A Cambridge Worthy

Before Newton. The Life and Times of Isaac Barrow. MORDECHAI FEINGOLD, Ed. Cambridge University Press, New York, 1990. xii, 380 pp., illus. $49.50.

According to John Aubrey, the indefatigable biographer of 17th-century English worthies, Isaac Barrow "was a strong man but pale as the candle he studied by." The phrase nicely captures both sides of this ambiguous Cambridge don and divine. His prodigious strength, mental and physical, is amply documented: producer of remarkable achievements in classical humanism and mathematics, a battler against Turkish pirates when traveling in the Mediterranean in the 1650s and subsequently a Constantinople street-fighter, sterling reformer of Cambridge scholarship after the Restoration, and energetic book collector. Charles II judged him to be "the best scholar in England." On the other hand, Barrow's character has heretofore remained strangely elusive. No doubt he has paled in comparison with his more illustrious successor as Lucasian professor of mathematics, Isaac Newton. Hence the title of this welcome collection of essays on Barrow's career and output. Indeed, the title is the least appealing aspect of this book, for the aim of the authors has been to flesh out the Barrovian contribution without that intimidating hindsight under whose gaze all 17th-century natural philosophy and mathematics has been judged solely by its culmination in Newton. Or perhaps a pun is intended, and some bold claims are to be made for Barrow's role as an autonomous, and prior, figure in the remarkable transformation of learning in the mid-17th century.

The essays presented here offer a rich survey of this transformation. Three-quarters of the book is preoccupied with a biographical essay by the editor and a pair of essays on Barrow's optical and mathematical work by Alan Shapiro and Michael Mahoney respectively. The balance comprises shorter pieces on Restoration Cambridge by its present-day historian, John Gascoigne, a note on Barrow's place in 17th-century classical scholarship by the master humanist Anthony Grafton, and a contribution from Irène Simon on Barrow's sermons, which summarizes and extends some of her earlier work on Restoration pulpit oratory. Mordechai Feingold adds a transcription of Barrow's library catalogue, a valuable document prepared by Newton for the disposal of Barrow's books after his death in 1677.

The theme of Barrow's amphibious position between the traditional humanist curriculum and the new philosophy of experiment and mathematical analysis runs throughout these papers. Where his contemporary Robert Boyle would describe Aristotle as "a dark and dubious writer" and Hobbes would charge that the Stagyrite was "the worst teacher that ever was," Barrow preached that he was the philosophers' "Unchallenged Prince." Gascoigne rightly marks Euclid and Aristotle as Barrow's "intellectual deities." But this apparent conservatism needs to be set in its proper milieu, a defense of humane values in a time of major institutional challenge, especially within his university, where Barrow was successively a college fellow, a brilliant editor of handbooks in Euclidean geometry and member of important experimental groupings, the regius professor of classics, the first Lucasian professor, and, ultimately, master of Trinity. Within the fenland university, Barrow's repute always stood high, evidenced by William Whewell's 1860 edition of his mathematics. Crises of vocation pervaded his career. These crises, often posed as choices between divinity and secular learning, will not best be understood if historians impose an anachronistic division between the professions of "scientist" and "priest." The use of the former term, coined by Whewell only in 1833, is unwelcome when accounting for the natural philosophy and mathematics of two centuries earlier.

