

structure of hair cells, histochemistry and intracellular biophysics are described with reference to the active processes undoubtedly needed for cochlear tuning. There is a welcome emphasis on mammalian work. Most students of audition are interested in the human condition and deserve not to be unduly distracted by the intriguing comparative neurophysiology of turtles, toads and lizards. Neural mechanisms are so divergent among vertebrate classes that direct extrapolation between them is hazardous.

'Sound-localizing' systems of the central nervous system are fully discussed. This term commonly means direction-finding alone, and ignores distance, the extra parameter needed for true localization. Here, the authors discuss the ambiguity in binaural disparities arising from distance and direction. They also clearly state that one-eared human direction-finding is better than can be explained by neurophysiology. Happily, they avoid using the bat as a model: that auditory specialist exploits a personal sound generator to compute distance by timing, a method denied to other terrestrial mammalian species.

The authors also touch on the discrepancies between conclusions from

neurophysiological experiments on putatively 'free-field' (as in the open air) direction-finding. Laboratory experiments usually proceed in far from strictly anechoic conditions, thus are not truly free-field, and very small animals are used, so that measuring/monitoring equipment near their heads introduces significant diffraction, which is hard to calibrate. In 1938, the careful work of Stevens and Newman on human direction-finding necessitated sitting the subject on top of a pole on a Harvard rooftop in the quiet of the night to satisfy free-field conditions. Unsurprisingly, neurophysiologists today do nothing like that. Yet for this work the only effective substitute is probably a true anechoic room. These expensive constructions are very rare, used often for commercial or governmental testing but normally unavailable for academic research. This is probably why discrepancies arise.

*Hearing* handsomely serves its intended readership. Physicists, engineers, musicians and philosophers should also find it enjoyable and informative. □

R. H. Kay is Emeritus Fellow in Physiology of Keble College, Oxford OX1 3PG, UK.

## Chronicle

Charles Tanford

**Companion to the History of Modern Science.** Edited by R. C. Olby, G. N. Cantor, J. R. R. Christie and M. J. S. Hodge. *Routledge*: 1989. Pp.1081. £65, \$85.95.

FORMAL professional education in science suffers from a deplorable neglect of the historical element, and many a working scientist has a genuine desire to remedy this deficiency. The scientist's own life is dominated by the sequence of experiments in his laboratory (or the sequence of theoretical explorations in his head) — a succession of sudden insights, false leads, unexpected results and so on. Did his predecessors in his own field report similar struggles in their memoirs or letters? Can he learn from their experience? From a broader perspective, when and how were the now solid foundations of his field (or of science in general) established? When, for example, was the need for conservation laws in physics first recognized? Who first discovered the true function of the liver and how did it happen? Can the scientist see his own work as contributing to some such historic growth of knowledge?

Where should the scientist turn for answers to such questions? To the historian of science, one might naturally suppose, but regrettably it's not that simple. For 'history of science' has become an academic discipline in its own right,

posting its own exclusive claims in the territories of knowledge and scholarship — with emphasis on originality, with specialized jargon and with in-house controversies. Its dominant themes are about science and its history, not for their own sake, but as fuel for complex historiography. Is science just another example of a "customarily expressed belief", its vaunted appeal to experimental test no more than a myth? Do popular theories for scientific revolutions ("internalist" versus "externalist") provide valid models? Mere factual history is banal or so, at least, this *Companion* would have us believe. "There is much more to the history of science than a chronicling of who got what right when", the *Companion* tells us and, a little later, "it [the history] is quite clearly much too important to be left to the self-interested and distorted perceptions of the working scientists themselves".

The *Companion* defines 'modern' science as beginning in the sixteenth century and the editors have by choice excluded medicine and technological applications. The book contains 67 essays, written by 61 contributors. Fewer than half the essays actually mention 'facts' of history at all — who did what or the traditional history of changing ideas — and, of course, most of those that do so continue with comment on that history in theoretical terms. Robert Olby, for example, writing about the molecular revolution in biology, moves quickly from fact to theory: "It is tempting to depict modern molecular biology as an example of a

Kuhnian phase of revolutionary science leading to the establishment of a new paradigm. Twentieth-century science can then be neatly packaged into two major revolutionary phases — first quantum physics, then molecular biology." Is this a trivialization of what is arguably the most important event in the entire history of biology or is it a new and deeper view of it?

The overall coverage of the *Companion* is, intentionally, selective rather than comprehensive. Almost every essay ends with valuable notes and with a long list of references for further reading. Contributions are organized into several different categories. One group adds up to a kind of course of instruction in related disciplines (philosophy, sociology, marxism, linguistics), encouraging historians to extend the scope of their work in those directions. Contributions that focus on particular subdivisions of science are divided into "turning points" (ranging from Copernicus to cybernetics) and "topics and interpretations" (dealing with longer-term matters). A final group of about twenty essays ("themes") goes far afield to issues that are outside the mainstreams of both traditional and analytical history — science and war, science and imperialism, science and education, scientific professionalism and so on. I found this to be the least satisfactory part of the book, with many glaring omissions of what surely should have been cardinal topics. One essay in this group, by R. M. Young, is pure political venom — sweatshops in the Korean computer-chip industry seen as a direct consequence of the scientific worldview and its adoption by capitalist society.

The *Companion* obviously speaks chiefly to the professional historian, for whom it will surely be a welcome reference, the first broad compendium of its kind. As in any multi-authored book, however, there is a lack of uniformity. Some of the essays are relatively non-technical and provide good reading for the general reader. For example, Robert Fox on the rise and fall of laplacian physics between 1799 and 1815; Raymond Fancher on Sigmund Freud, an objective account with references to a wide variety of interpretations; John Stachel on relativity; J. J. Gray on geometry and space; and Ernán McMullin on philosophy of science between 1600 and 1900.

Even the more technical parts might profitably be perused by the much denigrated laboratory scientists, most of whom are probably ignorant about current trends in 'history of science' as formally defined. Given that historians reflect how posterity may see today's science in the future, it is valuable to be made aware of the distinct ideology that is emerging in the field. □

Charles Tanford is at Tarlswold, Back Lane, Easingwold, North Yorkshire YO6 3BG, UK.