V.—*On the Fructification of some Ferns from the Carboniferous Formation.*

By Robert Kidston, F.R.S.E., F.G.S. (Plates VIII., IX.)

CONTENTS.

Calymmatotheca, Stur, emend.

Kidston, *Quart. Jour. Geol. Soc.*, vol. xl. p. 590.

In a Review * of Dr Stur's *Zur Morphologie und Systematik der Culm- und Carbonfarne*,† I pointed out that he appears to have included two types of fern fructifications in his genus *Calymmatotheca*.

The first type includes those forms originally placed in *Calymmatotheca* ‡ and consists of a number of exannulate sporangia arranged around a common point of attachment; the second type, which was first described in *Zur. Morph., u. Syst. d. Culm- u. Carbonfarne*,§ is there represented by *C. Avoldensis* and *C. Frenzli*. The fruit of these two species is apparently surrounded by an *involucre* or *indusium*, and it is only with this part of the fructification that we are at present acquainted. I also further indicated that in *Calymmatotheca*, as I proposed to restrict the genus, the fruiting portions of the frond are entirely deprived of foliage pinnules, whereas in the other type (*C. Avoldensis* and *C. Frenzli*) only a very slight modification takes place in the fertile portion of the fronds—the sporangia being borne on the ordinary foliage pinnules.

In a subsequent paper,‖ when describing the fruit of *Sphenopteris delicatula*, Sternb., I more fully explained the structure of such frutifications as those occurring in *C. Avoldensis* and *C. Frenzli*, and for these three species proposed the new genus *Zeilleria*.

* *Geol. Mag.*, Dec. III. vol. i. p. 328, July 1884.

† *Sitzb. der k. Akad. der Wissensch.*, Band lxxxviii. 1 Abth., 1883.

‡ "Culm-Flora," Heft ii. p. 255, *Abhandl. d. k. k. geol. Reichsanst.*, vol. viii. Of the four figures of Calymmatothecous fruits given here by Stur, *C. Schimperi*, *C. minor*, *C. Haueri*, and *C. Stangeri*, my interpretation of the structure of these fruits is chiefly founded on *C. Stangeri*, as this seems the most perfectly preserved.

§ p. 799.

‖ *Quart. Jour. Geol. Soc.*, vol. xl. p. 590.

On the specimens of *Z. delicatula*, Sternb., sp., figured in the *Quart. Jour. Geol. Soc.*, vol. xl. pl. xxv., the development of the fruit can be traced. It at first consists of a globular indusium, which at maturity splits into four valves for the dissemination of the spores.

On the other hand, what I regard as the true interpretation of the fruit of *Calymmatotheca* is that which was first propounded by RENAULT * and more fully explained and illustrated by ZEILLER,† viz., that in *Calymmatotheca* the fruit consists of a number of *exannulate sporangia* arranged around a common point of attachment.

In the case of *C.* (*Sorocladus*) *asteroides*, Lesqx.,‡ there can be no doubt that the component parts of this star-like fructification are sporangia, and not thong-like segments of a split involucre.

In his last work, *Die Carbon-Flora der Schatzlarer Schichten*,§ Dr STUR freely criticises my remarks on his genus *Calymmatotheca* as employed by him in his *Zur Morph. u. Syst. d. Culm- u. Carbonfarne*, and still adheres to his original opinion that the portion of the fruit of *Calymmatotheca* with which we are acquainted, is the thong-like remains of a split indusium. He also mentions, in regard to his *C. Stangeri*, that he has observed in a few cases at the base of the beaker-like indusium, small convex elevations.

Notwithstanding this, I still think that Dr STUR is mistaken in his interpretation of the fruit of *Calymmatotheca*, and that in *C. Stangeri* the fruit consists of a number of sporangia arranged around a common axis, as in *C.* (*Sorocladus*) *asteroides*, Lesqx., *C.* (*Sphenopteris*) *bifida*, L. & H., and *C. affinis*, L. & H., sp., to be presently described. The small elevations at the base of the inner cavity of the indusium (?) of *C. Stangeri*, to which Dr STUR again refers in his *Carbon-Flora*,‖ have, I am afraid, no organic connection with the fruit, and are perhaps due to mineralisation or to the adhesion of some extraneous matter. I make this suggestion from an examination of the fruit of *C.* (*Sphenopteris*) *bifida*, L. & H., and *C.* (*Sphenopteris*) *affinis*, L. & H., which are similar in all external respects to STUR'S *Calymmatotheca;* and as in these cases the fruit is certainly not composed of thong-like segments of a split indusium, but of true exannulate sporangia, I am induced to believe that Dr STUR, through imperfect preservation of his specimens, is mistaken in their interpretation.

* *Cours d. Botan. Foss.*, Troisième Année, p. 198, 1883.

† *Ann. d. Scienc. Nat.*, 6e sér. Bot., tome xvi. p. 182, pl. ix. figs. 10, 11.

‡ Lesquereux, *Rept. Geol. Survey of Illin.*, vol. iv. p. 406, pl. xiv. figs. 6, 7 ; *Coal Flora of Pennsyl.*, p. 328, pl. xlviii. fig. 9 ; see also Zeiller, *Ann. d. Scienc. Nat., loc. cit.*, p. 182, pl. ix. figs. 10, 11.

§ *Abhandl. d. k. k. geol. Reichsanst.*, Band xi. Abth. 1, p. 239, Wien, 1885. It is to be regretted that Dr STUR here accuses M. ZEILLER of writing anonymously my Review of his *Carbon-Flora*, contributed to the *Geol. Mag.*, which communication M. ZEILLER had neither seen nor was aware of, till after its publication—especially as the paper more fully explaining my views on this subject was published in the *Quart. Jour. Geol. Soc.*, Aug. 1, 1884.

‖ *Loc. cit.*, p. 238.

In regard to *C. Haueri*, Stur,* the type has apparently been so imperfectly preserved that little of its structure can be discerned—the specimen is represented by little more than a mere carbonaceous stain on the matrix. It, however, shows the peculiar character of the sporangia (?) (segments of the indusium according to Dr STUR) being united in pairs by their basal portions, but whether the thong-like bodies are segments of a split indusium or sporangia cannot be satisfactorily settled from an examination of his figure. The union of the thong-like bodies in pairs is taken as an objection by Dr STUR to the sporangial explanation of these fruits, but as the union of sporangia is of frequent occurrence in the *Marattiaceæ*, their apparent partial union in *C. Haueri* does not militate against the view that in *Calymmatotheca* we are dealing with marattiaceous sporangia arranged in groups.

As to the affinities of these ferns, I have nothing to add to that mentioned in my former paper in the *Quart. Jour. Geol. Soc.*, where I said, "*Calymmatotheca* as here restricted (and as restricted in the present communication) is probably related to the *Marattiaceæ*, whereas *Zeilleria* appears to have affinities with the *Hymenophyllaceæ*."† This is very different to that which Dr STUR gives as my views on the affinity of *Calymmatotheca*, where he states, "Dass *Calymmotheca* eine *Hymenophyllacee*, wie der ungenannte Autor meint, nicht sein könne, geht klar aus dem Fehlen des verlangerten oder fadenförmigen Receptaculums am Grunde der Kapsel hervor."‡

It was only the members of the genus *Zeilleria* that I thought might have *hymenophyllaceous* affinities, but as none of the specimens of this genus, which have come under my notice, have afforded any glimpse of the arrangement of the spores within the *indusium* (whether they were attached to a column or not), we can only throw out a suggestion as to the affinities of *Zeilleria*, a suggestion which must be corroborated or refuted as subsequent investigations decide. *Calymmatotheca*, however, as I have proposed to restrict it, possesses apparently an undoubted *marattiaceous* form of fruit.

The specimens to which reference was made when first treating of Dr STUR's genus *Calymmatotheca* were those on which the genus *Zeilleria* were founded,§ hence Dr STUR is mistaken in assuming that my views were established on a *Hawlea*.

A further distinction that was pointed out between *Calymmatotheca* and *Zeilleria* is found in the fruiting portions of the fronds of *Calymmatotheca* being reduced to masses of fruit, unassociated with any ordinary foliage pinnules, whereas in *Zeilleria* the fruiting portion of the frond varies little from the ordinary barren condition, the fertile being mixed with the ordinary barren

* *Culm-Flora*, Heft i. pl. i. fig. 2.

