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2002

13

Eudemus' History of Mathematics*

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1

About the founder of the historiography of science Eudemus of Rhodes we know very little. Ancient sources depict him as a devoted student of Aristotle, who even considered him (along with Theophrastus) as a possible scholarch of the Lyceum (fr. 5). We know neither when he was born, nor when he joined the Lyceum. Eudemus certainly was younger than Theophrastus (born c. 370) and after Aristotle's death he returned to Rhodes, where he continued to study and to teach (fr. 88). While Eudemus' *Physics* belongs to the second period of his activity, his works on the history of science must have been written while still in Athens. Being a part of Aristotle's historiographical project, along with Theophrastus' "physical" doxography and Menon's medical doxography, they can be dated between 335/4 (foundation of the Lyceum) and 322/1 (Eudemus' return to Rhodes). In the

* This paper is a part of my project *Historiography of Science in Antiquity* financially supported by the Russian Scientific Fund for Humanities (RGNF), grant Nr. 97-03-04184. I would like to thank Sir Geoffrey Lloyd and Carl Huffman for their comments on earlier drafts of this paper and István Bodnár for his generous help and patience.

IN EUDEMUS OF RHODES

list of Theophrastus' works there are three writings on the history of science with the same titles as Eudemus' works.¹ Since there are no traces of such writings by Theophrastus, the editors of his fragments believe that these were Eudemus' works, which were later mistakenly added to Theophrastus' list.² This misunderstanding indirectly confirms that all these works were written before Eudemus left Athens, otherwise they would hardly have been in Theophrastus' catalogue.

Beginning with Simplicius, the majority of those who have studied Eudemus' theoretical treatises agree that in this domain he was a true follower of Aristotle, clarifying his ideas and arranging them more systematically. But although Eudemus did not succeed much in developing Aristotle's system, or in creating his own philosophical system, this does not mean that he was bereft of originality. Since Aristotelianism by its very nature resisted any attempt at substantial modification, the Peripatetics became famous not so much in philosophy, but in the specific sciences. There is no doubt that ancient musicology, geography, botany and physics would appear incomparably more inferior without Aristoxenus, Dicaearchus, Theophrastus and Strato. Such an appraisal seems all the more appropriate to the historiography of science, as Eudemus' writings happened to be not only the first but also the last specimens of that genre in antiquity. To be sure, neither Eudemus himself, nor his works have been forgotten: they were still extant in the sixth century AD,³ and a special biography was devoted to Eudemus.⁴

¹ 'Ἀστρολογικῆς ἱστορίας α'–ζ', 'Ἀριθμητικῶν ἱστοριῶν (without the number of books), 'Ἱστορικῶν γεωμετρικῶν α'–δ' (D.L. V.48, 50 = 137 Nr. 43, 264 Nr. 2–3 FHS&G).

² This was suggested first by H. Usener. In the same list we find another work, τῶν περὶ τὸ θεῖον ἱστορίας α'–ζ', which contrary to Wehrli's opinion should be identified with Eudemus' *History of theology*, known from Damascius (251 Nr. 2 FHS&G = Eud. fr. 150). Cf. Damascius' reference κατὰ τὴν Εὐδήμου ἱστορίαν (Wehrli p. 70.6).

³ Simplicius gives a long verbatim quotation from the *History of geometry* (fr. 140) and cites about a hundred passages from Eudemus' *Physics*; he also gives three of the seven quotations preserved from the *History of astronomy* (fr. 146, 148–49); in quoting Eudemus, he makes it clear that he is dealing with his book (fr. 149). Eutocius also indicates that he has read the *History of geometry* (fr. 139). Damascius apparently used Eudemus' *History of theology* without intermediaries (fr. 150).

⁴ This biography (fr. 1), written by a certain Damas, is mentioned only by Simplicius. When Damas lived is unknown, but one can guess that he was Eudemus' student rather than a later biographer. Eudemus was not such a popular figure that a late author would be interested in writing his biography; besides, what were his possible sources? Eudemus' biography is mentioned in the Arabic sources (Rosenthal p. 36).

And yet in this particular genre he appeared to have no followers even among those who displayed some interest in the history of mathematics and astronomy. Eratosthenes dealt with the problem of the duplication of the cube in his dialogue *Platonicus* and in the letter to king Ptolemy.⁵ Hellenistic biographies of the famous scientists, popular "introductions" to the mathematical sciences, and later philosophical and scientific commentaries also included information on the history of the exact sciences. Each of these genres had, however, its own aims that only partially coincided with the aims of the history of science. Thus, in a general perspective, Eudemus' history of exact sciences happened to be not so much a promising beginning, as an exception.

Does his failure to found his own school explain the abortive development of the history of the exact sciences? Even if Eudemus really had only two students,⁶ Theophrastus had two thousand listeners (D.L. V.37), and nonetheless his botanical research was not further developed. Meanwhile the biographical genre founded by Aristoxenus and Dicaearchus, of whose students we also know nothing, was immediately picked up by the Hellenistic writers, since it corresponded to the interests and spirit of the epoch. It is revealing that Eratosthenes, who as a mathematician and historian could have continued Eudemus' history of mathematics, attempted instead of this to change the framework of the genre. In accordance with Eratosthenes' philosophical predisposition, the fictitious plot of the *Platonicus* combines a sober history of mathematics with the academic legends about Plato as architect of science. However, even this attempt to make this genre more popular and accessible had only limited success: although the *Platonicus* was widely known, we do not hear of any followers of Eratosthenes in the "belletristic" history of the exact sciences.

In spite of the general decay of this genre, I would not say that Eudemus "was virtually unknown" in the Hellenistic period,⁷ especially taking into account that we possess only meager remains of the vast Hellenistic literature. Eratosthenes, and probably Archimedes, drew upon his *History of geometry*; Diogenes Laertius and Clement of Alex-

⁵ Knorr (1986) p. 17ff., Knorr (1989) p. 131ff. brings convincing arguments that this letter is not a forgery.

⁶ Gottschalk p. 26. This seems to me rather improbable. A fragment of Eudemus' *Physics*, written on Rhodes, depicts a typical picture of a teacher lecturing to a group of students: καὶ γὰρ μυθολογήσω τὸ ραβδίον ἔχων ὑμῖν καθημένοις οὕτω (fr. 88).

⁷ Ibid.

andria, known for their extensive use of the Hellenistic sources, cite his *History of astronomy* (frr. 143–44).⁸ Later, Eudemus' theoretical treatises remained of interest only to Aristotle's commentators, whereas his works on the history of the exact sciences were not infrequently used by those who took these sciences up in one way or another: Theon of Smyrna, Porphyry, Pappus, Proclus, Eutocius. Thus, Eudemus — the expert in the exact sciences, their first and perhaps only historian, was not less important for the classical tradition than Eudemus — the true follower of Aristotle.

Judging by his works, Eudemus received a good mathematical education and was very competent in the problems of contemporary mathematics.⁹ Eudemus' professional training is also manifest in the fact that his histories of the exact sciences are devoted to strictly mathematical problems and methods, and not to the philosophical interpretation of mathematics which was so characteristic of Plato and all his students, including Aristotle. To be sure, a professional approach to mathematics was not the only possibility for Eudemus, as a fragment from his work *On Angle* shows (fr. 30). There he treats an angle as a certain quality, i.e., in the spirit of Aristotle.¹⁰ An interesting fragment from Eudemus' *Physics* (fr. 34) reveals one of the possibilities of combining philosophical and mathematical approaches.

According to Eudemus, after the mathematicians have defined their ἀρχαί and reached an agreement about them, they carry their research further. They refuse to study and to prove mathematical ἀρχαί, saying that this is not their business (ἀλλ' οὐδέ φασιν αὐτῶν εἶναι τὰ ἐπισκοπεῖν). Therefore, there is another science (ἐτέρα φιλοσοφία) to deal with these ἀρχαί, i.e., Aristotelian "first philosophy," or "wisdom."¹¹ Eudemus' position is thus very close to that of Plato and Aristotle, but in contrast to Plato who reproaches the mathematicians for the lack of interest in proving their ἀρχαί (*Resp.* 510C–E), Eudemus seems to consider the division of labor between philosophers and math-

ematicians as quite normal. Indeed, the mathematicians do not want to prove their ἀρχαί not because of their failure to think things through, but rather because such a position corresponds to the general rule according to which no one scientific discipline can prove its own ἀρχαί. Proceeding on such an understanding of the division of labor, one can suppose that when Eudemus deals with subjects that are in the jurisdiction of the mathematicians, he prefers to follow their norms and rules. Owing to this, his exposition of the history of exact sciences appears to be free from the preconceived philosophical tenets — at least free to such an extent that they do not harm the professional approach.¹²

2

If we confine ourselves to those of Wehrli's fragments where Eudemus' name is mentioned, leaving aside for the moment the so-called *Catalogue of geometers*,¹³ it turns out that there is not much material preserved from the *History of geometry*. Frr. 134–35 concern theorems of Thales, frr. 136–37 Pythagorean mathematics, fr. 138 Oenopides, frr. 139–40 the quadrature of a circle by Antiphon and the quadrature of lunes by Hippocrates of Chios, fr. 141 Archytas' solution to the problem of the duplication of the cube, and fr. 141.I the theory of irrationals developed by Theaetetus. The origins of these fragments vary and even taken together they are far from giving us an idea of what was the original scope of Eudemus' book.¹⁴ Of the nine fragments preserved under his name, five deal with the propositions of Euclid's book I (they come from Proclus' commentary on this book), one with those of book X (on the theory of irrationals, from Pappus), and the other three concern problems outside the scope of the *Elements* (two from Eutocius and one very long quotation from Simplicius). Thus, in their entirety Eudemus' fragments do not cover even one tenth of the material that — judging by the *Catalogue* in Proclus — was collected and examined in the *History of geometry*. Of the twenty mathematicians

⁸ See also: Eud. fr. 89 ap. D.L. I.9; fr. 145, Dercyllides ap. Theon of Smyrna.

⁹ Contrary to Aristotle, who believed that Hippocrates of Chios committed a logical fallacy in his quadrature of lunes (*Soph. El.* 171b12f.), Eudemus did not find any mistakes in Hippocrates' proofs (fr. 140). See: Lloyd. Aristotle was quite competent in elementary mathematics, but did not reveal a particular interest in the higher mathematics of the period: Heath (1949) p. 1f.

¹⁰ Arist. *Cat.* 10a11–24, *Phys.* 188a25, *Met.* 1020a35–b8. See Heath (1927) p. 177f.

¹¹ Cf. *Met.* 995b4f.; 996b26f., 1005a19ff.

