Equisetales . . . 41·56 per cent. Sphenophyllales . 6·64 ,, Lycopodiales . . 1·23 ,, Filicales and Pteridosperms . . 35·89 ,, Cordaitales . . . 14·68 ,,	The height of land surface slightly decreasing as compared with the preceding conditions of the last horizon. Marshy conditions more or less similar in both cases.
8	Fforest Fach . .	Equisetales . . . 27·83 per cent. Sphenophyllales . 3·35 ,, Lycopodiales . . 0·85 ,, Filicales and Pteridosperms . . 51·35 ,, Cordaitales . . . 16·62 ,,	A recurrence of high land surface causing the fern and fernlike plants to flourish in a luxuriant manner, only very restricted areas being of a marshy nature, as the Lycopodiales are now almost absent.
7	No. 1 Rhondda .	Equisetales . . . 36·24 per cent. Sphenophyllales . 1·87 ,, Lycopodiales . . 4·06 ,, Filicales and Pteridosperms . . 23·02 ,, Cordaitales . . . 36·68 ,,	The upraised land surface is becoming less here—the dry and damp places in the lowland almost balance, as the Equisetales and Cordaitales show in evidence. Marshy areas still limited.
6	No. 1 Rhondda, "Rider"	Equisetales . . . 88·69 per cent. Sphenophyllales . 0·01 ,, Lycopodiales . . 0·14 ,, Filicales and Pteridosperms . . 11·01 ,, Cordaitales . . . 0·15 ,,	A period of lowland surface with damp conditions over an extensive area. Swamps very restricted and the elevations also found only here and there.
5	Cefn Glas . . .	Equisetales . . . 26·50 per cent. Sphenophyllales . Nil. Lycopodiales . . 37·00 ,, Filicales and Pteridosperms . . 11·90 ,, Cordaitales . . . 24·60 ,,	Swampy conditions prevail, with lowland of dry and damp conditions almost evenly balanced —with but a small number of elevations of surface, as the fern and fernlike plants are now scarce.
4	Darran Ddu . .	Equisetales . . . 21·98 per cent. Sphenophyllales . 2·65 ,, Lycopodiales . . 2·65 ,, Filicales and Pteridosperms . . 64·09 ,, Cordaitales . . . 11·08 ,,	A marked period of extreme elevation of land surface. The fern and fernlike plants are at their zenith. Swampy condition comparatively small in area. Lycopodiales consequently weak in evidence.
3	No. 3 Llantwit .	Equisetales . . . 21·93 per cent. Sphenophyllales . 0·85 ,, Lycopodiales . . 5·63 ,, Filicales and Pteridosperms . . . 66·25 ,, Cordaitales . . . 5·34 ,,	Here again is shown a continuance of the physical conditions that prevailed in the preceding horizon. The increased number of Lycopodiales here show more marshy conditions.

HORIZON PERCENTAGES AND PHYSICAL CONDITIONS (continued).

Horizon No.	Name of Seam.	Percentage Composition of Flora.	Probable Physical Conditions.
2	No. 2 Llantwit .	Equisetales . . . 36·42 per cent. Sphenophyllales . 4·98 ,, Lycopodiales . . 1·60 ,, Filicales and Pteridosperms . 56·19 ,, Cordaitales . . . 0·81 ,,	High elevations of land surface still prevailing with lowland of a damp character. The marshes are again very restricted in area.
1	No. 1 Llantwit .	Equisetales . . . 24·05 per cent. Sphenophyllales . 0·18 ,, Lycopodiales . . 12·89 ,, Filicales and Pteridosperms . . 62·09 ,, Cordaitales . . . 0·79 ,,	A continuance of upraised land surface showing the fern and fernlike plants flourishing in luxuriance. An increased area of marshes as the Lycopodiales are increasing in their number.

(See (*a*) Chart VI.)

PHILOSOPHICAL TRANSACTIONS OF THE ROYAL SOCIETY B BIOLOGICAL SCIENCES

PHILOSOPHICAL TRANSACTIONS OF THE ROYAL SOCIETY B BIOLOGICAL SCIENCES

TABLE C, showing Series, Horizons and Dominant Forms.

Radstockian Series East Glamorgan Coalfield.

Llantwit or Upper Pennant Series.

Horizon.	Mean Thickness of Seam.	Mean Thickness of Strata to Seam above.	Thickness in Feet and relative Percentage to Total Thickness of Strata.						Dominant Class and Terms Per Cent.		Dominant Genus in each Class and Terms Per Cent.		
			Shale.		Sandstone.		Fireclay.		Class.	Per Cent.	Class.	Genus.	Per Cent.
			Feet.	Per cent.	Feet.	Per cent.	Feet.	Per cent.					
No. I . .	2 feet 10 inches	100 feet to surface	30	*30*	50	*50*	20	*20*	Filicales and Pteridosperms	*62·08*	Equisetales . . Sphenophyllales Lycopodiales . Filicales and Pteridosperms Cordaitales . .	Asterophyllites Sphenophyllum Lepidodendron Neuropteris . . Cordaite Leaves	*46·13* *100·00* *70·20* *70·09* *99·12*
No. II . .	4 feet 6 inches	300 feet	9	*3*	285	*95*	6	*2*	Filicales and Pteridosperms	*56·19*	Equisetales . Sphenophyllales Lycopodiales . Filicales and Pteridosperms Cordaitales . .	Asterophyllites . Sphenophyllum Lepidophyllum Neuropteris . . Cordaite Leaves	*66·08* *100·00* *70·41* *49·04* *89·16*
No. III . .	3 feet	270 feet	8	*3*	257	*95*	5	*2*	Filicales and Pteridosperms	*66·25*	Equisetales . . Sphenophyllales Lycopodiales . Filicales and Pteridosperms Cordaitales . .	Asterophyllites Sphenophyllum Sigillaria . . . Neuropteris . . Cordaite Leaves	*59·26* *100·00* *48·37* *57·15* *98·16*
Coal Seams, 3	Total Thickness of Coal Seams, 10 feet 4 inches	Total Strata, 670 feet	Total, 47 feet	*7*	Total, 592 feet	*89·8*	Total, 31 feet	*3·20*	Note the dominance of Filicales and Pteridosperms (Dry Flora)				

PHILOSOPHICAL TRANSACTIONS OF THE ROYAL SOCIETY B BIOLOGICAL SCIENCES

Table C (continued).

Staffordian Series—East Glamorgan Coalfield.

Lower Pennant Series.

Horizon	Mean Thickness of Seam.	Mean Thickness of Strata to Seam above.	Thickness in Feet and relative Percentage to Total Thickness of Strata.						Dominant Class and Terms Per Cent.		Dominant Genus in each Class and Terms Per Cent.		
			Shale.		Sandstone.		Fireclay.		Class.	Per Cent.	Class.	Genus.	Per Cent.
			Feet.	Per cent.	Feet.	Per cent.	Feet.	Per cent.					
No. IV . .	4 feet 3 inches	180 feet	6	*3·3*	166	*92·3*	8	*4·4*	Filicales and Pteridosperms	*64·09*	Equisetales . . Sphenophyllales Lycopodiales . Filicales and Pteridosperms Cordaitales . .	Asterophyllites Sphenophyllum Lepidophyllum Neuropteris . . Cordaite Leaves	*43·16* *100·00* *44·03* *67·07* *99·05*
No. V . .	4 feet 1 inch	270 feet	3	*1·15*	262	*97·00*	5	*1·85*	Lycopodiales	*37·00*	Equisetales . . Sphenophyllales Lycopodiales . Filicales and Pteridosperms Cordaitales . .	Asterophyllites Nil Lepidodendron Neuropteris . . Cordaite Leaves	*88·30* — *88·80* *82·01* *99·39*
No. VI .	2 feet	300 feet	5	*1·66*	290	*96·68*	5	*1·66*	Equisetales .	*88·69*	Equisetales . . Sphenophyllales Lycopodiales . Filicales and Pteridosperms Cordaitales . .	Asterophyllites Sphenophyllum Lepidodendron Neuropteris . . Cordaite Leaves	*42·56* *1 specimen only* *37·00* *86·07* *100·00*
No. VII .	2 feet 7 inches	21 feet	5	*24·0*	13	*62·00*	3	*14·00*	Cordaitales .	*36·68*	Equisetales . . Sphenophyllales Lycopodiales . Filicales and Pteridosperms Cordaitales . .	Asterophyllites Sphenophyllum Sigillaria . . . Neuropteris . . Cordaite Leaves	*54·77* *100·00* *79·51* *73·56* *99·38*

