Greek Science of the Hellenistic Era: A Sourcebook by Georgia L. Irby-Massie and Paul T. Keyser

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This book offers a selection of excerpts from all the major areas of ancient science broadly conceived. The focus is on the period *ca* 320 BC to AD 250. During this time major work was done in Greek science. Euclid, Aristarchus, Archimedes, Ptolemy, Galen, and numerous others belong to this half-millennium. Hence, this book offers a glimpse of Greek science at its best. The editors state correctly in the preface that 'selection and translation distort and disappoint—but a warped mirror and dim candle are better than no view at all'. Anyone interested in the history of science would surely agree with this: it is better to give the Greekless a taste of what was written over this 500-year period than it is to leave them in the dark about it. In addition, those with Greek have rarely read the full texts of more than a portion of the surviving works produced in this period, so this source book is a valuable guide to the rest of the material. Many of the works excerpted here, and in some cases even the authors of those works, are unknown to the average classicist or historian of science today. It is an updated version of Cohen and Drabkin's long out-of-print *A Source Book in Greek Science* (henceforth C/D), but there are some notable differences in approach.

C/D focused on the best of Greek science, where 'best' meant nearest to then-current 'correct' methods or opinions. They left out material they considered to be 'irrelevant', in two senses. First, complete topics that were no longer considered scientific, such as physiognomics, were omitted; and second, passages were occasionally edited to omit text that was 'irrelevant' to the scientific point at hand. For example, Aristotle, *Generation of Animals* 1.18 was edited to remove an example of (what we would call genetic) resemblance between first

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and third generations, skipping the second. (Aristotle cited the case of a woman from Elis who had intercourse with a negro; the child was not Negroid but the grandchild was.) Why they thought it desirable to edit out this brief example is a moot point. The result is that the overall impression of Greek science given by C/D is a rather misleading one. Irby-Massie and Keyser (henceforth IM/K) do not so confine themselves, but use a more generous concept of ancient science that includes, for example, astrology. A similar shift in approach can be seen in recent work on John Dee or Isaac Newton, for example. But with these inclusions is a novel exclusion: IM/K do not have a chapter entitled 'Physics'. Instead we find separate chapters on mechanics, optics, hydrostatics and pneumatics, and alchemy.

The resulting collections of material can be very enlightening. For example, this reviewer found the juxtaposition of passages concerning light and sight that IM/K bring together in the chapter on optics thought provoking. This is, in fact, a very effective way of overcoming unconscious anachronism born of the modern compartmentalization of intellectual life, unthinkingly transferred to the polymaths of antiquity. The strikingly novel associations of material that one finds throughout this book ensure that the material, however familiar, is read with fresh eyes. Archimedes' *Sand-Reckoner*, for example, is here highlighted not only for its system of dealing with large numbers, or its reference to Aristarchus' heliocentric theory, but for its explicit engagement with the empirical problems of gathering and measuring data about the sun with the naked eye and simple equipment in the attempt to find the apparent diameter of the sun.

The book concerns the period 320 BC–AD 250, so including the word 'Hellenistic' in the title is misleading. 'Hellenistic' refers to the period from the death of Alexander in 323 BC to the transformation of the Roman Republic into the Roman Empire (for which the watershed is usually drawn at the battle of Actium in 31 BC). Whilst this is the most flexible of the periodic labels in antiquity, the term 'Hellenistic' does not extend down to the mid-third century AD. IM/K say that they have chosen the time frame 320 BC–AD 250 because it 'reflects the model' of ancient science which they develop in chapter 1 [xxii]. As far as this reviewer understands it, the model in question attempts to explain the development of Greek science between its

emergence and its decline as a story in three parts: (1) initial 'political monopoly promoted intellectual synthesis', while subsequent (2) 'political pluralism promoted intellectual debate and productivity'. Ancient science effectively died when (3) 'political uniformity fostered the creation of a hyper-synthesis which promised a view of the body and the universe as an ordered and meaningful whole, with no openings for productive questions' [16–17]. The intellectual syntheses are essentially those of Plato, Aristotle and the other schools in the fourth century BC; the hyper-synthesis is the reconciling of Platonism and Aristotelianism from the third century AD; the middle part—the period in which intellectual debate between the various 'schools' took place, and science was 'productive'—is the focus of this source book.

