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XVIII.—On the relationship of Ulodendron, Lindley and Hutton, to Lepidodendron, Sternberg; Bothrodendron, Lindley and Hutton; Sigillaria, Brongniart; and Rhytidodendron, Boulay

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in different stations? These questions are equally curious and interesting to solve.

I have had the *Phænicurus* in abundance at the Laboratoire Arago. My boat, every time it went out to seek specimens of *Tethys* for me, brought me a great number of all sizes, free or fixed. I hope, therefore, shortly to elucidate this still obscure history.

XVIII.—On the Relationship of *Ulodendron*, *Lindley* and *Hutton*, to *Lepidodendron*, *Sternberg*; *Bothrodendron*, *Lindley* and *Hutton*; *Sigillaria*, *Brongniart*; and *Rhytidodendron*, *Boulay*. By ROBERT KIDSTON, F.G.S.

[Plates III.-VII.];

[Continued from page 139.]

II. DESCRIPTIONS OF SPECIMENS.

Lepidodendron Veltheimianum, Sternberg.

Specimen No. 1. From Burghlee Pit, Loanhead, Midlothian (Carboniferous Limestone Series). Pl. III. fig. 1 (nat. size).—This fossil, which is represented by an impression of the plant in a fine-grained micaceous sandstone, is 15 inches long and at its broadest part about $4\frac{1}{2}$ inches wide. Towards its upper part it shows one of the characteristic *Ulodendroid* scars, which is $4\frac{1}{2}$ inches high and $2\frac{1}{2}$ inches wide. The central umbilicus is situated about 2 inches above the lower margin of the scar. On the lower surface of the *Ulodendroid* scar, and extending slightly above and around its umbilicus, are rows of little "dots" arranged in spirals, converging towards the umbilicus. The little "dots" indicate the position of the vascular bundles of the aborted leaves, and become closer to each other as they approach the umbilicus. On the upper part of the scar is a number of straight lines which radiate from the umbilicus; these are the impressions of the basal leaves or bracts of the appendicular organ. The umbilicus is slightly raised. On other parts of the specimen are seen the impressions of the leaf-scars, which are, in form and arrangement, similar to those of *Lepidodendron Veltheimianum*. To the left of the fossil the leaf-scars are obliterated by a longitudinal splitting of the bark.

As the specimen is only an impression it must be remembered that the elevations on the fossil were depressions in the plant.

Specimen No. 2. From Straiton Oil Shales, near Edinburgh (Calcareous Sandstone Series).—This example is a fragment of what must have been a large stem. The specimen, which is an impression in very fine-grained bituminous oil shale, measures 9 inches in length by nearly 8 inches in breadth. Towards the centre are shown two Ulodendroid scars, about $1\frac{9}{10}$ inches long, by $1\frac{6}{10}$ inches broad, standing rather less than $1\frac{1}{2}$ inches apart. This example is chiefly interesting from the absence of the longitudinal fissures which are so characteristic of these Ulodendroid stems. As a consequence, from the increase in girth of the stem, the leaf-scars are much broader than in those examples where the bark is longitudinally fissured. This specimen shows a similar change in the lateral extension of the leaf-scars to that which occurs in the older stems of *Lepidodendra* which do not bear Ulodendroid scars. The leaf-scars on this fossil are very similar in general form to the figure of *Sagenaria Veltheimiana* given by Römer in 'Palæontographica,' vol. ix. pl. iii. fig. 6, only in the British specimen their breadth is greater in proportion to their length; they are, in fact, nearly as broad as long.

Specimen No. 3. From the Oil Shales, West Calder, Midlothian (Calcareous Sandstone Series).—Specimen in the collection of the Addiewell Oil Co., Addiewell. Pl. IV. fig. 2.—This figure shows a portion of a large stem of *Lepidodendron Veltheimianum*, 25 inches long and about 4 inches wide. The greater part of the fossil shows the outer surface of the stem, on which are exhibited, in a very early state of development, three Ulodendroid scars and a part of a fourth. The Ulodendroid scars, from centre to centre, are $5\frac{1}{2}$ inches apart. They are slightly elevated, and do not show a clearly defined umbilical nodule, having an appearance as if the appendicular organ had been forcibly removed. In this early condition of development of the Ulodendroid scar, the appendicular organ appears to have been attached at its upper margin. Another interesting point shown by this example is the presence of the ordinary leaf-scars on the Ulodendroid scar. These are a continuation of the ordinary series of the leaf-scars on the stem, and converge from all sides to the centre of the upper margin of the slight inflation. As there is here the outer surface of the stem, it is clearly shown that in the elementary condition the part bearing the appendicular organ stood at a slightly higher level than the rest of the bark. This inflation, however, eventually became effaced by the increase of the stem causing the bark to swell up around the base of the appendicular organ, and by this means the

originally slightly elevated cushion is converted into a circular or oval depression. The point of attachment of the appendicular organ in this example is in the centre of the upper margin. This point represents the umbilicus of the older scars. The part of the depression above the umbilicus on older stems is therefore entirely caused by the pressure of the base of the appendicular organ upon the bark.

The leaf-scars are elongated-rhomboidal, and slightly raised above the surface. Those of each series are connected with each other by a flexuous ridge. The vascular bundle dots are not shown, but the position of the vascular scar is indicated by a little ridge.

The bark at this age shows no traces of the longitudinal clefts which are so characteristic of older examples.