¹² The case of Aristoxenus is instructive as to the influence of Aristotelian philosophy on the professional approach. In his youth Aristoxenus studied with the Pythagoreans, but joining the Lyceum he abandoned the mathematical theory of music and developed his own harmonics, based on the qualitative approach to musical sound.

¹³ Procl. *In Eucl.* p. 64.16–68.23 Friedlein = fr. 133. See below, section 3.

¹⁴ The only fragment from his *History of arithmetic* (fr. 142) also deals not so much with arithmetic, as with Pythagorean harmonics, i.e., with the mathematical theory of music.

mentioned in the *Catalogue*,¹⁵ we find only five in the fragments, plus Antiphon, who is omitted from the *Catalogue*.

In reconstructing the original scope of the *History of geometry* we can rely on these fragments as solid ground, yet we cannot confine ourselves only to them. It is well known that for the late authors Eudemus was one of the main sources, if not *the* main source of information on pre-Euclidean geometry. This does not mean, of course, that *any* anonymous evidence concerning early Greek mathematics goes back to Eudemus. Nevertheless, there are many cases where his authorship seems to be firmly established. Proclus, for example, informs us about two of Thales' theorems with a reference to Eudemus (fr. 134–35), and about two others without mentioning his sources.¹⁶ It seems rather obvious that the latter two pieces of evidence are likewise based on Eudemus' authority.¹⁷ The same conclusion can be reached about two of Oenopides' discoveries, one of which Proclus mentions with reference to Eudemus (fr. 138) and the other without it (p. 283.7f.).¹⁸

Here is another example: who was the authority for Proclus' information (p. 304.11f.) that the Pythagoreans had knowledge of the theorem that only the following polygons can fill up the space about a point: the equilateral triangle, the square, and the regular hexagon? There is no such theorem in Euclid, but his older contemporary Eudemus could have referred to this, as well as to other Pythagorean discoveries.¹⁹ It seems very likely that the two pieces of evidence from the scholia to Euclid also go back to Eudemus: first, that the whole fourth book of Euclid belongs to the Pythagoreans, and second, that they constructed three regular solids (pyramid, cube and dodecahedron), whereas the octahedron and icosahedron were discovered by Theaetetus.²⁰ Eudemus, as we remember, wrote both on the Pythagoreans and on Theaetetus and definitively knew the subject better than those later

¹⁵ I include in this number Philip of Opus, but not Plato. Hippias of Elis is mentioned here only as a source, and not as a mathematician.

¹⁶ *In Eucl.* p. 157.10f., 250.20f.

¹⁷ van Pesch p. 78f.; Heath (1927) p. 36.

¹⁸ *Ibid.* It is very possible also that Eutocius, who derived Archytas' solution to the problem of doubling the cube from Eudemus (fr. 141), owes his information about the solutions of Eudoxus and Menaechmus to the same source (*In Archim. De sphaera*. III, p. 56.1ff., 78.13–80.24 Heiberg). See: Wehrli p. 118; Knorr (1986) p. 21; Knorr (1989) p. 77ff., 94ff.

¹⁹ van Pesch p. 79; Heath (1927) p. 36.

²⁰ *Schol. in Eucl.* p. 273.3–13, 654.3f. Heiberg. See Burkert (1972) p. 450.

authors who made Pythagoras the originator of all five regular solids.²¹ The anonymous scholia to book V of the *Elements* twice call Eudoxus the author of this book, which also may have Eudemus as the source.²²

The last proposition of the fourth book, on the fifteen-angled figure inscribed in the circle (IV.16), deserves special attention. Proclus, relying on the earlier commentaries on Euclid, notes that in the *Elements* there are not a few theorems and problems useful for astronomy, e.g., the problem IV.16 (p. 269.8ff.). The same is said here about the problem I.12 that belongs to Oenopides: "he thought it useful in astronomy" (p. 283.7f.). Since the last reference, as we noted, goes back to Eudemus, one can suspect that this remark too has the same origin. Proclus explains further that by inscribing the side of the fifteen-angled figure in the circle we get the angle between the celestial equator and the zodiacal circle, i.e. 24° . Here we should remember that Oenopides was that very astronomer who first measured the angle of the obliquity of ecliptic (41A7). In a short but regrettably error ridden résumé of Eudemus' *History of astronomy* we find decisive evidence: "Oenopides was the first who found the obliquity of the zodiacal circle,"²³ whereas "the others found that the angle between the zodiacal circle and the celestial equator is equal to the side of the fifteen-angled figure, or 24° " (fr. 145). K. von Fritz demonstrated long ago that originally both statements pertaining to the zodiac referred to Oenopides.²⁴ Therefore, Proclus' evidence on the astronomical significance of the problem IV.16 also goes back to Eudemus, although Proclus mentions neither his, nor Oenopides' name.²⁵

In fr. 141.I from the Arabic translation of Pappus, overlooked in the first Wehrli edition, Eudemus speaks about Theaetetus' contribution to the theory of irrationals. This fragment was added to the second edition, but Wehrli, following Burkert, does not include in it the preceding note on the Pythagoreans. It is clear from the text, however, that Eudemus

²¹ This tradition is preserved in Proclus' *Catalogue* (*In Eucl.* p. 65.15f.). See below, p. 286.

²² *Schol. in Eucl.* p. 280.7f., 282.12f. Heiberg.

²³ Diels' correction, $\lambda\acute{o}\xi\omega\sigma\iota\varsigma$ instead of manuscript $\delta\iota\acute{\alpha}\xi\omega\sigma\iota\varsigma$ (Theon Smyrn. *Exp.* p. 198.15 Hiller = 41A7), is fully justified by the parallels in Aëtius, Diodorus and Macrobius (41A7).

²⁴ von Fritz (1937) col. 2260f.

²⁵ According to Neuenschwander p. 374 the style of this problem differs from the other propositions of book IV, so it seems to be a later addition.

considered Theaetetus to continue and develop already *existing* theory. Hence, the preceding note (omitted by Wehrli), "This science had its origin in the school of Pythagoras, but underwent important development at the hands of Theaetetus,"²⁶ perfectly fits in such a context.²⁷ Among the predecessors of Theaetetus at least one person had to be mentioned: his Pythagorean teacher Theodorus of Cyrene. Theodorus is named as well in the *Catalogue* (p. 66.6), and Plato (*Theaet.* 147D) ascribes to him a proof of irrationality of the magnitudes between $\sqrt{3}$ and $\sqrt{7}$. Further, it seems very improbable that Eudemus, who left a detailed account on the authorship of many elementary propositions, would neglect to say something about the discovery of irrationality, which was made *before* Theodorus. In any case, it would be contrary to Eudemus' usual manner to mention Theaetetus (and Theodorus) without saying a word about the $\pi\rho\omega\tau\omicron\varsigma$ $\epsilon\upsilon\rho\epsilon\tau\eta\varsigma$ of irrationality, Hippasus of Metapontum.²⁸ Although Hippasus' name is not attested either in the *Catalogue*, or in the fragments, Eudemus in all likelihood did write about him too.

In the same fr. 141.I it is said that Theaetetus used in his theory three proportions, the arithmetic, geometric and harmonic, whereas in the *Catalogue* we read that Eudoxus added to the three known proportions three others (p. 67.2f.). If the information of the *Catalogue* goes back to Eudemus (and there are no grounds to doubt this), we can surmise that he mentioned also who discovered the first three proportions. In this connection I would like to draw attention to the reports of Nicomachus and Iamblichus on the discovery of the proportions. According to Nicomachus, the first three of them "came down to Plato and Aristotle from Pythagoras," the second three, subcontrary to them, which are called the fourth, fifth, and sixth, were discovered later; af-

ter which the moderns discover four others as well.²⁹ Thus, it comes out that the first three proportions were discovered by Pythagoras, the second three by contemporaries of Plato and Aristotle, and the last four by later mathematicians. This information is correct, but it lacks details that would allow us to connect it with Eudemus. We find such details, however, in Iamblichus' commentary to Nicomachus:

Of old there were but three means in the days of Pythagoras and the mathematicians of his times, the arithmetic, the geometric, and the third in order, which once was called the subcontrary, but had its own name changed forthwith to harmonic by Archytas and Hippasus, because it seemed to embrace the ratios that govern the harmonized and tuneful. And it was formerly called subcontrary because its character was somehow subcontrary to the arithmetic . . . After this name has been changed, those who came later, Eudoxus and his school, invented three more means, and called the fourth properly subcontrary because its properties were subcontrary to the harmonic . . . and the other two they named simply from their order, fifth and sixth. The ancients and their successors thought that this number, i.e., six, of means could be set up; but the moderns have found four more in addition . . .³⁰

It is clear that we have a fragment of the history of mathematics before us, taken by Iamblichus from some reliable and well-informed source. It contains the names of Hippasus, Archytas and Eudoxus that were missing in Nicomachus, along with much additional information on the early history of proportions. This information perfectly matches the fragment of Archytas quoted by Porphyry: there are three means in music, the arithmetic, geometric, and subcontrary "that we call harmonic."³¹ Since Eudemus ascribes an application of the first three proportions to Theaetetus and a discovery of the three others to Eudoxus, Iamblichus' passage likewise has to be connected with Eudemus. Specifically, he seemed to mention not only Eudoxus but also Pythagoras (in connection with the discovery of the first three means), as well as Hippasus and Archytas (as his followers).³² Interestingly, Iamblichus

²⁶ Pappus, p. 63–64; cf. Burkert (1972) p. 440 n. 182.

²⁷ Scholia to book X of Euclid also mention Pythagoreans as the originators of the theory of irrationality (p. 415.7, 416.13, 417.12f. Heiberg). Burkert's position in this question is inconsistent. He states that: 1) Eudemus, quoted by Pappus, does not mention the Pythagoreans; 2) scholia to book X are mostly from Pappus; 3) the same scholia, ascribing discovery of the irrationality to the Pythagoreans, are based ultimately on Eudemus. Cf. Burkert (1972) p. 450 n. 13, 457, 458 n. 57, 462 nn. 73–74. This contradiction can be easily reconciled by suggesting that Pappus' reference to the Pythagoreans goes back to Eudemus as well.

²⁸ Cf. his note on the discovery of the regular solids by the Pythagoreans and Theaetetus (*Schol. in Eucl.* p. 654.3f. Heiberg) and below, n. 49. On Hippasus see below, p. 287.

²⁹ *Intr. arith.* p. 122.11f., 142.21f. Hoche.

³⁰ *In Nicom.* p. 100.19–101.9 Pistelli = 18A15, tr. M. L. D'Ooge.

³¹ *In Ptol. Harm.* p. 92 Düring = 47B2. Philolaus also called this mean "harmonic" (*Nicom. Intr. arith.* p. 135.10f. Hoche = 44A24), which makes clear that it has been renamed before Archytas. Tannery believed that Archytas quoted Hippasus (Tannery [1885] p. 190). Even if this was not the case, Archytas surely could have mentioned his name (cf. 47A13, B1).