† *Quart. Jour. Geol. Soc.*, vol. xl. p. 591.

‡ *Carbon-Flora*, p. 241.

§ *Quart. Jour. Geol. Soc.*, vol. xl. p. 590.

pinnules. This condition is said by Dr STUR to occur in his *C. Schatzlariensis*,* but the figures of this species given on his pl. xxxviii. are very imperfect, and little can be learnt of the fruit from them; and from the meagre evidence afforded by the woodcut on p. 238, one would not like to say definitely whether this fern should be referred to *Calymmatotheca* or *Zeilleria*.†

Calymmatotheca bifida, L. & H., sp.

Pl. VIII. figs. 1, 2, 3, 4, 5, 6*a*; Pl. IX. figs. 16, 17.

Calymmatotheca bifida, Kidston, *Quart. Jour. Geol. Soc.*, vol. xl. p. 591 (foot-note).
Sphenopteris bifida, Lindley and Hutton, *Fossil Flora*, vol. i. pl. liii.
Sphenopteris bifida, Hibbert, *Trans. Roy. Soc. Edin.*, vol. xiii. p. 177, pl. vi. figs. 1, 2.
Sphenopteris bifida, Kidston, *Trans. Roy. Soc. Edin.*, vol. xxx. p. 537.
Sphenopteris bifida, Miller, *Testimony of the Rocks*, Edin., 1857, p. 466, fig. 129.
Trichomanites bifidus, Göppert, *Syst. fil. foss.*, p. 264, pl. xv. fig. 11.
Todea Lipoldi, Stur, *Culm Flora*, Heft. i. p. 71, pl. xi. fig. 8; Heft. ii. p. 291.
Todea Lipoldi, Schimper in Zittel, *Handbuch der Paleontologie*, Band ii. Heft. i. p. 107, fig. 75.
Sphenopteris frigida, Heer, *Foss. Flora Spitzbergens*,‡ p. 6, pl. i. figs. 1, 3–6.
(?) *Sphenopteris geniculata*, Heer, *Foss. Flora Spitzbergens*, p. 7, pl. i. figs. 8 and 10 (? 7 and 9).
Sphenopteris rutæfolia, Schmalhausen (not Gutbier), *Mém. de la Acad. Impér. d. Sciences de St Pétersbourg*, vii^e sér. vol. xxxi. No. 13, p. 4, pl. i. figs. 1–4 (? fig. 5), 1883.
Staphylopteris Peachii, Kidston (not Balfour), *Trans. Roy. Soc. Edin.*, vol. xxx. p. 539, pl. xxxi. fig. 6.
Sphenopteris (*Diplothmema*) *tracyana*, Lesquereux, *Coal Flora of Pennsyl.*, vol. iii. p. 766, pl. ci. fig. 2, 1884.

Description.—Frond divided into two symmetrical lanceolate portions by a dichotomy of the main axis. Pinnæ sub-opposite or alternate, linear; pinnules sub-opposite, or alternate and divided into 3–8 simple or bifid, narrow, linear, single-nerved segments. Fruiting pinnæ deprived of foliage pinnules, and borne on the main rachis in the neighbourhood of the bifurcation. Fruit consisting of about 16–20 linear sporangia arranged in a circle around a common axis, and situated at the extremities of the bifurcations of the fruiting pinnæ. Sporangia free in their upper portion, but united below.

Remarks.—The type specimen of this species, figured by LINDLEY and HUTTON, gives a very unsatisfactory idea of the true form of this fern, their example having evidently suffered so much from maceration before fossilisation took place, that the delicate limb of the pinnule has entirely decayed, the veins only remaining.

A much more characteristic figure than that given by the authors of the

* *Die Carbon-Flora*, p. 265, pl. xxxviii. figs. 1, 2.

† It is unfortunate that many of the figures on the plates of Dr STUR's *Carbon-Flora* are so indistinct that it is quite impossible to discuss minute details of structure from them.

‡ *Kongl. Svenska Vetenskaps-Akademiens Handlingar*, Band xiv. No. 5, Stockholm, 1876.

Fossil Flora, is the small woodcut given by the late HUGH MILLER in the *Testimony of the Rocks*. This example is refigured on Pl. IX. fig. 16. Another figure, showing well the form of the pinnæ and pinnules of *C. bifida*, is given by STUR in his *Culm Flora*, under the name of *Todea Lipoldi*. The pinnules are divided into 3–7 very narrow linear segments, in each of which is a simple central vein. The limb of the pinnule is very narrow, forming only a slight border to the nerve.

On Pl. VIII. fig. 1, the specimen has so suffered from decay, that nothing of the pinnules now remains but the veins, the specimen being in fact reduced to the same state of imperfection as that of LINDLEY and HUTTON'S original type of the species. This example, however, is specially interesting, as it shows the position of the fruit on the frond, which is here seen to be situated in the neighbourhood of the bifurcation of the main axis. From the specimen drawn at fig. 2, it is shown that in the fruiting pinnæ the *synangia* are borne at the extremities of the little branches resulting from a third or fourth series of dichotomies.

On the surface of the *sporangia* are generally seen, in well-preserved examples, a few longitudinal fine ridges. At figs. 6*a* and 3*a*, two of the *synangia* are exhibited in profile. At fig. 4, and also in figs. 2 and 3, are represented flattened out groups of sporangia.

The sporangia individually are slightly fusiform, and united in their basal portion.*

The affinities of this fern seem to be undoubtedly with the *Marattiaceæ*, and in the genus *Kaulfussia* the *sporangia* are united to each other round a common point, an arrangement with which the fruit of *C. bifida* closely corresponds.

In *C. bifida* the *synangia* differ from those of *Kaulfussia* in the *sporangia* being free for a considerable portion of their length and in the position of the *synangia* on the fern. In *Kaulfussia* the *synangia* are scattered on the back of the frond. In the more essential structural characters of the fruit, however, the close analogy between the fruit of *C. bifida* and *Kaulfussia* is very striking.

Specimens showing the bifurcation of the rachis are not uncommon, and on the main axis below the bifurcation there are a few barren pinnæ, which are usually much smaller and less divided than those above the bifurcation. The pinnæ within the fork, formed by the dichotomy of the axis, are at the base of the two arms much shorter than those on the outer side of the fork, but they gradually increase in size as the arms of the fork separate from each other. The fronds never seem to have attained to large dimensions.

* In one or two *sporangia* I think there can be detected a small elongated pore a little below the apex, but defer positively affirming its presence till I have more frequently seen its occurrence, and so convince myself that this appearance is not accidental.

The *sporangia* of *C. bifida* are more numerous, narrower, and slightly larger than those of *C. affinis*, L. & H., sp., to which I in error referred the first specimens of the fruit of *C. bifida*.*

Sph. frigida, Heer, and *Sph. geniculata*, Heer, seem to have been founded on imperfectly preserved fragments of *C. bifida*, L. & H., sp.

To *C. bifida* must also I think be referred *S. rutæfolia*, Schmalhausen (not Gutbeir) and *S. tracyana*, Lesquereux. Any one having only the original figure of LINDLEY and HUTTON to guide them in their identification of this species, may be very well excused for regarding *Todea Lipoldi*, *Sph. rutæfolia*, Schmalhausen, and *S. tracyana*, as specifically distinct from *C. bifida*; but from the examination of numerous specimens, many of which came from the original locality, I have no doubt that all the names included in the list of synonymy here given under *C. bifida* refer to this one species.

Description of Specimens.—Fig. 1. This specimen was collected by Mr JOHN JACKSON on the River Irthing, within a mile above Lampert, and communicated to me by Mr HUGH MILLER, F.G.S. The specimen is badly preserved, and reduced very much to the same condition as that of the original type figured by LINDLEY and HUTTON in their *Fossil Flora*, pl. liii., where the limb of the pinnules has entirely disappeared, leaving only the veins. Notwithstanding, however, the imperfect state of the example shown at fig. 1, it is interesting, as distinctly showing the position occupied by the fructification of this species, which is on the rachis below the dichotomy as well as on the base of the two arms of the fork.

