

XVI.—On a New Species of *Dineuron* and of *Botryopteris* from Pettycur, Fife.  
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Among the interesting specimens which have been yielded by the material of Calcareous Sandstone age (Culm), from Pettycur, near Burntisland, are a petiole of *Dineuron* and a very small species of *Botryopteris*. The former genus does not appear to have been previously discovered in Britain, and the present species is, as far as I am aware, only represented by a single example. The *Botryopteris*, in the form of fragments of petioles, is not infrequent, but its stems are of much more rare occurrence.

I. *Dineuron ellipticum*, Kidston, n. sp. (Plate, figs. 1–3.)

The specimen which forms the subject of the following description consists of a single transverse section of an almost circular petiole, whose greater width is about 2·25 mm. (fig. 1).

The petiole possesses an outer zone of stout cortex about 0·60 mm. wide (fig. 1, *o.C.*), which is succeeded inwards by a narrow band of delicate inner cortex (fig. 1, *in.C.*). This was separated by an endodermis (fig. 1, *end.*) from the thin-walled elements of the stele, which have almost entirely disappeared, and the mass of xylem now lies on one side of the space which they originally occupied (fig. 1).

The xylem of *Dineuron ellipticum* consists of an elliptic mass whose greater diameter is about 0·70 mm. It is composed of large tracheæ without any admixture of parenchyma; towards its two extremities the tracheæ suddenly become smaller where they meet the protoxylem elements (fig. 2, *prx.*).

At the right side of the xylem mass, a short distance within its margin, is a circular opening surrounded by the protoxylem elements. According to RENAULT, this circular opening was originally filled with parenchyma,\* which also occurs in a similar position in the stele of *Zygopteris duplex*, Will., sp.† ‡

At the left side of the stele a semicircular sinus is observable. This results from the separation of a portion of the xylem to form the outgoing pinna trace. There is, unfortunately, no clear evidence as to the mode of departure of the pinna trace, for the structure so interpreted by RENAULT in his *Dineuron pteroides* § is more probably an unequal division of the petiole stele. One can only suggest, from the great similarity of the stele of *Dineuron* to that of *Zygopteris duplex*, that a band was cut off alternately from

\* In *Dineuron pteroides*, RENAULT, *Bassin houil. et perm. d'Autun et d'Épinac, Flore foss.*, deux. part., p. 22, 1896.

† *Rachiopteris duplex*, WILL., *Phil Trans.*, vol. clxiv., p. 687, Plates.

‡ Several slides of *Zygopteris duplex* in my collection show this: Nos. 1315, 1314, 1313, etc.

§ RENAULT, *l.c.*, p. 23, fig. 19.

each end of the xylem to supply the pinnæ traces, which, as in *Zygopteris duplex*, possibly divided into two in their course through the cortex.

The metaxylem is multiseriate as seen in transverse sections of the tracheæ, while the protoxylem is apparently scalariform.

The soft elements of the stele have all decayed, and are only represented by carbonaceous fragments around its periphery.

The remains of the endodermis are seen at fig. 1, *end.*, and outside of this lies the inner cortex, composed of four or five rows of delicate parenchyma. This is succeeded by the outer cortex, formed of thick-walled prosenchyma, the component elements of which vary somewhat in the size of their lumen, but there is no regular arrangement of the larger and smaller elements. The peripheral portion of the cortex consists of smaller elements, but it is much destroyed and seems to have been of a more delicate structure than the zone lying immediately within it.

If one compares the description of *Dineuron ellipticum* with RENAULT's description of his *Dineuron pteroides*, the wisdom of placing the Pettycur plant in the genus *Dineuron* may at first sight be questioned; but if the figure of *Dineuron pteroides* be carefully examined, it will be seen that the tissue which occupies the central portion of the stele has much more the appearance of xylem than of parenchyma, as supposed by RENAULT. This circumstance, supported by the structure of the Pettycur plant, which agrees so completely with *Dineuron* in other respects, has led me to adopt this view, and a similar opinion seems to have been accepted by Mons. PAUL BERTRAND in his proposed classification of the *Zygopteridæ*.\*

## II. *Botryopteris antiqua*, Kidston, n. sp. (Plate, figs. 4-12.)

Three stems of *Botryopteris antiqua* are shown on Plate I. figs. 4, 6, 7. The one given at fig. 4 shows two attached petioles, and that at fig. 7 a single attached petiole, while the stem at fig. 6 illustrates the branching of the stele (*s', s''*) and also shows a petiole just freed from the stem.

Characteristic of the family to which it belongs, *Botryopteris antiqua* has a very small stem stele, when considered in relation to the size of the petioles to which it gives rise. The stele of the specimen seen at fig. 4 is only 0.40 mm. in diameter, while those of figs. 6 and 7 have a diameter of 0.50 mm.

The stem is irregular in form, owing to the departure of the petioles and roots. The cortex is formed of thick-walled prosenchymatous cells of small diameter and without intercellular spaces, the larger elements being placed towards the outer surface of the stem, which bears numerous hairs formed of a single row of cells.

