

BLACKWELL COMPANIONS TO THE ANCIENT WORLD

A COMPANION TO  
SCIENCE, TECHNOLOGY,  
AND MEDICINE IN ANCIENT  
GREECE AND ROME  
VOLUME I

EDITED BY  
GEORGIA L. IRBY



WILEY Blackwell



**A COMPANION TO SCIENCE, TECHNOLOGY, AND  
MEDICINE IN ANCIENT GREECE AND ROME**

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# A COMPANION TO SCIENCE, TECHNOLOGY, AND MEDICINE IN ANCIENT GREECE AND ROME

Volume I

*Edited by*

Georgia L. Irby

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**Gordon Campbell** is a lecturer in Ancient Classics at the National University of Ireland, Maynooth. He works on ancient philosophical poetry, anthropology, cosmology, and in particular on Lucretius and Empedocles

**Paul T. Craddock** graduated in Chemistry from the University of Birmingham in 1966 and joined the British Museum Research Laboratory, where he remained for his whole career, currently in an emeritus role. While there he obtained further qualifications in prehistoric archaeology and metallurgy, obtaining his PhD from the Institute of Archaeology in 1975 on classical bronze alloys. Most of his work has been concerned with metals through all stages of their production, from mining and smelting the ores, as exemplified by Rio Tinto, through to their final embellishment, as exemplified by studies on Corinthian bronze. He is currently working on a monograph investigating the technology of large hollow lost wax castings in Egyptian and classical antiquity

**Robert I. Curtis** is Professor Emeritus of Classics in the Department of Classics, University of Georgia. His primary research interests include food technology, Roman social and economic history, and Pompeii and Herculaneum.

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Fellow of the Royal Society of New Zealand. He has written extensively on the use of astronomy in Greek and Roman cultures. His recent publications include the books *Greek and Roman Calendars: Constructions of Time in the Classical World* (London, 2005), and *Time in Antiquity* (London, 2009). His current interests are in calendars, the measurement and perception of time, and star-based navigation.

**Ellen Harlizius-Klück** is Marie Curie-Research Fellow of the Gerda-Henkel Foundation at the Danish National Foundation's Centre for Textile Research. She was Guest Professor in Textile Studies at the University of Osnabrück and Scholar in Residence at the Deutsches Museum in Munich. In her PhD thesis, she combined mathematics, philosophy, and textile studies and since then focuses on the question of how ancient textile technology has contributed to the advent of mathematics and sciences in ancient Greece. She studied fine arts, mathematics, and philosophy and has explored and experienced warp-weighted loom technology in several exhibitions in Germany (Penelope rekonstruiert, Munich; Gesponnen und Verwoben, Bramsche).

**Devin Henry** is Associate Professor of Philosophy at the University of Western Ontario. He received his PhD from King's College London, where he wrote a dissertation on the metaphysical foundations of Aristotle's theory of biological generation. He is the author of several articles on topics in Aristotle's philosophy of science (including classification, teleology, inheritance, and sexism) as well as Plato's late epistemology. His work has appeared in *Oxford Studies in Ancient Philosophy*, *The Monist*, *Phronesis*, *The Journal of the History of Biology*, as well as part of various collected volumes.

**Georgia L. Irby** is Associate Professor in the Department of Classical Studies at the College of William and Mary. She studied Mathematics and Latin at the University of Georgia, Athens, and she holds a PhD in Classical Philology from the University of Colorado at Boulder. She is the author of several articles on cartography in the ancient world, the interstices of science and culture, Greco-Roman medicine, astrology, and Greek pedagogy. Her books include *Encyclopedia of Ancient Natural Scientists: The Greek Tradition and Its Many Heirs* (with Paul T. Keyser; London, 2008); *Greek Science of the Hellenistic Era: A Sourcebook* (with Paul T. Keyser; London, 2002); and *A New Latin Primer* (with Mary C. English; Oxford, 2015).

