durchgeführt hat, nämlich die beiden sogenannten Wiener mathematischen Schulen in den humanistischen Kontext einzuordnen und gleichzeitig zuverlässige Detailaussagen über die mathematischen und naturwissenschaftlichen Studien an der Wiener Universität im 15. und frühen 16. Jahrhundert zu liefern. Durch seine gründlichen Quellenstudien hat der Autor insbesondere unsere Kenntnis über Leben und Werk von Georg von Peuerbach wesentlich erweitert.

**Diophante: Les arithmétiques.** Volume III: Book IV, ccvi + 162 pp., illus., bibl.; Volume IV: Books V–VII, cxxxiv + 197 pp., app., index. Edited by Roshdi Rashed. Collection des Universités de France. Paris (Société d'Edition "les belles Lettres"). 1984. Fr 500 (cloth).

*Reviewed by George Saliba*

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We have known about the existence of a fragment of the Arabic translation of Diophantus' *Arithmetica* (comprising books IV–VII of the original Greek) for more than a decade now, thanks to two original publications of Roshdi Rashed that appeared in the *Revue d'Histoire des Sciences* (1974, 1975), presenting in great detail the contents of this Arabic fragment. Rashed also published a preliminary edition of the same fragment (Cairo, al-Hay'ah al-Miṣriyyah al-ʿāmmah li-l-kitāb, 1975), which included a historical introduction and a detailed mathematical commentary (all in Arabic). Several studies have since appeared that were inspired by his discovery and by new interest in Diophantus' *Arithmetica*. Rashed has now published a new critical edition of the same fragment, here under review as Volumes III and IV of the complete *Arithmetica* in the Budé series—the other volumes are devoted to the Greek part. The fragment is accompanied by a French translation on facing pages, a detailed historical introduction, a mathematical commentary, critical historical and philological notes, and an index of Arabic terms which is indeed a trilingual glossary comprising Arabic, French, and Greek.

The mathematics of Diophantus' *Arithmetica*, the relationship between the Arabic translation and the extant Greek text, and the general status of Diophantine studies—each of which has been more or less well established by Rashed in his earlier publications—are now restated in much greater detail. The conditions of the Arabic translation, and the analysis of the works of the translator Qusṭā b. Lūqā, also receive renewed attention.

Moreover, Rashed has shown that the discovery of a lost fragment of a text implies a general reconsideration of the whole text, and thus necessitates a new understanding of the parts we thought we already knew. For that reason, he collaborated with André Allard to reedit the entire work of Diophantus, including

the extant Greek fragments, so that they could be read in light of the new discovery and the newly established order of the original Greek books. He also thought that the work of the translator, Qusṭā b. Lūqā, could not have been a passive experience taking place in a historical and cultural vacuum. As a result Rashed's study of the type of language used by Qusṭā was based on a detailed analysis of the status of the mathematical sciences at the time when Qusṭā completed his translation. Rashed took into account the fact that Qusṭā had at his command the newly coined technical language of the algebraists of the ninth century, which meant that Qusṭā did not have to invent a new terminology, but made use of the terminology already available. This implies that the work of Diophantus could have been interpreted as an algebraic work since it was couched in the algebraic language current in the ninth century. Moreover, the Arabic language used to translate the Greek text could have been viewed as somewhat inappropriate simply because it contained anachronistic expressions such as the words *jabr* and *muqābalaʰ*, which had no Greek equivalents but were used by Qusṭā, in spite of the fact that he probably knew that these terms were coined in the ninth century and not in Diophantus' time (around the first centuries A.D.). The sensible approach that Rashed has taken in this regard helps him to explain the various anachronistic points in the language of the text.

The problems faced by Rashed are common to all editors of Arabic texts, whether or not these texts are translated from Greek. And since there is not yet a large library of edited Arabic scientific texts, it is appropriate that the editorial decisions made by Rashed be discussed here, for his edition will probably serve as a model for similar work in the future.

Because the edited text was indeed a translation of a Greek text, Rashed had to discuss the problems connected with translations, and thus had to analyze problems of transmission by considering the process of translation itself as a dynamic process occurring under specific historical conditions. As a result his treatment of the issue of translation sheds important light on the cultural and intellectual history of the first three centuries of Islam, and answers in part the questions related to the language and technical terminology that were available to the translator. Even the methods of translation, whether one takes the literal approach or the rephrasing approach, became important, and Rashed gathers all the medieval sources, mainly literary, in which such issues were discussed.

