III.—*On the Structure of the Stems of the Arborescent Lycopodiaceæ of the Coal-measures.* By W. CARRUTHERS, F.R.S.

IV. *On a Leaf-bearing Branch of a Species of Lepidodendron.*

(Read before the ROYAL MICROSCOPICAL SOCIETY, Jan. 3, 1872.)

PLATES VII. AND VIII.

THE beautiful series of specimens illustrating the structure of this *Lepidodendron* have been recently obtained for the British Museum from the valuable collection of Mr. John Butterworth, of Shaw, near Oldham. Like my friend Professor Williamson, I have also to express my great obligations to Mr. Butterworth for the singularly instructive specimens which he has submitted to my examination. Living as he does on the spot where the calcareous concretions, which have supplied such valuable materials to recent workers, occur, imbued with a love for the study of these ancient vegetable forms, and having an extensive and accurate knowledge of their structure, and a quick eye for the parts in their structure which are yet only obscurely known, Mr. Butterworth makes sections with his own hands of carefully-selected materials, in a manner which renders them highly instructive, and greatly facilitates the labour of interpretation and description. The truth of these observations will be apparent by the series of drawings accompanying this paper, made by Mr. Hollick from four slides representing transverse and longitudinal sections of the stem and transverse sections of the leaves close to and at a little distance from the stem.

Of the numerous figures that have been given by Witham,

EXPLANATION OF PLATES.

PLATE VII.

- FIG. 1.—Transverse section of the branch of a *Lepidodendron*—natural size.
 „ 2.—Longitudinal section of the same—natural size.
 „ 3.—The lower portion of Fig. 1 enlarged 8 diameters. *a.* the vascular axis with the processes representing the leaf bundles not yet liberated from the axis, and surrounded by the free leaf bundles. *b.* the space occupied by delicate cellular tissue, now filled with carbonate of lime. *c.* the epidermal tissues, with openings through which have passed the leaf bundles. *d.* the bases of the leaves, showing also the single vascular bundles passing to them.
 „ 4.—Portion of Fig. 2, enlarged 8 diameters. The letters indicate the same parts as are represented in Fig. 3. *e* is the leaf base, showing the line of articulation.

PLATE VIII.

- FIG. 1.—The bases of four leaves cut through near their connection with the stem.
 „ 2.—The bases of the leaves at a greater distance from the stem.
 „ 3.—A single leaf (*a.* from Fig. 1), magnified 18 diameters, showing the single vascular bundles at the lower part.
 „ 4.—A single leaf (*a.* from Fig. 2), magnified 18 diameters, showing the leaf bundle of Fig. 3 split into two distinct bundles.

A.T. Hollick. *ad. nat. del.*

W. West & Co. *imp.*

Branch of a *Lepidodendron* from the
Coal Measures.

Lindley and Hutton, Brongniart, Binney, and myself, none have shown the structure of the leaf bases, and their relation to the stem, except that which I figured in my first communication to this Society,* but in that figure the single leaf was exhibited in one direction only, and not with that completeness which, by the help of Mr. Butterworth's specimens, I am now able to give.

As, however, the specimen exhibits several differences in its internal structure from the *Lepidodendron* stem which I formerly figured, and to which I have referred, I will describe its structure at length. It is most desirable to have as many types of stem structure, and as many varieties of the same type before us, so that when we come to generalize as to their affinities, we may fairly estimate the value of the different variations, and intelligently interpret the affinities of these palæozoic stems to the similar structures in existing allied plants.

