Book Reviews

Important Years in Mathematics

Social History of Nineteenth Century Mathematics. Papers from a workshop, Berlin, July 1979. HERBERT MEHRTENS, HENK BOS, and IVO SCHNEIDER, Eds. Birkhäuser, Boston, 1981. xii, 302 pp. $24.95.

The 19th century was an exciting time in the history of mathematics. Besides the rise of modern theories associated with names like Cauchy, Weierstrass, Gauss, Riemann, Cantor, and Dedekind, it was marked both by the emergence of the ideal of pure mathematics and by applications of mathematics on an unprecedented scale. The century also saw the first mathematics journals, the splitting of the mathematics community into specialized disciplines, and large-scale public funding of institutions for mathematics teaching and research.

In his brief but masterly introductory essay for this book, Dirk Struik surveys and documents these prominent developments and describes them as part of the general "pioneering, renovation and rebellion" in all aspects of 19th-century European life. But to understand precisely how social context helped produce the flowering of 19th-century mathematical thought, it is not enough merely to assert that there was a relationship; the key question is, what are the mechanisms? or as Struik puts it, "how to argue the connection?"

Of the 16 papers in this book, three stand out as contributions to our general understanding. Philip Enros convincingly analyzes the institutional causes of the decline of mathematics in 18th-century England and the largely institutional reasons for its revival in the 1820's. Thomas Hawkins demonstrates the explanatory power of the concept of mathematical schools—groups sharing common views on what kind of mathematics is worth doing and how to do it—by showing that the approach taken by the Berlin-trained Frobenius and Killing, in their respective work on matrix algebra and on the structure of Lie algebras, stems from the Weierstrassian tradition of analyzing all possible special cases. Hawkins tellingly contrasts Killing's Weierstrassian approach to geometry with the more intuitive approach of Felix Klein, trained in the schools of Plücker (Bonn) and Clebsch (Göttingen). The strength of this paper flows in part from Hawkins's complete mastery of the mathematical developments involved.

David Bloor asks why, since W. R. Hamilton and George Peacock confronted essentially the same technical algebraic questions, they nevertheless came to quite different conclusions about the nature of algebra. As Thomas Hankins has recently demonstrated, Hamilton was deeply interested in the Idealist philosophy of men like Kant, Novalis, Carlyle, and Coleridge and in the conservative political ideas that accompanied this philosophy. By contrast, Bloor argues, Peacock was a rationalist, as were his associates Babbage, Herschel, Airy, and de Morgan, who took issue with traditional authority, first in mathematics teaching, later in a wider social context. Bloor sees Hamilton's view that algebra is the science of pure time as "irradiating algebra with spirit," symbolizing an organic social order of the kind advocated by Idealist philosophers; Peacock's formalistic view of algebra meant that mathematics was self-sufficient, indicating a freedom from authority and from dependence on the past in mathematics—and elsewhere. The extensive evidence Bloor cites for the relationship between Hamilton's and Peacock's contrasting philosophies and their mathematics deserves to be taken seriously even if one does not accept Bloor's explanation.

Among the other papers, some make large methodological or philosophical claims based on too little evidence; others are sketchy or cover relatively familiar ground. A few make modest additions to our knowledge. For instance, Gert Schubring discusses, in somewhat episodic fashion, the influence on Jacobi and Crelle of Humboldt's educational reforms, the "research imperative" in Prussian universities, and the neo-Kantian philosophy of mathematics of J. F. Fries. A. C. Lewis briefly documents the influence of Schleiermacher's dialectical philosophy on Grassman's approach to mathematics. Horst-Eckart Gross discusses, albeit briefly, the actual "working process" of mathematically trained people in the insurance industry. The 16-page bibliography prepared by Mehrtens is a mixture of diverse, interesting, and sometimes unexpected materials, though some important works, like Joseph Dauben's 1979 *Georg Cantor* (which may have appeared only after the bibliography was compiled) and J. T. Merz's seminal *History of European Thought in the Nineteenth Century* (1896–1914), are omitted.

The principal value of the present volume lies in Struik's fine short account of the major themes in the social history of 19th-century mathematics and in the polished and documented studies of Hawkins, Enros, and Bloor—methodologically so different from one another—as examples of what can be done to illuminate the connections between the development of mathematics and the social context in which that development takes place.

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The Grassland Ecologists

Saving the Prairies. The Life Cycle of the Founding School of American Plant Ecology, 1895–1955. RONALD C. TOBEY. University of California Press, Berkeley, 1982. x, 316 pp., illus. $25.

Among historians who try to grapple with groups or "schools" of scientists the currently fashionable goal is to relate a group's "cognitive" work to its social (and preferably quantifiable) characteristics, such as the origins of its doctorates and its correspondence networks, publications, coauthorships, citation patterns, employers, and location. This kind of sociology of knowledge is concerned with why particular people would have had particular ideas and worked on particular problems perhaps for decades when others, with many of the same characteristics, did not.

Ronald Tobey has applied this kind of analysis to the school of grassland plant ecologists that flourished in the American Midwest in the first half of the 20th century. At the University of Nebraska at Lincoln, Frederic Clements and Roscoe Pound (later dean of the Harvard Law School), both students of Charles

E. Bessey's, pioneered a new kind of quantitative plant ecology in the late 1890's. When they applied their method of "quadrats" (counting and mapping all the plants within a five-meter square) at intervals all across Nebraska, they were able to show that the distribution of species varied much more widely and gradually than was discernible to casual observers. Clements and Pound thus concluded that the Great Plains were much more diverse than had been reported by Europeans unacquainted with the region. From this methodological innovation, Clements, a philosophical idealist, moved (for reasons that Tobey explores in a long chapter) on to the more controversial idea of considering whole formations as an organism striving toward some predestined "climax." According to Tobey this view dominated ecological circles into the 1930's, even though H. C. Cowles of the University of Chicago for a time championed an alternative, more "mechanistic" kind of plant ecology.