Barrow was clearly an outstanding scholar, in a set of traditions well documented here. He might not have been happy about the large number of typographical errors that mar an otherwise fine book ("Sparkling" for the physician Robert Sprackling is my favorite). Grafton expertly places the editions of Euclid, Archimedes, Apollonius, and Theodosius in the context of variants of classical humanism, ranging from the encyclopedic to the pedagogical. Certainly, as Feingold shows, Barrow's *Euclid* was a massively popular work for the following century. His more substantial lectures on mathematics and optics, Shapiro and Mahoney both suggest, were perhaps less original. Shapiro deploys his own outstanding research in early modern optics to reinterpret Barrow's legacy: a clear formulation of the principle that identified the perceived and geometrical location of images (wrongly, we learn, baptized "Kepler's principle"), a brilliant set of geometrical techniques, and a challenging puzzle ("the Barrovian case") where convergent rays impinge on the eye, generating indistinct images. Shapiro argues that Barrow's optical lectures would likely have been forgotten without his presentation of this problem. The same lessons can be drawn from Mahoney's chapter. Those historians who earnestly strove to find the fundamental principle of calculus somewhere in Barrow are rightly castigated. Barrow, a resolute geometer, eschewed algebra's analytic power, and, again, his major work was barely discussed from 1700 until this century. Mahoney intelligently summarizes the major themes, especially Barrow's symbolic conception of number and his intriguing critique of algebraic method, and Feingold draws our attention to the surprisingly early date of Barrow's initial work on his mathematical editions. We learn that these were inaugurated in the mid-1650s, not the early 1660s, as Mahoney and others suggest. But, in context, Barrow emerges as a remarkable but representative humanist scholar rather than "one of the greatest living English scientists," as is occasionally hinted here.

This collection of papers is very worthwhile, therefore, for the light it sheds upon the challenge of early modern scholarship. The relationship between Barrow and Newton is handled sensitively, though it seems odd energetically to conjecture more links between the two than the documentary evidence will bear. There is, for example, no clear evidence that the younger man read in any of Barrow's stunning library until 1670. Better, surely, to praise Feingold and his collaborators for a set of papers that show, once more, how much exciting work is yet to be done on the complex processes by which divinity and classicism, geometry and optics, the pillars of learning, absorbed and transformed the worrisome challenges of new philosophies without abandoning the authentic virtues of the scholastic curriculum. The abandonment of a fashionable picture of a 17th-century revolutionary transformation and its replacement by a more nuanced and contextualized account of anxiety and negotiation would be a very welcome effect of work such as this. Hence Barrow's splendidly modest oratorial evaluation of the balance to be struck between ancient and modern learning, a statement that applies as much to himself as it does to his favored classics: "First, it seems pleasant to examine the foundations from which the sciences have been raised to their present height. Second, it will be of some interest to sample the sources from which virtually all the discoveries of the moderns are derived."

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Mathematics after Newton

The Development of Newtonian Calculus in Britain, 1700–1800. NICCOLÒ GUICCIARDINI. Cambridge University Press, New York, 1990. xii, 228 pp., illus. $54.50.

Guicciardini here aims to qualify the traditional view that British mathematics "declined" in the century after Newton, slipping from the creative leadership associated with such names as Wallis, Barrow, Gregory, and Taylor to the point, early in the 19th century, when few, if any, in England could follow the mathematical papers routinely presented to the French Academy of Sciences. To convey a more accurate appreciation of what happened after Newton, Guicciardini surveys the British mathematical community over the 18th century, dividing the period into three main segments. During the first three decades, Cotes, Taylor, and Stirling transformed Newton's sketchy presentations of fluxions into a system of mathematics and Berkeley dissected its conceptual foundations. From the mid-'30s to the mid-'80s textbook writers conveyed the subject with an emphasis on application rather than on theory. Writers admired Maclaurin's painstakingly rigorous *Treatise of Fluxions* (1742) as a definitive response to Berkeley, but they did not emulate it. Nor could others follow Maclaurin's lead in applying fluxions to such problems as the attraction of ellipsoids. Some writers did begin at this time to explore fluxions as a form of symbolic algebra, the "analytic art," laying the groundwork for the period of gradual reform that Guicciardini dates from 1785 to 1809 and follows at the Scottish universities, the military schools, and Dublin and Cambridge.