Specimen from Lewis Burn, rather over 200 yards below Lewis Burn Colliery, N. Tynedale, Northumberland (fig. 2), in the Collection of the Geological Survey of England, collected by Mr J. RHODES. This example, which occurs in association with barren fragments of *C. bifida*, exhibits the characteristic dichotomisation of the fructifying branches of this species, and in fact of the genus *Calymmatotheca*. The rachis of the pinnæ here seems to undergo three series of dichotomies, at the extremities of the ultimate forks of which the *synangia* were borne.†

Specimen from Back Burn, opposite Cranecleuch New Houses, N. Tynedale, Northumberland, collected by Mr J. RHODES, in the Collection of the Geological Survey of England (fig. 3). The specimen figured lies on the corner of a small slab which contains a great many groups of the sporangia of this species. These groups seem to be much crushed and flattened out, and little of the intimate structure is discernible. Only slight traces of the stem which bore the synangia is preserved in this example. The

* *Trans. Roy. Soc. Edin.*, vol. xxx. p. 539, pl. xxxi. fig. 6.

† See *Trans. Roy. Soc. Edin.*, vol. xxx. pl. xxxi. fig. 6.

synangium, lettered *a*, shows very clearly the union of the sporangia in their lower portions.

Specimen from Bateinghope Burn, Redesdale, Northumberland (figs. 4 and 5*a*). This small example shows four *synangia*, lettered respectively *a*, *b*, *c*, *d*, of which *a* and *b* are the two most perfect. Each *synangium* appears to contain from 18–20 *sporangia*. For about half their length the sporangia are free, but their basal portions are united. The individual sporangia, though now compressed, show a distinct rotundity, and have usually one or two well-marked longitudinal ridges. The sporangia must have originally possessed considerable substance, for in the fossil state they are frequently converted into a coaly material, which, from its brittle nature, when the stones containing the fossils are split, commonly causes the free portions of the sporangia to spring from the matrix, only leaving their impressions on the stone.

Specimen from Lewis Burn, over 200 yards below Lewis Burn Colliery, N. Tynedale, Northumberland (fig. 6), collected by Mr J. RHODES, in the Collection of the Geological Survey of England. This small slab shows two different types of fern fructification lying side by side. That marked *a* is a *synangium* of *C. bifida*, but the other is evidently the remains of an *indusium* split into five segments. Unfortunately, very few fragments of this interesting fern fructification (6*b*) have been discovered; but another, though imperfect example, shows the indusia attached to a rachis in a somewhat similar manner to those of *Sorocladus stellatus*, Lesqx.* It differs, however, from that species in the larger size of the indusium, and in the frond being apparently bipinnate, at least the small fragment showing these fruits attached to the rachis exhibits a bipinnate disposition of the indusia. I propose provisionally to designate this species as *Sorocladus antecedens*. The plant I here place in *Sorocladus* differs from *Zeilleria* in the fruiting portion being altogether destitute of ordinary foliage pinnules. The few fragments of this species which have been collected come from the same locality.

Specimen from Burdiehouse, Mid-Lothian, in the "Hugh Miller Collection," Museum of Science and Art, Edinburgh (Pl. IX. figs. 16 and 17). This example, which is the original of the small woodcut given by HUGH MILLER in the *Testimony of the Rocks*, Edinburgh, 1857, p. 466, fig. 129, is reproduced here natural size. It shows one of the two main divisions of the frond, and bears about 22 pairs of opposite pinnæ. The pinnæ on the right of the figure are longer than those on the left, the latter having been situated within the fork of the frond.

The pinnæ are lanceolate, the longer ones bearing about 14 pairs of pinnules, which vary from simple to being divided into 8 linear, single-nerved, simple, or bifid segments, according to their position on the pinnæ. The

* *Coal Flora of Pennsyl.*, p. 328, pl. xlviii. fig. 8.

pinnules towards the centre of the pinnæ are longest. The pinnules of the superior side of the pinnæ are longer than those on its inferior side. Figs. 17, *a*, *b*, *c*, show some of the pinnules slightly enlarged.

There is another example from Burdiehouse in the "Hugh Miller Collection," Museum of Science and Art, Edinburgh, which is interesting as showing very beautifully the bifurcation of the main axis, below which, as well as on the two arms of the fork, the frond bears barren pinnæ. It further shows that the pinnæ within the fork are shorter than those attached to the outer side of the fork, a character well shown in fig. 16.

Several specimens, also showing the bifurcation of the main axis, are contained in the Collection of the Geological Survey of Great Britain.

My thanks are due to Dr TRAQUAIR, keeper of the Natural History Department, Museum of Science and Art, Edinburgh, for permission to figure the specimen shown on Pl. IX. fig. 16.

Horizon.—Calciferous Sandstone Series.

Localities:—

Scotland.—Burdiehouse, near Edinburgh; Muir Burn, Kershope Burn, and Tweeden Burn, Liddesdale;* and River Esk, Glencartholm, Eskdale.*

England—Northumberland.—Shore section, Sandstone Quarry, a little south of Sea Houses; Bateinghope Burn, 1 mile from head of stream, Redesdale; east bank of Lewis Burn, Barney's Cut, a little more than $\frac{1}{4}$ mile south-west of Lewis Burn Bridge, North Tynedale; Lewis Burn, more than 200 yards below Lewis Burn Colliery, North Tynedale; Buck Burn, $\frac{3}{4}$ mile north-west of Willow Bog, Oakenshaw Burn, North Tynedale; Cranecleuch Burn, opposite Cranecleuch New Houses, Whickhope Burn, North Tynedale; foot of Sauchy Sike, Little Whickhope Burn, North Tynedale; Rigend Burn, Kielder, N. Tynedale. *Cumberland.*—River Irthing, $\frac{7}{8}$ mile north of Lampert (county boundary, Northumberland and Cumberland); foot of streamlet, $\frac{3}{4}$ mile south-west of Wileysike, River Irthing; River Irthing, 2 miles north-east of Waterhead; River Irthing, $\frac{3}{4}$ mile east of Waterhead; Bothrigg Burn, near its head, 1 mile east of the Flat, Bewcastle; stream between Oakshaw and Whintingstone, Clattering Ford, Bewcastle.†

* Collected by Mr A. MACCONCHIE, Fossil Collector to the *Geol. Sur. of Scotland.*

† The specimens from Northumberland and Cumberland have been mostly collected by Mr J. RHODES, Fossil Collector to the *Geol. Sur. of England.*

Calymmatotheca affinis, L. & H., sp.

Plate IX. figs. 18–22.

Calymmatotheca affinis, Kidston, *Catalogue of Palæoz. Plants in Brit. Mus.*, p. 66, 1886.
Sphenopteris affinis, Lindley and Hutton, *Foss. Flora*, vol. i. pl. xlv.
Sphenopteris affinis, Hibbert, *Trans. Roy. Soc. Edin.*, vol. xiii. p. 178, pl. vi. fig. 4; Pl. v. *bis.*
Sphenopteris affinis, Peach, *Quart. Jour. Geol. Soc.*, vol. xxxiv. p. 131, pl. vii.
Sphenopteris affinis, Peach, *Trans. Bot. Soc. Edin.*, vol. xii. pp. 162 and 187.
Sphenopteris linearis, Brongniart (not Sternberg), *Hist. d. végét. foss.*, p. 175, pl. liv. fig. 1.
Sphenopteris linearis, Hibbert, *Trans. Roy. Soc. Edin.*, vol. xiii. p. 178, pl. vi. fig. 3.
Staphylopteris (?) *Peachii*, Peach, *Quart. Jour. Geol. Soc.*, vol. xxxiv. p. 131, pl. viii. figs. 1, 2, 3 (4 ?).
Sphenopteris frigida, Heer (*in part*) *Foss. Flora Spitzbergens*, pl. i. fig. 2.
Sphenopteris flexilis, Heer (*in part*), *Foss. Flora Spitzbergens*, p. 8, pl. i. figs. 11–27 (pl. ii. figs. 7–10 ?)

Description.—Frond divided into two symmetrical, lanceolate parts, tripinnate or decompound; primary pinnæ alternate, lanceolate; secondary and tertiary pinnæ alternate and broadly lanceolate; pinnules cuneate, entire or divided into 2–3 cuneate lobes. Veins numerous, radiating from the base of the pinnule, and dichotomising 2–3 times. Fructification consisting of 4–6 oblong exannulate sporangia borne at the extremities of the dichotomously divided fertile pinnæ, which are wholly deprived of foliage pinnules. Position of fertile pinnæ not yet observed, but probably holding the same position on the frond as those of *Calymmatotheca bifida*. Rachis smooth.