The full width of the stem at its lower portion is about 4 inches, and that this is its complete breadth is proved by the impression of one of the Ulodendroid scars of the corresponding opposite vertical row occurring in the matrix where part of the stem has been removed. The surface of the bark between the leaf-scars, at certain parts of the stem, is ornamented with fine ridges, though they are not present, or only feebly so, on the small portion which forms the subject of figure 2.

Specimen No. 4. From Dalmeny, Linlithgowshire (Calcareous Sandstone Series). Collected by Dr. Macfarlane. Pl. IV. fig. 3 (nat. size).—This specimen, which measures about 6 by $4\frac{1}{2}$ inches, is preserved in a very fine-grained bituminous oil shale. The leaf-scars are fusiform and slightly elevated, those of the same series being connected with each other by a slightly raised flexuous ridge. The surface of the bark between the leaf-scars is beautifully ornamented with fine, somewhat irregularly placed wavy lines. The vascular scar is not clearly shown, but appears as a slightly raised point towards the upper part of the leaf-scar. As the example only shows one of the outer margins of the stem, its original width cannot be ascertained.

Specimen No. 5. From West Calder, Midlothian (Calcareous Sandstone Series). Pl. IV. fig. 4 (nat. size).—This figure shows a small portion of an impression of a large stem, which is fully 2 feet long. The upper portion apparently represents the complete breadth of the stem, which is 7 inches across. The specimen shows no sign of any Ulodendroid scar. The leaf-scars are elongated-rhomboidal or fusiform, those in one series connected with each other by a ridge. The vascular scar is situated towards the upper part of the

leaf-scar, but its details of structure are not shown. The leaf-scars are almost contiguous, being only separated laterally from each other by the caudate extension, which runs from the apex of one scar to the base of another. The bark is much cleft by longitudinal fissures; a portion of one of these is shown in the figure. The matrix on which the impression has been stamped is a very fine bituminous oil shale.

This example also shows at certain parts the same character, though not so strongly carried out, as in the specimen of *Lepidodendron acuminatum* mentioned by Stur, *Culm-Flora*, p. 398, pl. xxii. (xxxix.) fig. 4, where the leaf-scars sometimes seem to lose their spiral arrangement, and appear to be placed in vertical rows, simulating somewhat in this peculiarity a *sigillarian* arrangement of leaf-scars.

Specimen No. 6. From Blackbraes, West Calder, Midlothian (Calcareous Sandstone Series). Collected by J. Linn, Esq. Pl. VI. fig. 11.—The specimen, shown in fig. 11 reduced to $\frac{1}{3}$ natural size, measures in its greatest length 7 inches, its width being about 4 inches. The fossil shows part of a stem, which must have been of considerable size. The small fragment of it that has been collected, still retains its rounded form, and seems to have suffered little from pressure. The matrix of this example is a fine-grained sandstone, and though the leaf-scars are not very well shown, at *a*, fig. 11, they are sufficiently well preserved to admit of a satisfactory specific determination. The Ulodendroid scar is almost circular, considerably depressed, and measures about $1\frac{1}{2}$ inches in diameter. The basal portion of the appendicular organ which fits into the scar has also fortunately been preserved. This is shown in profile at fig. 11 *b*, and a view of its basal aspect is seen at fig. 11 *c*; both of these figures are natural size. The outer surface of the fossil is discoloured by the carbonaceous matter of the plant. This is especially marked on the surface of the depressed Ulodendroid scar, and on the base of the appendicular organ, which, with the exception of a very small spot towards the centre of each, indicating the point of attachment of the appendicular organ, are stained dark brown. Had the appendicular organ been attached to the stem by the whole of its surface, its base and the surface of the Ulodendroid scar could not have been covered with carbonaceous matter. To the right of fig. 11 *c* are seen in the matrix what may possibly be the remains of leaves. In the profile, fig. 11 *b*, the markings on the outer surface of the appendicular organ have very much the appearance of leaf-scars, but cones, when the upward extending portion of their bracts is broken off, have also a resem-

blance to ordinary leaf-scars, as is well shown in Sir Joseph Hooker's plates of *Lepidostrobi* *. This specimen, therefore, does not, unfortunately, help us to decide whether stalked or sessile cones were attached to the Ulodendroid scars.

At fig. 11 *a* is shown, natural size, the small portion of the stem marked *a*, fig. 11. This part is at a slightly lower level than the rest of the outer surface of the fossil, and the leaf-scars are slightly larger; it is therefore probable that this fragment of the specimen is not in its true position.

This example shows no traces of longitudinal clefts in the bark.

Specimen No. 7. From Addiewell, Midlothian (Calcareous Sandstone Series). Collected by Dr. Macfarlane. — This example, which is about 4 inches high and $4\frac{1}{2}$ inches wide, shows towards the left side of the fossil a Ulodendroid scar. This is oval, and measures across the umbilicus about $\frac{7}{10}$ of an inch. Its upper border is clearly defined, but the lower portion of the scar, from the umbilicus downward, gradually assumes the appearance of the ordinary leaf-scar-covered bark, being clearly covered with broadly-fusiform leaf-scars, similar in shape to those occurring on other parts of the stem and belonging to the same spiral series. The leaf-scars on the upper part of the Ulodendroid scar are, however, obliterated.