The differences in the structure of this stem are so distinct from those that have been already published, that it would be quite in accordance with the practice hitherto adopted to give to this fragment a specific name. But as the species in *Lepidodendron* are distinguished by the form and markings on the leaf scars, and as these are at present unknown in this fragment, it is better to leave it in the meantime unnamed, and trust that the continued labours of Mr. Butterworth, or some other investigator, may result in identifying the named form to which this belongs. The practice of recklessly bestowing names on fragments that obviously belong to, but cannot at the time be certainly correlated with known species, which is followed by some students of vegetable palæontology, is not only adding innumerable synonymes to the already heavily-burthened pages of systematic works, but is creating a terrible and a thankless labour for every honest and exhaustive worker. It is, no doubt, a short and ready solution of every difficulty to set aside the labours of previous workers, and it is besides rather flattering to one's self to be the creator of a series of names. But what would be thought of such a practice in any other department of Natural History? Suppose, for instance, it were discovered that we had in this country another *Papilio* beside the Swallow-tail, and that one entomologist got hold of a hind wing and found that it had two tails, and so full of his important discovery he figures and describes his fragment as *P. bicaudatus*, MICH; another finds a head with the antennæ attached, and these are obviously more club-shaped than the known species, and of course it is *P. clavatus*, MICH; the body falls into the hands of a third, and it is thick and short and blunt, and easily distinguished from *Machaon*, so it becomes *P. truncatus*, MICH; the fore wing turns up, and it has got blue lines and spots, and it would be

*'Mon. Micr. Journ.,' vol. ii., Pl. XXVII., Fig. 1 h.

absurd not to give this beautiful new species a name, and it is *P. cæruleus*, МИН; but the body is investigated by an entomologist with an anatomical bias, and he makes some important observations deserving to be published, and the subject must have a name, so it becomes *P. intestinalis*, МИН; and to terminate an illustration which might be carried to any extent, the caterpillar is found in a field of carrots, a discovery so important must be published at once, and it is *P. Carotæ*, МИН. The absurdity of such proceedings is apparent from such an illustration as this, but in fossil botany the terrible reality has to be encountered, and not only roots, stems, branches, leaves, and fruit get different names, but different states of the same stem receive different generic and specific names. In the progress of my descriptions I shall take occasion to point out the origin of these accidental states which have received generic positions, and give my reasons for eliminating many worthless names from the science. And I shall further, in the present case, avoid introducing a name which in my next communication I may have good reason for placing as a synonym to a well-known and well-described species.

The axis of this *Lepidodendron* (Pl. VII., Figs. 3 a, 4 a) is entirely composed of scalariform tissue, which in the transverse section is seen to be irregularly arranged, with the long diameter of the vessels having a radial direction. The ends of the vessels are more or less circular or polyhedral, and they are tolerably uniform in size throughout, except at the exterior, where they are very much smaller. It is important to notice that this central vascular axis is not invested at any part of its circumference by the cylinder of radiating scalariform tissue which I described in *Lepidodendron selaginoides*, Sternb.* The boundary line of this axis is irregular. The small scalariform vessels project, and form recesses in which free bundles of vessels of similar size occur. The projections are the leaf bundles to be given off somewhat higher up the stem. They form as yet only ridges, gradually becoming more prominent, until they are completely separated from the axis, and then they appear as described, as free bundles in a deep furrow. Those bundles are to be found throughout the transverse section of the stem; near the centre they are always cut right across, but as they proceed towards the circumference of the stem, they are cut in a more and more increasingly oblique direction. This is the result of the course the bundles take, being at first almost erect and parallel with the axis, but gradually taking a more outward course until they reach the base of the leaves. They spring from the outer margin of the central vascular axis, a long way below where they pass off to the leaf.

Prof. Williamson, in his recent investigations into the organiza-

* 'Mon. Micr. Journ.,' 1869, Pl. XXVII., Figs. 1 b and 2 b.

A.T. Hollick, del. nat. size

W. West & Co. imp.

Leaves of a *Lepidodendron* from the
Coal Measures.

tion of *Lepidodendron*, proposes to call this axis a medulla.* Our specimen clearly establishes that this cannot be the nature of the axis. It is, as we have said, entirely composed of scalariform tissue; it gives off from its outer surface the vascular bundles which supply the leaves; it has no investing scalariform or woody tissue, and it is placed in the centre of the cellular tissue of the stem. There can be no doubt that it is homologous with the vascular axis of the living *Lycopodiaceæ*, as Witham, in the first paper that treated of the internal structure of a *Lepidodendron*, with remarkable sagacity suggested.† The circumference of the axis is precisely similar to that of *Lepidodendron Harcourtii*, With., being entirely without any investing cylinder; but in that species, as figured by Witham,‡ by Lindley and Hutton,§ and by Brongniart,|| the interior of the axis is composed of "elongated cellular tissue" (Brongn.), with acute terminations, and having a scalariform structure. There is no indication of such a change in the structure of the axis of this plant either in the transverse or longitudinal section.

