

XXIII.—*The Jurassic Flora of Sutherland.* By A. C. Seward, F.R.S., Professor of Botany, Cambridge. *Communicated by* Dr R. KIDSTON, F.R.S. (Plates I.–X. ; text-figures 1–14 ; sketch-maps, and views of the coast.)

(MS. received September 28, 1910. Read December 19, 1910. Issued separately, February 10, 1911.)

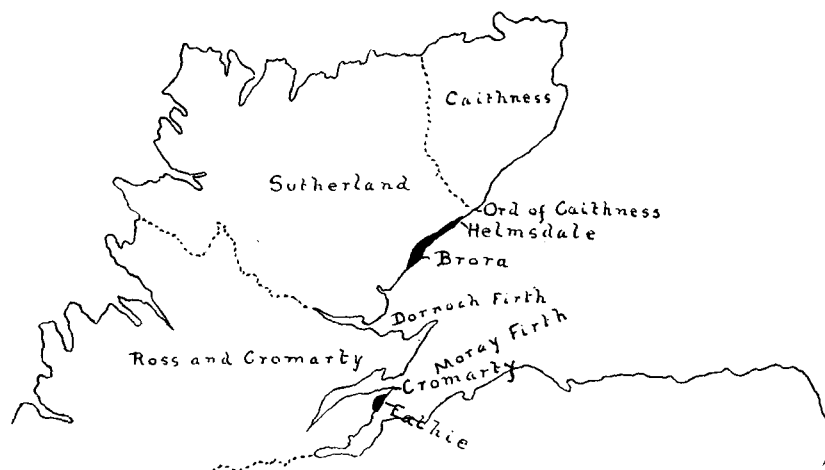
The majority of the fossils described in this paper were collected by the late Dr MARCUS GUNN on the coast of Sutherland between Brora and Helmsdale, more especially on the beach of Culgower Bay in the neighbourhood of Culgower (Maps I. and II.). It is several years since I first had an opportunity of seeing Dr GUNN's collection at his house in London : at that time pressure of other work made it impossible for me to do more than recognise the importance of the fossils as records of a Jurassic flora from a country which has afforded very little information in regard to Mesozoic Botany. A few years ago I suggested to Dr GUNN that we should collaborate in an account of the Sutherland plants, and to this proposal a ready assent was given. Our joint work had made but little progress when my friend was seized with an illness which terminated fatally in November 1909. Dr GUNN's fossils, which have been acquired by the Trustees of the British Museum, were collected in the course of repeated visits to his native country during brief respites from exacting professional duties in London. In MARCUS GUNN Palæontology had a devoted disciple whose recreation consisted mainly in collecting records of past life, both animal and plant. The Old Red Sandstone fish from Achanarras, Caithness, described by Dr TRAQUAIR as *Palæospondylus Gunni*,* permanently associates the name of GUNN with Palæozoology, and, despite the imperfection of the records, the following pages show the importance of the data he contributed towards a fuller knowledge of the Upper Jurassic flora of Scotland.

During a hurried visit to the Sutherland coast in July of the present year (1910), when I had the advantage of the guidance of Mrs GUNN over ground long familiar to her and to her husband, I was able to obtain a general impression of the manner of occurrence of the plant-bearing strata, which form a narrow strip of land between the rounded hills of granite and Old Red Sandstone and the sea. The simplified and partially diagrammatic sketch-map (Map II.), based on the one-inch Geological Survey sheet 103 (Golspie), shows the position of the more important localities and illustrates the following notes specially written for me by Mr H. B. WOODWARD, who is at present engaged upon a comprehensive account of the district. I am greatly indebted to him for his clear and concise notes, as also for references to earlier papers on the Jurassic rocks of Sutherland.

“Bordering the coast from Navidale and Helmsdale to Lothbeg (Map II.) there is a tract of undulating low land, from a quarter of a mile to about a mile in breadth. This tract is formed of blown sand, peat, river gravel, marine shingle, and boulder-clay,

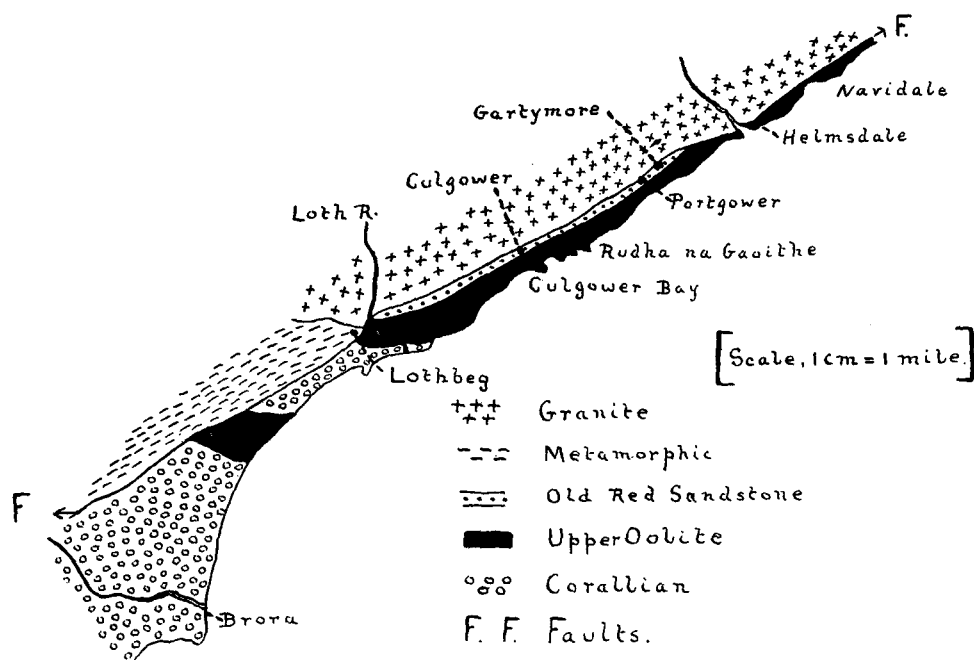
* TRAQUAIR (90).

which overlie and almost entirely conceal a platform of Upper Jurassic rocks. This platform is faulted inland against the granite of the Ord of Caithness and Helmsdale,



MAP I.—Outline map of the north of Scotland, showing the position of the Jurassic rocks (black patches) on the coast of Sutherland and Ross and Cromarty.

while from Gartymore to Lothbeg there is an intervening faulted strip of Old Red Sandstone between the granite of Culgower Hill and the Jurassic rocks."



MAP II.—Geological sketch-map of part of the coast of Sutherland, showing the relation of the Jurassic to the older rocks.

[The photograph p. 645, taken from the beach near Culgower, shows part of the platform of low ground stretching out to sea, with the granite hills shading off towards Brora. The rock in the foreground is a portion of one of the Jurassic reefs which are uncovered at low tide.]

“Exposed for the most part in rugged reefs along the foreshore, the Jurassic rocks appear in places also at the base of the low cliffs formed of the recent and Pleistocene deposits and for a short distance along the banks of the burns. It is, however, difficult to ascertain in detail the sequence of the strata, and no reliable estimate of their thickness can be given. The reefs on the whole have a general dip seawards, the strike coinciding roughly with that of the coast-line. The strata are much faulted, bent, and twisted: they are traversed by pseudo (sandstone) dykes and are weathered into fantastic shapes. They include shales, limestones, sandstones, conglomerates, and



Photograph of the coast of Sutherland, looking south; in the foreground is a block of Kimeridgian rock, in the middle distance the platform of Kimeridgian strata and superficial deposits, with the granite hills to the right.

boulder-beds. The general sequence is as follows, the higher divisions being exposed in the northern part of the area from near the Ord of Caithness to near Portgower:—

6. Shales, conglomerates, and boulder-beds, with blocks of flags (Old Red Sandstone), lignite, large portions of tree trunks, and other plant remains, *Bennettites Peachianus* Carr. and *Zamites Milleri* Zig. [= *Zamites Buchianus* (Ett.)], also Corals (*Isastræa*), spines of *Cidaritis*, *Ostrea*, *Exogyra*, and *Ammonites* near to *A. giganteus* Sow.
5. Calcareous sandstones and shelly limestones, with *Rhynchonella Sutherlandi* Dav., *Exogyra*, *Ammonites endoxus* D'Orb., *A. alternans* von Buch.
4. Shaly beds with plant remains. [The plants include *Nilssonia*, *Hausmannia*, *Sagenopteris*, *Elatides*, etc.]
3. Shales with thin bands of calcareous sandstone, more or less conglomeratic, spines of *Cidaritis*, *Ammonites* cf. *A. mutabilis* Sow., *A. alternans* von Buch, *Belemnites*, *Pecten articulatus* Schloth.
2. Alternation of sandstone and shale.

1. White sandstones with bands of dark shaly carbonaceous sand: *Cidaris florigemma* Phill., *Hemicidaris intermedia* Flem., *Rhynchonella pinguis* Roem., *Trigonia* cf. *T. hemispherica* Lyc.

The fossils obtained from Sput Dubh, mostly by MARCUS GUNN, fix the Corallian age of the strata No. 1; and with them No. 2 may probably be included. The strata Nos. 3, 4, and 5 may be assigned to the Kimeridgian, and it is possible that in No. 6 there may be representatives of Portlandian. The richer plant-beds No. 4 were discovered by MARCUS GUNN at Sron Rudha na Gaoithe, at the northern end of Culgower Bay. Elsewhere in the bay the strata consist probably of dark shales, but they are hidden by beach-sand and boulders. The old cliff-line, moreover, from Wester Garty to Loth is mostly obscured, though the presence of shaly beds along the base may be inferred from the springs and rushy ground.

“The evidence seems to justify the following conclusions. The shales and sandstones were deposited in an estuary or bay having features somewhat similar to those of the Moray Firth at the present day. High cliffs of Old Red Sandstone (flags, etc.) bordered the coast, and from these were formed screes, the material of which now and again slipped into the waters and was partially rolled; while huge blocks of flagstone occasionally broke away and fell among the sediments, producing much disturbance. Even layers were again deposited over the disturbed beds. In course of time widespread earth-movements took place, whereby fissures were produced in the sediments already to some extent consolidated, and these were filled from above by succeeding deposits, or possibly to some extent from below, if the fissures were due to earthquakes. Evidence of contemporaneous erosion also indicates local upheaval. Long subsequently the main faulting was produced whereby the Jurassic rocks bordering the Old Red Sandstone and granite were much crushed and broken, and numerous subsidiary faults were produced. Hence we find complex structures, in part due to original irregularities of bedding and to disturbance that led to the formation of pseudo-dykes, the mass of Jurassic strata being afterwards broken and faulted in places by the later movements.”

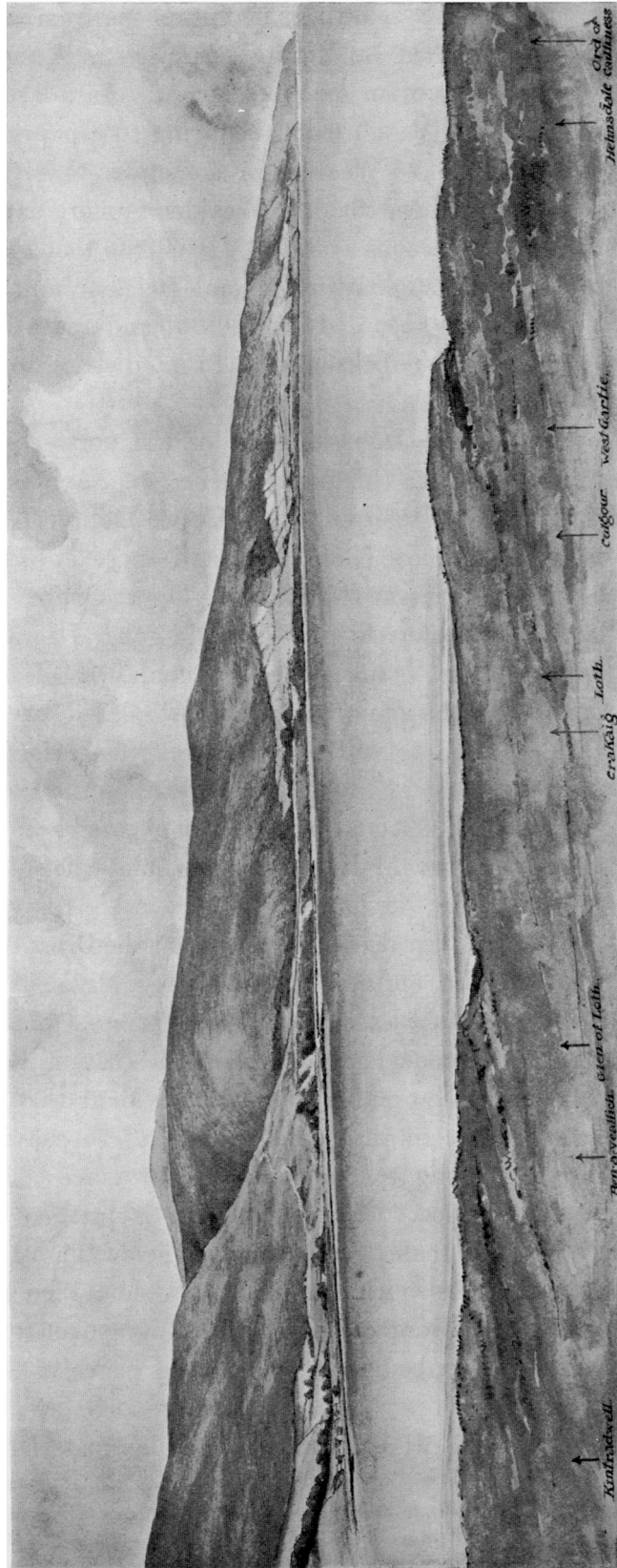
In support of the Upper Oolite age of the strata between the Loth river and Helmsdale a long list of fossils is given by Professor JUDD* in his paper on this district. Three species of shells associated with Culgower plants, which I sent to the British Museum, were identified by Mr NEWTON and Mr CRICK as *Avicula ædilignensis* Blake, *Lima concentrica* Sow., and *Amæboceras* (*Ammonites*) *alternans* von Buch, all Kimeridgian species.

In an appendix to MURCHISON's paper on the Brora coal-field, published in 1829, KÖNIG† described an Equisetaceous stem as *Oncylogonatum carbonarium*, and some other plant impressions as “subtriangular carbonaceous plates.” The Equisetaceous casts, as NICOL and HUGH MILLER‡ believed, are no doubt identical with the well-known species

* JUDD (73), p. 182; see also DAVIDSON (73), p. 196.

† KÖNIG, in MURCHISON (29), Pl. xxxiii.

‡ MILLER (57), p. 468; (59), p. 142.



The accompanying view, reproduced from a black-and-white wash-drawing, for which I wish to express my cordial thanks to Mr R. J. SERJEANTSON of Brora, admirably illustrates the physical features of the district from which the Gunn collection was obtained. The drawing was made from the golf-links at Brora: it shows the Upper Jurassic beds and the superficial deposits as a narrow fringe of low-lying ground between the sea and the slopes of the older hills.

Equisetites columnaris * founded by BRONGNIART on specimens from the Inferior Oolite of Whitby. The Brora stem was named by ZIGNO † *Equisetites Koenigii*. The scales figured by KÖNIG are probably pieces of an Araucarian cone. In a later communication to the Geological Society of London MURCHISON, ‡ referring to a paper by ROBERTSON, § in which the Brora beds are spoken of as Wealden in age, states that the facts adduced by that author “tend to confirm the idea that the Wealden is more naturally connected with the Jurassic than with the Cretaceous system.” It is true that the floras described from Upper Jurassic beds differ but slightly in general facies from those of Wealden age, but the evidence of the plants recorded by KÖNIG, and recently by Dr MARIE STOPES, || is in favour of assigning the rocks of the Brora district to a lower horizon (Lower Oolite).

The most complete account of the Jurassic rocks of the north-east of Scotland is that published by Professor JUDD. ¶ In this paper the beds at Navidale, Helmsdale, and at the mouth of the Loth river are referred to as Upper Oolite (Kimeridgian); the Brora rocks are classed as Middle Oolite (Corallian), and those at Eathie Bay, which MILLER ** assigned to the Liassic series, are identified as Upper Oolite. The plants from the Upper Oolite of Sutherland are referred to by JUDD in general terms, and only one species, *Bennettites Peachianus* Carr., is mentioned by name. Professor JUDD wrote: “The beautiful flora of these beds, the age of which is now placed beyond all question as that of the Upper Oolite, will be made the subject of a critical study by Mr CARRUTHERS. It will form a new and highly interesting link in the history of vegetable life.” †† Thanks to the labours of Dr MARCUS GUNN, it is now possible to do ampler justice to this northern British flora than would have been possible when JUDD’s paper was written. The Kimeridgian age of the Navidale to Loth-river beds is confirmed by the recent work of HORACE WOODWARD, who also informs me that the Brora coal is Bathonian; “it belongs to the Great Oolite series, and might possibly be equivalent to Cornbrash.” ‡‡

The most recent of the few published accounts of the Jurassic plants of north-east Scotland is by Miss STOPES, §§ who considerably extends the list of Brora species: she concludes her paper by expressing the opinion that “it is evident that the flora of the Inferior Oolite of Brora is so similar to that of Yorkshire as to convince us that the plants of the Scottish district belong to the same life-province as the one which included Yorkshire during that period.” This conclusion is justified by the evidence of the plants found by her in the shale “cropping out below high-tide level on the coast, about a mile and a quarter due south of Brora.” It should be noted that these plants were not collected from the Brora coal-field, which is spoken of by WOODWARD as Bathonian. The specimens described in the following pages, nearly all of which were collected on the shores of Culgower Bay and farther north, are, however, from a higher horizon than that from which Miss STOPES obtained her material; it is significant

* SEWARD (00), p. 56.

§ ROBERTSON (47).

†† JUDD (73), p. 182.

† ZIGNO (59), p. 113.

|| STOPES (07).

‡‡ Letter from H. B. WOODWARD, July 1910.

‡ MURCHISON (43).

¶ JUDD (73).

** MILLER (57), p. 469.

§§ STOPES (07).

that the more recent flora includes some species identical with Wealden plants. The specimens collected by MARCUS GUNN cannot be individually assigned to localities within narrow limits. Many were obtained on the beach from loose blocks, while others were found *in situ*. In all cases the specimens may safely be described as coming from Kimeridgian strata between Navidale and the Loth river. The flora may conveniently be spoken of as the "Culgower flora." In addition to the Gunn collection, which first drew my attention to the Jurassic plants of Sutherland, I have included in this account specimens collected by Mr PEACH and now in the Geological Department of the British Museum, some well-preserved and interesting plants collected by Mr ARBER at Gartymore and Culgower Bay and generously placed by him at my service,* also the Hugh Miller collection† from Sutherland and Eathie Bay (Cromarty) (see Map I.), which I have been able to examine through the kind offices of Dr SHAND of the Royal Scottish Museum. It is my intention to deal with some of the Eathie specimens, the internal structure of which is partially preserved, in a separate paper. I wish also to thank Dr HORNE for allowing me to have sections cut from pieces of coniferous wood from Helmsdale in the possession of the Scotch Geological Survey. The work of HUGH MILLER on the Jurassic flora of the north-east of Scotland calls for special notice. The twelfth lecture of the series published by this extraordinarily acute observer in his *Testimony of the Rocks*‡ includes an account, accompanied by several carefully drawn illustrations, of Eathie and Sutherland plants. He points out that in 1844 Professor NICOL of Aberdeen mentioned two fossil plants, *Equisetites columnaris* from Brora and *Pinites eiggensis* from the western island of Eigg, as the sole representatives of the Jurassic flora of Scotland. He goes on to say that his own researches enable him to increase the list to rather more than fifty species. In speaking of the numerous conifers obtained from the Sutherland rocks, MILLER wrote: "It is worthy of notice that they resemble in the group rather the conifers of the southern than those of the northern hemisphere"; he compares some of the specimens with twigs of the Norfolk Island pine (*Araucaria excelsa*) and *Araucaria Cunninghamii*. He recognised the great development of the Cycadaceæ as a feature of the Oolite flora, but his identification of several specimens as species of *Zamia* cannot be maintained. *Sagenopteris* leaflets are referred to *Glossopteris*, a mistake which has been frequently made by other authors. Among ferns he mentions *Pecopteris whitbiensis*, *P. obtusifolia*, and *P. insignis*: the first name has often been applied to a fern now known as *Todites Williamsoni*, a species which I believe to be represented in the Culgower flora; the second name is a synonym of *Klukia exilis*, a species which I have not been able to recognise with certainty. *Pecopteris insignis* is a synonym of *Cladophlebis denticulata*, which occurs in the Sutherland flora. With his characteristic acumen he recognises the probability that a dicotyledon-like leaf is a fragment of a fern to which LINDLEY

* Mr ARBER's plants are in the Sedgwick Museum, Cambridge.

† In all probability some of MILLER's plants from Sutherland were collected south of Helmsdale, though all are labelled 'Helmsdale'; they are from Kimeridgian beds.

‡ MILLER (57), pp. 468 *et seq.*

and HUTTON gave the name *Dictyophyllum*. Among recent floras MILLER cites that of New Zealand, characterised by its wealth of ferns and forests of conifers, as most closely resembling the Jurassic flora of Sutherland.

The following is a list of the plants figured by HUGH MILLER in *The Testimony of the Rocks*; the specimens, with one or two exceptions, are in the Royal Scottish Museum:—

References to figures in <i>The Testimony of the Rocks</i> . [Where Miller includes more than one specimen under one figure, I refer to them as A, B, etc., reading from left to right.]	Remarks or identifications by Miller.	Names under which the specimens are now described.
Fig. 130, A-F, p. 472	"Conifers." Miller speaks of several distinct species, and compares some with recent species of <i>Araucaria</i>	Fig. 130, A, <i>Sphenolepidium</i> sp., cf. <i>S. Kurrianum</i> (Dunk.), $\frac{2}{3}$ nat. size; Helmsdale. B, C, D, F, <i>Elatides curvifolia</i> (Dunk.): B, D, $\frac{2}{3}$ nat. size; C, F, slightly reduced; Eathie (B) and Helmsdale (C, D, F). E, <i>Elatides Sternbergiana</i> , $\frac{2}{3}$ nat. size; Eathie.
Fig. 131, A, B	Fig. 131, A, <i>Taxites Jeffreyi</i> sp. nov., nat. size; Eathie. B, <i>Elatides Sternbergiana</i> [not in the collection].
Fig. 132	"Sprig of a Conifer with four apparently embryo cones"	<i>Masculostrobus</i> sp. gen. nov., nat. size; Eathie.
Fig. 133	<i>Zamia pectinata</i>	<i>Pseudoctenis eathiensis</i> (Rich.) gen. nov., $\frac{1}{2}$ nat. size; Eathie.
Fig. 134	<i>Zamia</i>	<i>Nilssonina orientalis</i> Heer, $\frac{5}{8}$ nat. size; Helmsdale.
Fig. 135	<i>Pseudoctenis eathiensis</i> (Rich.), $\frac{1}{2}$ nat. size; Helmsdale.
Fig. 136	<i>Zamia</i>	<i>Zamites Buchianus</i> (Ett.), $\frac{1}{2}$ nat. size; Helmsdale.
Fig. 137	<i>Zamia</i>	<i>Zamites Carruthersi</i> (Sew.), $\frac{1}{2}$ nat. size; Helmsdale.
Fig. 138	Cone	<i>Williamsonia</i> sp., $\frac{1}{2}$ nat. size; Eathie.
Fig. 139	? Cone	Probably a piece of a partially preserved coniferous stem, nat. size; Eathie.
Fig. 140, A, B	Fig. 140, A, <i>Williamsonia pecten</i> (Phill.), slightly reduced; Helmsdale. B, <i>Nilssonina orientalis</i> ? Heer, $\frac{2}{3}$ nat. size; Helmsdale.
Fig. 141, A-E	A, B, "simple fronds resembling those of the Hart's-tongue fern"	Fig. 141, A, indeterminable; B, <i>Nilssonina orientalis</i> Heer, nat. size; Eathie. C, <i>Nilssonina orientalis</i> Heer, $\frac{2}{3}$ nat. size; Helmsdale.
	D, E, <i>Glossopteris</i>	D, E, <i>Sagenopteris Phillipsi</i> (Brongn.), $\frac{2}{3}$ and $\frac{2}{3}$ nat. size; Helmsdale.
Fig. 142	<i>Tæniopteris</i> sp.	<i>Nilssonina compta</i> (Phill.) [Original not found in the Edinburgh collection.]
Fig. 143	<i>Pecopteris obtusifolia</i> L. and H.	Specimen very obscure.

References to figures in <i>The Testimony of the Rocks</i> . [Where Miller includes more than one specimen under one figure, I refer to them as A, B, etc., reading from left to right.]	Remarks or identifications by Miller.	Names under which the specimens are now described.
Fig. 144	Probably a new fern	<i>Cladophlebis denticulata</i> Brongn., slightly reduced; Helmsdale.
Fig. 145	"A well-defined <i>Pachypteris</i> "	<i>Thinnfeldia</i> sp. [Original not in the collection.]
Fig. 146	<i>Phlebopteris</i>	<i>Pterophyllum Nathorsti</i> , Sew., $\frac{1}{2}$ nat. size; Helmsdale.
Fig. 147, A, B	A, Miller compares it with <i>Lycopodium</i> B, "probably a true fern"	Fig. 147, A, indeterminable; Helmsdale. B, ? <i>Dichopteris</i> sp., nat. size; Helmsdale.
Fig. 149	Imbricated stem	<i>Brachyphyllum</i> sp., $\frac{1}{2}$ nat. size; Helmsdale.
Fig. 150	[Original not found in the collection.]
Fig. 151	"True Dicotyledonous leaf"	<i>Hausmannia Buchii</i> (And.), nat. size; Helmsdale.
Fig. 152	Miller compares this fragment with <i>Dictyophyllum</i>	? <i>Dictyophyllum</i> sp., slightly reduced; Helmsdale.

Since HUGH MILLER'S time very few additions have been made to our knowledge of Scotch Jurassic plants. In 1870 CARRUTHERS* described the Cycadean stem *Bennettites Peachianus* from Helmsdale, *Yatesia crassa*, *Y. Joassiana* and *Bucklandia Milleri* from Brora. In 1884 Mr T. RICHARDS† published a short account of Cycadean species contained in the Hugh Miller collection, and reference has already been made to the Brora plants described by Miss STOPES.

During the short visit of the Nordenskiöld Greenland expedition to Thurso in 1883, Professor NATHORST and some of his colleagues collected specimens of fossil plants in the neighbourhood of Helmsdale. Since describing the Gunn collection I have received from my friend Professor NATHORST a list of species provisionally named by him from his material: it is satisfactory to find that in several cases his determinations agree with my own. It is not improbable that an examination of the specimens in Stockholm may result in the recognition of one or two forms which are not represented in the British collections.

In his paper on Mesozoic Cycadophyta, NATHORST‡ describes one of his Helmsdale plants as *Beania Carruthersi* Nath., a species which differs from *Beania gracilis* Carr. in its rather smaller dimensions and in the more crowded disposition of the sporophylls. On each sporophyll are two spherical bodies which NATHORST suggested might be microsporangia; but he now informs me that he believes them to be small seeds, a much more probable interpretation.

* CARRUTHERS (70).

† RICHARDS (84).

‡ NATHORST (02), p. 21, pl. i. figs. 14, 15.

The specimens from the Inferior Oolite of Yorkshire on which CARRUTHERS founded the genus *Beania* were regarded by him as female Cycadean flowers.* It has also been suggested that they may be seed-bearing shoots of a member of the Ginkgoales,† but decisive evidence as to the affinity of *Beania* is still lacking.

In the introduction to his paper on the Secondary rocks of Scotland, Professor JUDD, though mainly concerned with those on the north-east coast, refers to the Mesozoic strata of the West, which have been sealed up under thousands of feet of Tertiary volcanic rocks.‡ From these patches of Jurassic strata scattered through the Western Isles, the only plant remains which have come under my notice are specimens of petrified coniferous wood. The history of our knowledge of the Western beds in Eigg and other islands has been given by Mr HARKER in his paper on the geological structure of the Sgùrr of Eigg.§ The species named by LINDLEY and HUTTON *Pinites eiggensis*, though one of the most familiar of plant-names, has not been thoroughly investigated in recent years. HUGH MILLER in *The Cruise of the Betsey* || speaks of the “gigantic Scur of Eigg” as resting “on the remains of a prostrate forest,” a description which is more picturesque than accurate. He believed the Eigg species to be identical with the coniferous wood which was then found in great abundance and may still be collected on the beach at Helmsdale; this opinion was, however, not based on any thorough anatomical examination. It would seem that the numerous specimens of *Pinites eiggensis* in museum collections are probably pieces of a single trunk. Mr HARKER states that he was unable to learn from the published accounts, from the information of residents, or from personal search, that wood has ever been discovered under the Sgùrr, except at one locality at the southern base of the pitchstone where it was enclosed in decomposed volcanic rock. The position of the log of wood is clearly shown in a section published by Mr HARKER.¶ In addition to *Pinites eiggensis*, the structure of which I hope to describe on another occasion, some imperfectly preserved specimens, examined at Mr HARKER's request, from Camas Sgiotaig, Eigg, showed the arrangement of pits on the radial walls of the tracheids characteristic of the *Araucariæ*.** In an appendix on the palæontology of Skye and Raasay to Mr BRYCE's paper on the Jurassic rocks of those islands, Mr TATE mentions the occurrence of “obscure Cycads and Ferns” in Inferior Oolite beds,†† but no description of the fossils has been published. Although, as Sir ARCHIBALD GEIKIE points out,‡‡ Jurassic rocks play a much more important part in the geology of the West, our knowledge of the Jurassic flora of Scotland is based on the records obtained from the narrow strip of beds faulted against the north-eastern edge of the Highlands.