Specimen No. 8. From Todholes, on the Bannoch-Burn, about 5 miles S.W. of Stirling (Carboniferous Limestone Series). — This specimen is the impression of a portion of an old and much-cleft stem. The fossil measures about 11 inches in length and 8 in breadth. The main interest of this example lies in the numerous ridges (the casts of the clefts in the bark) which occur on its surface. Evidently these ridges originally stood up at right angles to the surface of the impression, but have been flattened or bent over by subsequent pressure, and now hide the leaf-scars beneath their extended surface. Some of these ridges have at different parts of the fossil been broken off, and show that their line of attachment to the fossil is comparatively small in proportion to the superficial area they now in their flattened condition present. As an instance, the width of one of these ridges measures fully $\frac{8}{10}$ of an inch, but where it is broken off, the line which represents the original width of the cleft, and on which no leaf-scars are seen, only measures $\frac{4}{10}$ of an inch; the remaining $\frac{4}{10}$ inch of the flattened ridge is simply superin-

* Memoirs of the Geol. Survey of Great Britain, vol. ii. pt. ii. p. 440; pls. iv., vii., & viii., 1848. (Remarks on the Structure and Affinities of some *Lepidostrobi*.)

cumbent on the surface of the stem, and hides beneath it the impressions of the ordinary leaf-scars.

As these ridges are often more a bending over to one side than a flattening out of the ridge, probably the surface they now present represents the original depth of the clefts in the bark; if this view is correct, in this case they cannot have been much less than an inch deep. The form of the leaf-scars is broadly fusiform, and they agree well in character with those of *Sagenaria* (*Lepidodendron*) *acuminata*, Göppert*.

Specimen No. 9. From same locality as No. 8.—On another impression, which is about 6 inches high and 10 inches broad, the flattening of the casts of the clefts in the bark is carried to a greater extent than in the last specimen. Over a space of about $5\frac{1}{2}$ inches, the whole of the leaf-scars are obliterated by the flattening of what appear to have been 7 ridges (the casts of what were originally 7 clefts in the bark). This is succeeded by a vertical band of about 1 inch wide, on which the impressions of the leaves are shown; succeeding this there is another ridge about $\frac{5}{10}$ of an inch wide, then another vertical band exhibiting the leaf-scars $1\frac{1}{2}$ inch wide, then another flattened ridge fully an inch wide. Impressions of *Lepidodendron Veltheimianum*, on which the leaf-scars are quite obliterated by these flattened ridges, have been handed to me several times as Sigillarian stems.

Specimen No. 10. *Lepidodendron* (*Veltheimianum*?). From Grange Colliery, Bo'ness, Linlithgowshire (Carboniferous Limestone Series). Collected by H. M. Cadell, Esq.—This specimen occurred along with numerous examples of *Lepidodendron Veltheimianum*; but as none of the leaf-scars are seen on the fossil, it would be unsafe positively to refer it to that species. It represents the impression of a fragment of a very old stem, from which all traces of the leaf-scars have been obliterated by longitudinal furrows; these have rounded surfaces, and do not run continuously for any great length, but as soon as one ceases, another originates to take its place. It appears to have been a similar condition of an old *Lepidodendroid* stem that has given rise to the *Lyginodendron Landsburgii*, Gourlie†. A somewhat similar state of an old stem of *Lepidodendron* has been figured by Sir William Dawson‡. Probably the Bo'ness example only represents a further stage of the

* Foss. Flora d. Uebergangsgebirges, pl. xxiii. fig. 4, and pl. xliii. fig. 8.

† Proceed. of Phil. Soc. of Glasgow, vol. i. pt. ii. p. 108 (1841-44). I am doubtful if the plant whose curious structure has been so fully explained by Dr. Williamson as *Lyginodendron Oldhamii* has any connexion with the genus *Lyginodendron* of Gourlie.

‡ Acadian Geol. 2nd ed. p. 445, fig. 170 c (1863).

longitudinal fissuring of the bark mentioned as occurring in the last described specimen of *Lepidodendron Veltheimianum*.

Specimen No. 11. Small branches and stems of *Lepidodendron Veltheimianum*, in a beautiful state of preservation, with the leaf-scars similar to that figured by Göppert in his Foss. Flora d. Uebergangsgebirges, pl. xxiii. figs. 1–3, are extremely abundant at many localities in the Calciferous Sandstone Series in the neighbourhood of Edinburgh. There also occur frequently examples with leaf-scars which agree in character with those named *Lepidodendron* (*Sagenaria*) *elliptica* by Göppert * (Pl. IV. fig. 4). This is a common form of *Lepidodendron Veltheimianum* in Scotland.

Sigillaria discophora, König, sp.

Specimen No. 12. From Devonside, Tillicoultry, Clackmannanshire (Coal Measures). Collected by Mr. T. Mitchell. Pl. VII. fig. 12 (nat. size).

This example is preserved in a fine-grained micaceous sandstone, and is the *impression* of the plant. The outer layer of the bark is converted into a bright coaly matter, which has adhered to the matrix; hence the fossil shows the *inner surface of the outer cortical layer*. Towards the left is seen a portion of a Ulodendroid scar, on whose surface are exhibited in series, which evidently converge towards the umbilicus, several rows of elevated little dots that mark the position of the vascular bundles of the aborted leaves. The remainder of the fossil is covered by the leaf-scars, which vary much in size and shape. At *a*, fig. 12, they are very small, some only measuring about $\frac{1}{8}$ of an inch in their transverse diameter; their upper and lower angles are rounded, the lateral angles sharp and prominent. The vascular-bundle scar is slightly above the centre.

On the greater portion of the specimen the leaf-scars are rhomboidal, the boundary-line of the leaf-scar being slightly raised. The position of the vascular bundle is usually indicated by a small tubercle, but sometimes this appears to be double. On none of the leaf-scars are the vascular-bundle impressions clearly seen.