Remarks.—The plant figured by Brongniart as *Sphenopteris linearis* is evidently not Sternberg's fern of that name.* The specimen that has served as the type of Sternberg's *Sph. linearis* is so imperfect that, from any evidence afforded by the figure, it is very improbable it will ever be known what his fern really is.

On the other hand, the plant figured by Brongniart as *Sph. linearis* is the same as that earlier described by Lindley and Hutton as *Sph. affinis*. The type figure of *Sph. affinis* is unfortunately not very characteristic of the species, and though small pinnuled forms occur, the pinnules are always more cuneate than shown in the figure given on plate xlv. (vol. i.) of the *Foss. Flora*. As far as this character is concerned, the figure given by Brongniart is more satisfactory, but perhaps the most characteristic figures are those given by Hibbert.†

It may be added that the specimen figured by Lindley and Hutton as *Sph. linearis*,‡ which is fortunately preserved in the Hutton Collection (Museum of Natural History, Newcastle-on-Tyne), is not the *Sph. linearis*, Bgt. (=*Sph.*

* Sternberg, Vers. ii. p. 15, pl. xlii. fig. 4.

† *Trans. Roy. Soc. Edin.*, *loc cit.*

‡ *Foss. Flora*, vol. iii. pl. ccxxx.

affinis, L. & H.), but a fine specimen of the upper portion of *Sph. crassa*, L. & H. Their plate is not a satisfactory rendering of the fossil.*

C. affinis, in the dichotomisation of the main axis and the general distribution of the primary pinnæ on the two forks of the dichotomy, follows the same arrangement as that occurring in *C. bifida*, L. & H., sp.

Specimens of the fruit of *C. affinis* were first exhibited by the late Mr C. W. PEACH at the meeting of the Bot. Soc. Edin., May 1874.† These were subsequently named *Staphylopteris* (?) *Peachii* by the late Prof. BALFOUR. Later Mr C. W. PEACH found the *Staphylopteris* (?) *Peachii* united to *Sphenopteris affinis*,‡ but regarded it as a parasite. The structure, however, of *Staphylopteris* (?) *Peachii*, being that of a marattiaceous fructification, independently of the fact of a similar structure having been found organically attached to *C. bifida* in such a manner as to conclusively prove it is the fruit of that species, shows beyond all doubt that *Staphylopteris* (?) *Peachii* is the fruit of *Sphenopteris affinis*, and not a parasite.

Mr C. W. PEACH communicated a paper to the Geol. Soc. London on *Sph. affinis* and *Staphylopteris* (?) *Peachii*,§ in which he figured some small specimens of the latter fossil.‖

In the same communication he describes and figures what he believed to be the true fruit of *Sph. affinis*.¶ The specimen from which this figure was taken was kindly shown me by its describer, but I could not distinguish other than some sand-grains or other inorganic matter adhering to the pinnules, which had been mistaken by my friend for fruit. I believe this view of the supposed fruit is that accepted by others who have seen the specimen.

A very good restoration of the complete frond of *C. affinis* is given by HUGH MILLER as a frontispiece to his *Testimony of the Rocks*.

The figures of *Sph. frigida* and *Sph. flexilis*, mentioned in the synonymy, appear to belong to this species.

Description of Specimens.—Fig. 18. From Burdiehouse, near Edinburgh. This specimen, which is preserved in a dark grey limestone, shows the general form of the fern. The pinnæ are lanceolate, the secondary pinnæ being somewhat more broadly lanceolate than the primary. The tertiary pinnæ bear 2–4 cuneate pinnules, which are either simple or compounded of 2–3 cuneate lobes. The veins are indistinctly preserved, the carbon of the plant being converted into a bright coal-like substance.

Fig. 19. From Harwood Burn, below Limefield House, near West Calder, Mid-Lothian, in the Collection of the Geological Survey of Scotland.

* See Kidston, *Proc. Roy. Phys. Soc. Edin.*, vol. vii. p. 238.

† *Trans. Bot. Soc. Edin.*, vol. xii. p. 162.

‡ *Trans. Bot. Soc., loc. cit.*, p. 187.

§ *Quart. Jour. Geol. Soc.*, vol. xxxiv. p. 131.

‖ Pl. viii. figs. 1–3 (4?).

¶ Pl. vii. fig. 2.

Fig. 19*b* shows one of the pinnæ of a large pinnuled form of *C. affinis*. This example, in the size of the pinnules, corresponds to BRONGNIART'S *Sphenopteris linearis*.* The nervation is beautifully preserved, and is shown in the enlarged drawing, fig. 19*a*.

Fig. 20. From West Calder, collected by the late Mr C. W. PEACH. This sketch shows one of the largest fertile pinnæ of *C. affinis* with which I have met. The pinna is destitute of foliage pinnules, and ramifies by a series of dichotomies. At *a* are shown the ultimate branchlets, but the *synangia* have become detached from their parent stalks, a few of which, however, are seen at *a* and *b*. These consist of 4–5 sporangia.

Figs. 21–22 are copied from the plate which accompanies Mr C. W. PEACH'S paper in the *Quart. Jour. Geol. Soc.*, vol. xxxiv. p. 131. Fig. 21 shows the *synangia* attached to their supporting pedicels, and fig. 22 gives a single *synangium*, which is enlarged at fig. 22*b* to show the five exannulate sporangia of which it is composed.

Horizon.—Hitherto only found in the Calciferous Sandstone series, where in some localities it is plentiful.

Localities :—

Scotland—Berwickshire.—Bilsdean Creek, 1½ miles west of Cockburnspath (J. Bennie); Shore, west of Harbour, Cove, Cockburnspath (J. Bennie). *Fifeshire.*—Rocks above Kinghorn; Flisk Quarry, St Andrews; Grange Quarry, Burntisland; Kilmundy Limestone Quarry, Burntisland (J. Bennie); Kilmundy Sandstone Quarry, Burntisland (J. Bennie); Dodhead Quarry, Burntisland (J. Bennie); east side of the Binn near Burntisland (J. Bennie); Brosyhall Lime Quarry, east of Burntisland (J. Bennie); Binnend Shale Works, Burntisland (J. Bennie). *Haddingtonshire.*—Long Craigs Bay, 1½ miles west of Dunbar (J. Bennie). *Buteshire.*—Island of Arran (British Museum). *Dumfriesshire.*—Docken Beck, near Langholm (A. Macconochie); Glencartholm, Eskdale (A. Macconochie); Tinnis Burn, near Newcastleton, Liddesdale (A. Macconochie). *Linlithgowshire.*—Railway Cutting, Dalmeny Railway Station; Dalmeny Shore, halfway between Long Craig and Newhall Piers, Queensferry (J. Bennie). *Mid-Lothian.*—Raw Camps, Mid-Calder (*Fruit*); Straiton Oil Works, near Loanhead; Queen's Park, Edinburgh (Professor Ross); Craigleith Quarry, near Edinburgh; Lochend, Edinburgh; Addiewell; Water of Leith, below Redhall Mill Dam; Hailes Quarry, Kingsknowe, near Slateford (Professor D'Arcy Thomson), (*Fruit*), (T. Stock); Burdiehouse; Banks of the Almond, Cramond (R. F. B. Bishop); Suburban Railway Cutting, Edinburgh (J. Gaul); West Hermand, near West Calder (*Fruit*), (C. W. Peach); Harwood Burn, below Limefield House, near West Calder (J. Bennie); Currie (*Fruit*), (J. Bennie); Slateford; Shore at

* *Loc. cit.*, pl. liv. fig. 1.

Wardie, near Granton (C. W. Peach); Inchkeith, Frith of Forth (J. Gaul).

England—Cumberland.—Bull Cleuch, Kirk Beck, Bewcastle (H. Miller). *Northumberland.*—Warksburn, North Tynedale (H. Miller).

Calymmatotheca asteroides, Lesqx., sp.

Calymmatotheca asteroides, Zeiller, *Ann. des Scienc. nat.*, 6e sér. Bot., vol. xvi. p. 182, pl. ix. figs. 10, 11.

Staphylopteris asteroides, Lesquereux, *Report Geol. Survey of Illin.*, vol. iv. p. 406, pl. xiv. figs. 6, 7; Schimper, *Traité d. paléont. végét.*, vol. iii. p. 512.

Sorocladus asteroides, Lesquereux, *Coal Flora of Pennsyl.*, p. 328, pl. xlviii. figs. 9, 9*b*.