³² According to Aristoxenus (fr. 90 Wehrli), Hippasus made an experiment with four bronze discs, using the so-called "musical proportion" (6:8 = 9:12) that includes

turns two more times to the history of proportions, saying again that the first three come from Hippasus and Archytas, whereas the first six were used from the times of Plato until Eratosthenes.³³ His immediate source here was in all probability Porphyry's commentary on the *Elements*, which traced the history of means from Pythagoras to Eratosthenes, relying mainly on Eudemus.³⁴

The name of the first author of *Elements*, Hippocrates of Chios, occurs both in the *Catalogue* (p. 66.4) and in two of Eudemus' fragments (fr. 139–40). As follows from his detailed account on the quadrature of lunes (fr. 140), Eudemus was well acquainted with Hippocrates' work and highly estimated his contribution to mathematics. In Eratosthenes' letter to king Ptolemy, devoted to the problem of the duplication of the cube, it is said that

Hippocrates of Chios first conceived (πρῶτος ἐπενόησεν) that if, for two given lines, two mean proportionals were found in continued proportion, the cube will be doubled. Whence he turned his puzzle (ἀπόρημα) into another no less puzzling.³⁵

These words almost certainly go back to Eudemus, on whose material Eratosthenes heavily relied.³⁶ In Proclus we find a similar account of Hippocrates. Giving a definition of the ἀπαγωγή, i.e., of the reduction of a complicated problem to another which, if known or constructed,

both the arithmetic and harmonic means. This clearly shows that the first three means were known not only to him, but also to his teacher Pythagoras, whose acoustical experiments Hippasus has followed: Zhmud (1997) p. 191 ff. Iamblichus connects the "musical proportion" with Pythagoras and Philolaus (*In Nicom.* p. 118.23f. Pistelli = 44A24). On the theory of proportions in the Pythagorean school see Heath (1921) vol. I, p. 85f.

³³ *In Nicom.* p. 113.16f., 116:1f. Pistelli. Since Eratosthenes studied all the ten means, it was probably him who discovered the last four: Wolfer p. 20ff.; van der Waerden (1956) p. 385. Iamblichus erroneously ascribes these four means not to Eratosthenes, but to otherwise unknown Pythagoreans (*ibid.* p. 116.5).

³⁴ See below, p. 283. Lasserre (1966) p. 175 connects Iamblichus' passage with Eudemus via Eratosthenes' *Platonicus*. Wolfer, however, rightly points out (p. 24) that in this dialogue only the first three proportions known to Plato were discussed. Besides, in Iamblichus' passage the name of the *Platonicus*' main hero is missing, whereas Nicomachus, Theon of Smyrna, and Pappus, who knew the material of this dialogue, did not mention Eudoxus in connection with the proportions.

³⁵ Eutoc. *In Archim. De sphaer.* III, p. 88.18–23 Heiberg = 42A4, tr. Knorr (1989) p. 147. Cf. above, n. 5.

³⁶ Wehrli p. 118f.; Knorr (1986) p. 21.

will make the original proposition evident, he adds: so, for example, the problem of doubling the cube was reduced to the finding of two means in continuous proportion between two given straight lines.

They say that the first to effect reduction (ἀπαγωγή) of difficult constructions (τῶν ἀπορουμένων διαγραμμάτων) was Hippocrates of Chios, who also squared the lunc and made many other discoveries in geometry, being a man of genius when it came to construction, if there ever was one.³⁷

As follows from Proclus' φασί, we have here a reference to a source, which seems to be the same as that of Eratosthenes. In both cases Hippocrates is called πρῶτος εὐρετής of the reduction of the problem of doubling the cube, and this was a standard method of Eudemus for describing mathematical and astronomical discoveries.³⁸ In both cases the same ἀπόρημα, i.e., a difficult geometric puzzle, is in question, which Hippocrates reduced to the other problem. It is revealing that for the first time ἀπαγωγή is mentioned in Aristotle (*An. Pr.* 69a25), and as an example of its application he brings the problem of quadrature of the circle with the help of the lunes (69a30–34), i.e., the famous problem of Hippocrates!³⁹ It is quite natural that Aristotle's student also applied the term ἀπαγωγή to Hippocrates' method, which allows us to ascribe Proclus' note to Eudemus. To him, probably, belong as well the words of admiration of Hippocrates' talent, much more suitable for the classical than for the later author.

In Diogenes Laertius' biography of Archytas there is a passage that also can be connected with Eudemus. In this passage Archytas is called πρῶτος twice:

He was the first to bring mechanics to a system by applying mathematical principles; he also first employed mechanical motion (κίνησις ὀργανικὴ) in a geometrical construction, namely, when he tried, by means of a section of a half-cylinder, to find two mean proportionals in order to duplicate the cube (VIII.83, tr. R. Hicks).

The immediate source of Diogenes is likely to be Favorinus: he was very much interested in various εὐρήματα and mentioned elsewhere Archytas' discoveries in mechanics.⁴⁰ Favorinus, in turn, could have

³⁷ *In Eucl.* p. 213.7–11, tr. G. Morrow.

³⁸ See below, n. 158.

³⁹ *Soph. El.* 171b12f. = 42A3; see below, n. 46 and Knorr (1986) p. 71f.

⁴⁰ Fr. 66 Mensching = 47A10a. The passages in Diogenes Laertius where he enu-

relied on Eratosthenes, who certainly used Eudemus.⁴¹ The second part of Diogenes' passage closely matches both Eratosthenes' letter that also mentions half-cylinders⁴² and Archytas' solution to the problem of doubling the cube, known from Eudemus (fr. 140). Does the first part come from the same source too? An obvious symmetry between the two parts of the passage indicates that they belong to the same context: Archytas applied mathematics to mechanics and (mechanical) motion to mathematics.⁴³ Eudemus wrote on Archytas both in the *History of geometry* and in the *Physics*, where he states that Archytas considered things unequal (τὸ ἀνίσον) and uneven (τὸ ἀνώμαλον) to be causes of motion (fr. 60). Fr. Krafft has appropriately connected this idea with the main principle of motion in Aristotle's *Mechanical problems*, i.e., with the principle of the unequal concentric circles, and concluded that Aristotle drew upon Archytas' *Mechanics*.⁴⁴ Hence, Archytas as the founder of mechanics was known to Eudemus, which confirms his authority in Diogenes Laertius' passage.

Another piece of evidence is the passage from the *Quadrature of parabola*, where Archimedes refers to the geometers who tried to square a circle but, according to the opinion of most experts, failed to do so.⁴⁵ He clearly means here the attempts of Hippocrates, Antiphon, and Bryson to square a circle that were briefly mentioned by Aristotle⁴⁶ and more extensively treated by Eudemus (frr. 139–40; he, however, passes over Bryson in silence). Since Eudemus, in contrast to Aristotle, usually presented both the geometrical procedures and his own judgment concerning them, he is almost surely included among the experts to whom Archimedes alludes.

merates one εὐρημα after another usually derive from Favorinus. In his *Manifold history* there was a special book on πρῶτοι εὐρεταί: Mensching p. 31f., 161 (index on the word πρῶτος).

⁴¹ Cf. fr. 27 Mensching (Eratosthenes as a source). Favorinus' contemporary and friend Plutarch also drew upon Eratosthenes' *Platonicus* and mentioned some ὀργανικαὶ καὶ μηχανικαὶ κατασκευαί designed by Archytas, Eudoxus, and Menaechmus (*Quaest. conv.* 718E).

⁴² Eutoc. *In Archim. De sphaer.* III p. 96.6 Heiberg.

⁴³ See Heath (1921) p. 246f.; van der Waerden (1956) p. 150f.; cf. Knorr (1989) p. 109.

⁴⁴ Krafft p. 149f.

⁴⁵ διόπερ αὐτοῖς ὑπὸ τῶν πλείστων οὐχ εὐρισκόμενα ταῦτα κατεγνώσθην (II, p. 262.13ff. Heiberg).

⁴⁶ *Cat.* 7b27f., *An. Pr.* 69a30–34, 75b37f., *Soph. El.* 171b12f., b34ff.; *Phys.* 185a14f.

The following example is less obvious, but no less interesting. In the introduction to his work the *Method*, Archimedes writes:

In the case of the theorems the proof of which Eudoxus was first to discover, namely, that the cone is a third part of the cylinder, and the pyramid of the prism, having the same base and equal height, we should give no small share of credit to Democritus, who was the first to make assertion with regard to the said figure though he did not prove it.⁴⁷

Archimedes refers to Democritus only once and hardly knew his works. Eudoxus, as it seems, also does not mention Democritus. This follows from the introduction to Archimedes' treatise *On the sphere and cylinder*, written before the *Method*, where he refers to the same discoveries of Eudoxus, adding that before him no geometer came to these ideas.⁴⁸ Thus, at that point, Archimedes did not know of any of Eudoxus' predecessors in this field. Later, in the *Method* he corrects his view, but was this correction due to his acquaintance with Democritus' books? The following prompts us rather to suppose that Archimedes took the comparison of Eudoxus and Democritus from Eudemus' *History of geometry*:

- 1) It was characteristic of Eudemus' style to compare the results of several scientists who worked on the same problem.⁴⁹
- 2) The expression ἐξηύρηκεν πρῶτος is also typical for Eudemus; it occurs in almost every fragment of his historical works.⁵⁰
- 3) Eudemus was concerned to specify whether a strict mathematical proof was given or not.⁵¹
- 4) In his *Physics*, Eudemus mentions Democritus (fr. 54a–b) and at one place he even addresses him in the vocative (fr. 75).
- 5) Eratosthenes, to whom the *Method* was addressed, certainly used Eudemus' work. This reinforces the possibility, implied by the passage from the *Quadrature of parabola*, that Archimedes too was acquainted with the *History of geometry*.

⁴⁷ II, p. 430.1ff. Heiberg = fr. 61c Lasserre. Cf. 68B155 DK.

⁴⁸ I, p. 4.5f. Heiberg = fr. 62b Lasserre.

⁴⁹ Frr. 139–40, 146; *Schol. in Eucl.* p. 654.3f. Heiberg; Pappus, p. 63.

⁵⁰ See below, n. 158.

⁵¹ Cf. his remarks on Thales: fr. 135; *Procl. In Eucl.* p. 157.10f., 250.20f.; Heath (1921) vol. 1, p. 130f.

If my assertion is right, we can add Democritus to the list of the mathematicians named by Eudemus. An absence of his name in Proclus' *Catalogue*, which appeared rather strange to many historians of mathematics,⁵² could be due to the Neoplatonic editing of this text.