Remains of the foliage are indicated at several points at the margin of the specimen. The leaves appear to have been very narrow and long, and are single-nerved. Their complete length is not shown, all of the leaves being imperfectly preserved. Figs. 12 *a* and 12 *b* show a few of the leaf-scars enlarged, to illustrate their variation in form on the same

* Göppert, *l. c.* pl. xliii. fig. 7.

example. These two figures correspond to the parts lettered *a* and *b* on fig. 12.

Specimen No. 13. Locality: "Coal Measures, British." Specimen in the collection of the Geological Survey of Great Britain, Museum of Practical Geology, Jermyn Street, London. Pl. V. fig. 8 (nat. size).—This is one of the most beautiful specimens of *Sigillaria discophora*, König, sp., that I have seen. It is about $3\frac{1}{2}$ inches square. Towards the right there are two *Ulodendroid* scars, from the umbilicus of which very slightly elevated ridges radiate on all sides. A small part of the outer cortical layer has been removed, but on the portion which shows the outer surface of the stem the leaf-scars are well preserved. Their transverse diameter is slightly greater than their vertical height; the upper and lower angles are rounded, and the lateral angles prominent. The scar of the vascular bundle is situated towards the upper part of the leaf-scar, and slightly above the centre.

Where the outer layer of the bark has been removed, the inner surface exhibits delicate markings, among which are conspicuous the little elevated "dots" that mark the position of the passages for the foliar vascular bundles. This latter condition of the stem forms the genus *Bothrodendron*, Lindley and Hutton. The two *Ulodendroid* scars have evidently almost touched each other; but this character is slightly obscured, on account of the lower edge of the upper *Ulodendroid* scar having been slightly broken.

My thanks are due to Dr. A. Geikie, Director-General of the Geological Survey of Great Britain, for kindly allowing me to figure and describe this interesting example.

Specimen No. 14. From Furnace Bank Pit, Old Sauchie, Clackmannanshire (Coal Measures). Pl. VII. fig. 13 ($\frac{1}{4}$ nat. size).—The specimen, the figure of which is a quarter natural size, measures fully 16 inches long by 11 inches broad. It is preserved in a fine-grained, purple micaceous sandstone. The fossil is an impression of what must have been a very large stem; adhering to its surface is part of the epidermal layer of the bark. Towards the right of the fossil are portions of two large *Ulodendroid* scars, whose vertical height is about $3\frac{1}{2}$ inches. Owing, in part, to the age of the specimen, and in part to its state of preservation, the leaf-scars assume, at some portions of the stem, an almost quadrangular form, and show at their centre a large rounded tubercle. Some such leaf-scars are shown, natural size, at fig. 13 *a*. On other parts of this specimen the *Bothrodendron* condition is exhibited. A small portion of the stem, showing this state, is represented, natural size, at fig. 13 *b*. Here there are ar-

ranged, in quincuncial order, rows of shallow elongated pits, the channels through which the foliar bundles passed to the leaves. The impression bears numerous longitudinal ridges, which are more or less interrupted during their course; they cease after extending some distance, when others spring up alongside of those which have terminated, and continue their course in the same direction. On the reduced sketch, fig. 13, the leaf-scars are rather too small.

Specimen No. 15. From the same locality as No. 14. Pl. IV. fig. 5 (nat. size).—This specimen is the impression of a small fragment of the outer surface of the bark, showing the rhomboidal leaf-scars. The upper and lower angle of the leaf-scar is rounded; the lateral angles are prominent. In the compressed state in which the fossil occurs the leaf-scars appear as if separated by an interval, but this interval is the impression of the slightly raised cushion on which the leaf-scar is situated. At the part marked *a*, fig. 5, the intervening space between the leaf-scars shows a central line, clearly indicating that it belongs in part to the two contiguous leaf-scars, and is, in fact, the now compressed cushion whose area slightly exceeded that of the leaf-scar which it bore. Fig. 5 *a* shows a few of the leaf-scars enlarged. The vascular-bundle scar is situated towards the upper part of the leaf-scar, and is only indicated in this example by a single "dot." Towards the centre and right hand of the specimen the bark is seen to be longitudinally split*.

Sigillaria Taylora, Carruthers, sp.

Specimen No. 16. From Camps Lime Quarry, Midcalder, Midlothian (Calciferous Sandstone Series). Collected by the late R. F. B. Hislop, Esq., Edinburgh. Pl. IV. fig. 6 (nat. size).

The greater portion of this specimen is badly preserved, and nothing further is shown on the fossil than that represented in fig. 6. Of the two Ulodendroid scars, the upper is much larger than the lower. On the upper part of both is seen a row of slightly elevated ridges arranged in a semi-circle. These are evidently casts of the channels through which the vascular bundles passed to the aborted leaves.

The chief point of interest afforded by this example, which exhibits the true outer surface of the bark, is the beautifully preserved leaf-scars seen to the right of the lower Ulodendroid scar. A few of these are enlarged in fig. 6 *a*.

The leaf-scars are rhomboidal, slightly elevated, very small, being little more than one tenth of an inch in transverse diameter; their upper and lower angles are rounded, and their

* Figs. 5 and 5 *a* are drawn on the Plate in inverted position.

lateral angles sharp. The cushion on which they are placed very slightly exceeds the size of the leaf-scar. The vascular-bundle impression is situated a little above the centre of the leaf-scar.

