THE ROOTS OF WILD RICE. ZIZANIA AQUATICA L.

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This grass grows from Maine to Minnesota in aquatic habitats (2 and 5). It is common in marsh lands all around the Great Lakes although rapidly being destroyed in a great many places by our civilization.

The roots of this plant when it is mature, as in a great many grasses, is an adventitious root system which is submerged. The roots are rather large having a diameter as great as three or four millimeters. The root cap is of small size and extends from the tip of the root for a distance of about three millimeters. The writer was not able to find any root hairs although the growing tips of the roots are usually imbedded in the mud.

Janczewski (3) describes five types of root development as follows:

1. The root tip is composed of four primary independent tissues: the rootcap, the epidermis, the cortex and the central cylinder.

2. The root tip is composed of three primary independent tissues: the rootcap, the cortex and central cylinder.

The epidermis is derived later from the cortex.

3. The three primary tissues are the same as in the second type, but it is the calyptrogen layer developing the rootcap which gives rise to the epidermis.

4. The primary tissues are at the tip in one meristematic region.

5. The root contains only two primary tissues: the central cylinder and cortex.

From all the data that the writer has been able to obtain the grasses belong to the first two groups. Zizania aquatica belongs to the second group.

The Cortex.

In a cross section of the mature roots of wild rice the cortex is very thick and with very large air spaces (Fig. 1). The epidermal cells are small cells and in the older roots are torn and destroyed (Fig. 1) by the increase in the periphery of the root.

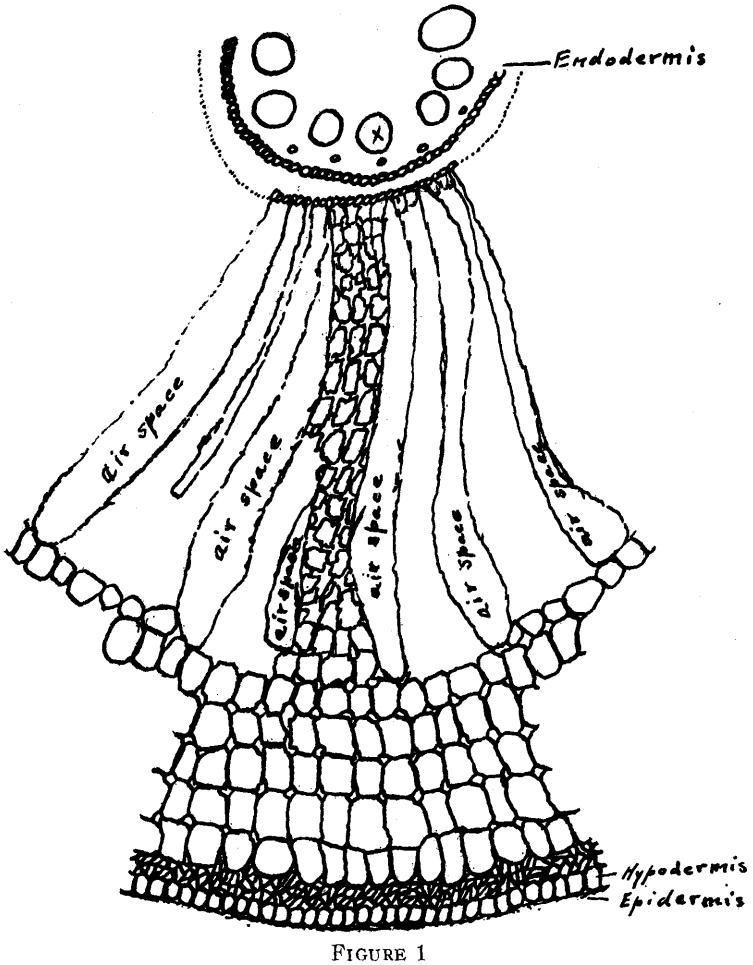


Figure 1

The hypodermis is composed of very large cells (Fig. 2) which apparently is the functioning epidermis of the older part of the root. Adjacent to the hypodermis there is a region, two or three cells in thickness (Fig. 2), which becomes lignified and functions as a mechanical tissue preventing the collapse of the aerenchyma of the cortex.