* CARRUTHERS (69).

† SEWARD (00), p. 275.

‡ JUDD (73), p. 99; see also GEIKIE (01), p. 140.

§ HARKER (06); see also HARKER (08).

|| MILLER (58), p. 32.

¶ HARKER (06), p. 57, fig. 5.

** *Ibid.*, p. 63.

†† TATE (73), p. 346.

‡‡ GEIKIE (01), p. 140.

LIST OF JURASSIC PLANTS RECORDED FROM SCOTLAND.

The species distinguished by an asterisk are not described in the following pages, and in most cases are recorded by other authors. In cases where the plants are not from the Kimeridgian beds of the Sutherland coast, the horizon, or approximate horizon, is mentioned.

I. PTERIDOPHYTA.

A. EQUISETALES.

- | | |
|--|----------------------|
| * <i>Equisetites Beani</i> Bunb.* | Brora, Lower Oolite. |
| * <i>Equisetites columnaris</i> Brongn.† | „ „ „ |
| * <i>Equisetites broraensis</i> , Stopes.* | „ „ „ |

B. HYDROPTERIDÆ (?).

Sagenopteris Phillipsi (Brongn.).

C. FILICINÆ.

1. Dipteridinæ.

Hausmannia dichotoma Dunk.

Hausmannia Buchii (And.).

Hausmannia Richteri sp. nov.

- | | |
|-------------------------------|--|
| * <i>Dictyophyllum</i> , sp.‡ | Helmsdale (Kimeridgian) and
Brora (Lower Oolite). |
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2. Matoninæ.

Laccopteris Dunkeri Schenk.

Matonidium Goepperti (Ett.).

3. Gleicheniaceæ.

Gleichenites Boodlei sp. nov.

Gleichenites cycadina (Schenk).

4. ? Cyatheaceæ.

- | | |
|---|---|
| <i>Coniopteris hymenophylloides</i> (Brongn.).§ | Culgower (Kimeridgian) and
Brora (Lower Oolite). |
|---|---|

Coniopteris quingeloba (Phill.).§

Coniopteris arguta (Lind. and Hutt.).

5. Osmundaceæ.

- | | |
|--|---------------------|
| <i>Todites Williamsoni</i> (Brongn.).§ | Culgower and Brora. |
|--|---------------------|

? Osmundaceæ.

- | | |
|---|---------------------|
| <i>Cladophlebis denticulata</i> (Brongn.).§ | Culgower and Brora. |
|---|---------------------|

6. Marattiaceæ.

Marattiopsis Boweri sp. nov.

7. Ferns of uncertain affinity.

Cladophlebis sp. cf. *C. hailburnensis* (Lind. and Hutt.).

Cladophlebis sp. cf. *C. distans* (Heer).

Cladophlebis sp.

Rhizomopteris Gunni sp. nov.

Sphenopteris onychiopsoides sp. nov.

Tæniopteris sp.

Aphlebia sp.

Rachises of fern fronds.

Spiropteris sp.

* Described by M. C. STOPES (07).

† Recorded by KÖNIG (MURCHISON, 1829) as *Oncylogonatum carbonarium*.

‡ Recorded by M. C. STOPES (07); the fragment figured by HUGH MILLER (*Testimony of the Rocks*, fig. 152, p. 495) is perhaps referable to this species.

§ Recorded by M. C. STOPES from Brora, and recognised in the Culgower flora.

D. FILICINEÆ OR PTERIDOSPERMÆ (?).

- Thinnfeldia rhomboidalis* Ett.
Thinnfeldia sp.
Thinnfeldia arctica Heer.
Thinnfeldia de Geeri (Nath.).
Thinnfeldia sp.
Dichopteris Pomelii (Sap.).
? *Dichopteris* sp.

II. GYMNOSPERMÆ.

A. GINKGOALES.

- Ginkgo sibirica* Heer.
* *Ginkgo digitata* (Brongn.).
Baiera Brauniana (Dunk.).

? GINKGOALES.

- Baiera Lindleyana* (Schimp.).
Czekanowskia Murrayana (Lind. and Hutt.).
Phœnicopsis Gunni sp. nov.
* *Beania Carruthersi* Nath.

B. CONIFERALES.

1. Araucariinæ.

- Araucarites Milleri* sp. nov.
* *Araucarites* sp.*
Araucarioxylon sp.†

? Araucariinæ.

- Brachyphyllum* sp.
Elatides curvifolia (Dunk.).
Elatides Sternbergiana (Schenk).

2. Conifers of uncertain position.

- Masculostrobus Zeilleri*, gen. et spec. nov.
Masculostrobus sp.
* *Cheirolepis* sp.‡ Brora (Lower Oolite)
Taxites Jeffreyi sp. nov.
Taxites sp.
Taxites sp. cf. *T. gramineus* (Heer).
Sphenolepidium sp. cf. *S. Kurrianum* (Dunk.).
Coniferocaulon colymbæforme Fliche.

3. Abietinæ.

- Pinites (Pityospermum)* sp.
* *Pinites eigensis* (Lind. and Hutt.).§ Eigg (Lower Oolite).

C. CYCADOPHYTA.

1. Bennettitales.

- Williamsonia pecten* (Phill.).
Williamsonia sp.
* *Bennettites Peachianus* Carr.||

2. Cycadophyta incertæ sedis.

- Pseudoctenis eathiensis* (Rich.) gen. nov.
Pseudoctenis crassinervis gen. et spec. nov.
Zamites Buchianus (Ett.).
Zamites Carruthersi, Sew.

* Recorded by Miss STOPES (07).

† Recorded also in HARKER's paper on the Island of Eigg (06).

‡ Recorded by M. C. STOPES (07).

§ Described by LINDLEY and HUTTON (31), and by WITHAM (33).

|| Described by CARRUTHERS (70).

<i>Zamites</i> sp.*	Brora (Lower Oolite).
<i>Pterophyllum</i> <i>Nathorsti</i> Sew.	
<i>Nilssonia</i> <i>orientalis</i> Heer.	
<i>Nilssonia</i> <i>brevis</i> Brongn.	
<i>Nilssonia</i> sp. cf. <i>Nilssonia</i> <i>compta</i> (Phill.).	
<i>Nilssonia</i> <i>mediana</i> (Leek.).	
<i>Bucklandia</i> <i>Milleriana</i> , Carr.†	Brora (Lower Oolite).
* <i>Yatesia</i> <i>crassa</i> Carr.†	" " "
* <i>Yatesia</i> <i>Joassiana</i> Carr.†	" " "
<i>Otozamites</i> sp.	
* <i>Otozamites</i> sp.‡	Brora (Lower Oolite).
Cycadean pinnæ, cf. <i>Dioonites</i> <i>Dunkerianus</i> (Goepp.).	
<i>Cycadospadix</i> <i>Pasinianus</i> Zig.	

PLANTÆ INCERTÆ SEDIS.

A, B, C, D (! *Podozamites* sp.).

I. PTERIDOPHYTA.

Hydropterideæ (?)

SAGENOPTERIS, Presl.

The systematic position of this genus of Mesozoic plants is still uncertain. It is not improbable that NATHORST and some earlier writers are correct in assigning Sagenopteris to the Hydropterideæ, an opinion based in the first instance on the resemblance of the leaves to those of Marsilia, and subsequently supported by NATHORST's discovery of bean-shaped bodies, closely resembling the sporocarps of the recent genus, in association with the leaves. These bodies, which have recently been assigned by HALLE§ to a new genus, Hydropterangium, have, however, not been found in organic connection with fronds, and the reference of Sagenopteris to the Hydropterideæ must, therefore, be regarded as provisional and still lacking confirmation.

Sagenopteris Phillipsi (Brongniart). (Text-fig. 1; Pl. I. figs. 1-4; Pl. VI. photos. 3-5; Pl. VII. photo. 19, s.)

Professor LESTER WARD,|| who is a whole-hearted adherent to the rule of priority in its strictest application, has revived the forgotten name [*Pecopteris*] *paucifolia* employed by PHILLIPS in 1829 for this species, which is familiar to all students of Mesozoic botany as *Sagenopteris Phillipsi*, on the ground that BRONGNIART's description was published in 1830, a year subsequent to the date of PHILLIPS' *Geology of Yorkshire*.

The genus Sagenopteris is represented by numerous specimens from Culgower, occurring for the most part as single and usually imperfect leaflets. They vary in size from about 11 cm. in length to 1.5 cm. (cf. Pl. VI. photo. 5, and Pl. VII. photo. 19, s),

* Recorded by M. C. STOPES (07).

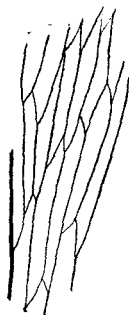
† Described by CARRUTHERS (70).

‡ Recorded by M. C. STOPES.

§ HALLE (10), p. 11. For other references, see SEWARD (10), p. 477.

|| WARD (05), p. 85 (footnote).

and differ considerably in shape. I am, however, unable to detect any satisfactory distinguishing features which justify the specific separation of the several specimens. A considerable range in form and size, in the extent and distinctness of the midrib, and in the contour of the apex is characteristic of the genus; moreover, an examination of a large number of leaflets shows that such distinct forms as those shown in figs. 1 and 3, Pl. I., and photo. 5, Pl. VI., are connected by intermediate types. The portion of a leaf, 8 cm. long, represented in photo. 5, Pl. VI., must have reached a length of at least 11 cm. The midrib extends almost to the apex, and the lateral veins form narrow and long areolæ as they bend steeply upwards and outwards to the edge of the lamina (text-fig. 1). This larger form of leaflet bears a close resemblance to some specimens from the Inferior Oolite of Yorkshire described as *S. Phillipsi* var. *major*.^{*} Photo. 4, Pl. VI., shows an almost complete leaflet in which the midrib is particularly distinct and the characteristic asymmetrical form of the lamina is clearly shown. This specimen



TEXT-FIG. 1.—*Sagenopteris Phillipsi* (Brongn.). Reticulum of secondary veins, with a portion of the midrib on the left. The long sides of the areolæ are approximately .6 mm. apart. (Gunn collection.)

appears to be indistinguishable from *S. Nilssoniana* (= *S. rhoifolia*) as figured by HALLE.[†] The best example in the collection is that shown, rather less than natural size, in photo. 3, Pl. VI. A small piece of axis on the left of the leaflets may be a portion of the common petiole. Fig. 1, Pl. I., shows a slightly larger leaflet in which the apex is somewhat sharper. The linear leaflet, 5.5 cm. long, represented in fig. 3 agrees closely with some of the Yorkshire specimens referred to this species; the secondary veins are obscure, but the midrib is distinct. This narrower form agrees more nearly with *S. undulata* Nath. than with the other Rhætic species *S. Nilssoniana*. The preservation of the specimen shown in fig. 4, though far from good, is sufficiently clear to enable one to refer it to *Sagenopteris*. The leaflets are to some extent intermediate in shape between the longer forms shown in fig. 3 and the shorter and broader examples shown in fig. 1 and in photo. 3, Pl. VI. The apical portion represented in fig. 2 illustrates a lanceolate termination in contrast to the broader tips of many specimens. The small cuneate leaflet seen in photo. 19, s, Pl. VII., is identical with the type described by some authors as a separate species, *S. cuneata*; it is almost certainly a small form of *S. Phillipsi*.

^{*} SEWARD (00), fig. 26, p. 169; (00²), pl. iii. fig. 8.

[†] HALLE (10), pl. ii. figs. 19, 20, etc.

As HALLE points out in his recent paper on *Sagenopteris*,* it is not always possible to distinguish between *S. Nilssoniana* (Brongn.) and *S. Goeppertiana* Zig.; nor indeed is the distinction between *S. Phillipsi* Brongn. and *S. Nilssoniana* by any means clear in all cases, though the latter and older species has usually larger and broader leaflets. The Wealden species *S. Mantelli* (Dunk.), as figured by SCHENK† and other authors, is another variable type which presents a fairly close resemblance to *S. Phillipsi*, but the leaflets tend to be shorter and broader. The separation by MÖLLER‡ of *Sagenopteris* leaflets from the Lower Jurassic of Bornholm into the two species *S. rhoifolia* (= *S. Nilssoniana*) and *S. Phillipsi* does not appear to rest on adequate grounds, nor is it clear why RACIBORSKI§ recognises the two species *S. Phillipsi* and *S. Goeppertiana* in the material from the Lower Jurassic of Cracow. *Sagenopteris Phillipsi* was widely spread in the Jurassic floras of Europe; it has been recorded also from Jurassic beds in North America,|| and the specimens figured by FONTAINE from Lower Cretaceous strata of California as *S. elliptica*¶ probably belong to the same species. NATHORST** describes an Antarctic specimen from Louis Philippe Land as possibly identical with *S. Phillipsi*, and YABE's species *S. bilobata*,†† from the Jurassic of Korea, is perhaps an example of the same type.

FILICINEÆ.

1. Dipteridinæ.

HAUSMANNIA, Dunker.

One of the most interesting discoveries made by Dr GUNN is the presence of *Hausmannia* in the Culgower flora. This generic name, employed in the wider sense in which it is used by RICHTER‡‡ in his admirable monograph of the genus, includes both the Wealden species on which DUNKER founded the genus and the Jurassic species on which ANDRAE§§ founded his genus *Protorhipis*. *Hausmannia* bears a close resemblance in habit to the existing ferns *Dipteris* and *Platycerium*, though the venation and soral characters show it to be more nearly akin to *Dipteris*, a genus which has persisted through the ages in the Indian and Malayan regions.

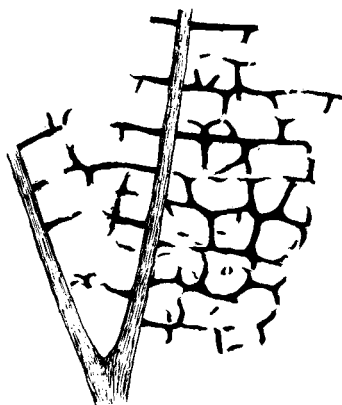
Hausmannia dichotoma Dunk. (Pl. I. figs. 14–17, fig. 19; Pl. II. fig. 20.)

1846. Dunker, *Wealdenbildung*, p. 12, pl. v. fig. 1.

This species is represented by several specimens, many of which are fragmentary, though some (figs. 14, 15, Pl. I.; fig. 20, Pl. II.) furnish striking examples of the deeply lobed fan-shaped fronds. The impression seen in fig. 20 bears a superficial resemblance to *Ginkgo* or *Baiera*, from which it is, however, distinguished by venation characters.

* HALLE (10).	+ SCHENK (71), pl. x. fig. 5.	‡ MÖLLER (02).
§ RACIBORSKI (94), pl. xx.	WARD (05).	¶ WARD (05), p. 236.
** NATHORST (04).	†† YABE (05), pl. iii. fig. 16.	‡‡ RICHTER (06).
		§§ ANDRAE (53).

This leaf, 12 cm. broad, shows a division of the lamina into four primary segments, each of which is deeply lobed. No sporangia have been found on this or any of the specimens. In the leaf represented in fig. 14, Pl. I., 14.5 cm. long, the main ribs are much more clearly preserved, and traces of the finer reticulum are also visible connecting the chief vascular strands, as shown in text-fig. 2 and in fig. 21, Pl. II. The fronds represented in figs. 14, 20 agree exactly with some of RICHTER's specimens from the Lower Cretaceous of Quedlinburg, and exhibit a close resemblance to leaves of recent species of *Dipteris*. Fig. 15, Pl. I., shows part of a smaller leaf with narrow segments, and a piece of a broader lobe with several ribs is seen in fig. 16: the surface of the lamina in the latter specimen presents a pitted appearance,—like that more clearly shown in fig. 17, and which is particularly obvious in RICHTER's photographs,—due to the division of the leaf-area into numerous areolæ by the fine anastomosing veins. The



TEXT-FIG. 2.—*Hausmannia* sp. Part of a dichotomously branched main rib and the intercostal reticulum ($\times 5$). (Peach collection, British Museum, V. 4365.)

imperfect frond shown in fig. 19, though possibly a distinct species, bears a close resemblance to the smaller specimens figured by RICHTER as *H. dichotoma* var. *linearis*.^{*} It differs from the majority of the examples referred to *H. dichotoma* in the more linear form and uniform breadth of the segments, each of which has one median rib. This specimen is very similar to fronds of *Dipteris quinquefurcata* (Baker).[†]

Hausmannia Buchii (Andrae). (Fig. 21, Pl. II.; photo. 6, Pl. VI.; text-fig. 3.)

1853. *Protorhipis Buchii*, Andrae, *Lias Flora von Steierdorf im Banate*, p. 36, pl. viii. fig. 1.

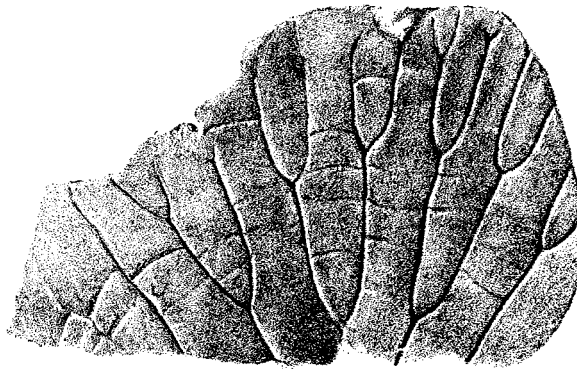
The specimens shown in fig. 21, Pl. II., photo. 6, Pl. VI., and in text-fig. 3 are referred to ANDRAE's species because they agree with his type in the absence of a median sinus and in venation characters. ANDRAE described his species as follows:—"Protorhipis fronde late sinuato-dentata, venis primariis pluries dichotomis validis remotis, venis secundariis et venulis tenerrimis."[‡]

^{*} RICHTER (06), pl. iv. figs. 6, 9, 9a.

[†] SEWARD and DALE (01), pl. xlviii. figs. 13, 18.

[‡] ANDRAE, (53), p. 36.

ZEILLER* has assigned to ANDRAE's species specimens from the Steierdorf beds which differ from the type in the presence of a median sinus, and in this respect agree with RICHTER's species *H. Kohlmanni*: the latter author has made ZEILLER's specimens the type of a new species, *H. Zeilleri*. In the two specimens from Culgower shown in text-fig. 3 and in fig. 6, Pl. VI., the edge of the lamina is torn, and it is difficult to distinguish between true lobing and the result of tearing. The lamina probably reached a length of 12 cm. from the top of the petiole, and a breadth of 16 cm. In some places there are indications of finer veins at right angles to the main ribs. The typical Hausmannia venation is shown in the fragment represented in text-fig. 2, which may belong to this species, and in the enlarged portion of a leaf shown in fig. 21, Pl. II. In RICHTER's species *H. Kohlmanni* the fronds differ but little from those of *H. Buchii*, but the lamina appears to be always characterised by a distinct median sinus. Some of



TEXT-FIG. 3.—*Hausmannia Buchii* (And.) From a block lent by the Cambridge University Press.* (Nat. size.)

* Seward (10), p. 393, fig. 289.

the larger specimens figured by BARTHOLIN† and by MÖLLER‡ from the Lias of Bornholm as *H. Forchammeri* Barth. are hardly distinguishable from *H. Buchii*, though in the Bornholm type there is evidence of considerable variation in the degree of dissection of the lamina.

*General Remarks on the two species Hausmannia dichotoma Dunk. and
H. Buchii (And.).*

Though it would be rash and perhaps incorrect to unite under one specific term fronds differing as much from one another as those represented in fig. 14, Pl. I., and photo. 6, Pl. VI., it is admissible to suggest the possibility that Hausmannia may have been a heterophyllous epiphytic fern like *Platyserium*. As in that tropical epiphyte we find long and deeply lobed leaves like those of *H. dichotoma*, acting as carbon-assimilating organs, and another form of frond, the so-called mantle-leaf, orbicular and entire, adapted to the collection of débris; so in the Jurassic species there may have been a similar division of labour in the foliar organs. This somewhat

* ZEILLER (97), pl. xxi. figs. 1-5, p. 51.

† BARTHOLIN (92), pls. xi., xii.

‡ MÖLLER (02), pls. iv., v.

TRANS. ROY. SOC. EDIN., VOL. XLVII. PART IV. (NO. 23).

fanciful suggestion was prompted by a photograph illustrating a new species of *Platycterium*, recently described from Malaya by Dr CHRIST,* in which the longer and deeply lobed fronds are almost identical with those of *H. dichotoma*, while the smaller orbicular leaves may be compared with those represented in text-fig. 3 and in photo. 6, Pl. VI. In the recent genus *Dipteris* the stem is rooted in the ground and the fronds are not markedly dimorphic, and it is to this genus rather than to *Platycterium* that *Hausmannia* appears to be closely allied. The Bornholm species *H. Forchammeri* shows a degree of variation in the dissection of the lamina which illustrates the risk of regarding such differences as characterise *H. dichotoma* and *H. Buchii* as necessarily of specific rank. It would, however, be unjustifiable to unite forms so distinct as those shown in fig. 14, Pl. I., and photo. 6, Pl. VI., without the evidence of clearly marked transitional fronds. The important point is, not so much the delimitation of specific boundaries, a task on which the palæobotanist wastes much time, but the fact that the genus *Hausmannia* played a prominent part in the Jurassic floras of Europe. There can be little doubt that in the Malayan and Indian *Dipteris* we have a nearly related fern, which is a direct descendant of Jurassic ancestors some of which played a part in the flora of Culgower. *Hausmannia* is recorded from the Wealden of North Germany by DUNKER and SCHENK: the fragment described from the English Wealden as *Dictyophyllum Römeri* Schenk,† and a specimen from the Bernissart beds of Belgium referred to that species,‡ are probably portions of *Hausmannia* leaves. The Lower Cretaceous species *Asplenium Forsteri* Deb. and Ett.§ is probably identical with *H. dichotoma*. The fragment figured by FONTAINE from the Lower Cretaceous Shasta formation as ? *Hausmannia californica* || may be a piece of a *Hausmannia* frond; it is possible that the specimen described by the same author as *Marchantites erectus* (Leck.) ¶ from the Jurassic of Oregon is also referable to *Hausmannia*.

Hausmannia Richteri sp. nov. (Figs. 18, 18A, Pl. I.)

The small incomplete leaf shown in fig. 18 seems worthy of a distinctive name. A similar form is described by NATHORST as *Hausmannia crenata* ** from the Rhætic of Scania, the type-specimen being refigured by SAPORTA; †† other similar leaves are represented by ZIGNO's *Protorhipis asarifolia* ‡‡ from the Jurassic of Northern Italy, and *P. cordata* Heer §§ from the Lower Cretaceous of Greenland. The orbicular Culgower type is characterised by a somewhat irregularly crenulate margin and by the absence of prominent main ribs. As seen in fig. 18A, the lamina is divided by anastomosing veinlets into polygonal areas abutting on forked veins: the enlarged drawing is shown with the upper end pointing downwards. A similar form of leaf is met with also in the recent *Dipteris conjugata*.|||

* CHRIST (09). † SEWARD (94), p. 140.

§ DEBEY and ETTINGSHAUSEN (59), pl. ii. fig. 11.

¶ WARD (05), pl. vi. fig. 1, p. 53.

†† SAPORTA (94), pl. xxii. fig. 12.

§§ HEER (80), pl. iii. fig. 11.

‡ SEWARD (00³), pl. iii. fig. 34.

|| WARD (05), pl. lxxv.

** NATHORST (86), pl. xi. fig. 4.

‡‡ ZIGNO (68), pl. ix. fig. 2.

||| SEWARD and DALE (01), pl. xlviii. fig. 23.

2. Matonineæ.

LACCOPTERIS, Presl.

The Sutherland specimens referred to this genus would no doubt be placed by some authors in SAPORTA'S genus *Microdictyon*, but as stated elsewhere,* the supposed distinction as regards venation which led to the creation of the latter name does not seem to me sufficiently important to justify generic separation.

Lacopteris Dunkeri Schenk. (Pl. I. figs. 5-13; Pl. V. figs. 101, 101A; Pl. VII. photo. 7; text-fig. 4.)

1871. Schenk, *Palæontographica*, Bd. xix. p. 219, pl. viii. figs. 3-5.

This species is abundantly represented by fragments of pinnules nearly all of which are fertile; in a few specimens part of a rachis or pinna-axis is preserved showing the attachment of linear segments (fig. 6, Pl. I.; fig. 101, Pl. V.; photo. 7, Pl. VI.). While most of the pinnules have a breadth of about 5 mm., a few are 9 mm. broad. The lamina is usually represented by a fairly thick layer of carbonaceous matter, and the edges are often revolute, facts pointing to strong and thick pinnules. The specimens illustrated in figs. 5, 8, 9, 10, Pl. I., and photo. 7, Pl. VI., despite the difference in size, are included under one name because of the occurrence of intermediate forms and their agreement as regards venation. Several specimens were treated with nitric acid and chlorate of potash, but no sporangia were found. The sori are circular, with a central receptacle (fig. 11A, Pl. I.), as in the recent genus *Matonia*.

Fig. 101, Pl. V., shows part of an axis 11 cm. long bearing alternate and sub-opposite linear segments characterised by a prominent midrib. At first sight this very obscure impression suggested a comparison with NATHORST'S genus *Pseudocycas*,† but closer examination revealed the presence of faint soral impressions (fig. 101A). One of the longest pinnules is seen in fig. 9, Pl. I.; this has a length of 6 cm. and a uniform breadth of 4 mm., but it is broken across at each end and must have been much longer. The sori, which occur in two rows, are generally preserved as prominent bosses with a central pit (figs. 11, 11A). The repeatedly branched secondary veins form a reticulum like that in the Inferior Oolite species *L. polypodioides* and in the specimens of *L. Dunkeri* from the Wealden of Germany and Belgium. The venation of sterile segments is clearly shown in text-fig. 4, and in the smaller pinnule in figs. 8, 8A. Fig. 12, Pl. I., shows the repeatedly forked veins at right angles to the midrib of a fertile segment. The fertile fragment represented in fig. 7, Pl. I., illustrates a fairly common manner of occurrence of detached pinnules; the coiled lamina may indicate immaturity. In some specimens (fig. 10) the base of the lamina is slightly rounded, while in fig. 6 the attachment to the axis appears to be by the whole base. The fragment shown in fig. 13 is identical, except

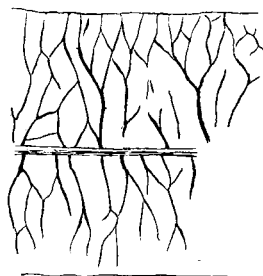
* SEWARD (10), p. 360. See also SEWARD (99).

† NATHORST (07).

in its greater breadth, with such specimens as those seen in figs. 9 and 11. The larger example shown in photo. 7, Pl. VI., bears a close resemblance to the genus *Nathorstia*, the fructification of which has been recently described by NATHORST,* but I have no doubt as to its generic identity with the smaller forms.

It is not always easy to distinguish between *Lacopteris* and *Nathorstia*; the form of the pinnules is the same but the sori are distinct, those of the latter genus having Marattiaceous affinities, while *Lacopteris* appears to be allied to *Matonia*. Dr NATHORST, whose opinion I sought as to the nature of the fossil shown in photo. 7, examined specimens from the same locality in his own collection and expressed the view that the resemblance to *Nathorstia* does mean near relationship.

Specimens undoubtedly identical with the Culgower plant are recorded from the Wealden of Belgium, Germany, and England. The Jurassic species *L. polypodioides* Brongn. and *L. Woodwardi* (Leck.)† differ but little from the Sutherland fern.



TEXT-FIG. 4.—*Lacopteris Dunkeri* Schenk. Venation of a piece of sterile pinnule ($\times 8$). (Gunn collection.)

SAPORTA's specimens from the Bathonian of France described as *Microdictyon Woodwardi*‡ and RACIBORSKI's fossils§ from the Lias of Poland described under the same name afford examples of this widely spread Mesozoic generic type. The specimens figured by DEBEY and ETTINGSHAUSEN from the Lower Cretaceous of Aachen as *Carolopteris aquensis*|| bear a close resemblance to the Scotch species, and examples of *Lacopteris* figured by BARTHOLIN as *Microdictyon* sp.¶ from Bornholm are very similar to the specimen represented in photo. 7, Pl. VI.

