David Whitehead and P. H. Blyth

Athenaeus Mechanicus, On Machines (Περί μηχανημάτων)

Translated with Introduction and Commentary

Geschichte

Historia Einzelschriften – 182

Franz Steiner Verlag

David Whitehead and P. H. Blyth Athenaeus Mechanicus, On Machines (Περὶ μηχανημάτων)

HISTORIA

Zeitschrift für Alte Geschichte Revue d'histoire ancienne Journal of Ancient History Rivista di storia antica

EINZELSCHRIFTEN

Herausgegeben von Kai Brodersen/Mannheim Mortimer Chambers/Los Angeles Martin Jehne/Dresden François Paschoud/Geneve Hildegard Temporini/Tübingen

HEFT 182

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Franz Steiner Verlag Stuttgart 2004

Bibliographische Information der Deutschen Bibliothek Die Deutsche Bibliothek verzeichnet diese Publikation in der Deutschen Nationalbibliographie; detaillierte bibliographische Daten sind im Internet über <<u>http://dnb.ddb.de</u>> abrufbar. ISBN 3-515-08532-7



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Gedruckt auf säurefreiem, alterungsbeständigem Papier. Druck: Printservice Decker & Bokor, München. Printed in Germany

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PREFACE

Users of the third edition of the Oxford Classical Dictionary are reckoned to need information about three writers called Athenaeus. Their order there has no discernible rationale, chronological or other – though they do appear together, and in this same order, in the Pauly-Wissowa RE (as its nos.22–24). No.1, at all events, is the author of the encyclopaedic, fifteen-volume Deipnosophistai (Dons at Dinner), written around the turn of the second century A.D. On this man – the one who for most classicists is the Athenaeus – OCD readers can benefit from the accumulated wisdom and the bibliographical awareness of W.M. Edwards, Robert Browning, and now N.G. Wilson, the whole amounting to some five columninches. No.3 is the medical writer Athenaeus (of disputed date) who founded the Pneumatist school. Here Vivian Nutton updates the earlier entry by Ludwig Edelstein; and the upshot is a piece of similar length, with bibliography appended.

Between these two comes an entry which appears in the third edition of the OCD (1996) exactly as it did in the second (1970), apart from the addition of internal cross-references and some cosmetic points of style. The work of E.W. Marsden, it reads in full as follows:

Athenaeus(2)Mechanicus, author of an extant work on siege-engines (Π ερù μηχανημάτων; see ARTILLERY, SIEGECRAFT), may probably be dated in the 1st cent. BC.

Ed. R. Schneider, Abh. d. Gesellsch. d. Wissensch. zu Göttingen (Phil.-hist. Kl.) NF 12 (1912).

Eric Marsden died, before his time, in 1976; and his combination of theoretical and practical mastery of topics like this has proved, in the Anglophone world at least, hard to replace. No wonder the *OCD*'s editors, Simon Hornblower and Antony Spawforth, were content to reissue his expert summary. But can one agree with their view, inherited from their editorial predecessors N.G.L. Hammond and H.H. Scullard, that such a summary goes far enough, even granted the constraints imposed by an all-purpose work of reference? It is to those who would like to know more about Athenaeus Mechanicus that we proffer this book.

Its first-person plurals, as just exemplified, should be understood literally. 'We' does mean David Whitehead (classicist, ancient historian, author of two existing commentaries on Greek prose authors) and Henry Blyth (educated first in classics, later in engineering, and Honorary Fellow in both subjects at the University of Reading). Everything that follows here, having long since passed the time when its original authorship remained either discernible or significant, is therefore our joint responsibility.

Preface

The process of reaching a point where such a declaration could be made, and meant, has been a considerable challenge for two scholars who knew little of each other until the turn of the millennium; who live on different land-masses (praise be for e-mail!); and who, as their collaboration unfolded, turned out to have very different working methods and academic temperaments. What has sustained us is the stimulus of each other's strengths, together with the conviction that our joint efforts will do far more for Athenaeus than either of us could have managed alone.

This is true, we believe, in two respects. First and foremost we are rescuing from relative oblivion a writer whose interest and importance, it transpires, is by no means confined to the history of military engineering. He also commands a modest place in the cultural history of late-Hellenistic Greece and late-Republican Rome. But in addition, fathoming Athenaeus inevitably involves some overall judgements on the poliorcetic "genre". Here we wish to urge both more scepticism and more sophistication than has been customary in the past. Too many scholars have approached these works as if they were modern engineering manuals - very much as naive lay authors (of the Who Moved The Stone? school) take it for granted that the Bible is History, and are upset when told otherwise. To do this with the likes of Athenaeus, we say, is to risk a double error: falling into modernizing fallacies when assessing the feasibility of the designs and mechanisms which his work describes, and over-simplifying the contexts - intellectual as well as technological - which have generated them. We realise full well that our views are likely to provoke debate, but this we will welcome, for here is a subject which (on this level) has long been in need of more of it.

Given the character and outcome of our working relationship, votes of thanks can properly begin in the words of the late Russell Meiggs and David Lewis, when prefacing their *Greek Historical Inscriptions*: 'we should...compliment one another, for we have found a surprising measure of agreement and our few differences of opinion have never escalated'. Beyond that, we have been heartened at every stage by the support and encouragement of Brian Bosworth (who should incur no reproach for the directions in which this valuable fuel has propelled us); and others whom we wish to name – without, again, incriminating – for input at different times and of various kinds are Tony Birley, Tim Cornell, John Curran, Brian Cotterell, John Davies, Keith Dix, Andrew Fear, George Houston, George Jeronimidis, and Robert Parker.

We dedicate this book to our wives, than whom only Mrs Athenaeus will have needed greater forbearance.

Belfast and Thame

January 2004

CONVENTIONS AND ABBREVIATIONS

1. The author of the text which is our concern here, Athenaeus (Athenaios, 'A $\theta\eta\nu\alpha\tilde{\iota}\alpha\varsigma$), is routinely foreshortened to Ath. ('Athen.' will indicate his better-known homonym, the author of the *Deipnosophistai*.)

Conventions for abbreviating the names of other ancient writers and their works generally follow those of standard reference-works such as LS-J, the OCD and the *TLG Canon* (for all of which see section 3 below), any deviations from such standards being in the direction of greater explicitness. (On the impossible matter of consistency between Latinization and transliteration we enter the usual disclaimer.)