The tissue surrounding the axis, Pl. VII., Figs. 3*b*, 4*b*, has completely perished in the specimen figured, and the space which it occupied is filled with semi-transparent carbonate of lime, except when here and there a leaf bundle has resisted decay. The destroyed tissue, which is well preserved in some specimens that I hope to figure in due time, was a thin-walled parenchyma.

Beyond this, Pl. VII., Figs. 3*c*, 4*c*, are the true epidermal tissues of the stem. The spherical cells have thickened walls. They are of larger size towards the interior of the stem, and the smaller cells of the exterior are found in longitudinal section to be slightly elongated, yet not to so great an extent as in *Lepidodendron selaginoides*, Sternb.¶ This epidermal layer has successfully resisted decay. Scattered through it are several leaf bundles in open spaces apparently completely detached from the tissue itself. This isolation has been produced by the decay of the delicate cellular tissue which accompanied the bundles from the inner perishable layer. Stems frequently occur, especially in arenaceous rocks, in which the hollow interior has been filled in with the amorphous substance of the rock, and this has pushed itself from the interior outwards through the empty passages occupied by the cellular tissue of the leaf bundles. The indurated epidermal tissues having been subsequently converted into coal, and removed, by slow combustion before the specimen was taken from the rock, or by accident

* 'Proc. Roy. Soc.,' vol. xix., p. 500.

† 'Trans. Nat. Hist. Soc.,' Newcastle-on-Tyne, March, 1832.

‡ *l. c.*, Pl. ii., figs. 2 and 4.

§ 'Fossil Flora,' Pl. xcviii., fig. 2.

|| 'Observ. Sigillaria elegans,' Pl. xxx., figs. 5, 8; xxxi., fig. 4.

¶ 'Mon. Micr. Journ.,' 1869, Pl. XXVII., Fig. 2*c*.

or atmospheric agency after its discovery, the amorphous cast of the interior with its longer or shorter processes corresponding to the leaf bundles have been supposed to be stems with leaves, and have received the generic name of *Knorria*, and the numerous accidental varieties have obtained a large series of specific designations. The longitudinal section (Pl. VII., Fig. 4) shows one of these empty canals passing upwards and outwards from the vascular axis.

From the exterior of the stem spring the bases of the leaves (Pl. VII., Figs. 1 and 2). There is no cuticle to the stem, as its outer surface is entirely made up of the bases of the leaves. The cellular tissue of the leaves is a continuation of the epidermal tissue (Pl. VIII., Figs. 3, 4). The cells in the interior of the leaf are large, and in longitudinal section somewhat oblong. Towards the margin they are much smaller and more compact, forming a firm surface to the leaf. The leaves proper have fallen from the branch figured, and have left a cicatrix which can be detected in those leaves which are cut through the centre, and to some extent it may be seen in the lower leaf in the longitudinal section, Pl. VII., Fig. 4 *e*. A single bundle passed from the axis into each leaf, and it remained single, for some short distance, through the base of the leaf (Pl. VIII., Fig. 3), but before reaching the articulating surface to which the true leaf was attached, it divided into two distinct bundles (Pl. VIII., Fig. 4). It is important to notice the two appearances that the outer surface of this specimen would exhibit, depending on whether we were examining the surface of the stem or the surface of leaf bases; in the one case the leaf bundle would be single, in the other double.

The leaf bases had a direction nearly at right angles to the supporting stem. They were rhomboidal in transverse section, with the lateral angles acute. It is probable that in both *Lepidodendron* and *Sigillaria* the leaf bases were persistent, and consequently that the principal character on which Corda separated *Lepidophloios* from *Lepidodendron* does not hold good. Indeed the specimen which I have now described should be rather placed in *Lepidophloios* than *Lepidodendron*, were the two designations retained.