MATONIDIUM, Schenk.

Matonidium Goepperti (Ettingshausen). (Pl. II. figs. 25, 26.)

1846. *Pecopteris Althausii*, Dunker, *Wealdenbildung*, p. 5, pl. ii. fig. 2.

1852. *Alethopteris Goepperti*, Ettingshausen, *Abh. k.-k. geol. Reichs.*, Bd. i., Abth. iii., No. 2, p. 16, pl. v.

1871. *Matonidium Goepperti*, Schenk, *Palæont.*, Bd. xix. p. 219, pls. xxvii., xxviii.

I have retained the specific name instituted by ETTINGSHAUSEN as being better known than the older name under which DUNKER first described the Wealden specimens

* NATHORST (08).

† SAPORTA (73), pl. xxx.

|| DEBEY and ETTINGSHAUSEN (50), pl. iii. figs. 20-27.

† SEWARD (00), pls. xii. xiii.; text-fig. 11a.

§ RACIBORSKI (94), pl. xiii. figs. 10-14.

¶ BARTHOLIN (92), pl. x. fig. 2.

of this fern. LESTER WARD* has revived DUNKER's original name on the ground of strict priority.

The two specimens shown in figs. 25, 26, Pl. II., though imperfectly preserved, bear so close a resemblance to the Jurassic and Wealden type *Matonidium Goepperti*, as also to the pinnæ of the recent species *Matonia pectinata*, that I venture to regard them as pieces of a *Matonidium* frond. The ultimate segments are falcate, with blunt apices and a prominent midrib; the lateral veins are only slightly indicated. In herbarium specimens of *Matonia* the prominence of the midrib is a striking feature, and it is easy to realise the possibility that an impression of a pinna on a coarse matrix might well lack any traces of the lateral veins.

3. Gleicheniaceæ.

GLEICHENITES, Goeppert.

Gleichenites Boodlei sp. nov. (Pl. III. figs. 42, 42A, 43, 43A.)

Though it is impossible to give an adequate diagnosis of the fragment which I have named after Mr BOODLE of the Jodrell Laboratory, Kew, who has considerably extended our knowledge of the anatomical features of the recent Gleicheniaceæ, it is convenient to adopt a specific name. The fragment reproduced natural size in fig. 42, Pl. III., consists of two prominent carbonised rods, enclosed in fibrous tissue, converging and slightly increasing in diameter towards the lower edge of the specimen. A section of the two axes along the line *ab* is shown in fig. 42A. Each axis consists of a central rod of xylem, *X*, fig. 43, partially surrounded by patches of more delicate tissue, *P*, probably representing the remains of phloem and pericyclic tissue. Separated from the xylem-rod or protostele by a space occupied by crystalline material is a broad cylinder of cortical tissue; the inner portion of the cortex, *c'*, is almost opaque and is composed of very thick cells; this is succeeded by a zone of well-preserved and fairly thick-walled cells, *c''*, which are crushed in the peripheral region, *c'''*. The portion of the stele enclosed in the loop *a*, fig. 43, is shown on a larger scale in fig. 43A. The group of small elements at *Px* may safely be identified as protoxylem; the main mass of the stele is composed of scalariform metaxylem tracheids, *Mx*, with occasional islands of parenchyma. At *P*, fig. 43A, a portion of the smaller and thinner phloem elements is shown. A few of the patches of protoxylem can be made out in the two steles, occupying a position slightly internal to the outer edge of the xylem. The structure of the protosteles in the axes appears to be identical with that of some recent species of *Gleichenia*. The convergence of the two axes suggests dichotomous branching, presumably of a rhizome, as the vascular structure agrees with that in the stem rather than with that of the rachis of recent species.

* WARD (99), p. 653.

Gleichenites cycadina (Schenk). (Text-fig. 5; Pl. III. figs. 48–54A;
Pl. V. figs. 87–89, 92–96.)

1871. *Alethopteris cycadina*, Schenk, *Palæontographica*, Bd. xix. p. 218, pl. xxvii. figs. 6, 6a, pl. xxxi. fig. 2.
1871. *Pecopteris Dunkeri* (pars), *ibid.*, pl. xxxi. fig. 1.
1876. *Alethopteris cycadina*, Schenk, *Palæont.*, Bd. xxiii., pl. xxvi. fig. 6.
1894. *Nathorstia valdensis*, Seward, *Wealden Flora*, vol. i. p. 145, pl. vii. fig. 5, pl. ix. figs. 2, 2a.
1895. *Leckenbya valdensis*, Seward, *Wealden Flora*, vol. ii. p. 225.
1900. *Leckenbya valdensis* and *Cladophlebis Dunkeri* (pars), Seward, *Mém. Mus. d'Hist. Nat. Belgique*, tome i. p. 24, pl. iii. figs. 42–46, 51.

The fern identified as *Gleichenites cycadina* is one of the commonest species in the Culgower flora, but its abundance is no doubt in great measure due to the delicate or brittle structure of the pinnæ; it occurs almost always as very small pieces of fronds. The best specimen is that represented in fig. 50, Pl. III., one of the few examples showing pinnæ in connection with a supporting axis. The examination of a large number of examples enables me to give the following incomplete diagnosis:—Frond compound; pinnæ, which are given off at a wide angle (fig. 50), usually narrow and linear, and probably reaching a considerable length without much difference in breadth; as seen in figs. 52, Pl. III., 88, 89, Pl. V., they taper very gradually towards the distal end. The fronds also bore pinnæ of a lanceolate form with pinnule decreasing more rapidly in length towards the apex of the pinna (figs. 54, Pl. III.; 94, 95, Pl. V.). Pinnules thick, contiguous or slightly separated (figs. 48, 49, 52, Pl. III.; text-fig. 5, A, B), varying considerably in size and form; the smaller pinnules may be more or less semicircular, sub-orbicular, or deltoid (*cf.* figs. 51, 51A, 53, Pl. III.; 87, 89, Pl. V.), with a bluntly rounded apex and basal angles; these pass into longer and relatively narrower segments (figs. 48, 48A, 50, 52, etc.), some of which are several times longer than broad (*e.g.* fig. 49, Pl. III.). In the case of some of the smaller pinnules the lamina appears to be attached by the whole breadth of the base (figs. 92, 96), but in this specimen the actual pinnules are not preserved and the appearance of the hollow mould may be misleading. As a rule the base of the pinnule is rounded and the lower edge forms a prominent and thick lobe (figs. 48A, 49, Pl. III.; 87, 88A, Pl. V.). In the unusually large pinnule represented in fig. 92, Pl. V., the upper edge of the base is slightly lobed. The lamina is usually entire, but in the longer pinnules the edge becomes crenulate (figs. 54, 54A, Pl. III.; 93, 93A, 95, 95A, Pl. V.). The sori are circular and occur in a single row on each side of the midrib; they are best seen in pinnules from which the thick carbonaceous film has been removed, and are preserved as a projecting circular rim enclosing a depression which no doubt marks the position of a central receptacle like that in *Laccopteris* and other ferns (figs. 54A, Pl. III.; 95A, Pl. V.). No sporangia have been found. The venation consists of a midrib giving off dichotomously branched veins at a fairly wide angle (figs. 48A, 49, Pl. III.; 87, 96, Pl. V.; text-fig. 5). The thick carbonaceous layer representing the lamina indicates pinnules of a fleshy xerophilous type.

No decisive evidence has been obtained as to the affinity of this fern, though the facts favour the view that it is closely allied to the genus *Gleichenia*. Such specimens as those represented in figs. 50–52, Pl. III., 88, 89, Pl. V., bear a close resemblance to the pinnæ of recent species of *Gleichenia*, as also to some of the Lower Cretaceous species figured by HEER: the form of the soral casts is consistent with this comparison. A piece of collateral evidence is furnished by the petrified fragment, presumably of a stem, represented in figs. 42–43, Pl. III., and described as *Gleichenites Boodlei*. This specimen has no pinnules in connection with it and cannot therefore be assigned to the same species as the detached pinnæ of *G. cycadina*. The Gleicheniaceæ are known to have been represented in European floras during the Lower Cretaceous period: HEER's Greenland specimens of well-preserved fronds and the anatomical characters discovered by Dr BOMMER in stems from Wealden beds in Belgium constitute decisive proof.* Some at least of the specimens which I described in 1894 as *Leckenbya valdensis*† from the Wealden of Sussex are identical with the Culgower fern; there is, however,



TEXT-FIG. 5.—*Gleichenites cycadina* (Schenk).

- A. Sterile pinnules ($\times 5$). (Arber collection, 496.)
 B. Sterile pinnules ($\times 4$). (Arber collection, 554.)

little doubt as to the identity of the German Wealden species described by SCHENK as *Alethopteris cycadina* with the Sutherland type, which is therefore referred to the older species founded in 1871. The sori of the German specimens appear to agree with those represented in fig. 95A, Pl. V. The small fragment figured by SCHENK as *Sphenopteris delicatissima*‡ may be a piece of the distal end of a pinna of *Gleichenites cycadina*, and some of the examples identified by SCHENK as *Pecopteris Dunkeri* are indistinguishable from the Culgower fern. The prominent basal lobe of the pinnules of *Gleichenites cycadina* constitutes a distinguishing feature between this type and several species of the same genus described from Jurassic and Lower Cretaceous localities. A comparison may be made with the following species: *Gleichenites* sp. described by NATHORST§ from Upper Jurassic beds in Spitzbergen; pieces of pinnæ from Wealden rocks in Japan referred by the same author to *Pecopteris Geyleriana*;|| HEER's Greenland species *Gleichenites delicatula*;¶ FONTAINE's plant from the Lower Cretaceous of California figured as *Gleichenia Nordenskioldi* Heer; ** FEISTMANTEL's *Pecopteris tenera*†† from the Jurassic of Cutch, India; also the Indian fern *Pecopteris*

* SEWARD (10), p. 353.

‡ SCHENK (71), pl. xxvii. fig. 3.

¶ HEER (75), pls. ix., x.

† SEWARD (94), p. 145; (95), p. 225.

§ NATHORST (97), pl. ii. figs. 15, 16.

** WARD (05), pl. lxv.

|| NATHORST (90), pl. iv. fig. 3.

†† FEISTMANTEL (76), pl. iii. fig. 5.

gleichenoides Old. and Morr.;* some of the species of *Gleichenites*† recorded by VELENOSKÝ from Lower Cretaceous rocks of Bohemia; the Lower Jurassic fern described by RACIBORSKI from Poland as *Gleichenites Rostafinskii*,‡ as well as other species. In the absence of venation-characters it would be easy to confuse small pieces of *Weichselia Mantelli* with *Gleichenites*; fragments of *Weichselia* from the Wealden beds of Bernissart in Belgium,§ apart from the reticulate venation, bear a very close resemblance to *Gleichenites*. The plant described by FONTAINE from the Lower Cretaceous Shasta formation of California as ? *Gleichenia Gilbert Thompsoni*|| is probably part of a *Weichselia* frond.

4. Cyatheaceæ (?).

CONIOPTERIS, Brongniart.

Coniopteris hymenophylloides (Brongniart). (Pl. III. figs. 44-46 A ; Pl. VIII., photo. 27.)

1828. Brongniart, *Hist. vég. foss.*, p. 189, pl. lvi. fig. 4.

The small pieces of leaves of the *Sphenopteris* type obtained from the Sutherland rocks do not afford very decisive evidence as to their affinity, but, with the exception of the specimen represented in Pl. VIII., fig. 28, they agree closely with Brongniart's species *Coniopteris hymenophylloides*. The rachis is winged and the pinnules vary slightly in the degree of dissection of the lamina. The fragment shown in fig. 46A, Pl. III., slightly enlarged, is characterised by the narrow form and distally expanded end of some of the segments, features which suggest comparison with the more complete fertile examples of the species from other localities. *Coniopteris hymenophylloides* is an exceedingly abundant Jurassic fern which has been described under various generic names, *Thyrsopteris*, *Dicksonia*, *Sphenopteris*, etc. It is recorded from such widely separated regions as the Antarctic and Arctic regions, California and Japan.

Coniopteris arguta (Lindley and Hutton). (Pl. IV. figs. 58, 59 ; Pl. VIII. photo. 31.)

1834. *Neuropteris arguta*, Lindley and Hutton, *Foss. Flor.*, pl. cv.

1900. *Coniopteris arguta*, Seward, *Jurassic Flor.*, vol. i. p. 115, pl. xvi. figs. 3, 3a, pl. xvii. figs. 4, 5.

The habit of this fern is most clearly seen in the large but faint impression shown in fig. 58. A broad rachis, 15 cm. long, gives off alternate short linear-acuminate pinnæ bearing oblique linear pinnules with apparently entire margins and rather blunt apices. A smaller specimen is reproduced in photo. 31, Pl. VIII.; the venation is very obscure, a few traces of secondary veins being visible. The broader pinna shown in fig. 59, which agrees in shape with the smaller pinnæ on other specimens, bears longer-lobed pinnules. In the absence of fertile pinnules it is impossible to determine the affinity of these

* OLDHAM and MORRIS (63), pl. xxv.

† RACIBORSKI (94), pl. xiii. figs. 15-21.

‡ VELENOSKÝ (85), pl. iii.

§ SEWARD (00³).

|| WARD (05), p. 232.

specimens with confidence, but the resemblance to the sterile fronds of *Coniopteris arguta* from the Yorkshire beds is, I think, sufficiently close to justify the adoption of that specific name. It is difficult in the case of fragmentary examples to distinguish between the pinnæ of *C. arguta* and *Klukia exilis* (Phill.). An Indian species, *Pecopteris? lobata* Old. and Morr.,* may be identical with this type.

Coniopteris quinqueloba (Phillips). (Pl. VIII. fig. 28.)

1875. *Sphenopteris quinqueloba*, Phillips, *Geol. Yorks.*, p. 215, fig. 33.

The small pinnules of the piece of frond represented in photo. 28 indicate a more delicate type than *Coniopteris hymenophylloides*; they agree in their oblong deltoid shape and lobed, basally constricted, lamina with the segments of the species which PHILLIPS described from the Yorkshire coast as *Sphenopteris quinqueloba*, a fern subsequently referred to *Coniopteris* on the discovery of fertile segments by NATHORST.† A specimen of PHILLIPS' species in the Bean collection in the British Museum (39,263) agrees precisely with the Culgower fragment in the nature of the pinnæ and pinnules. This fern may be compared with *Hymenophyllites delicatulus* Sap.‡ from the French Corallian, and with SALFELD's figure of *Stachypteris lithophylla*§ from the Corallian of Germany.

5. Osmundaceæ.

TODITES.

Todites Williamsoni (Brongn.). (Pl. II. figs. 27, 27A; Pl. IV. fig. 57; Pl. VII. fig. 15.)

1828. *Pecopteris Williamsoni*, Brongniart, *Prodrome*, p. 57.

1900. *Todites Williamsoni*, Seward, *Jurassic Flora*, vol. i. p. 87, pl. xiv. figs. 2, 5, 7; pls. xv., xxi.

The specimen represented in fig. 27, Pl. II., 7 cm. in length, has an almost uniform breadth, 5–8 mm., and gives the impression of having formed part of a long and very gradually tapered pinna. The pinnules are falcate and acutely pointed, the upper margin is slightly lobed at the base and the lower edge strongly curved; the venation is obscure, but is seen in the enlarged drawing (fig. 27A) to consist of a midrib with secondary forked veins arising at an acute angle. An almost complete distal end of a linear pinna is shown in fig. 57, Pl. IV. A larger though more imperfectly preserved specimen reproduced in photo. 15, Pl. VII., affords evidence as to the nature of the plant. Portions of four linear pinnæ are attached at an acute angle to a broad rachis, the longest pinna being indistinguishable from the pieces shown in figs. 27, 57; it reaches a length of 12 cm. The axis of each pinna is fairly broad. This larger example exhibits the features characteristic of *Todites Williamsoni*, which are well illustrated in the numerous specimens described from the Inferior Oolite of Yorkshire,|| namely

* OLDHAM and MORRIS (63), p. 52.

† SEWARD (00), p. 114, fig. 15.

‡ SAPORTA (91), p. 389.

§ SALFELD (09), pl. iii. fig. 4.

|| SEWARD (00).

the very long tapering pinnæ, the broad pinnules with a strongly curved lower margin, and the broad rachis. Unfortunately none of the segments in the Sutherland specimens show any certain indications of sporangia, but in spite of this I have no hesitation in adopting the generic title *Todites*. Portions of smaller pinnæ of this type bear a close resemblance to the Wealden species *Cladophlebis longipennis* Sew.,* but the slightly contracted base of the pinnules in that species is a distinguishing feature. It is at first sight not always easy to distinguish between the smaller *Todites* pinnæ and those of *Sphenopteris onychiopsoides*† such as that shown in fig. 24, Pl. II., but closer inspection reveals a deeper sinus between the narrow segments of the latter type. The specimens referred to *Todites Williamsoni* have rather smaller pinnules than those borne on some of the larger specimens from the Yorkshire beds, but in some cases the agreement seems to be absolute: compare especially photo. 15, Pl. VII., with figs. 1 and 2, pl. xv., of my *Jurassic Flora of Yorkshire* (vol. i., 1900).

The specimens figured by YOKOYAMA‡ from China as *Todites Williamsoni* are undoubtedly portions of *Cladophlebis* fronds, in habit like *C. denticulata*, but in venation agreeing with *C. Raciborski* Zeill.§ The Keuper species described by LEUTHARDT from Basel as *Pecopteris Rutimeyeri*,|| though not specifically identical with the Culgower plant, is almost certainly a species of *Todites*. RACIBORSKI's species from the Lower Jurassic of Poland, *Cladophlebis solida*,¶ is very close to the Scotch specimens in habit and in the form of the pinnules.

Osmundaceæ (?).

CLADOPHLEBIS, Brongniart.

The employment of this name is professedly a confession of ignorance as regards the family position of the species so named; but in regard to *Cladophlebis denticulata* Brongn., or at least some of the examples of this type, it is probable that we should be correct in assigning the species to the Osmundaceæ.**

Cladophlebis denticulata (Brongniart). (Pl. II. figs. 31–36, 38; Pl. VI. photos. 8, 9; Pl. VIII., photo. 29.)

1828. *Pecopteris denticulata*, Brongniart, *Prodrome*, p. 57.

The limits of this species are very difficult, or indeed impossible, to determine with precision. It is clear that the fronds reached a considerable size, and there must have been a considerable range in the form and size of the pinnules. Professor ZEILLER, in the *Monograph of the Tonkin Flora*, discusses with his customary clearness the distinguishing features of certain types of *Cladophlebis*. He speaks of *C. denticulata*†† as usually

* SEWARD (94), pl. ix. fig. 1.

† See *postea*, p. 672.

‡ YOKOYAMA (06), pls. v.–viii.

§ ZEILLER (03), p. 49.

|| LEUTHARDT (04), pl. xv.

¶ RACIBORSKI (94), pl. xxiv. figs. 10–13.

** SEWARD (10), p. 340.

†† ZEILLER (03), p. 47.

recognisable by its large pinnules, broadest at the base and with denticulate margins, also by the ultimate segments being less crowded than in the similar type *C. nebbensis*, and by the single dichotomy of the secondary veins. It is very doubtful whether the presence or absence of marginal teeth is a feature of importance. Pinnæ are often met with in Jurassic rocks bearing entire pinnules indistinguishable from those of *C. denticulata* except by the absence of denticulations. The specimen reproduced in photo. 9, Pl. VI., is a case in point: the pinnules are apparently entire, but in other respects identical with those of the typical *C. denticulata*. A denticulate margin is seen in the portion of a pinnule represented in fig. 38, Pl. II., and in the pinnules enlarged in fig. 31. It is not easy in the case of apical portions of fronds to separate *C. denticulata* from *Todites Williamsoni* (Brongn.), but as a rule the shorter and relatively broader segments and their more crowded arrangement constitute well-defined characteristics of the latter species. Photo. 9, Pl. VI., shows the falcate form of the linear pinnules with broad bases, the alternate pinnæ, and the single dichotomy of the lateral veins. In some of the Culgower specimens the pinnules reach a length of 2.5 cm. and a breadth of 7 mm. The rachis is narrower than in *Todites Williamsoni*. The degree of inclination of the segments to the pinna axis is by no means constant; the lower edge is usually strongly curved upwards, as in photo. 9, and a still greater inclination is seen in figs. 35, 36, Pl. II. The specimen represented in photo. 8, Pl. VI., has shorter pinnules than those seen in many examples, but the venation appears to conform to the type. A smaller apical piece is shown on fig. 34, Pl. II.: fig. 32, Pl. II., shows the characteristic venation. With some hesitation I refer the specimens represented in photo. 29, Pl. VIII., and in fig. 33, Pl. II., to this species, though the straighter and narrower form of the pinnules may be a specific character. In the case of the impression shown in photo. 29 the preservation is far from good, and the narrower form may be partially due to this fact. The imperfect fragment represented in fig. 56, Pl. IV., is apparently characterised by a lobing of the pinnules and may belong to a distinct type or even to another genus, *e.g.* *Thinnfeldia*: the preservation is, however, too imperfect for satisfactory determination. Photo. 29, Pl. VIII., bears a very close resemblance to specimens described by VELENOVSKÝ* as *Pteris frigida* Heer from Lower Cretaceous rocks in Bohemia, and to the Indian Jurassic fern figured by FEISTMANTEL as *Alethopteris Medlicottiana* Old.†

Cladophlebis denticulata had a very wide geographical range in the Jurassic period; it closely resembles *C. nebbensis* Brongn. as represented by such specimens as those figured by NATHORST‡ from the Rhætic beds of Scania, and by ZEILLER§ and YOKOYAMA|| from the Rhætic of Tonkin and Japan respectively. The Lower Cretaceous species *C. Albertsi* (Dunk.) from the Wealden of Germany and England,¶ also *C. frigida* (Heer) from Greenland** and elsewhere, are similar forms of the genus. The fronds described by HARTZ from Lower Jurassic (or Rhætic) strata in Greenland as

* VELENOVSKÝ (85), pl. iv.

§ ZEILLER (03).

† FEISTMANTEL (77), pl. i.

|| YOKOYAMA (05).

‡ NATHORST (78).

¶ SEWARD (94).

** HEER (82).

*C. Roesserti groenlandica** agree closely with the Culgower specimens bearing broader pinnules, and *C. Stewartiana* Hartz is hardly distinguishable from the example represented in Pl. VI. fig. 9. The specimens described by YOKOYAMA from Wealden beds in Japan as *C. Nathorsti*† are probably pieces of *C. denticulata*. In recording the occurrence of *C. denticulata* in Jurassic rocks in the Caucasus‡ I incorrectly referred to a specimen, described by YOKOYAMA from the Jurassic of China as *Todites Williamsoni*, as being *C. denticulata*, without noticing that the secondary veins are more than once forked: the China species may be identical with *C. Raciborski* Zeill. from the Rhætic of Tonkin; it is certainly not *Todites*.

6. Marattiaceæ.

MARATTIOPSIS, Schimper.

Marattiopsis Boweri sp. nov. (Pl. II. figs. 28, 29.)

The incomplete leaflet shown in fig. 29 is characterised by a fairly broad midrib which gives off single or forked lateral veins at a wide angle, and by the occurrence of marginal sori. Although no sporangia can be recognised, I have little doubt as to the close relationship of this and similar pinnules to recent Marattiaceous ferns. The sterile fragment represented in fig. 28 probably belongs to the same species: the lateral veins are obscure, though it is clear that they were more numerous than in the pinnules of such a species as *Cladophlebis denticulata*, from which they differ also in the thinner lamina, which in most of the few examples met with is more or less torn. It is unfortunate that the material on which this species is founded is not more satisfactory, but despite the imperfection of the specimens I venture to regard the pinnules as those of a Marattiaceous fern probably distinct from species hitherto recorded. The well-known Rhætic species *M. Muensteri* (Goepp.) and *Angiopteridium californicum* Font. from the Jurassic flora of Oregon bear a resemblance to the smaller Culgower type. §

7. Ferns of Uncertain Affinity.

CLADOPHLEBIS, Brongniart.

Cladophlebis sp. cf. *C. haiburnensis* (Lind. and Hutt.). (Fig. 30, Pl. II.)

In a few of the numerous specimens of *Cladophlebis* the pinnules are more crowded on the pinnæ than is usual in *C. denticulata*, and differ in their straighter form and in the repeated dichotomy of the secondary veins. One of these is shown in fig. 30, Pl. II. This form agrees very closely with that described by LINDLEY and HUTTON as *Pecopteris haiburnensis*|| from the Inferior Oolite of East Yorkshire. This species is recorded also from Jurassic beds in Turkestan,¶ and by Fontaine** from Jurassic beds in Oregon.

* HARTZ (96).

† YOKOYAMA (94).

‡ SEWARD (07).

§ WARD (00), pl. lv.

|| LINDLEY and HUTTON (36), pl. clxxxvii.

¶ SEWARD (07), pl. vi.

** WARD (05).

A very similar, if not identical type, is figured by HEER from Jurassic rocks in the Amur district as *Asplenium spectabile*.^{*} Specimens figured by BARTHOLIN[†] and by MÖLLER[‡] from Bornholm as *C. nebbensis* also agree closely with the Culgower fossil.

Cladophlebis sp. cf. *C. distans* (Heer). (Photo. 16, Pl. VII.)

In this specimen the pinnules are very similar to those seen in fig. 30, Pl. II., but the lamina is slightly narrower and the veins are once forked as in *C. denticulata*. This specimen may be identical with HEER's Siberian Jurassic type *Asplenium distans*.[§] The same form is recorded also by DAWSON^{||} from the Lower Cretaceous of the Rocky Mountains of Canada and by SCHENK[¶] from Jurassic rocks in China as *Asplenium distans* and *A. argutulum* Heer respectively.

Cladophlebis sp. (Pl. III. fig. 47.)

This imperfectly preserved distal portion of a frond or large pinna bears a fairly close resemblance to the specimens which I have included in *Coniopteris arguta*, but the evidence for describing it under that species is hardly sufficient. In the upper branches of the rachis the lamina is crenulate, while in the lower pinnæ the lobes of the lamina are replaced by small pinnules.

RHIZOMOPTERIS, Schimper.

Rhizomopteris Gunni sp. nov. (Pl. II. fig. 40; Pl. III. figs. 41, 41A.)

Fig. 40, Pl. II., shows part of a trailing rhizome of a fern similar to that of *Davallia*, *Dipteris*, and many other recent ferns. The portion of the specimen preserved as a solid rod shows the stumps of three petioles, and, towards the lower surface, the small scars of adventitious roots. The anatomical examination of this fragment has been only partially successful, owing to the imperfection of the preservation of the tissues and to the difficulty of obtaining sections. The diagrammatic sketch of a transverse section (6 × 4 mm.) reproduced in fig. 41, Pl. III., illustrates the general features. The greater part of the section consists of thick-walled tissue composed of cells fairly uniform in size, A, B; the outer region, A, is clearly cortical (ground-tissue), but the nature of the central region, B, is less easy to determine. My first impression was that the axial tissue consisted of xylem surrounded by a black band of partially disorganised phloem and pericycle, S. More thorough examination, however, leads me to describe the axial tissue, B, as ground-tissue enclosed by a ring of crushed and very imperfectly preserved vascular tissue, S. I regard the rhizome as solenostelic: the stele, S, S, fig. 41A, shows but little structure, but here and there one sees a few large elements, which probably represent xylem tracheids, and groups of small cells, presumably phloem or pericycle elements. The appearance of the central tissue, B, is seen to correspond exactly with that of the patch

* HEER (77), pl. xxi.

§ HEER (77), pl. xix.

† BARTHOLIN (92), pl. vii.

|| DAWSON (85), pl. iii.

‡ MÖLLER (02), pl. iii.

¶ SCHENK (83), pl. xlv.

of ground-tissue (cortex) shown at A'. In spite of the unsatisfactory condition of the specimen, I feel little doubt as to the solenostelic structure of the stem. Attempts * to obtain a longitudinal section were unsuccessful, nor was it possible to cut a transverse section through the base of a petiole, which would probably have shown the solenostele interrupted by the departure of the leaf-trace.

The type of stele which I believe to be illustrated by the Culgower rhizome, namely a hollow cylinder or solenostele, is met with in several genera of recent ferns, notably in the genus *Dipteris*. The resemblance to this fern is especially significant in view of the abundance of *Hausmannia* leaves in the same rocks, a Mesozoic genus which is almost certainly very closely related to recent species of *Dipteris*. The habit of *Hausmannia* rhizomes as described by RICHTER † agrees with that of the fossil stem, and both resemble closely the rhizome of *Dipteris*. A transverse section of a rhizome of *Dipteris* bears a striking resemblance to that of the Culgower specimen in the structure of the cortical and axial ground-tissue and, making allowance for contraction of the vascular tissue previous to petrification, the form and size of the stele are very similar. While recognising the necessity of describing *Rhizomopteris Gunni* as a rhizome of uncertain position, I am inclined to regard it as belonging to one of the species of *Hausmannia*.