The two surviving parts of the *Mechanike Syntaxis* of Philo(n) of Byzantium (a.k.a. Philo Mechanicus), books 4 (*Belopoeica*) and 7-8 (*vulgo* 5: *Parasceuastica* and *Poliorcetica*), we abbreviate as *Bel.* and *Pol.* respectively. References to the former are by Thévenot pages and lines (*pace* LS-J, there is no edition by Wescher), taken over by Diels/Schramm and Marsden; to the latter by Diels/Schramm sections and chapters, taken over by Garlan and Lawrence. *Lat.Alex.* = *Laterculi Alexandrini aus einem Papyrus ptolemaïscher Zeit*, ed. H. Diels, *Abh. d. Königl. preuss. Akad. der Wiss.* (Berlin 1904).

2. The editions of Ath. by Wescher and Schneider (see Introduction A.i) and the translation by Rochas d'Aiglun (see Introduction, A.ii) are all cited by the name of the editor or translator only. So too is the edition of the *Par(angelmata) Pol(iorketika)* by Sullivan (see Introduction A.iv). Concerning Vitr(uvius), 'Granger' means F. Granger (ed.), Vitruvius, On Architecture (two vols.: Loeb Classical Library, London & New York 1931); and 'Callebat/Fleury' signifies L. Callebat and P. Fleury (eds.), Vitruve, de l'architecture, livre X (Association Guillaume Budé: Paris 1986). (These are the two editions of Vitruvius that have proved most useful to us, but we also make occasional mention of those by J.G. Schneider (Leipzig 1807–8), A. (= Luigi) Marini (Rome 1836), V. Rose (Leipzig 1867 [1899]), and C. Fensterbusch (Darmstadt 1964).)

3. For other secondary literature (if cited more than once) see the Select Bibliography. There, as throughout this book, the following abbreviations are employed:

Berve Berve, H. Das Alexanderreich auf prosopographischer Grundlage (Munich 1926) (entries as numbered in vol.2)

BGU Berliner Griechische Urkunden

CAH The Cambridge Ancient History (Second edn. unless otherwise indicated)

CHCL Easterling, P.E. and Kenney, E.J. (eds.) The Cambridge History of Classical Literature, I: Greek Literature (Cambridge 1985)

DK Diels, H. and Kranz, W. Die Fragmente der Vorsokratiker, tenth edn. (Berlin 1961)

DNP Cancik, H. and Schneider, H. (eds.) Der Neue Pauly: Enzyklopädie der Antike (Stuttgart 1996-)

FGrH Jacoby, F. Die Fragmente der griechischen Historiker (Berlin & Leiden 1926–1958)

GRT Humphrey, J.W., Oleson, J.P., and Sherwood, A.N. Greek and Roman Technology: a sourcebook (London & New York 1998)

Harding Harding, P. From the Peloponnesian War to the Battle of Ipsus (Cambridge 1985)

HCA Bosworth, A.B. A Historical Commentary on Arrian's History of Alexander, two volumes thus far (Oxford 1980–1995)

HCP Walbank, F.W. A Historical Commentary on Polybius, three volumes (Oxford 1957–1979)

HCT Gomme, A.W., Andrewes, A., and Dover K.J. A Historical Commentary on Thucydides, five volumes (Oxford 1945–1981)

IG Inscriptiones Graecae

LS-J Liddell, H.G., Scott, R., and Jones, H.S. A Greek-English Lexicon, ninth edn. with revised Supplement (Oxford 1996)

LTUR Steinby, E.M. (ed.) Lexicon Topographicum Urbis Romae (Rome 1993-1999)

OCD Hornblower, S. and Spawforth, A. (eds.) The Oxford Classical Dictionary, third edn. (Oxford 1996)

Platner-Ashby Platner, S.B. and Ashby, T. A Pictorial Dictionary of Ancient Rome (Oxford 1929)

RE Pauly, A.F., Wissowa, G., Kroll, W., and others (eds.) *Real-Encyclo*pädie der classischen Altertumswissenschaft (Stuttgart 1894–1980)

SEG Supplementum Epigraphicum Graecum

Syll.³ Dittenberger, W. (ed.), Sylloge Inscriptionum Graecarum, third edition (4 vols: Leipzig 1919–1924, reprinted Hildesheim 1982)

TLG Canon Berkowitz, L. and Squitier, K.A. Thesaurus Linguae Graecae: Canon of Greek authors and works, third edn. (New York & Oxford 1990)

MEASURES AND WEIGHTS

Where Ath. gives exact figures for linear measures and for weights we leave them, in translation, in their original Greek forms but supply (in parenthesis) modern, metric equivalents.

(1) MEASURES. The smallest unit was the *dactyl* ($\delta \dot{\alpha} \kappa \tau \upsilon \lambda \sigma \varsigma$). Four dactyls made a *palm* ($\pi \alpha \lambda \alpha (\iota) \sigma \tau \dot{\eta}$), twelve dactyls a *span* ($\sigma \pi \iota \theta \alpha \mu \dot{\eta}$), sixteen dactyls a *foot* ($\pi \sigma \dot{\upsilon} \varsigma$), and twenty-four dactyls a *cubit* ($\pi \tilde{\eta} \chi \upsilon \varsigma$).

Though Ath. uses all five terms, his preference is for dactyls, palms and cubits. (The span occurs only in the 'three-span' catapult of 8.7–8; 12.1, 12.7 and 21.8 have ' $x^{-1}/_2$ cubits', rather than saying x cubits and 1 span; and '3 palms' – again, rather than 1 span – appears six times. As to feet, single ones occur in 12.1, 17.1, and 24.1, and two feet in 23.12, but note 'sixteen dactyls'(!) in 35.1).

We follow Marsden (*Development* xix, *Treatises* xvii) — and ultimately Hultsch, *Metrologie* 697 — in operating with millimetre equivalents as follows: dactyl 19.3, palm 77.1, span 231.2, foot 308.3, cubit 462.4. (Note that the equivalences used by Lendle in *Schildkröten* and *Texte* are marginally smaller: see *Schildkröten* 7 n.21.) Cf. generally Cotterell and Kamminga, *Mechanics* 19 (Table 2.1). To avoid confusion in what follows here, all modern equivalences we supply are metric, and all dimensions in feet signify ancient Greek feet.

For the stade ($\sigma \tau \alpha \delta \iota \sigma \nu$), a measure of long distance, see the Commentary to 8.7-8.

(2) WEIGHTS. By comparison with the lavish provision of quantified linear measurements, weights figure very little in Ath.'s presentation. See merely 8.8, for a catapult with 'twelve minas-(weight) of spring', and 27.6, 36.2 and 36.3 for rather heavier weights expressed in talents. Vastly heavier weights (by three orders of magnitude) in talents appear at 26.5 and 37.1: see the Commentary there.