In evaluating the language and method of Qusṭā, Rashed concluded that Qusṭā's insecure command of Arabic and his adherence to the original Greek text forced him sometimes to adopt a tortured Arabic syntax (p. xxxi). Moreover, whenever the Greek text was cryptic, Qusṭā apparently paraphrased the text at that point, thereby producing what appears to be his own rewording of the text. On the other hand, Qusṭā seems to have understood the spirit of the text as well as the mathematics of his time. For example, when he came across a mathematical operation that had a single name in the Arabic language of his time, he did not refrain from using that name despite the fact that the original Greek had a descriptive phrase for the same concept. Words such as *jabr* and *muqābalaʰ* are good examples of

such a procedure (note, p. 109). And when he had to coin a new term to render a Greek concept, he would at times add an explanatory remark to warn the reader that the words were being given new meanings.

This analysis of Qusṭā's method of translation helped Rashed to understand the process of the translation itself, and thus understand the final form of the text. But the most important section for future editors of Arabic scientific texts is the one entitled "Establishment of the Text" (p. lxxivf). Here Rashed discusses the difficulties connected with editions based on unique manuscripts. Faced with the choice between taking liberties with the text, for there is no other manuscript to check, and leaving the text sacrosanct, and thus allowing even mistakes to survive, Rashed opted for a middle ground, and decided to "correct the mistakes" which were either scribal errors or slips made by Qusṭā, while otherwise interfering with the text as little as possible. To set the record straight and to clarify his methodology, Rashed defined the points at which he interfered with the text:

(1) when the text has a "flagrant" error, or when it has a clumsy mathematical or syntactical expression (*gaucherie syntaxique*),

(2) when the text, as it stands, would otherwise remain inaccessible to the reader because of a mathematical or a linguistic difficulty,

(3) when a grammatical mistake is in no way defensible after all possible grammatical justifications have been considered.

In all cases, Rashed asserted that it is the duty of the editor to determine, whenever possible, the source of these errors, be it the author, the scribe, the original translation, or even the original Greek.

Errors that may have resulted from the translation, for example, were those that were committed by the translator when, in his zeal to avoid confusing later copyists and readers who could misinterpret the Arabic alphabetic numerals, he decided to spell out in words the alphabetic numbers and symbols that were used in the original Greek text. But since the rules governing numerals in Arabic are rather complex, the translator himself could have introduced some of the errors. Moreover, to avoid the confusion that could result from the use of symbols for higher powers of the unknown, the translator also decided to spell out those powers as a series of connected words essentially repeating the square or the cube powers. The expression for $x^9$, for example, is cubo-cubo-cube (*ka$^c$b ka$^c$b ka$^c$b*). Since the same word is repeated several times, the scribe could possibly skip a term and end up with cubo-cube (= $x^6$).

In Arabic, nouns that follow numbers greater than 10, but not 100 or 1000, are normally designated as "specified by the numbers," and should thus be given accusative case endings. The translator himself may not have been sure how to apply this rule and thus may have violated it. Such mistakes are corrected by Rashed.

Other mistakes resulting from the violation of the rules connected with the grammatical requirements of *kāna* or *inna*, and their sisters, or from the use of weak verbs, or exceptive particles such as *illā*, are corrected. This was probably

done to avoid offending the sensibilities of the modern Arabic reader for whom the text was edited in the first place. For the same reason, peculiar medieval orthography of certain Arabic words, such as *kilā* (written with *alif maqsūra*), *kullamā*, and *limakāna*, is made to conform to modern spelling, *kilā*, *kull^a mā*, and *limā kāna*. Similarly, words spelled with *dagger alifs* in the archaic forms, or words spelled with the improper chair of the *hamzah*, are also made to conform to modern spelling. Those who wish to use the text as linguistic evidence of medieval Arabic, and thus would like to see these archaic spellings preserved, should be assured that in each case the critical apparatus preserves these variants; therefore they may use the text for linguistic purposes without offending the sensibilities of the modern Arabic reader.

On a purely aesthetic level, Rashed's edition is a pleasure to read. The typeface is probably the most elegant typeface used for scientific Arabic and is far superior to the typeface that was used to produce the preliminary Cairene edition.

In brief, Rashed's edition promises to become the model to be followed by other editors of Arabic scientific texts, for it has answered most of the technical questions to which scientific texts might give rise.

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*Reviewed by J. L. Berggren*

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Diophantos' *Arithmetica* stands in sharp contrast to the number-theoretic books of Euclid's Elements. Far from being an axiomatic development of number theory, the *Arithmetica* is a collection of problems asking for rational numbers satisfying one or more conditions involving several unknown quantities, an example being to find two cubes whose sum is equal to the difference of two given squares.

However, although there are no axioms there is a structure to the book inherent in the grouping of problems and their interrelationships. In addition, not only are the rational solutions given but their derivation is performed in broad daylight. However, more often than not the derivations involve some neat trick of the sort that makes a mathematician laugh in amazement—an aspect of the work that has occasioned the most trouble for historians who have tried to give an account of Diophantos' method that would give the work more the appearance of normal

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* J. L. Berggren was asked to review this book from a mathematical point of view, while George Saliba was asked to review it from a philological perspective.