**M. Eleanor Irwin** was a member of the Department of Humanities at the University of Toronto Scarborough until her retirement in 2001. She is presently a Dean's Designate for academic integrity at UTSC. In addition to publications on color terms and plants in Classical literature, she has contributed articles on Classical scholars, most recently on Kathleen Freeman. She is working on the problem of identifying plants in a pre-Linnaean world while gaining practical knowledge by gardening in Haliburton, Ontario.

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**Sarah Lepinski** holds a PhD in Classical and Near Eastern Archaeology from Bryn Mawr College. She specializes in ancient and medieval surface decoration, and her research interests encompass ancient materials, artistic practices and processes, the historiography of ancient art, and cultural heritage conservation and preservation. Her publications include the edited volume *Beyond Iconography: Methods, Materials and Meaning in Ancient Surface*

*Decoration* (Archaeological Institute of America/Kress Foundation, 2015).

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# Abbreviations

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AA:	<i>Archäologischer Anzeiger</i>
ABSA:	<i>Annual of the British School at Athens</i>
ABull:	<i>The Art Bulletin</i>
AEA:	<i>Archivo Español de Arqueología</i>
AGPh:	<i>Archiv für Geschichte der Philosophie</i>
AHES:	<i>Archive for History of Exact Sciences</i>
AIHS:	<i>Archives internationales d'histoire des sciences</i>
AJA:	<i>American Journal of Archaeology</i>
AJPh:	<i>American Journal of Philology</i>
AncSoc:	<i>Ancient Society</i>
ANET:	Pritchard, J. B., ed. 1969. <i>Ancient Near Eastern Texts Relating to the Old Testament</i> . 3rd edition. Princeton: Princeton University Press
ANRW:	<i>Aufstieg und Niedergang der römischen Welt</i> . Berlin: de Gruyter. 1972–
AntCl:	<i>L'Antiquité classique</i>
AS:	<i>Anatolian Studies</i>
AW:	<i>Antike Welt</i>
BABesch:	<i>Bulletin Antieke Beschaving</i>
BAR:	<i>British Archaeological Reports</i>
BAR-IS:	<i>British Archaeological Reports–International Series</i>
BASP:	<i>Bulletin of the American Society of Papyrologists</i>
BCH:	<i>Bulletin de correspondance hellénique</i>
BCTH:	<i>Bulletin archéologique du Comité des travaux historiques</i>
BHM:	<i>Bulletin of the History of Medicine</i>
BICS:	<i>Bulletin of the Institute of Classical Studies of the University of London</i>
BJ:	<i>Bonner Jahrbücher des Rheinischen Landesmuseums in Bonn und des Vereins von Altertumsfreunden im Rheinlande</i>
BNP:	<i>Brill's New Pauly</i> Leiden, edited by H. Cancik and H. Schneider. 2002–. Leiden: Brill
CAAG:	Berthelot, Marcelin, and Charles-Émile Ruelle. 1887–88. <i>Collection des anciens alchimistes grecs</i> . Paris: George Steinheil