PHILOSOPHICAL TRANSACTIONS OF THE ROYAL SOCIETY B BIOLOGICAL SCIENCES

No. VIII .	2 feet 10 inches	225 feet	6	*2·70*	215	*95·50*	4	*1·80*	Filicales and Pteridosperms	*51·35*	Equisetales . .	Asterophyllites	*44·33*
											Sphenophyllales	Sphenophyllum	*100·00*
											Lycopodiales .	Sigillaria . . .	*73·75*
											Filicales and Pteridosperms	Neuropteris . .	*76·34*
											Cordaitales . .	Cordaite Leaves	*96·60*
No. IX .	4 feet 3 inches	75 feet	6	*8·00*	65	*86·67*	4	*5·33*	Equisetales .	*41·56*	Equisetales . .	Asterophyllites	*37·55*
											Sphenophyllales	Sphenophyllum	*100·00*
											Lycopodiales .	Lepidodendron	*59·20*
											Filicales and Pteridosperms	Neuropteris . .	*73·87*
											Cordaitales . .	Cordaite Leaves	*94·80*
No. X . .	2 feet 8 inches	75 feet	20	*26·66*	51	*68·00*	4	*5·34*	Filicales and Pteridosperms	*51·40*	Equisetales . .	Asterophyllites	*43·64*
											Sphenophyllales	Sphenophyllum	*100·00*
											Lycopodiales .	Lepidodendron	*65·56*
											Filicales and Pteridosperms	Neuropteris . .	*61·37*
											Cordaitales . .	Cordaite Leaves	*99·39*
No. XI .	2 feet 4 inches	239 feet	12	*5·00*	222	*93·00*	5	*2·00*	Filicales and Pteridosperms	*40·43*	Equisetales . .	Asterophyllites	*34·81*
											Sphenophyllales	Sphenophyllum	*100·00*
											Lycopodiales .	Sigillaria . . .	*64·28*
											Filicales and Pteridosperms	Neuropteris . .	*32·36*
											Cordaitales . .	Cordaite Leaves	*97·14*
Coal Seams, 8	Total, 25 feet	Total, 1,385 feet	Total, 63 feet	*Average per cent. 4·54*	Total, 1,284 feet	*Average per cent. 92·72*	Total, 38 feet	*Average per cent. 2·74*					

PHILOSOPHICAL TRANSACTIONS OF THE ROYAL SOCIETY B BIOLOGICAL SCIENCES

Table C (continued).

Westphalian or White Ash Series. East Glamorgan Coalfield.

Horizon.	Mean Thickness of Seam.	Mean Thickness of Strata to Seam above.	Thickness in Feet and relative Percentage to Total Thickness of Strata.						Dominant Class and Terms Per Cent.		Dominant Genus in each Class and Terms Per Cent.		
			Shale.		Sandstone.		Fireclay.		Class.	Per Cent.	Class.	Genus.	Per Cent.
			Feet.	Per cent.	Feet.	Per cent.	Feet.	Per cent.					
No. XII .	1 foot 8 inches	177 feet	164	*92·5*	9	*5·0*	4	*2·5*	Equisetales .	*44·42*	Equisetales . .	Asterophyllites	*59·41*
											Sphenophyllales	Sphenophyllum	*100·00*
											Lycopodiales .	Sigillaria . . .	*50·83*
											Filicales and Pteridosperms	Neuropteris . .	*45·30*
											Cordaitales . .	Cordaite Leaves	*100·00*
No. XIII .	2 feet 9 inches	30 feet	24	*80·0*	—	—	6	*20·0*	Equisetales .	*83·73*	Equisetales . .	Asterophyllites	*72·20*
											Sphenophyllales	Sphenophyllum	*4 specimens only*
											Lycopodiales .	Lepidodendron	*61·58*
											Filicales and Pteridosperms	Neuropteris . .	*13·76*
											Cordaitales . .	Cordaite Leaves	*96·83*
No. XIV .	2 feet 1 inch	183 feet	167·5	*91·5*	9·5	*5·2*	6	*3·3*	Equisetales .	*84·29*	Equisetales . .	Asterophyllites	*63·25*
											Sphenophyllales	Sphenophyllum	*100·00*
											Lycopodiales .	Stigmaria . . .	*only 9 specimens in class.*
											Filicales and Pteridosperms	Neuropteris . .	*30·75*
											Cordaitales . .	Cordaite Leaves	*96·00*
No. XV .	3 feet 1 inch	112 feet	72	*64·0*	32	*28·8*	8	*7·2*	Lycopodiales	*38·79*	Equisetales . .	Asterophyllites	*52·98*
											Sphenophyllales	Sphenophyllum	*100·00*
											Lycopodiales .	Lepidodendron	*53·05*
											Filicales and Pteridosperms	Mariopteris . .	*15·60*
											Cordaitales . .	Cordaite Leaves	*98·94*

PHILOSOPHICAL TRANSACTIONS OF THE ROYAL SOCIETY B BIOLOGICAL SCIENCES

No. XVI	2 feet 4 inches	21 feet	15	*71·4*	3	*14·3*	3	*14·3*	Equisetales	*47·18*	Equisetales Sphenophyllales Lycopodiales Filicales and Pteridosperms Cordaitales	Calamites Sphenophyllum Sigillaria Neuropteris Cordaite Leaves	*37·08* *100·00* *30·38* *48·65* *100·00*
No. XVII	2 feet 1 inch	172 feet	112	*65·0*	34	*20·0*	26	*15·0*	Equisetales	*94·03*	Equisetales Sphenophyllales Lycopodiales Filicales and Pteridosperms Cordaitales	Asterophyllites Sphenophyllum Sigillaria Neuropteris Cordaite Leaves	*61·25* *Only 7 species.* *44·18* *48·15* *Only 25 specimens in Class.*
No. XVIII	1 foot 3 inches	104 feet	87	*84·0*	12	*11·0*	5	*5·0*	Lycopodiales	*48·51*	Equisetales Sphenophyllales Lycopodiales Filicales and Pteridosperms Cordaitales	Asterophyllites (Absent) Lepidodendron Mariopteris (very rare) Cordaite Leaves	*73·27* — *65·43* *1·15* *57·26*
No. XIX	3 feet 7 inches	160 feet	32	*57·0*	21	*37·0*	3	*6·0*	Equisetales	*60·12*	Equisetales Sphenophyllales Lycopodiales Filicales and Pteridosperms Cordaitales	Asterophyllites Sphenophyllum Sigillaria Neuropteris Cordaite Leaves	*62·99* *2 specimens only.* *61·20* *74·81* *98·24*
No. XX	3 feet 5 inches	170 feet	8	*80·0*	—	—	2	*20·0*	Lycopodiales	*66·69*	Equisetales Sphenophyllales Lycopodiales Filicales and Pteridosperms Cordaitales	Calamites (Absent) Lepidodendron Neuropteris Cordaite Leaves	*92·85* — *69·20* *79·17* *98·88*
No. XXI	1 foot 8 inches	37 feet	33	*86·5*	—	—	4	*13·5*	Equisetales	*62·03*	Equisetales Sphenophyllales Lycopodiales Filicales and Pteridosperms Cordaitales	Asterophyllites Sphenophyllum Lepidodendron Neuropteris Cordaite Leaves	*58·92* *25 specimens only.* *56·68* *12·15* *19 specimens only.*

PHILOSOPHICAL TRANSACTIONS OF THE ROYAL SOCIETY B BIOLOGICAL SCIENCES

Table C (continued).

Westphalian or White Ash Series. East Glamorgan Coalfield.

