slight notice) that is well-informed, often entertaining, and sometimes illuminating.

It is not clear, however, that a single message serves the needs of a wide audience sharing little more than concern with books. Knight's text will be only of modest use to the serious collector or the professional historian. In this treatment of books of and about science, and books that, though not scientific, significantly influenced scientists, there is little on them *as books*. Despite occasional remarks about the rarity, beauty, or publication peculiarities of these books, the great bulk of Knight's exposition is devoted to the task of placing their purposes and contents in historical context. In 11 topically designed chapters (plus introduction and epilogue) one finds something closely resembling a condensed series of lectures on the history of modern British science, with both the strengths and the weaknesses associated with that form of presentation. Knight's learning is broad, but he covers too much too rapidly to penetrate very much beyond a superficial interpretative level, or to present recent historical thinking more than hastily. The chapter "Scientific publications in the nineteenth century," which may most nearly approach fulfillment of Knight's avowed aim to offer "a book about books," almost equally approaches the character of a bibliographical essay. The book's substance, format, and price, however, seem to suggest the hope of attracting a genteel reader in search of erudite entertainment. While anyone can read it with profit, perhaps the greatest service this book can be expected to perform is to lead the curious dilettante to the serious literature of the history and bibliography of science.

The bibliographies after each chapter yield a total of over 1500 original works —including journal titles and English translations of works in Latin and Continental vernacular tongues—as well as more than 260 citations of works of secondary scholarship and reference. The 100 illustrations include some seldom-reproduced plates, but generally contribute rather marginally to the textual material. The index is far from thorough, diminishing the book's reference utility.

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Naturalist under attack by toucans. The frontispiece to volume 1 of H. W. Bate's *Naturalist on the Amazons*, 1863. [Reproduced in *Natural Science Books in English*]

Egyptian Accomplishments

Mathematics in the Time of the Pharaohs. RICHARD J. GILLINGS. M.I.T. Press, Cambridge, Mass., 1972. xii, 286 pp., illus. $25.

What is really at the root of the belief, still widely held and promoted, that the ancient Egyptians were sophisticated, but clandestine, mathematicians? Just this, I think: that the cotangent of the batter of the great pyramid of Cheops was (that is, before the smooth casing was stripped) very nearly $\pi/4$. Now in general the pyramid builders favored batter angles in the 45° to 54° region—doubtless for a mixture of esthetic and functional reasons. Here are the relevant data on the three pyramid tombs of Giza:

	batter angle, α	cot α
Mycerinos	50° 46′	$(\pi/4) \times 1.0396$
Cheops	51° 52′	0.9995
Chephren	53° 4′	0.9571

If you decide that the Cheops data, in this context, are unremarkable, and if, in addition, you are aware that $\pi/4$ happens to be numerically close to $1/\sqrt{\tau}$ (where τ is the parameter of the golden section), you need not waste time pondering the extraordinary arcana of mathematical pyramidolatry. Turn, instead, to Gillings's exposition of what is reliably inferable about the mathematics of the Nile valley in the Pharaohs' times.

Actually, the surviving papyri of the Middle Kingdom (inscribed almost a millennium after the erection of the great pyramid) indicate that π was then taken to be $(4/3)^4$, which is correct to 0.6 percent, and therefore good—but not mysteriously good. Other notable accomplishments that the author discusses are: the solving of problems in proportion; the summing of certain arithmetic and geometric progressions; the computation of various square roots; the solution of simple equations of the second and third degrees; and the finding of many nonsimple regular areas and volumes—including, it seems, the surface area of the hemisphere. His researches also support what other scholars have averred but nonspecialists are always surprised to hear, namely, that Pythagoras' theorem remained unknown during the entire era.

Gillings assesses the material in an original way. He emphasizes, on the one hand, that the mathematics at issue was based on two elementary multiplication processes, binary and "two-thirds"; and, on the other hand, that it was innocent of abstraction and the concept of proof. Within these constraints the achievement was massive, and is worthy of more respect than it is usually accorded. Gillings suggests that we glibly associate neglect of proof in mathematics with logical shallowness. The ancient Egyptians were not concerned with "a priori symbolic argument that would show clearly and logically their thought processes. What they did was to explain and define in an ordered sequence the steps necessary in the proper procedure. . . . This was science as they knew it, and it is not proper or fitting that we of the twentieth century should compare too critically their methods with those of the Greeks. . . ." Which is fair comment, and it might be added that Egyptian arithmetic, unlike its Greek counterpart, was never bedeviled by number mysticism and contempt for calculation.