Remarks.—Among many other specimens of fossil plants contained in the collection of the late WILLIAM HENRY JOHNSON, Dudley, I observed two small specimens of this species.

Unfortunately, they are not verywell preserved, and do not add any additional information to the knowledge of the species. The general growth of the species is well shown in LESQUEREUX's figures, and their more minute structural details have been illustrated by ZEILLER. The fructification consists of a number of elongated sporangia, usually six in number, arranged in a stellate manner around a common point of attachment. It is not yet known to which fern this fructification belongs, as the fertile portion shows no traces of the barren pinnules.

Horizon.—Middle Coal Measures.

Locality.—Coseley, near Dudley.

Zeilleria Avoldensis, Stur, sp.

Plate VIII. figs. 8–10.

Zeilleria Avoldensis, Kidston, *Quart. Jour. Geol. Soc.*, vol. xl. p. 591, 1884.

Calymmotheca Avoldensis, Stur, "Morph. u. Syst. d. Culm. u. Carbonfarne," *Sitzb. d. k. Akad. d. Wissensch.*, vol. lxxxviii. p. 171, fig. 37.

Die Carbon-Flora d. Schatzlarer Schichten, *Abhandl. d. k. k. geol. Reichsanst.*, vol. xi. Abth. i. p. 251, pl. xxxviii. fig. 1, text fig. 41 on p. 238.

Description.—Frond decompound (4–5 pinnate); primary pinnæ broadly lanceolate, secondary pinnæ lanceolate, and composed of about twenty pairs of tertiary pinnæ. The tertiary pinnæ are more or less lanceolate, but vary in outline according to their position on the frond. Pinnules attached to the rachis by their whole base and united among themselves, the free portion of the limb is ovate-triangular; medial nerve clearly defined, and giving off 2–4 simple lateral branchlets, all of which extend to the margin of the pinnule. Fruiting

portion of the frond confined to the lower secondary pinnæ, where the fertile pinnules bear 1–3 pedicellate indusia at the extremities of the excurrent veins. In the earlier condition the indusia are oval, but at maturity split into four valves.

Remarks.—From the figure of this species given by Dr STUR in his *Carbon Flora*, the fronds of this fern must have attained to large dimensions. The form of the tertiary pinnæ varies much on the upper and lower parts of the fern; on the upper portion they are small, about 3 mm. long, 2 mm. broad, and more or less oval in outline; those towards the apex of the secondary pinnæ are more or less united among themselves. On the lower secondary pinnæ the tertiary pinnæ are 15–20 mm. or more long, and bear many pairs of alternate pinnules, which are usually united to each other for $\frac{1}{3}$ or $\frac{2}{3}$ of their length. The free portion is triangular, and has a well-defined central and usually two lateral veins, one given off from each side of the medial nerve. The fertile pinnules do not differ in form from the barren, except in the veins being produced to form little pedicels to which the oval indusia are attached (Pl. VIII. figs. 9, 10). Occasionally only the upper pinnules are fertile, but quite as frequently the lower, as well as the upper pinnules bear fruit.

The fruit of this fern, as pointed out by Dr STUR,* is composed of four valves. This four-cleft appearance, however, is only shown when the indusium has reached maturity and split for the dissemination of the spores; in the young state the indusia are oval as seen at Pl. VIII. fig. 9. As to the manner in which the spores are arranged within the indusium nothing is known.

Description of Specimen.—Pl. VIII. fig. 8. The example figured is the only British specimen of this species with which I have yet met. It shows a portion of a secondary pinnæ, bearing the remains of twelve tertiary pinnæ, none of which are very complete, but all are fertile, except the two upper pairs. The fertile pinnules bear in some cases three (fig. 10) and in others only one indusium (fig. 9).

At fig. 9 is exhibited the young, and at fig. 10 the more advanced condition of the indusia, where they have split into valves.

This specimen was in the collection of the late Mr HENRY JOHNSON, F.G.S., Dudley, from whom I received it for examination.

Horizon.—Middle Coal Measures.

Locality.—Corseley, near Dudley.

* *Carbon Flora, &c.*, p. 254.

Neuropteris heterophylla, Brongniart.

Plate VIII. fig. 7.

Neuropteris heterophylla, Brongniart, "Classification des Végétaux Fossiles," Extract from *Mémoires du Muséum d' histoire naturelle*, tomè viii. p. 33, pl. ii. fig. 6, 1822.
Hist. d. Végétaux Fossiles, p. 243, pl. lxxi. and pl. lxxii. fig. 2, 1828.
Neuropteris Loshii, Brongniart, *Hist. d. Végétaux Fossiles*, p. 242, pl. lxxii. fig. 1, and pl. lxxiii. 1828.

Several authors have described what they believe was the fructification of the genus *Neuropteris,* Brongniart, but in all these cases the supposed fruit was either a parasitic fungus, or the fern bearing the fruit described had been referred to the genus *Neuropteris* in error.

As early as 1826, HOFFMANN figured what he regarded as the fruit of his *Neuropteris ovata.** This consisted of a single lanceolate pinnule, 3 cm. long and 1 cm. wide, whose basal extremity appears to me rather to lie under the stem which is supposed to have borne it than to be attached to it. The upper surface of this supposed fruiting pinnule shows an indistinct granulation. Its preservation is, however, so imperfect that it seems impossible to say that this supposed fruit belongs to *N. ovata,* or even to any other member of the genus *Neuropteris.*

The next supposed fruit of *Neuropteris* was figured by BRONGNIART in his *Hist. d. vêgét. foss.*, p. 239, plate lxv. figs. 3 and 3*a*, where certain linear swellings situated *between* the nerves are irregularly scattered over the upper surface of a pinnule of *Neuropteris flexuosa.* In a subsequent part of the same work, p. 326, BRONGNIART corrected this erroneous interpretation of these bodies, and refers them to parasitic fungi, a view which receives confirmation from the occurrence of similar organisms on ferns belonging to different recent genera.

Almost conclusive evidence against these bodies being the fruit of ferns is further afforded by their occupying the tissue of the pinnules *between* the veins, whereas the fruit of ferns is situated *on* some part of their nervation.

In 1880 FONTAINE and WHITE, in their *Permian and Upper Carboniferous Flora,* give a figure of *N. hirsuta,*† showing what they believed to be its fructification, but again this supposed fruit appears to be only another of those parasitic fungi, and one which seems very closely related to the species affecting the specimen of *N. flexuosa* described by BRONGNIART. The supposed *sori* figured by

* "Uber die Pflanzenreste des Kohlengebirges von Ibbenbühren und vom Piesberge bei Osnabruck," in Keferstein's *Teuchland geognostisch-geologisch dargetsellt*, vol. iv. p. 158, pl. i. figs. 5–8, Weimar, 1826. His fig. 8 is the supposed fruiting pinnule.

† "Second Geol. Survey of Pennsylvania, Report of Progress P.P.," *The Permian or Upper Carboniferous Flora of West Virginia and S.-W. Pennsylvania*, p. 47, pl. viii. figs. 7, 8, Harrisburg, 1880.

FONTAINE and WHITE are also stated to lie *between* the veins, a circumstance which is fatal to the view that these bodies are the fructification of their fern.

BUNBURY * had previously figured and described similar organisms on the pinnules of *N. Scheuchzeri* (*N. cordata*, Bunbury, not Brongniart),† and had rightly referred them to a disease of the parenchyma or a parasitic fungus.

In the Carboniferous formation, fossil parasitical fungi occur not only on various spcies of ferns, but on other plants also, and have been figured and described by various writers.‡

N. heterophylla, Brongt. (with which *N. Loshii*, Brongt., is now known to be synonymous), has also had its supposed fruit described by GUTBIER in 1849,§ but in this case, even if the bodies which were supposed by GUTBIER to be the fruit of his fern really prove to be its fructification, we are still in ignorance of the fruit of *Neuropteris*, as GUTBIER'S fern does not belong to this genus, but to *Odontopteris*.‖

The specimen now described exhibits very clearly the mode and character of the growth of the fruiting portion of *Neuropteris*. It was discovered by Mr T. STOCK, by whom it was communicated to me for examination.