Specimen No. 17. From the Oil Shales, Addiewell, Midlothian. In the collection of the Addiewell Oil Company (Calcareous Sandstone Series). Pl. VI. fig. 10, 10 *b*, *c*, *d* (fig. 10, $\frac{1}{3}$ nat. size; fig. 10 *b*, *c*, *d*, nat. size).

This specimen, which is preserved in a fine-grained bituminous oil-shale, exhibits the termination of a branch. It measures $15\frac{3}{4}$ inches in length and 4 inches in breadth. Very little of the fossil proper is preserved, the greater part of the example showing only the impression of the plant. The part marked *a*, fig. 10, is a small portion of the outer surface of the plant. That lettered *b*, *c*, *d* shows the *inner surface of the outer cortical layer*, and that marked *e*, *e* the impression of the outer surface of the stem in the matrix.

We must now enter more fully into the description of the various parts of this instructive specimen. On the small part of the fossil proper which is preserved (fig. 10 *a*) there is only a portion of one of the *Ulodendroid* scars shown; this occurs as a circular depression about $\frac{3}{4}$ inch wide. The opposite and corresponding row of *Ulodendroid* scars occurs on that part of the specimen lettered in the figure *b*, *c*, *d*. The epidermal layer of the bark has here adhered to the matrix, a circumstance which frequently takes place in this group of fossils, so that the view presented of this part is the *inner surface of the outer cortical layer*. On this are seen the casts of twelve *Ulodendroid* scars; and as they are looked at from the *inside* of the stem, they appear as elevations. In form and size they vary considerably. Many of them touch each other, but some are separated by a slight interval. A few are almost circular, whilst others are more or less elliptical; and occasionally, when two *Ulodendroid* scars come in contact, their sides become somewhat flattened from mutual pressure. The largest of these scars measures transversely $1\frac{1}{10}$ inch, the smallest about $\frac{7}{10}$ inch. The scar lettered *c*, fig. 10, is shown natural size at fig. 10 *c*. The whole of its surface is covered with little dots arranged in spirals, some belonging to series which do not converge towards the umbilicus, but go past it.

None of the *Ulodendroid* scars, of course, on the part lettered *b*, *c*, *d* show the straight or slightly bent bands on their upper part, which so commonly radiate from the umbilicus of *Ulodendroid* scars, as we are viewing the *inner* surface of the outer cortical layer; this also explains why the little "dots"

of the foliar bundles are exhibited so distinctly on their upper portions.

At *b*, fig. 10, the form of the leaf-scars is shown; these are represented natural size at fig. 10 *b*. This view likewise shows the *inner* surface of the outer cortical layer, and only gives a general idea of their form, which is rhomboidal. Slightly above the centre the channel through which the foliar vascular bundle has passed is indicated by a little "dot." At *d*, fig. 10, is exhibited the *Bothrodendron* condition of the fossil; this is represented natural size at fig. 10 *d*. Here all trace of the leaf-scar is obliterated, and nothing is left to indicate its position except the little "dots" which mark the channels of the foliar vascular bundles.

At *e*, fig. 10, is seen the impression of the outer surface of the stem. The form of the leaf-scars is not shown, as the specimen has been thickly covered with foliage; many of the leaves are seen extending past the margins and apex of the fossil.

This specimen is very interesting as exhibiting the termination of a branch, and is, so far as I know, the only specimen extant which shows that character.

Hugh Miller refers to a similar example, but, unfortunately, it has been lost*. The branch appears to have suddenly terminated in a truncated or obtuse apex, to the very summit of which were borne the *Ulodendroid* scars.

Specimen No. 18. From the bituminous Oil Shales (Calcareous Sandstone Series). Collected by Dr. Macfarlane. Pl. V. fig. 9 (nat. size).

The specimen, of which the sketch is natural size, is about 4 inches high by about the same wide. On the left of the plant are seen attached four of the *upward directed* appendicular organs. These, as well as the stem, are covered by foliage, but most of the leaves on the stem are broken off, and only their bases now remain attached to the leaf-scars.

The leaves or bracts on the appendicular organs are closely adpressed, and are best seen on that second from the base. The appendicular organs are in so young a state of development, that from any points they show it would be unsafe to state definitely whether they are sessile or stalked cones; but I incline to the former view. A portion of the fossil towards the lower part of the specimen has been removed, and on the matrix is seen the impression of one of the *Ulodendroid* scars of the opposite and corresponding row. From this we gather that the full width of the specimen could not have been much greater in its compressed state than 4 inches. The appendi-

* 'Testimony of the Rocks,' ed. 1857, pp. 462-464.

cular organs, which stand out in some relief, are about $\frac{3}{4}$ inch long and nearly as broad, and appear to have had rounded apices. The fourth and uppermost appendicular organ is not well shown, being partly covered with the matrix. From the presence of the foliage, the form of the leaf-scars cannot be seen.

Specimen No. 19. From the bituminous Oil Shales, Straiton, near Loanhead, Midlothian (Calcareous Sandstone Series).

This specimen is a portion of a branch about 1 foot long and 3 inches wide. It shows a vertical row of twelve *Ulodendroid* scars, and is mainly interesting as partly exhibiting the true outer surface of the stem, in which occur a few longitudinal clefts.

III. GENERAL CONCLUSIONS.

The point in which lies the essential generic difference between *Lepidodendron*, *Lepidophloios*, *Sigillaria*, and *Rhytidodendron* is the form and structure of the leaf-scar. My apology for referring to the generic characters of three such well-known genera as *Lepidodendron*, *Lepidophloios*, and *Sigillaria* is that their generic differences form the basis of my subsequent remarks. I am aware that, in addition to the structure of the leaf-scar, there are other points of minor importance which enter into the definitions of these genera; but as far as the subject which specially occupies our attention at present is concerned, we shall not require to enter more fully into the generic differences of the above-mentioned four genera other than those characters derived from the structure of the leaf-scar, the mode of the attachment of the leaf to the scar, and the cortical extension on which, in some cases, the leaf-scar is supported.