An attempt to attribute to Eudemus mention of all the significant mathematicians before Euclid is justified not in the least by the fact that practically every mathematician that is known to us from the times of Thales to the second third of the fourth century *does* appear in Eudemus' fragments and in the evidence that can be safely attributed to him (including the *Catalogue*). More than that: from the other sources we do not know of *any* mathematician of that period who would not be mentioned by Eudemus (except for Hippasus and Democritus). Some of them, e.g., Mamercus, Neoclides, Leon, Theudius, Athenaeus and Hermotimus are known *only* from Eudemus. This appears to be a sufficient ground for further attempts to connect with his works those names as well, which for various reasons are omitted in the *Catalogue* (if, indeed, we have independent and reliable evidence on them).

On the other hand, this very fact prompts us to examine the chronology of the mathematicians *not* mentioned by Eudemus. In Proclus we find several references to a certain Amphinomus, taken from the mathematical encyclopedia of Geminus.⁵³ In one case, he associates Amphinomus with Speusippus, opposing them to the mathematicians of Menaechmus' school (p. 77.16f.); in the other, on the contrary, he writes about the mathematicians from the circle of Menaechmus and Amphinomus (p. 254.3f.). In all the references to Amphinomus specific mathematical discoveries are not in question; rather methodological debates and problems of terminology. This seems to be a sufficient reason for omitting Amphinomus in the *History of geometry*. After all, Speusippus and Xenocrates, who wrote a lot on these subjects, do not appear in this book either. There is, however, another possibility: Amphinomus worked after Eudemus had finished his book. This would make him a younger contemporary of Menaechmus, whose generation is the last to appear in Eudemus. According to Geminus, Amphinomus held the view that mathematics does not investigate the causes, while the originator of this view was Aristotle (p. 201.11). This might imply

⁵² Tannery (1882) p. 172; van Pesch p. 82; Heath (1927) p. 36; van der Waerden (1956) p. 150.

⁵³ In *Eucl.* p. 77.16f., 202.11, 220.9, 254.3f.; cf. Tannery (1887) p. 24; van Pesch p. 112f. On Geminus see below, p. 282.

that Amphinomus lived after him. To be sure, Geminus (or his source) was not interested in chronology and could associate the persons according to the similarity of their views, regardless of when they lived.⁵⁴ One more reference of Proclus, likewise taken from Geminus, concerns a certain Zenodotus, "who belonged to the succession of Oenopides, although he was a pupil of Andron" (p. 80.15f.). The mathematicians Zenodotus and Andron are otherwise unknown, while Oenopides of Chios was an older contemporary of Hippocrates. But did Geminus really have in mind that Oenopides? Again, he speaks here about the distinction between theorems and problems; their definitions given by Zenodotus are very close to those of Posidonius and his followers (p. 80.15f.). It seems, then, that Oenopides, Zenodotus, and Andron belong to the Hellenistic period.⁵⁵

3

Moving from the evident cases to the less evident, we come to one of our central problems: Who was the author of the *Catalogue of geometers* and how did this document come to Proclus?⁵⁶ It is customary since the second half of the 19th century to think of the information in the *Catalogue* as going back, albeit through intermediaries, to Eudemus' *History of geometry* (fr. 133).⁵⁷ Although Proclus does not mention Eudemus in connection with the *Catalogue*, he refers to "those who wrote the history of geometry" before Euclid (p. 68.4). Besides, Eudemus' fragments, including those quoted by Proclus himself, coincide thematically with the *Catalogue*: they tell us about the development of mathematics from the sixth to the fourth century (fr. 134–41).

⁵⁴ Cf. Lasserre (1987) p. 149f., 587f. Knorr (1986) p. 75 was indecisive about Amphinomus' chronology.

⁵⁵ Cf. Knorr (1986) p. 374 n. 70. Since Geminus' methodological discussion of theorems and problems (In *Eucl.* p. 77.7–78.10 and 80.15–81.4) is based on Posidonius (see fr. 195 Edelstein-Kidd with commentary), the other references to Amphinomus, Speusippus, Menaechmus, Oenopides, Zenodotus, and Andron might derive from the same source. Cf. Lasserre (1987) p. 552f., 614f. and 20F17–23. A Stoic Oenopides is mentioned in Aëtius (I.7.17). See: Zeller, p. 48 n. 1.

⁵⁶ This section partly overlaps with my recent article, where I have treated this subject in more detail: Zhmud (1998) p. 219ff.

⁵⁷ It was suggested first in 1866 by his editor L. Spengel. See also Tannery (1882) p. 171ff.; van Pesch p. 80: "Inter omnes viros doctos constat originem id ab Eudemi historia duxisse."

However, in the last decades this *opinio communis* has been challenged, especially after the publications of the *History of the Academy* by Philodemus (first century BC), formerly known as the *Index academicorum*. In column Y of the Herculaneum papyrus 1021, which contains a part of Philodemus' book, we read the following:

At this time the mathematical sciences were also greatly advanced, with Plato being the architect of this development; he set problems to the mathematicians, who in turn eagerly studied them. In this way, μετρολογία (the theory of proportions?) and the research on definitions reached their peak, as Eudoxus of Cnidus and his students completely revised the old theory of Hippocrates (of Chios). Especially great progress was made in geometry, as the methods of analysis and of diorism were discovered. Optics and mechanics also were not (left in contempt?) . . .⁵⁸

The name of the author of this passage, taken by Philodemus from some early source, is omitted in the papyrus, and several theories have been proposed about his identity. Lasserre suggested that the passage comes ultimately from the book Περὶ Πλάτωνος by Plato's secretary Philip of Opus,⁵⁹ whereas Gaiser argued in favor of the Peripatetic Dicaearchus.⁶⁰ Lasserre's suggestion was supported by Burkert and Dorandi,⁶¹ and it seems to be much more plausible than Gaiser's.⁶² Whoever wrote this passage certainly belonged to the Academy, since only an Academician could have ascribed to Plato such an important role in the development of mathematics. On the other hand, the passage from Philodemus closely matches the description of Plato given in the *Catalogue*:

Plato [. . .] greatly advanced mathematics in general and geometry in particular because of his zeal for these studies. It is well known that his writings are thickly sprinkled with mathematical terms and that he everywhere tries to arouse admiration for mathematics among students of philosophy.

⁵⁸ For the text see Gaiser p. 152; Dorandi (1991) p. 126f. It is worth mentioning that the occurrence of mechanics in the passage that praises Plato's achievements destroys all the attempts of Plutarch to ascribe to him a contemptuous approach to this science (*Marc.* 14.9–11; *Quaest. conv.* 718E–F).

⁵⁹ Lasserre (1987) 20F15a–15b, p. 611ff.

⁶⁰ Gaiser p. 76f., 97f., 342ff.

⁶¹ Burkert (1993) p. 26f.; Dorandi (2001).

⁶² To judge from the preserved fragments of Dicaearchus (frs. 42, 43, 44, 71 Wehrli), he had a quite critical opinion of Plato. See also Philodemus, col. VI; Burkert (1993) p. 26f.

whereas Philip is described here as one of those "academic mathematicians" who studied mathematics under Plato's methodological direction:

Philip [. . .] of Mende, a pupil whom Plato had encouraged to study mathematics, also carried on his investigations according to Plato's instructions and set himself to study all the problems that he thought would contribute to Plato's philosophy.⁶³

Against the background of Eudemus' fragments and the other sections of the *Catalogue*, both these passages look rather odd. Eudemus records everywhere specific discoveries and achievements of the Greek geometers, but in these two passages there is not a single word about any discovery. It is hard to believe that Eudemus considered Philip's foremost merit in mathematics to be that he studied problems connected as he thought with Platonic philosophy. And was it really relevant for Eudemus' history of geometry that Plato's writings were "thickly sprinkled with mathematical terms"? In this connection, the following question arises: Does it follow, as Lasserre thought, that we should credit Philip, instead of Eudemus, with the second part of the *Catalogue* — which begins with Plato and ends with Philip himself — if not with the *Catalogue* in its entirety?⁶⁴

I believe that there are no grounds for such a conclusion. First, it is far from evident that Philip was the author of the papyrus passage and that it was taken from his book Περὶ Πλάτωνος, of which we know virtually nothing. Hermodorus of Syracuse, another student of Plato, may well have been its author.⁶⁵ Besides Περὶ μαθημάτων,⁶⁶ he also wrote a work Περὶ Πλάτωνος.⁶⁷ Philodemus mentions his book on Plato (col. VI), so it must have been available to him. Further, there are two other Academicians who shared Philip's and Hermodorus' interests in mathematics and in Plato's biography. Xenocrates was the author of Περὶ τοῦ Πλάτωνος βίου⁶⁸ and many works on mathematics.⁶⁹

⁶³ In *Eucl.* p. 66.8f., 67.23f., tr. G. Morrow.

⁶⁴ Lasserre (1987) p. 611ff. Earlier he shared a traditional view on the *Catalogue*: Lasserre (1966), fr. 22.

⁶⁵ Lasserre (1987) p. 433f. considered Hermodorus only an intermediary figure between Philodemus and Philip.

⁶⁶ D.L. 1.2 and 8 = fr. 6 Isnardi Parente.

⁶⁷ Frs. 7–8 Isnardi Parente = *FGrHist* 1008F2a–b.

⁶⁸ Frs. 264–66 Isnardi Parente = *FGrHist* 1010F1a–c.

⁶⁹ Περὶ τῶν μαθημάτων, Περὶ γεωμετρῶν, Περὶ ἀριθμῶν, Περὶ ἀστρολογίας,

Speusippus wrote Πλάτωνος περίδειπνον⁷⁰ that was known to Philodemus,⁷¹ as well as the Μαθηματικός and Περί τῶν Πυθαγορικῶν ἀριθμῶν.⁷² Since Philodemus apparently did not have any difficulties in finding the fourth-century sources, it is very hard to decide who authored the passage he cited.

Second, the *Catalogue* contains too much detailed information that has no connection with Plato, especially in its first part which narrates the development of geometry from Thales to Hippocrates and coincides with Eudemus' fragments. To be sure, Plato occupies a central place in the second part of the *Catalogue* and such a perspective brings it closer to the papyrus passage. But in spite of some similarities between the papyrus passage and the *Catalogue*,⁷³ the latter has a number of features that prevent us from suggesting a common origin for both texts. To say nothing of the first part of the *Catalogue*, even the perspective of the second part is much wider than that of the Philodemus passage, which is continued further with a polemic against certain students of Plato who used "the fruits of learning" for their own purposes. Although the end of column Y is in a very damaged state, and Gaiser's restoration of what follows after "optics and mechanics" is only tentative,⁷⁴ nothing that is discernible here implies that this quotation comes from a work on the history of mathematics. This work clearly focuses on Plato, and the passage on the progress of μαθήματα appears to be just a digression, intended to show that his influence has reached this sphere too.⁷⁵

Περί γεωμετρίας, Ἀριθμῶν θεωρία (D.L. IV.13–14).