All Greek systems of weights had six *obols* to the *drachma*, a hundred drachmas to the *mina* ($\mu\nu\alpha$), and sixty minas to the *talent* ($\tau\alpha\lambda\alpha\nu\tau\sigma\nu$); in absolute terms, however, there was no equivalent here of the universal foot (etc.). Nevertheless, the Attic-Euboic standard, with the mina at 436.6 grammes (see generally Hultsch, *Metrologie* 700), was widespread. Marsden, *Treatises* xviii (and cf. already *Development* xix) argues that this is what 'Greek artificers and writers of treatises on artillery' used; and we have assumed, *faute de mieux*, that Ath. followed suit. Cf. generally Cotterell and Kamminga, *Mechanics* 21 (Table 2.2).

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INTRODUCTION

(A) BASICS

(i) Text(s)

Editio princeps: Melchisédec Thévenot (1620–1692) and others, Veterum mathematicorum Athenaei, Apollodori, Philonis, Bitonis, Heronis et aliorum opera Graece et Latine pleraque nunc primum edita (Paris, 1693) – a corpus published under the auspices of Louis XIV – at pp.1–12.

Re-edited, on the basis of significant new manuscript discoveries, by Carl(e) Wescher (1832–1904), *Poliorcétique des Grecs: traités théoriques, récits historiques* (Paris, 1867), at pp. 1–40. Plain text, with *apparatus criticus*, and twelve intertextual illustrations (cf. pp. 367–68 of the *elenchus figurarum*) transcribed from the eleventh-century ms. M (= Codex Parisinus inter supplementa Graeca 607); geographical and historical index (to all the treatises covered); addenda and corrigenda.

Re-edited by Rudolf Schneider (1851–1911), Griechische Poliorketiker mit den handschriftlichen Bildern herausgegeben und übersetzt, III: Athenaios, Über Maschinen (Abhandlungen der Königlichen Gesellschaft der Wissenschaften zu Göttingen, philologisch-historische Klasse, neue Folge 12, no.5: Berlin, 1912). Short introduction; text, with apparatus and facing German translation, of both Athenaeus' treatise and Vitruvius Book 10 chapters 13-15.7, plus 16.4 (with which it shows a close affinity); notes; Greek index; observations on, and photographs of, the manuscript illustrations.

Schneider's posthumous edition – the one cited in the OCD – took over Wescher's page- and line-numbers, and they remain the standard mode of reference to the treatise (as also to several others in the genre). The availability of these publications is very limited, however. In Britain we know of copies of Wescher in only two university libraries: Glasgow (borrowable) and Oxford (not borrowable, though photocopying permitted). With Schneider the case is better but not much: one ideally needs access to a library which holds the relevant run of this journal, and very few do.

To be sure, Schneider's text can now reach a worldwide audience through its inclusion on the CD-ROM periodically issued from California by the *Thesaurus Linguae Graecae* project. This is a tremendous boon – as far as it goes: a plain text of distinctly rebarbative appearance, which lacks an *apparatus* (to say nothing of a translation or notes) and which makes allusion to manuscript illustrations not reproduced on-screen.

(ii) Translations

Schneider's German translation is the only complete one. It is relatively loose, and therefore not always very helpful for the grasp of technical detail.

Two other, partial translations also exist. In *Mélanges Graux: recueil de travaux d'érudition classique dédié à la mémoire de Charles Graux* (Paris, 1884), at 780–801, Eugène August Albert de Rochas d'Aiglun (1837-1914) – a polymath with a particular interest in ancient military history – proffered a French 'Traduction du Traité des Machines d'Athénée' (set out in thirty short, common-sense chapters of the translator's own devising). It is notionally complete but in fact involves omissions: the bulk of the preface (3.5-7.4) and some short technical sections (22.11-23.10, 24.2-9, 25.1-7, 28.3-5, 29.5-8, 31.4-5). And nearer our own time Otto Lendle of Marburg, who until his death in 1999 was the doyen of "kitchen-table" experts on siege-engines,¹ included in his two monographs on the subject long stretches of Athenaeus in German translation: 12.12-14.3, 16.4-26.5, and 33.5-37.2 in *Schildkröten*; 11.4-12.11, 14.4-15.2, 27.2-28.6, 29.9-31.5, 32.2-33.3, and 38.9-13 in *Texte*.

(iii) Commentaries

There is no comprehensive commentary on the treatise. Those able to translate it can only look, for any further enlightenment they need, to the notes in Schneider (if accessible to them), to the discontinuous explications in Lendle (and in Sackur, *Vitruv*), and to occasional comments elsewhere.

(iv) Influence

The close affinity between the core section of Athenaeus' treatise, 9.4–27.6, and Vitruvius 10.13ff (see already i above) could in theory represent the influence of the former on the latter, and in the past such a view has indeed been held.² However, it has long since given way to an orthodoxy first argued by Maximilian Thiel, *Quae ratio intercedat inter Vitruvium et Athenaeum Mechanicum*: that neither Vitruvius nor Athenaeus copied from the other, but each closely followed a common source.³

¹ We intend no offence by this description. The point is simply that whereas Marsden built full-scale models of the machines he was studying (Marsden, *Development* viii and Plates 4, 6, 7, 8), Lendle contented himself with small-scale ones (Lendle, *Schildkröten* 5 with n.19; 'Kriegsmaschinen' 332 n.5; *Texte* xviii with n.4). Such a procedure can test some things but not others, e.g. stability and dynamics.

² By, for instance, J.L. Ussing, *Observations on Vitruvii de architectura libri decem with special regard to the time at which this work was written* (London 1898), a revised translation of *Betragtninger over Vitruvii...* (Copenhagen 1896).

³ Diss. Leipzig, 1895; published in *Leipziger Studien* 17 (1896) 275–308; see further below, text to nn.17–18.

(B) The author

The 'influence' of Athenaeus must therefore be sought in a much later age. Together with others of its kind, his treatise was explicitly quarried by "Heron of Byzantium" – actually an anonymous Byzantine author of the tenth century A.D. This work too was edited by Schneider, under the title *Parangelmata Poliorcetica (Instructions for Siege-Warfare*);⁴ and it has recently been re-edited, with English translation and commentary, by the American Byzantinist Denis L. Sullivan.⁵ Material from Athenaeus' Preface reappears in the last part (200.14–204.4 Wescher = ch.3 Sullivan) of the preface here too, and see also: (?)204.19–205.7 (ch.5 S) *re* Ath. 37.5–38.1, esp. 37.7; 205.8–16 (ch.6 S) *re* 38.2–9; 230.1–232.5 (ch.25 S), *re* 21.1–26.5; 232.6–12 (ch.26 S), *re* 9.15–10.5, etc.; (?)238.12–239.12 (ch.30 S), *re* 10.10–12.10; 262.12–264.14 (ch.50 S), *re* 29.9–31.2; 267.11–270.7 (ch.53 S), *re* 27.7–28.6 and 31.3–33.2; and 270.8–271.9 (ch.54 S), *re* 35.4–37.2.