In chapter 5 Tobey shifts from this intellectual history of ideas and personalities (which he condemns as outmoded in his introduction) to a quantitative study of the 535 publications on plant ecology between 1895 and 1955 that were listed in various bibliographies (mostly *Biological Abstracts* and its predecessors). He then focuses on the 58 persons (including five women) who wrote three or more of these books and articles. Data on them support what he has prepared us to expect—24 held doctorates from the University of Nebraska (compared with eight from Chicago and 12 from elsewhere), and many published with each other, cited each other (of the women only Irene Mueller was cited more than the minimum), and worked chiefly in certain academic departments (most often the University of Nebraska at Lincoln and Kansas State College at Fort Hays). From all these data Tobey maps the rise and then fall (the "life cycle") of the field and asserts that it all conforms strikingly to recent models suggested by Thomas S. Kuhn, Diana Crane, and Derek J. DeS. Price of how ideas spread and publications multiply.

Yet Tobey is too eager to confirm his elders' models and does not press on to extend or modify them for this at least partially applied science. For instance, though he admits in his methodological appendix that both U.S. Department of Agriculture (USDA) and agricultural experiment station publications "were regularly used by grassland ecologists" (p. 223), he relies on bibliographies that omitted them and makes no attempt to correct for this distortion, even though the link between agricultural and "pure" botany is central to his story and we are told repeatedly that it was Nebraska's agricultural problems from the 1890's through the 1930's that underlay and justified much of the plant ecology. Then, too, seven of the 53 items that were most often cited in the 535 publications (that were in the bibliographies) were USDA and experiment station reports.

This tendency to stick to the growth curves that fit the model and not to explore the interactions between "botany" and "agriculture" further is most serious in the last chapter, which is still the freshest and most interesting, since it deals with "saving the prairies," or the plant ecologists' valiant but futile attempts to stem the devastation brought on by the Great Drought of 1933–41, when dust storms almost blew Fort Hays away. This crisis changed the field and its practitioners dramatically. No longer could idealists stand back and let the prairies change themselves. Human intervention was necessary after all. Before long the Taylor Grazing Act of 1934 created a new branch of the USDA devoted to "range management," and even Clements, earlier considered a biological "conservative" for resisting the mathematicization of the field in the 1920's, became a liberal-to-radical New Deal reformer advocating still greater federal planning to save the Dust Bowl. But rather than seeing range management as a new vista for economic botany, Tobey is prepared by the subsidence of his bibliographical growth curves to see it all as failure and exhaustion of the old plant ecology; and rather than giving John Weaver of Nebraska, who we were told in the introduction was "the leading scientist of the second generation" (p. 3), his due, Tobey minimizes all this later work as mere intellectual "technology" (p. 218). Although Tobey claims to be telling the history of the grasslands plant ecologists and up to a point he does so as well as anyone is likely to, in the end his model runs away with the story and we are left with a most un-Clementsian anticlimax. The "life cycle" analogy is too restrictive here, unless it allows for a posthumous ("Lazarus"?) phase for all a specialty's activities after it is officially dead.

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Atomic Spectroscopy

The Theory of Atomic Structure and Spectra. ROBERT D. COWAN. University of California Press, Berkeley, 1981. xviii, 732 pp., illus. $45. Los Alamos Series in Basic and Applied Sciences.

The field of atomic spectroscopy is currently experiencing a resurgence of interest owing on the one hand to its applications in astrophysics, plasma physics, and other fields and on the other hand to the development of new experimental tools to probe atomic structures. One example of the latter is the use of tunable lasers to study highly excited atoms in the presence of strong external electric and magnetic fields. Another is the use of synchrotron radiation to probe with increasing detail the inner shell structure of rare earth, actinide, and other heavy atoms.

The theoretical foundations of atomic spectroscopy were given in a classic 1935 book, *The Theory of Atomic Spectra* by Condon and Shortley. It served the physics community for decades and is still useful today. The development of powerful techniques of tensor analysis by Racah in the 1940's has prompted a number of authors to write books on the theory of atomic spectra from this more modern point of view. The most recent of these books is that of Robert D. Cowan. His gives probably the most practical detail of all the recent books on the subject; it will therefore prove invaluable to those who plan to carry out numerical calculations and will be useful generally to all who wish examples of how well modern theoretical calculations compare with experimental data.

Cowan has made his career as a theorist in the field of atomic spectroscopy, and his book contains much of the wealth of practical experience he has acquired. The book is based on lectures he gave at Purdue University in spring 1971 and at the University of New Mexico in spring 1972. Though Cowan has greatly expanded the lectures, the book is still intended for possible use as a graduate-level textbook. Thus, all of the theory is developed from an elementary point of view, and there are suggested exercises at the end of many sections of the book. Though the theories of antisymmetric N-electron wavefunctions, irreducible tensor operators, radiative transitions, and so on are all included, the emphasis is on the actual numerical calculation of atomic energy levels. Flow charts of computer programs, detailed comparison with experimental data, ex-