is of value in the identification of *Listerella*. To determine if the organism under investigation could cause conjunctivitis a drop of a heavy suspension of the bacteria was placed in the eye of a rabbit and a guinea pig. Two days later a severe conjunctivitis appeared in both animals. While the pathogenesis of this organism is thus established, its abortifacient properties, if any, are not established.

The results of agglutination tests are of particular interest. Julianelle and Pons[2] found two serological types of *Listerella* among the strains they studied. Type I was composed of two rabbit and two human strains, while Type II comprised one strain each from cattle, sheep, goats, and man. The strain herein reported, when set up against antisera of these two types kindly furnished by Dr. Julianelle, was partially agglutinated by the ruminant type antiserum in a titer of 1–25, while with the rodent type antiserum it was completely agglutinated at a titer of 1–1600. Apparently the serological and host relations of *Listerella* strains are more complex than heretofore believed.

Jones and Little[3] first mentioned the relation of *Listerella* to bovine encephalitis. Olafson, according to Udall,[4] also recognized the spontaneous disease in cattle and sheep in New York State, while more than a year ago encephalitis and encephalomyelitis in both cattle and sheep associated with *Listerella* were recognized in Illinois.[5] More recently Biester and Schwarte[6] reported spontaneous bovine listerellosis in Iowa. During the past few months two unreported outbreaks in cattle and one unreported outbreak in sheep have come to our attention, but so far as we know the presence of *Listerella* has not been reported heretofore in the tissues of a prematurely born calf. However, Burn[7] reported Listerella infection in a day-old infant and a prematurely born child. His findings and our own observation suggest the desirability of further study to determine the significance of *Listerella* in the premature bovine fetus. The possible extended role of this pathogen heretofore regarded as an encephalitic and/or encephalomyelitic factor in cattle is further suggested by an apparent artificially induced abortion in a healthy pregnant heifer. This heifer originated in a small Bang's disease-free herd, and proved negative to the agglutination test for Bang's disease immediately preceding exposure to *Listerella*. Ten days following intravenous inoculation of the *Listerella* culture isolated from the bovine fetus described herein, abortion occurred. From the aborted fetus, *Listerella* was regained in pure and abundant culture from the brain stem, cerebrum, heart blood, thymus gland and bone marrow.

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[2] L. A. Julianelle and C. A. Pons, *Proc. Soc. Exp. Biol. and Med.*, 40: 364, 1939.
[3] F. S. Jones and R. B. Little, *Arch. Path.*, 18: 580, 1934.
[4] D. H. Udall, "The Practice of Veterinary Medicine," p. 113, Ithaca, New York, 1936.
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[6] H. E. Biester and L. H. Schwarte, *Jour. Inf. Dis.*, 64: 135, 1939.
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[8] Assigned by the State Department of Agriculture to the Animal Pathology and Hygiene Laboratory to assist in diagnosis and research.

SOLUTE TRANSPORT IN PLANTS

The problem of water and solute movement in plants periodically appears for reconsideration. Though work of Strasburger, Dixon, Ursprung, Renner and others, resulting in the cohesion theory of water movement, and its corollary, the upward transport of mineral nutrients in the transpiration stream, satisfied many, Curtis contends that salts ascend the stem in the phloem, and Priestley, Peirce and others question the cohesion mechanism as explaining the rise of water.

Work by Maskell and Mason[1] and Clements and Engard[2] clearly indicated upward transport of salts in the xylem. Even more convincing are results by Stout and Hoagland[3] and Bennett and Snell[4] with radioactive elements showing that salts absorbed by the roots ascend unringed as well as ringed stems in the xylem.

Though described years ago, certain details of the cohesion mechanism continue to elude clear interpretation. Micro-dissection studies conducted in connection with the translocation of herbicides in plants have thrown light on a number of obscure points. When transpirational water loss exceeds absorption by the roots, the water balance soon becomes negative, and hydrostatic pressure in the xylem lowers until, crossing the zero point, a state of tension is developed in the conducting tracts. When in this state of tension, liquid, contrary to popular opinion, displays tensile strength as would a solid. And the degree of tension may reach many atmospheres and the state persist for long periods.