(B) THE AUTHOR

(i) Background

Attempts to date and contextualize the A Θ HNAIOY Π EPI MHXANHMAT Ω N, and to identify its author, go back four hundred years. Marsden's standpoint in the *OCD* (see already our Preface) – probably first century B.C. – should in our view be accepted. Nevertheless, the issues would benefit from some unravelling.

Athenaios/Athenaeus is a relatively common name, especially from the third century B.C. onwards, and it proffers in itself no clues to dating (or provenance). Bearers of the name encountered in explicitly military contexts could obviously narrow the field; and the great Isaac Casaubon (1559–1614) was the first to nominate the one who in his view was this author: Athenaeus of Byzantium, mentioned with his fellow-citizen Cleodamas in the *Historia Augusta* as having been entrusted by the emperor Gallienus (reigned A.D. 253–268) with assignments in fortress building and repair (*instaurandis urbibus muniendisque praefecit*).⁶

⁴ R. Schneider, Griechische Poliorketiker mit den handschriftlichen Bildern herausgegeben und übersetzt, II: Anweisen zur Belagerungkunst (Abhandlungen der Königlichen Gesellschaft der Wissenschaften zu Göttingen, philologisch-historische Klasse, neue Folge 11 no. 1: Berlin 1908 [1909]).

⁵ D.L. Sullivan, Siegecraft: two tenth-century instructional manuals by "Heron of Byzantium" (Dumbarton Oaks Studies 36: Washington D.C. 2000). Sullivan divides the Par.Pol. into 58 short chapters, each with their own line-numbers, and adds Wescher/Schneider page numbers in the margin. (We cite by both systems.) Sullivan's boldness in proffering something more helpful than Wescher/Schneider is admirable, and his innovation deserves to succeed in the long run; nevertheless we have (reluctantly) eschewed anything similar with Ath., an author more widely used and cited (LS-J, TLG, etc.) in the traditional way.

⁶ 'Trebellius Pollio', SHA Gallieni duo 13.6; I. Casaubon, Historiae Augustae Scriptores (Leiden 1671, originally Paris 1603) 2.221 n.4. (We owe both this reference and the one in the next note to Schneider 1–2.) For Cleodamas, attested also elsewhere, see now K. Gross-Albenhausen in DNP 6 (1999) col. 577.

Introduction

Casaubon's suggestion was challenged, however, by one of the lesser luminaries of seventeenth-century scholarship, the librarian Peter Lambeck (1628-1680). In the seventh volume of his eight-volume catalogue of the Imperial Library in Vienna, Lambeck not merely listed Athenaeus' treatise (and quoted its opening lines) but ventilated a decidedly un-Casaubonian idea on its date.⁷ Athenaeus addresses his sententious Preface to a dignitary called Marcellus: 'o most august Marcellus' ($\check{\alpha}$ σεμνότατε Μάρκελλε), it apostrophizes. Lambeck proposed that this naturally placed Athenaeus a full 479 years before his Casaubonian time: namely, in 213-12 B.C., when M. Claudius Marcellus famously blockaded and captured Syracuse, in Sicily, with Archimedes as inventor-inchief for the besieged and (on this hypothesis) Athenaeus his counterpart for the besiegers.

So Casaubon or Lambeck? The next – long – phase of scholarship consisted of a seesawing back and forth between these two positions.

Despite occasional voices raised against it (as being earlier than anything else in the treatise could corroborate), Lambeck's dating held general sway for the remainder of the seventeenth century and on throughout the eighteenth. Early in the nineteenth century J. Schweighaeuser in his edition of the *Deipnosophistai* and J.G. Schneider in his edition of Vitruvius each sought to revive Casaubon's dating, on the basis that the treatise's mention of Ctesibius (29.9ff) ruled out Lambeck's dating.⁸ Nevertheless, the standard literary histories of the later nineteenth century (T. Bergk in 1887, W. Christ in 1889, F. Susemihl in 1891) all ignored this and labelled Athenaeus as a *Zeitgenosse des Archimedes*.

Yet already the tide had begun to turn. In 1884 the translator Rochas d'Aiglun broke new ground by rejecting the Casaubon and Lambeck datings (uncredited) alike. The former he spurned on the grounds that there was no obvious Marcellus of distinction in that era, the mid-third century A.D., to be the work's dedicatee. With the latter his objection was that two other names mentioned in the treatise were inconsistent with a third-century-B.C. dating. One is Apollonius (8.9ff), described as the teacher ($\delta \iota \delta \dot{\alpha} \sigma \kappa \alpha \lambda o \varsigma$) of the Agesistratus who taught Athenaeus himself, and taken to be the mathematician Apollonius of Perge (*fl.200*). The other name of relevance is – as it had been for Schweighaeuser and Schneider – Ctesibius, 'qu'on s'accorde à regarder comme vivant au commencement du IIe siècle avant notre ère'.

Such *termini post quos* might well have led Rochas to favour precisely that century, the second B.C., when first the homonymous son and then the homonymous grandson of the victor at Syracuse are available as dedicatees;⁹ but instead his nominee was the Pompeian M. Claudius Marcellus (*cos.* 51 B.C.).¹⁰ 'Athénée se trouverait ainsi le contemporain de Vitruve, qui a puisé aux mêmes sources que

⁷ P. Lambeck (Petrus Lambecius), *Biblioth. Caesar. Vindob.* VII (1655–1679), ad cod. CXIV.

⁸ Schweighaeuser at pp. 637–638 of his second volume of notes (Strasbourg 1802); Schneider, more tersely, at p. 361 of his vol. 3 (Leipzig 1808).

⁹ See in brief OCD p.341, under Claudius (RE 222) Marcellus (2), Marcus and Claudius (RE 225) Marcellus (3), Marcus.

¹⁰ See in brief OCD p. 341, under Claudius (RE 229) Marcellus (4), Marcus.

lui pour composer son livre X et qui ne l'a point cité parmi les ingénieurs ayant traité des machines (*Preface* du livre VII)'.

