On a 'Mixed Pith' in an Anomalous Stem of *Osmunda regalis*.

BY

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With Plate **XXI**.

IN a paper published by Dr. R. Kidston and myself in the year 1910 an account is given of a fossil plant, *Osmundites Kolbei*, Seward, which deserves particular attention because it is the first member of the Osmundaceae that has been described with a 'mixed pith'.¹ That is to say, the medulla of this plant is not homogeneous, but contains a number of well-defined tracheal elements scattered throughout its tissue. It is, in fact, exactly the same as the mixed piths that are present in the steles of several of the Zygopterideae (*Ankyropteris Grayii*, *A. corrugata*, &c.). The discovery of the existence of a mixed pith in the Order Osmundaceae attracts special interest to an anomalous stem of *Osmunda regalis* that was met with in the course of the advanced class-work at Birkbeck College, London, and was kindly placed at my disposal by the Head of the Botanical Department. The plant in question was not grown in cultivation, but so far as could be ascertained was collected at random in a wild condition from a moist situation in Cornwall.

A number of sections, perhaps a dozen or more, were cut from the lower end of the stem by the students of the class, in all of which the anomaly probably occurred. A few of these were recovered and came into my possession together with the remainder of the stem. Further sections were then taken from the exposed end of the stem, but, unfortunately, after three or four had been obtained the anomaly abruptly came to an end.

In the region of the anomaly the stem was 8 mm. in diameter and the stele, which contained a ring of nine separate xylem strands, about 2.5 mm. In the stele the xylem, phloem, and porose layers are perfectly normal, but the parenchyma of the pith contains a large number of scattered tracheal elements (Figs. 1 and 2). In one section there are well over sixty of these

¹ Kidston and Gwynne-Vaughan : On the Fossil Osmundaceae, Pt. IV. *Trans. Roy. Soc. Edin.*, vol. xlvii, 1910, p. 455.

medullary tracheae distributed quite irregularly over the whole area of the pith. They occur as isolated elements or in small groups up to as many as nine together. In a few cases they are seen in contact with the tracheae of the normal xylem ring, but they do not extend into the medullary rays. As seen in transverse section they are very irregular in form and vary much in size, closely resembling in these respects the parenchymatous cells of the rest of the pith. A few, however, are somewhat larger and more or less vesicular or sack-like in appearance. Since the surfaces of the end walls of most of them are visible in a transverse section they must be quite short in the vertical direction. Indeed, some of them seem to be broader transversally than they are long (Fig. 1). The elements in question are entirely tracheal in character. They are quite dead and empty, with thick and well-lignified walls. Their pitting is irregularly scalariform, passing over in many cases to a reticulate or even a porose marking (Fig. 3). A very similar reticulate-porose marking is also characteristic of the medullary tracheae of *Osmundites Kolbei* (Fig. 4).

The whole length of the stem, which was about 55 mm. long, was carefully cut into successive transverse sections, but no more medullary tracheae were encountered until a point was reached about 8 mm. from the apex, where they appeared once more and persisted for about a dozen sections. Above this point the stem was cut longitudinally, but did not disclose any medullary tracheae. In this upper anomalous region the medullary tracheae are essentially the same in character as those in the lower region, but they are fewer in number, not exceeding nine in any one transverse section (Fig. 5).

The presence of this unusual type of pith in our specimen is undoubtedly due to injury. Indeed, the pith is obviously in an unhealthy condition throughout the whole length of the stem. It is traversed in all directions by cracks which in alcohol material are filled with a yellow mucilaginous substance. They are formed partly by the tearing apart of the pith cells and partly by the breaking down of the same, and are usually bordered by the remains of the disintegrated cells (Figs. 1 and 5). It is seen that the medullary tracheae are mostly found in close relation to these cracks, from which in Fig. 5 the mucilage has been removed by the action of eau de Javelle.

It is not clear whether the plant was suffering from some constitutional disease or whether it had received a definite external wound. The fact that there is no trace of such a wound and that the anomaly reappears in a region just below the apex seems to point to the former suggestion. At the same time a traumatism may appear at a considerable distance away from the wound that causes it, and in this case the wound may have been inflicted on a part of the stem below that collected. The lower anomalous region may have been formed shortly after the reception of the injury, and since the

plant would still be in a debilitated condition, a weak place in the stem would probably result, where it would be very likely to snap off when the specimen was collected.