In the tensile condition xylem sap is virtually a superheated liquid in a metastable state, and the stability of the system depends upon the fact that there are no unwet surfaces upon which the vapor phase may become initiated. As Dixon, Askenasy and others have shown, this situation may be demonstrated in a strictly physical system and depends not upon the form

[1] E. J. Maskell and T. G. Mason, *Ann. Bot.*, 43: 205, 1929.
[2] H. F. Clements and C. J. Engard, *Plant Physiol.*, 13: 103, 1938.
[3] P. R. Stout and D. R. Hoagland, *Amer. Jour. Bot.*, 26: 320, 1939.
[4] J. P. Bennett and A. Snell, private communication.

or structure of plant cells but upon the properties of water.

In the dissection experiments made by the author, both intact and cut stems of plants growing in soil tubes were studied under the dissecting binocular. When a stem with tensile sap columns is cut, air immediately enters all the severed vessels, and the liquid columns recede from the cut end. However, if the deficit is not excessive, menisci in the smaller vessels soon reverse their movement, and these tubes are refilled. Meanwhile liquid in the large vessels continues to recede, supplying water for the refilling ones as well as that lost by transpiration. As expected from laws of capillarity, competition for water by various-sized tubes results in readjustment, the larger vessels losing and the smaller gaining. As the larger ones become depleted, successively smaller elements lose their contents until finally all conductors are sucked dry. During the various stages of readjustment, and particularly immediately following cutting, columns of sap, water vapor and air may be seen moving in opposite directions in the xylem—a fact that seems clear in terms of capillary action, yet one that has confused many students of translocation.

As might further be predicted, when tensile sap columns in intact xylem vessels are jarred or deformed by flattening the elements with a rounded instrument, they break and the vapor columns expand until they reach the limits of the elements in which they are formed, or until the pressure rises somewhat above the zero point. This proves the tensile state of the water columns, for the vapor phase would not continue to expand if the pressure was above that of saturated water vapor at the temperature of the experiment. As in the cut stem, if vapor is formed in several vessels and the stem is not further disturbed readjustment follows with the vapor columns in the smaller elements contracting and those in the larger continuing to expand. That the columns are water vapor and not air is proved by their rapid collapse under increased pressure. The forcing of air into solution by the surface forces of the bubble would require much more time, as is proved by similar tests with the Askenasy apparatus.

Though the above experiments provide satisfactory evidence of the existence and characteristics of tensile sap columns in plants, the old experiment on subaqueous transpiration performed by Dixon in 1897 has never been explained on a purely physical basis. As recently reported,[5] Smith, Dustman and Shull[6] failed to account for this phenomenon, for Dixon was able to obtain a rise of eosin after saturating his test shoots by immersion for twenty-four hours.

[5] H. H. Dixon, *Bot. School of Trinity Coll., Dublin, Notes*, 4: 319, 1938.

[6] F. Smith, R. B. Dustman and C. A. Shull, *Bot. Gaz.*, 91: 395, 1931.

The fact, recently confirmed by the writer, that subaqueous transpiration occurs only in the light suggested the following explanation: The pressure flow mechanism of solute transport in the phloem requires the osmotic absorption of water from the xylem in regions of active synthesis. Assimilates in solution move to regions of utilization where water is lost to the xylem or to expanding tissues.

Though a recirculation of water in the xylem will not explain the rise of eosin in subaqueous water movements, there are other places that the water might go. All growing cells of the cambium or expanding leaves of the shoot tips require water. Some liquid might also be lost to the intercellular spaces of leaves which often show a partial flooding. Uptake of water from the xylem would in all cases be a function of phloem activity rather than a secretory process of mesophyl cells as originally suggested by Dixon.

To substantiate these deductions, the writer has recently shown that when experiments on subaqueous water movement are set up using forked branches of *Syringa vulgaris*, ringing one of the branches will favor eosin movement up the unringed branch, especially if there is an appreciable portion of bare stem below the fork to provide an adequate differential of living tissue to consume the moving assimilates. These results indicate that the rise of sap in the non-living conduits of the xylem can be accounted for on purely physical grounds, and they explain the single exception made by Dixon to this assumption. On the other hand, they reemphasize the complexity of the over-all processes of translocation and point out the essential part played by living cells and tissues.

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