CCAG:	Catalogus Codicum Astrologorum Graecorum
CIL:	<i>Corpus inscriptionum Latinarum</i> . Berlin 1862–
CJ:	<i>The Classical Journal</i>
CMG:	<i>Corpus Medicorum Graecorum</i> Berlin: Akademie-Verlag, 1908–
CML:	<i>Corpus Medicorum Latinorum</i> . Leipzig: Teubner, 1915–
CP:	Theophrastus, <i>De Causis Plantarum</i> ( <i>On the Causes of Plants</i> )
CPh:	<i>Classical Philology</i>
CQ:	<i>Classical Quarterly</i>
CRAI:	<i>Comptes rendus de l'Académie des inscriptions et belles-lettres</i>
CW:	<i>The Classical World</i>
DHA:	<i>Dialogues d'histoire ancienne</i>
DK:	Diels, Hermann and Walther Kranz. 1951–52. <i>Die Fragmente der Vorsokratiker, griechisch und deutsch</i> . Berlin: Weidmann
EANS:	Keyser, Paul and Georgia L. Irby-Massie, eds. 2008. <i>The Encyclopedia of Ancient Natural Scientists</i> . London: Routledge
EMC:	<i>Échos du monde classique</i>
G&R:	<i>Greece and Rome</i>
GA:	Aristotle, <i>On the Generation of Animals</i>
GC:	Aristotle, <i>On Generation and Corruption</i>
	GeogrAnt: <i>Geographia Antiqua</i>
GRBS:	<i>Greek, Roman, and Byzantine Studies</i>
HA:	Aristotle, <i>De Historia Animalium</i> ( <i>On the Enquiry into Animals</i> )
HP:	Theophrastus, <i>De Historia Plantarum</i> ( <i>On the Enquiry into Plants</i> )
HR:	<i>History of Religions</i>
HSPb:	<i>Harvard Studies in Classical Philology</i>
IEJ:	<i>Israel Exploration Journal</i>
IEph:	<i>Die Inschriften von Ephesos</i> . 1979–84. Bonn: Habelt
IG:	<i>Inscriptiones Graecae</i> , 3rd ed. 1981–. Berlin
IGUR:	Moretti, L., ed. 1968–. <i>Inscriptiones Graecae Urbis Romae</i> . Rome
IJNA:	<i>International Journal of Nautical Archaeology</i>
IJPP:	<i>International Journal of Paleopathology</i>
ILS:	Dessau, Hermann. ed. <i>Inscriptiones Latinae Selectae</i> . 1892–1916. Berlin
JAS:	<i>Journal of the Royal Asiatic Society of Great Britain and Ireland</i>
JDAI:	<i>Jahrbuch des Deutschen Archäologischen Instituts</i>
JESHO:	<i>Journal of the Economic and Social History of the Orient</i>
JGS:	<i>Journal of Glass Studies</i>
JHB:	<i>Journal of the History of Biology</i>
JHS:	<i>Journal of Hellenic Studies</i>
JMA:	<i>Journal of Mediterranean Archaeology</i>
JNES:	<i>Journal of Near Eastern Studies</i>
JRA:	<i>Journal of Roman Archaeology</i>
JRS:	<i>Journal of Roman Studies</i>
JSAH:	<i>Journal of the Society of Architectural Historians</i>
KJ:	<i>Kölner Jahrbuch</i>
KRS:	Kirk, G.S., J.E. Raven, and M. Schofield. 1984. <i>The Presocratic Philosophers: A Critical History with a Selection of Texts</i> , 2nd ed. Cambridge: Cambridge University Press