SPHENOPTERIS, Brongniart.

Sphenopteris onychiopsoides sp. nov. (Pl. II. figs. 22–24A ; Pl. VI. photo. 10.)

1871. *Pecopteris Geinitzii*, Schenk, *Palæontographica*, Bd. xix. p. 215, pl. xxix. figs. 2, 2a.

The fragmentary specimens on which this species is founded were at first sight considered to be identical with *Onychiopsis Mantelli* (Brongn.), a characteristic Wealden fern, but a closer examination revealed certain differences which convinced me that the resemblance is only superficial. The best specimen is that reproduced in Photo. 10, Pl. VI. ; a comparatively slender rachis gives off several linear pinnæ bearing narrow oval segments terminating in a lanceolate or rather blunt apex. The longest pinna, 2·8 cm., tapers very gradually to an acuminate distal end ; the veins are not visible. Fig. 22, Pl. II., shows the apex of a similar frond in which the linear pinnæ pass into simple apical segments. The obscure example represented in fig. 23 is especially close to *Onychiopsis* in appearance, but it is probably a badly preserved piece of a frond of the same species as fig. 22. The piece of pinna shown in figs. 24, 24A illustrates the uniform breadth of the branches of the rachis, as also the basal constriction of the pinnules, which are more acutely terminated in this specimen than in that shown in figs. 22, 22A.

Sphenopteris onychiopsoides is characterised by the elongated narrow pinnæ, by the oval, basally constricted, ultimate segments continuous with one another on the edge of the axis. The venation, which is seldom preserved, consists of a midrib giving off

* The whole of the small piece of stem was destroyed in abortive attempts to obtain sections. Only two complete (transverse) sections were made.

† RICHTER (06).

a few highly inclined secondary veins. In *Onychiopsis Mantelli* the pinnæ have a serrate lamina or, in the more deeply dissected pinnæ, the ultimate segments are longer and relatively narrower than in the Culgower specimens. Good examples of *O. Mantelli*, which LESTER WARD speaks of as *Onychiopsis psilotoides* (STOKES and WEBB *) in accordance with strict adherence to priority, are figured by SCHENK,† VELENOVSKÝ,‡ and HEER§ from Wealden localities in Germany, Bohemia, and Portugal, and by myself from the Wealden of England,|| also by GEYLER and YOKOYAMA from Japan; the same type is described also from South Africa.¶ Some specimens referred to SAPORTA's genus *Scleropteris* bear a fairly close resemblance to *Sphenopteris onychiopsoides*, but in such a type as *Scleropteris Pomelii* ** the habit is much more rigid. Comparison may also be made with *Scleropteris virginiana* Font.†† from the Potomac of Virginia and with *S. distantifolia* described by the same author from the Black Hills of Dakota.‡‡ Similar fern fronds are figured by HEER, YOKOYAMA, and other authors as species of *Dicksonia*, but as a rule without adequate evidence in favour of the use of the generic name *Dicksonia*: *D. gracilis* Heer,§§ from Siberia and Japan, especially resembles the Culgower plant. A fragment figured by NATHORST as *Sphenopteris* sp. |||| from the Upper Jurassic of Spitzbergen may be compared with *S. onychiopsoides*. In the first volume of my *Wealden Flora* it was suggested that *Pecopteris Geinitzii*,¶¶ as figured by SCHENK from the Wealden of North Germany, might be identical with the plant which I called *Nathorstia valdensis* and afterwards changed to *Leckenbya valdensis* on account of the previous use of the genus *Nathorstia*.*** A more recent examination of the specimens convinces me that this comparison is incorrect. SCHENK's specimen is, I believe, identical with the Culgower species, but as the specific name *Geinitzii* has already been used in connection with *Sphenopteris* the new name *onychiopsoides* is adopted. The non-committal name *Sphenopteris* is preferred to *Onychiopsis*, as we have no evidence as to the nature of the fertile pinnules of the Scotch fern.

TÆNIOPTERIS, Brongniart.

Tæniopteris sp. (Pl. II. figs. 39, 39A.)

The genus *Tæniopteris* is represented by a solitary specimen in the Culgower flora which is too incomplete to be assigned to a species. The fragment shows part of one side of a lamina characterised by curved oblique veins forked at the base and in other parts of their course (fig. 39A, Pl. II.). In the Jurassic *T. vittata* Brongn. the veins are more crowded and pursue a more direct course to the edge of the lamina. Specimens figured by YOKOYAMA as *T. cf. Richthofeni* Schenk††† from Japan bear a close resemblance to that shown in fig. 39.

* WARD (05).

§ HEER (81).

** SAPORTA (73), pl. xlvii.

§§ HEER (77) (78).

*** SEWARD (95), p. 225.

† SCHENK (71)

|| SEWARD (94); see references to literature, p. 41.

†† FONTAINE (89), pl. xxviii.

|||| NATHORST (97), p. 49.

††† YOKOYAMA (89), pl. iii.

‡ VELENOVSKÝ (88).

¶ SEWARD (03).

‡‡ WARD (99).

¶¶ SEWARD (94), p. 145.

APHLEBIA, Presl.

Aphlebia sp. (Text-fig. 6.)

The incomplete specimen represented in text-fig. 6 is the impression of a comparatively thick organ characterised by a stouter median portion and a torn or irregularly lobed margin. The general appearance of the fossil suggests a strong fibrous scale with several vascular bundles curving upwards and outwards from the median line. It is impossible to speak with much confidence as to the nature of this specimen, but it may be part of an *Aphlebia* leaf or stipule-like organ, possibly of a fern. It resembles



TEXT-FIG. 6.—*Aphlebia* sp. (nat. size). (Gunn collection.)

to some extent the scale-like impressions described from the Wealden of England* and South Africa† as *Cycadolepis*, but on the whole the resemblance to the fleshy stipules of the recent fern *Angiopteris evecta* is closer than to a scale from a Cycadean stem.

RACHISES OF FERN FRONDS.

The Gunn collection contains several impressions of branched rachises which in the absence of pinnules cannot be determined with certainty. One of the larger specimens shows a flat rachis 24 cm. long, with a uniform breadth of 1 cm., giving off a few pinnae almost at right angles. This may be part of a large frond of *Cladophlebis denticulata*.

Spiropteris sp. (Pl. I. fig. 19A.)

The spirally coiled rachis shown in fig. 19A, Pl. I., may be a young frond of *Gleichenites*, but no pinnules are visible.

* SEWARD (94).

† SEWARD (03).

Filicineæ or Pteridospermæ (?)**THINNFELDIA, Ettingshausen.**

The determination of the numerous fragmentary specimens dealt with under this genus is a difficult task in view of the lack of large examples, which would enable one to determine the range of variation as regards the shape and size of the ultimate segments on a single frond. The more complete specimens figured by FEISTMANTEL from Australia* show that *Thinnfeldia* leaves reached a considerable size and demonstrate the small value of the size of the pinnules as a specific criterion. *Thinnfeldia* is a genus of which our knowledge is very incomplete, and no little confusion has been caused by the use of such generic names as *Lomatopteris*, *Cycadopteris*, and other designations for fronds which exhibit a close agreement in habit and texture.

Thinnfeldia rhomboidalis, Ett. (Pl. IV. figs. 66, 70, 70A, 72; Pl. V. figs. 82, 83, 83A; Pl. VII. photo. 21.)

1852. *Thinnfeldia rhomboidalis*, Ettingshausen, *Abh. k.k. geol. Reichs.*, Bd. i., Abt. 3, p. 2, pl. i. figs. 4-7.

1853. *Pachypteris Thinnfeldi*, Andrae, *ibid.*, Bd. ii., Abt. 4, p. 43, pl. xi. fig. 6; pl. xii. figs. 7, 9.

The imperfectly preserved specimen represented in fig. 66, Pl. IV., which appears to be identical with some of the Lias specimens on which ETTINGSHAUSEN founded the species, illustrates a considerable difference in the size of the pinnules on a single axis. The pinnules of this type are characterised by the decurrent lower margin and by the narrow and usually fairly deep sinus between the upper portion of the base of the lamina and the axis of the pinna or rachis. The venation is very indistinct, but a midrib can be seen in some of the segments giving off acute secondary veins.

The small piece of a pinna shown in fig. 70 bears pinnules of the form of the upper segments seen in fig. 66. Fig. 70A shows a slightly narrower and longer pinnule with a distinct midrib and the same sudden curve of the upper edge of the lamina. This is precisely like a fragment figured by MÖLLER from the Lower Jurassic of Bornholm as *T. rhomboidalis*.† The large specimen represented in fig. 83, Pl. V., has a strong axis bearing several incomplete pinnules which differ in their greater length and more linear form from those shown in fig. 66, Pl. IV. : this difference is probably well within the range of variation met with in the fronds of the same plant. The venation is much more clearly preserved in the fragment (slightly enlarged) in fig. 83A. With this species I associate a specimen with smaller pinnules, a portion of which is represented in fig. 82, Pl. V. ; the habit is bi-pinnate, the ultimate segments agree in shape and manner of attachment with those seen in figs. 66, 70, 70A, Pl. IV. This example agrees closely with a small Rhætic form figured by SCHENK ‡ as *T. rhomboidalis*, and

* FEISTMANTEL (90), pls. xxiv., xxv.

† MÖLLER (02), pl. ii. fig. 18.

‡ SCHENK (67), pl. xxvii. fig. 6.

with MÖLLER'S Bornholm species described as *Cycadopteris heterophylla** Zig., a species which he regards as identical with *Lomatopteris jurensis* of KURR. It may be compared also with *Pecopteris Schönleiniani* Brongn. described by SZAJNOCHA† from the Argentine Rhætic, and with *Pachypteris ovata* Brongn. figured by SAPORTA.‡

The pinnules shown in the photo. 21, Pl. VII., are of the *T. rhomboidalis* type, but are much more highly inclined to the pinna axis. The specimen represented in fig. 72, Pl. IV., though possibly a distinct species, is included under *T. rhomboidalis* because of its close resemblance to the smaller fragment shown in fig. 70A, Pl. IV., which forms a connecting link with the larger example represented in fig. 66. Fig. 72 presents a close agreement with *Lomatopteris Schimperii* as figured by SALFELD§ from the Jurassic of Germany, a species founded by SCHENK on Wealden fronds; the resemblance probably does not amount to specific identity.

Rhætic examples of *Thinnfeldia* from South America (Cacheuta), for which I am indebted to Dr KURTZ, appear to be identical with the larger Culgower specimens; similarly the Rhætic specimens described by SCHENK from Franconia, and by myself from South Africa as *T. rhomboidalis*, cannot be distinguished satisfactorily from the Scotch examples. It would seem that this type of *Thinnfeldia* had a wide range in time, persisting from the Rhætic|| and Liassic¶ to the latter part of the Jurassic era. A very similar type is represented by *T. indica* Feist.** recorded from India, Australia, and elsewhere.

In the case of small specimens such as that shown in fig. 82, Pl. V., it is practically impossible to decide between *Dichopteris* or *Pachypteris* and *Thinnfeldia* as the more appropriate generic name; the specimens referred to bear a close resemblance to the fragment figured from the English Wealden as *Dichopteris* sp.,†† and may be compared also with a Lower Cretaceous species described by KERNER‡‡ from the island of Lesina.

Thinnfeldia sp. (Text-fig. 7, A-C.)

Text-fig. 7, A, shows the outline of a small piece of a *Thinnfeldia* leaf detached from the shale as a cuticular film and treated with nitric acid and chlorate of potash. The specimen, 1.5 cm. long, agrees in habit and may be specifically identical with that shown in fig. 72, Pl. IV. It may be compared also with *Pachypteris brevipinnata* Feist. from Jurassic beds of India.§§ The broad rachis is covered with a layer of elongated cells as shown in fig. 7, C, and cells of the same type occur over the central veins of each leaflet. The cell walls are thick and, at first sight, appear to be slightly sinuous, but this is no doubt due to an unequal swelling of the membrane. The epidermis of the pinnules, with the exception of a median strip, consists of polygonal cells with straight walls. There are no indications of any lateral veins. The stomata,

* MÖLLER (02), pl. ii.

§ SALFELD (09), pl. vi.

** FEISTMANTEL (80), pls. xxxix., xl.

†† KERNER (95).

† SZAJNOCHA (88), pl. xxvii.

|| SCHENK (67), pl. xvii.

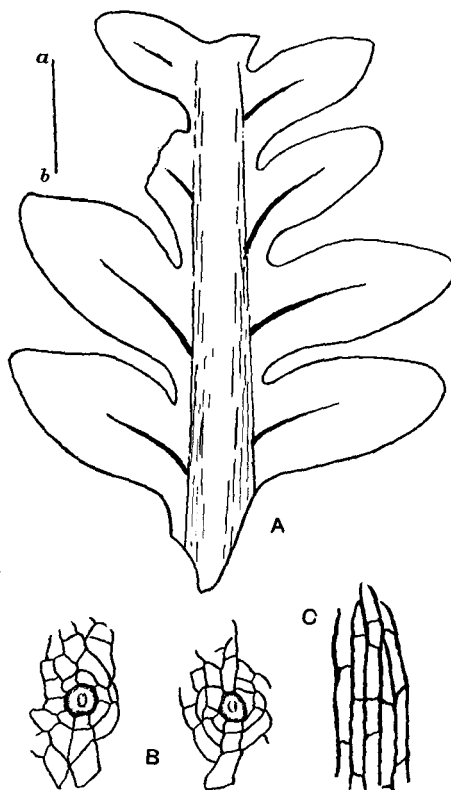
†† SEWARD (94), pl. xii. fig. 6.

§§ FEISTMANTEL (80), pls. iii., iv.

‡ SAPORTA (73), pl. xlvi.

¶ SEWARD (04), pl. iv.

which are fairly numerous, are surrounded by a ring of flatter cells (fig. 7, B); the actual form of the guard-cells is not seen, but a hole in the film represents the external stomatal pore. Drawings like that in fig. 7, B, have been published by SCHENK.*



TEXT-FIG. 7.—*Thinnfeldia* sp.

- ab. Actual size of the fragment enlarged in fig. A.
 B. Stomata from one of the leaflets.
 C. Outline of cells from the rachis. (Gunn collection.)

Thinnfeldia arctica Heer. (Pl. II. figs. 37, 37A; Pl. IV. fig. 68.)

1875. Heer, *Flor. Foss. Arct.*, vol. iii., 2, p. 123, pl. xxxv. figs. 11–16, pl. xxxvi. fig. 10b.

Fig. 68, Pl. IV., shows the impressions of a pinna fragment on which the bluntly terminated segments are rather more crowded than in *T. rhomboidalis*. The same type with more distinct venation is represented in figs. 37, 37A, Pl. II. This fragment bears a superficial resemblance to *Cladophlebis*, but in *Thinnfeldia* the secondary veins are given off at a more acute angle; moreover, the lamina is often easily detachable from the matrix, which may denote a more strongly cuticularised epidermis. These specimens agree closely with HEER's type-specimens from the Upper Jurassic of Spitzbergen† and with NATHORST's specimens‡ from the same locality.

* SCHENK (67), pl. xxvii.

† HEER (75), pls. xxxv., xxxvi.

‡ NATHORST (97), pl. i. figs. 23, 24.

Thinnfeldia de Geeri (Nathorst). (Pl. V. fig. 80.)

1897. ? *Sphenopteris de Geeri*, Nathorst, *Kongl. Svensk. Vet. Akad. Hand.*, Bd. xxx., No. 1, p. 48, pl. ii. fig. 8, pl. vi. fig. 1.

The imperfect leaflet represented in fig. 80, though too small to determine with confidence, bears so close a resemblance to the specimens described by NATHORST from the Upper Jurassic of Spitzbergen that I venture to adopt his name, with the substitution of *Thinnfeldia* for *Sphenopteris*. A similar type is figured by KERNER from the Lower Cretaceous of Lesina as *Pachypteris dimorpha*.*

Thinnfeldia sp. (Photo. 14, Pl. VII.)

The branched axis represented in Pl. VII. fig. 14 probably belongs to a *Thinnfeldia* frond; it shows the characteristic V-shaped form of branching which is a feature of the genus.

DICHOPTERIS, Zigno.

Dichopteris Pomelii (Saporta). (Pl. III. figs. 55, 55 A; Pl. IV. fig. 71.)

1873. *Scleropteris Pomelii*, Saporta, *Pal. Franç. Jurass. Flor.*, i. p. 370, pls. xlvii., xlviii.

The fragment shown in fig. 71, Pl. IV., considered by itself might well be regarded as specifically identical with fig. 82, Pl. V. (*T. rhomboidalis*), but in another specimen pinnules of the same size are borne on short pinnæ attached at an acute angle to a piece of rachis. More important evidence is afforded by the specimen shown in fig. 55, Pl. III., in which we have a strong rachis bearing portions of pinnæ with bluntly terminated pinnules like those in fig. 71. No veins are visible. The genus *Scleropteris* was founded by SAPORTA on French Jurassic specimens characterised by a rigid coriaceous habit, bearing pinnules more or less contracted at the base and usually showing no venation. Under this name he included some species previously referred to *Dichopteris* and *Pachypteris*, but, as I have elsewhere † stated, the reasons for the creation of an additional genus do not appear to be adequate. There can be little doubt that fronds described by authors under *Dichopteris* are very closely related to *Thinnfeldia*, but ZIGNO's genus may be conveniently retained for such smaller forms as *Scleropteris Pomelii* Sap. The specimen shown in fig. 55, though imperfectly preserved, agrees so closely with SAPORTA's species from the Corallian of France, that I have adopted his specific designation.

? *Dichopteris* sp. (Text-fig. 8, A, B.)

The fragment represented in fig. 8, A, may be specifically identical with *D. Pomelii*, but, on the other hand, it may belong to a small pinna of a *Thinnfeldia* frond. The venation is clearly shown; a few secondary veins arise at an acute angle from a slender midrib.

* KERNER (95), pl. iii.

† SEWARD (10), p. 552.

TEXT-FIG. 8.—? *Dichopteris* sp.

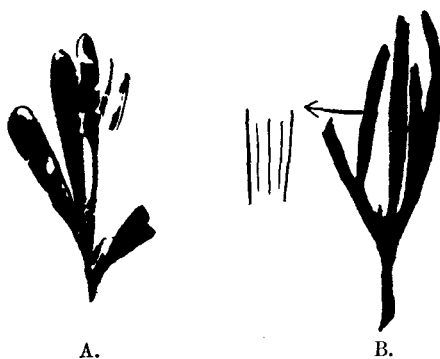
A. Natural size.

B. Leaflet enlarged, showing venation. (Peach collection, 52,659e.)

II. GYMNOSPERMÆ.

A. *GINKGOALES*.

The only two specimens found in the collections from the north of Brora referable to this group of Gymnosperms are the leaves shown in text-fig. 9, A and B. The genus *Ginkgo* is recorded by Miss STOPES from the older beds south of Brora.*



TEXT-FIG. 9.

A. *Ginkgo sibirica*, Heer (nat. size). (Arber collection, 553.)B. *Baiera Brauniana* (Dunker) (nat. size), showing the veins in an enlarged piece of one of the linear segments. (Gunn collection.)

The considerable range in the degree of subdivision of the lamina of the leaves of the recent *Ginkgo biloba* and the numerous forms of *Baiera* and *Ginkgo* from Mesozoic strata render satisfactory specific diagnosis impossible.

GINKGO, Kaempfer.

Ginkgo sibirica Heer. (Text-fig. 9, A.)1876. *Ginkgo sibirica*, Heer, *Flor. Foss. Arct.*, vol. iv., 2, p. 61, pls. vii., ix., etc.

The imperfect leaf represented in fig. 9, A, collected at Gartymore by Mr ARBER, is characterised by a lamina deeply dissected into blunt segments with about eight veins in a breadth of 8 mm. It resembles numerous leaves of Jurassic age referred to different species of *Ginkgo* and *Baiera*, and is similar to *B. multipartita* Schimp., which was first

* STOPES (07).

described by DUNKER* from Wealden rocks as *Cyclopteris digitata*, but in the German specimens the segments are rather broader. The two species *G. sibirica* and *G. lepida* Heer represent the same type as the Gartymore plant. *G. sibirica* is a widely spread species; it is recorded by FONTAINE from Jurassic strata of Oregon,† by NEWTON and TEALL from Franz Josef Land,‡ by DAWSON from the Lower Cretaceous of Canada,§ and by myself from Jurassic beds in Turkestan,|| also by other authors from various regions. The specimens described by YOKOYAMA as *G. cf. lepida*¶ from Japan are probably identical with *G. sibirica*; a similar type is represented also by the same author's *G. flabellata*** from the Jurassic of China. *Ginkgo Schmidtiana* var. *parvifolia* †† figured by KRASSER from China is another example of a similar or possibly identical type.

BAIERA, Braun.

Baiera Brauniana (Dunker). (Text-fig. 9, B.)

1846. *Jeanpaulia Brauniana*, Dunker, *Wealdenbildung*, p. 11, pl. v. fig. 4.

1849. *Baiera Brauniana*, Brongniart, *Tableau*, p. 107.

The imperfect leaf represented in text-fig. 9, B, bears a close resemblance to the Wealden species *Baiera Brauniana* as figured by DUNKER and by SCHENK ‡ from Germany. One of DUNKER's specimens referred by him to this species is no doubt a badly preserved piece of a deeply lobed Hausmannia. In the Culgower fragment the narrow linear segments have more than one vein, as seen in the enlargement, and are certainly not the divisions of a Hausmannia leaf. NATHORST's fossil from the Upper Jurassic of Spitzbergen, *B. spetsbergensis*, §§ in which the venation is not seen, represents a similar form with rather narrower segments. It is possible that BUNBURY's species *B. gracilis* ||| from the Inferior Oolite of Yorkshire may be identical with the Culgower type, but in his species the leaves are usually broader and more spreading. The plant figured by HEER as *B. angustifolia* ¶ from the Jurassic of Siberia and the Chinese Jurassic specimens referred by SCHENK to HEER's species are probably identical with *B. gracilis*, as also KRASSER's specimens which he refers to *Ginkgo lepida*.*** HEER's *Ginkgo concinna* †† from Siberia is a closely allied type, and the Rhætic species described by ZEILLER from Tonkin as *B. Guilhaumati* ††† is hardly distinguishable from the Sutherland leaf.

Ginkgoales (?).

Baiera Lindleyana (Schimper). (Pl. V. fig. 105.)

The fragment represented in fig. 105 is too imperfect to determine with any degree of confidence. It agrees very closely with the type-specimen of *Baiera microphylla*

* DUNKER (46), pl. i. fig. 8.

§ DAWSON (85), pl. ii.

** YOKOYAMA (06), pl. vii.

§§ NATHORST (97), pl. iii.

¶ HEER (78), pl. vii.

†† HEER (77), pls. vii., xiii.

† WARD (05), pl. xxxiii.

|| SEWARD (07), pl. vii.

†† KRASSER (05), pl. ii. fig. 5.

||| BUNBURY (51), pl. xii.; see also SEWARD (00), p. 263

*** KRASSER (05).

††† ZEILLER (03), p. 205.

‡ NEWTON and TEALL (97), pl. xxxviii.

¶ YOKOYAMA (89), pl. xiv.

‡‡ SCHENK (71), pl. xxiv.

of PHILLIPS* from the Jurassic of Yorkshire, which is regarded as a synonym of *B. Lindleyana* (Schimp.) and of *Solenites furcata* of LINDLEY and HUTTON. The same type is described by SAPORTA as *Trichopitys Lindleyana*.†

CZEKANOWSKIA, Heer.

The genus *Czekanowskia* is usually placed in the Ginkgoales, but Professor JEFFREY‡ has recently founded a new genus, *Araucariopitys*, on petrified branches, characterised by Araucarian features, which occur in association with fascicles of *Czekanowskia* leaves in Cretaceous beds in Staten Island. It is possible, therefore, that JEFFREY may be correct in forecasting the probable removal of HEER's genus from the Ginkgoales; it is at least certain that we have no convincing evidence in favour of the customary inclusion of *Czekanowskia* in the Ginkgoales.

Czekanowskia Murrayana (Lindley and Hutton). (Pl. V. fig. 103.)

1834. *Solenites Murrayana*, Lindley and Hutton, *Foss. Flor. Gt. Britain*, vol. ii., pl. cxxi.

The imperfectly preserved specimen seen in fig. 103, Pl. V., consists of a few ragged filiform leaves identical with those of the widely distributed species *Czekanowskia Murrayana* (L. & H.) and *C. rigida* Heer. These two names have been applied to examples of the genus, which I believe to be indistinguishable, collected from Jurassic rocks in various parts of the world.§

PHŒNICOPSIS Heer.

Phœnicopsis Gunni sp. nov. (Pl. IX. photo. 35.)

The generic name *Phœnicopsis* stands for parallel-veined leaves borne in clusters on short shoots and enclosed at the base by small bracts. The author of the genus compared it with Ginkgo, Baiera, and *Czekanowskia* and placed it with these genera in the Taxineæ, or, in modern parlance, in the Ginkgoales. SOLMS-LAUBACH|| who examined petrified specimens of *Phœnicopsis* leaves from Franz Josef Land, found that their structure is consistent with a Gymnospermous affinity; but we are still in ignorance of the precise position of the genus. SALFELD¶ has recently instituted a new genus, *Phyllotenia*, for specimens from the Corallian of Germany, which he includes in the Ginkgoales because of the associated Ginkgo-like seeds. In his type-specimen, *P. longifolia*, the leaves appear to be arranged spirally on a stout axis and not in clusters, but the evidence he adduces suggests doubts as to the necessity for the creation of an additional genus. Some of HEER's figures of Siberian Jurassic examples of *Phœnicopsis angustifolia*** show clusters of leaves attached to an axis and resemble the fossil figured by SALFELD, though the correspondence may be only superficial.

The specimen represented in the photograph shows portions of seven leaves con-

* SEWARD (00), p. 266.

† SAPORTA (84), pl. clv.

‡ JEFFREY (07).

§ SEWARD (00), p. 279.

|| SOLMS-LAUBACH (04).

¶ SALFELD (09), p. 26.

** HEER (78), pl. vii.

verging toward a common base; no basal bracts are visible, but there is a distinct depression in the shale which may indicate the position of the enveloping bracts. The leaves gradually taper towards the apex: the actual termination is seen in one leaf only and has a rounded contour. The lamina is about 3–4 mm. broad and 12 cm. long, and there appear to be approximately eight veins in a leaf 4 mm. wide, in addition to traces of interstitial veins. The species of *Phœnicopsis* nearest to the Culgower type is *P. angustifolia* Heer, recorded from the Jurassic of Siberia, from China by KRASSER,* by NATHORST † from the New Siberian Islands, and by myself from Turkestan.‡ HEER's species *P. speciosa* is another similar type.§ *P. Gunni* differs from *P. angustifolia* in the rather narrower leaves and the presence of interstitial veins.

B. CONIFERALES.

1. Araucariinæ.

ARAUCARITES, Presl.

Araucarites Milleri sp. nov. (Pl. V. figs. 97, 98, 102.)

Despite the imperfection of the material, I venture to refer the Araucarian cone-scales shown in figs. 97, 98, 102 to a new species, *A. Milleri*, named after HUGH MILLER, who recognised many years ago the presence in the Sutherland beds of Conifers agreeing in the habit of the foliage-shoots with recent species of *Araucaria*. The cone-scales are characterised by a broad membranous wing, the presence of a distal spinous process and a single seed-cavity. They have the same form as those of *Araucaria excelsa* and other species of the Eutacta division of the genus. Fig. 98, Pl. V., represents one of the largest and best-preserved examples, 3 cm. long, with a rounded and somewhat ragged distal border prolonged into a terminal spine. The actual base of the scale is not preserved. A shallow depression shows the shape of the seed, the vascular supply of which (or possibly the resin-canals accompanying the vascular strands) is represented by several yellow lines converging slightly towards the base and giving off branches into the adjacent parts of the scale. Fig. 102 shows the distal spine in a more complete form, and fig. 97 represents a smaller scale with strands on the floor of the seed-cavity.

Among the numerous examples of Araucarian cone-scales described from Jurassic and Lower Cretaceous rocks there are none which are undoubtedly identical with the present species, though several exhibit a close resemblance. From the Jurassic of England we have *Araucarites Phillipsi* Carr., *A. Brodii* Carr., *A. sphærocarpa* Carr., as examples of similar scales.|| Other allied types are *A. cutchensis* Feist.¶ from India and the Antarctic regions,** *Araucarites* sp. from the Jurassic of Germany,†† *A. wyomingensis*

* KRASSER (05), pl. iii. fig. 2.