Horizon.	Mean Thickness of Seam.	Mean Thickness of Strata to Seam above.	Thickness in Feet and relative Percentage to Total Thickness of Strata.						Dominant Class and Terms Per Cent.		Dominant Genus in each Class and Terms Per Cent.		
			Shale.		Sandstone.		Fireclay.		Class.	Per Cent.	Class.	Genus.	Per Cent.
			Feet.	Per cent.	Feet.	Per cent.	Feet.	Per cent.					
No. XXII	6 feet 5 inches	10 feet	8	*80·0*	—	—	2	*20·0*	Equisetales .	*68·71*	Equisetales . .	Asterophyllites	*69·88*
											Sphenophyllales	Sphenophyllum	*100·00*
											Lycopodiales .	Lepidodendron	*60·93*
											Filicales and Pteridosperms	Neuropteris . .	*35·53*
											Cordaitales . .	Cordaite Leaves	*99·34*
No. XXIII	7 feet	66 feet	48	*80·0*	3	*5·0*	15	*15·0*	Filicales and Pteridosperms	*44·36*	Equisetales . .	Asterophyllites	*91·08*
											Sphenophyllales	(Absent)	—
											Lycopodiales .	Lepidodendron	*53·12*
											Filicales and Pteridosperms	Neuropteris . .	*95·36*
											Cordaitales . .	Cordaite Leaves	*99·50*
No. XXIV	9 feet 6 inches	120 feet	76	*61·0*	14	*13·0*	30	*26·0*	Equisetales .	*50·93*	Equisetales . .	Asterophyllites	*72·14*
											Sphenophyllales	(Absent)	—
											Lycopodiales .	Lepidodendron	*71·94*
											Filicales and Pteridosperms	Neuropteris . .	*96·97*
											Cordaitales . .	Cordaite Leaves	*98·23*
No. XXV	4 feet 6 inches	30 feet	22	*73·33*	—	—	8	*26·67*	Equisetales .	*68·66*	Equisetales . .	Myrophyllites .	*54·11*
											Sphenophyllales	Sphenophyllum	*100·00*
											Lycopodiales .	Lepidodendron	*85·62*
											Filicales and Pteridosperms	Neuropteris . .	*47·65*
											Cordaitales . .	Cordaite Leaves	*98·62*
No. XXVI	4 feet 9 inches	90 feet	39·6	*66·0*	7·2	*12·0*	13·2	*22·0*	Filicales and Pteridosperms	*40·61*	Equisetales . .	Calamites . . .	*59·61*
											Sphenophyllales	(Absent)	—
											Lycopodiales .	Lepidodendron	*88·38*
											Filicales and Pteridosperms	Neuropteris . .	*49·94*
											Cordaitales . .	Cordaite Leaves	*99·64*

PHILOSOPHICAL TRANSACTIONS OF THE ROYAL SOCIETY B BIOLOGICAL SCIENCES

No. XXVII	3 feet 6 inches	33 feet	20	*60·6*	5	*15·2*	8	*24·2*	Equisetales .	*72·19*	Equisetales . .	Asterophyllites	*50·35*
											Sphenophyllales	Sphenophyllum	*11 specimens only.*
											Lycopodiales .	Stigmaria . . .	*29 specimens only.*
											Filicales and Pteridosperms	Sphenopteris .	*21·46*
											Cordaitales . .	Cordaite Leaves	*100·00*
No. XXVIII	5 feet 6 inches	51 feet	34	*66·0*	7	*14·0*	10	*20·0*	Cordaitales .	*44·35*	Equisetales . .	Calamites . . .	*55·16*
											Sphenophyllales	(Absent)	—
											Lycopodiales .	Lepidodendron	*4 specimens only.*
											Filicales and Pteridosperms	Alethopteris .	*40·39*
											Cordaitales . .	Cordaite Leaves	*99·85*
No. XXIX	4 feet 6 inches	30 feet	18	*60·0*	3	*10·0*	9	*30·0*	Filicales and Pteridosperms	*54·45*	Equisetales . .	Myrophyllites .	*52·96*
											Sphenophyllales	Sphenophyllum	*4 specimens only.*
											Lycopodiales .	Lepidodendron	*52·22*
											Filicales and Pteridosperms	Neuropteris . .	*66·85*
											Cordaitales . .	Cordaite Leaves	*99·88*
Total Horizons.	*Total Mean Thickness of 18 Seams.*	*Total Thickness of Strata.*											
			Total.		Total.		Total.						
18	*68 feet 7 inches*	*1,302 feet (434 yards)*	980·1	*75·3*	159·7	*12·3*	162·2	*12·4*					

Equisetales dominate	*11 times.*
Lycopodiales dominate	*3* ,,
Filicales and Pteridosperms dominate .	*3* ,,
Cordaitales dominate	*1* ,,
Total . . .	18 ,,

Base of Westphalian or White Ash Series, resting on Millstone Grit.

PHILOSOPHICAL TRANSACTIONS OF THE ROYAL SOCIETY B BIOLOGICAL SCIENCES

The Radstockian or Upper Pennant—The Staffordian or Lower Pennant and Westphalian or White Ash Series.

Series.	No. of Seams.	No. of Localities.	Total Thickness of Coal Seams.	Total Thickness of Strata.	Total Thickness in Feet, and relative Percentage to Total Thickness of Strata in each case.						Blocks of Shale Examined.	Individual Split Surfaces Examined.	Total Plants Recorded.	Number of Times each Class Dominates.		Dominant Genus.	
					Shale.		Sandstone.		Fireclay.								
					Feet.	Per cent.	Feet.	Per cent.	Feet.	Per cent.							
Radstockian or Upper Pennant	3	6	10 ft. 4 ins.	670 ft. or 233·3 yds.	47	*7*	592	*89·90*	31	*3·10*	1,557	7,214	48,516	Filicales and Pteridosperms . .	3	*Sphenophyllum*	*3 times.*
																Lepidodendron } *Sigillaria* . . } *Lepidophyllum*	*Once each*
																Neuropteris .	*3 times.*
															3	*Cordaite Leaves*	*3* ,,
Staffordian or Lower Pennant	8	8	25 ft. 0 ins.	1,358 ft. or 461·66 yds.	63	*4·54*	1,284	*92·73*	38	*2·74*	3,938	17,079	111,666	Filicales and Pteridosperms	4	*Asterophyllites*	*8 times.*
														Equisetales .	2	*Sphenophyllales*	*7 appear*
														Lycopodiales	1	*Lepidodendron*	*4 times.*
														Cordaitales .	1	*Neuropteris* .	*8* ,,
																Cordaite Leaves	*8* ,,
															8		
Westphalian or White Ash	18	6	68 ft. 7 ins.	1,302 ft. or 434 yds.	980·1	*75·3*	159·7	*12·3*	162·2	*12·4*	13,154	42,250	229,801	Equisetales .	11	*Asterophyllites*	*12 times.*
														Lycopodiales	3	*Sphenophyllum*	*12* ,,
														Filicales and Pteridosperms	3	*Lepidodendron*	*13* ,,
																Neuropteris .	*15* ,,
														Cordaitales .	1	*Cordaite Leaves*	*18* ,,
															18		
Total .	29	20	103·11 ft.	3,357 ft. or 1,119 yds.	1,090·1	*32·47*	2,035·7	*60·64*	231·2	*6·99*	18,649	66,543	389,983	Equisetales .	13	*Asterophyllites*	*23 times.*
														Filicales and Pteridosperms	10	*Sphenophyllum*	*22* ,,
														Lycopodiales	4	*Lepidodendron*	18 ,,
														Cordaitales .	2	*Neuropteris* .	*26* ,,
																Cordaite Leaves	*29* ,,
															29		

The total thickness of Coal and Strata examined equals 3,460 feet 11 inches, or 1,153 yards 1 foot.

Conclusion.

It becomes evident, from the composition of the different floras, that changes occurred in the physical conditions of the land surfaces which prevailed from time to time during the deposition of the various shales that overlie the 29 horizons.

The 4 lowest horizons, the Gellideg, Five Feet, Middle Yard and Upper Yard Seams show a prolonged episode of elevated land surfaces as the dry flora dominates over the wet flora. The succeeding horizon, namely, the Lower Nine Feet Seam shows a brief episode of a wet flora dominating. In the 3 succeeding horizons, the Six Feet, Nine Feet and Four Feet Seams, there is a recurrence of the dominance of the dry flora. This episode represents a fair duration of time.