These arguments were noted and evaluated in the *RE* article on Athenaeus (2 (1896) cols. 2033–2034) by F.O. Hultsch, he of the authoritative *Griechische und Römische Metrologie*. Hultsch agreed that mention of Ctesibius ruled out the third century,¹¹ but he opted for the second century over the first. No particular Marcellus, in his view, could (or should) be identified as the dedicatee; and Athenaeus' Apollonius, the teacher of his own teacher Agesistratus, was not the mathematician from Perge¹² but a homonym active in the first half of the second century – so that the Apollonius \rightarrow Agesistratus \rightarrow Athenaeus sequence put the treatise there too.¹³

Hultsch contended, in passing, that the lack of any mention of Hero of Alexandria was a *prima facie* argument against late datings;¹⁴ but already, as he was to discover, a new variant of them had been propounded. 'Ingenieur etwa hadrianischer Zeit' was how Athenaeus had by now been characterized by Hermann Diels, who went on to speak of a *Rokokocharakter* in Athenaeus' work which smacked of the second century A.D. Although nothing more than *obiter dicta* in a study of Strato of Lampsacus,¹⁵ they did not go unnoticed amongst would-be daters of Athenaeus. Hultsch rejected them, in addenda to his *RE* entry;¹⁶ Schneider embraced them as summarizing the best that could be done. Hultsch's addenda also noted, and likewise rejected, the similar dating (second or even third century A.D.) espoused in Thiel's Leipzig dissertation *Quae ratio intercedat inter Vitruvium et Athenaeum Mechanicum*¹⁷ – a dating again offered

¹¹ Since this dating-criterion attracted less (and ultimately no) attention in later scholarship, it may be pointed out here that Ctesibius apparently does, on the contrary, belong in the third century (f1. 270–230). So in brief G.J. Toomer in *OCD* s.v.; F. Krafft, 'Ktesibios (1)', in *DNP* 6 (1999) cols. 876–878. For the arguments and issues see Marsden, *Treatises* 6–9; and further here at text to nn. 97–98 below and in the Commentary to 29.9. See also Endnote 1, where we sketch out (but give reasons why one should not, ultimately, accept) a neo-Lambeckian context for Ath. and Marcellus.

 12 In his actual entry on Apollonius (Apollonius (113), in RE 2 (1896) cols. 160–161) Hultsch labels him 'from Athens', but this was corrected in RE suppl.vol. 1 (1903) col. 111: he had meant to say 'mentioned in Athenaeus'. On A. of Perge see now G.J. Toomer in OCD s.v. Apollonius (2); M. Folkerts, 'Apollonios (13)', in DNP 1 (1996) cols. 885–887.

¹³ Hultsch's entries on Agesistratus (Agesistratus (4), in the addenda to RE 1 (1894) col. 2889) as well as on Apollonius (see preceding note) leave his dating for them unstated; it takes on explicitness only in the Athenaeus entry.

¹⁴ By this, it is clear, Hultsch meant later than the second century B.C. – the prevailing view in his day being that Hero was a pupil of Ctesibius. But nowadays Hero is placed much later: *fl.* A.D. 62 (the year of a lunar eclipse which, as Otto Neugebauer pointed out, ch. 35 of Hero's *Dioptra* almost certainly presupposes). See on this e.g. Marsden, *Treatises* 1 and (more fully) 209; White, *Technology* 180; M. Folkerts in *DNP* 5 (1998) cols. 480–483, at 480; Landels, *Engineering* 200–201.

¹⁵ H. Diels, 'Über die physikalische System des Straton', *Sitzber. der K. preuss. Akad. d. Wiss. zu Berlin* 1893, I. 101–127, at 111. For Strato see further below, text to nn. 42–43.

¹⁶ Col. 2862 in the same volume. The original entry and the addenda were brought together in suppl.vol. I (1903) cols. 220–221.

¹⁷ See above, at n. 3.

obiter, it is fair to say, because Thiel's main concern was to prove that neither Athenaeus nor Vitruvius copied from the other but that each drew on the same source: Agesistratus.

Thiel's central thesis has long since become orthodox, at least in its negative aspect.¹⁸ His (and Diels') date for Athenaeus, however, has not. Rather, as one glimpses in the *OCD* entry, it is Rochas d'Aiglun's idea about the first century B.C. that has lived on, but in a more cogent and persuasive form. Chapter VII.4 (pp. 271–79) of the *Römische Studien* of Conrad Cichorius¹⁹ was entitled 'Das Werk des Athenaeus über Kriegsmaschinen', and this ingenious scholar set himself there to put the dating of the *Werk* on a new footing.

Fundamental to it is the Apollonius \rightarrow Agesistratus \rightarrow Athenaeus chain. Its importance for dating purposes had already been appreciated by Hultsch (above); but whereas Hultsch had put Apollonius in the first half of the second century, Cichorius brought him down into the first quarter of the first. Here is the relevant passage (8.9–13):

Apollonius, who was his teacher, dragged onto the mole around the harbour in Rhodes stones in loads of such a size that the onlookers were often baffled as to how exactly he took them onto the ships and by what means he unloaded them onto Rhodian soil ($A\pi o\lambda \lambda \dot{\omega}v_{10} \zeta$ de d verovàc autoũ didátkalog thlikaũta hyare fortía lítuw etil tò xũµa tò πerì tòv luµéva tòv ev 'Póda, sotte kai à aophat nollákus toùs ópũvtas autá mũs mote els tàs vaũs aveláµBave kai tívi tróna este auto auto à tà tỹ rỹ tỹ tố vậ).

When would Rhodian fortifications have needed strengthening in this way? The famously unsuccessful blockade by Demetrius Poliorcetes in 305/4 B.C. (Diodorus 20.81–100, etc.) is far too early. However, the city was besieged again – and again to no avail – in 88/7 B.C., by Mithridates VI Eupator; and Appian expressly mentions that on this occasion 'the Rhodians strengthened their city walls and the harbours and placed machines at them all' ('Ρόδιοι τὰ τε τείχη σφῶν καὶ τοὺς λιμένας ἐκρατύναντο καὶ μηχανὰς ἅπασιν ἐφίσταντο: Appian, *Mithridatica* 94).

With Athenaeus, the pupil of the pupil of this Apollonius, thus to be envisaged as writing in the second half of the first century B.C.,²⁰ the identity of that $\sigma \epsilon \mu v \delta \tau \alpha \tau \sigma \varsigma$ Marcellus who was to have the benefit of the writer's military wisdom is obvious, Cichorius contended. It is none other than M. Claudius

¹⁸ Cf. Lendle, 'Vitruv' 189. In thus becoming orthodox, Thiel's view has relegated to the status of an historical curiosity an (anyway doomed) attempt to argue that Vitruvius and Athenaeus were one and the same individual: F. Krohn, Quaestiones Vitrivianae II: de Vitruvio auctore commentarii qui inscribitur 'Αθηναίου περὶ μηχανημάτων, Beilage zum Jahresbericht des Schillergymnasiums (Münster 1913) (non vidimus).

¹⁹ Cichorius, 'Athenaeus'.

 20 An historian seeking to proceed by historical arguments, Cichorius felt the need to consult a linguist on the question of Diels' judgement that the treatise belonged in the second century A.D., and in this regard he quoted (Cichorius, 'Athenaeus' 277) the verdict of one of the most venerable experts of the day, August Brinkmann (1863–1923). It amounts to the opinion that the supposed *Rokokocharakter* of the treatise reflects a superficial veneer present in manuscript M, by contrast with which the fundamentals of Ath.'s own language belong perfectly well in the first (or second) century B.C. We see no call to disagree.