† NATHORST (07²).

‡ SEWARD (07).

§ HEER (77), pl. xxx.

|| SEWARD (00), pp. 285, etc.; (04), pl. iii.

¶ FEISTMANTEL (80), pl. viii.

** NATHORST (04).

†† SALFELD (09), pl. iv. fig. 7; SALFELD (07), pl. xxi.

Ward from the Lower Cretaceous of Dakota,* *A. Jeffreyi* Berry † from the Cretaceous of Carolina, and *A. Falsani* Sap.‡ from the Kimeridgian of France.

CONIFEROUS WOOD.

The petrified wood, which MILLER speaks of in *The Testimony of the Rocks* as very abundant on the beach at Helmsdale, may still be picked up in quantity. Most of the material is in a poor state of preservation, but in some pieces the anatomical characters were found to be sufficiently clear to admit of identification, at least as regards generic affinity. My intention is to describe in detail one or two of the best specimens in a subsequent paper.

ARAUCARIOXYLON, Kraus.

Araucarioxylon sp.

While deferring a description of the material until a later date, I may mention the discovery of Araucarian characters in two different pieces of Helmsdale wood; one of these is in the Gunn collection, and the other was sent to me for examination by Dr HORNE from the collection of the Scottish Geological Survey. In both these specimens, which appear to be specifically distinct, the tracheids are characterised by contiguous and frequently flattened bordered pits on their radial walls in single, double, and treble rows. It is highly probable that both *Elatides* and *Brachyphyllum* shoots possessed wood of the Araucarian type, and some at least of the Helmsdale specimens may be petrified branches of these Conifers.

? *Araucariinæ*.

BRACHYPHYLLUM, Brongniart.

Brachyphyllum sp. (Pl. IX. fig. 39.)

The genus *Brachyphyllum* is represented in the Gunn collection by a few obscure pieces of vegetative branches; one of these is shown in photo. 39. The outlines of triangular scale-leaves are fairly distinct. A larger and better preserved specimen is figured by HUGH MILLER in fig. 149 of *The Testimony of the Rocks* as an "imbricated stem." In that specimen some of the broadly triangular leaves are well preserved and are characterised by longitudinal striations on the thick lamina. Transverse sections of the branch, which is partially petrified, throw no light on the arrangement of the pits on the tracheid walls.

JEFFREY and HOLLICK § have recently contributed valuable information in regard to the Araucarian affinity of a Cretaceous species, *B. macrocarpum* Newb. from the Eastern States of America. The Culgower fragments agree closely in the form and size of the leaves with the English Wealden species *B. spinosum* Sew.,|| but they afford no evidence of the occurrence of spinous branches. The species described from the

* WARD (99), pl. clxxiii.

† BERRY (08).

‡ SAPORTA (84), pl. lviii.

§ JEFFREY and HOLLICK (09), pl. iv.

|| SEWARD (95), pl. xvii.

Wealden of Portugal by HEER as *B. obesum** and recognised in the Wealden flora of England agrees very closely with the Scotch specimens. *Brachyphyllum crassicaule* Font.† from the Potomac beds is a very similar, if not identical, type. It is hopeless to attempt to determine with accuracy the numerous examples of *Brachyphyllum* branches which are widely spread in both Cretaceous and Jurassic floras.

ELATIDES, Heer.

Elatides curvifolia (Dunker). (Pl. V. figs. 76, 77; Pl. VIII. photos. 22–25, 30; text-fig. 10, A, B.)

1846. *Lycopodites curvifolius*, Dunker, *Wealdenbildung*, p. 20, pl. vii. fig. 9.

1897. *Elatides curvifolia*, Nathorst, *Kongl. Svensk. Vet. Akad. Hand.*, Bd. xxx., No. i., pls. i., ii.

This Wealden species, originally figured by DUNKER as a species of *Lycopodites*, transferred by ETTINGSHAUSEN to *Araucarites*, and placed by other authors in other genera, has recently been included by NATHORST in HEER's genus *Elatides*.‡ That genus was founded on coniferous shoots characterised by falcate leaves with a single vein and by oval or cylindrical cones composed of imbricate scales. This species is one of the most abundant in the Culgower flora. The habit is best seen in photo. 22, Pl. VIII.; the falcate, spirally disposed leaves are identical in form with those of *Araucaria excelsa* and other species of the genus. In photo. 23 the leaves are rather shorter, but the branch is clearly of the same type as the larger example shown in photo. 22. A slightly different form is seen in photo. 30. As NATHORST shows in his description of the rich material from the Upper Jurassic of Spitzbergen, the foliage-shoots of this type exhibit a considerable range of variation in the size and form of the leaves. The cones are unfortunately represented by incomplete specimens, but these are not without interest. The fertile shoot seen in fig. 76, Pl. V., shows crowded imbricate scales composing an elongate-oval strobilus. On some of the scales, as at *a*, fig. 76, which is shown more clearly in text-fig. 10, B, and on the scales *a* and *b* of the example reproduced in text-fig. 10, A, there is some evidence of the occurrence of a single seed on the upper surface of the scales, a feature, if my interpretation is correct, which supports the view naturally suggested by the habit of the vegetative shoots that this species is a member of the *Araucarieæ*, a possibility recognised by NATHORST as by other authors. The scale shown in text-fig. 10, B,§ is very similar to those shown in figs. 97, 98, Pl. V., and there is a faint indication of a spinous process at the apex, as in the larger scales, which has been pressed down on to the upper face of the seminiferous scale. As, however, the evidence of Araucarian affinity afforded by the badly preserved scales is not conclusive, it would be premature to substitute the name *Araucarites* for *Elatides*.

HUGH MILLER figured several specimens of this species and recognised their resemblance to recent *Araucarias*. In one of his specimens (fig. 130, C)|| the single

* HEER (81), pl. xvii. figs. 1–4.

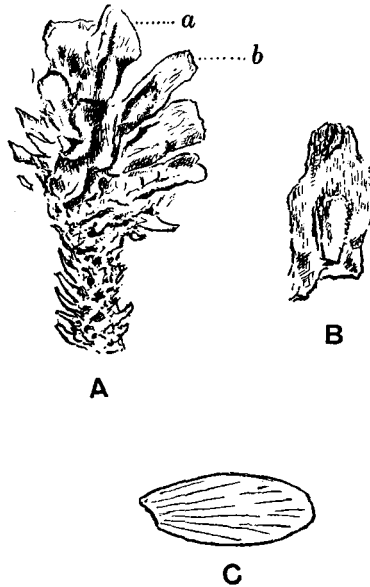
† FONTAINE (89), pls. cxi., cxii.

‡ For synonymy, see NATHORST (97).

§ The drawing reproduced in text-fig. 10, B, slightly exaggerates the surface-features, but I have endeavoured to indicate in the sketch the nature of the scale so far as it is possible to interpret the very imperfect specimen.

|| MILLER (57), p. 472.

leaf-bundle is seen very clearly passing from stem to leaf-lamina. It is not improbable that the fragmentary specimen shown in text-fig. 11, *d*, may be part of a male flower of this species; similarly the small cone shown in fig. 77, Pl. V., may be compared with some male cones figured by NATHORST on a branch of *Elatides curvifolia*.



TEXT-FIG. 10.

- A. Part of a cone of *Elatides curvifolia* (Dunk.). *a*, *b*. Cone-scales with faint indication of seeds (nat. size). (Gunn collection.)
 B. Cone-scale with indistinct impression of a single seed. Slightly enlarged and somewhat diagrammatically represented. (The cone from which the scale was drawn is shown in Pl. V. fig. 76.) (Gunn collection.)
 C. ? *Podozamites* sp. (Very slightly enlarged.) (Gunn collection.)

The Jurassic species *Pagiophyllum Williamsoni* (Brongn.) represents a very closely allied type. SCHENK's species *Pagiophyllum crassifolium** is another similar form. As NATHORST points out, some of HEER's Lower Cretaceous specimens described as *Sequoia Reichenbachii*† are examples of *Elatides curvifolia*, and specimens figured by SCHENK under HEER's designation from Lower Cretaceous rocks in the Tyrol‡ cannot be distinguished from the Culgower and Spitzbergen fossils. It is probable that some of the specimens identified by me from the English Wealden as *Sphenolepidium Sternbergianum*§ are referable to *Elatides curvifolia*.

Elatides Sternbergiana (Schenk). (Pl. V. figs. 75, 75A.)

1846. *Muscites Sternbergianus*, Dunker, *Wealdenbildung*, p. 20, pl. vii. fig. 10.

1871. *Sphenolepis Sternbergiana*, Schenk, *Palæontographica*, Bd. xix. p. 243, pl. xxxvii. figs. 3, 4, pl. xxxviii. figs. 3, 13.

1895. *Sphenolepidium Sternbergianum*, Seward, *Wealden Flora*, vol. ii. p. 206, pl. xv. figs. 5, 6.

It is by no means unlikely that under this specific name SCHENK has included more than one type; similarly, some of the Wealden specimens described by ETTINGSHAUSEN as

* SCHENK (71), pl. xl. † HEER (75), pl. xxxvi. ‡ SCHENK (76²), pl. xxiv. § SEWARD (95), pl. xvi.

*Araucarites curvifolius** may well be identical with SCHENK's *Sphenolepis Sternbergiana*, while others are specifically identical with *Elatides curvifolia*. The specimens which I figured in the *Wealden Flora* as *Sphenolepidium Sternbergianum* differ in the longer and more scattered leaves from some of the examples referred by SCHENK to this species, and may be incorrectly included in his species. The specimen represented in fig. 75, Pl. V., while agreeing closely with *Elatides curvifolia* in habit, differs in the shorter and rather more crowded leaves; it may, however, be specifically identical, though the occurrence of other specimens in the Miller collection (e.g. his fig. 130, E) and one in Mr ARBER'S collection with still smaller leaves leads me to adopt a distinguishing specific name.

The Jurassic plant described by PHILLIPS as *Brachyphyllum setosum*† and subsequently referred to the genus *Cheirolepis*‡ is a similar type. SALFELD'S *Pagiophyllum densifolium*§ and the Rhætic species *Brachyphyllum Muensteri* figured by SCHENK|| from Franconia present a striking resemblance to *Elatides Sternbergiana*: other comparable types are *Sphenolepidium Choffati* Sap.¶ from Portugal, *Lycopodites tenellus* of EICHWALD,** and the Indian species *Palissya conferta* Feist.†† These, and other references which could be given, afford illustrations of the abundance of coniferous twigs of this general form and emphasise the confused state of nomenclature in palæobotanical literature.

2. Conifers of Uncertain Affinity.

MASCULOSTROBUS, gen. nov.

The provisional designation *Conites* serves a useful purpose in the case of larger cones, presumably of gymnospermous affinity, which cannot be referred with certainty to a particular genus of Conifers or Cycads; but in practice this genus is usually applied to strobili which bore seeds. It frequently happens that detached specimens of smaller strobili are met with which afford evidence, either by the presence of microspores or by their habit, of a microsporangial nature. It is for such strobili that I propose the designation *Masculostrobus*.

Masculostrobus Zeilleri gen. et sp. nov. (Text-fig. 11, A, a-c.)

The specimen represented somewhat diagrammatically in the text-figure consists of an axis, 13 cm. long, which appears to be attached at the base to another branch. The preservation is very imperfect. Numerous small and frequently overlapping branchlets are borne on the larger stem, which seem to consist of a slender axis bearing numerous spirally disposed bracts or sporophylls broader at the lower end and vertical at the distal end. In one place (text-fig. 11, b) the bracts are seen to be triangular in form.

* ETTINGSHAUSEN (52).

§ SALFELD (09), pl. v.

** EICHWALD (68), pl. iv.

† PHILLIPS (75), p. 229.

|| SCHENK (67), pl. xliii.

†† FEISTMANTEL (80), pl. viii.

‡ SEWARD (00), p. 294.

¶ SAPORTA (94), p. 53.

A few oval spores were isolated, two of which are shown in fig. *c*; these are 30μ and 20μ in size.

This specimen is probably an inflorescence of male flowers of a Conifer. It bears a close resemblance to a plant described by ZEILLER from the Kimeridgian of Spain as



TEXT-FIG. 11.

- A. *Masculostrobus Zeilleri* gen. et spec. nov. (nat. size). (Gunn collection.)
a, b. Portions of A enlarged, showing the bracts in section (*a*) and surface-veins (*b*).
c. Spores from specimen A.
d. *Masculostrobus* sp., showing part of axis with bracts (nat. size). (Gunn collection.)
e. Spores from specimen *d*.

Pseudoasterophyllites Vidalii,* but in that plant the slender leaves are borne in whorls and the shoot appears to be sterile. Some of the cone-bearing branches described by FONTAINE as *Athrotaxopsis grandis*† from the Potomac beds agree with the Culgower specimen in the occurrence of scattered cones on a common shoot, but otherwise there

* ZEILLER and VIDAL (02), pl. ii.

† FONTAINE (89), pls. cxiv., cxvi.

is little in common between the two plants. In recent Conifers the male flowers sometimes occur in the form of a long inflorescence, as in *Podocarpus spicata*, but in no recent type do we find a male inflorescence agreeing closely with the problematical fossil shown in text-fig. 11.

Masculostrobus sp. (Text-fig. 11, *d, e*.)

This specimen, as already pointed out, may belong to *Elatides curvifolia*, though there is no proof of connection. It is a piece of a male flower bearing bracts similar to those in *Masculostrobus Zeilleri*, but rather larger. Two spores are seen in fig. 11, *e*, which in size (60μ in diameter) agree approximately with the microspores of the recent species *Araucaria imbricata*.

TAXITES, Brongniart.

Taxites Jeffreyi sp. nov. (Pl. V. fig. 73.)

The specimen from Eathie figured by MILLER on page 473 (fig. 131, A) of *The Testimony of the Rocks* is probably specifically identical with the smaller specimen represented in fig. 73. The leaves are spirally disposed and of the *Taxites* type, using this designation in a wide sense and not as implying affinity only with the genus *Taxus*. The Eathie example is partially petrified: the axis, 2.5 mm. in diameter, has an eccentric pith of large cells surrounded by two rings of homogeneous wood. Unfortunately I have not been able to recognise any bordered pits on the tracheal walls; the anatomical features do not, therefore, enable me to determine the affinity of the species. The leaves, which are plano-convex in section, appear to have a single median vascular bundle; the mesophyll shows no palisade cells, but there appear to be indications of secretory canals. I have called these specimens after Professor JEFFREY, whose researches have considerably increased our knowledge of the affinities of Mesozoic Conifers. The use of the generic name *Torreya* by YOKOYAMA* for a Japanese species of *Taxites* which closely resembles *Taxites Jeffreyi* is misleading, and is not supported by any satisfactory evidence of relationship to that genus.†

Taxites sp. (Pl. V. fig. 74; text-fig. 12, A.)

Accurate specific determination of such fragmentary specimens as those shown in text-fig. 12, A, and in fig. 74 is impossible. The larger specimen shown in the text-figure may be identical with *Taxites zamioides* (Leck. ex Bean MS.).‡

Taxites sp. cf. *Taxites gramineus* (Heer). (Pl. V. figs. 90, 91, 104.)

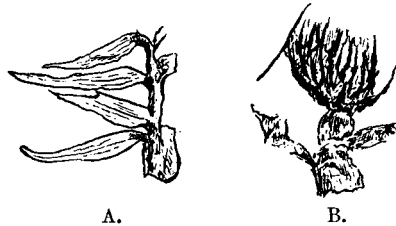
These fragments of linear leaves probably belong to the same species. The lamina reaches a maximum breadth of 4.5 mm., and one specimen (not figured) has a length of 4 cm.; there is a distinct midrib, but no lateral veins; one specimen, fig. 90, shows some

* YOKOYAMA (94), pl. xxii.

† HEER (75) refers similar specimens of coniferous twigs from the Lower Cretaceous of Greenland to the genus *Torreya*.

‡ SEWARD (00), p. 300.

indistinct transverse wrinklings. In describing leaves of this form NATHORST has made use of the generic designation *Pityophyllum*, but he uses also the genus *Taxites* for leaves which do not appear to differ from those assigned to *Pityophyllum* in any features worthy of generic recognition. Though I have previously adopted the name *Pityophyllum*, I think it is preferable to use the name *Taxites*, employing it in a wide sense as embracing coniferous leaves of the form met with in *Taxus*, *Cephalotaxus*, *Torreya*, etc.; the long and narrow form of leaves referred to *Pityophyllum* does not suggest affinity to recent species of *Pinus* or to the *Abietineæ* generally. The Culgower specimens agree very closely with *Pityophyllum Staratschini* (Heer)* figured by NATHORST from Spitzbergen, and with NATHORST's species *Pityophyllum longifolia*.† The leaves described by NATHORST from Upper Jurassic beds of Franz Josef Land as “*cf. Taxites gramineus* (Heer)”‡ appear to be indistinguishable from the Culgower



TEXT-FIG. 12.

A. *Taxites* sp. (nat. size). (Gunn collection.)

B. *Williamsonia* sp., terminating a branched axis (nat. size.) (Gunn collection.)

fragments, though one might make use of such names as *Taxites longifolius* or *Pityophyllum Staratschini* with equal justification. The somewhat smaller and narrower leaves from the Wealden of Germany which ROEMER§ first described as *Abies Linkii*, and DUNKER|| and SCHENK¶ subsequently described under ROEMER's specific name, are very similar to the leaves which I refer to *Taxites gramineus*.

SPHENOLEPIDIUM, Heer.

Sphenolepidium sp. *cf. Sphenolepidium Kurrianum* (Dunk.).

1857. Miller, *Testimony of the Rocks*, p. 472, fig. 130, A (“Conifer”).

The piece of twig figured by MILLER in his fig. 130, A, was at first taken for a pinna of *Sphenopteris onychiopsis*, but an examination of the actual specimen showed that the leaves are thick, more constricted basally than in the fern, and the lamina of the leaves is not continuous. This fragment, which I believe to be a Conifer, bears a very close resemblance to some of the specimens figured by SCHENK as *Sphenolepis Kurriana*, especially to his fig. 2, pl. xxxviii,** which I have elsewhere †† spoken of as *Onychiopsis Mantelli*. Though too imperfect to determine with certainty, the fossil figured by MILLER may be referred to DUNKER's species.

* NATHORST (97), pl. vi.

§ ROEMER (39), pl. xvii, fig. 2.

** SCHENK (71).

† MÖLLER (93), pl. vi.

|| DUNKER (46), p. 18.

†† SEWARD (95), p. 42.

‡ NATHORST (99), pl. ii.

¶ SCHENK (71), p. 241.

CONIFEROCAULON, Fliche.

Coniferocaulon colymbæforme, Fliche. (Pl. IX. fig. 41.)1900. Fliche, *Bull. Soc. Sci. Nancy*, p. 5, figs. 1-3.

Under this name FLICHE described some casts from the Lower Cretaceous of France which he regarded as Araucarian stems. In describing similar specimens from the Uitenhage series (Wealden) of South Africa, I adopted the generic name *Benstedtia*,* a title first applied to some English Lower Cretaceous fossils.† The latter are larger than FLICHE's examples and, as I have elsewhere suggested, they may be cycadean, the smaller forms being probably coniferous. The impression shown in photo. 41, Pl. IX., collected by Mr ARBER at Gartymore, is characterised by irregular transverse wrinklins on the carbonaceous surface, as in the type-specimen of FLICHE and the South African casts. At the lower end the removal of a piece of the cortical tissue has exposed a central axis which is longitudinally striated and may represent a pith. The narrowness of the pith favours the comparison with a Conifer stem and leads me to use FLICHE's generic name rather than *Benstedtia*.‡

3. Abietineæ.

PINITES (PITYOSPERMUM), Endlicher and Nathorst.

Pinites (Pityospermum) sp. (Pl. V. figs. 85, 85A.)

The small specimen represented in fig. 85 consists of an imperfectly preserved scale, 8 mm. long, bearing at the narrower end a raised oval area which marks the position of a seed. The close resemblance of this incomplete fossil to the winged seeds of *Pinus*, *Abies*, *Pseudotsuga*, and other members of the Abietineæ justifies the use of the comprehensive generic term *Pinites* of ENDLICHER and the sub-genus *Pityospermum* proposed by NATHORST. Winged seeds similar to the Culgower specimen have been figured by several authors, by NEWTON and TEALL§ and NATHORST|| from Franz Josef Land, by NATHORST¶ from the Upper Jurassic of Spitzbergen, by FONTAINE** from the Potomac beds, by HEER from the Jurassic of Siberia,†† and by other authors.

C. CYCADOPHYTA.

1. Bennettitales.

WILLIAMSONIA, Carruthers.

Williamsonia pecten (Phillips). (Pl. VII. photos. 19, 20; Pl. VIII. fig. 26.)1829. *Cycadites pecten*, Phillips, *Geol. Yorks.*, p. 148, pl. vii. fig. 22.1870. *Williamsonia pecten*, Carruthers, *Trans. Linn. Soc. London*, vol. xxvi. p. 694.

Fragments of fronds of this type are fairly common in the Culgower beds; they

* SEWARD (03), p. 36.

† SEWARD (96).

‡ Miss STOPES, who has recently examined the specimens of *Benstedtia* in the British Museum, informs me that she has found traces of xylem elements showing pits of the coniferous type (November 1910).

§ NEWTON and TEALL (97), pl. xxxviii.

|| NATHORST (99), pl. ii.

¶ NATHORST (97), pl. v.

** WARD (05), pl. cix. figs. 4-6.

†† HEER (77), pl. xiv.

vary in breadth from about 4 cm. to rather less than 1 cm. The typical form is that represented in photo. 19, Pl. VII., and photo. 26, Pl. VIII., in which the linear pinnæ are gradually tapered to the apex, the upward curve of the lower edge of the lamina at the tip being stronger than that of the upper margin; the pinnæ are contiguous at the base, which may be slightly expanded. The veins are usually obscure, but in the fragment seen in photo. 26 they are clearly shown; there are approximately four veins to a millimetre of lamina. Photo. 20, Pl. VII., illustrates a form not uncommon in the Jurassic beds of the Yorkshire coast and at Stonesfield, in which the pinnæ are close together, relatively shorter, and more abruptly contracted at the apex. The variation met with in fronds referred to this species is well illustrated in Pl. III. of the second volume of my *Jurassic Flora*.

This very widely spread species has recently been recorded by NATHORST from the Antarctic regions* and by myself from Turkestan and the Caucasus.†

Williamsonia sp. (Pl. V. fig. 99; text-fig. 12, B.)

The imperfect specimen represented in fig. 99 consists of portions of what seem to be partially decayed fibrous bracts; their position suggests that they formed a protecting envelope to a fertile shoot as in the flowers of *Williamsonia* and *Bennettites*. This is the largest example among the few fossils of this type contained in the Gunn collection. In another specimen (text-fig. 12, B) the bracts are more closely arranged, as in a closed bud borne on a branched axis. The form of the bracts, their texture, and disposition favour the view that these fragmentary fossils are the remains of fertile shoots of a *Williamsonia*.

A comparison may be made with *Blastolepis otozamitis* described by ZIGNO,‡ with *Williamsonia cretacea* Heer,§ *W. microps* Feist.,|| and *W. oregonensis* Font.¶

2. Cycadophyta incertæ sedis.

PSEUDOTENIS, gen. nov.

The genus *Ctenis* of LINDLEY and HUTTON, as represented by the type-species *C. falcata*,** is characterised by the fairly frequent anastomosing of the parallel veins of the broadly linear segments; the pinnæ are laterally attached as in *Pterophyllum*, the lower margin is decurrent, and the upper border of the lamina curves slightly upwards as it joins the stout rachis. The venation is usually coarser than in *Pterophyllum*, and the longer spreading pinnæ give the fronds a habit less formal and rectangular than that of most *Pterophyllum* leaves. In the *Wealden Flora*, vol. ii., I described a specimen as ?*Zamites* sp.†† which agrees very closely in habit with *Ctenis falcata* L. & H., but is distinguished by the absence of lateral anastomoses between the

* NATHORST (04).

† SEWARD (07).

‡ ZIGNO (85), pl. xlii.

§ HEER (82), pls. xii., xiii.

|| FEISTMANTEL (80), pl. xli.

¶ WARD (05), pl. xxix, fig. 6.

** LINDLEY and HUTTON (34), pl. ciii.

†† SEWARD (95), p. 89, fig. 5.

veins. This specimen is in all probability specifically identical with the Culgower fronds referred to *Pseudoctenis eathiensis*. It might be legitimate to include such fronds as show the characters of *Ctenis* except as regards anastomosing of the veins in that genus, on the analogy of the occasional occurrence of undoubted *Glossopteris* leaves in which venation reticula are very rare;* but on the whole it is more convenient to adopt a distinctive generic name such as *Pseudoctenis*.

Pseudoctenis eathiensis (Richards). (Pl. IV. figs. 62, 62A, 67, 67A; Pl. VII. photos. 11, 12; Pl. VIII. photo. 32; Pl. X. photo. 45.)

1884. *Zamites eathiensis*, Richards, *R. Phys. Soc. Edin.*, p. 117.

Photo. 45, Pl. X., shows part of the large specimen figured by HUGH MILLER as *Zamia*, and made the type of a new species by RICHARDS. This example, with a rachis 27 cm. long and incomplete at each end, no doubt represents the lower portion of a very large frond. The linear pinnæ, only portions of which are preserved, show several parallel veins, approximately 1 mm. apart, very distinctly; there are no undoubted lateral connections between the parallel strands. The bases of some of the pinnæ show that the lower margin was decurrent on the rachis. The rachis is partially petrified, and in a transverse section it is possible to recognise hypodermal thick-walled tissue with indications of some secretory canals, as in the axis of recent Cycadean fronds. Another specimen figured by MILLER in his *Testimony of the Rocks*, fig. 135, which RICHARDS speaks of as possibly *Ctenis falcata* L. & H., is, I have no doubt, identical with the larger example represented in photo. 43. The specimen, part of which is reproduced in photo. 11, Pl. VII., has a length of 26 cm., the upper part of the rachis, not included in the photograph, being bent almost at right angles to the lower and thicker part. The bases of the pinnæ agree with those of the apical portion of the frond shown in photo. 32, Pl. VIII. In photo. 32 the bases of some of the pinnæ slightly overlap the axis of the frond and afford some indication of a basal callosity such as occurs in the fronds of *Ceratozamia mexicana* and other recent Cycads. This specimen bears a striking resemblance to fronds of *Zamites Buchianus* (Ett.), a Wealden species, but the venation of the Culgower species is much coarser, and the bases and manner of attachment of the pinnæ are different. A small piece of a similar frond is seen in fig. 62, Pl. IV., which illustrates the characteristic bases of the linear segments; in one of the pinnæ (fig. 62A) the veins show forking and there is a suggestion of a cross-connection. The specimens represented in fig. 62 and photo. 11 are from the lower part of fronds, where the pinnæ are given off at a much wider angle than in the more apical part (e.g. photo. 32). In the best example of this type, reproduced in photo. 32, Pl. VIII., the apical linear segments are almost parallel to the rachis; the longest reaches a length of 17 cm.; the lamina is gradually tapered towards a slender apex and contains about eight or nine veins per 5 mm. of lamina. The form of the base of

* SEWARD (10), p. 508.

the pinnæ is clearly seen in photo. 12, Pl. VII. ; in the middle pinna near the base there seems to be a cross-connection between adjacent veins. In the example seen in fig. 67, Pl. IV., the incomplete narrower pinnæ show one or two oblique cross-veins (fig. 67A).

Among species referred to *Ctenis* and other genera with which *Pseudoctenis eathiensis* may be compared are—*Ctenophyllum grandifolium* Font.* from the Trias of Virginia, *C. Wardi* Font. from the Jurassic of Oregon,† *Zamites africana* from the Wealden of South Africa,‡ *Z. Weberi* from the Jurassic of the Caucasus,§ etc. EICHWALD's species *Zamites angustifolius*|| from Persia resembles the Culgower plant except in the more numerous veins. It is noteworthy that in *Ctenophyllum Wardi*, FONTAINE describes the anastomoses as far from frequent; the parallel veins are more numerous than in *Pseudoctenis eathiensis*. The species to which SCHIMPER applied the name *Ctenophyllum* have the *Pterophyllum* rather than the *Ctenis* habit, and I have therefore made use of a new name rather than adopt the designation *Ctenophyllum*.

Pseudoctenis crassinervis sp. nov. (Pl. IV. fig. 69; Pl. VII. photo. 17.)

The two specimens represented in fig. 69 and photo. 17, while agreeing in the manner of attachment of the pinnæ with *P. eathiensis*, differ from that type in the more prominent and coarser venation and, as regards photo. 17, in having shorter segments. Two complete pinnæ are preserved in the specimen reproduced in photo. 17, in which the rather broad acuminate tips are seen at *a*, *a*. It is possible that the greater coarseness of the venation may be due to an accident of preservation, but it is more probable that the frond belongs to a distinct species.