This aerenchyma of the cortex begins quite early by the pulling apart of the corners of the cortical cells. This continues with the enlargement of the cortex until the cells in the transverse section have the form of a cross (Figs. 3, 4, 5). The continuation of the enlargement of the cortex tears these cells apart completely, or actually destroys some of the cells, until the mature cortex shows radiating plates of cells with the larger cavities bordered with the torn fragments of cells (Figs. 6 and 1).

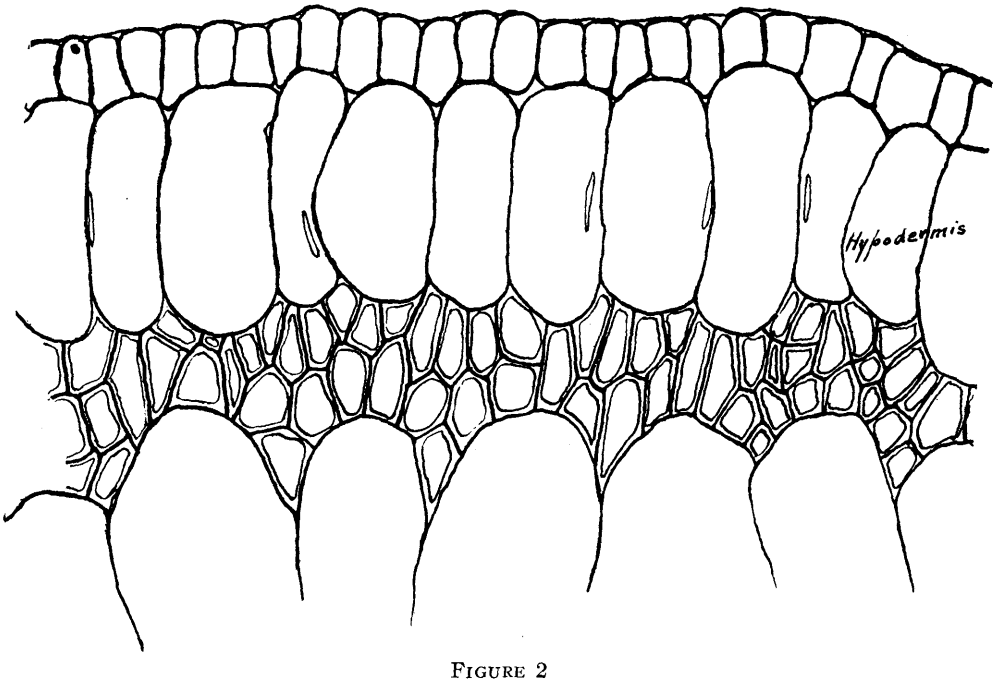


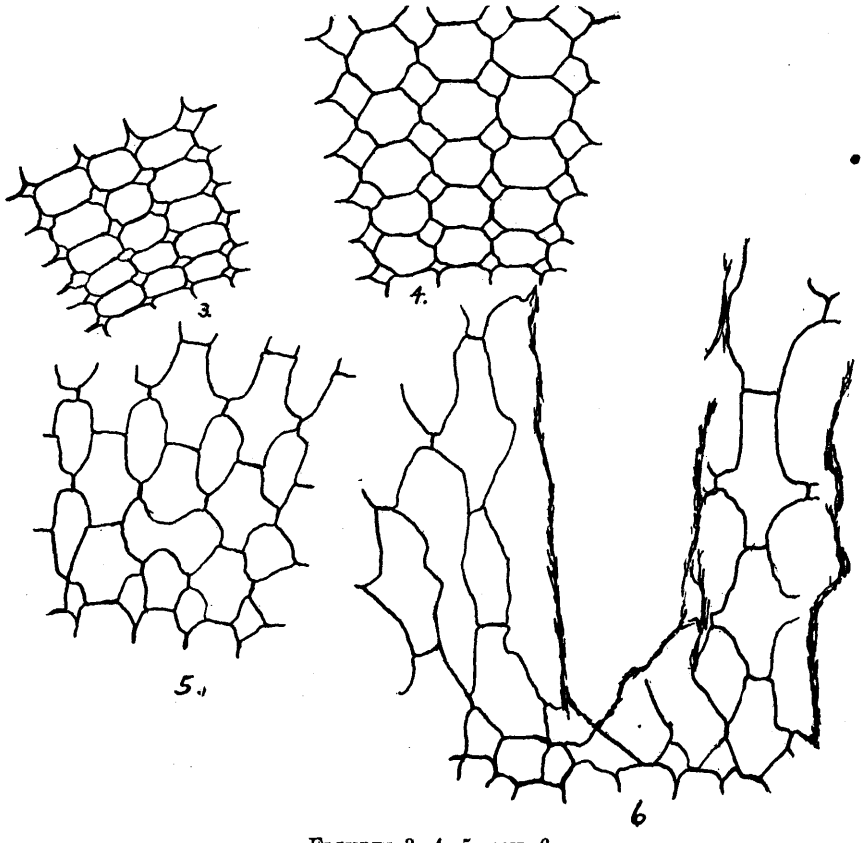
FIGURE 2

In the roots of Echinochloa walteri c. lysigenous formation of the larger cavities does not occur and is entirely schizogenous.

THE CENTRAL CYLINDER.

The central cylinder is quite easily seen in cross section at the tip of the root (Fig. 7). A very few cells from this toward the stem are the cells which finally become the so-called metaxylem vessels. They are enlarged and are easily distinguished because of this from the other cells of the central cylinder (Fig. 8). The protoxylem cells are differentiated centrifugally from these and are formed by the pericycle (Fig. 9). These cells are the first cells to have their walls thickened (Fig. 10) and because this

deposition occurs at the beginning of the region of elongation of the root, these protoxylem vessels become spiral vessels (6 and 1). Lignification begins in these cells and the surrounding cells and continues centripetally until all of the central cylinder is somewhat lignified.



FIGURES 3, 4, 5, AND 6

DIFFERENTIATION OF XYLEM.

A number of our books state that one of the differences between stems and roots is that the primary xylem cells are formed centripetally in roots. Jeffrey (4) states that it may occur in both directions. However, if we consider the morphological changes in growth from meristematic regions to be: (1) cell divisions, (2) cell enlargement and elongation, and (3) maturation (or differentiation), then it is certain that in grasses the primary xylem is centrifugal in its development although lignification occurs centripetally.