⁷⁰ This work might be the same as his Πλάτωνος ἐγκώμιον (fr. 1 Tarán = *FGrHist* 1009T2–3, F1–3).

⁷¹ Col. VI and Pap. Herc. 164, fr. 12. See Gaiser p. 185, 441f.; Dorandi (1991) p. 178.

⁷² D.L. IV.5; fr. 28 Tarán.

⁷³ E.g., the references to Eudoxus who "applied the method of analysis to the theory of the section, which originated with Plato" (p. 67.6), and to another geometer, Leon, who discovered the method of diorism (p. 66.20). Cf. below, n. 96.

⁷⁴ Gaiser p. 153.

⁷⁵ In the same direction points the beginning of citation: [κατε]νεόητο καὶ τῶν μαθημάτων ἐπίδοσις πολλὴ κατ' ἐκείνον τὸν χρόνον. The motif of the rapid development of the exact sciences is known from Aristotle's *Protrepticus*: ἐν ὀλίγῳ χρόνῳ τοσαύτην ἐπίδοσιν τὴν τῶν μαθημάτων θεωρίαν λαβεῖν (fr. 5 Ross = fr. C 52:2 Düring); τοσούτων δὲ νῦν προεληλύθασιν ἐκ μικρῶν ἀφορμῶν ἐν ἐλαχίστῳ χρόνῳ ζητοῦντες οἱ τε περὶ τὴν γεωμετρίαν καὶ τοὺς λόγους καὶ τὰς ἄλλας παιδείας, ὅσον οὐδὲν ἕτερον γένος ἐν οὐδεμιᾷ τῶν τεχνῶν (fr. 8 Ross = fr. C 55:2 Düring).

Third, although Plato could not have been a reference point in Eudemus' history of fourth-century geometry, he could play such a role both for the early Academicians and for the Neoplatonists. Thus, it is possible to come up with the following alternatives: either the *Catalogue* was taken from a book by one of Plato's students and does not have any connection with Eudemus, or it was compiled on the basis of Eudemus' writing and its Platonic features are explained by later Neoplatonic editing. The second alternative seems to me preferable, since the traces of such editing are discernible as well in the first part of the *Catalogue*, e.g., in the section where a discovery of the five regular solids is ascribed to Pythagoras (p. 65.15f.) and typically Neoplatonic terms occur (ἀύλως, νοερῶς). Also the reference to the late pseudo-Platonic dialogue *Anterastai* (p. 66.3) can belong neither to Philip, nor to Eudemus. Further, if the *Catalogue* goes back to the same text as Philodemus' quotation, he must have known this text. Meanwhile, in his list of Plato's students (col. VI) only two of the twelve mathematicians of the fourth century, listed in the *Catalogue*, are named: Amyclas of Heraclea (who, however, is called here Amyntas) and Archytas, whereas Philip is inexplicably missing! Both of these names also occur in the source of Diogenes Laertius' list of Plato's students and can thus be traced back to a common tradition that has no connection with the *Catalogue*, where Archytas is *not* called Plato's student.⁷⁶

When analyzing the *Catalogue* many have overlooked the fact that the Platonizing tendency in this text does not end with Philip, but includes Euclid as well. Proclus, once again uniting all the previous mathematicians around Plato, says:

Euclid was younger than οἱ περὶ Πλάτωνα . . . , but belonged to his school and had an excellent knowledge of his philosophy, and he even set the final goal of the *Elements* as the construction of the five Platonic bodies (p. 68.17f.).

For simple chronological reasons, this description could come neither from Eudemus nor from any of Plato's students. It is, however, so similar to Philip's description that the two passages might appear to have

⁷⁶ Diogenes' list (III.46) probably goes back to Plato's biography written by Theon of Smyrna (Gaiser p. 439f., 444). Theon's list, preserved in Arabic, contains both Amyclas and Archytas, whereas in Diogenes Archytas is omitted, since he belonged to the Pythagorean school, and not to the Academy.

been written by the same hand. Both mathematicians worked under Plato's guidance (although in Euclid's case this guidance was indirect), and for both Platonic philosophy was the final goal in mathematics. This similarity proves again that the whole historical digression in Proclus' second introduction was subjected to Platonizing editing after the fourth century.

In a paper devoted to the *Catalogue*, Eggers Lan also notes many passages where Neoplatonic influence is clearly observed, but this leads him to completely different conclusions: the *Catalogue* was compiled by Proclus himself and besides two or three references it does not go back to Eudemus, either directly or indirectly.⁷⁷ To be sure, in addition to all the aforesaid, the late composition of the *Catalogue* is evident from the fact that, besides Euclid, it mentions Archimedes and Eratosthenes. This, however, does not mean that we should exclude Eudemus from its main sources. Even if we had not known about his *History of geometry*, we would have to infer the existence of such a work, proceeding from the detailed information of the *Catalogue* on mathematics of the 6th–4th centuries and precise chronological indications. The very fact that it contains many of the mathematicians' names, practically unknown to us from the other sources, suggests its early origin. Where, if not in Eudemus, could a later author get the information that Neoclides was younger than Leodamas (p. 66.18), and that his student Leon was a little older than Eudoxus (p. 67.2), if Neoclides and Leon are not mentioned elsewhere?

Considering Eudemus as the main source of the *Catalogue*, the scholars differently replied to the question whether his *History of geometry* was available to Proclus and whether Proclus himself could have been the editor of the *Catalogue*. Whereas Tannery denied both propositions, van Pesch and Heath were inclined to the following conclusion: although Proclus probably had access to Eudemus' book (as later did Simplicius and Eutocius)⁷⁸ he did not compile the *Catalogue*, but took it from an earlier source.⁷⁹ Both van Pesch and Heath emphatically denied Tannery's idea that Posidonius' student Geminus was an editor of the *Catalogue* and an intermediary between Eudemus and Proclus.⁸⁰ In fact, nothing that we know about Geminus and his work

⁷⁷ Eggers Lan p. 154ff.

⁷⁸ Cf. above, n. 3.

⁷⁹ van Pesch p. 84; Heath (1927) p. 37f.

⁸⁰ Tannery (1882) p. 172ff.; Tannery (1887) p. 71ff.

Μαθημάτων θεωρία⁸¹ suggests him as a source of either Neoplatonic influence in the *Catalogue* or its special interest in those predecessors of Euclid who compiled *Elements*.⁸² Geminus' work was devoted to the foundations of the exact sciences and to their classification; his main goal was to show the logical consistency of Euclid's mathematics and to refute its critique by the Sceptics and Epicureans.⁸³ There is no evidence that he was particularly interested in the history of mathematics before Euclid, or that he knew Eudemus' book.⁸⁴ One gets the same impression from his *Introduction to phaenomena*: clearly, the Eudemian *History of astronomy* was not used there.

Generally, one has to say that Tannery's arguments in favor of Geminus are so weak that it makes no sense even to repeat them.⁸⁵ Incidentally, apart from Geminus' encyclopedia there were three commentaries to the *Elements* among Proclus' sources: by Hero, Porphyry and Pappus. There is no point in discussing Hero as a Platonizing editor of Eudemus. Pappus, although he suits this role better than Hero,⁸⁶ does not mention Eudemus in his vast *Collectio* and only once in the commentary on book X of Euclid. Plato's name occurs only twice in the *Collectio*: first, in connection with the "nature of proportion" and second, concerning the so-called Platonic bodies.⁸⁷ Pappus was clearly too "technical" an author to be enthusiastic about Plato's contribution to geometry. As for the Neoplatonist Porphyry, he is the most appropriate

⁸¹ This title is given in Eutocius (*In Apoll. Con.* II, p. 170.25f. Heiberg), while Pappus refers to Περὶ τῆς τῶν μαθημάτων τάξεως (*Coll.* VIII, p. 1026.8f. Hultsch). Tannery (1887) p. 18f. and Tittel col. 1040f. were inclined in favor of the first title, Mansfeld (1998) p. 24 n. 21 — the second.

⁸² See van Pesch p. 80f.; Heath (1927) p. 37; Eggers Lan p. 140f.

⁸³ Tittel col. 1040ff. The same was characteristic of his teacher Posidonius (frr. 46–47, 195–99 Edelstein-Kidd).

⁸⁴ Tittel col. 1048 thought that Geminus knew Eudemus through Eratosthenes, but in this case Eratosthenes becomes the editor of the *Catalogue*. The only mathematician of the fourth century mentioned in that part of Proclus' commentary which can be safely attributed to Geminus (see: van Pesch p. 112ff.) is Menaechmus, the older contemporary of Euclid. In two cases methodological debates and terminology are in question (*In Eucl.* p. 72.24f., 78.9f, 78.17f.), and only once he refers to Menaechmus' discovery of the conic sections (p. 111.21). But even here his authority is Eratosthenes' epigram, and not Eudemus. About the earlier mathematicians he says nothing. Cf. above, n. 55.

⁸⁵ Tannery (1887) p. 71f., cf. van Pesch p. 81f.

⁸⁶ On Neoplatonic influence on Pappus see Mansfeld (1998) p. 99ff.

⁸⁷ III, p. 86.19f., V, 352.11f. Hultsch.

option for the role of an intermediary-editor. Actually, Tannery too considered this option, but then rejected it in favor of Geminus.⁸⁸ Such a decision was largely affected by his own, rather mechanical division of the "spheres of influences" between Porphyry and Geminus. Tannery believed that Geminus is mostly presented in the first part of Proclus' commentary, where the *Catalogue* is located, and Porphyry in the second. Yet this picture is far from being correct: in both introductions to the commentary there is material both from Geminus and from Porphyry.⁸⁹ What makes Porphyry the preferable candidate?

- 1) Proclus in his *Commentary* five times refers to Porphyry's work that was, in all probability, a commentary to Euclid.⁹⁰ Such a commentary, written by the Neoplatonist Porphyry, could explain both the Platonism of the second part of the *Catalogue* (as well as of some portions of the first part) and its interest in the predecessors of Euclid.
- 2) Proclus twice refers to Eudemus immediately after Porphyry, the first time in the space of one page (p. 297.4–298.10 and 299.3, on prop. XIV and XV), and the second time in the very same line (p. 352.14, on prop. XXVI). This reinforces the probability that Porphyry's commentary included references to Eudemus' book (in both cases theorems of Thales are in question).⁹¹
- 3) Porphyry was the author of a commentary to Ptolemy's *Harmonics* that preserved the only fragment from Eudemus' *History of arithmetic* (fr. 142).

