On the sesquicentennial of Fick's laws of diffusion

To the editor:

One hundred and fifty years ago Adolf Eugen Fick (1829–1901), a 26-year-old physician, published his first paper in the physical sciences[1] and an abstracted translation in English[2,3] about the diffusion of chemical species in aqueous solutions. He reported a series of rather insightful and accurate experiments—despite his own doubts due to apparent discrepancies between predictions and his experimental results[4]. During his career, first in Zürich and later in Würzburg, Fick also made very significant contributions in medical physiology and developed a number of devices, including the first contact lens[5]. *Übber Diffusion*[1] was published while Fick was working with his mentor and friend Carl Ludwig at the University of Zürich shortly after receiving his M. D. from Marburg University. Drawing inspiration on Fourier's heat transfer equations and building up on Thomas Graham's work, Adolf Fick formulated the laws of diffusion that have become fundamental in physical chemistry. Indeed, they are currently taught with different degrees of detail from secondary education to postgraduate school. Fick's first law states that the rate of diffusion for a chemical species in a solution increases with the difference in concentration between two adjacent regions. Such a concentration difference acts as the driving force for the spontaneous movement of solute particles toward the region of lower concentration. Fick's second law states that the movement of the species dramatically decreases with the distance from the region of higher concentration. For instance, a small solute can diffuse across a cell in just over half a second, but several years are required for diffusion to occur over one meter[6]. Fick's seminal work, which can be found in textbooks and often cited in scientific publications, has impacted many fields, including plant sciences, medicine, climatology, vulcanology and civil engineering. Today, we offer a tribute to a pioneer who was doing cross-disciplinary research before it was a hot and well funded activity.

ACKNOWLEDGMENTS

I thank UC-MEXUS for a Postdoctoral Research Fellowship. A version of this letter was presented as a symposium introduction during the XVI Meeting of the Sociedad Botánica de México (Oaxaca, Mexico, 2004).

Erick De la Barrera

Departamento de Investigaciones Científicas y Tecnológicas, Universidad de Sonora, Hermosillo, Sonora 83000, Mexico.
e-mail: erickdlb@ucr.edu

1. Fick, A. Poggendorff's Annalen der Physik und Chemie **94**, 59–86 (1855).
2. Fick, A. *Phil. Mag. J. Sci.* **10**, 30–39 (1855).
3. Reprinted in *J. Membr. Sci.* **100**, 33–38 (1995).
4. Patzek, T.W. Lecture notes, University of California, Berkeley (2001), available online at http://petroleum.berkeley.edu/papers/patzek/fick.htm.
5. Fick, A.E. *Arch. of Ophthalmol.* **106**, 1373–1377 (1988).
6. Nobel, P.S. *Physicochemical and Environmental Plant Physiology* (3rd Ed., Academic Press/Elsevier, 2005).