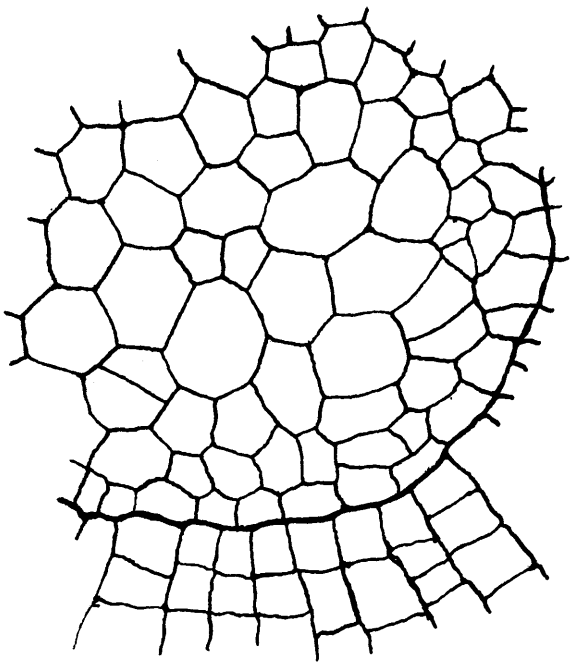


FIGURE 7

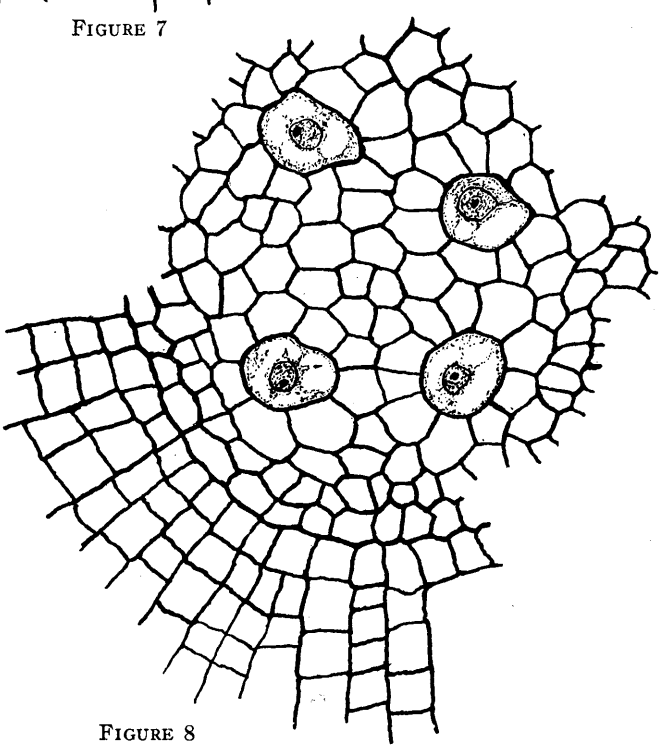


FIGURE 8

Other monocotyledonous plants examined by the writer indicate that the above development is not peculiar to the grasses as a group. The only records obtained by the writer on this point from the literature is that of Janczewski (3) in which he states that the metaxylem vessels are the first to be seen in the root tips of Fagopyrum, Pistia, Hordeum, Hydrocharis and Pisum.

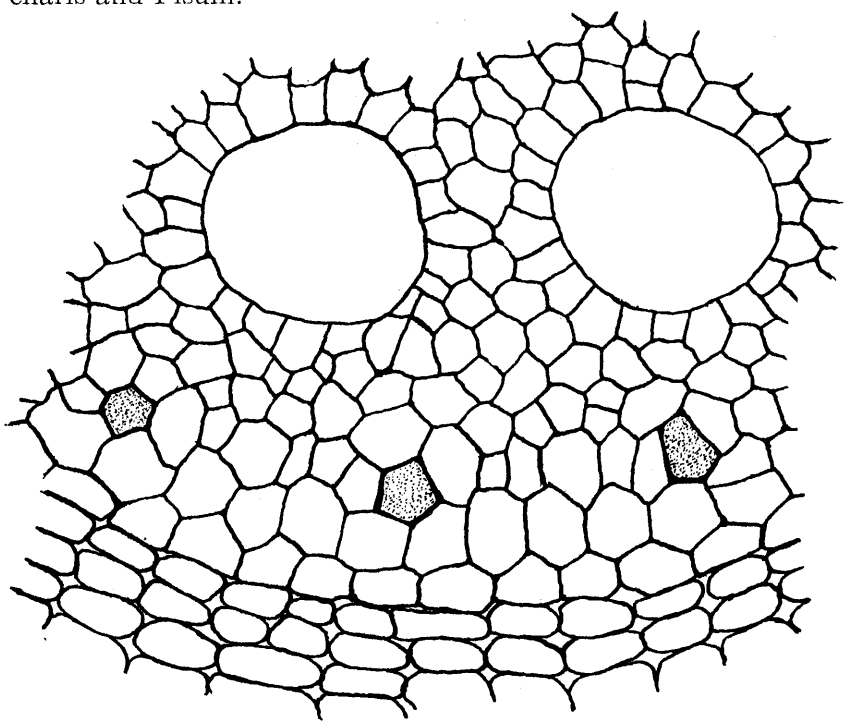


FIGURE 9

There is little doubt in the mind of the writer that the development of the primary xylem of roots is centrifugal although lignification is centripetal.

SUMMARY.

