Letters

Founding of Association of American Geologists

The recent article in *Science* [**129**, 1106 (1959)] entitled "Geology, geologists, and the AAAS" reminds me of the part played by the Franklin Institute in the founding of the Association of American Geologists. The organization meeting of that association was held in the hall of the Franklin Institute 2, 3, and 4 April 1840. At the request of the association an abstract of the proceedings of the meeting was prepared by its secretary, Lewis C. Beck, "for publication in the American Journal of Science, and in the Journal of the Franklin Institute." This abstract appeared in the *Journal of The Franklin Institute* in April 1840 (vol. 29, pp. 219–220) and in the *American Journal of Science* in July 1840 (vol. 39, pp. 189–191) and was also published by the association in 1843 (*Reports of the First, Second, and Third Meetings of the Association of American Geologists and Naturalists,* pages 9–11). The text is the same in all three publications, but Beck's name appears at the end of the abstract only in the *Journal of The Franklin Institute.*

The archives of the Franklin Institute contain a holographic communication, signed by Lewis C. Beck, secretary, and containing a resolution of thanks to the institute for the use of its rooms by the Association of American Geologists "during the present meeting"; it is endorsed on its back "read April 15/40." The manuscript minutes of the stated meeting of the board of managers of the Franklin Institute on 15 April 1840 record the receipt of this communication and contain its complete text. Of the 18 founders of the association, seven were members of the Franklin Institute.

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Is There a Vapor Gap Around Plant Roots?

A "narrow vapor gap" around plant roots has been invoked by J. Bonner to explain the movement of water into roots without an accompanying transport of salt [*Science* **129**, 447 (1959)]. While there is a distinct need for improved theory to explain observed effects of soil salinity on plant growth, the following appear to be formidable obstacles to the vapor gap hypothesis.

The osmotic effect of salinity on plant growth in water culture is comparable to that in soil culture (*1*), and a vapor gap explanation for the osmotic gradient is, of course, out of the question in water cultures. Furthermore, the effects of salinity on plant growth are apparent at high levels of soil moisture and at low rates of water absorption from the soil. These conditions, as a matter of fact, are induced by soil salinity which reduces the rate of water uptake from soil and makes it impossible for the plant to deplete the soil moisture to values that would be obtained under nonsaline conditions. In other words, the factors that would be necessary for the development of a vapor gap, rapid water uptake and low soil-moisture content, do not usually develop in saline soils.

At low water contents, large gradients may be set up in the vicinity of the root. However, the existing data (*2*), including values estimated by Philip (*3*), indicate that, even at the dry end of the plant-growth moisture range, water movement in the liquid phase is still more important than that in the vapor phase. Under isothermal conditions, the soil-water diffusivity for vapor movement, expressed in terms of the gradient of the water content of the soil, is calculated to be of the order of 10^{-6} cm^2/sec and probably seldom exceeds 10^{-5}

cm^2/sec. This is to be compared with the film-flow diffusivities of 10^{-5} cm^2/sec measured for air-dry soil and 10^{-4} cm^2/sec for soils with water contents in the wilting range. At higher water contents, the film-flow diffusivity is much greater, and is of the order of 10^{-2} cm^2/sec at the upper limit of the field moisture range. Thus, in the wilting range, film flow probably accounts for at least 90 percent of the water movement and, at higher water contents, vapor movement should be entirely negligible.

The experimental data of Gurr, Marshall, and Hutton (*4*) indicate that a temperature gradient which in their experiments averaged 1.5°C/cm is required to produce a sufficient vapor pressure gradient for the water flux density by vapor diffusion to be equal numerically to the liquid flux density in the opposite direction produced by a moderate soil-water content gradient. These experiments with a loam soil included water contents extending well into the wilting range. The vapor-gap hypothesis, therefore, would appear to require the existence of a large radial temperature gradient at the root if liquid flux is to be negligible in comparison to vapor flux. The maintenance of such a temperature gradient would require, at the root, a refrigerating system of substantial capacity.

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It is certainly true, as the distinguished group of Riverside investigators have pointed out, that the addition of salts to liquid nutrient solutions depresses plant growth in such solutions. The greater the ability of the test plant to accumulate the salt in question, the less is this growth-depressing effect. Thus the growth of halophytes, which readily accumulate sodium ions, is less depressed by NaCl than is the growth of crop plants which do not readily accumulate sodium ions. I grant at once, therefore, that particular ions can be found which exert osmotic effects upon plant growth, either in nutrient solution or in soil at high levels of soil moisture.

The remaining question is, then, does high soil moisture tension reduce ion uptake by the plant root? The conclusion of Philip (*1*) that development of a vapor gap around the root, under conditions of high transpiration and low soil moisture, should depress salt uptake by the root finds experimental support in the work of Danielson and Russel (*2*). These workers have shown that moisture stress generated in solution by the presence of a nonabsorbable solute (mannitol) has less effect on ion absorption than an equal moisture stress generated in soil by soil moisture tension. The results indicate that moderate-to-high soil moisture tensions interfere physically with the movement of ions from soil to root. Perhaps the physical barrier to ion movement from soil to root generated by removal of water from the soil by the root should be given a less picturesque name than "vapor gap." Nonetheless it acts like one.

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