LIMC:	<i>Lexicon Iconographicum Mythologiae Classicae</i> . 1981–2009. Zurich: Artemis
LSCG:	Sokolowski, Franciszek. 1969. <i>Lois sacrées des cités grecques</i> . Paris: de Boccard
LSJ:	Liddell, H. G., R. Scott, and Jones, H.S., eds. 1996 (revised). <i>A Greek–English Lexicon</i> . Oxford: Clarendon. 9th edition
MDAI(A):	<i>Mitteilungen des Deutschen Archäologischen Instituts</i>
MEFRA:	<i>Mélanges d’Archéologie et d’Histoire de l’école Française de Rome, Antiquité</i>
MNIR:	<i>Mededelingen van het Nederlandsch historisch Instituut te Rome</i>
NH:	Pliny the Elder, <i>Naturalis Historia</i> ( <i>Natural History</i> )
NQ:	Seneca the Younger, <i>Naturales Quaestiones</i> ( <i>Natural Questions</i> )
OGIS:	<i>Orientis Graeci Inscriptiones Selectae</i> . 1903–1905. Leipzig: Hildesheim
OJA:	<i>Oxford Journal of Archaeology</i>
ORom:	<i>Opuscula Romana</i>
OSAPh:	<i>Oxford Studies in Ancient Philosophy</i>
PA:	Aristotle, <i>On the Parts of Animals</i>
PAA:	<i>Praktika tes Akademias Athenon</i>
PAS:	<i>Proceedings of the Aristotelian Society</i>
PBSR:	<i>Papers of the British School at Rome</i>
PCPhS:	<i>Proceedings of the Cambridge Philological Society</i>
PECS:	Stillwell, Richard. 1972. <i>Princeton Encyclopedia of Classical Sites</i> . Princeton, NJ: Princeton University Press
PhR:	<i>Philosophical Review</i>
POxy:	<i>The Oxyrhynchus Papyri</i> . 1898–. London: Egypt Exploration Fund
RA:	<i>Revue archéologique</i>
RBPh:	<i>Revue belge de philologie et d’histoire</i>
RCCM:	<i>Rivista di cultura classica e medioevale</i>
REA:	<i>Revue des études anciennes</i>
REL:	<i>Revue des études latines</i>
RUSCH:	<i>Rutgers University Studies in Classical Humanities</i>
SHPS:	<i>Studies in History and Philosophy of Science</i>
SIG:	Dittenberger, Wilhelm, ed. 1917–1920. <i>Sylloge Inscriptionum Graecarum</i> . Hildesheim: Olms
SMEA:	<i>Studi micenei ed egeo-anatolici</i>
SMSR:	<i>Studi e materiali di storia delle religioni</i>
SVF:	von Arnim, Hans. 1964. <i>Stoicorum Veterum Fragmenta</i> . Stuttgart: Teubner
TAPhA:	<i>Transactions and Proceedings of the American Philological Association</i>
TAPhS:	<i>Transactions of the American Philosophical Society</i>
TEGP:	Graham, Daniel W. 2010. <i>The Texts of Early Greek Philosophy: The Complete Fragments and Selected Testimonies of the Major Presocratics</i> . 2 vols. Cambridge: Cambridge University Press
TrGF:	Diggle, James et al., eds. 1998–. <i>Tragicorum Graecorum Fragmenta</i> . Oxford: Clarendon.
VT:	<i>Vetus Testamentum</i>
YCS:	<i>Yale Classical Studies</i>
ZPE:	<i>Zeitschrift für Papyrologie und Epigraphik</i>
ZWG:	<i>Sudhoffs Archiv: Zeitschrift für Wissenschaftsgeschichte</i>





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# Introduction

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## 1. “Science” in Antiquity

From Thales onward, Greek intellectuals sought to understand the world around them, and from this tradition we derive two very important scientific terms: *physics*, a Greek term for “the nature of things”; and *science*, the Latin word for “knowledge.” Science, as the ancients envisioned it, can hardly be separated from other intellectual pursuits, including technology (broadly, the application of scientific principles) and medicine (drawing on mathematical and natural sciences, technology, as well as religion and magic, often nearly indistinguishable). Spheres of knowledge in antiquity were understood as having more fluid boundaries. Thus seeking or imposing modern disciplinary compartmentalization on ancient initiatives does violence to the ancient thinkers and trivializes their accomplishments. “Science” in the ancient world, moreover, never lost its sense of wonder nor its intimate connection with ethics and the divine: even in the Aristotelian corpus (among the most “scientific” collections in the ancient world) matters of theology are considered (Barnes 1995, 67, 106; cf. *NATURE AND THE DIVINE*). “Scientist,” furthermore, was not a recognized profession until the nineteenth century, and natural philosophers in the ancient world followed many paradigms: after the death of Alexander the Great (323 BCE), royal patronage enabled talented minds to pursue “science” full time (especially at Alexandria, whose Museum and Library attracted scholars from across the Greek-speaking world into the fifth century CE), but Pliny the Elder was a Roman statesman of broad learning and curiosity, like the nineteenth-century gentleman scholar. The notion of academic specialization, furthermore, would have been anathema to the ancients. For example, in addition to four-element theory to explain *physis* (nature), Empedocles proposed hypotheses on optics, evolution, and theology; Democritus’ interests included mathematics, music, and ethics, as well as physics (atomic theory).

