LATERAL WATER TRANSFER IN LEAVES OF GINKGO BILoba

(with one figure)

Some years ago, while the writer was investigating the mass factor1 in the energy relations of leaves, an interesting observation was made on the lateral transfer of water in the leaf tissues of Ginkgo biloba. When the leaves of Ginkgo, still attached to the twig, had been perforated with the Ganong leaf punch, it was noticed that the tissues distal to the cut died from desiccation within 24 to 48 hours. The edges of the dead tissue ran parallel to the venation of the leaf, but a certain amount of lateral transfer of water from uncut veins into the region whose water supply had been cut off was observed. At that time it was not possible to follow up this interesting problem.

Punching the leaves of ordinary dicotyledonous net-veined leaves does not greatly hamper water distribution throughout the leaf. Leaflets of the bush honeysuckle (Lonicera morrowi), for instance, have been cut transversely near the base of the leaflet in such a manner as to sever the mid-vein water supply, and to leave less than a millimeter of uncut tissue on each flank of the leaflet. Such cut leaflets, if supported mechanically so that they are not torn by air movement, remain green and turgid for days, showing that water enough for the entire leaf can be distributed to the tissues beyond the cut, through the very small uncut basal marginal vein-system. It should be extremely interesting to observe under a microscope the distribution of dyes in leaves thus injured.

Ginkgo, with its dichotomous, parallel venation, and with no connection between the veins except mesophyll cells, presents an entirely different problem when the veins are severed transversely. In such a case the transfer of water into the tissues distal to the severed region must be accomplished by a lateral diffusion of water from the nearest uncut veins. To determine how far water can be transmitted laterally through the mesophyll cells with speed sufficient to maintain life, leaves were cut during the seasons 1931, 1932, and 1933, and some measurements made.

In figure 1 are shown some of the leaves after they had developed the necrotic areas after transverse cutting of the veins. In leaf no. 1 the cut is about 10 mm. long; in no. 2, 5 mm.; no. 3, 4 mm.; and no. 4, 2.5 mm. Leaves cut to a less degree than no. 4 did not show death of tissues beyond the severed region. As may be clearly observed in the photograph, the water travels laterally and maintains the life of the tissues to a somewhat variable distance. Careful measurements from the first uncut vein on

1 Shull, Charles A. The mass factor in the energy relations of leaves. Plant Physiol. 5: 279–282. 1930.
either side to the edge of the tissue which is killed show that the lateral diffusion of water is rapid enough to supply the cells in certain cases to a distance of 2.6 to 3 mm. In traversing this distance the water passes through three or four interveinal tracts, as the vascular bundles are usually less than 1 mm. apart. In leaf no. 4 the dead tissue at the narrowest point seems to represent just one interveinal tract. In this instance the lateral transfer is effective through a shorter distance than in leaf no. 1. The leaves vary considerably in their ability to transmit the water through the mesophyll cells.

The results seem to depend somewhat on the age and condition of the leaf at the time of cutting, and its position on the tree. In more exposed situations the tissues die to a greater extent than in less exposed situations. Young leaves seem to transfer water laterally farther than old leaves. In some cases young leaves seemed to become adjusted, and transmitted the water farther than would have been the case if the leaves had been cut after a greater degree of maturity had been attained. Possibly the cells retain thinner walls, and maintain a more permeable protoplasm in this region, when the cut is made early. To establish this point would require a careful investigation of the aging of leaf tissues; and a comparative study of protoplasmic permeability in young and old leaves, and in old regions which had been isolated by cutting while young. No such studies have been made.
The distance to which water could be transported laterally and successfully maintain cell turgor was much less than had been anticipated. The experiment is one that lends itself very readily to elementary class instruction, and requires only a Ginkgo tree, a pen knife, and a millimeter rule. The contrasting behavior of net-veined leaves is easily established by similar methods.—Charles A. Shull, University of Chicago.

COMPARISON OF ANATOMICAL AND HISTOLOGICAL DIFFERENCES BETWEEN ROOTS OF BARLEY GROWN IN AERATED AND IN NON-AERATED CULTURE SOLUTIONS

It has been observed by workers on absorption problems in this laboratory that the roots of barley grown in an aerated culture solution have a strikingly different growth habit from those grown under non-aerated conditions. The primary roots of the former are several times as long and the secondaries less numerous. This paper is a preliminary report of a study undertaken to ascertain whether there were any well defined anatomical or histological differences accompanying these different types of root systems.

Two culture tanks made of black sheet iron coated inside with a non-toxic asphaltum paint were used, each tank having a capacity of 112.4 liters. Hoagland’s culture solution supplied the necessary inorganic salts, the original volume in each tank being maintained by the addition of distilled water to replace the loss due to transpiration. In one tank aeration was effected by means of fine continuous streams of washed air from an air compressor; in the other the oxygen supply was limited to that diffusing downward from the surface of the culture solution.

A pure strain of barley of the Sacramento variety was employed, a great number of seeds being germinated in the usual manner, and from these the necessary number of seedlings selected for the experiment. Selection was made on the basis of uniformity of size, number of leaves, length of leaves, etc. Thirty-two such plants were grown in each tank.

Once every week for a period of two months two plants were taken from each culture tank. The leaves were counted and the length of each leaf measured. The whole root system was cut off and floated in a large tank of water. With care the roots could be separated, counted, and their lengths measured. The number of roots refers to those emerging from the stem plate or crown. At each sampling transverse sections for microscopic examination were prepared from at least ten different roots taken from the plants grown in the aerated culture solution, and a like number from those grown in the non-aerated solution. The sections were taken from the following positions back from the root tip: 5, 15, 25, 35, 45, 55 mm., and at