⁸⁸ Tannery (1882) p. 171f.

⁸⁹ Proclus refers to Porphyry's Συμμετὰ ζητήματα in the same second introduction (p. 56.24), where the *Catalogue* is located. To be sure, direct references do not give an adequate picture. In the first introduction Proclus extensively borrows from Iamblichus' *De communi mathematica scientia*, but he nowhere mentions his name in the entire *Commentary*. See Mueller (1987b).

⁹⁰ In *Eucl.* p. 255.12–14, 297.1–298.3, 315.11–316.13, 323.5–326.5, 347.20–352.14 = fr. 482–86 Smith. See Tannery (1882) p. 170f.; van Pesch p. 127f.; Heath (1921) vol. 2, p. 529; (1927) p. 24; Mansfeld (1998) p. 24. On the influence of Porphyry's commentary on Proclus, see Mueller (1987a) p. 311f.

⁹¹ It is possible that Proclus took these two citations of Eudemus not directly from the *History of geometry* (as was the case with the other excerpts), but from Porphyry. It is equally arguable, however, that Porphyry's references prompted Proclus to look in Eudemus' book. Simplicius too used Eudemus' book both directly and indirectly, through Alexander's paraphrase (fr. 140). See Knorr (1987) p. 29ff.

- 4) The passage from the *Catalogue* relating to Pythagoras (p. 65.15f.) contains, on the one hand, Neoplatonic terms and, on the other, partly coincides with the passage from the work by Porphyry's student Iamblichus.⁹² In the same work of Iamblichus there is a short mention of Theodorus and Hippocrates (p. 77.24f. Festa), missing in the parallel passage of his biography of Pythagoras (VP 89). This remark is very similar to that place in the *Catalogue* where both mathematicians are also mentioned in one sentence (p. 66.4f.). It looks as though Iamblichus used the same source as Proclus,⁹³ i.e., Porphyry. To the same source must go back Iamblichus' information on the development of the theory of means from Pythagoras to Eratosthenes.⁹⁴
- 5) Porphyry wrote a history of philosophy that embraces practically the same period as the *Catalogue*: it starts from the Oriental predecessors of philosophy; covers Thales, Pythagoras and other Presocratics; and ends with Plato.⁹⁵ Porphyry clearly viewed Plato's system as the *telos* of the whole previous philosophy, and this attitude seems to be very close to the "Platocentrism" of the second part of the *Catalogue*, where the construction of the five Platonic bodies is called "the final goal of the whole *Elements*" (p. 68.18f.). This provides additional support to the hypothesis that Porphyry was the principal intermediary between Eudemus and Proclus.⁹⁶

To sum up, we find in Porphyry exactly what is missing in Geminus that would have enabled us to consider him the editor of the *Catalogue*: predisposition to Platonism, obvious knowledge of Eudemus' works,

⁹² *De comm. math. sc.* p. 70.1f. Festa. See: Burkert (1972) p. 410.

⁹³ Björnbo col. 1782; Burkert (1972) p. 458 n. 59. In Iamblichus' passage there are two examples of the "progressive" terms (ἐπιιδόναι and προαγαγεῖν), so characteristic of the *Catalogue*. See below, n. 151.

⁹⁴ See above, p. 271. The latter is mentioned at the very end of the *Catalogue* (p. 68.18–20).

⁹⁵ φιλόσοφος ἱστορία ἐν βιβλίοις δ' = fr. 193–224 Smith. Apart from the fragments, only one part of the first book is preserved, containing the biography of Pythagoras.

⁹⁶ Porphyry might have derived additional information from the same work as Philodemus, which would explain certain similarities between the *Catalogue* and column Y. It is noteworthy that he knew, although indirectly, Hermodorus' book *On Plato* (fr. 7–8 Isnardi Parente = *FGrHist* 1008F2a–b = fr. 146 Smith).

interest in the intellectual history of the 6th–4th centuries in general and in Euclid's predecessors in particular. This seems to be a sufficient ground to think that we owe to Porphyry the present form of the *Catalogue*, i.e., a very abridged and tendentiously revised version of the *History of geometry*. Following Eudemus' chronological exposition, he compiled a short outline of geometry from Thales to the immediate precursors of Euclid and used it as a historical introduction to his commentary on the *Elements*. It is conspicuous that as soon as Porphyry leaves Eudemus' text and turns to Euclid, he begins to lack the reliable historical data. An absence of Eudemus' followers in the Hellenistic period made it very problematic for Porphyry to figure out even a rough date for Euclid: he had to rely on casual remarks of Archimedes and Eratosthenes, and on historical anecdotes (p. 68.10f.). What a contrast with Eudemus' chronologies, which are precise almost to the decade!

It would be mistaken to think, however, that the final version of the *Catalogue* is due to Porphyry. Specifically, the passage that ascribes to Pythagoras the discovery of irrationality and of the five regular solids (p. 65.15f.) can likely be attributed to Proclus.⁹⁷ At any rate, we do not find this information in the parallel passage in Iamblichus (*De comm. math. sc.*, p. 70.1f.) nor in his other works. Meanwhile, "Panpythagoreanism" is much more characteristic of Iamblichus than of Proclus, so if he had known this tradition, either from Porphyry or from elsewhere, he would have certainly mentioned it. While the version referring all the regular solids to Pythagoras is known before Proclus,⁹⁸ the idea that he was the author of the theory of irrationals (*τῶν ἀλόγων πραγματεία*) is not attested in any other ancient source. In this connection it was proposed long ago to change the reading *τῶν ἀλόγων πραγματεία* into *τῶν ἀνὰ λόγων πραγματεία*, i.e., into the theory of proportions.⁹⁹ This reading, however, is attested only in one manuscript, all the others have *τῶν ἀλόγων πραγματεία*.¹⁰⁰ To judge from Iamblichus' passages that connect Pythagoras with the first three means,¹⁰¹ Porphyry and, correspondingly, Eudemus wrote about *τῶν ἀνὰ λόγων πραγματεία*. It is confirmed both by Nicomachus and by the obvious fact that Pythagoras really dealt with proportions. What

⁹⁷ Cf. Burkert (1972) p. 411f.

⁹⁸ Aët. II.6.5 = 44A15; Burkert (1972) p. 70 n. 113.

⁹⁹ DK I, p. 98.23; Heath (1921) vol. I, p. 84f.

¹⁰⁰ I discussed this passage in Zhmud (1997) p. 158f.

¹⁰¹ See above, p. 271.

made Proclus change the "theory of proportion" into the "theory of irrationals"?

I suppose he did it for the same reason he is silent about Hippasus, one of the important mathematicians of the early fifth century. Late tradition connects with Hippasus two significant discoveries: the construction of the dodecahedron inscribed in the sphere and the discovery of irrationals. One part of the evidence (Clemens of Alexandria, Iamblichus) mentions Hippasus' name, the other speaks about some anonymous Pythagorean.¹⁰² At least two pieces of evidence from the last group, which concern the discovery of irrationality, are based on Eudemus: Pappus' commentary on book X of Euclid and the scholia to the same book.¹⁰³ To them we should add the first scholium to book XIII that relates to the Pythagoreans the discovery of the first three regular solids, including the dodecahedron. Does it follow from this evidence that Eudemus has referred to some anonymous Pythagoreans, and the late tradition filled in Hippasus' name? If so, we are not in a position to determine who in fact was the author of these discoveries. Besides, it means that Hippasus totally disappears from the history of mathematics, since no other discoveries are ascribed to him. In other words, if Eudemus and his contemporaries had not known the mathematician Hippasus, he did not exist.

Meanwhile, Hippasus was known as a philosopher to Aristotle and Theophrastus;¹⁰⁴ Aristoxenus referred to his acoustical experiment, based on mathematical proportions;¹⁰⁵ Iamblichus, relying on the tradition that most likely derives from Eudemus, likewise connected his name with the first three proportions.¹⁰⁶ Thus, the Pythagorean Hippasus who took up philosophy, harmonics, and mathematics did not merely exist but was known at the end of the fourth century. On the other hand, Eudemus mentioned the discovery of the irrationals and the construction of the dodecahedron by the Pythagoreans. I believe, therefore, that the late tradition assigning these discoveries to Hippasus, contains a historical core and might go back to Eudemus. If, however,

¹⁰² The evidence and its analysis, see Zhmud (1997) p. 170ff.

¹⁰³ Pappus, p. 63f.; *Schol. in Eucl.* p. 415.7, 416.13, 417.12f. Heiberg. See above, n. 27.

¹⁰⁴ Arist. *Met.* 984a7; Theophr. fr. 225 FHS&G, cf. Aët. I.3.11, IV.3.4 = 18A9.

¹⁰⁵ Fr. 90 Wehrli, cf. 18A13. See above, n. 32.

¹⁰⁶ In *Nicom.* p. 100.23, 113.17, 116.4 Pistelli. See above, p. 271f.

Eudemus named Hippiasus, why then is his name missing from the *Catalogue*? There is at least one important ground for such an omission. Proclus, unlike Eudemus, attributed to Pythagoras these very discoveries that the late tradition connects with Hippiasus: the theory of the irrationals and the construction of all five regular solids, including the dodecahedron. Therefore, for the mathematician Hippiasus there was no place left in the *Catalogue*. One might surmise that Proclus had decided to trust the tradition that persistently connected Hippiasus with plagiarism and with divulging of the Pythagorean secrets¹⁰⁷ and to sacrifice this figure by “returning” his discoveries to Pythagoras.¹⁰⁸

4

Eudemus’ history of the exact sciences has to be considered against the background of other historical genres that were initiated or cultivated in the Lyceum. Aristotle himself compiled lists of the Olympian and Pythian victors, of the dramatic victors at the Dionysia,¹⁰⁹ and wrote a number of other writings of a historical character.¹¹⁰ Besides cultural history and philosophical doxography, developed by Aristotle,¹¹¹ and after him by Dicaearchus (Βίος Ἑλλάδος) and Theophrastus (Φυσικῶν δόξαι), a new genre, the biography, was founded by Aristoxenus and Dicaearchus. Being fully aware of the historical character of such human accomplishments as the state, art, philosophy or science, Aristotle tried to reveal the inner logic of their development. Even if Aristotle does not entirely meet the *modern* re-

¹⁰⁷ This tradition is presented in Iamblichus’ work that Proclus certainly used (*De comm. math. sc.* p. 77.18f. Festa, cf. VP 88, 246–47).

¹⁰⁸ The motives of Pappus’ silence can be more prosaic: he was not very concerned about mentioning the names of the mathematicians. While Nicomachus says that the first three means “came down to Plato and Aristotle from Pythagoras” (*Intr. arith.* p. 122.11f.), Pappus quoting him omits all the names (*Coll.* III, p. 84.1f. Hultsch). This is not the only example: in the fourth book of the *Collectio* Pappus presents three methods of angle trisection without any attribution. On Pappus’ method, see Knorr (1989) p. 227ff.

