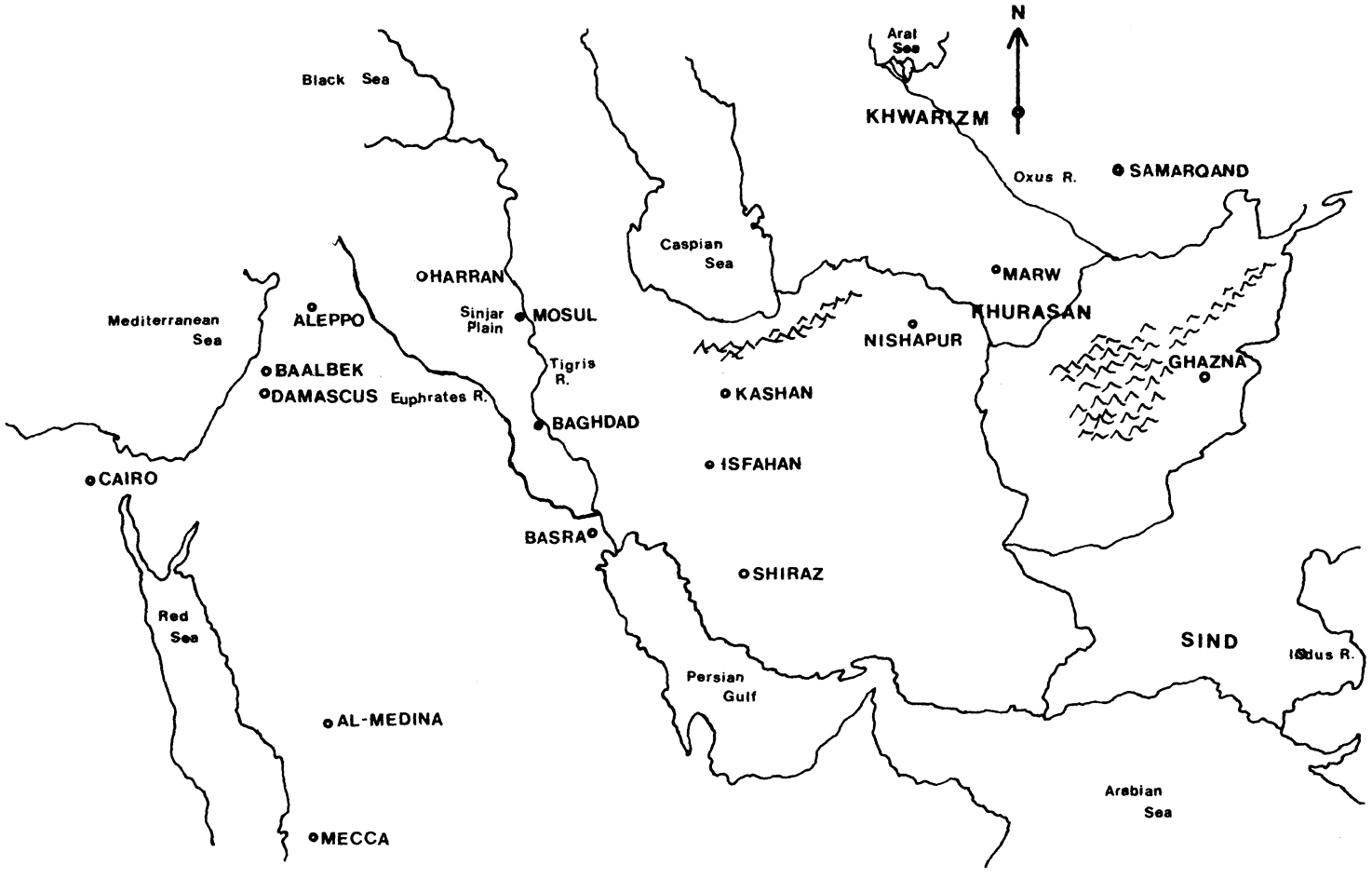
Episodes in the Mathematics of Medieval Islam



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J.L. Berggren

Episodes in the Mathematics of Medieval Islam

With 97 Figures and 20 Plates

Springer

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To My Parents
Evelyn and Thorsten

Preface

Many people today know something of the debt our mathematics owes medieval Islamic civilization. They know "algebra" is an Arabic word and they speak of our Arabic numerals. In recent years, as well, historians of mathematics have re-learned what our medieval and Renaissance forbears knew: the Islamic contribution affected the development of all branches of mathematics in the West and was of prime importance in many. Despite this, no textbook on the history of mathematics in English deals with the Islamic contribution in more than a general way. This is unfortunate, not only from a scholarly point of view but from a pedagogical one as well, for Islam's contributions include some gems of mathematical reasoning, accessible to anyone who has learned high school mathematics. Many of these mark important stages in the development of decimal arithmetic, plane and spherical trigonometry, algebra and such mathematical methods as interpolation and approximation of roots of equations.