The circular stem stele is formed of very small tracheæ, without any admixture of parenchyma. Stem protoxylems are not distinguishable (fig. 5). In longitudinal

\* "Classification des Zygoptéridées d'après les caractères de leurs traces foliaires," *Comptes rendus*, 4th November 1907.

section the tracheæ are seen to possess scalariform thickenings without the occurrence of any porose markings.

None of the stems yet met with show the departure of the leaf-trace from the stele, but in several of them the leaf-traces are seen in their passage through the cortex.

At fig. 4, two petioles are being given off, apparently in spiral series; at figs. 6 and 7, one is seen on each stem, though in the former case it has probably become free.

The petioles, which are larger than the stems from which they arise, are circular or slightly oval in form, the largest met with attaining a diameter of 2.20 mm., with a leaf-trace 0.75 mm. in its greatest width. The leaf-trace is thus a half larger than the diameter of the stele of the stem.

The cortex of the petioles forms a broad zone of thick-walled prosenchymatous cells, the smaller of which lie at the periphery, while the larger elements are towards the centre of the zone, whence they decrease in size towards the endodermis, though even here they are larger than those of the peripheral area (fig. 6, *pet.*).

The endodermis is clearly defined by its dark contents, and is seen at fig. 8, *end.*

The whole of the soft elements of the leaf-trace have almost entirely disappeared, and when any fragments remain they are too imperfectly preserved to admit of a detailed description. The leaf-trace thus comes to occupy the centre of a clear space, or has fallen to one side (fig. 4, *pet.*!, *pet.*''; fig. 6, *pet.*; fig. 9).

In form the leaf-trace is oval, with one side slightly flattened, its more pointed or adaxial side being formed of protoxylem elements (fig. 8, *prx.*). In their distribution, however, the protoxylem elements are very irregular, and though their usual condition is to form a prominent band-like group at the apex of the trace, they occasionally have a greater or less lateral extension in the form of a narrow band down both sides of the xylem, or even extend some distance on the abaxial surface (fig. 8, *prx.*). At other times they are almost entirely limited to the adaxial margin, with a few isolated elements scattered along its lateral margins; but in no case do the protoxylems form teeth as in the other known species of the genus.

In longitudinal section the protoxylem elements are seen to be scalariform.

The metaxylem of the leaf-trace is composed of large tracheæ arranged without any definite order, but which become slightly smaller as they abut on the protoxylem (fig. 8). Their walls are porose.

The petioles underwent bifurcation. At fig. 11 an early stage in the dichotomy of a petiole is seen. Here the trace has become transversely elongated, and an indentation has appeared on one side. At fig. 12 the same petiole trace is seen divided into two equal arms.

The pinnæ appear to have been alternate, and their traces arise as small protuberances on the trace of the petiole (fig. 9, *pin.*). A further stage in their departure is seen at fig. 10, *pin.*, where the pinna trace is free from that of the petiole, though still enclosed in a common cortex. The protoxylem of the pinna trace is adaxial to the trace of the petiole.

The roots which rise direct from the xylem of the stem (fig. 6, *r.*) are very small, and contain a typical diarch strand composed of scalariform tracheæ.

The foliage and fructification of *Botryopteris antiqua* are unknown.

*Botryopteris antiqua* is a typical member of the genus, though perhaps its smallest species, and is easily distinguished by its minute size and the protoxylem elements of the leaf-trace being evenly distributed and not forming prominent teeth as in the other known species. The tracheæ of the stem are scalariform, not porose.

The general character of growth of *Botryopteris antiqua* was that of a fern with a branching stem of slender dimensions which bore petioles of large size when compared with the stem from which they originated, and that must have supported itself by scrambling amongst the surrounding vegetation.

It is an interesting point to notice the progressive development of the protoxylem in the form of prominent teeth. In *Botryopteris antiqua*, from the Calciferous Sandstone series (Culm), protoxylem teeth are absent; in *Botryopteris hirsuta*, Will., sp., from the Lamarkian series,\* they are very distinct, and in some specimens even prominent; while in *Botryopteris forensis*, Renault, from the Upper Coal Measures of Grand-Croix, they form long, narrow prolongations. There seems to be a tendency in the petiole trace to become more simple in form as traced back in geological time.

#### EXPLANATION OF PLATE.

[*s.* = stele; *prx.* = protoxylem; *in.C.* = inner cortex; *o.C.* = outer cortex; *end.* = endodermis; *pet.* = petiole; *r.* = root; *h.* = hairs; *pin.* = pinna.]

#### Figs. 1-3. *Dineuron ellipticum*, Kidston, n. sp.

- Fig. 1. Trans. section of petiole. × 30. Slide No. 57.  
 Fig. 2. Trans. section of stele. × 70.  
 Fig. 3. Trans. section of protoxylem group. × 160.

