Lepidodendron) or the greater part (*Tmesipteris*) of the primary wood is centripetal.

The Calamite which forms the subject of the present communication occurs in the well-known Burntisland beds of the Calciferous Sandstone Series, at the base of the Carboniferous Formation. The material is calcified, and the structure excellently preserved, though the specimens so far discovered are small and fragmentary. Their interest depends on the fact that each vascular bundle possesses a distinct arc of centripetal wood on the side towards the pith. The carinal canals are present, as in an ordinary Calamite, and contain, as usual, the remains of the disorganized protoxylem. They do not, however, as in other Equisetales, form the inner limit of the wood, but xylem of a considerable thickness, and consisting of typical tracheides, extends into the pith on the inner side of the canal, which is thus completely enclosed by the wood. Hence, starting from the spiral tracheides of the protoxylem, there was here a considerable development of xylem in a centripetal as well as in a centrifugal direction. That the organ was a stem, and not a root, is proved, not only by the presence of the carinal canals, but by the occurrence of nodes, at which the outgoing leaf-traces are clearly seen.

This appears to be the first case of centripetal wood observed in a Calamarian stem, and thus serves to furnish a new link between the Palaeozoic Equisetales and the Sphenophyllales, and through them with the Lycopods.

The specimens have not as yet supplied any evidence as to the superposition or alternation of the verticils, so we are not at present in a position to determine the genus to which they belonged. Provisionally, until further investigation has cleared up this question, the new stem may bear the name of *Calamites pettycurensis*, from the locality where it occurs.

D. H. SCOTT.

KEW.

REMARKS UPON THE NATURE OF THE STELE OF EQUISETUM¹.—The vascular bundles of *Equisetum* are usually compared with those of a monostelic Phanerogam both in structural detail and with regard to their course out into the leaf. The following

¹ Abstract of paper read before the Botanical Section of the British Association, Glasgow, September, 1901.

observations made upon the stems of *E. Telmateja*, &c., show that this comparison cannot be satisfactorily maintained.

It was found that of the three strands of xylem present in each bundle of the internode, the carinal strand alone passes out at the node as a leaf-trace. The two lateral strands join on to the xylem of the nodal ring, and in certain species (*E. hiemale*, and better still in *E. giganteum*) they may be traced as externally projecting ridges over the nodal xylem into the internode above. In passing through the node they diverge from one another so that in the internode they are found on the adjacent sides of two different bundles. At the node above they approach each other, and in the next internode they both occur in the same bundle once again. The leaf-trace protoxylem, having entered the bundle, runs downwards for one internode between the two lateral strands; at the node below it divides into two branches, which curve to the right and the left in order to fuse with the neighbouring leaf-traces that enter at this node.

So the xylem of the so-called vascular bundle of *Equisetum* consists of three strands, two of which are lateral and cauline, while the median, or carinal, strand is common to both stem and leaf. The fact that only a small portion passes out as a leaf-trace, and not the bundle as a whole, constitutes an essential point of difference between it and the bundle of a Phanerogam.

The tracheides in each strand are very few, and consequently it is difficult to determine the direction of their development. However, as regards the leaf-trace and the carinal strand, it appears clear that they are not exarch but endarch, or perhaps slightly mesarch on the adaxial side. The lateral strands, as a whole, are differentiated later than the carinal strand (as might be expected from the close relation of the latter to the leaves), but they do not seem to be a continuation of its centrifugal development. On the contrary, in *E. giganteum*, where as many as ten to fifteen elements are present in each lateral strand, the smallest of them are invariably at the outer extremity, and they gradually increase in size inwards. Longitudinal sections show that the largest tracheides are coarsely reticulate, with large pits and very broad bands of thickening between them; in the smaller elements the reticulation becomes finer and more regular, and in the smallest it closely resembles true spiral thickening. To state definitely whether the lateral strands are exarch or not was not possible, because no incompletely differentiated portions of the stem were available; so the

question must remain at present undecided, although the mature structure certainly gives a strong impression of centripetal development. Potonié¹ has established a comparison between the secondary vascular tissues of the *Calamariaceae* and the *Sphenophyllaceae* by mentally doing away with the central mass of primary xylem that exists in the latter. By inverting this procedure, and considering it possible that the ancestors of the Equisetums may have possessed a xylem that extended to the centre of the stem, one is led to derive their structure, as it exists at present, from the modification of a stele with a solid central mass of centripetal xylem such as that of *Sphenophyllum*, or of certain Lepidodendreae. To illustrate the nature of the modifications that such a stele would have to undergo, a series of parallel developments may be pointed out within the latter group (*Lepidodendron Rhodumnense*, *selaginoides*, *Harcourtii*, *Sigillaria spinulosa*, and *Menardi*), in which parenchyma appears in the xylem, and gradually increases in quantity until only an attenuated peripheral ring of xylem remains, which then becomes more or less broken up into separate strands.

It is suggested that the lateral xylem-strands in the vascular bundles of the existing Equisetums may perhaps be taken to represent the last remnants of a primitive central mass, and that this would be entirely in agreement with their apparently centripetal development, and in particular with their cauline course.

D. T. GWYNNE-VAUGHAN.

GLASGOW.

SOME OBSERVATIONS UPON THE VASCULAR ANATOMY OF THE CYATHEACEAE².—In a number of Dicksonias with creeping or prostrate stems it is shown that the vascular system is solenostelic, the leaf-traces departing as a single strand curved into the form of a horseshoe, with its concavity facing towards the median line of the rhizome—*Dicksonia adiantoides*, *cicutaria*, *davallioides*, *apiifolia*, and *punctiloba*.

In *D. apiifolia* it is found that along the free margin of the leaf-gap there is a considerable increase in the amount of xylem in the

¹ Pflanzenpalaeontologie, p. 205.

² Abstract of paper read before the Botanical Section of the British Association, Glasgow, September, 1901.

Gwynne-Vaughan, D. T. 1901. "Remarks upon the nature of the stele of Equisetum." *Annals of botany* 15, 774–776.

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