Scientific traditions cannot be separated from the culture which produced and employed them—any more than trends in literature or religion. And the methods and principles of Greek science were forged by the agonistic nature of Greek society, which

prejudiced Greek investigations into the natural world and shaped the interrelationships between teacher and student as well as between competing schools. Greek science was an exercise in debate and persuasion. Given the state of the instrumentation, many scientific hypotheses were unprovable; thus, scholars aimed to persuade their audiences of the truth of a given theory. The Greeks also valued autonomy, and their philosophical schools were not so much “schools” in the modern sense as groups of like-minded thinkers. Many thinkers were autodidacts, and even those who studied under famous teachers were not altogether content to follow the direction of their predecessors, often carving out their own paths, citing predecessors’ views or ignoring them—whichever proved more convenient. This attitude, of course, varied from one author to another: Pliny the Elder, although more polemical than Vitruvius, nonetheless still relied largely on his predecessors (see Fögen 2009).

The methods of Greek science were largely theoretical owing to the limitations of equipment and technology. Experimentation was not a virtue, and this attitude reflects the contention between “art” and “skill” (or “doing”—the prejudice was against those who worked with their hands, such as the dirty, sweaty craftsmen; Galen tackled the question of whether medicine is an art or a skill, and he also argued that the best physicians were likewise philosophers). In the context of natural philosophy, Aristotle recognized and recommended empirical data and observation, long valued by medical practitioners and theorists (Mithridates’ notorious immunity to all known poisons and venoms was the result of a long program of research and development of antidotes by the toxicologists in his service combined with empirical trials on death-row prisoners). But theory almost always held sway, even in the light of empirical evidence (e.g., the rejection of Eratosthenes’ remarkably accurate estimate of the earth’s circumference, and the enduring theory of geocentrism: ASTRONOMY, GEOGRAPHY).

Although most ancient Mediterranean science, technology, and medicine stems from the Greek intellectual praxis, the Romans fostered and advanced these conventions (ROMAN RESPONSES TO GREEK SCIENCE AND SCHOLARSHIP AS A CULTURAL AND POLITICAL PHENOMENON, SCIENTIFIC ENCYCLOPEDIAS). Scholars living under the hegemony of the Roman Empire preserved and synthesized much of the Greek accomplishment in Latin (e.g., Pliny the Elder) and Greek (e.g., Athenaeus), new advances continued to be made on both sides of the Ionian Sea, and the Greco-Roman achievement was preserved and enhanced by later traditions (TRANSLATION AND TRANSMISSION OF ANCIENT SCIENTIFIC TEXTS, THE RECEPTION OF GRECO-ROMAN SCIENCE IN THE RENAISSANCE: ASSIMILATION(S), TRANSFORMATION(S), REJECTION, HYBRIDIZATION).

Preservation and transmission was a long process that began with the Greeks themselves. As thinkers distilled the work of their predecessors, usually in the interest of refuting them, original texts were lost, and much survives only in fragments, paraphrase, or redaction: for example, the Presocratic Natural Philosophers, culled by Aristotle and others, neatly collected, translated, and annotated in the *TEGP*; and the medical thinkers (third century BCE to second century CE), plundered by Galen who effectively silenced those voices with which he disagreed. Much of the surviving corpus is a distorted and often uncontextualized selection, but a selection nonetheless that was considered worthy to be copied numerous times over the span of 2500 years (and in many cases translated into Arabic and other languages, which thus accounts for their survival). Furthermore, ancient texts remain unedited and untranslated into modern languages (consequently, the works of Galen which survive only in Arabic transmission or translation still remain