The present text is an attempt to fill such a need. My original idea was to write a book modelled on that of the admirable *Episodes from the Early History of Mathematics* by A. Aaboe. However, I soon realized that for the history of mathematics in the world of Islam there was no general backdrop, against which I could highlight certain episodes, such as T. L. Heath's two-volume *History of Greek Mathematics* provides for the Greek world. In addition, the Islamic material contains a relatively larger number of short but important treatises than does the Greek, where a few major, polished works dominate the landscape. For both these reasons, then, I have had to fill in more background and provide a more connected account of 600 years of activity than I first intended. Despite this, the book reflects my conviction that a proper study of the history of mathematics begins with a study of the texts themselves, and for this reason I have written the chapters not as catalogues of results but rather as expositions of portions of mathematical treatises, which I have followed as closely as I feel is possible for an introductory study. When I have departed from the texts it has most often been in

the use of abbreviations or symbols where the texts employ words. In any case I have always tried to make the extent of my departures clear enough so that the reader could form a notion of the character of the treatise in question.

Although the study of the history of mathematics begins with a reading of the texts one soon becomes aware that these texts have a context. Each forms a segment of a network of treatises embedded in a particular civilization, and this civilization is itself related, geographically and historically, to other civilizations. I have to some extent tried to exhibit these connections. Also, my study of Islamic mathematics has made me aware that some features of it were responses to the evolving requirements of Islamic faith, and I have tried to indicate some of these features in sections headed "The Islamic Dimension" in Chapters 1, 2, 4 and 6. The section on Islamic art in Chapter 3 also bears on this matter.

At the same time Islamic mathematics, like the civilization itself, was deeply influenced by other great civilizations, some prior to it and others contemporary with it. For the history of mathematics the most important of these were the Greek and Hindu civilizations. Accordingly, I have tried to point out those parts of Greek and Hindu mathematics that the mathematicians of the Islamic world used.

I have not attempted to write "The History of Mathematics in Medieval Islam". Such a book could not be written yet, for so much material remains unstudied that we do not know enough of the whole story. (The nearest we have to such a work is A. P. Youschkevitch's excellent *Les Mathématiques Arabes (VII^{e}–XV^{e} Siècles)*. Paris: J. Vrin, 1976.) My aim, rather, has been to exhibit some ways in which writers of the Islamic world contributed to the development of the mathematics one learns in high school, and so the principal mathematical topics treated in this book are arithmetic, algebra, geometry and trigonometry. Even these I have not treated exhaustively, and in particular I have avoided some aspects of them that go well beyond high school mathematics. Also, I have concentrated on developments in the Eastern parts of the Islamic world, largely because this is the area I know best and it proved possible to illustrate the points I wanted to make with examples chosen from this area.

In this book I have restricted the word "Arabic" to designate only the language, and I describe as "Arab" only one coming from the Arabian peninsula. Many who could properly consider themselves to be Arabs are excluded on the basis of my usage but the meaning of "Arab", even within the Arabic-speaking world, has shifted too much over the centuries for the word to be of much use to me. I prefer the designation "Islamic" for that civilization whose mathematical achievements I shall describe. For, although it was home to men and women of many different races and faiths, its essential features were defined by those who professed the Islamic belief that "There is no god but God and Muḥammad is the Messenger of God".

There are a few features of the book which should be mentioned here. I

have included a map (page ii) so that the reader may locate the places in which so much of the story is set. I have also included photographs of places and art germane to my account in order, for example, that seeing al-Kāshī's observatory may help fix his name in the reader's mind.

Lest the reader be confused by dates of the form "946–947" I should mention here that the Muslim year is a lunar, not a solar, year. In consequence it is about 11 days shorter than the Western year and it frequently happens that a Muslim year begins in one Western year and ends in the next. Hence, when our Arabic sources tell us only that Abū Fulān was born in a certain Muslim year we cannot usually be more specific than assigning two possible Western years. Finally, a reference in the text of the form "Smith" (or Smith, 1984) refers to the work by Smith listed in the bibliography at the end of the chapter (or to the work he published in 1984 in case more than one work of his is listed).

It remains to thank those who have helped me in the preparation of this book. Asger Aaboe of Yale University has shaped much of my approach to the study of the history of mathematics, and for his years of instruction, encouragement and friendship I offer my thanks. E. S. Kennedy provided me access to his remarkable library in ʿAinab, Lebanon when I began reading for this book, and he and his wife Mary Helen offered my family abundant hospitality, both in Lebanon and Syria. To both of them warm thanks are due. I also wish to thank H. E. Kassis and D. A. King for making photographs available to me from their private collections. I say "Tack så mycket" to Arne Broman and Jöran Friberg, of Chalmers Tekniska Högskola in Göteborg, Sweden, who arranged for me to give the first version of this book in the form of lectures at the Mathematics Department there, and to the many faculty and students at Chalmers who showed such an interest in these lectures. I also thank C. Anagnostakis, J. Hogendijk and W. B. Mc Dermott, all of whom made detailed comments on parts of an early draft of this book, and G. van Brummelen for help reading proofs.

Finally, I want to thank my wife Tasoula who has shared my enthusiasm for the history of mathematics, and our sons, Thorsten and Karl, who offered so many hours of help on illustrations and corrections to the text.

Contents