A period of depression with swamps and marshes follows and continues into the 4 succeeding horizons, namely, the Four Feet Rider, Two Feet Nine, Three Coals (B) and the Lower Gorllwyn Seams. After this an uplifting of land takes place with a period of dry flora which is represented in 2 horizons, namely, the Gorllwyn and Lower Pentre Seams.

Another brief episode of wet flora follows and appears in a single horizon, *i.e.*, the Two Feet Nine Seam. A prolonged episode of elevation of land surface then occurs, giving a continuous dry flora on no less than 9 successive horizons, namely, the Abergorky, Hafod, Hafod Rider, No. 3 Rhondda, Three Coals (A), No. 2 Rhondda, Fforest Fach, No. 1 Rhondda, and No. 1 Rhondda Rider Seams. Without doubt we have a period of time with elevated lands persisting, giving an easy dominance to ferns and fernlike plants over the wet flora as represented in the class Lycopodiales.

A third brief episode of wet flora occurs in a single horizon, namely, the Cefn Glas Seam. After this, the last episode is of elevated land surfaces, with dry flora continuing upwards in the 4 highest horizons, namely, the Daran Ddu, No. 3 Llantwit, No. 2 Llantwit, and No. 1 Llantwit Seams. (No. 1 Llantwit is the top seam in the Coal Measures examined.)

Thus during the Westphalian times we have four episodes of dry flora. The first episode was prolonged in time but the second and third episodes were of short duration. The fourth episode was very prolonged, because it commenced in the third horizon from the top of the Westphalian Series and continued upwards into the Staffordian Series, passing upwards through no less than 6 horizons in the latter series.

Again, a fifth episode of dry flora of long duration commenced in the uppermost horizon of the Staffordian Series and continued up to the period represented by the highest horizon in the Radstockian Measures preserved in the district. There were also four episodes of wet flora, three of them in the Westphalian Series. The first was of brief duration, the second was rather more prolonged as it continued through 4 successive horizons. The third and fourth episodes were both of brief duration.

Of the 29 horizons no less than 15, or 52 per cent., show a dominance of intermediate flora; 10, or 35 per cent., have a dominance of dry flora, and 4, or 13 per cent., of wet flora. If we are to believe that the Lycopodiales are essentially a wet flora, and

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that the fern and fernlike plants are essentially a dry flora, we must conclude that the consistent recurrence throughout the 29 horizons of these classes (showing the dominance of one over the other, *i.e.*, the reaction of the wet and dry flora) is evidence and that the physical conditions were the principal factors that determined the distribution and relative proportions of these plants. Elevation and depression of land surfaces were the direct causes of the difference in the flora found in the various shales.

We may now consider whether there is any evidence that uplifted land surfaces were accompanied by deeper water conditions. The strata between any two coal seams furnish an approximate measure of the amount of subsidence that occurred between the formation of the two seams. The actual amount of subsidence cannot be known exactly because the original sediments were laid down more or less in a plastic state, and therefore must have occupied far greater bulk than is shown in their present compressed form.*

The maximum thickness of strata between certain pairs of coal seams is no less than 300 feet, indicating a maximum depression of the sea or delta floor between such seams. However, the thickness of the intervening strata serves to give us the relative "peak points" from seam to seam. If the dry and wet flora indicate respectively elevated and swampy conditions of land surface, in relation to sea-level, we may proceed further with this enquiry and draw certain conclusions as to the probable elevation of land surfaces above the sea-level and the probable depression of the sea floors from time to time.

Eighteen of the twenty-nine horizons indicate either elevated or swampy conditions of land surface with deep or shallow sea bottoms accompanying. On the other hand, the 11 remaining horizons fail to show the elevations and swampy conditions of land surfaces. In other words we have positive evidence of 62 per cent. of elevated or swampy land surface, accompanied by a corresponding deep or shallow sea-floor, as the case may be. There is also the negative evidence of 38 per cent. elevated or swampy lands. Thus there is a ratio of nearly two to one in favour of elevations of land being followed by corresponding deeper water conditions, and also of swampy conditions of land surface being followed by a corresponding shallow or delta floor.

The maximum thickness of strata between certain pairs of coal seams lies between 100 and 300 feet, and if it is safe to assume that we have a corresponding elevation of land above the water level or delta prevailing, upon which the Filicales and Pteridosperms, the dry flora, would show their dominance, we could also assume that from zero to 20 feet above water level or delta would show the dominance of the wet flora, namely, the Lycopodiales.

If we are correct in our assumption that the two extreme floras for wet and dry conditions respectively, are the Lycopodiales, Filicales and Pteridosperms, then the maximum development of the intermediate flora, namely, the Cordaitales and

* For discussion on this point see W. G. Fearnsides, 'Trans. Inst. Mining Engineers.'

Equisetales, must lie at an intermediate position about 60 feet above water level and would diminish in their number with either increase or decrease in the height of ground from this critical level. (See accompanying Chart VI (*a*).)

Explanation of Chart VI, Part (a).

(*a*) The " peak points " represent the *assumed height of land surfaces above sea-level* that give dominance to different classes of plants on the 29 horizons.

(*b*) The " peak points " below sea-level represent the actual mean thickness of strata intervening between the coal seams of the 29 horizons and denote the amount of subsidence of the sea-floor to form the strata from one seam to another.

Lycopodiales = 0–20 feet (wet flora); Equisetales and Cordaitales = 20–100 feet (intermediary flora); Filicales and Pteridosperms = 100–300 feet (dry flora).

Two significant facts come to light:—(*a*) pairs of seams, widely separated from one another, show dominance of fern and fernlike plants or dry flora, and (*b*) pairs of seams, close together, show dominance of the Lycopodiales or wet flora.

Faunal.

Faunal remains on the whole are somewhat rare, and of the different genera, Carbonicola, Anthracomya and Naiadites are sometimes very rare. At other times they appear in well-defined bands, but how far such bands extend laterally is not known.

A significant fact is that on horizons where plants of the class Lycopodiales are dominant, shell bands generally occur. Further, the shales in such bands are of a carbonaceous nature. Possibly swampy lagoons with brackish water conditions would have a disastrous effect on the Mollusca, owing to the poisoning of the waters. (Hydrocarbons due to decaying vegetation would have strongly impregnated the sluggish waters.) Fresh-water shells exist under such conditions to-day.

The soft black sediments themselves would be covered with dead vegetable tissue, with the result that the Mollusca would perish on the spot. The shells appear in all stages of growth in the black shales. Every slab of shale is covered with their remains in an uncrushed state, showing clearly that they died on the spot where they once lived.

The small shells of Spirorbis are found on Cordaite leaves and in the pinnules of Neuropteris, Alethopteris and Mariopteris.

A few examples of worm burrows were found on the bedding surfaces of some of the fine-grained shales. Insect remains were found low down in the Westphalian Series on horizon 25, the Lower Nine Feet Seam. They also occur sparsely in a few other horizons above in the measures. There is only one solitary record of Prestwichia. This Arthropod appeared on horizon 11, the lowest horizon in the Staffordian Series, namely, the No. 3 Rhondda Seam.

Although a good number of horizons show Mollusca rather plentifully, yet despite careful search, there are only 3 horizons in which records of fish remains were found, namely, horizons 26, 25 and 21, which are the Bute, Lower Nine Feet and Four Feet " Rider " Seams, respectively.

SUMMARY. (See Chart VI (*b*), (*c*), (*d*).)

1. The coal seams are of three types, namely, the " Regional," " Split " and " Local " types.

2. The lithology of the Coal Measures consists of about 80 per cent. shale in the Westphalian Series and about 90 per cent. sandstone in both Staffordian and Radstockian Series.

3. The shales overlying the various horizons show the dominance of a certain class of plants.

4. The dominance of a certain class of plants may be of a brief or long duration.

5. Probably the elevation or depression of land surfaces is the principal factor for the altered flora on the different horizons.

6. Horizons where Filicales and Pteridosperms dominate the other classes of plants show the greatest number of species of the different classes of plants.