These four genera may be briefly defined as follows:—

LEPIDODENDRON. (Pl. VII. fig. 15.)

Leaf-scars contiguous or distant, rhomboidal or fusiform, consisting of a "field" (*c*) and vascular-bundle scar (*a*), which is usually situated towards the upper part of the field. The vascular-bundle scar is transversely rhomboidal, its upper and lower angles rounded, the lateral angles more or less prominent. Vascular-bundle cicatricules *three, punctiform* (*b*). Immediately beneath the vascular-bundle scar are two small oval pits (*d*), one placed on each side of the median line (*f*). Above the vascular scar and on the medial line is the "ligule" depression (*e*). *Leaf-base attached to the whole area of the leaf-scar (including the "field")*.

LEPIDOPHLOIOS. (Pl. VII. fig. 14.)

Leaf-scars *unprovided with a field* and reduced to the vascular scar (*a*), which is placed at the *lower extremity of a downward-directed cortical cushion* (*g*); its upper and lower angles are rounded, the lateral angles prominent. Vascular-bundle cicatricules *three, punctiform, the central one sometimes triangular*. On the cushion, above the leaf-scar, there occurs in some species a small tubercle. *Leaf attached to the vascular scar only*. Cushions to which the leaves are attached imbricated.

SIGILLARIA. (Pl. IV. fig. 7.)

Leaf-scars *unprovided with a "field,"* and reduced to the vascular scar. Stems smooth or furrowed.

(A) *Stem smooth*.—Leaf-scars distant (*Liodermaria*) or contiguous (*Clathraria*, fig. 7), and placed in more or less elevated cushions.

(B) *Stems furrowed*.—Leaf-scars in vertical series, distant or contiguous (*Rhytidolepis*).

(In A & B.) Vascular scar more or less rhomboidal; upper and lower angles rounded; lateral angles prominent. Vascular-bundle cicatricules *three, central punctiform or more or less transversely elongated; the two lateral lunate or linear*. *Leaf-attachment restricted to the area of the vascular scar*.

RHYTIDODENDRON, Boulay.

(*Bothrodendron*, Zeiller, not Lindley and Hutton.)

Leaf-scars *unprovided with a "field,"* distant, and reduced to a vascular scar, which is *transversely oval or quadrate, with rounded angles*, very small, in the two described species * not $\frac{1}{10}$ inch in diameter. Vascular-bundle cicatricules *three, punctiform*.

As the form of the leaf varies among the species of a given genus, being in *Lepidodendron* and *Sigillaria* either long and grass-like or short and lanceolate, its shape only becomes a specific character.

The fructification of these plants is still imperfectly

* *Rhytidodendron minutifolium*, Boulay, and *R. punctatum*, Zeiller, sp. The former species I have seen from two localities in the Scotch Coal Measures—from debris at Keliybank Pit, Dollar, Clackmannanshire, and also from Bonnington Pit, Kilmarnock, Ayrshire (in the collection of Rev. D. Landsborough, Kilmarnock).

The plant I place here as *R. punctatum*, Zeiller, sp., was described by that botanist as *Bothrodendron punctatum*, L. & H. See Ann. d. Scienc. Nat. 6^e sér., Bot. tome xiii. p. 218, pl. ix. figs. 1-3; also Végét. foss. du terr. houil. p. 116.

known. In *Lepidodendron* and *Sigillaria** it consisted of cones, and in *Rhytidodendron* it was probably of a similar nature. In certain *Sigillariae* and *Rhytidodendra* (*R. punctatum*) there is also occasionally a small tubercle above the leaf-scar or on some other part of the back (*Sig. spinulosa*, Germar)†.

The evidence afforded by the various specimens which have been described in the earlier part of this communication, as well as that derivable from examples figured and described by previous writers on this subject, may now be summarized, when I hope to show that plants not only belonging to *Lepidodendron*, but also to *Sigillaria* and *Rhytidodendron*, possess large scars, arranged on their stems in two opposite vertical rows.

Lepidodendron Veltheimianum, Sternberg.

It has been stated by some authors (Brongniart, Schimper, and others) that the leaf-scars on the stems of *Ulodendron* were always smaller than those occurring on the stems of *Lepidodendron* of a similar size, and also that the vertical clefts which occur in the bark of *Ulodendron* were not common to *Lepidodendron*. This may be a general rule, but it is by no means a universal one. The size of the leaf-scars on those so-called *Ulodendra* is very much influenced by the extent to which the bark has become longitudinally fissured, for these clefts act as escapements to the lateral strain (if not produced by it), which is caused by the increase in girth of the stem; whilst in those cases where the bark does not become fissured, the leaf-scars are laterally expanded by the same strain which produces the fissuring of the bark.

On specimen No. 1, Pl. III. fig. 1, it will be seen that the leaf-scars have attained a considerable size, and they cannot be said to be characteristically smaller than those of ordinary *Lepidodendra*, nor do they in any point differ in shape or arrangement from characteristic leaf-scars of *Lepidodendron Veltheimianum*. It is also to be noted that in this example the bark is more than usually free from the vertical fissures

* See Zeiller, "Sur des Cônes de Fructification des Sigillaires" ('Comptes Rendus des Séances de l'Académie des Sciences,' 30 June, 1884); also "Cônes de Fructification des Sigillaires" (Ann. des Scienc. Nat. 6^e sér., Bot. tome xix. p. 256, pls. xi., xii.).