¹⁰⁹ D.L. V.26, Nr. 130–31, fr. 615–17 Rose = fr. 408–14 Gigon; D.L. V.26, Nr. 135.

¹¹⁰ See, e.g., his dialogue *On poets* (fr. 70–77 Rose = fr. 14–22 Gigon), where much attention is paid to the founders of the different genres, and especially his history of rhetoric in *Τεχνῶν συναγωγή* (fr. 136–41 Rose = fr. 123–34 Gigon). Cf. De Ste. Croix p. 29 with further references.

¹¹¹ On Aristotle’s doxography, see Mansfeld (1990) p. 28ff.

quirements of history, he did much more for its development than any ancient philosopher.¹¹² Therefore, it is difficult to agree with the views that he held history in very low regard, because it deals *only* with the particular,¹¹³ or that history (including intellectual history, the history of ideas and of philosophy) interested Aristotle not *per se*, but only as material for dialectical discussion in the course of developing his own theories.¹¹⁴

We can better understand what value the Peripatetics did assign to historical research, if we remember that Aristotle’s theory of science stresses the empirical origin of any knowledge. The question of *ὅτι* (collection and description of the facts) precedes and makes possible the question of *διότι* (explanation of the general or particular causes). Any scientific explanation must be based on the previously arranged relevant facts.¹¹⁵ In this way, even purely descriptive work is a legitimate and necessary part of scientific procedure, if it presupposes subsequent theoretical analysis, and the Peripatetics wrote, as we know, hundreds of such works. It seems very probable that the entire historiographical project, conceived by Aristotle, i.e., Eudemus’ histories of the exact sciences and his history of theology, Theophrastus’ “physical” doxography, and Menon’s medical doxography, set as a general task the collection, systematization and at least preliminary analysis of evidence for subsequent philosophical examination. It is conspicuous, further, that the study of the different fields of knowledge was distributed among Aristotle’s students according to his division of theoretical sciences into mathematics, physics, and theology.¹¹⁶ This corresponds

¹¹² See von Fritz (1956).

¹¹³ Zoepffel p. 37: “so ist Historia in ihrem Bereich, vom philosophischen Standpunkt aus betrachtet, kein wirkliches Wissen.” Cf. De Ste. Croix p. 29: Aristotle “evidently saw research into historical facts as a necessary condition, though not of course a sufficient condition, of full scientific knowledge of human society.”

¹¹⁴ Baltussen, e.g., suggests that Aristotle was not a historian *sensu stricto* and that we can hardly regard him and his followers as historians in the modern sense of the word (p. 335f.). This is of course correct, yet is “a historian in the modern sense of the word” the *only possible* kind of historian? What would remain of Jacoby’s *Fragmente der griechischen Historiker*, if we apply to them modern conceptions of objective historical research? The Peripatetic way of doing the history of philosophy certainly was methodologically immature and subjective. Still, I do not think that the best way to study doxography is to isolate it from the other historical genres practiced in the Lyceum and to regard it as a part of Aristotle’s dialectical procedure.

¹¹⁵ *An. Post.* 89b29, 93a16ff. See Kullmann p. 204ff.

¹¹⁶ *Met.* 1026a18ff., 1064b1ff.

quite well to Aristotle's common method and to his other project, the collection and the arranging of material for his *Politics*, in the course of which the 158 polities of the different Greek cities were written. They were also classified according to his theoretical scheme of the different types of power.¹¹⁷ It hardly needs reminding, however, that Aristotle's *Athenian polity* is a historical treatise of independent value, addressed to a wide audience, and not just a dossier. In fact, nothing suggests that Aristotle and his followers self-consciously limited their historical writings *only* to the question of facts and of particulars, trying to avoid any generalization.¹¹⁸ Modern historians will agree with Aristotle that history as such does not belong to the theoretical sciences, although there *are* some historical regularities that we can discern and study.¹¹⁹

What was the difference between the approaches of Eudemus, Theophrastus, and Menon to the various fields of knowledge within the framework of the Peripatetic project? How were Eudemus' writings arranged: chronologically, thematically or problematically? Is it appropriate to define them as a history of developing knowledge, or were they rather "a classification of the authors according to different mathematical topics"?¹²⁰ Let us begin from the titles of Eudemus' books.¹²¹ What, e.g., does the title Γεωμητρικὴ ἱστορία mean: "geometric inquiry," "inquiry into geometry" or "history of geometry"? It is clear that this book was not a mathematical treatise and that Eudemus was inter-

¹¹⁷ See the title: Constitution of 158 cities, according to the type, democratic, oligarchic, tyrannical, aristocratic (D.L. V.26).

¹¹⁸ Dicaearchus' Βίος Ἑλλάδος deals apart from particular events and individuals with the general stages of the development of civilization (frr. 47–51). At the beginning of his *History of geometry* Eudemus states a general rule of the cognitive evolution from αἴσθησις to λογισμός and further to νοῦς (fr. 133), and this is clearly not the only case of διότι. Two of Theophrastus' works, *Historia plantarum* and *De causis plantarum*, are devoted respectively to the research of ὅτι and of διότι. In *Historia plantarum* one finds, however, not merely assembled data but botanical classification, morphology, and taxonomy.

¹¹⁹ De Ste. Croix p. 24f. discusses in this connection an important Aristotelian concept, ὡς ἐπὶ τὸ πολὺ, "as a general rule." According to Aristotle, this kind of regularity along with the universal and the necessary also belongs to the theoretical ἐπιστήμη (Met. 1027a20–21, 1064b32–36, 1065a1–6).

¹²⁰ Eggers Lan p. 130.

¹²¹ They are given by several authors, the most exact variant being preserved by Simplicius: Γεωμητρικὴ ἱστορία (fr. 140), Ἀστρολογικὴ ἱστορία (fr. 148). Porphyry refers to Ἀριθμητικὴ ἱστορία (fr. 142).

ested not in geometrical problems themselves, but in the way they were solved by others. Thus, the subject of his study coincides with the subject of the history of science, as we understand it. That is why the titles of his works should be compared not so much with the notion *περὶ φύσεως ἱστορία*, reflected in the titles of Aristotle's and Theophrastus' works (*ἱστορία ζώων* and *περὶ φυτῶν ἱστορία*), but rather with that usage of *ἱστορία* which is attested already in Herodotus (VII.96) and is understood commonly as a "written account of one's inquiries, narrative, history."¹²² But even if Eudemus' book had been entitled simply *περὶ γεωμετρίας*,¹²³ or had no title at all, this would not have crucial importance for defining its genre. Although Thucydides' book had no title, and he never uses the word *ἱστορία* this does not prevent us from referring his book to the historical genre. The sentence already quoted from the *Catalogue*, οἱ τὰς ἱστορίας ἀναγράψαντες μέχρι τούτου προάγουσι τὴν τῆς ἐπιστήμης ταύτης τελείωσιν (p. 68.4) definitively shows that readers took Eudemus' book as a historical exposition of the development of geometry.

To be sure, for Aristotle and for the Lyceum in general *ἱστορία περὶ φύσεως* was not yet so strictly separated from *ἱστορία* of human πράξεις and γένηματα as it is for us. Comparing the fragments that come from the books with the same title *Ἱστορικά ὑπομνήματα*, by Theophrastus (fr. 196A FHS&G), Aristoxenus (fr. 131) and Hieronymus of Rhodes (frr. 35–36), we can see that Theophrastus deals with "natural history," whereas the two other Peripatetics examine the historical (biographical) material.¹²⁴ A specific feature of human history

¹²² *LSJ*, s.v. II; Hornblower p. 9. On *ἱστορία* as "history" see: Arist. *Rhet.* 1359b30f., 1360a30–37; *Poet.* 1451b1–7, 1459a21–24; Anaximenes (*FGrHist* 72F3, 9). Ephorus, the older contemporary of Eudemus, gave the title *Ἱστορίαι* to his universal history. Theophrastus' student Praxiphanes criticizes Thucydides in his *Περὶ ἱστορίας* (fr. 18 Wehrli). The content of Theophrastus' work *Περὶ ἱστορίας* (D.L. V.47) is unknown.

¹²³ Cf. Aristoxenus' *περὶ ἀριθμητικῆς* (fr. 23 Wehrli) that also deals with the history of mathematics.

¹²⁴ It is worth noting that whereas *ἱστορία ζώων* was considered by Aristotle as "natural history," *περὶ φύσεως ἱστορία* was traditionally understood as "natural philosophy." This hardly justifies Zoepffel's idea that *ἱστορία* as such rules out any research into the general causes. At *De caelo* 268a1 *περὶ φύσεως ἱστορία* means the same as *περὶ φύσεως ἐπιστήμη* (298b2), and at *De an.* 402a4 ἡ τῆς ψυχῆς ἱστορία is characterized as a purely theoretical investigation (cf. Socrates' ironical narration about τῆς σοφίας ἦν δὲ καλοῦσι *περὶ φύσεως ἱστορίαν* that investigates τὰς αἰτίας ἐκάστου at Pl. *Phaedo* 96A). Quite consistently with this usage Theophrastus employs the notion

is that the chronological principle is the most natural and convenient way to systematize the facts (Arist. *Poet.* 1459a21–24), whereas in the *ἱστορία περὶ φύσεως* other principles of systematization are usually applied.

The subject of Eudemos' works was the development of the exact sciences from their origin to the second third of the fourth century. The last mathematicians he refers to in the *History of geometry* are Eudoxus' students. This corresponds to the chronological framework of his *History of astronomy* which starts from Thales (fr. 143) and ends with Eudoxus' student Callippus (fr. 149), Eudemos' own contemporary. The fact that in the *Catalogue* all the names of the geometers are given in chronological order, often with indications of who was older and younger, who was whose student, etc., also speaks to the historical character of Eudemos' writings.¹²⁵ Besides, we know that Eudemos considered the Pythagoreans in the first book of the *History of arithmetic* (fr. 142), the quadrature of lunes in the second book of the *History of geometry* (fr. 140), and the theories of Eudoxus and Callippus in the second book of the *History of astronomy* (frr. 148–49).

