Discoid Pith in Woody Plants.

By F. W. Foxworthy.

The occurrence of a discoid pith, i. e., one which is interrupted at frequent intervals by cross partitions variously known as disks, diaphragms, plates or lamellæ, has been noted by numerous observers in certain of the woody plants.

The first mention of it seems to have been by the Anatomist Grew (Anat. Plantarum, 1682. Pl. 19, f. 4), who described and figured it in *Juglans*.

Ch. Morren, in the Ann. Nat. Hist., Vol. 4, No. 22, 1839, gave a good historical sketch of the observed cases of discoid pith, and described in detail and figured certain forms.

W. C. Williamson (Proc. Man. Lit. and Phil. Soc. for 1851) in a paper "On the Structure and affinities of the plants hitherto known as Sternbergiæ"—described the casts of this kind of pith which had been considered entire fossil plants—with the group name *Sternbergiæ*, and showed their true nature and affinities—as members of the genus *Dadoxylon Brongn.* He also mentioned the occurrence of discoid pith in a number of recent plants.

M. Gris, in his very painstaking work "Sur la moelle les plantes ligneuses" (Ann. des Sci. Nat. ser. 5, No. 14, 1872), described two structurally distinct forms of discoid pith. The first, which he terms *Heterogenous Continuous Diaphragmatic*, has the pith continuous between the disks, e. g. *Liriodendron*.

The second he terms *Heterogenous Discontinuous Diaphragmatic* and, in this, the pith is not continuous between the disks, the interspaces being empty or filled with air, e. g. *Juglans*.

Pith of the first type occurs in *Liriodendron* and *Magnolia species*, in *Asimina* and some other representatives of the *Anonaceæ*, in *Nyssa*, and, according to Solereder (Anatomie der Dicotyledonen, Stuttgart, 1899), in many of the *Ternstroemiaceæ*, as well as in *Brachynema* (*Ebenaceæ*) and in certain of the *Convolvulaceæ*.

The cells making up these disks are large, irregular in outline, very thick-walled, lignified, and contain starch in winter. The cells filling the interspaces are small, regular, very thin-walled, unlignified and empty.

The formation of the disks takes place at a very early stage in the growth of the twig; they may be seen just back of the growing point in Fig. 1, which is a longitudinal section through a young twig of *Liriodendron*.

The genus *Magnolia* presents some interesting modifications of this type. The genus has been described as always having these partitions in the pith; but, several have pointed out that this statement is incorrect. In the examination of the American and some of the Asiatic species, I have found only two, *M. Virginiana* and *M. fœtida*, in which the fully developed disks occurred. In all the other species examined, cells of the sort described as making up the disks occurred scattered singly or in small groups throughout the pith. Baillon, in his Natural History of Plants, says of this: "In the rapidly developed shoots of some Magnolias we have seen these septa reduced to a single cell, nearly central, on which all the surrounding cells of the ordinary parenchyma abut by one end, bent, or drawn out in a quite peculiar fashion."

In Fig. 2, which is a longitudinal section of a twig of *M. tripetala*, these scattered groups of cells are shown; and, Fig. 3 shows the same kind of cells in a cross-section of a twig of the same species.

In *Asimina* the disks seem to be made up of more regular and thicker-walled cells than are found in *Magnolia* and *Liriodendron*.

In the slender woody twigs of *Nyssa*, very strongly developed disks were found, stronger in fact than in any other case examined.

Function of pith of this type:—

No satisfactory explanation of the function of this type of pith has been offered. From superficial examination, the suggestion that its function was one of mechanical support would seem reasonable; but, the fact that the most strongly developed diaphragms were found in the strong and slender twigs of *Nyssa*, while the thick *Magnolia* twigs with their relatively large pith showed the weakest development of this type, seems to indicate that the suggestion of mechanical support is not a sufficient explanation of their function.

The second type of pith has often been mentioned and figured in species of *Juglans*. I have also studied it in *Pterocarya*, *Celtis*, *Mohrodendron* (*Halesia*), *Forsythia viridissima*, *Jasminum species*, *Paulownia*, and

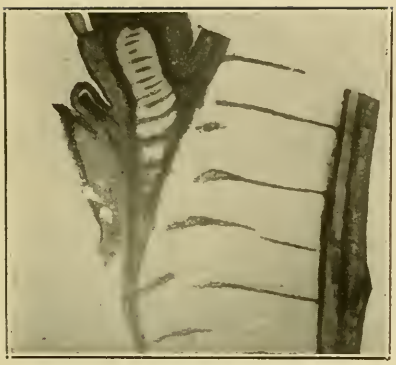

Fig. 1.

Fig. 2.

Fig. 3.

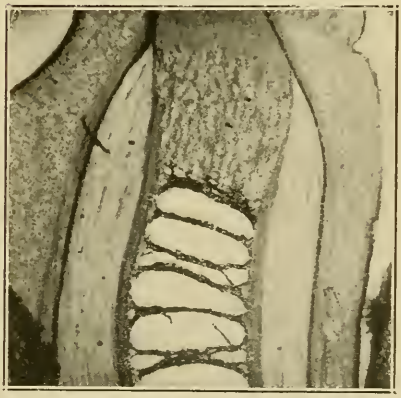

Fig. 4

Actinidia. Besides these, Solereder found it in *Wormia* (*Dilleniaceæ*), *Diplotaxis* (*Cruciferæ*)-*Fouqiera* (*Tamariscæ*), *Princepia Chrysobalanaceæ*), *Aucuba* (*Cornaceæ*, only in herbarium material), *Pedalium* (*Pedaliaceæ*), *Daphnyphyllum* (*Daphnyphyllaceæ*): Williamson also found it in the fossil plants known as *Sternbergiæ* and mentions it as occurring in certain living species of *Pinus*. In some genera, as e. g. *Forsythia* and *Jasminum*, it occurs in some species but not in others.

The cells making up the partitions are thin-walled, empty and often shrunken and the space between the partitions is irregular in outline and extent. Fig. 4, from a twig of *Juglans cinerea*, shows this type.

Function and manner of formation:—

Morren and Williamson both considered that the pith served as a mamilla for the bud and, as the nourishment is exhausted from the pith it separates into disks—beginning first in the immediate vicinity of the bud. The cells in the center of the pith become shrunken and the pith separates into layers. This takes place quite early in the growing season. Morren gives good figures of this process in *Juglans regia*. The fact that twigs of *Celtis* often have the pith very plainly discoid in the region of the nodes but solid in the central part of the long internodes lends support to this view.

Taxonomic value of the occurrence of discoid pith:—

Juglans and *Pterocarya* are definitely separated off from the rest of the *Juglandaceæ* (A. Engler in Engler & Prantl-Nat. Pflanz. Fam. 111. I. p. 21) by the possession of discoid pith. In *Liriodendron*, *Asimina*, *Nyssa Celtis*, *Mohrodendron*, *Actinidia*, and several others, the presence of discoid pith seems a good generic distinction; but, in certain cases, as, *Forsythia* and *Jasminum*, it is of only specific value.