† I have not entered into the differences in internal structure between *Lepidodendron*, *Sigillaria*, and *Ulodendron*. Suffice it to say, that the internal organization of *Lepidodendron* and *Sigillaria* is distinctly different, and that the few specimens of *Ulodendron* which have been found with their internal structure preserved apparently agree with *Lepidodendron*.

which so frequently occur on large Ulodendroid stems. The leaf-scars on this fossil are, however, larger than they usually are on most Ulodendroid specimens, such as those figured by Brongniart*, Allan†, Stur‡, and Schimper§. When the leaf-scars are small they are usually more or less distant (specimen No. 3, Pl. IV. fig. 2); but with their increase in size, the intervening space becomes gradually reduced till the leaf-scars are contiguous (fig. 1, Pl. III.) or nearly so, as in Stur's pl. xxii. fig. 3b.

The leaf-scars appear to have been somewhat elevated; hence, when impressions of the plant are examined, the spaces intervening between the leaf-scars naturally appear as ridges running between them. These ridges, when partially flattened over the edges of the leaf-scars by pressure, thus somewhat obscure their upper and lower extremities as well as the margins of the leaf-scars generally, and cause the vascular impression to appear as if situated at the extreme upper angle of the leaf-scar¶. It is this state of the plant that has given rise to the supposed "*Lepidophloios*-condition" of *Lepidodendron Veltheimianum*¶.

The Ulodendroid scars, in their earlier condition, are also covered with leaf-scars belonging to the ordinary spiral series of the stem (see specimens Nos. 3 and 7).

In some cases the bark is quite free from longitudinal fissures, as mentioned in the description of specimen No. 2, where from lateral pressure exerted on the leaf-scars by the increase in girth of the stem, they are almost rhomboidal. In Pl. IV. fig. 2 is shown a small portion of the outer surface of a Ulodendroid specimen. The leaf-scars are distant, and connected with each other by a narrow flexuous ridge. This is more fully described in the notes on specimen No. 3, from which the figure is taken. In fig. 3, Pl. IV. (specimen No. 4) this character is more marked. In fig. 4, Pl. IV. is shown a very common form of leaf-scar, occurring both on specimens showing the large Ulodendroid scars and also on those on which they are not present, as was

* Hist. d. végét. foss. vol. ii. pl. xviii.

† Trans. Roy. Soc. Edin. vol. ix. pl. xiv.

‡ Culm-Flora, pl. xxii. (xxxix.) fig. 3.

§ Traité d. paléont. végét. pl. lxiii.

¶ Probably, in attempting to reconcile a *Lepidophloios* condition of *Lepidodendron* with *Lepidophloios*, Renault has been entrapped into producing a copy of Goldenberg's figure 6, pl. xvi., on his pl. ix. fig. 1, with the vascular scar at the upper end of the cushion, whereas it should have been at its lower extremity.

¶ See Renault, Cours d. botan. foss. deuxième année, p. 10, pl. v. fig. 1.

the case with the example from which this sketch was made. This figure illustrates the form of the leaf-scar to which Göppert applied the name of *Lepidodendron* (*Sagenaria*) *ellipticum* *.

The fissures in the bark do not appear to have ever become filled with a subsequent development of tissue, but to have remained as open gashes, for of the numerous *impressions* of these plants which have come under my notice, in every case these clefts were represented as *elevated ridges* on the surface of the impression, or as *fissures* in the bark; hence they must have been open clefts at the time of mineralization. Nor do these clefts appear to have been caused by shrinkage or breakage of the bark after the plant was imbedded in the material which now forms its matrix; for had it been brought about by any secondary cause, we should expect to find these clefts in the bark of all *Lepidodendra*, which we do not.

But, on the other hand, all *Lepidodendroid Ulodendra* do not show this peculiar character of the bark becoming split, for I have seen specimens, some of them very large, of a *Lepidodendroid Ulodendron* from the Scotch Coal-Measures †, in whose bark, in only one case, was there a slight and indistinct indication of these vertical clefts. Therefore, although perhaps of specific value, I am not inclined to regard the longitudinal fissuring of the bark as of generic importance.

From many specimens of these so-called *Ulodendra* (*Ulodendron parmatum*, Carr.=*U. commutatum*, Schimper, &c.), some of which I figure (figs. 1-2), portions of the stems had been broken off, either from the sides of the fossils or from between the scars; such pieces could not have been distinguished from *Lepidodendron Veltheimianum*, Sternberg, with which they entirely agree.

Sigillaria discophora, König, sp.

I have given on Pl. IV. fig. 7, a copy of a few leaf-scars of *Sigillaria Brardii* ‡, for comparison with those of this and the following species.

The leaf-scars (*a*, fig. 7) of *Sigillaria Brardii* are placed on more or less elevated cushions (*g*, fig. 7). These cushions, as in *Lepidophloios*, are morphologically distinct from the leaf-structure, and belong to the cortical envelope, being portions of it, in fact, only mamilliform protuberances. Superficially

* Foss. Flora d. Uebergangsgebirges, pl. xliii. fig. 7.

† From Rosewell Colliery, Midlothian, and Bonnington Pit, Kilmarnock, Ayrshire.