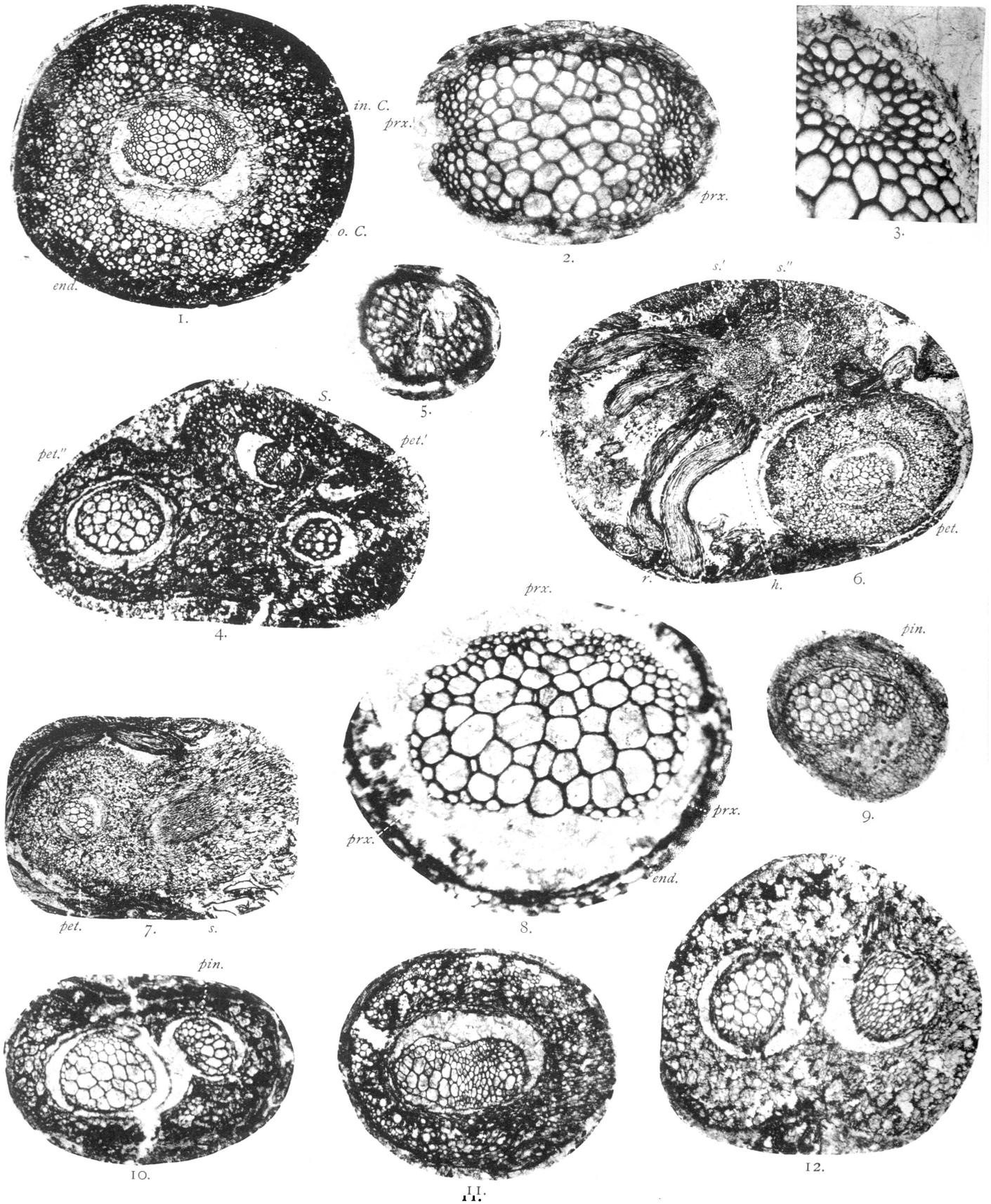
#### Figs. 4-12. *Botryopteris antiqua*, Kidston, n. sp.

- Fig. 4. Trans. section of stem giving off two petioles. × 30. Slide No. 1084.  
 Fig. 5. Trans. section of stele of last specimen. × 70.  
 Fig. 6. Trans. section of stem showing division of stele, petiole, roots, and hairs. × 15. Slide No. 549c.  
 Fig. 7. Trans. section of stem giving off a petiole. × 15. Slide No. 782.  
 Fig. 8. Trans. section of leaf-trace. × 80. Slide No. 508.  
 Fig. 9. Trans. section of petiole giving off pinna. × 30. Slide No. 1347.  
 Fig. 10. Trans. section of petiole giving off pinna. × 30. Slide No. 1086.  
 Fig. 11. Trans. section of petiole showing early stage of dichotomy of leaf-trace. × 30. Slide No. 1348.  
 Fig. 12. Trans. section of petiole showing leaf-trace dichotomously divided. × 30. Slide No. 1346.

All the figured specimens are in the Author's collection.

\* KIDSTON, *Quart. Journ. Geol. Soc.*, vol. lxi, p. 320, 1905.

KIDSTON: NEW SPECIES OF DINEURON AND BOTRYOPTERIS.



Figs. 1-3.—DINEURON ELLIPTICUM. *Kidston, n. sp.*