The fossil shows an axis *a* about 8 cm. long, which gives off apparently two pairs of lateral pinnæ, *b, c* and *d, e*. The terminal portion of the specimen ends in a number of dichotomous branchlets, the ultimate divisions being about 8 mm. long, and bearing the fruit at their summits. On the terminal part of the fossil there is no trace of the ordinary foliage pinnules. At *b* and *c* are shown what appears to be the remains of a pair of lateral pinnæ, each of which seems to have supported four fructifications. Associated with these pinnæ are the remains of a small number of ordinary barren pinnules. Of the two lower pinnæ, that marked *d* is very incomplete, and only shows some fragments of the ordinary barren pinnules; the corresponding opposite pinna is, however, more perfect, and shows three fructifications and a portion of a pedicel of a fourth. At the base of this pinnæ are preserved some remains of

* *Quart. Jour. Geol. Soc.*, vol. iii. p. 424, pl. xxv. fig. 1*e* and 1*f*.

† See Zeiller, "Notes sur la Flore houillère des Asturies," *Mém. Soc. Géol. du Nord. Lille*, p. 6, 1882.

‡ See Göppert, " Foss. Farrnkräuter," *Syst. fil. foss.*, p. 262, pl. xxxvi. fig. 4, *Excipulites Neesii;* Weiss, *Foss. Flora d. jüng. Stk. u. d. Rothl.*, p. 19; Schimper, *Traité d. paléont. végét.*, vol. i. p. 141, pl. i. fig. 19, and Explanation to pl. xxxii. figs. 6 7; Geinitz, *Vers. d. Steink. in Sachsen*, p. 2, pl. xxiii. fig. 13, *Excipulites Neesii*; pl. xxv. fig. 10, *Depazites Rabenhorsti;* Feistmantel, "Der Handendflötzzug," &c., *Archiv. d. Naturw. Landesdurchforschung von Böhmen*, iv. Band, No. 6 (Geol. Abth.), p. 62, pl. i. fig. 1, *Xylomides ellipticus;* Weiss, "Steinkohlen-Calamarien," *Abhandl. z. geol. specialkarte v. Preussen u. d. Thüringischen Staaten*, Band v. Heft. ii. p. 66, pl. i. fig. 2; Grand' Eury, *Flore carbon. du Départ. de la Loire et du centre de la France*, p. 10, *Excipulites punctatus* and *Hysterites cordaitis*, pl. i. fig. 7, &c.

§ *Die Versteinerungen die Rothliegenden in Sachsen*, p. 12, pl. iv. figs. 2, 3.

‖ See Weiss, *Foss. Flora d. jüng. Stk. u. d. Rothl.*, p. 27; also for the fruit of *Odontopteris*, see Gand' Eury, *Flore carbon. du Départ. de la Loire*, p. iii. pl. xiii. fig. 4.

the ordinary barren pinnules. It would appear, therefore, that each of the lateral pinnæ supported four fruits, and on the terminal portion; though the remains of only eleven fructifications are seen, there were probably originally twelve. There may be combined in this part two lateral pinnæ and the apex of the frond, each bearing four fruits, but this cannot be clearly traced. At *f* is shown a small fragment of a pinna, drawn in the natural position it holds to the larger specimen. This shows the remains of two fructifications and portions of three barren pinnules, one of which is very perfect. The fortunate occurrence of barren pinnules associated with this fructification, conclusively identifies this interesting specimen with the genus *Neuropteris*, and further the barren pinnules *f** and *e** do not differ in any way from many shown on the figure of *N. heterophylla*, given by BRONGNIART in the *Hist. d. Végét. foss.*, plate lxxi. In the same beds from which this specimen was collected *N. heterophylla* is plentiful.

As to the affinities of this species, either with past or present existing genera of ferns, unfortunately this specimen does not afford sufficient data from which to form any opinion.

In the description of this specimen, I have therefore refrained from employing the terms *indusium* or *sporangium* to the little expansions at the extremities of the pedicels, as I cannot determine their true structure, though they are apparently composed of two or four segments.

Horizon.—Lower Coal Measures.

Locality.—Blairpoint, Dysart, Fife.

ALCICORNOPTERIS, n. gen., Kidston.

Generic Description.—Rachis ramifying by a series of dichotomies. Barren pinnæ composed of a foliaceous *Rhacophyllum*-like expansion. Fruiting portion consisting of much divided circinately convoluted pinnæ. Form and mode of attachment of sporangia to the fruiting pinnæ unknown.

Remarks.—This genus in the barren condition approaches closely to *Rhacophyllum*, and in its fruiting branches to SCHIMPER'S *Triphyllopteris collombi* and DAWSON'S *Cyclopteris acadica*.

Alcicornopteris convoluta, n. sp., Kidston.

Plate VIII. figs. 11–15.

Rhacophyllum Lactuca, Kidst. (not Sternb.), *Trans. Roy. Soc. Edin.*, vol. xxx. p. 540.

Description.—Rachis flattened with a central angular ridge, and dividing by a series of dichotomies. The primary (?) dichotomy forming an obtuse

angle; those angles formed by subsequent dichotomies are a little more acute. The pinnæ of the barren fronds possess a broad foliaceous expansion cut into spirally bent lobes, in which the nerves are indicated by dichotomously dividing ridges. Fertile pinnæ dividing dichotomously and reduced to winged circinately convoluted rachis-like segments. The convolutions of the basal portion of the pinnæ overlap each other; their ultimate divisions are narrower, less prominently winged, and do not apparently overlap each other, or only do so to a limited extent.

Remarks.—Specimens of this fern have been in the Collection of the Geological Survey of Scotland for many years, that figured on Plate VIII. fig. 13, having been collected by the late Mr RICHARD GIBBS about twenty-five years ago. The portions of the species with which I first met were fragments of the scorpiod fruiting pinnæ. These, I thought, might perhaps belong to *Triphyllopteris Collombi*, Schimper,* or to *Cyclopteris* (*Aneimites*) *Acadica*, Dawson,† both of which species have very close affinities to each other, if not specifically identical.

Associated with the British examples, though careful examination was made, no barren pinnules were ever discovered that could be identified with either SCHIMPER'S or DAWSON'S ferns.

It was only towards the end of 1884 that my difficulties in the identification of this fern were removed by Mr JOHN RHODES, Fossil Collector to the Geological Survey of England, finding the specimens figured on Plate VIII. figs. 11, 12, which show the barren condition of this plant. I had previously seen a small fragment of the barren condition of *Alcicornopteris convoluta* from Docken Beck, Eskdale, collected by Mr A. MACCONOCHIE, one of the Fossil Collectors to the Geological Survey of Scotland, but had erroneously identified it as *Rhacophyllum Lactuca*,‡ to which small fragments have a great resemblance, so much is this the case, that with fragmentary specimens it is almost impossible to distinguish them. The fruiting portions of *A. convoluta* have apparently a more strongly winged rachis than occurs in *Cyclopteris Acadica*, or in *Triphyllopteris Collombi*; but here also small fragments of the ultimate segments of the fruiting portions of *Alcicornopteris convoluta* would be with difficulty distinguished from fragments of the fruiting portions of the two ferns already mentioned (see Plate VIII. fig. 15).

* *Triphyllopteris Collombi*, Schimper-Zittel, *Handbuch der paléontologie*, ii. Band, 1 Lief, p. 114, fig. 84, 1879; *Traité d. paléont. végét.*, vol. i. p. 479, pl. cvii. fig. 13; "Les végét. foss. du terrain de trans. d. Vosges" (in *Le terrain de trans. d. Vosges*, by J. Koechlin-Schlumberger and W. Ph. Schimper, Strasburg, 1862), p. 339, pl. xxvii. figs. 8–11 (*Sphenopteris*).

† *Cyclopteris* (*Ancimites*) *Acadica*, Dawson, "Geological Survey of Canada," *Fossil Plants of the Lower Carboniferous and Millstone Grit Form. of Canada*, p. 26, pl. vii. figs. 53–63, 1873; *Acadian Geol.*, 2nd ed., p. 481, fig. 75, 1868; *Quart. Jour. Geol. Soc.*, vol. xxii. p. 153, pl. viii. fig. 32, 1865.

‡ *Trans. Roy. Soc. Edin.*, vol. xxx. p. 540.

On the other hand, when more perfect specimens are secured, the differences between the fruiting portions of *A. convoluta* and *C. Acadica* and *T. Collombi* are very well marked, and in the barren condition, the British species has no similarity with either SCHIMPER's or DAWSON's plants.