‡ From Brougniart's Hist. d. végét. foss. pl. clviii. fig. 4.

these cushions more or less exceed in area the surface to which the leaf is articulated, and have a casual resemblance to the "field" in *Lepidodendron*, but with this they have no real relation. In *Lepidodendron* the leaf-base is attached to the "field" (c, fig. 15) as well as to the vascular scar; in *Sigillaria*, on the other hand, it is only attached to the vascular scar.

I now hope to show that in *Sigillaria discophora*, König sp. (= *U. majus*, L. & H., and *U. minus*, L. & H.), and *Ulodendron Taylora*, Carruthers, the leaf-scar agrees in all essential points with those of the Clathrarian *Sigillariae*, of which I have taken *Sigillaria Brardii*, Brongniart, as the type. In fig. 12, Pl. VII. (specimen No. 12), a great diversity is seen in the form of the leaf-scar. Immediately beneath the *Ulodendroid* scar the leaf-scars are of the *Sigillaria-Brardii* type. These are enlarged in fig. 12 a, Pl. VII. They are rhomboidal, their upper and lower angles rounded, and their lateral angles produced and prominent; the leaf-scars are also placed upon slightly elevated cushions, and though the cushion is not much larger than the vascular scar, its presence is clearly observable. The small cushions on which the leaf-scars sit are well seen in Pl. V. fig. 8. This, I think, proves the structural identity of the leaf-scar of *Sigillaria discophora*, König, sp. (= *Ulodendron majus*, L. & H.), with that of the Clathrarian group of the genus *Sigillaria*.

I have not met with any specimens of *Sigillaria discophora* which clearly show the vascular-bundle cicatricules; but such have been figured by Sir William Dawson under the name of *Lepidophloios parvus**, where they are represented as of the ordinary Sigillarian type, with three vascular-bundle "dots," the central punctiform and the two lateral lunate. At the part marked b, fig. 12, Pl. VII. (specimen No. 12), and enlarged at fig. 12 b, the scars assume a quadrangular form and usually show a central "dot." Fig. 13 a, Pl. VII., gives a few leaf-scars, natural size, from fig. 13 (specimen No. 14). This form of leaf-scar, arising from the age of the specimen, and perhaps also from changes which have taken place during mineralization, has given rise to Dawson's *Lepidophloios tetragonus*†. The fact of this form of leaf-scar occurring on the specimen represented in fig. 12, Pl. VII., along with the ordinary leaf-scars of the species, proves conclusively the identity of *Lepidophloios tetragonus*, Dawson, with *Sigillaria discophora*, König, sp. On some specimens of this species, especially the older and larger ones, the bark also becomes

* *Acadian Geol.* 2nd ed. p. 455, fig. 170 G 3.

† *L. c.* p. 455, fig. 170 D.

fissured as in *Lepidodendron Veltheimianum*; this is seen in the fossils illustrated in figs. 5 & 13, Pls. IV. and VII.

Sigillaria Taylora, Carruthers, sp.

In form the leaf-scars in this species are essentially of the same type as those occurring in *Sigillaria discophora*, König, sp. They are small and seldom occur in so good a state of preservation as to give a clear idea of their form. I have, however, succeeded in securing several examples which afford the necessary details on this point. In fig. 6, Pl. IV. (specimen No. 16), the form of the leaf-scars is well seen. It is remarkable that on one small part of this fossil they should be so well preserved, and on all the rest of its surface be completely effaced. The upper and larger Ulodendroid scar appears to have been displaced.

The leaves of this and the previous species seem to have remained attached to the stem for a considerable time, and very often their being buried in the matrix appears to have given the outer layer of the bark a tendency to adhere to the impression side of the slab when the stones were split; when this happens there is presented to our view the form of the leaf-scars as seen on the *inner surface of the outer layer of the bark*. This condition is exhibited at the part marked *b*, fig. 10, Pl. VI., which is shown of the natural size in fig. 10 *b*. Fig. 12, Pl. VII., shows a like state of preservation.

At various parts of the specimens of *Sigillaria discophora* and *Sigillaria Taylora* are shown their decorticated conditions, for which Lindley and Hutton founded the genus *Bothrodendron* (Pl. VII. fig. 13 *b*, and Pl. VI. fig. 10 *d*).

[To be continued.]

XIX.—*On a Variety of the Freshwater Sponge Meyenia fluviatilis, auctt., from Florida.* By H. J. CARTER, F.R.S. &c.

NEXT to Mr. Ed. Potts, of Philadelphia, comes Mr. Henry Mills, of Buffalo, in the discovery of freshwater sponges in his particular locality, and in the praiseworthy desire to advance the subject by sending specimens of them to European as well as American naturalists. Of the species in the Niagara River Mr. Mills has long since forwarded to me

R. Kidston del. 2, 4. *Ispilodendron Veltheimianum*, Sternb. 5. *Sigillaria discophora*, König sp. 6. *Sigillaria Taylori*, Carr. sp. 7. *Sigillaria Harvardii*, Brongt. Münster. Bras. lith.

R. Kidston del.

Mintern Bros. lith.

8. *Sigillaria discophora*, König sp.

9. *Sigillaria Toylori*, Carruthers sp.

R. Kidston del.
10. *Sigillaria Taylori*, Carruthers sp.

Mintern Bros. lith.
11. *Lepidodendron Veltheimianum*, Sternberg.

R Kidston del.

Mintern Eros. lith.

12. *B. Sigillaria discophora*, Konig sp.

14. *Lepidophlois scoticus*, Kidston.

15. *Lepidodendron*.

$\frac{1}{4}$ nat. size.