1. The formation of the air passages in the roots of Zizania are first schizogenous and finally lysigenous.

2. The epidermis is a layer of small cells, and the hypodermal cells become quite large in comparison, functioning as the epidermis because of the destruction of the epidermal cells.

3. Adjacent to the hypodermis there is a band of sclerenchyma which stiffens the outer cortex apparently preventing the

collapse of the inner cortex which is mostly aerenchyma.

4. The xylem is centrifugal in development. (a) The largest water vessels are the first to be differentiated and are nearer the center of the root. When mature they are reticulate or pitted.

(b) The second water tube is formed from the pericycle and becomes a spiral vessel, or when elongation is slight is a reticulate vessel.

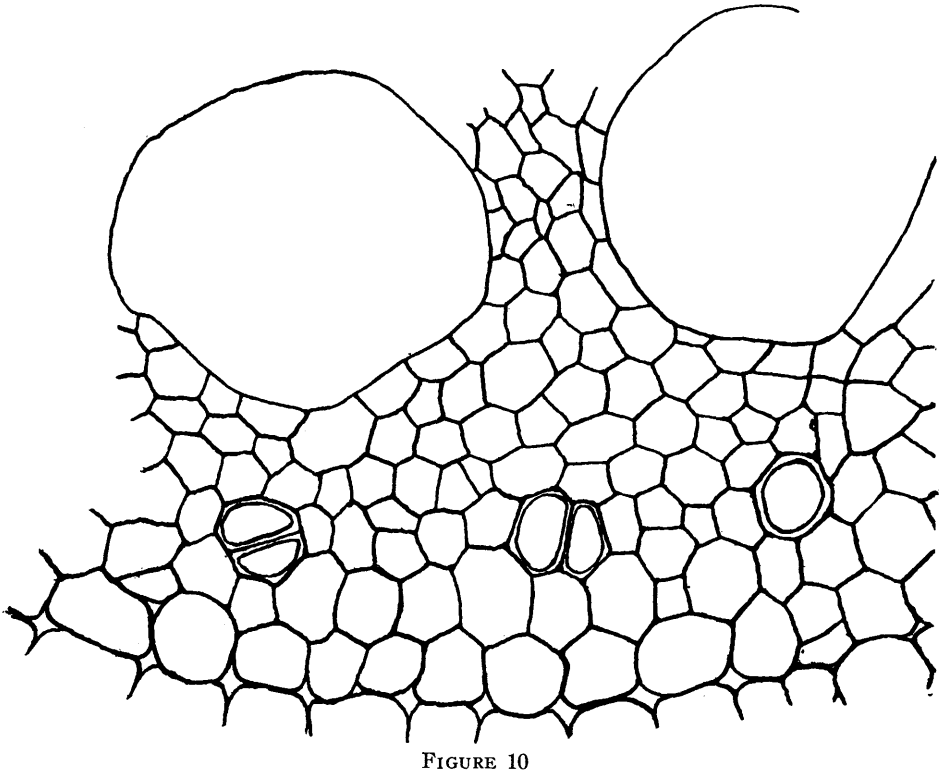


FIGURE 10

5. The second and smaller water tubes are the first lignified. Lignification then progresses toward the center of the cylinder.

REFERENCES.

1. EAMES, A. J., and DANIELS, L. H. Plant Anatomy. McGraw-Hill Co. 1925.
2. HITCHCOCK, H. S. The Genera of Grasses of the United States. United States Department of Agriculture, Bul. 772. 1920.
3. JANCZEWSKI, DE ED. Recherches sur le development des radicelles dan les phaneroganses. Ann. Sci. Nat. Bot. 5 ser. 20:208–233, pl. 1–5. 1904.
4. JEFFREY, E. C. Anatomy of Woody Plants. Univ. of Chicago Press. 1917.
5. MACOUN, JOHN. Catalogue of Canadian Plants. Part IV—Endogens. Geol. and Nat. Hist. Sur. of Canada. 1888.
6. STOVER, E. L. The Anatomy of Calamovilfa longifolia. Ohio Jour. of Sci. Vol. 24. 1924.