This species may be compared with *Ctenophyllum pachynerve* Font. from Oregon¶ and with *Zamites pachynervis*** described by SCHENK from the Wernsdorf beds in the Carpathians.

ZAMITES, Brongniart.

Zamites Buchianus (Ettingshausen). (Pl. X. photo. 47.)

1852. *Pterophyllum Buchianum*, Ettingshausen, *Abh. k.k. geol. Reichs.*, Bd. i., Abth. 3, No. 2, p. 21, pl. i. fig. 1.

1873. *Zamites Milleri*, Zigno, *Flor. Foss. Oolit.*, p. 40.

1884. *Podozamites Heerianus*, Richards, *Proc. R. Phys. Soc. Edin.*, p. 121.

1890. *Zamiophyllum Buchianum*, Nathorst, *Denks. k. Akad. Wiss. Wien*, Bd. lvii. p. 46, pls. ii., iii., v.

1895. *Zamites Buchianus*, Seward, *Wealden Flora*, vol. ii. p. 79, pls. iii., iv., viii.

Fig. 47, Pl. X., represents part of MILLER's original specimen †† which RICHARDS named *Podozamites Heerianus* before he discovered that ZIGNO had already designated the Scotch specimen *Zamites Milleri*. The habit of the frond and the presence of numerous fine veins in the pinnæ lead me to identify this specimen without

* FONTAINE (83), pls. xxxix.-xlii.

§ SEWARD (07), pl. ii.

** SCHENK (71²), pl. iv.

† WARD (05), pl. xxiii.

|| EICHWALD (68), pl. ii. fig. 7.

†† MILLER (57), fig. 136.

‡ SEWARD (03), pl. v.

¶ WARD (05), pl. xxiii.

hesitation with the characteristic Wealden type *Z. Buchianus* recorded from the south of England, Japan, the Potomac of Virginia, N.W. Germany, and elsewhere.*

Zamites Carruthersi Seward. (Pl. X. photo. 43.)

1884. *Podozamites Milleri*, Richards, *Proc. R. Phys. Soc. Edin.*, p. 120.

1895. *Zamites Carruthersi*, Seward, *Wealden Flora*, vol. ii. p. 86, pl. vi. figs. 2-4.

Photo. 43, Pl. X., shows part of the specimen which MILLER figured as one of his Cycadean fronds included under the general designation *Zamia*: the pinnæ are not in reality so much contracted at the base as would appear from MILLER's drawing. A comparison of this specimen with those from the Wealden of Sussex, which I described as *Zamites Carruthersi*,† leads me to refer the Sutherland plant to that species; the specimens agree in the form and venation of the pinnæ, which are characterised by the presence of numerous fine veins radiating from the base as in *Otozamites*, and by the clean-cut base as seen at *a* in the photograph. As pointed out in the description of the type-specimens, the pinnæ bear a close resemblance to those of certain recent species of the South African genus *Encephalartos*, e.g. *E. longifolius* Lehm.

PTEROPHYLLUM, Brongniart.

In discussing the application of this generic name, ZEILLER‡ has pointed out that the description of fronds of the *Pterophyllum* type under different sub-generic or generic designations is in most cases based upon characters which are too variable or artificial to justify generic rank. His use of BRONGNIART's genus in a wide sense is, I believe, a sound course to follow.

Pterophyllum Nathorsti (Seward). (Pl. IV. figs. 60A, 61, 61A; Pl. V. figs. 79, 86, 86A; Pl. IX. fig. 36; Pl. X. fig. 44; text-fig. 13, A, B.)

1871. *Pterophyllum Dunkerianum*, Schenk (*pars*), *Palæontographica*, Bd. xix., pl. xxxiv. fig. 5.

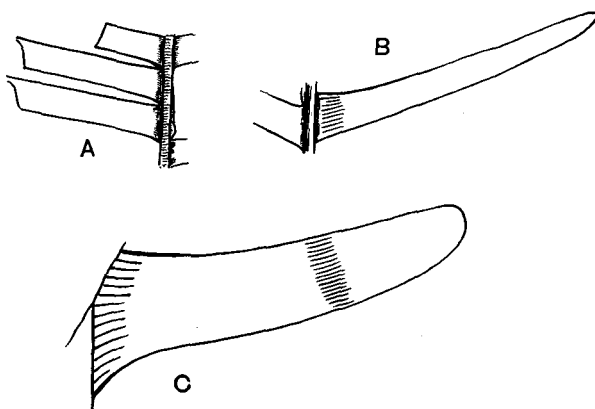
1900. *Dioonites Nathorsti*, Seward, *Jurassic Flora*, vol. i. p. 239.

The type-specimen of *Dioonites Nathorsti* from Yorkshire in the Sedgwick Museum, Cambridge, is, I believe, specifically identical with the specimen figured by MILLER in *The Testimony of the Rocks* as *Phlebopteris* and reproduced natural size in photo. 44, Pl. IX., also with smaller specimens more recently acquired from the Sutherland beds. MILLER's specimen has a rachis preserved as a ridge 2 mm. broad bearing laterally attached pinnæ, the longest of which reaches a length of 5.5 cm. In a few cases the apex is preserved, showing a slightly truncate form with the lower margin of the lamina more strongly curved than the upper. The linear pinnæ vary somewhat in breadth, from 3 to 4 mm.; the veins are indistinct, but there appear to be about three to each millimetre. The smaller specimen shown in text-fig. 13, A, B, in which both upper and lower surfaces are seen, demonstrates the lateral attachment of the pinnæ. The rachis

* SEWARD (95), p. 79. See also SALFELD (07²). † SEWARD (95), p. 86, pl. vi. figs. 2-4. ‡ ZEILLER (03).

is wrinkled and the segments show the venation clearly. The lower edge of the pinnæ is slightly decurrent as in the type-specimen. The specimen represented in figs. 86, 86A, though apparently characterised by a coarser venation, bears too close a resemblance to the other examples to be placed in a distinct species. Photo. 36, Pl. IX., shows a fragment from the apical end of a frond, and a smaller distal fragment is seen in fig. 79, Pl. V. The obscure specimen represented in figs. 61, 61A shows traces of parallel veins in the almost filiform segments, and may be a smaller example of this type.

The specimen figured by SCHENK from the German Wealden as *Pterophyllum Dunkerianum* in his pl. xxxiv. fig. 5* is probably identical with the British species and distinct from the other examples which I described in the second volume of my



TEXT-FIG. 13.

A, B. *Pterophyllum Nathorsti*, Sew. (Gunn collection.) A. From below. B. From above.
C. *Nilssonina mediana* (Leck.). (Arber collection, 539.)

Wealden Flora as *Dioonites Dunkerianus*. In the true *Dioonites Dunkerianus*, as represented by SCHENK's other figures and by the English specimens, the segments are longer and are attached to the upper face of the rachis.

Like many other Jurassic species, *Pterophyllum Nathorsti* exhibits a great similarity to some Rhætic species, e.g. *Pterophyllum æquale* Brongn. figured by ZEILLER† from Tonkin, SCHENK's Franconian specimens of *P. Braunianum* Goepp., and *P. carnalianum* Goepp.‡ Among Jurassic species agreeing more or less closely with *P. Nathorsti* are *Ctenophyllum angustifolium* Font. from Oregon,§ *Pterophyllum distans* Morr., and *P. Footeanum* Feist. from India.||

NILSSONIA, Brongniart.

Nilssonina orientalis Heer. (Pl. IV. figs. 60, 63–65; Pl. IX. photos. 34, 40, 42; Pl. X. photo. 46.)

1878. Heer, *Flor. Foss. Arct.*, Bd. v., ii., p. 18, pl. iv. figs. 5–9.

The specimens from the Culgower flora referred to this species differ considerably in size, but agree in the possession of numerous unbranched lateral veins which are given

* SCHENK (71).

† ZEILLER (03), pl. xlx.

‡ SCHENK (67), pls. xxxviii., xxxix.

§ WARD (05), pl. xxii.

|| OLDHAM and MORRIS (63); FEISTMANTEL (80).

off from the median line of the lamina at almost a right-angle. The broadest leaf is that represented in the photo. 46, Pl. X., taken from the specimen figured by HUGH MILLER with other Cycadean fronds as *Zamia*. The lamina is torn in several places parallel to the veins, but the leaf was no doubt originally entire. In the Miller collection is another specimen of the same type, 14.5 cm. long, with a rachis 7 mm. in breadth exposed by the removal of half the lamina; the portion of the lamina preserved is 2.5 cm. broad; there are 6-7 veins per millimetre. The incomplete leaf shown in fig. 60 illustrates the broad form of rachis, which in more complete specimens is hidden by the lamina. The tapered base of a frond is seen in fig. 64, and fig. 63 represents the bluntly rounded apex of a narrow leaf in which the rachis is shown as a groove. In the narrow fragment seen in fig. 65 the median line projects as a narrow ridge from which the veins arise almost at right-angles. Better specimens are represented in figs. 34, 42, Pl. IX.; in the smaller example seen in fig. 40 the lamina is traversed by fairly prominent ribs about 1 mm. apart: it is possible that this is a piece of a distinct species, but, on the other hand, the apparently coarser venation may be an accident of preservation. It is easy to confuse veins with ribs due to the presence of hypodermal strands of strengthening tissue. A petrified specimen of *N. orientalis* of Cretaceous age from Japan has recently been described by Miss STOPES* in which stereome strands occur below the epidermis. A comparison of the Culgowrie material with the species from the Yorkshire coast to which NATHORST gave the name *N. tenuinervis* led me to regard the two sets of specimens as specifically identical; but it would appear from a recent description by NATHORST of a leaf of *N. tenuinervis*† from a Yorkshire locality that the secondary veins are occasionally forked and that the cuticular structure differs from that of true *Nilssonia* fronds. The discovery of these differences led NATHORST to institute a new genus *Nilssoniopteris* for the English type. In some impressions of the Yorkshire plant which I have examined I have failed to detect any dichotomously branched veins; it is possible, as NATHORST suggests, that some of the specimens referred to *Nilssonia tenuinervis* are true *Nilssonias*, though this is hardly likely. In describing some specimens from the Jurassic of Oregon identified as *N. orientalis*,‡ FONTAINE speaks of the secondary veins being rarely forked, a fact which suggests the possibility of identity with *Nilssoniopteris* of NATHORST. *Nilssonia orientalis* is a widely spread Jurassic type, and it is probable that the plant described by HEER from the Lower Cretaceous of Greenland as *N. Johnstruppi*§ is identical with the Jurassic species. From Jurassic strata *N. orientalis*|| is recorded by HEER from Siberia, by YABE from Korea,¶ by FONTAINE from Oregon,** by NATHORST and YOKOYAMA from beds probably of Wealden age in Japan,†† and by myself from Jurassic rocks of the Caucasus. A fragment figured by NATHORST from Upper Jurassic beds in Spitzbergen as *N. cf. N. orientalis*‡‡ is probably referable to this species.

* STOPES (10).

§ HEER (82), pl. vi.

** WARD (05), pl. xvi.

† NATHORST (09), pl. vi. figs. 23, 24.

|| HEER (78), pl. v.

†† NATHORST (90); YOKOYAMA (89).

‡ WARD (05), pl. xvi.

¶ YABE (05), pl. iii.

‡‡ NATHORST (97), pl. i. fig. 18.

Nilssonia brevis Brongniart. (Pl. IX. photo. 37.)1825. Brongniart, *Ann. Sci. Nat.*, tome iv. p. 218, pl. xii. figs. 4, 5.

The specimen represented in photo. 37 consists of a portion of a frond with a median ridge and a lamina characterised by transverse folds which divide it into approximately equal strips. In the reverse piece of the same impression the axis is represented by a groove and the edge of the lamina is seen to be entire, but the transverse folds tend to converge slightly towards the margin. There is no definite venation recognisable, but in places one can detect some striations at right angles to the central axis. This fossil bears a close resemblance to some of the smaller impressions of *Nilssonia brevis* recently figured by NATHORST in his important monograph of the genus.* *N. brevis* was founded by BRONGNIART on material from the Hör sandstone of Sweden of Liassic age. NATHORST shows clearly how the upper and lower surfaces of this type differ from one another, not only in the presence of a prominent rachis on the lower face, but in the appearance of the lamina; seen from above, the lamina is divided by grooves or folds into transverse, smooth, and slightly convex strips, while on the lower face the regions between the folds are traversed by several subordinate ridges and grooves. The exposed face of the Culgower specimen is probably the upper, the lamina being destroyed along the median line. The upper part of the specimen reproduced in NATHORST's fig. 11. Pl. II., agrees very closely with the impression shown in photo. 37. Among other figures given by NATHORST which exhibit the most striking likeness to the Sutherland specimen are the following: pl. i. fig. 14; pl. ii. figs. 14, 16, 17; pl. vi. fig. 5, etc. This species is said to occur very rarely in the Rhætic of Scania and is recorded from several localities in Germany. *Nilssonia brevis*, as represented by the Culgower specimen, may be compared with *Pterophyllum contiguum* Schenk† as figured by ZEILLER from the Rhætic of Tonkin.

Nilssonia cf. Nilssonia compta (Phillips). (Pl. V. figs. 78, 81.)

The fragment seen in fig. 78 shows a broad rachis bearing portions of broad truncated segments transversed by numerous fine veins about .5 mm. apart. In the pinna represented in fig. 81 the veins are more prominent and rather farther apart. These specimens, though possibly not specifically identical, closely resemble the common Jurassic type *Nilssonia compta*;‡ they agree also, but to a less extent, with the Wealden species *Nilssonia Schaumburgensis* (Dunk.) as figured by DUNKER§ and by SCHENK.||

Nilssonia mediana (Leckenby ex Bean MS.). (Pl. VII. photo. 13; text-fig. 13, C.)1864. *Pterophyllum medianum*, Leckenby, *Quart. Journ. Geol. Soc. London*, vol. vi. p. 77, pl. viii. fig. 3.

The imperfect specimen reproduced in photo. 13 is characterised by the long and relatively narrow pinnæ, the least incomplete of which has a length of 6 cm. and a blunt

* NATHORST (09), p. 12, pls. i., ii., v.-viii.

† ZEILLER (03), pl. xlviii.

‡ SEWARD (00), p. 223, pl. iv. fig. 5.

§ DUNKER (46), pl. vi.

|| SCHENK (71), pl. xxxiii.

apex like that seen in the fragment represented in text-fig. 13, C. The venation is obscure, but the veins seem to be more numerous than in the pinna shown in the text-figure. This specimen may be compared with *Pterophyllum longifolium* Brongn. figured by ANDRAE,* but the agreement with the English species is sufficient to justify the employment of LECKENBY's designation, though it is impossible to feel certain as to identity in the case of so imperfect a fragment.

Text-fig. 13, C, shows a fragment of lamina with a bluntly rounded apex characterised by the strongly upward curve of the lower margin; the base of the pinna is expanded. The veins, of which there are about fifteen in the segment, 1 cm. broad, are clearly preserved. The two specimens (photo. 13 and the text-fig. 13, C) present a striking agreement with some of the specimens from the Yorkshire strata figured in vol. i. of the *Jurassic Flora*, pl. iv.

BUCKLANDIA, Presl.

Bucklandia Milleriana Carruthers.

1870. Carruthers, *Trans. Linn. Soc. London*, vol. xxvi. p. 687, pl. lv. fig. 1.

A specimen in the Gunn collection from an unknown locality, possibly Brora, agrees very closely with the type-specimen of CARRUTHERS which he described from Brora, as also with his other Brora species, *Yatesia crassa* and *Y. Joassiana*. A compressed pith-cast, like those seen in some of CARRUTHERS' fossils and in that figured by SCHENK † from the Wealden of Germany, is partially enclosed in a cylinder of contiguous leaf-bases, the larger of which measure 2.5×1 cm.; the larger leaf-bases pass into a broad band of smaller ones, as in CARRUTHERS' specimens. I have elsewhere ‡ expressed the opinion that there is no real distinction between the casts placed by CARRUTHERS in *Yatesia* and *Bucklandia*. With the exception of *Bennettites Peachianus*, which shows the fertile shoots characteristic of that genus, the Cycadean stems described by CARRUTHERS from Sutherland appear to be of the same type: they agree with modern Cycadean stems in the absence of lateral flowering axes.

OTOZAMITES, Braun.

Otozamites sp. (Pl. V. fig. 84.)

The material from the Sutherland plant-beds includes a few fragments which appear to be portions of pinnæ of the Cycadean genus *Otozamites*. One of these is seen in fig. 84, in which the numerous fine veins are shown to spread from the incomplete base and to pass in a gradual curve towards the edge of the lamina. In the absence of well-preserved pinnæ it is difficult to distinguish those of *Otozamites* from such segments as are characteristic of the species *Zamites Carruthersi*, but on the whole fig. 84 presents a closer agreement with a pinna of *Otozamites*.

* ANDRAE (53), pl. x.

† SCHENK (71), pl. xxx

‡ SEWARD (95), p. 165.

Cycadean pinnæ, *cf. Dioonites Dunkerianus* (Goepp.). (Pl. V. fig. 100.)

The pieces of two linear segments represented in fig. 100 are characterised by the presence of a shallow median groove, but show no signs of undoubted veins. As I have elsewhere shown,* it is very difficult to distinguish imperfectly preserved segments of Cycadites from the narrow linear pinnæ of such fronds as those of the Wealden species *Dioonites Dunkerianus* (Goepp.). The fronds of the recent Cycad *Encephalartos Ghellinckii* afford an example of the close agreement between narrow segments with a revolute margin, in which the median groove formed by the recurved edge simulates a midrib, and the segments of Cycadites. A specimen similar to that seen in fig. 100 is figured by HEER from the Cretaceous of Greenland as *Cycadites Dicksoni*;† the pinnæ of *Cycadites Saprota*‡ and other species may also be compared with the Culgower fragment. There is no evidence, however, which would justify the use of the generic name Cycadites in the present case.

CYCADOSPADIX, Zigno.

Cycadospadix Pasinianus Zigno. (Pl. VII. fig. 18.)

1885. Zigno, *Flor. Foss. Oolit.*, p. 156, pl. xlii. figs. 2, 3.

The specimen reproduced in photo. 18, Pl. VII., consists of a leaf-like organ of fibrous structure in which there is no distinct indication of veins, characterised by a fimbriate margin identical with that on some examples figured by ZIGNO from Italian Jurassic beds. Carpellary leaves of *Cycas revoluta* and some other recent species usually consist of a long stalk terminating in a triangular expansion like that shown in photo. 18. The absence of a stalk or of any indication of a scar in the fossil made me hesitate to adopt the generic name Cycadospadix, but the discovery of specimens of *Cycas pectinata* in the Herbaria of Kew and the British Museum in which carpels of the normal type are associated with others consisting only of the triangular terminal portion identical in form with the impression from Culgower, adds weight to the suggested Cycadean relationship. The fossil may be compared with a fimbriate stipule such as is borne on the fronds of some recent Marattias. Similar specimens of Cycadospadix have also been described by SAPORTA.§

PLANTÆ INCERTÆ SEDIS.

A. Photo. 1, Pl. VI.

The specimen represented slightly less than natural size in photo. 1 consists of numerous torn carbonaceous films in which no veins can be recognised; many of the ragged segments lie in different planes, as seen at *a*, separated from one another by narrow strips of matrix. There is a slight resemblance as regards the overlapping of

* SEWARD (95), p. 44.

† HEER (82), pl. xiv.

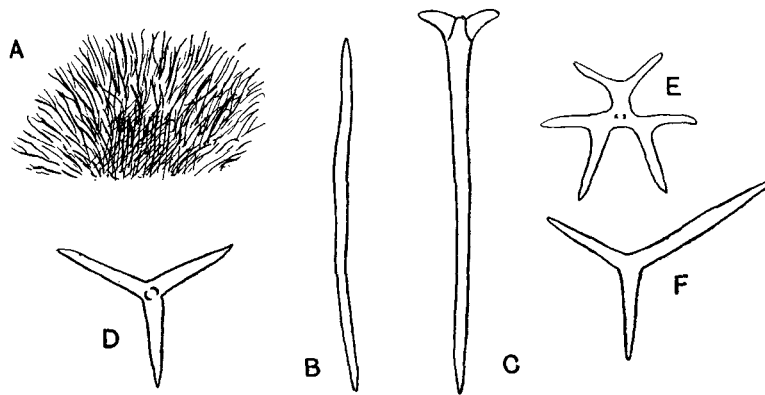
‡ SEWARD (95), p. 29, pls. iii., vi., viii.

§ SAPORTA (75), pl. cxvi.

the carbonaceous films between this fossil and one figured by HEER from the Kome beds of Greenland as *Eolirion primigenius*,* a species founded by SCHENK† on much more satisfactory material from the Wernsdorf beds in the northern Carpathians and described as a Monocotyledon. *Eolirion* was afterwards recognised by SCHENK as a *Phœnicopsis*.‡ The Culgower plant has nothing in common with SCHENK's specimen, and it differs from the Greenland fossil in the absence of veins and in its much more ragged and filmy form: its position must be left undecided.

B. Photo. 2, Pl. VI.

This imperfectly preserved impression, reproduced rather less than natural size, affords no indication of veins, nor does it present the appearance of a woody axis. While recognising the possibility of its algal nature, it is too obscure to be referred to the genus *Algites*. A similar specimen in the Peach collection in the British Museum (No. 4313) has a more woody appearance and may be part of a forked fern rachis.



TEXT-FIG. 14.

A. *Planta incertæ sedis* ($\frac{2}{3}$ nat. size). (Gunn collection.)

B-F. Sponge spicules, from drawings made by Dr HINDE. For explanation, see text. (\times circ. 30). (Gunn collection.)

C. Plate IX. figs. 33, 38; text-fig. 14, A-F.

Some obscure impressions on a large slab of rock, though I am unable to express any satisfactory opinion as to their true nature, may be briefly described. Fig. 38, Pl. IX., shows one of these problematical fossils: the specimen consists of an axis 1 cm. wide, with three branches, each of which terminates in an ill-defined mop-like head. The main axis shows faint traces of irregularly longitudinal lines, but there is no definite venation; at the proximal end of the axis is an oval depression oblique to the rock, which may be the scar of some other organ. On examining the mop-like head on the right one is able, with a lens, to make out imperfectly preserved branched threads like those somewhat diagrammatically shown in text-fig. 14, A. The specimen represented in photo. 33 consists of an approximately circular but ill-defined mass of branching

* HEER (75), pl. xxiv. figs. 1-3.

† SCHENK (71), pl. vii. fig. 4.

‡ SCHENK (90), p. 269.

threads associated with a gradually tapered stalk, which on closer inspection is seen to be characterised by the presence of numerous parallel veins and is possibly part of a *Phoenicopsis* leaf. It may be that the association in this case between mop and stalk is accidental, while in the larger specimen (fig. 38) there is organic continuity. On the other hand, it is by no means improbable that the mops are the remains of some filamentous alga which grew epiphytically on pieces of larger plants. The mops appear to be denser in the centre, gradually shading off as a fainter and vaguely delimited stain at the periphery.

An interesting feature of these impressions is the association of small white spicules, simple and branched, which suggested the presence of sponge fragments. The spicules are most abundant in association with the mop-like heads, though they also occur scattered over the stalks and other parts of the rock. I submitted the specimens to Dr HINDE, who very kindly sent me the following notes:—

“Further examination of the slab of rock confirms my view that the sponge spicules which occur on the carbonaceous axes and their moss-like heads, and are dispersed more or less thickly throughout the rock, are not specially connected with the carbonaceous bodies, and I do not think that the sponges to which they belonged were attached for support to the plant remains. I can make out four kinds of the siliceous spicules; possibly there may have been others, now too fragmentary for recognition; the forms are: straight or slightly curved, fusiform (text-fig. 14, B); trifid spicule with short horizontal head-rays, sometimes recurved (fig. C); four-rayed spicules (figs. D, F); dermal spicule of tetractinellid sponge (fig. E). All these forms are common types and may be found in pretty well every fossil deposit of sponge spicules, whether Cretaceous or Tertiary, and they are also present in recent dredgings. Nos. 1 and 2 (figs. B, C) might belong to a form of *Stellata*; Nos. 3, 3a (figs. D, F) to *Pachastrella*. The spicules in these sponges are not organically connected, and thus are readily detached and scattered after the death of the animal. It is possible that the circular expansion on the right of the slab may represent portions of two small specimens of *Stellata*, for the spicules are all of the same kind of trifids. I have not recognised any spicules of Lithistid or Hexactinellid sponges. It is unusual, in my experience, to find sponge remains in a rock associated with such a number of plants.”

D. ? *Podozamites* sp. (Text-fig. 10, C.)

The single leaf, incomplete at the base, represented in text-fig. 10, C (p. 685), shows a few slightly spreading veins which appear to fork near the obtuse apex. This solitary specimen occurs on the back of the slab with the impression of *Nilssonia orientalis* reproduced in photo. 42, Pl. IX. Accurate determination is impossible; but a comparison may be made with *Podozamites* sp. figured by YOKOYAMA* from Japan and with *Podozamites obovatus* described by SCHENK from the Wernsdorf beds.† Leaves of similar form are figured by BERRY in his species *Araucaria Bladenensis*.‡ The leaflet

* YOKOYAMA (94), pl. xxv.

† SCHENK (71²), pls. ii., iii.

‡ BERRY (08), pls. xii.–xiv.

may be compared also with segments of the narrow fronds recently figured by SALFELD from the Lias of N.W. Germany as *Otozamites Mandelslohi* Kurr.*

CONCLUSION.

The Kimeridgian age of the beds from which the plants of the Culgower flora were obtained has been determined by Professor JUDD and by Mr H. B. WOODWARD from evidence other than palæobotanical: Mr WOODWARD considers that the Portlandian series may be represented in the uppermost strata.† The composition of the flora is consistent with the conclusions based on stratigraphical and palæozoological grounds.

It is generally agreed that the differences between Wealden floras and those from different horizons in the Jurassic system are comparatively small. It may be said without exaggeration, that from the Rhætic and Liassic periods to the end of the Jurassic period, including the Wealden, the vegetation of Europe experienced no very striking or fundamental change. Many species died out and not a few new types made their appearance during this phase of geological history, but, so far as we know, there was nothing which can reasonably be spoken of as a revolution in the plant-world from the period immediately preceding the beginning of the Jurassic period up to the time immediately following the close of that era. A comparison of such a flora as that described by SCHENK from the Rhætic strata of Franconia with the Wealden floras of England and Northern Germany demonstrates a general agreement, which stands out above the many differences as regards individual elements in these widely separated floras. Similarly, the composition of such Lower Oolitic floras as those from the Yorkshire coast and the plant-beds of Siberia conforms in general terms to that of Rhætic and Wealden floras. The bearing of this comparison on the Culgower flora is that we should not expect to find an assemblage of plants differing both from older Jurassic types and from the constituents of Wealden floras. Several genera of plants which range from Rhætic to Wealden floras have been described under different specific names, in some cases as a concession to difference in age rather than as an indication of the existence of well-defined or constant specific characters.

In the Culgower flora there are certain species which are characteristic of Wealden floras, e.g. *Hausmannia dichotoma*, *Gleichenites cycadina*, *Baiera Brauniana*, *Elatides curvifolia*, *Lacopteris Dunkeri*. These species, as I have pointed out in the descriptive part of the paper, can all be closely matched with Jurassic types, and in some cases, e.g. *Lacopteris*, *Gleichenites*, and *Baiera*, with Liassic or Rhætic species. *Matonidium Goepperti*, not to mention others, is an example of a species common to Middle Jurassic and Wealden floras. In a considerable number of the Culgower plants we have species which are widely distributed in Middle Jurassic floras, e.g. *Coniopteris hymenophylloides*, *Cladophlebis denticulata*, *Todites Williamsoni*, etc. Finally, the species *Nilssonia brevis* and *Thinnfeldia rhomboidalis* are Rhætic types, the latter species being recorded also from Liassic rocks in England and elsewhere.

* SALFELD (07), pl. xvi.

† See *ante*, p. 646.

The Culgower flora has many features in common with the Upper Jurassic (Wealden) flora of Spitzbergen, the Wealden of England, Germany, and other regions, as also with the older Jurassic flora of East Yorkshire which may be taken as a type of Middle Jurassic floras in various parts of the world. As one would expect in a flora of Kimeridgian age, we find an admixture of Wealden or Upper Jurassic, Middle, and Lower Jurassic species.