(B) The author

Marcellus (42–23 B.C.), nephew, son-in-law, and putative heir of Augustus²¹ – his mother Octavia credited by Plutarch (*Antonius* 31.4) with virtues including, precisely, $\sigma \epsilon \mu v \delta \tau \eta \varsigma$. At the tender age of fifteen, in late 27, Marcellus accompanied Augustus to north-western Spain, there to spend the next two years subduing the Cantabri and the Astures. They were opponents 'confident in their strongholds' ($\dot{\epsilon}\pi\dot{\iota}$ $\tau \sigma \tilde{\iota} \varsigma \dot{\epsilon}\rho \nu \mu v \sigma \tilde{\iota} \varsigma \dot{\epsilon}\pi \alpha \iota \rho \delta \mu \epsilon v \sigma \iota$: Cassius Dio 53.25.5); the campaign duly involved several sieges; and it was in preparation for them that Athenaeus gave the young man what he had written. Cichorius drew particular attention to a passage (6.5–11) in the Preface where – citing the precedent of Isocrates' *Philippus* – Athenaeus declares himself anxious to ensure that his advice 'did not come too late for its purpose', $\dot{\upsilon} \sigma \tau \rho \rho \sigma \sigma \iota \tau \eta \varsigma \pi \rho \sigma \theta \dot{\varepsilon} \sigma \varepsilon \omega \varsigma$.²² Cichorius also placed Marcellus and Athenaeus, in this regard, in a advisee/advisor succession which was to continue, under the Empire proper, with Trajan (Apollodorus) and M. Aurelius and L. Verus (Polyaenus).

What is needed, accordingly, is an Athenaeus living in Rome (and moving in the highest circles there) in the 20s B.C. And Cichorius produced one, from what Strabo says about the city of Seleucia-on-the-Calycadnus, in Rough Cilicia:²³

Here there were in my time noteworthy men of the Peripatetic school of philosophers, Athenaeus and Xenarchus. Of these, Athenaeus also had a public career and for a time was a leader of the people in his native city; then, having fallen into a friendship with Murena, he was captured along with him while fleeing, once the plot hatched against Caesar Augustus had been detected; but after being proved innocent he was freed by Caesar. And when, on his return from Rome,²⁴ the first men who met him were greeting him and questioning him, he quoted the line of Euripides [Hecuba 1-2]: "I am come, having left the vault of the dead and the gates of darkness". But he lived on only a short time: he died in the collapse, one night, of the house in which he was living (ἐνταῦθα ἐγένοντο καθ' ἡμᾶς άνδρες άξιόλογοι τῶν ἐκ τοῦ περιπάτου φιλοσόφων Αθηναῖος τε καὶ Ξέναργος, ὧν ὁ μέν 'Αθηναῖος καὶ ἐπολιτεύσατο καὶ ἐδημαγώγησε χρόνον τινὰ ἐν τῆ πατρίδι· εἶτ' έμπεσών είς την Μουρήνα φιλίαν έκείνω συνεάλω φεύγων, φωραθείσης τῆς κατὰ Καίσαρος τοῦ Σεβαστοῦ συσταθείσης ἐπιβουλῆς: ἀναίτιος δὲ φανεὶς ἀφείθη ὑπὸ Καίσαρος. ώς δ' έπανιόντα έκ 'Ρώμης ήσπάζοντο καὶ έπυνθάνοντο οἱ πρῶτοι έντυγχάνοντες, τὸ τοῦ Εὐριπίδου ἔφη· ἥκω, νεκρῶν κευθμῶνα καὶ σκότου πύλας λιπών. ὀλίγον δ' έπιβίους χρόνον έν συμπτώσει τῆς οἰκίας, ὤν ἦ ὤκει, διεφθάρη, νύκτωρ γενομένη: Strabo 14.5.4).

 21 See in brief *OCD* p. 341, under Claudius (*RE* 230) Marcellus (5), Marcus. A slip in Marsden, *Treatises* 5 gives him his father's praenomen, Gaius; it is reproduced in Callebat/ Fleury xxvii. (Cichorius, incidentally, makes the acute observation that if this Marcellus had, as claimed, lived a century or more earlier, Athenaeus would be most unlikely to have addressed him by cognomen alone.)

 22 See Isoc. 5.7: while he was still busy framing arguments why Philip and the Athenians should make peace with one another, they anticipated him by doing so (346 B.C.).

²³ Modern Silifke, on the river of SE coastal Turkey now called the Göksu. See generally F. Hild and H. Hellenkemper, *Tabula Imperii Byzantini 5.1: Kilikien und Isaurien* (Österreichische Akademie der Wissenschaften, Wien, philos.-hist. Klasse, Denkschriften 215: Vienna 1990) 402–406; F. Hild, 'Seleukeia(5)', in DNP 11 (2001) col. 357.

²⁴ The older mss. have 'to Rome' here, but the correctness of emendation from εἰς 'Ρώμην to ἐκ 'Ρώμης (Casaubon, Kramer) is corroborated by the Vatican Palimpsest of c.A.D. 500. See G.W. Bowersock, 'A correction in Strabo confirmed', CR 14 (1964) 12–13.

Introduction

This Athenaeus, then, was indeed in Rome until his alleged involvement – in 23 or, more probably, 22 - in the conspiracy of Fannius Caepio and 'Licinius' (Terentius Varro) Murena.²⁵ And he is just the sort of intellectual/literary figure likely to have been welcomed in the house of Octavia, along with (e.g.) his fellow-Cilicians from Tarsus, Athenodorus (son of Sandon) and Nestor.²⁶

(ii) Issues

In the eighty years since Cichorius (with Brinkmann) constructed the elegant chain of argumentation just described, nobody, to the best of our knowledge, has sought to challenge it.²⁷ On the contrary: in an update to the *RE* entry on Athenaeus (*RE* suppl. vol. 6 (1935) cols. 16–17) W. Kroll accepted it *tout court*, and later Glen Bowersock did the same.²⁸ Others – Granger, Marsden, Callebat

²⁵ Cassius Dio 54.3, etc. For issues and bibliography, too complex (and insufficiently relevant) to be pursued here in detail, see Rich, *Cassius Dio* 174–177. We agree with Rich and others – and ultimately with Dio himself – in placing the conspiracy in the year 22, not 23.