It may be questioned if this new plant should not be included in *Rhacophyllum*, with which its barren pinnæ have so great a resemblance, but against adopting this course is the fact that *Rhacophyllum* is essentially a Coal Measure genus, whereas *A. convoluta* has hitherto only been found in the Calciferous Sandstones, and then usually in the basement beds. Whatever view may be taken of the genus *Rhacophyllum*, whether as forming an individual genus or as a provisional one, only containing the accessory pinnules of other ferns, I am not in a position to decide; but in regard to *A. convoluta* there can remain no doubt as to its being an autonomous fern, and not a portion of another species.

In *Triphyllopteris Collombi* the fruit is borne at the extremity of the circinately bent segments, and it probably occupied a similar position on *A. convoluta*, but none of the specimens that have come under my notice have shown any traces of sporangia.

Description of Specimens.—Specimen from Horncliffe Dean, near the Mill, River Tweed, South of Horncliffe Village, Northumberland, collected by Mr J. RHODES (Plate VIII. fig. 11), in the Collection of the Geological Survey of England. This specimen shows a small portion of a barren frond. The rachis is very stout, and gives off apparently alternate pinnæ, possessing a midrib with a sharp angular ridge. This example is not well preserved, and does not show any perfect pinnæ or pinnules, but these were apparently cut into lobes, having curious spirally twisted segments, which at their point of separation formed an almost circular sinus giving the frond a curled appearance.

Specimen from River Tweed, 100 yards below Norham Castle, Northumberland, collected by Mr J. RHODES (Plate VIII. fig. 12), in the Collection of the Geological Survey of England. This specimen, though also fragmentary, is a very good example of the mode of ramification of *Alcicornopteris convoluta*. It exhibits a portion of a rachis 4 cm. long, and 5 mm. broad at the lower broken-over extremity, and 1 cm. wide immediately below the point where it bifurcates. The two arms of the first bifurcation go off from the parent rachis at almost right angles, and then again bifurcate. Both the upper forks of this second dichotomy are broken over, but the lower arm on the left forms a third series of dichotomies. On this is borne the barren pinnules. A portion of one of the corresponding forks of the right hand dichotomy of the third series is also present. Here again the pinnules are badly preserved, but show the same characteristics as fig. 11. The rachis appears to have been flat, and traversed by a prominent vascular system which appears as a triangular ridge. The helicoid nature of the frond is well shown on the frondose portion of this specimen. An imperfect fragment of a pinnule lies between the primary forks

of the rachis, but its position there is accidental. The surface of the rachis is finely striated.

Specimen from Cove Shore, east of Cove Harbour, Berwickshire, collected by the late Mr R. GIBBS (Plate VIII. fig. 13), in the Collection of the Geological Survey of Scotland. This specimen, which is preserved in a hard micaceous sandstone containing many vegetable fragments, shows probably a primary dichotomy of the rachis. Before the pinnule segments are reached, there also appears here a threefold diohotomy of the axis, similar to that shown in fig. 12.

Except the main axis, the other portions of the specimen are indifferently preserved. The rachis is very distinctly striated longitudinally, and seems to have been originally flat, with a well-pronounced central angular ridge, probably representing the vascular system of the rachis. The portion of the rachis shown in this figure is so flat that it must be described as winged. In fact, the frondose expansion of the barren pinnæ seems to be only a further development of this wing.

Specimen from Long Craigs Bay, near Dunbar, Haddingtonshire, collected by Mr JAMES BENNIE (Plate VIII. fig. 14), in the Collection of the Geological Survey of Scotland. This example of a fruiting portion of the frond of *A. convoluta* from Long Craigs Bay is preserved in a fine-grained red shale. The main rachis and those springing from it are broadly winged, the vascular bundle appearing as an angular ridge running in the centre of the rachis. The lateral pinnæ, of which only the basal portions are preserved, are best seen to the right of the figure, and consist of a series of dichotomously divided helicoid segments. The segments of these pinnæ overlap each other, and produce an almost inextricable confusion of convolutions.

Specimen from River Tweed, about 100 yards below Norham Castle, Northumberland (Pl. VIII. fig. 15). This specimen probably exhibits the ultimate divisions of the fertile pinnæ, and a comparison of this figure with the fruiting examples *Triphyllopteris Collombi*, Schimper, figured in the *Handbuch der Paleontologie*, p. 144, fig. 87, and with the figures of *Cyclopteris Acadica* given by DAWSON, in the *Fossil Plants of the Lower Carb. of Canada*, plate vii., will show the great similarity between certain portions of these three ferns. The rachis in this part of the pinnæ can scarcely be said to be winged, though distinctly flattened.

Horizon.—Calciferous Sandstone series.

Localities:—

Scotland—Berwickshire.—Cove Shore, ½ mile east of Cove Harbour, 1½ miles north-east of Cockburnspath. "In a hard bed of micaceous sandstone at the base of the Carbonificerous Rocks, or rather at the base of that portion of them which immediately overlies the red and yellow sandstones of Berwickshire"* (R. Gibbs, collector) Kimmerghame Quarry, near Duns; (A. Macconochie). *Haddingtonshire.*—Long Craigs Bay, east of Belhaven Bay,

* "Memoirs of the Geol. Survey of Great Britain," *The Geology of Eastern Berwickshire*, p. 58, 1864.

1 mile west of Dunbar (J. Bennie). *Dumfriesshire.*—Docken Beck, 3 miles south of Langholm (A. Macconochie).

England—Northumberland.—River Tweed, 100 yards below Norham Castle; River Tweed, south of Horncliffe Village; Horncliffe Dean, near mill south of Horncliffe Village; River Coquet, ½ mile north-north-east of Holystone; Coomsdon Burn, ½ mile south-west from its junction with the River Rede; Hawk Burn, near Catcleugh, Redesdale; Spithope Burn, Redesdale; Crawley Dean (east of road), ⅓ mile south of Powburn, near Ingram. *Cumberland.*—Bull Cleugh, Kirk Beck, Bewcastle.

I am indebted to Dr A. Geikie, F.R.S., for permission to figure and describe the various specimens, mentioned in this communication, belonging to the Geological Surveys of England and Scotland.

EXPLANATION OF PLATE VIII.

Figs. 1–6*a*. *Calymmatotheca bifida*, L. & H., sp.
- Fig. 1. From River Irthing, near Lampert.
- Fig. 2. From Lewis Burn, near Lewis Burn Colliery, N. Tynedale, Northumberland.
- Fig. 3. From Back Burn, opposite Cranecleuch New Houses, N. Tynedale.
- Fig. 4. From Bateinghope Burn, Redesdale.
- Fig. 5. Synangium, lettered *a* on fig. 4; enlarged.
- Fig. 6*a*. From Lewis Burn, near Lewis Burn Colliery, Northumberland.

Fig. 6*b*. *Sorocladus antecedens*, Kidston.

Fig. 7. *Neuropteris heterophylla*, Brongt. From Blairpoint, Dysart, Fife.

Figs. 8–10. *Zeilleria Avoldensis*, Stur, sp. From Coseley, near Dudley.

Figs. 9–10. Pinnules; enlarged.

Figs. 11–15. *Alcicornopteris convoluta*, Kidston.
- Fig. 11. From Horncliffe Dean, River Tweed, Northumberland.
- Fig. 12. From Norham Castle, Northumberland.
- Fig. 13. From Cove Shore, east of Cove Harbour, Berwickshire.
- Fig. 14. From Long Craigs Bay, near Dunbar, Haddingtonshire.
- Fig. 15. From River Tweed, near Norham Castle, Northumberland.

EXPLANATION OF PLATE IX.

Figs. 16–17. *Calymmatotheca bifida*, L. & H., sp.
- Fig. 16. From Burdiehouse, near Edinburgh. Specimen in the "Hugh Miller Collection," Museum of Science and Art, Edinburgh (natural size).
- Fig. 17*abc*. Three Pinnules, enlarged.

Fig. 18. *Calymmatotheca affinis*, L. & H., sp. From Burdiehouse, Mid-Lothian.

Fig. 19. *Calymmatotheca affinis*, L. & H., sp. From Harwood Burn, below Limefield House, near West Calder. In the Collection of the Geological Survey of Scotland (fig. 19*a*, enlarged; 19*b*, natural size).

Fig. 20. *Calymmatotheca affinis*, L. & H., sp. From West Calder, Mid-Lothian. Collected by the late Mr C. W. Peach.