7. Horizons where Lycopodiales dominate show the least number of species of the different classes of plants.

8. Filicales and Pteridosperms accompany an episode of elevated land surface (dry flora). Lycopodiales represent an episode of swampy conditions (wet flora).

9. Upraised land surface is followed by an increase in the number of species of the different classes of plants.

10. Depressed land surface is followed by a decrease in the number of species of the different classes of plants.

11. The Westphalian Series show the dominance of the Equisetales over the other classes of plants, whereas both the Staffordian and Radstockian Series show the dominance of the Filicales and Pteridosperms.

12. Probably the Westphalian Series with its 80 per cent. shale is more or less of a lowland condition, whereas both the Staffordian and Radstockian Series with their 90 per cent. sandstone show a more or less elevated condition of land surface.

13. Mollusca, when present on certain horizons, were dominated in each case by Lycopodiales. This suggests that the habitat was deltaic or brackish water rather than marine.

14. Fish remains were rarely found in the Coal Measures.

15. Insect remains were found near the base of the Westphalian Series.

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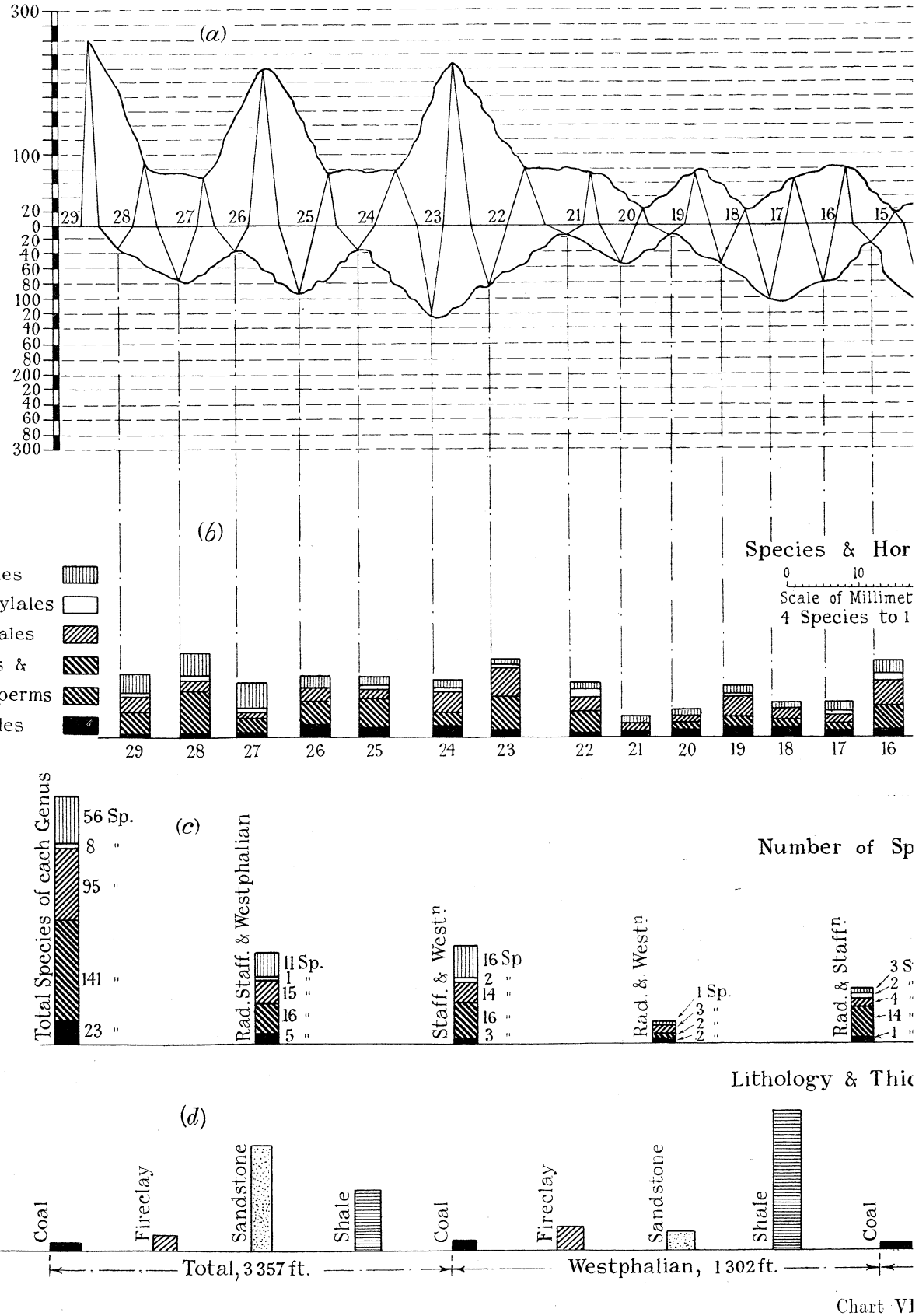
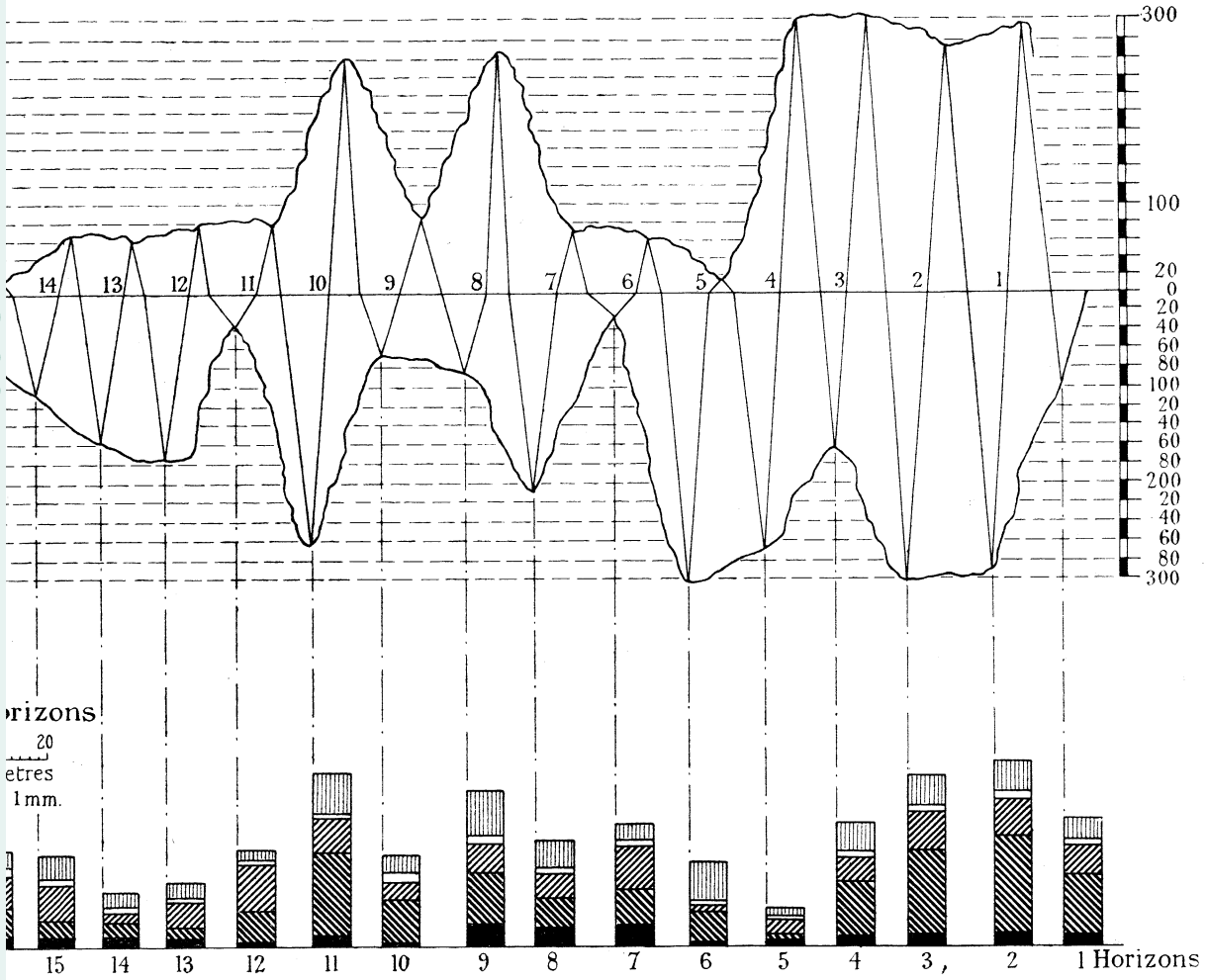
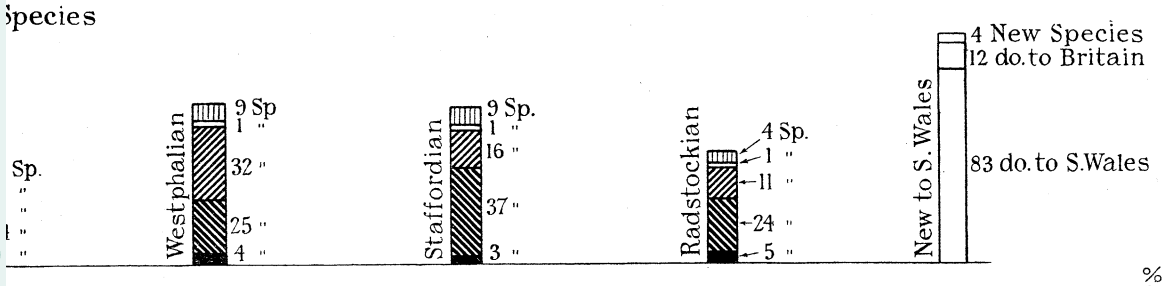
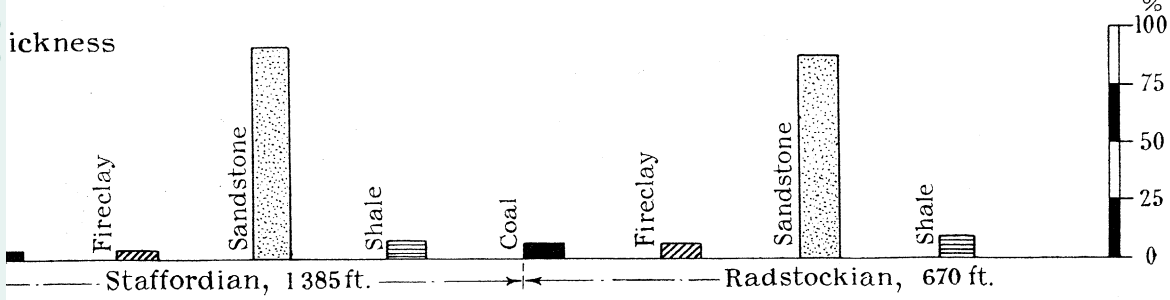