²⁶ Athenodorus, son of Sandon (not to be confused with his older Tarsian namesake A. Cordylion: Strabo 14.5.14): see *OCD* s.v.; *FGrH* 746 (where F 2 is Plutarch, *Publicola* 17.8: A. addresses a work to Octavia); Bowersock, *Augustus* 32 (and index s.v.); Rawson, *Intellectual Life* 81–83. Nestor: (?) Lucian, *Macrobioi* 21 has him (sc. in old age) as a teacher of Tiberius; Cichorius, 'Athenaeus' 278 n. 2, argued that this could well make him a teacher of Marcellus too; cf. Bowersock, *Augustus* 34 (and index s.v.); Rawson, *Intellectual Life* 81. (For the young Tiberius and Marcellus as a pair see e.g. Suetonius, *Tiberius* 6.4 on the post-Actium triumph; Cassius Dio 53.26.1 on the foundation games at Augusta Emerita.) Also in the circle: the epigrammatist Crinagoras of Mytilene (A.D.E. Cameron in *OCD* s.v.; M.G. Albiani in *DNP* 6 (1999) cols. 847–848; Bowersock, *Augustus* 25 and index s.v.), who dedicated two of his poems to Marcellus (*Greek Anthology* 6.161, in which Marcellus goes to 'the western war' a boy and returns a man, and 9.545).

²⁷ The notion in chaps.5–6 of Sackur, Vitruv, that what we have represents a third-century-B.C. Athenaeus ('Athenaeus Maior') conflated with a Byzantine homonym ('Athenaeus Minor') is no exception to this statement, since Sackur wrote without knowledge of Cichorius' work. Kroll (see next note), while conceding that Sackur had made a significant contribution in technical and substantive areas, dismissed this aspect of his study as absurd ('nicht ernst zu nehmen'); cf. Lendle, 'Kriegsmaschinen' 333 n. 7. Sackur's solution was undoubtedly heavyhanded; it did, nevertheless, recognize the uncomfortable fact that the text of Athenaeus as transmitted has drawn in a certain amount of later material. Some of this pertains to the manuscript illustrations and as such is relatively easy to detect: for examples see below, text to n. 78. Some of it looks dubious because it is absent from the equivalent passage in Vitruvius: Schneider took this view of 10.4-5; Sackur then carried the principle further (e.g. with 12.6-10, 13.9-10, 14.11-12). Other material still, in the Preface and elsewhere, seems to varying extents intrusive and/or clumsy in its context and may, accordingly, have been interpolated: e.g. 3.7-10, 7.11-8.1, 8.2-4, 15.2-4, 25.1-2, 28.3-5, 33.2-3, 38.7-9. For the criteria one would seek to apply, and their results in a comparable case, see generally Blyth, 'Apollodorus'; and consult the Commentary on these passages.

 28 Kroll in *RE* suppl. vol. 6 (1935) cols. 16–17; Bowersock, *Augustus* 34–35 ('Nestor's colleague [*sc.* as mentor of Marcellus] was Athenaeus, the authority on siege-works, who composed a treatise for Marcellus setting out to war. Athenaeus must have been instructing Marcellus at the time of his departure for Spain with Augustus. Since the Seleuceian Peripatetic

and Fleury, Lendle, Sullivan – have passed over in silence the identification with Athenaeus of Seleucia but have endorsed, explicitly or tacitly, the rest.²⁹

Of these modern contributions, that of Marsden is especially worth noting here, on two counts:

(1) Catapults. At some point in the technical development of catapults, their washers (choinikides, modioli) were crucially modified in shape, from round to oval. This permitted a significantly larger quantity of cord in each spring and hence, obviously, gave the weapon greater power and range. When did the modification occur? Marsden pointed out that the metal catapult components discovered at Ampurias/Empuries (ancient Emporion) in NE Spain, in 1914, date from the second half of the second century B.C. and include round washers. This he took to be an indication that oval washers were not yet in use at that time. They do, on the other hand, seem to be necessitated by the ranges of the two catapults of Agesistratus which Athenaeus describes (8.5-9). In Marsden's judgement these ranges - three and a half stades for a three-span euthytone, four stades for a four-cubit palintone - were attainable (albeit as absolute maxima), and they provided circumstantial evidence that it was Agesistratus himself, in the first century, who had effected the necessary improvement.³⁰ Here then, it seems, is corroboration of the correct century in which to place the Apollonius \rightarrow Agesistratus \rightarrow Athenaeus sequence.

(2) The Porticus Octaviae Library (in the Campus Martius). Cichorius had used a brief footnote to point out the fact – without comment on its implications – that Octavia established a public library, embracing both Greek and Latin literature. Plutarch (*Marcellus* 30.11) says that it was founded to commemorate Marcellus' untimely death; Suetonius (*de grammaticis et rhetoribus* 21) gives a thumbnail sketch of its inaugural librarian, the learned freedman C. Maecenas Melissus.³¹

who was called Athenaeus was living in Rome at precisely this time, there is no difficulty in identifying him with the military instructor of Marcellus. The Seleuceian was an intimate of Murena, the alleged conspirator, in the years before he was charged with treachery – when his kinship with Maecenas' wife brought him close to the Emperor. Athenaeus managed to survive the fall of Murena, although he fled when the conspiracy was uncovered. Augustus discovered that Murena's friend was innocent, and Athenaeus was spared. He returned to Seleuceia with the opening words of Euripides' *Hecuba* appropriately on his lips. But he lived only a little while longer: one night the house in which he was living collapsed and crushed him'). Rawson, *Intellectual Life* 192 n. 28 mentions Cichorius' thesis – that part of it, at any rate, which identified Athenaeus' dedicatee as Augustus' nephew – without expressing a view on it.

²⁹ Granger 2.342 n. 1 (Ath.'s Marcellus probably Augustus' nephew); Drachmann, *Technology* 12, cf. 191 (where 'A.D.' should read B.C.); Marsden, *Treatises* 4–5, and see next note; Callebat and Fleury 300 and *passim*; Lendle, 'Vitruv' 189–190; Sullivan 2. (Rowland and Howe, *Vitruvius* 297 misunderstand the chronological argument when they place Agesistratus in the late second century.)

³⁰ Marsden, *Development* 42, 88–89, 205–206; cf. *Treatises* 4–5, 54 (fig. 17), 270. In accepting these figures Marsden was disagreeing with his main predecessor in the field of ancient ballistics, E.A. Schramm: see the Commentary to 8.7–8.

³¹ Cichorius, 'Athenaeus' 278 n.1. See generally on this library Platner-Ashby 84–85; L. Casson, *Libraries in the Ancient World* (New Haven & London 2001) 81, 93. For Melissus see P.L. Schmidt in *DNP* 7 (1999) col. 1189.