This is a pioneer full-length study. It is also wide-ranging, covering incidentally the calendar, and quantity surveying, and units of measurement. The important matters of notation and translations are handled very well.

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More Recent Mathematics

Mathematical Thought from Ancient to Modern Times. MORRIS KLINE. Oxford University Press, New York, 1972. xviii, 1238 pp., illus. $35.

General histories of mathematics have appeared fairly regularly for many years, and all of them have suffered from the vastness of the subject and the paucity of reliable historical studies on which to draw. In particular, they often peter out with brief sections on the 19th century, and do not regard 20th-century mathematics as historical at all.

By contrast, nearly half of Kline's new book deals with developments after 1800, with a previous 200 pages for the 18th century. It is the first general history which begins to reflect the actual development of mathematics, and is by far the best yet to appear. Its size has made inevitable a price that will confine its sales to libraries, but one hopes institutions that offer courses in the history of mathematics will purchase several copies for the use of their students. It is excellently printed and furnished with comprehensive name and subject indexes.

In a review of this kind I can only indicate general features and note selected points of detail. Though the book is large, it does not cover all branches of mathematics, as Kline notes in his preface (p. vii). But I cannot fully understand how the criteria described there have determined the selection of topics for the main text following. The book is strong on the calculus, mathematical analysis, differential equations, set theory and foundations, the various geometries (including differential geometry), and calculus of variations. But it is much less detailed on complex variables, linear algebra, algebraic structures, number theory, rational mechanics, and numerical analysis and is silent about probability and statistics.

A pleasant feature of the book is three interludes (chapters 18, 26, and 43) where Kline reflects on the conception of mathematics at the beginning of the 18th, 19th, and 20th centuries and provides information on the support of mathematicians and the changing media of mathematical publication. Sociological matters of this kind are of considerable importance, especially for the professionalization of mathematics during the last 300 years.

Kline is obviously most at home in these later periods, for the early chapters seem too brief, and perhaps derivative, for the material covered. It is noticeable that there are barely a dozen footnotes in the first dozen chapters (which take the story from Mesopotamia to the Renaissance), whereas many later chapters have more than 40 each. The standard of reference citation is high; works that have appeared in collected editions of their authors' work are also cited in their original appearances, and each chapter ends with a bibliography of the principal primary and secondary sources used.

Impressive though the book is, there do seem to be significant matters for criticism. I shall give a few examples of mistakes or questionable interpretations from those bits of the history of mathematics with which I have some acquaintance.

1) On p. 677 Kline gives the diagram of a Fourier series over several periods of its representation. But he leaves blank the jumps of the graph over its discontinuities, whereas Fourier joined such jumps by vertical lines. This point could have motivated several historical problems, such as the naive envelope argument on which Fourier seems to have drawn and its relation to multiple limit techniques, the interpretation of a function as a curve rather than as an expression, the extension of continuity to incorporate this geometric connectedness and its relation to differentiability, and so on. Fourier also ought to have appeared on p. 270 for the inductive proof of Descartes' rule of signs, on p. 715 with his analysis of the cooling cylinder as inspiration for his admirers Sturm and Liouville, and much more prominently on p. 710 for his comprehensive treatment of the particular "Bessel function" $J_0(x)$, years before Bessel, en route to the cylinder solution. Further, Poisson's enthusiasm for Fourier's methods was much more muted than Kline states on p. 678; indeed, an important "political" battle over Fourierian versus other methods has been missed here.

2) Cauchy's 1814 paper on definite integrals seems to me to contain much clearer indications for the development of complex variable function theory than Kline allows on p. 635; indeed, the seeds of the whole basic theory are there. It was delayed in publication until 1825 (rather than submitted then, as Kline claims), at which time Cauchy published as a pamphlet a marvelous sequel paper. Kline is quite wrong in saying that it was not published until 1874 (p. 637); the 26 volumes of Cauchy's works mentioned on p. vii