DEMONSTRATION OF SOME OF THE MECHANISMS INVOLVED IN THE ASCENT OF SAP IN PLANTS

(WITH ONE FIGURE)

The usual demonstration of osmosis with sugar solution separated from water by a differentially permeable membrane is unsatisfactory as a model representing the plant mechanisms involved in sap ascent. Beginning students are often confused because in the demonstration they see a solution rising in a tube due to a force exerted not from above, as it is in the plant, but from below. A simple rearrangement of the materials ordinarily used provides a very convincing demonstration of the process of osmosis, and at the same time shows more exactly how osmosis in the leaf cell brings about the rise of water in the stem below. The addition of a capillary evaporating surface to the apparatus then makes the picture of the mechanisms involved and their coordination quite complete.

Figure 1 (A) shows how the apparatus is arranged. A glass tube (t), one or more meters long, communicating above with a short glass cylinder
Movement of the solute, the water, and the column of water in the tube (t) falls. Movement of the water may be measured conveniently by means of a potometer (p) attached below. Sucrose crystals are now dropped into the thistle tube from above (through a water-filled funnel attached to the stem of the thistle tube) with the result that the water immediately reverses its direction of flow. This rise of water, following as a result of merely adding a solute, affords an especially convincing demonstration of the power of osmosis.

If, now, a porous clay evaporating cylinder (e) be filled with water and fastened to the end of the thistle tube as shown in the figure, the rise of the water in the tube as in the plant will clearly be affected by surface and evaporational forces, as well as by osmosis. Subjecting the apparatus to hot, dry moving air will cause the water to move rapidly in the tube. Surrounding the evaporating surface with a humid atmosphere, on the contrary, will cause osmosis to work alone, and the solution will be forced out through the porous clay walls, superficially simulating guttation. When osmosis dominates over evaporation, the membrane is expanded to its maximum (as would be a leaf-cell wall and protoplast under these conditions) and bulges downward. When the rate of evaporation is very high, the membrane becomes slack or may even bulge upward. It is a good exercise for the student to explain the various observed rates of water movement in terms of the relative vapor tension in the water, solution, capillaries, and atmosphere, and clarifying to see the working together of the different processes involved in this simple model.

The tabulation (p. 858) gives data representative of the type of results that may be expected.

For more advanced students acquainted with the use of precipitated membranes in osmometers, a modification of this apparatus may be used. Here the porous cylinder alone serves as both the osmotic and the evaporating unit, thus approaching a step nearer the situation in the leaf cell where there may be no essential difference except in position between the absorbing and evaporating parts. Copper ferrocyanide is precipitated into the walls of the cylinder according to the usual procedure. After being filled with syrup or sugar solution, the porous cylinder is tightly stoppered and fitted into the water cylinder (e), so that only its lower half is immersed, the upper part being exposed to evaporation (fig. 1 B). A narrow rub-
<table>
<thead>
<tr>
<th>CONDITIONS</th>
<th>RATE OF RISE PER MINUTE</th>
<th>OBSERVED RATE OF MOVEMENT IN CAPILLARY TUBE OF POTOMETER PER MINUTE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Before adding evaporating surface—osmosis alone</td>
<td>19.9</td>
<td>3 mm.</td>
</tr>
<tr>
<td>Evaporation plus osmosis. Quiet air</td>
<td>26.2</td>
<td>7.6 cm.</td>
</tr>
<tr>
<td>Evaporation plus osmosis. Hot, moving air</td>
<td>52.3</td>
<td>10.0 cm.</td>
</tr>
<tr>
<td>Osmosis. Evaporation prevented by moist towel and beaker</td>
<td>14.6</td>
<td>20.0 cm.</td>
</tr>
</tbody>
</table>

Membrane: pig bladder
Room temperature: 26°C.
Weight of sucrose: 50 gm.
Volume thistle tube: 32 ml.
Volume evaporating cylinder: 50 ml.
Total height of water column: 1.5 m.

ber ring fitted around the porous cylinder makes the seal between it and the water cylinder. This apparatus works as does the one previously described, except, of course, that it will not "guttate" unless the membrane is incomplete at the stoppered end.—Ernest H. Runyon, 92 Edgewood Ave., La Grange, Illinois.

A NOTE ON FRUITING APPLE SPUR PHYLLOTAXY

The writer was considerably interested in Hubbell's paper1 in the April, 1934, issue of Plant Physiology on blind wood in roses, particularly in his observation that the fruitful shoots of the hybrid tea rose, Mme. Butterfly, averaged 7.3 nodes per shoot, while the unfruitful shoots averaged 4.9 nodes per shoot. In 1927 while at Oregon State College a nearly identical observation was recorded with respect to apple cluster bases. Usually the fruiting spurs showed 8 or 10 leaves below the terminal fruit stalks on the cluster base; 8 leaves were present in a phyllotaxy of $\frac{5}{2}$, or 10 leaves in a phyllotaxy of $\frac{3}{2}$. Spurs unfolding small numbers of leaves were seldom fruiting. The rule is not invariable, but the majority of cases adhere closely to it. Spurs of the Starking apple in the University of Wisconsin orchards this spring showed the arrangement beautifully. Incidentally, 8 nodes or leaflets on shoots of hybrid tea roses usually represent one complete phyllotaxy in $\frac{5}{2}$ arrangement. In the apple in strong fruiting spurs, one complete