Given Guicciardini's broad focus, much of the book consists of capsule biographies and brief characterizations of the mathematical literature and of the institutions where mathematics was taught. He leaves the details to the primary and secondary literature cited in the ample bibliography. Curiously, the evidence he does present and the conclusions he draws from it often tend to reinforce the traditional view he is trying to refute. Fluxions did not lead as easily as differentials to such important concepts as partial derivatives and partial differential equations; notation did make a difference. British mathematicians did, on the whole, prefer a geometrical approach to their subject, including in geometry an intuitive concept of motion through space over time. The many textbooks published dealt largely with elementary material, conserving rather than raising the low level of mathematical education. Despite the promises of curricula and published lectures, not much mathematics was either taught or learned in British universities and military schools, the latter of which catered to boys in their early teens. As impressive as Maclaurin's or Simpson's work may have been in its own right, it had no influence on the development of mathematics.

Indeed, in the last chapter Guicciardini brings out an irony of the "reform" that offers a measure of the decline it was meant to reverse. Trained to think in terms of series and fluxions, the Cambridge analysts embraced Lagrange's algebraic version of the calculus, which treated differentiation as an operation and identified derivatives with the coefficients of series expansions of functions. As outside observers of Continental mathematics, they did not see the new directions in which Cauchy's work was taking analysis. Hence, while the Lagrangian view steered Babbage and others to interesting new work in the calculus of operators and functional analysis, it diverted their attention from the mainstream that flowed toward Weierstrass, Cantor, and Dedekind. Though not in isolation, British mathematics would follow its own course during much of the 19th century as well.

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Evolutionary Themes

Population Biology of Genes and Molecules. NAOYUKI TAKAHATA and JAMES F. CROW, Eds. Baifukan, Tokyo, 1990. xii, 370 pp., illus. ¥9,270. From a symposium, Tokyo, Dec. 1988.

It is somewhat unfortunate that the name of Motoo Kimura has become synonymous with the neutral theory of molecular evolution in the minds of many biologists. Kimura is rightly given credit for much of the current structure of the neutral theory, which has had an enormous impact on modern biology (for example, molecular biologists constructing consensus sequences are in effect applying the neutral-theory result that regions under the most selection evolve the most slowly). What is unfortunate is that biologists are ignorant of Kimura's other major contributions to population genetics. Indeed, models introduced as alternatives to the neutral theory often rely on methods of analysis introduced by him. His influence on quantitative genetics and on the study of genome evolution, population structure, and molecular evolution is apparent in *Population Biology of Genes and Molecules*, a collection of 21 papers presented on the occasion of Kimura's being awarded the Fourth International Prize for Biology. (He is the first Japanese biologist to win this major award, established in 1985 by Emperor Hirohito, himself a renowned biologist.) I found the papers uniformly interesting, although they are mainly reviews of previous work rather than new material. There is a roughly equal mix of theoretical and empirical work, and this collection serves as a nice introduction to much of current population genetics.

The quantitative genetics papers in this volume by Hill, Tachida and Cockerham, and the recently deceased Terumi Mukai testify to Kimura's influence on this field. Kimura's results on the fixation probability of a selected allele were used by Robertson in his landmark 1960 paper on the expected selection limit in artificially selected populations. Likewise, Kimura developed the first detailed model specifying the amount of genetic variability maintained in a quantitative character by mutation and selection. This is currently a major growth area for theoreticians. As reflected in the papers by Ohta, Watterson, and Yamazaki, the neutral theory underpins much of current theories of the evolution of genomic structures such as mobile elements and tandem arrays.

An especially interesting paper is by Provine, who traces the historical development of the neutral theory. Though genetic drift is a major component of Sewall Wright's shifting-balance theory of evolution as well as in Kimura's development of the neutral theory, Provine notes a critical distinction between the role of drift in the two theories. Wright did not view drift, by itself, as an important evolutionary process. Rather, he envisioned it as a process for generating genetic combinations to be acted on by selection. Although Wright acknowledged the presence of neutral alleles, he was more concerned with alleles having direct physiological effects on some aspect of the phenotype. Conversely, Kimura viewed drift itself as a major evolutionary force, especially when considering evolution at the level of individual nucleotides. Thus, whereas Wright's theory deals with evolution at the phenotypic level, Kimura's deals