The model is thought-provoking, but superimposes a political driver for developments in ancient science that, in the opinion of this reviewer, is just one of many possible factors in the story. It is not obvious that the hyper-synthesis would not have happened anyway without the Antonines' (especially Hadrian's) creation of greater uniformity in the empire. Galen's eclecticism may represent one facet of the hyper-synthesis at its birth, but it is patently obvious that in his day, i.e., the second century AD, which IM/K describe as one of 'organic and corporate wholeness' [15], there are still plenty of rival schools arguing issues in medical and biological science. Nor are those arguments obviously productive (at least, not if one believes Galen's self-advertisements).

One of the notable features of ancient science is that it appears discontinuous in time and especially in space. Great scientists hailing from a variety of socio-economic backgrounds and working in a variety of political environments (e.g., tyranny, democracy, monarchy, oligarchy, 'capital city' of large kingdoms, provincial towns of client states) appear in isolation doing innovative things throughout the ancient world over the centuries. For example, to cite a few of the more famous ones, Archimedes arises in Syracuse, Aristarchus in Samos, and Hipparchus in Nicaea. Archimedes is born, educated and works in an independent tyranny of long-standing. Aristarchus is born and (as far as we know) educated and works in a provincial town that had a great past but has long since been subordinate to a large kingdom and then to the Roman Empire. Hipparchus comes from what was in his time a relatively new provincial town that has no other

claim to fame than that he was born there and that (500 years later) the first ecumenical church council met there and came out with the Nicene Creed. He moved to and spent much of his life at Rhodes, which was not at that time renowned for scientific achievements of its own sons or immigrants, and had recently become subordinate to Rome. This isolation is perhaps simply an appearance, because we have lost much evidence about high schools outside Athens and about the Athenian schools which failed at any period in their long histories to produce scientists of the same quality as their founders.[1] Likewise, we know little of temples to the Muses outside Alexandria (which is not to suggest that we know much about the structure or functioning of that famous institution and its Library). However, the autodidact remains a familiar character from the beginning to the end of Greek science. For example, the only suggestion of a mechanical (what we would now call 'clockwork') cosmos known to this reviewer was made in the mid-fifth century AD by an otherwise unknown engineer called Theodorus in a letter to Proclus. The Neoplatonist *par excellence* took some time and effort to show Theodorus the error of his ways, using the full arsenal of the hyper-synthesis at his disposal; and IM/K's model may help to explain why we hear no more about it, in the same way that it helps to explain why commentators take over from innovators. But the story demonstrates that at least one person, another autodidact, was asking potentially productive questions when ancient science was apparently breathing its last and intellectual conformity was about as tight as it ever got in antiquity. One needs to look elsewhere to explain the decline of ancient science.

IM/K had to make a number of difficult decisions over the style and content of the book, and all possible options would doubtless find supporters and detractors. They decided to opt for few explanatory notes in favour of increasing the space for texts, but they do provide short introductions to each chapter. There are very helpful cross-references to other pertinent passages sprinkled liberally through the texts, but they are not always as helpful as they might have been: for example, the vague reference to 'the Kosmos passage above' made on page 143 requires the reader to track back 12 pages to find it.

[1] On teaching in Athens and the clientele during the Classical period, see Rihll 2003, 179–184.

If space was limited, this decision to sacrifice notes for texts has to be the right one; but is a pity, as some of these texts are far from self-explanatory. They also decided not to waste space reproducing texts that are widely available in translation elsewhere. They generally avoid giving snippets, preferring to offer longer extracts that allow fuller engagement with the text and which are (slightly) less prone to mislead as to the content and style of the work as a whole. This results in fewer passages being included than might have been otherwise, but their preference for depth over breadth is a sound one in the opinion of this reviewer. More guidance on the larger significance of some of the passages included would, however, have been welcomed.