The investigation of the Sutherland Kimeridgian flora reveals facts which are of greater interest from a botanical than from a geological point of view. During the closing stages of the Jurassic era there flourished in the north-west of the European continent a flora which extended into Arctic latitudes: many of the genera which were then prominent no longer exist, but others have left descendants in tropical and sub-tropical floras of the present day. *Hausmannia* is no doubt closely related to the Indo-Malay fern *Dipteris*; *Laccopteris* and *Matonidium* may be said to survive in the Malayan genus *Matonia*; in *Gleichenites* we have a type now represented by the recent species of *Gleichenia* in the southern tropics and south temperate regions; *Todites* and probably *Cladophlebis denticulata* are links with *Todea barbara* of South Africa and Australia. The Cycadean species, which were conspicuous in the Culgower flora, are connected, more or less closely, with the dwindled family of Cycads, which is now mainly tropical in its distribution. *Araucarites* and, in all probability, *Elatides curvifolia* have their nearest allies in the Norfolk Island Pine (*Araucaria excelsa*) and other species of *Araucaria* in Eastern Australia, New Caledonia, and adjacent regions. The botanical data collected by MARCUS GUNN and others from the Upper Jurassic rocks of Sutherland furnish evidence of striking changes in the geographical distribution of several generic types which have persisted through the ages.

The more experience one has in the determination of fragmentary fossil plants, the less confidence one feels as to the value of attempts to draw fine specific distinctions. I am well aware that some of my determinations rest on a basis which is far from satisfactory; I have, however, endeavoured to keep under control the temptation to read into the imperfect records more than they contain. The task of deciphering or piecing together the *disjuncta membra* of this Kimeridgian flora has not been easy; but to the interest inseparable from a study of an ancient flora, there has been added the satisfaction of doing what I could to produce a contribution to British Mesozoic Botany which might be worthy of dedication to the memory of MARCUS GUNN.

BIBLIOGRAPHY.

- ANDRAE, K. T. (53), "Fossile Flora Siebenbürgens und des Banates," *Abh. k.k. geol. Reichs.*, Bd. ii., Abth. 3, No. iv.
- BARTHOLIN, C. T. (92), "Nogle i den bornholmske Juraformation forekommende Planteforsteninger," *Bot. Tidssk. Kjöbenhavn*, vol. xviii., Heft 1.
- BERRY, E. W. (08), "Some Araucarian Remains from the Atlantic Coastal Plain," *Bull. Torrey Bot. Club*, vol. xxxv. p. 249.
- BUNBURY, C. F. J. (51), "On some Fossil Plants from the Jurassic Strata of the Yorkshire Coast," *Quart. Journ. Geol. Soc.*, vol. vii. p. 179.
- CARRUTHERS, W. (69), "On Beania, a new Genus of Cycadean Fruit, from the Yorkshire Oolite," *Geol. Mag.*, vol. vi. [i.] p. 1.
- (70), "On Fossil Cycadean Stems from the Secondary Rocks of Britain," *Trans. Linn. Soc.*, vol. xxvi. p. 675.
- CHRIST, H. (09), "Deux espèces de *Platyserium* Désv.," *Ann. Jard. Buitenzorg* [2], suppl. iii.
- DAVIDSON, T. (73), "Notes on some Brachiopods collected by Mr Judd from the Jurassic Deposits of the East Coast of Scotland," *Quart. Journ. Geol. Soc.*, vol. xxix. p. 196.
- DAWSON, J. W. (85), "On the Mesozoic Floras of the Rocky Mountain Region of Canada," *Trans. Roy. Soc. Canada*, sect. iv.
- DEBEY, M. H., and C. VON ETTINGSHAUSEN (59), "Die urweltlichen Acrobryen des Kreidegebirges von Aachen und Maestricht," *Denksch. k. Akad. Wiss. Wien*, Bd. xvii.
- DUNKER, W. (46), *Monographie der norddeutschen Wealdenbildung*, Braunschweig.
- EICHWALD, E. D' (68), *Lethæa Rossica*, Stuttgart.
- ETTINGSHAUSEN, C. VON (52), "Begründung einiger neuen oder nicht genau bekannten Arten der Lias- und der Oolithflora," *Abh. k.k. geol. Reich.*, Wien, Bd. i., Abth. 3.
- FEISTMANTEL, O. (76), "Jurassic Flora of Kach," *Mem. Geol. Surv. India*, vol. ii., pt. 1.
- (77), "Flora of the Jabalpur Group," *ibid.*, pt. 2.
- (80), "The Flora of the Damuda Panchet Divisions," *ibid.*, vol. iii., pt. 2.
- (90), "Coal and Plant-bearing beds of Palæozoic and Mesozoic Age in Eastern Australia, etc.," *Mem. Geol. Surv. N.S. Wales*.
- FLICHE (00), "Contribution à la flore fossile de la Haute-Marne," *Bull. Soc. Sci. Nancy*.
- FONTAINE, W. M. (83), "Contributions to the Knowledge of the Older Mesozoic Flora of Virginia," *U.S. Geol. Surv. Mon.*, vol. vii.
- (89), "The Potomac or Younger Mesozoic Flora," *ibid.*, vol. xv.
- GEIKIE, Sir ARCHIBALD (01), *The Scenery of Scotland*, 3rd ed., London.
- HALLE, T. G. (10), "On the Swedish Species of *Sagenopteris* Presl, and on *Hydropterangium* nov. gen.," *K. Svensk. Vet. Akad. Hand.*, Bd. xlv., No. 7.
- HARKER, A. (06), "The Geological Structure of the Sgurr of Eigg," *Quart. Journ. Geol. Soc.*, vol. lxii. p. 40.
- (08), "The Geology of the Small Isles of Inverness-shire," *Mem. Geol. Surv. (Scotland)*.
- HARTZ, N. (96), "Planteforsteninger fra Cap Stewart i Østgrønland," *Medal. Grøn.*, vol. xix. p. 217.
- HEER, O. (75), *Flora Fossilis Arctica*, vol. iii., pt. 2.
- (77), *Ibid.*, vol. iv., pt. 2.
- (78), *Ibid.*, vol. v., pt. 2.
- (80), *Ibid.*, vol. vi., pt. 2.
- (81), "Contributions à la flore fossile du Portugal," *Secc. Trab. Geol. Portugal*.
- (82), *Flora Fossilis Arctica*, vol. vi.
- JEFFREY, E. C. (07), "Araucariopitys, a New Genus of Araucarians," *Bot. Gazette*, vol. xli. p. 435.
- JEFFREY, E. C., and A. HOLICK (09), "Studies of Cretaceous Coniferous Plants," *Mem. New York Bot. Gard.*, vol. iii.
- JUDD, J. W. (73), "The Secondary Rocks of Scotland," *Quart. Journ. Geol. Soc.*, vol. xxix. p. 97.
- KERNER, F. VON (95), "Kreidepflanzen von Lesina," *Jahrb. k.k. geol. Reich. Wien*, Bd. xlv., Heft 1, p. 37.
- KÖNIG, C. See MURCHISON (29).

- KRASSER, F. (05), "Fossile Pflanzen aus Transbaikalien, der Mongolei und Mandschurei," *Denks. k. Akad. Wiss. Wien*, Bd. lxxviii. p. 589.
- LEUTHARDT, F. (04), "Die Keuperflora von Neuwelt bei Basel," *Abh. Schweiz. Pal. Ges.*, Bd. xxxi. p. 25.
- LINDLEY, J., and W. HUTTON (31-37), *The Fossil Flora of Great Britain*, London.
- MILLER, H. (57), *The Testimony of the Rocks*, Edinburgh.
- (58), *The Cruise of the Betsey*, Edinburgh.
- (59), *Sketch-book of Popular Geology*, Edinburgh.
- MÖLLER, H. (02), "Bidrag till Bornholms Fossila Flora (Pteridofyter)," *Lunds. Univ. Arsskrift*, Bd. xxxviii., No. 5.
- (03), *Ibid.* (Gymnospermer), *Kongl. Svensk. Vetakad.*, Bd. xxxvi., No. 6.
- MURCHISON, R. I. (29), "On the Coal-field of Brora in Sutherlandshire," *Trans. Geol. Soc.*, vol. ii. [2] p. 293.
- (43), "Observations on the Occurrence of Fresh-water Beds in the Oolitic Deposits of Brora, Sutherlandshire," *Quart. Journ. Geol. Soc.*, vol. iv., *Proc.*, p. 174.
- NATHORST, A. G. (78), *Über einige rhätische Pflanzen von Pålajö in Schonen*, Stuttgart.
- (86), "Om Floran i Skanes kolforande Bildningar: I. Floran vid Bjuf," *Sverig. Geol. Unders.*, Ser. C.
- (90), "Beiträge zur mesozoischen Flora Japans," *Denks. k. Akad. Wiss. Wien*, Bd. lvii. p. 43.
- (97), "Zur fossilen Flora der Polarländer: Zur mesozoisch. Flor. Spitzbergens," *K. Svensk. Vetakad. Hand.*, Bd. xxx.
- (99), *Fossil Plants from Franz Josef Land: The Norwegian North-Polar Expedition (1893-96)*.
- (02), "Beiträge zur Kenntniss einiger mesozoischen Cycadophyten," *K. Svensk. Vetakad. Hand.*, Bd. xxxvi., No. 4.
- (04), "Sur la Flore Fossile Antarctique," *Compt. Rend.*
- (07), "Palaeobotanische Mittheilungen," I. und II., *K. Svensk. Vetakad. Hand.*, Bd. xlii., No. 5.
- (07²), "Über Trias und Jurapflanzen von der Insel Kotelny," *Mém. Acad. Imp. St Pétersbourg*, tome xxi., No. 2.
- (08), "Palaeobot. Mitt.," III., *K. Svensk. Vetakad. Hand.*, Bd. xliii., No. 3.
- (09), "Über die Gattung *Nilssonia*, Brongn.," *Ibid.*, Bd. xliii. No. 12.
- NEWTON, E. T., and J. J. H. TEALL (97), "Notes on a Collection of Rocks and Fossils from Franz Josef Land," *Quart. Journ. Geol. Soc.*, vol. liii. p. 477.
- OLDHAM, T., and J. MORRIS (63), "Fossil Flora of the Gondwana System," *Mem. Geol. Surv. India*, series 2.
- PHILLIPS, J. (75), *Illustrations of the Geology of Yorkshire*, 3rd ed. (edited by R. Etheridge), London.
- RACIBORSKI, M. (94), "Flora Kopalna," *Pamięt. Akad. Umiejętnosci*.
- RICHARDS, J. T. (84), "On Scottish Fossil Cycadaceous Leaves contained in the Hugh Miller Collection," *Proc. R. Phys. Sci. Edinburgh*.
- RICHTER, P. B. (06), *Beiträge zur Flora der unteren Kreide Quedlinburgs*, I., Leipzig.
- ROBERTSON, A. (47), "On the Wealden Beds of Brora, Sutherlandshire," *Quart. Journ. Geol. Soc.*, vol. iii. p. 113.
- ROEMER, F. A. (39), *Die Versteinerungen der norddeutschen Oolithen-Gebirges*, Hannover.
- SALFELD, H. (07), "Fossile Landpflanzen der Rät- und Juraformation Südwestdeutschlands," *Palaeont.*, Bd. liv.
- (07²), "Über das Vorkommen von *Zamites Buchianus* Ett. im Wealden Nordwestdeutschlands," *Jahrb. Prov. Mus. Hannover*.
- (09), "Beiträge zur Kenntniss jurassische Pflanzenreste aus Norddeutschland," *Palaeont.*, Bd. lvi.
- SAPORTA, Le Marquis de (73), *Plantes Jurassiques*, *Pal. Franç.*, Paris.
- (75), *Ibid.*, tome ii.
- (84), *Ibid.*, tome iii.
- (91), *Ibid.*, tome iv.
- (94), *Flore fossile du Portugal*, Lisbon.
- SCHENK, A. (67), *Die fossile Flora der Grenzschichten der Keupers und Lias Frankens.*, Wiesbaden.
- (71), "Die Flora der nordwestdeutschen Wealdenformation," *Palaeont.*, Bd. xix.
- (71²), "Die fossilen Pflanzen der Wernsdorfer Schichten in der Nordkarpathen," *Palaeont.*, Bd. xix.
- (76), "Zur Flora der nordwestdeutschen Wealdenformation," *Palaeont.*, Bd. xxiii.

- SCHENK, A. (76²), "Über einige Pflanzenreste aus der Gosauformation Nordtirols," *Palaeont.*, Bd. xxiii.
- (83), "Pflanzliche Versteinerungen": Richthofen's *China*, Bd. iv., Berlin.
- (90), Zittel's *Handbuch der Palaeontologie*, Munich and Leipzig.
- SEWARD, A. C. (94), *The Wealden Flora*, vol. i. (Brit. Mus. Catalogue), London.
- (95), *Ibid.*, vol. ii.
- (96), "Notes on the Geological History of Monocotyledons," *Ann. Bot.*, vol. x. p. 205.
- (99), "On the Structure and Affinities of *Matonia pectinata*," *Phil. Trans. Roy. Soc.*, vol. cxc. p. 171.
- (00), *The Jurassic Flora*, vol. i. (Brit. Mus. Catalogue), London.
- (00²), "Notes on some Jurassic Plants in the Manchester Museum," *Mem. Proc. Lit. Phil. Soc. Manchester*, vol. xiv., Pt. 3, p. 1.
- (00³), "La flore Wealdienne de Bernissart," *Mém. Mus. Roy. d'hist. nat. Belg.*, tome i.
- (03), "Fossil Floras of Cape Colony," *Ann. S. African Mus.*, vol. iv.
- (04), *The Jurassic Flora*, vol. ii. (Brit. Mus. Catalogue), London.
- (07), "Jurassic Plants from Caucasia and Turkestan," *Mém. Com. Géol. St. Pétersbourg*, liv. xxxviii.
- (10), *Fossil Plants*, vol. ii., Cambridge.
- SEWARD, A. C., and E. DALE (01), "On the Structure and Affinities of *Dipteris*," *Phil. Trans. Roy. Soc.*, vol. cxiv. p. 487.
- SOLMS-LAUBACH, H. Graf zu (04), "Die strukturbietenden Pflanzengesteine von Franz Josef Land," *K. Svensk. Vetakad. Hand.*, Bd. xxxvii., No. 7.
- STOPES, M. C. (07), "The Flora of the Inferior Oolite of Brora (Scotland)," *Quart. Journ. Geol. Soc.*, vol. lxiii. p. 376.
- (10), "The Internal Anatomy of *Nilssonia orientalis*," *Ann. Bot.*, vol. xxiv. p. 389.
- SZAJNOCHA, L. (88), "Über fossile Pflanzenreste aus Cacheuta in den Argentinischen Republik," *Sitz. k. Akad. Wiss. Wien*, Bd. xcvi., Abth. 1, p. 219.
- TATE, R. (73), "On the Palæontology of Skye and Raasay," *Quart. Journ. Geol. Soc.*, vol. xxix. p. 339.
- TRAQUAIR, R. H. (90), "On the Fossil Fishes found at Achanarras Quarry, Caithness," *Ann. Mag. Nat. Hist.*, vol. vi. [3] p. 479.
- VELENOVSKÝ, J. (85), *Die Gymnospermen der böhmischen Kreideformation*, Prag.
- (88), *Die Farne der böhmischen Kreideformation*, Prag.
- WARD, L. F. (99), "The Cretaceous Formation of the Black Hills," *U.S. Geol. Surv. 19th Ann. Rep.*
- (00), "Status of the Mesozoic Floras of the United States," I., *ibid.*, 20th Rep.
- (05), *Ibid.*, II., *Monographs*, vol. xlviii.
- WITHAM, H. (33), *The Internal Structure of Fossil Vegetables*, Edinburgh.
- YABE, H. (05), "Mesozoic Plants from Korea," *Journ. Coll. Sci. Japan*, vol. xx.
- YOKOYAMA, M. (89), "Jurassic Plants from Kaga, etc.," *Journ. Coll. Sci. Univ. Japan*, vol. iii.
- (94), "Mesozoic Plants from Kozuke, etc.," *ibid.*, vol. vii., pt. 2.
- (05), "Mesozoic Plants from Nagato and Bitchu," *ibid.*, vol. xx.
- (06), "Mesozoic Plants from China," *ibid.*, vol. xxi.
- ZEILLER, R. (97), "Revue des travaux de Paléontologie végétale (1893-06)," *Rev. gén. bot.*, tome ix.
- (03), "Flore fossile des gîtes de charbon du Tonkin," *Études des gîtes min. France*, Paris.
- ZEILLER, R., and L. M. VIDAL (02), "Sobre algunas impresiones vegetales del Kimeridgense de Santa Maria de Meya," *Mem. Real. Acad. Cienc. y Art. Barcelona*, vol. iv.
- ZIGNO, A. DE (56-85), *Flora fossilis formationis Oolithicæ*, vols. i., ii., Padova.

EXPLANATION OF PLATES.

I gratefully acknowledge a grant of £20 made by the Royal Society of London towards the cost of the Plates.

With a few exceptions, where the magnification or reduction is stated, the specimens are represented natural size.

I am indebted to my Wife for giving me much assistance with the drawings.—A. C. S.

PLATE I.

FIGS. 1-4.	<i>Sagenopteris Phillipsi</i> Brongn.	Gunn collection (British Museum).
„ 5-13.	<i>Laccopteris Dunkeri</i> Schenk. Fig. 12, $\times 6$.	„ „
„ 14-17.	<i>Hausmannia dichotoma</i> Dunk.	„ „
FIGS. 18, 18A.	<i>Hausmannia Richteri</i> sp. nov.	„ „
FIG. 19.	<i>Hausmannia dichotoma</i> Dunk. var. <i>linearis</i> Richt.	„ „
„ 19a.	<i>Spiropteris</i> (? <i>Gleichenites</i>).	„ „

PLATE II.

FIG. 20.	<i>Hausmannia dichotoma</i> Dunk.	Gunn. coll.
„ 21.	<i>Hausmannia Buchii</i> (And.) ($\times 6$).	„
FIGS. 22-24.	<i>Sphenopteris onychiopsoides</i> sp. nov.	„
„ 25, 26.	<i>Matonidium Goepperti</i> (Ett.).	„
„ 27, 27A.	<i>Todites Williamsoni</i> (Brongn.).	„
„ 28, 29.	<i>Marattiopsis Boweri</i> sp. nov.	Fig. 28, Gunn coll.
		Fig. 29, Arber coll., Sedgwick Museum, Cambridge (525).
FIG. 30.	<i>Cladophlebis</i> sp. cf. <i>C. haiburnensis</i> (Lind. and Hutt.).	Gunn coll.
„ 31.	<i>Cladophlebis denticulata</i> (Brongn.) ($\times 2$).	Arber coll. (517).
FIGS. 32-36.	<i>Cladophlebis denticulata</i> (Brongn.). Fig. 32, $\times 7$.	Gunn coll.
„ 37, 37A.	<i>Thimfeldia arctica</i> Heer.	Peach coll. (Brit. Mus.).
FIG. 38.	<i>Cladophlebis denticulata</i> (Brongn.).	Arber coll. (523).
FIGS. 39, 39A.	<i>Tæniopteris</i> sp.	Gunn coll.
FIG. 40.	<i>Rhizomopteris Gunni</i> sp. nov.	„

PLATE III.

FIGS. 41, 41A.	<i>Rhizomopteris Gunni</i> sp. nov.	Gunn. coll.
	A', A, B, ground-tissue S, stele.	
	Fig. 41, $\times 12$; fig. 41A, part of fig. 40 enclosed by line <i>a</i> , enlarged.	
„ 42, 42A, 43, 43A.	<i>Gleichenites Boodlei</i> sp. nov.	„
	Fig. 42. <i>a-b</i> , plane in which the section shown in 42A, 43, 43A was cut.	
	Fig. 43. One of the arms of fig. 42 magnified 19 diameters.	
	X, xylem; P, phloem and pericycle; <i>c'</i> , <i>c''</i> , <i>c'''</i> , zones of cortex. The line <i>a</i> encloses the portion enlarged in fig. 43A.	
	Fig. 43A. Portion of stele of fig. 43 enlarged. Mx, metaxylem; Px, protoxylem; P, phloem.	
„ 44, 45, 46, 46A.	<i>Coniopteris hymenophylloides</i> (Brongn.). Fig. 46a, $\times 4$.	Figs. 44, 45, Gunn coll.
		Figs. 46, 46A, Peach coll.
FIG. 47.	<i>Cladophlebis</i> sp.	Peach coll.
FIGS. 48-54.	<i>Gleichenites cycadina</i> (Schenk). Fig. 49, $\times 7$.	Figs. 48, 49, 51, 53, 54, Gunn coll.
		Figs. 50, 52, Arber coll. (505, 496).
„ 55, 55A.	<i>Dichopteris Pomelii</i> (Sap.).	Gunn coll.

PLATE IV.

FIG. 56.	Indeterminable fragment (? <i>Thinnfeldia</i> sp.).	Gunn coll.
„ 57.	<i>Todites Williamsoni</i> (Brongn.).	„
FIGS. 58, 59.	<i>Coniopteris arguta</i> (Lind. and Hutt.).	„
FIG. 60.	<i>Nilssonia orientalis</i> Heer.	„
„ 60A.	<i>Pterophyllum Nathorsti</i> Sew.	Arber coll. (494).
FIGS. 61, 61A.	<i>Pterophyllum Nathorsti</i> Sew.	Peach coll.
„ 62, 62A.	<i>Pseudoctenis eathiensis</i> (Rich.) gen. nov.	„
„ 63-65.	<i>Nilssonia orientalis</i> Heer.	Gunn coll.
FIG. 66.	<i>Thinnfeldia rhomboidalis</i> Ett.	„
FIGS. 67, 67A.	<i>Pseudoctenis eathiensis</i> (Rich.).	„
FIG. 68.	<i>Thinnfeldia arctica</i> Heer.	„
„ 69.	<i>Pseudoctenis crassinervis</i> gen. et spec. nov.	„
FIGS. 70, 70A.	<i>Thinnfeldia rhomboidalis</i> (Ett.).	Fig. 70, Gunn coll. Fig. 70A, Arber coll. (563).
FIG. 71.	<i>Dichopteris Pomelii</i> (Sap.).	Gunn coll.
„ 72.	? <i>Thinnfeldia rhomboidalis</i> Ett.	„

PLATE V.

FIG. 73.	<i>Taxites Jeffreyi</i> sp. nov.	Gunn coll.
„ 74.	<i>Taxites</i> sp.	„
FIGS. 75, 75A.	<i>Elatides Sternbergiana</i> (Schenk).	Peach coll.
FIG. 76.	<i>Elatides curvifolia</i> (Dunk.).	Gunn coll.
	A scale of this cone is shown in text-fig. 11, B.	
FIG. 77.	? <i>Elatides curvifolia</i> (Dunk.).	Gunn coll.
„ 78.	<i>Nilssonia</i> sp. cf. <i>N. compta</i> (Phill.).	„
„ 79.	<i>Pterophyllum Nathorsti</i> Sew.	„
„ 80.	<i>Thinnfeldia de Geeri</i> (Nath.).	„
„ 81.	<i>Nilssonia</i> sp. cf. <i>N. compta</i> (Phill.).	„
FIGS. 82, 83, 83A.	<i>Thinnfeldia rhomboidalis</i> Ett.	Fig. 82, Arber coll. (497). Figs. 83, 83A, Gunn coll.
„ 84.	<i>Otozamites</i> sp.	Gunn Coll. (497).
FIGS. 85, 85A.	<i>Pinites (Pityospermum)</i> sp.	„
„ 86, 86A.	<i>Pterophyllum Nathorsti</i> Sew.	„
„ 87-89.	<i>Gleichenites cycadina</i> (Schenk). Fig. 87, $\times 18$	„
„ 90, 91.	<i>Taxites</i> sp. cf. <i>T. gramineus</i> (Heer).	„
„ 92-96.	<i>Gleichenites cycadina</i> (Schenk). Fig. 96, $\times 12$.	Fig. 92, Peach coll. Figs. 93-96, Gunn coll.
„ 97, 98.	<i>Araucarites Milleri</i> sp. nov.	Gunn coll.
FIG. 99.	<i>Williamsonia</i> sp.	„
„ 100.	Cycadean pinnæ, cf. <i>Dioonites Dunkerianus</i> (Goepp.).	„
FIGS. 100, 101A.	<i>Laccopteris Dunkeri</i> (Schenk).	„
FIG. 102.	<i>Araucarites Milleri</i> sp. nov.	„
„ 103.	<i>Czekanowskia Murrayana</i> (Lind and Hutt.).	„
„ 104.	<i>Taxites</i> sp. cf. <i>T. gramineus</i> (Heer).	„
„ 105.	<i>Baiera Lindleyana</i> (Schimp.).	„

PLATE VI.

PHOTO. 1.	<i>Planta incertæ sedis</i> , A. a, carbonaceous films seen in different planes. (Very slightly reduced.)	Gunn coll.
„ 2.	<i>Planta incertæ sedis</i> , B. (Very slightly reduced.)	„
PHOTOS. 3-5.	<i>Sagenopteris Phillipsi</i> (Brongn.). (Photo. 3 slightly reduced.)	„

PHOTO. 6.	<i>Hausmannia Buchii</i> (And.).	Peach coll.
„ 7.	<i>Laccopteris Dunkeri</i> Schenk.	Gunn coll.
PHOTOS. 8, 9.	<i>Cladophlebis denticulata</i> (Brongn.).	Photo. 8, Gunn coll.
		„ 9, Peach coll.
PHOTO. 10.	<i>Sphenopteris onychiopsoides</i> sp. nov.	Gunn coll.

PLATE VII.

PHOTOS. 11, 12.	<i>Pseudoctenis eathiensis</i> (Rich.)	Photo. 11, Arber coll. (498).
		„ 12, Gunn coll.
PHOTO. 13.	<i>Nilssonina mediana</i> (Leck. ex Bean MS.). ($\frac{3}{4}$ nat. size.)	Gunn coll.
„ 14.	<i>Thinnfeldia</i> sp. (Slightly reduced.)	„
„ 15.	<i>Todites Williamsoni</i> (Brongn.).	Peach coll.
„ 16.	<i>Cladophlebis</i> cf. <i>C. distans</i> (Heer).	Gunn coll.
„ 17.	<i>Pseudoctenis crassinervis</i> gen. et spec. nov. α , α , apex of pinnæ.	„
„ 18.	<i>Cycadospadia Pasinianus</i> Zig.	„
PHOTOS. 19, 20.	<i>Williamsonia pecten</i> (Phill.). Phot. 190, $s = Sagenopteris$ <i>Phillipsi</i> (Brongn.).	„
PHOTO. 21.	<i>Thinnfeldia rhomboidalis</i> Ett.	Peach coll.

PLATE VIII.

PHOTOS. 22-25.	<i>Elatides curvifolia</i> (Dunk.).	Gunn coll.
PHOTO. 26.	<i>Williamsonia pecten</i> (Phill.).	„
„ 27.	<i>Coniopteris hymenophylloides</i> (Brongn.).	„
„ 28.	<i>Coniopteris quinqueloba</i> (Phill.).	„
„ 29.	<i>Cladophlebis denticulata</i> (Brongn.).	„
„ 30.	<i>Elatides curvifolia</i> (Dunk.).	„
„ 31.	<i>Coniopteris arguta</i> (Lind. and Hutt.).	„
„ 32.	<i>Pseudoctenis eathiensis</i> (Rich.).	„

PLATE IX.

PHOTO. 33.	<i>Planta incertæ sedis</i> , C.	Gunn coll.
„ 34.	<i>Nilssonina orientalis</i> Heer.	„
„ 35.	<i>Phænicopsis Gunni</i> sp. nov.	„
„ 36.	<i>Pterophyllum Nathorsti</i> Sew.	„
„ 37.	<i>Nilssonina brevis</i> Brongn.	„
„ 38.	<i>Planta incertæ sedis</i> , C.	„
„ 39.	<i>Brachyphyllum</i> sp.	„
„ 40.	<i>Nilssonina orientalis</i> Heer.	„
„ 41.	<i>Coniferocaulon colymbæforme</i> Fliche.	Arber coll. (569).
„ 42.	<i>Nilssonina orientalis</i> Heer.	Gunn coll.

PLATE X.