Chart VI

PHILOSOPHICAL TRANSACTIONS OF THE ROYAL SOCIETY B BIOLOGICAL SCIENCES


300
100
20
0
20
40
60
80
100
20
40
60
80
200
20
40
60
80
300
14 13 12 11 10 9 8 7 6 5 4 3 2 1
rizons
20
etres
1 mm.
15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 Horizons


pecies
Sp.
Westphalian
9 Sp
1
32
25
4
Staffordian
9 Sp.
1
16
37
3
Radstockian
4 Sp.
1
11
24
5
New to S. Wales
4 New Species
12 do. to Britain
83 do. to S.Wales


ickness
%
100
75
50
25
0
Fireclay
Sandstone
Shale
Coal
Fireclay
Sandstone
Shale
Staffordian, 1385 ft.
Radstockian, 670 ft.

VI.

VIII. Literature.

Appended is a short list of the authorities which I have consulted :—

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Idem., " Fossil Flora of the South Wales Coalfield and the relationship of its Strata to the Somerset and Bristol Coalfield," ' Trans. Royal Society, Edin.,' vol. 37 (1894), pp. 565–614.

Idem., " On the Fossil Flora of the Yorkshire Coalfield " (Second paper), *ibid.*, vol. 38 (1897), pp. 33–62.

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Chart II.—Ecology.

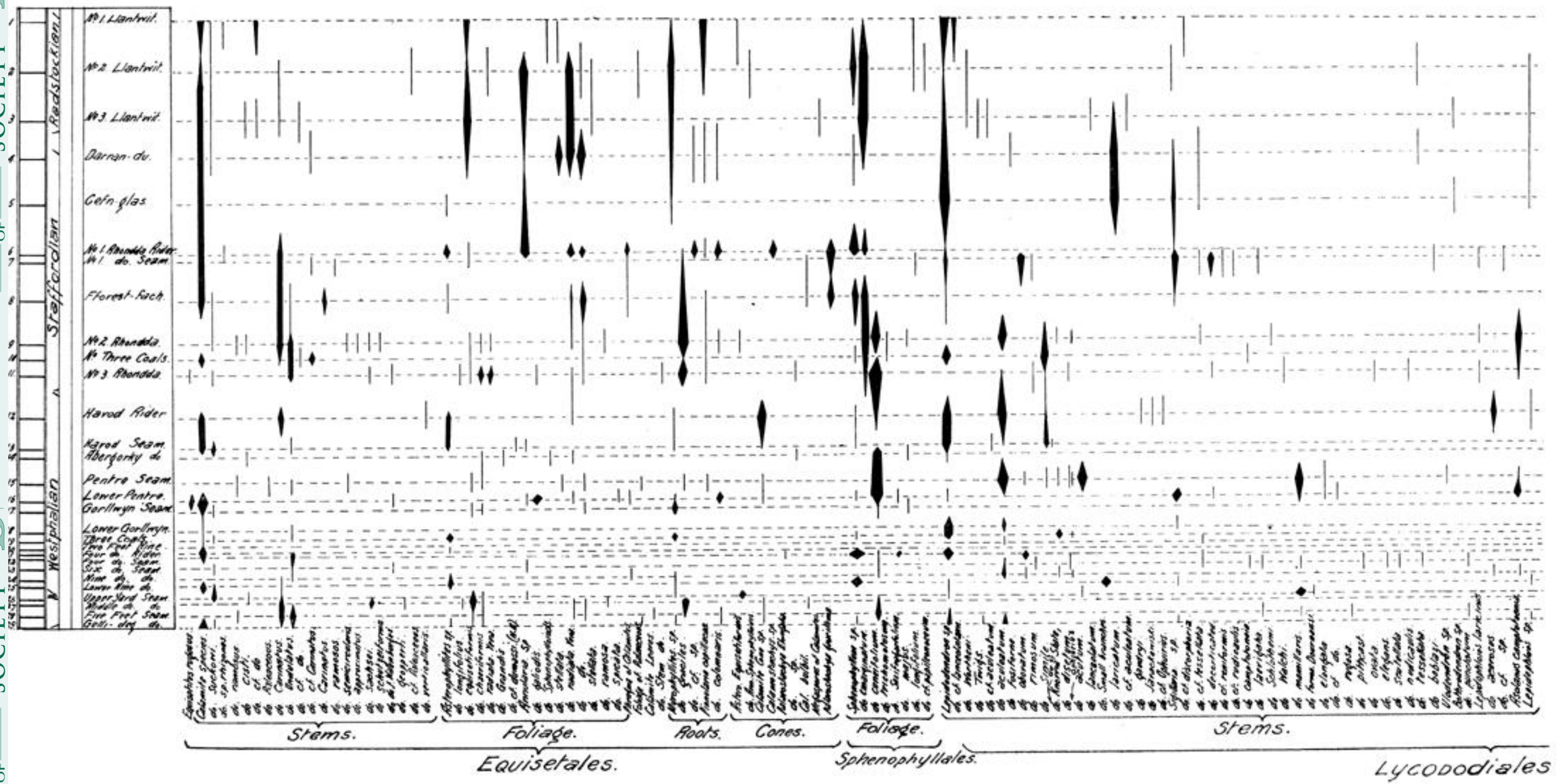

Chart III.—Tabulation of Species.