Most of the translations in this source book were done by others and have already been published, although a large number of them are either out of print or difficult to access. IM/K state that they have checked, and if necessary revised, those translations originally published before 1976 'the better to accord with the Greek' [xxii], though this is not always evident. For example, Marsden's translation of sections of Philo's *Belopoiika* is reproduced complete with Marsden's addition to the text at 70.23 [160]; and IM/K give no indication that ἀγκῶνος (arm) is bracketed in Marsden's Greek text (but not in his translation), and that it is a word introduced to the text by Marsden. This really should have been bracketed in a revised translation. The original Greek text states that the pin runs not through the arm, as stated in the translation, but through the finger. Marsden could not see how this machine would work (it would not as he read and reconstructed it), so he introduced the word 'arm' into the text [Marsden 1971, 176n101]. Given Marsden's divergence from the text both in his translation and in his reconstruction, it would have also been better not to reproduce his image of the bronze-spring catapult. Generally the figures are helpful, but this one is not; nor is the figure of Heron's 'steam engine' on page 224—the bottom of tube ZE is shown as open to $\Gamma\Delta$ instead of to AB.

IM/K have produced new, sometimes the first, English translations of a number of passages; and some of these are a very welcome addition to the corpus available for Greekless students and readers. Dioscorides, for example, existed until now only in a translation

made in the 1600s; although technically that is an English translation, its meaning is often far from clear to an English speaker today. Moving from Shakespearean to modern times, this reviewer finds the frequent use of ellipsis (it's, aren't, and so on) in the new and revised translations a distraction.

Roughly 200 years ago William Ewart Gladstone complained about the inconsistency of rendering Greek names into English—with some names Latinized, some transliterated—but allowed himself a few exceptions to his preferred system; and most modern scholars are still doing the same. The trouble is that those who, like Gladstone (and this reviewer), prefer by default to transliterate, generally make exceptions of the familiarized Latin names—Plato instead of Platon, Aristotle instead of Aristoteles for instance—but everyone's conception of what is 'familiar' appears to be different. So in this source book on Greek science, we find one of the most famous names in the history of science rendered (correctly) as Eukleidēs, whilst the less famous Alexanders (of Aphrodisias, or still more of Mundos) appear as Alexander not Alexandros; Hero and Philo are Heron and Philon, but Strabo is Strabo not Strabon. In the field of classics as a whole there seems to be no solution to this problem. But it would have been helpful to the general reader and students, for whom this book is intended, to have provided the common substitutes, where such exist (in brackets at least) for the very rarely transliterated names such as Euclid's.

To summarize, there are 359 pages of text divided between 12 chapters (an Introduction, Mathematics, Astronomy, Astrology, Geography, Mechanics, Optics, Hydrostatics and Pneumatics, Alchemy, Biology, Medicine, and Psychology); bibliography and indices fill a further 32 pages. The range is outstanding. Unfortunately, there is no index of the primary sources in translation here, and a detailed table of contents is not in this reviewer's opinion an adequate substitute. The contents state which authors and which passages, on what topics, are here in translation. There is a handy timeline of the relevant authors [xxxi–xxxv] and a couple of maps. There is an extensive bibliography in four parts (sources of translations reproduced, texts newly translated, works cited, select further reading), four useful indices (of terms, of metals, stones, plants and animals, of people excluding authors in the main body of the book, and of places), and a concordance of passages cited but not excerpted.

If there is one word that sums up this book, it is 'novel'. In content, arrangement, and presentation there is a surprise on almost every page. For those teaching ancient science, it is a very welcome addition. Students now have access to a huge range of ancient thought and at a price within their budget. Unfortunately, they still have to get Aristotle independently: this reviewer understands but deeply regrets his exclusion from the volume. Irby-Massie and Keyser have performed a valuable service for all those interested in Greek science, and (despite the niggles above) this reviewer and her students are very grateful for all their hard work.

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