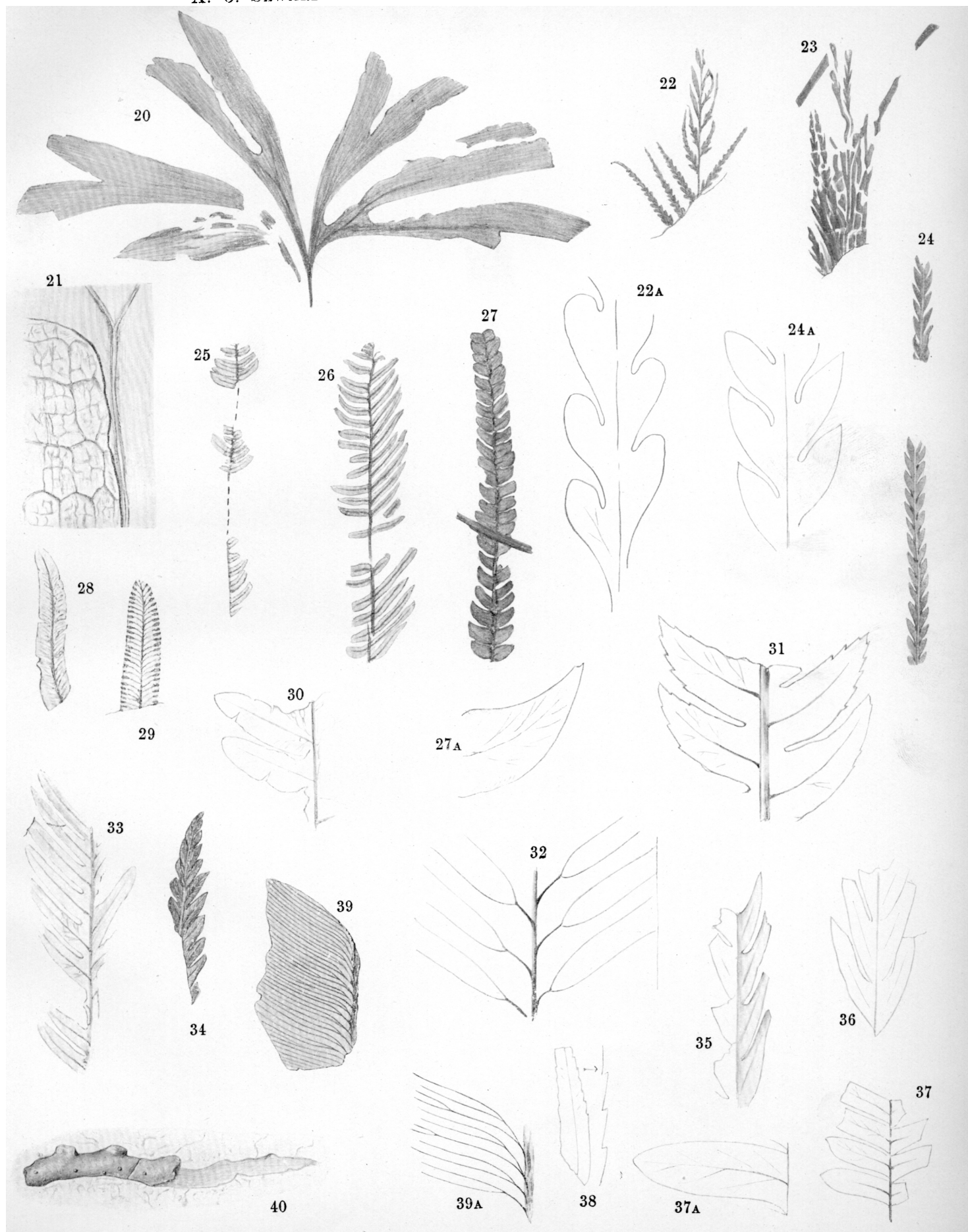
PHOTO. 43.	<i>Zamites Carruthersi</i> Sew. A, base of pinna.	Hugh Miller coll. Edinburgh.
„ 44.	<i>Pterophyllum Nathorsti</i> Sew.	„ „
„ 45.	<i>Pseudoctenis eathiensis</i> (Rich.).	„ „
„ 46.	<i>Nilssonina orientalis</i> Heer.	„ „
„ 47.	<i>Zamites Buchianus</i> (Ett.).	„ „

A. C. SEWARD: THE JURASSIC FLORA OF SUTHERLAND—PLATE I.



M'Farlane & Erskine, Lith., Edin.

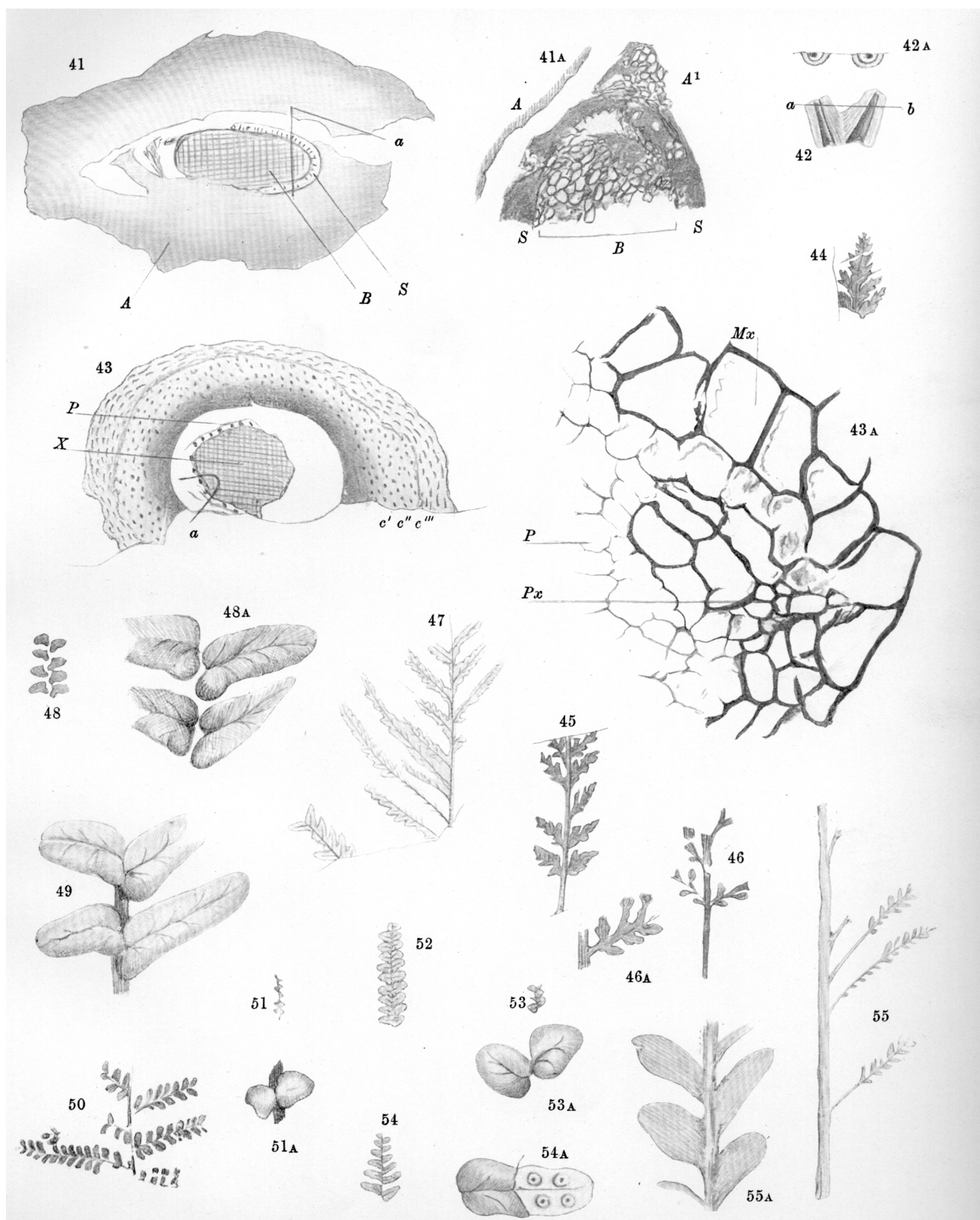
Figures 1-4, *Sagenopteris*. 5-13, *Laccopteris*. 14-19, *Hausmannia*. 19A, *Spiropteris*.



M'Farlane & Erskine, Lith., Edin.

Figures 20, 21, *Hausmannia*. 22–24, *Sphenopteris*. 25, 26, *Matonidium*. 27, *Todites*. 28, 29, *Marattiopsis*.
 30–36, 38, *Cladophlebis*. 37, *Thinnfeldia*. 39, *Tæniopteris*. 40, *Rhizomopteris*.

A. C. SEWARD: THE JURASSIC FLORA OF SUTHERLAND—PLATE III.



M'Farlane & Erskine, Lith., Edin.

Figures 41, *Rhizomopteris*.
47, *Cladophlebis*.

42, 43, *Gleichenites*.
48-54, *Gleichenites*.

44-46A, *Coniopteris*.
55, *Dichopteris*.



M'Farlane & Erskine, Lith., Edin.

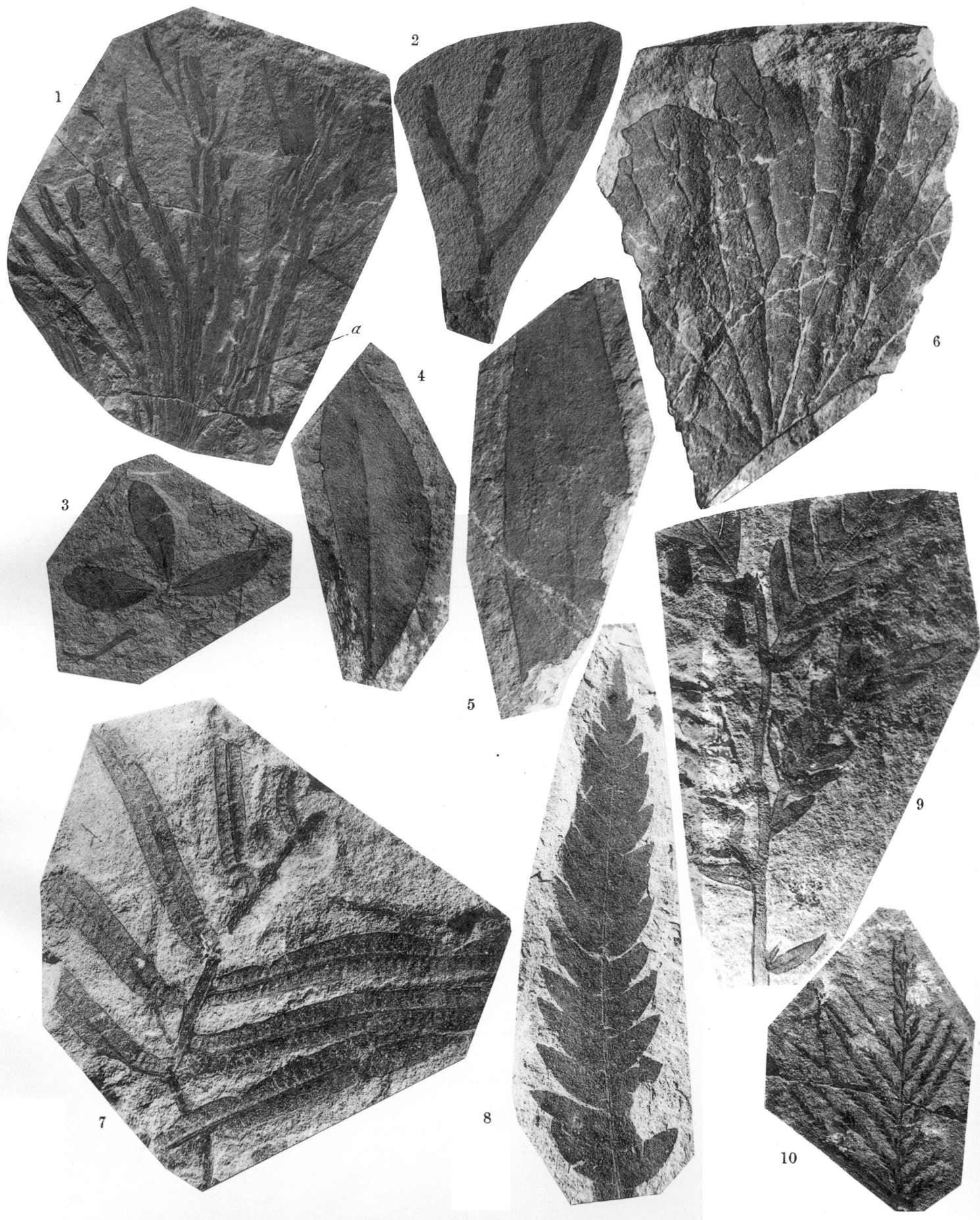
Figures 56, ?*Thinnfeldia*. 57, *Todites*. 58, 59, *Coniopteris*. 60, 63–65, *Nilssonia*. 60A, 61, *Pterophyllum*.
 62, 67, 69, *Pseudoctenis*. 66, 68, 70, 70A, 72, *Thinnfeldia*. 71, *Dichopteris*.

A. C. SEWARD: THE JURASSIC FLORA OF SUTHERLAND—PLATE V.



M'Farlane & Erskine, Lith., Edin.

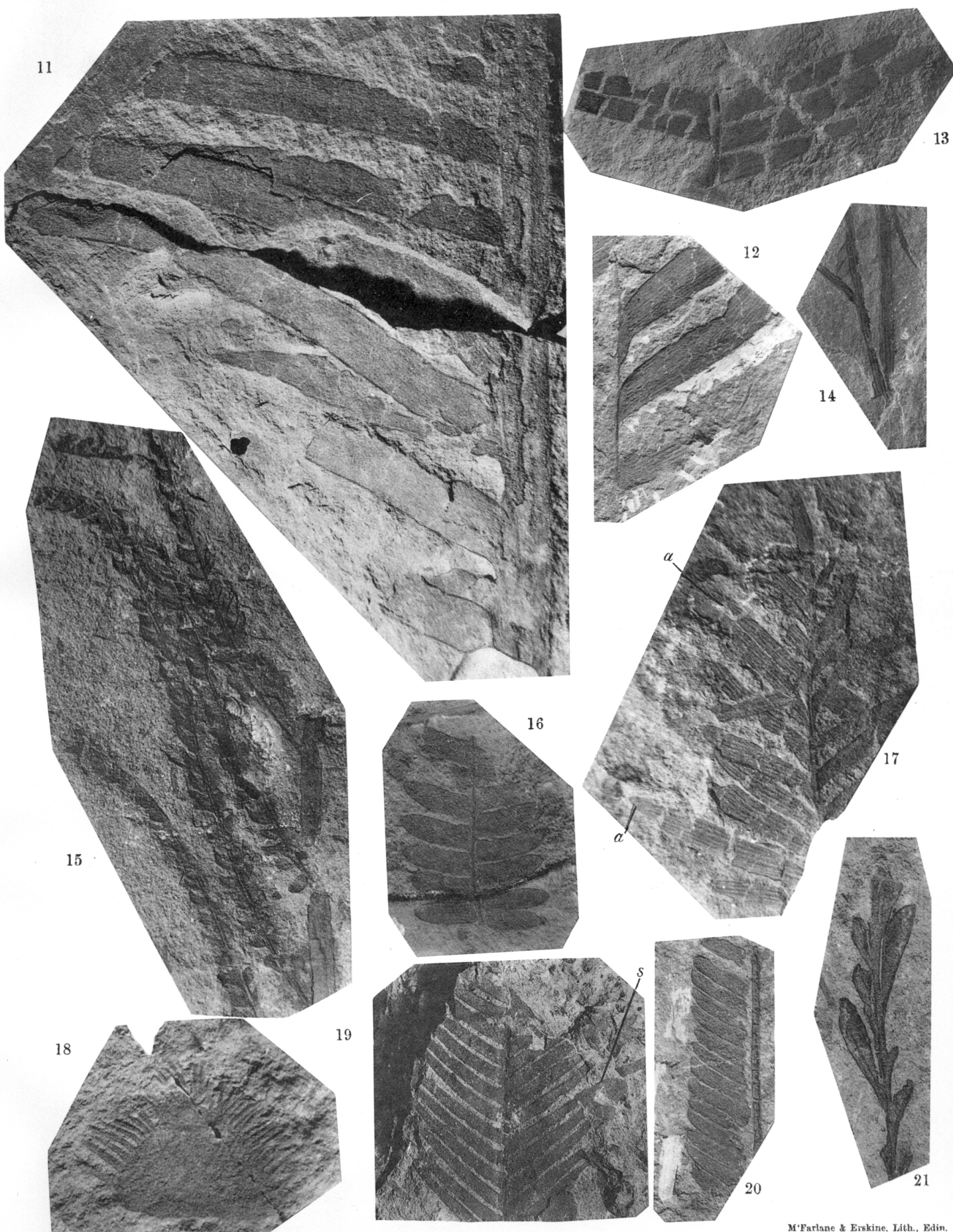
Figures 73, 74, 90, 91, 104, *Taxites*. 75-77, *Elatides*. 78, 81, *Nilssonia*. 79, 86, *Pterophyllum*.
 80, 82, 83, *Thinnfeldia*. 84, *Otozamites*. 85, *Pinites*. 87-89, 92-96, *Gleichenites*. 97, 98, 102, *Araucarites*.
 99, *Williamsonia*. 100, cf. *Dioonites*. 101, *Lacopteris*. 103, *Czekanowskia*. 105, *Baiera*.



D. Elliott, Photo.

M'Farlane & Erskine, Lith., Edin.

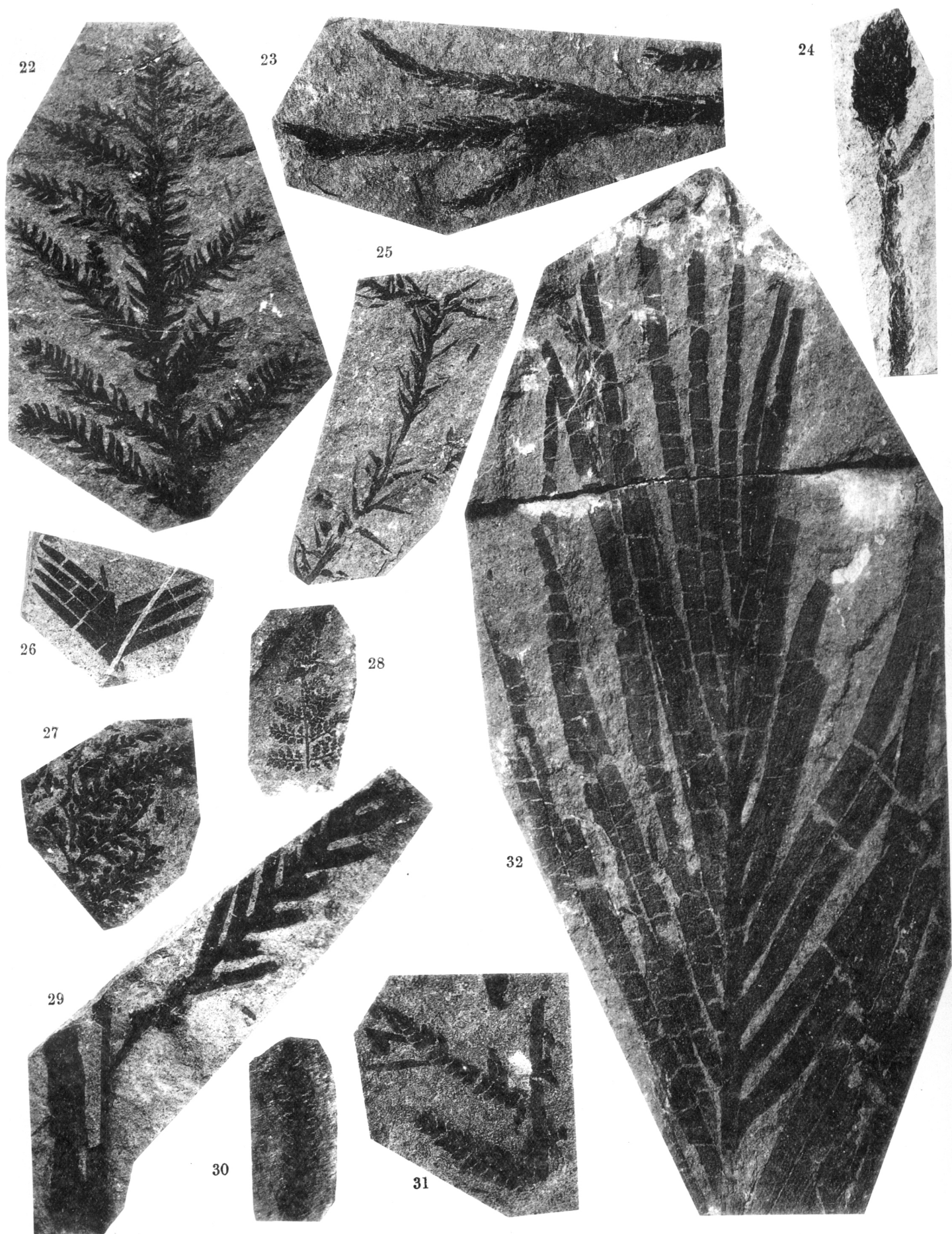
Photographs 1, 2, *Plantæ incertæ sedis*. 3-5, *Sagenopteris*. 6, *Hausmannia*.



Photographs 11, 12, *Pseudoctenis*.
18, *Cycadospadix*.

13, *Nilssonia*. 14, *Thinnfeldia*. 15, *Todites*. 16, *Cladophlebis*.
19, *Williamsonia* and *Sagenopteris*. 20, *Williamsonia*.

17, *Pseudoctenis*.
21, *Thinnfeldia*.



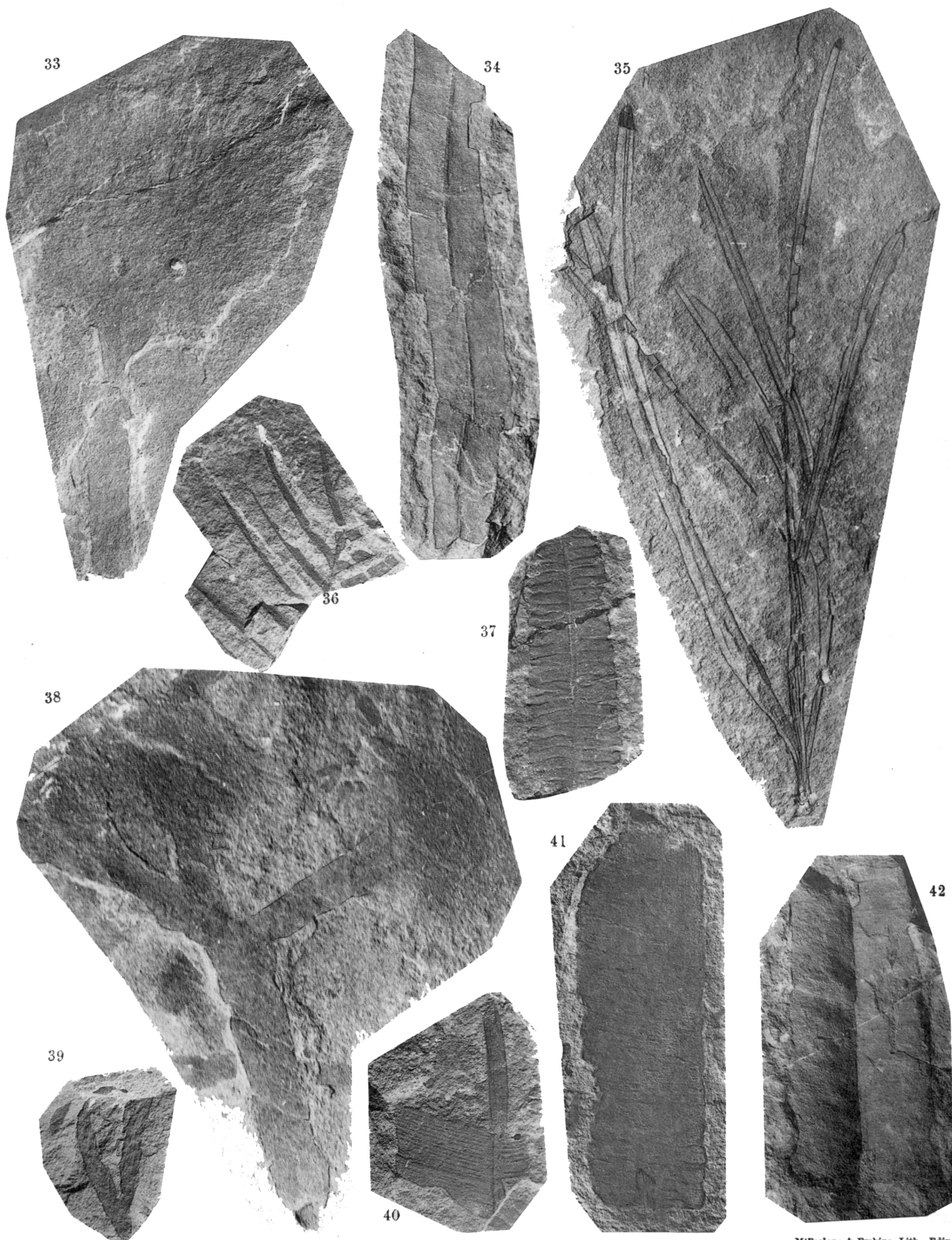
Scott & Wilkinson, Photo.

M'Farlane & Erskine, Lith., Edin.

Photographs 22-25-30, *Elatides*.
29, *Cladophlebis*.

26, *Williamsonia*.
31, *Coniopteris*.

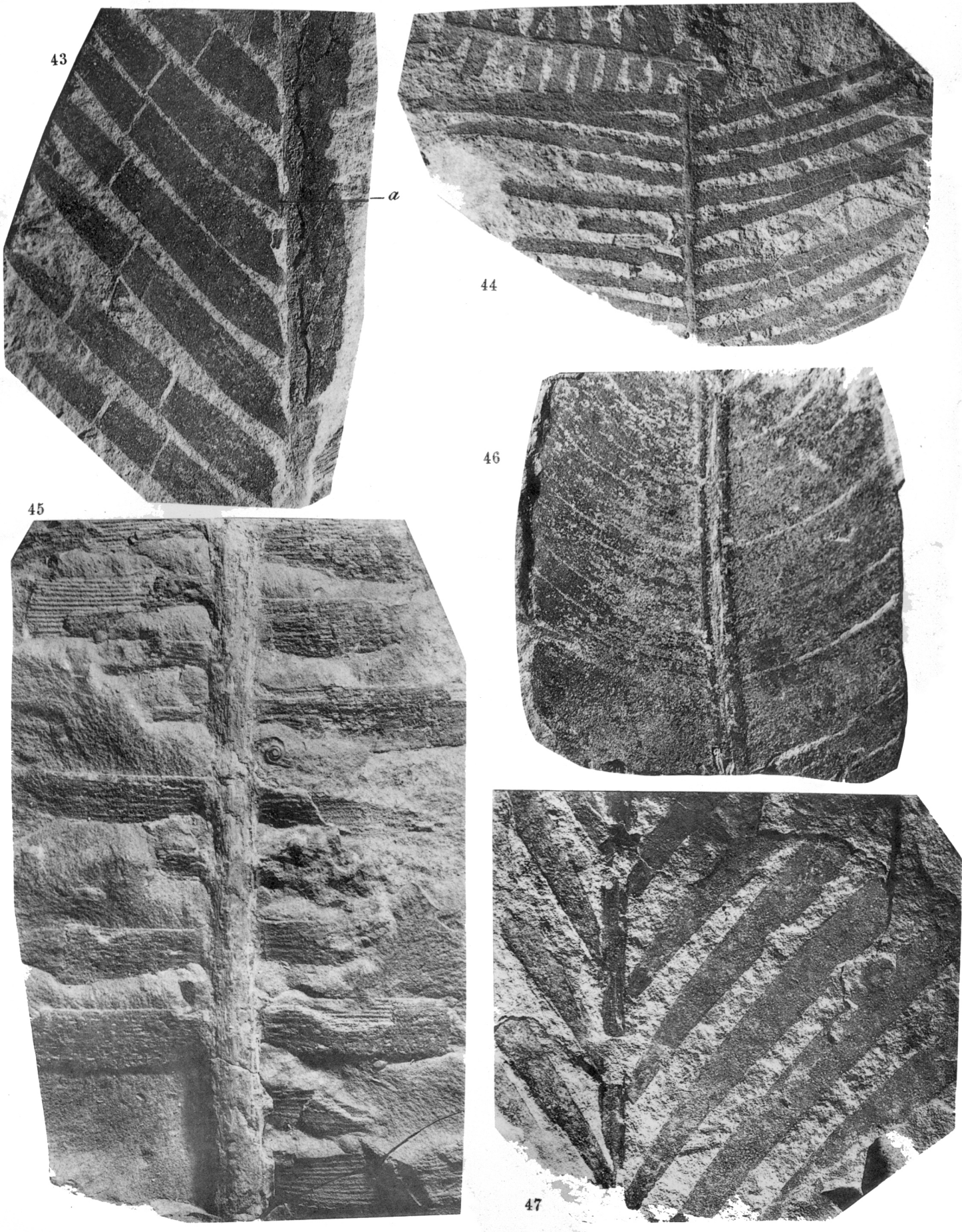
27, 28, *Coniopteris*.
32, *Pseudoctenis*.



D. Elliott, Photo.

M'Farlane & Erskine, Lith., Edin.

Photographs 33, 38, *Plantæ incertæ sedis*. 34, 37, 40, 42, *Nilssonia*. 35, *Phenicopsis*.
36, *Pterophyllum*. 39, *Brachyphyllum*. 41, *Coniferocaulon*.



D. Elliott, Photo.

M'Farlane & Erskine, Lith., Edin.

Photographs 43, *Zamites*. 44, *Pterophyllum*. 45, *Pseudoctenis*. 46, *Nilssonia*. 47, *Zamites*.