[*Continued on Plate* 36.]

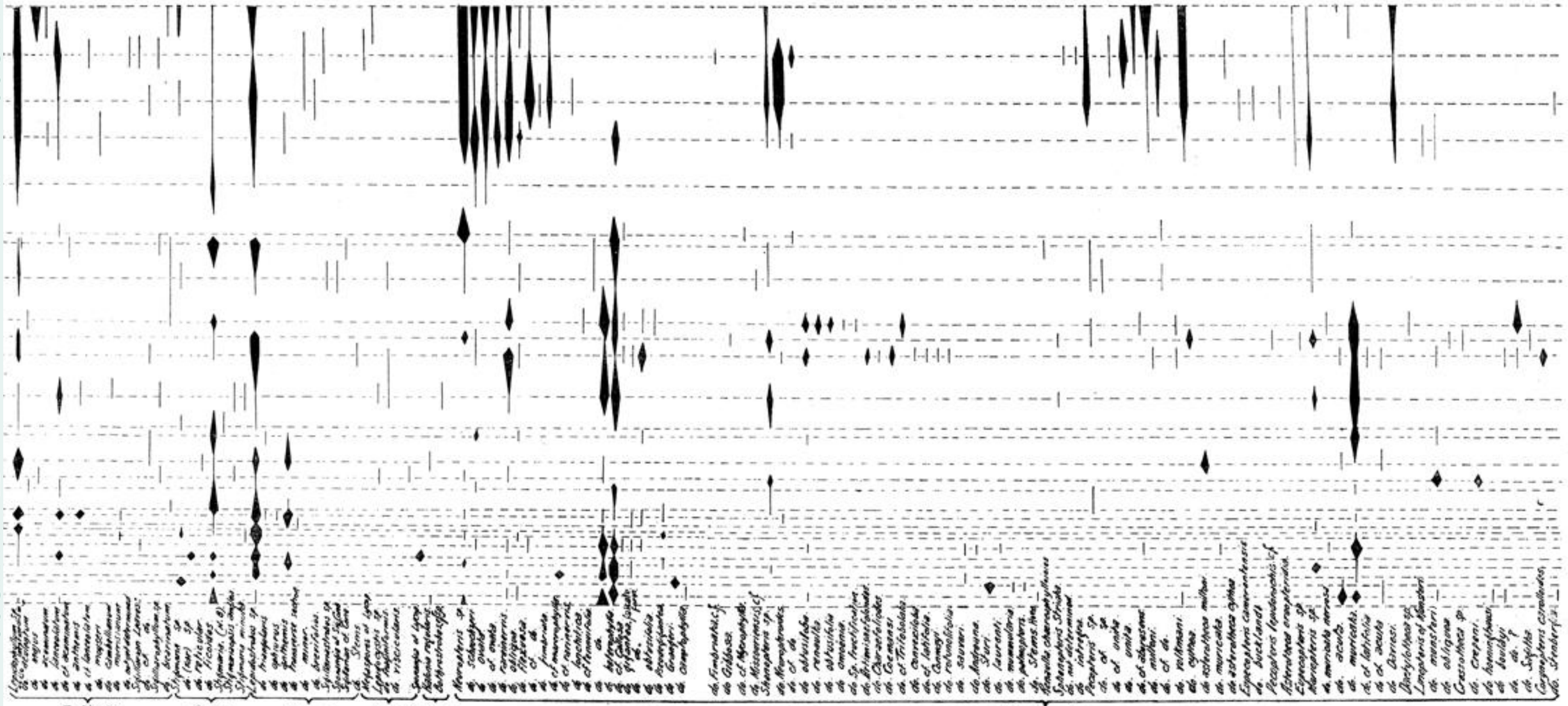

Chart III (continued).

[Concluded on Plate 37.]

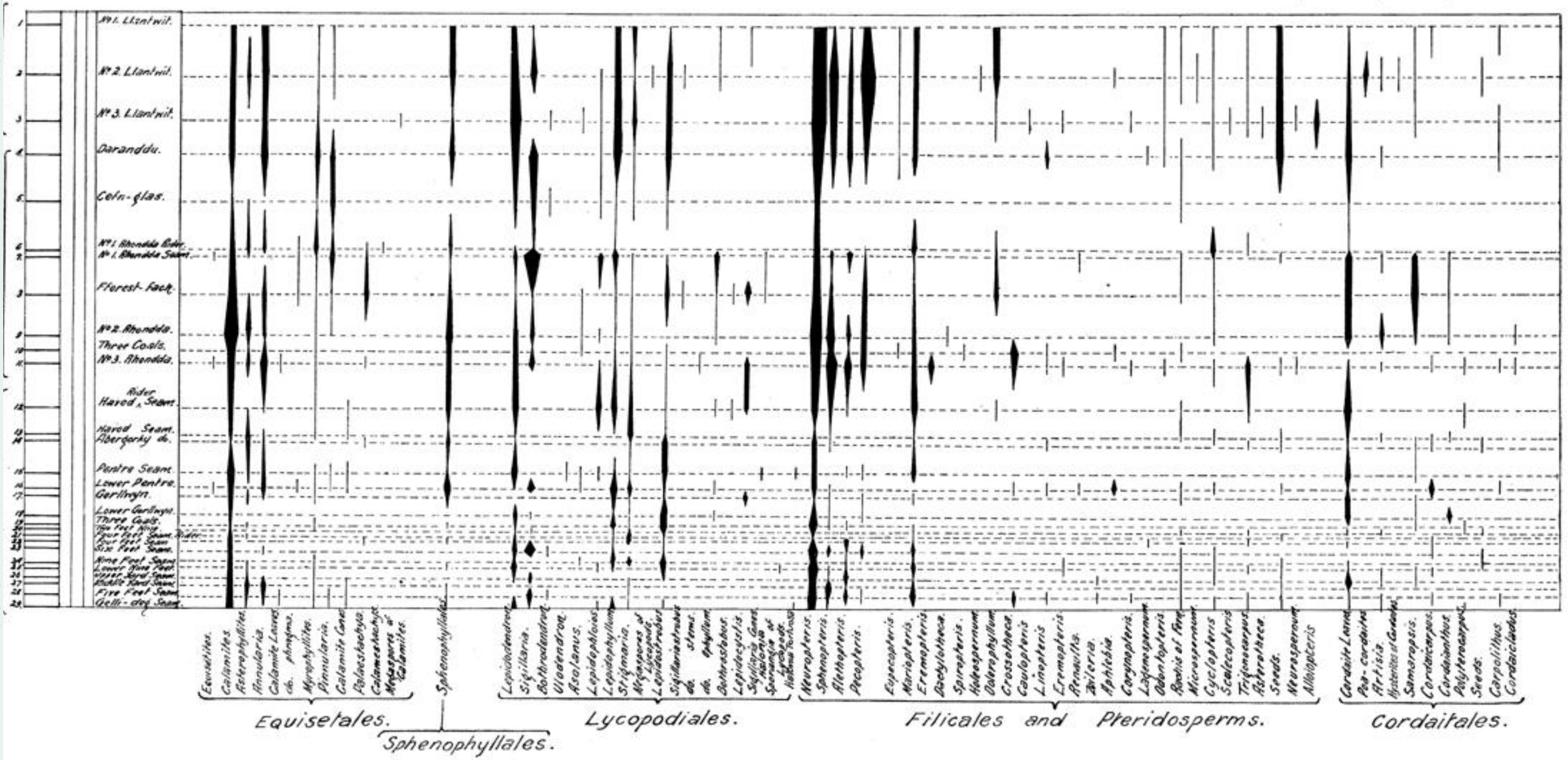

Chart IV.—Divergence and Convergence of Species.