Marsden developed the point, explicitly, as follows:

It may be that Athenaeus Mechanicus and Vitruvius, who seem most likely to have had the same patroness, Augustus' sister Octavia, found Agesistratus' treatise in the same collection of volumes, namely the library of one branch of the Claudii Marcelli. When C.[sic] Claudius Marcellus, Augustus' nephew and son-in-law, the man to whom Athenaeus Mechanicus addressed his booklet, died in 23 B.C., his mother created a public library in his memory in the Porticus Octaviae. He may well have been the first Roman to have a library named after him. While the selection of a library for this honorific purpose may have been purely fortuitous, it is possible that a library was specifically and appropriately chosen because Marcellus' own family collection of books formed its nucleus. If so, Vitruvius and Athenaeus Mechanicus will both previously have used the same collection [...].³²

The matter of 'Agesistratus' treatise' is more elusive than it looks, as will emerge below; let it suffice for now to say that the key word here is the adverb in the final sentence. Whatever the case with Vitruvius, who did not dedicate his work to Marcellus (but merely claimed, in the Preface to Book I, that Octavia had given her brother the Emperor her *commendatio* of it), Athenaeus, who did, can only have done so while the young man was alive, and thus before the opening, to all comers, of his Memorial Library. In Cichorius' scenario Marcellus receives the book to take to Spain with him in 27. Be that as it may, his death in (late) 23 is a *terminus post quem non* for it.³³

A similar lower *terminus* is in any case entailed by Cichorius' identification of this author as Athenaeus of Seleucia. In Strabo, quoted above, this individual meets his own, accidental death 'a short time' after returning East, absolved of complicity in the Caepio-Murena plot (of, probably, 22) but no longer, one supposes, a credible figure in Rome. So does the identification convince?

Its attractions, once other considerations have drawn one to the 20s, are certainly clear. A well-connected Athenaeus in Rome in that decade.³⁴ A man of learning, whose quotation of Euripides (in Strabo) is all of a piece with the parade of erudition in the Preface of our treatise – which begins with what might just be a Peripatetic *captatio benevolentiae*,³⁵ and goes on to invoke, alongside specialist writers, Homer,³⁶ Isocrates,³⁷ and the historian Callisthenes of Olynthus (nephew of Aristotle),³⁸ as well as both Delphic and Eastern wisdom.³⁹ A man of an age –

³² Marsden, Treatises 5.

³³ In remarking that Cichorius' identification of Augustus' nephew as the Marcellus of the treatise falls short of absolute certainty, Lendle, 'Vitruv' 190 n. 3 mentions only earlier ones: three of them, from the previous generation. On the date of Marcellus' death (second half of 23) see A.J. Woodman, Velleius Paterculus, The Caesarian and Augustan Narrative (2.41–93) (Cambridge 1983) 278–279.

³⁴ For an alleged connection between Marcellus and the conspiracy, via the proconsul of Macedonia M. Primus, see Cassius Dio 54.3.2 (with D.L. Stockton, 'Primus and Murena', *Historia* 14 (1965) 18–40, at 36–37).

³⁵ See the Commentary, opening lemma.

³⁶ See the Commentary to 4.3-4.

 37 See above, at n.22, and the Commentary to 6.6–7.

³⁸ See the Commentary to 7.1-2.

³⁹ Delphic: see the Commentary to 3.2–3 and 5.2. Eastern: see the Commentary to 5.8 and 8–9.

surely older than Strabo himself (who was born c.64), so probably now in his 50s or $60s^{40}$ – to condescend to 'younger devotees of knowledge' (vɛωτέροις...φιλομαθοῦσιν: 5.4–5) without offending this particular youth, who was supposed to tell his mother and uncle/father-in-law how much he had learned from the book dedicated to him by Athenaeus.

Were it to be objected that Strabo did not attribute any writings to this Athenaeus, an apt reply would be that the same is true of the other Seleucian whom he mentions, his own teacher Xenarchus; yet there are Xenarchan "fragments" preserved (in Simplicius). Where Athenaeus is concerned, whatever induced Strabo to label him 'distinguished' ($\dot{\alpha}\xi_1\dot{\alpha}\lambda_0\gamma_0\zeta$) seems most unlikely to have been a short treatise on the history and practice of military engineering; one could reasonably envisage earlier work, of quite different kinds. We suspect, in short, that Strabo knew more about this Athenaeus than he discloses in 14.5.4. The truly pertinent issue, at all events, is this: if Athenaeus of Seleucia had wanted to send Marcellus out to Spain with something to read and profit from, is this what it would have been? Is *this work* a plausible product of *this Athenaeus*, someone who was not only an ex-politician but also one 'of the Peripatetic school of philosophers' (Strabo)?

By the first century B.C. such a designation was looser than it had once been, with the Peripatos no longer manifesting sharp doctrinal distinctions from the Academy and the Stoa.⁴¹ But more importantly, Aristotelianism itself had from the outset embraced empirically-driven research in all recognized fields of endeavour, low-brow as well as high-brow, physical as well as metaphysical. For the role of physics in the Peripatetic mainstream one need only cite the early scholarchs themselves, Aristotle, Theophrastus, Strato; and physics fed into mechanics, both pure and applied. If the *Mechanica* and cognate works attributed to Aristotle were not truly by him, they were at least by his successor-but-one Strato, or included material from Strato. 'On Mechanics includes a study of the lever and of three other simple machines, the pulley, the wedge and the windlass, and Strato seems to have been the first person to carry out a series of empirical investigations in dynamics, doing so in connection with the phenomena of acceleration in particular'.⁴² Strato is also credited by Diogenes Laertius (5.59) with a treatise On machines for mines, $\Pi \epsilon \rho i \mu \epsilon \alpha \lambda \lambda \kappa \omega \mu \eta \alpha \nu \mu \alpha \nu$

Now, the author of our treatise mentions Strato in his Preface. Strato heads there an unchronological list of four writers (5.3): Strato, Hestiaeus (of Perinthus), Archytas (of Taras), and Aristotle. These men 'and the others who have written works similar to theirs', it is claimed, can train the beginner in elementary

⁴⁰ Strabo's phrase ἐγένοντο καθ' ἡμᾶς in 14.5.4 should not be taken to mean that Athenaeus and Xenarchus – the latter in any case his teacher – were born within his lifetime. Cf. exactly the same in 13.4.3, introducing broadly contemporary Pergamenes of note.

⁴¹ So D.J. Furley in OCD s.v. Peripatetic school.

⁴² G.E.R. Lloyd, Aristotle: the growth and structure of his thought (Cambridge 1968) 101. Note also e.g. Marsden, *Development* 71 n. 4 for the suggestion (following D. Ross) that Strato is the author of the *De audibilibus* (Περὶ ἀκουστῶν), which at 800b13 casually mentions catapults. For Strato (and Aristotle) see further in the next paragraph, and fully in the Commentary to 5.3.