Figs. 21, 22. *Calymmatotheca affinis*, L. & H. Copied from Peach, *Quart. Jour. Geol. Soc.*, vol. xxxiv. pl. viii. figs. 1*a* (= 21) and 3-3*a* (= 22*a*, *b*).

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Fig. 1 6a C. BIFIDA, L.&H sp 6b S ANTECEDENS KIDSTON 7 N HETEROPHYLLA BRONGT
8–10. Z AVOLDENSIS, STUR. sp 11 15 A CONVOLUTA KIDSTON

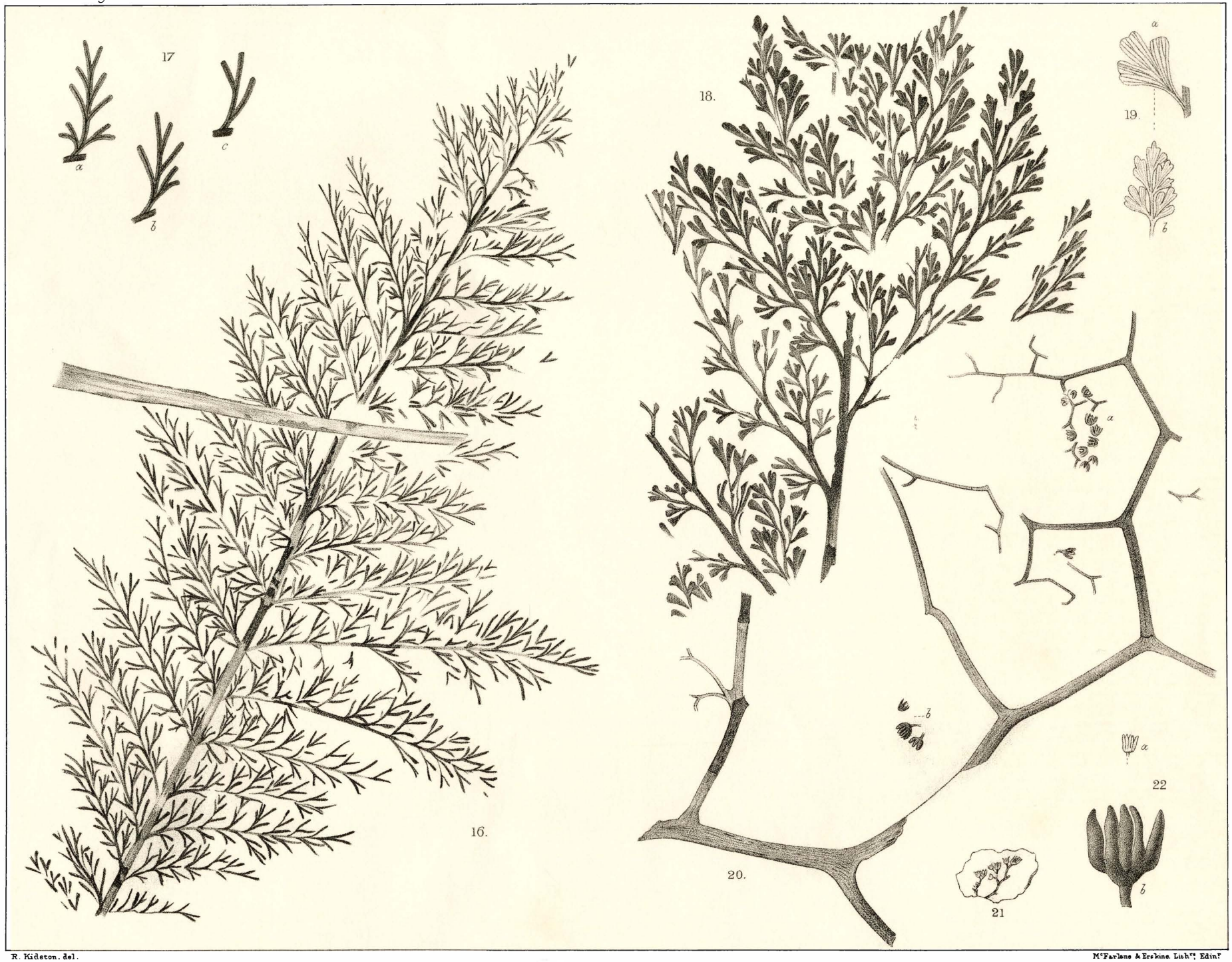

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Fig. 16 17 C BIFIDA L.&H. sp 18-22 C AFFINIS L & H sp.

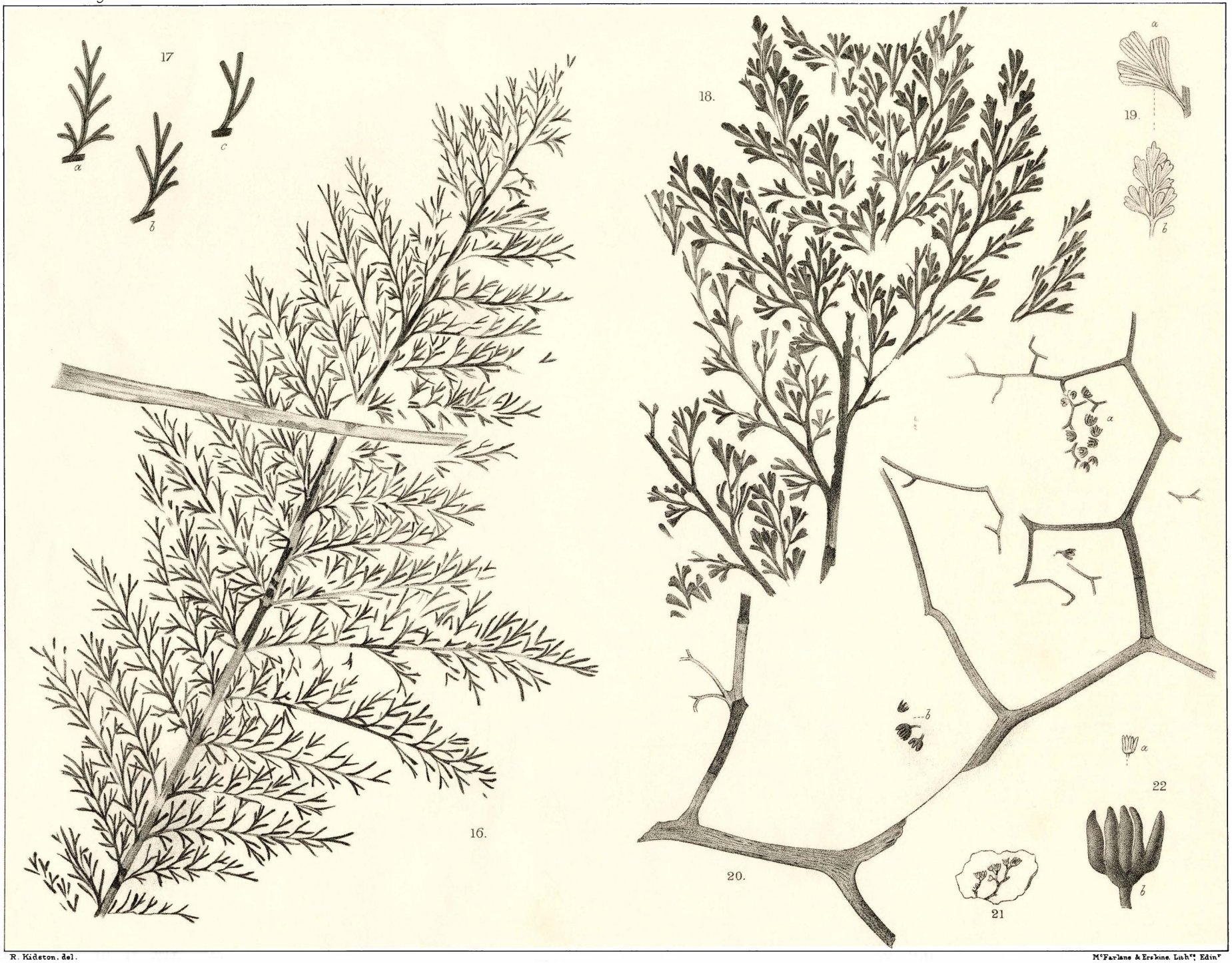

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Fig. 16 17 C BIFIDA L.&H. sp 18-22 C AFFINIS L & H sp.