In *Osmundites Kolbei* a mixed pith was found throughout the whole length of the specimen examined, and there is no reason to believe that it is not a perfectly constant and diagnostic character of the plant. Apart from the larger size and vertical elongation of the medullary tracheae (Figs. 4 and 6), it is essentially the same type of pith as that in the specimen of *Osmunda regalis* described above. It may be held, therefore, that if the normal differentiation of the pith of the present-day *Osmunda regalis* is interfered with by traumatic conditions, some of its elements are liable to revert to their earlier phylogenetic habit and are still able to give rise to tracheae instead of parenchyma. We have thus a return to an ancestral type of pith-structure that was normal in the Cretaceous fossil *Osmundites Kolbei*. If this is so, additional support is given by our specimen to the theory that the pith of the Osmundaceae is truly stelar in origin; that it arose by the conversion of the central tracheae of an originally solid mass of xylem into thin-walled parenchyma; and that this transformation did not take place simultaneously in all of them, but some retained their tracheal characters long after the rest had become converted into parenchyma.

The fact that valuable phylogenetic information may be obtained from traumatic variations in structure has already been pointed out in the Gymnosperms, both fossil and recent, by Professor E. C. Jeffrey.¹ He has shown that tracheidal cells appear traumatically in the medullary rays of the secondary wood of *Cunninghamia sinensis*, in the normal secondary wood of which they are entirely absent. It is interesting to note that these traumatic ray-tracheides are to be found in tissues that are formed some time after the reception of the wound and in a region some distance away from it. Again, in *Sequoia sempervirens* the normal secondary wood is entirely devoid of resin-passages, yet such appear traumatically, as in the case above, subsequent to and at some distance from the wound. Jeffrey considers that these facts may be taken as evidence of the descent of the plants concerned from abietinous ancestors in which ray-tracheides and resin-passages respectively occurred in the normal secondary wood.

It would no doubt be dangerous to place any great phylogenetic weight upon the peculiarities of traumatic tissues considered apart and by themselves. At the same time I agree with Professor Jeffrey in so far that when traumatic characters 'are supported by a considerable body of collateral evidence, especially if such evidence is derived from extinct species', they

¹ Jeffrey: (i) Traumatic Ray-tracheides in *Cunninghamia sinensis*. *Annals of Botany*, vol. xxii, 1908, p. 593. (ii) The Wound Reactions of Brachyphyllum. *Ann. of Bot.*, vol. xx, 1906, p. 383. (iii) Comparative Anatomy and Phylogeny of the Coniferales. Pt. I, The Genus *Sequoia*. *Mem. Boston Soc. Nat. Hist.*, vol. v, 1903, p. 441. Pt. II, The Abietineae. *Ibid.*, vol. vi, 1905, p. 1.

may be safely taken as strong confirmatory evidence in the consideration of phylogenetic hypotheses.

My thanks are due to Dr. R. Kidston for kindly taking the photographs used in illustration.

SUMMARY.

1. An anomalous stem of *Osmunda regalis* is described, the pith of which at certain points contains scattered medullary tracheae.
2. It is held that this gives support to the theory that the pith of the Osmundaceae is phylogenetically stelar and not cortical, and that it arose by the progressive conversion of the central tracheae of a solid xylem strand into parenchyma.

EXPLANATION OF PLATE XXI.

Fig. 1 is from a drawing. The others are from untouched photographs.

Fig. 1. *Osmunda regalis*. Transverse section from the lower end of the specimen, showing the mixed pith and the greater part of the xylem ring. $\times 52$.

Fig. 2. *Osmunda regalis*. Photograph of another section from the same region. $\times 50$.

Fig. 3. *Osmunda regalis*. Surface view of the wall of one of the medullary tracheae to show porose pitting. $\times 200$.

Fig. 4. *Osmundites Kolbei*. Surface view of the wall of one of the medullary tracheae. $\times 200$.

Fig. 5. *Osmunda regalis*. Transverse section of the upper anomalous region, showing the traumatic cracks and a few medullary tracheae. $\times 50$.

Fig. 6. *Osmundites Kolbei*. Longitudinal section through the stele, showing the elongation of the tracheae in the 'mixed pith'. $\times 10$.

1.

3.

4.

5.

2.

6.

R. Kidston phot.

Huth. coll.

GWYNNE-VAUGHAN - OSMUNDA.

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