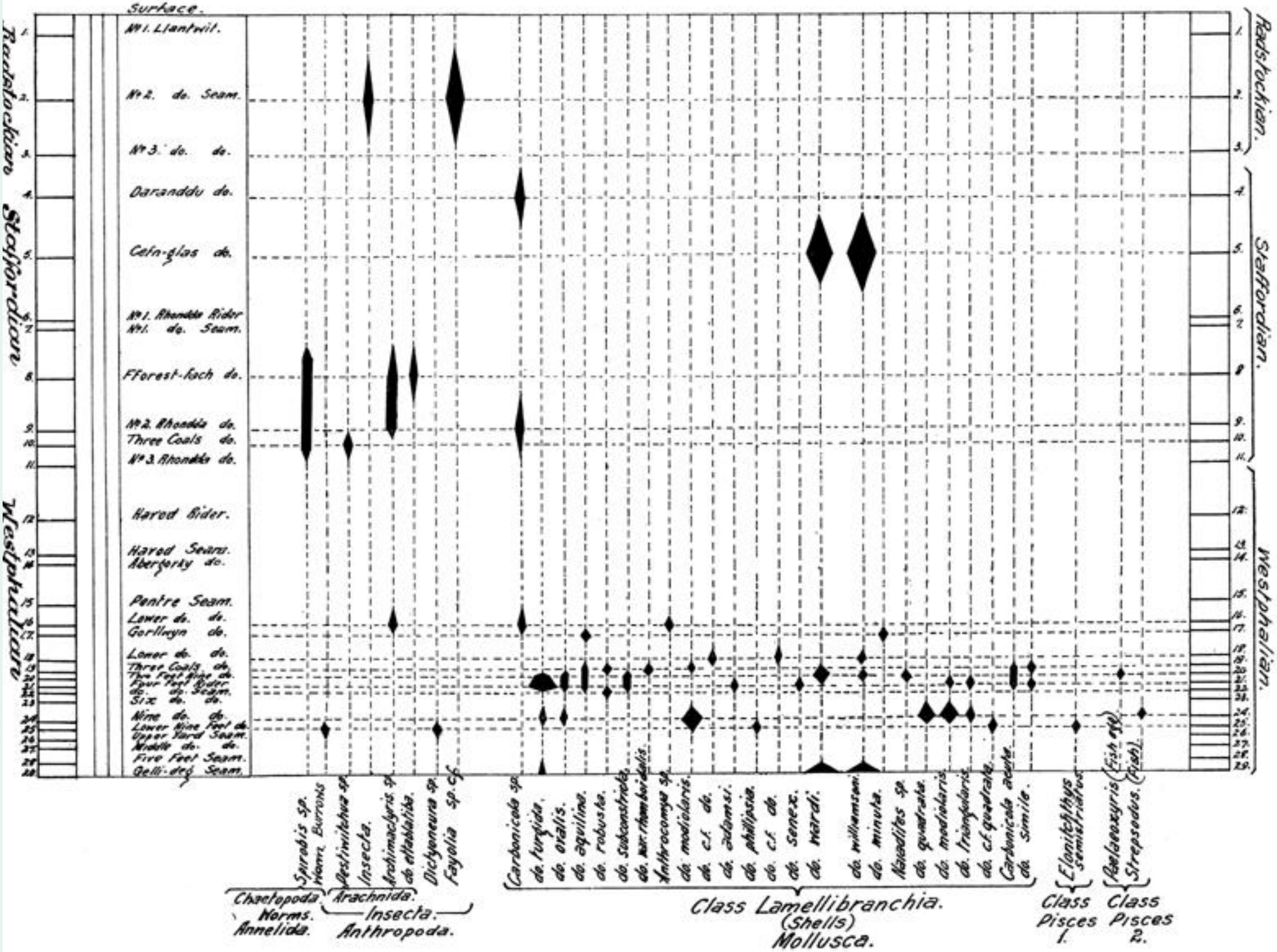

Chart V.—Tabulation of (Fauna) Species.

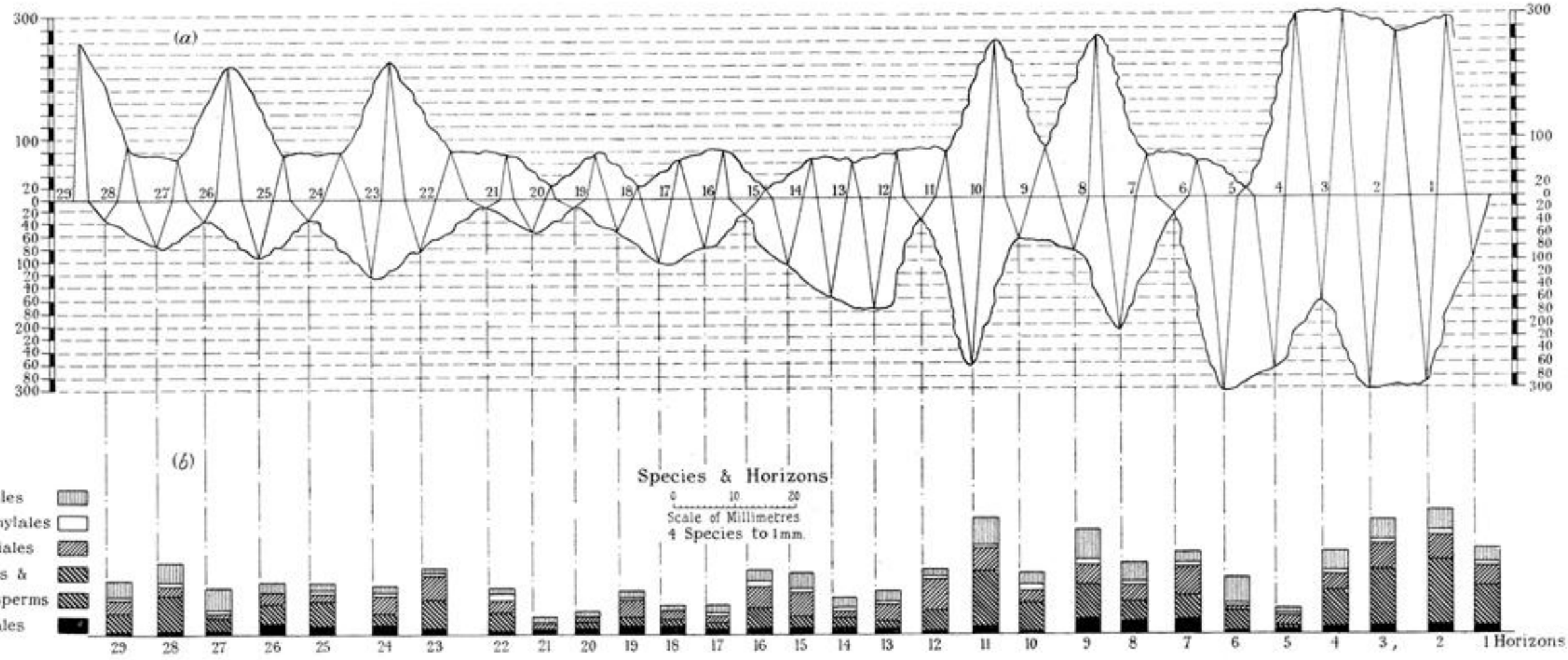
(a)
300
100
20
0
20
40
60
80
100
20
40
60
80
200
20
40
60
80
300
29 28 27 26 25 24 23 22 21 20 19 18 17 16 15 14 13 12 11 10 9 8 7 6 5 4 3 2 1
(b)
Species & Horizons
0 10 20
Scale of Millimetres
4 Species to 1mm.
quisetales
henophylales
copodiales
ilicales &
teridosperms
ordaitales
29 28 27 26 25 24 23 22 21 20 19 18 17 16 15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 Horizons
(c)
Number of Species
Total Species of each Genus
56 Sp.
8
95
141
23
Rad. Staff. & Westphalian
11 Sp.
15
16
5
Staff. & West.n
16 Sp
2
14
16
3
Rad. & West.n
1 Sp.
3
Rad. & Staff.n
3 Sp.
4
14
1
Westphalian
9 Sp
1
32
25
4
Staffordian
9 Sp.
1
16
37
3
Radstockian
4 Sp.
1
11
24
5
New to S. Wales
4 New Species
12 do. to Britain
83 do. to S.Wales
(d)
Lithology & Thickness
%
100
75
50
25
0
Coal
Fireclay
Sandstone
Shale
Total, 3357 ft.
Westphalian, 1302 ft.
Staffordian, 1385 ft.
Radstockian, 670 ft.

Chart VI.