In the doxographic treatises of Theophrastus and Menon the material is arranged as a rule along different lines. They classified δόξαι not according to the chronology of their authors, but according to certain topics or problems, such as the nature of the moon's light or the causes of diseases. The same pattern of organization is to a large degree characteristic of the doxographic passages in Aristotle, where he discusses the ἀρχαί of his predecessors (*Met.* 1.3–7; *De An.* 1.2; *Phys.* 1.2–4). This pattern was originated by Hippias of Elis, Gorgias, Isocrates and others, who classified ideas on thematic or systematic principles, e.g., according to the character and/or number of ἀρχαί that were held by a philosopher.¹²⁶ We cannot say, however, that the Peripatetics blindly followed the schemes of the early doxography. Already Aristotle, and particularly Theophrastus tried to combine the systematic pattern with the chronological, by tracing the development of the ideas from teacher to student, from one school to another, etc.¹²⁷ These attempts to give,

περὶ φύσεως ἱστορία both to Thales' and to Plato' philosophy (frr. 225, 230 FHS&G). See also fr. 224 on Xenophanes.

¹²⁵ Heath (1927) p. 38.

¹²⁶ Mansfeld (1990) p. 55f.

¹²⁷ Ibid. p. 28ff. It is conspicuous especially in the first book of *Φυσικῶν δόξαι* (von Kienle p. 38f., 52f., 58f.).

at least partially, a historical dimension to the doxography were based on the idea, very important for Aristotle, of the gradual perfection of philosophy from its first immature ideas to the present state.¹²⁸ If the idea of development and the historical approach that follows from it were not applied consistently, it is because the systematic pattern answered much better the purposes of doxography and the material it dealt with.

Doxography aimed to describe *all* the (relevant) δόξαι, not merely the true ones; putting it another way, its subject was φυσικῶν δόξαι, and not φυσικὴ ἐπιστήμη. Furthermore, in the physical and medical theories studied by Theophrastus and Menon there were no hard proofs, and to separate the true δόξαι from the untrue was difficult. The ideas of the sixth-century thinkers often appeared to be more convincing than those of the more recent periods, thus they did not always fit the chronological pattern. As for Eudemos, he could employ an historical approach much more consistently than his colleagues mostly due to the character of his material. Indeed, at that time the cumulative development of the exact sciences was more manifest than that of natural philosophy or medicine. The discoveries of many mathematicians immediately depended on what was done before them: Hippocrates and Theaetetus relied on Pythagorean mathematics, Archytas and Eudoxus developed the theories of Hippocrates, etc. Progress in mathematics is all the more evident, because, according to Aristotle's concession, "it alone among human activities knows of proofs."¹²⁹ That is why a mathematician could base his research on a solid foundation created by his predecessors and move further in his quest for the truth. To be sure, Eudemos records some unsuccessful attempts to solve mathematical problems, e.g., that by Antiphon to square a circle (frr. 139–40). It lies, however, in the nature of mathematics that its history, more than that of any other science, lists a much larger number of victories than of failures.

And yet I would not exaggerate the dependence of Eudemos' approach on the material he was dealing with. Both his inclination to historical (or, at least, chronological) schemes and his interest in the history of ideas are revealed outside the exact sciences. In the *History of theology* he also names the *theologoi* according to their chronol-

¹²⁸ *Met.* 993a15–17; fr. 53 Rose; see below, p. 296f.

¹²⁹ Arist. ap. Iamb. *De comm. math. sc.* p. 78.8f. Festa. See Burkert (1972) p. 447f.

ogy.¹³⁰ In the fragments of his *Physics* there are unusually many doxographical digressions, presenting and/or criticizing the views of Parmenides, Zeno, Melissus, Anaxagoras, Empedocles, the Pythagoreans, Archytas, and Plato.¹³¹ The same names (except for Archytas) could be found in Aristotle's *Physics*, but Eudemus, it seems, pays much more attention to them.

Returning to the problem of how material was organized in Eudemus' history, I quote Wehrli's opinion: "Der Stoff war nach Auftreten und Entwicklung der maßgebenden Gedanken, nicht nach Autoren geordnet."¹³² To be sure, one and the same mathematician, e.g., Hippocrates, could appear in connection with the problem of doubling the cube (along with Archytas and Eudoxus) and in connection with the quadrature of the circle (with Antiphon). The same can be said about the Pythagoreans and Theaetetus, Democritus and Eudoxus, etc. But I still do not think that the thematic or problematic principle predominates in Eudemus. Such a principle is suitable for examination of how *different* mathematicians solved the *same* problem — e.g., the duplication of the cube — but it does not fit the historical study of whom a particular mathematical discovery belongs to. It is evident, at least, that such figures as Thales, Mamercus, Pythagoras and Oenopides were treated by Eudemus in connection with their discoveries. By the way, it is hard to call Oenopides' discoveries *maßgebende Gedanken*; Eudemus very likely referred to them only because he knew that it was Oenopides who made them. As to Mamercus, Eudemus scarcely knew more about him than that he was famous as a mathematician; such a figure could be mentioned only in a historical context. Eudemus appeared to deviate from the chronological principle only when he treated the problems that several mathematicians of different generations had worked on. But usually he moves from generation to generation, from teachers to stu-

¹³⁰ Fr. 150. With one exception: Acusilaus (ca. 500 BC) is mentioned after Hesiod, but before Epimenides and Pherecydes who are older than he. One reason for this might be that Acusilaus appears to follow Hesiod very closely in his *Genealogiai* (DK 9A4). This was explicitly mentioned by Plato (*Symp.* 178B = DK 9B2), on whom Eudemus could have relied. It could be also that Eudemus simply did not know the correct chronology of Acusilaus.

¹³¹ Fr. 31, 35–47, 49, 53–54, 60, 65, 67, 75, 78, 82, 89, 110–11, 118.

¹³² Wehrli p. 113; "problemgeschichtliche Anordnung," *ibid.* p. 119.

dents, as is seen in the *Catalogue*, and not from one problem to the other.¹³³

A few words about Eudemus' style. Simplicius twice notes the laconic and clear style of his *History of astronomy* (fr. 149) and in quoting a long passage from the *History of geometry* he refers again to Eudemus' memorandum-like style (fr. 140). It is interesting that Simplicius mentions the "archaic brevity" of his account at the very place (fr. 140, p. 59.26) where Eudemus himself was going to consider the problem in detail (fr. 140, p. 60.1). It seems, therefore, that in this case Eudemus simply reproduced Hippocrates' proofs, which were not sufficiently complete from Simplicius' point of view. In any case, we know that Eudemus did not confine himself to the abbreviated exposition of the material. Speaking about Thales' discoveries, he notes both his archaic terminology,¹³⁴ and whether the latter gave a scientific proof or not (fr. 135). At one point Eudemus even tries to "reconstruct" the theorem that he ascribes to Thales (fr. 134). Referring to the Pythagorean application of the areas, he emphasizes that this discovery was ancient (fr. 137), and his commentary on the quadrature of the circle contains a criticism of Antiphon (fr. 140).

Generally, one can say that Eudemus paid attention not only to the results and the form of their exposition but also to the method of the proof and whether it corresponded to what was customary in his own time. In the *Catalogue*, the perfecting of the geometrical methods is discussed in much detail. It is said here that Thales' method was in some cases more empirical, and in others more general, i.e., scientific (*In Eucl.*, p. 65.10), whereas Pythagoras is credited with the transformation of geometry into abstract science and its inclusion in the canon of higher education.¹³⁵ Owing to the efforts of Leodamas, Archytas, and Theaetetus geometry became "more scientific and systematic," while Leon discovered the method of diorism, Eudoxus used the method of

¹³³ Heath (1927) p. 38; Edelstein p. 95. Quite a different approach was characteristic of the later authors like Pappus or Eutocius. They could describe various solutions of the same problem ignoring either the chronology of their authors (Eutoc. *In Archim. De sphaer.* III, p. 57.13ff. Heiberg), or even their names (Papp. *Coll.* IV, p. 270.1ff. Hultsch); see Knorr (1989) p. 77ff., 213ff.

¹³⁴ *In Eucl.* p. 250.20f. See the similar note on Oenopides (*ibid.* p. 283.8).

¹³⁵ Cf. Arist. *Met.* 985b23f., *Protr.* fr. 18, 20 Düring; Aristox. fr. 23.

analysis, and his students Menaechmus and Dinostratus “made the whole of geometry still more perfect” (ἔτι τελεωτέραν ἐποίησαν τὴν ὅλην γεωμετρίαν). It is significant that the *Catalogue* starts with the words about the transition ἀπὸ τοῦ ἀτελοῦς εἰς τὸ τέλειον and ends with the notice that “those who compiled histories of geometry bring the perfecting (τελείωσις) of this science up to this point.” The idea of the “completion” of geometry at the end of the fourth century, i.e., before Euclid, Archimedes, and Apollonius, could not belong to any author later than Eudemus. This confirms once again that the beginning of the *Catalogue* also goes back to him.

I have suggested above that in his histories of the exact sciences Eudemus employed the professional approach, to the extent, of course, that it was possible for a Peripatetic philosopher. This does not contradict the fact that his views on development in general, and on development of science in particular, rely on the Aristotelian doctrine which can be tentatively called “teleological progressivism.” According to this doctrine, everything in nature, society and culture develops from a primitive state to a perfect one.¹³⁶ and for many things this state of perfection was thought to have already been achieved or almost achieved. So, tragedy has already “attained its very nature” (*Poet.* 1449a15), society has found its best and final state in the *polis* (*Pol.* 1252a26–1253a9), and philosophy, whose early ideas were as immature as childish speech (*Met.* 993a15–17), will be completed soon (fr. 53 Rose).¹³⁷ Against this background, Eudemus’ idea that geometry had achieved or almost achieved perfection seems quite natural.¹³⁸

To be sure, the epistemological optimism that Eudemus shared with his teacher was not exceptional in this period of classical rationalism. The author of the *Ancient medicine* was convinced: “what still remains undiscovered in medicine will be discovered” (*VM* 2), if the inquirer uses the right method. The other Hippocratics believed the whole of medicine to be already discovered,¹³⁹ and no less optimistic ideas were

¹³⁶ “There is evolution towards a state of excellence all over in the design of nature; the goal is the end, *telos*,” Burkert (1997) p. 31.

¹³⁷ “Since in few years great progress has been achieved, philosophy will be finished and perfected in a short time.” Cf. his similar remarks on the arts (*EN* 1098a22f.) and political systems (*Pol.* 1264a3).

¹³⁸ Theophrastus expressed similar views: were men to live longer, the arts and sciences might be brought to perfection (fr. 34A FHS&G). See Edelstein p. 148 n. 31.

¹³⁹ *De locis in hom.* 46; *De arte* 1. See Jouanna p. 43f.

expressed by the poets of the fourth century.¹⁴⁰ Although these parallels do not cast doubt upon Eudemus’ Aristotelianism, they show that he did not slavishly follow his teacher’s ideas, but rather that both shared views common for that period.¹⁴¹ The same common attitude is seen in the thesis that all the sciences appeared due to their practical necessity, the Egyptians being the first to discover geometry (*In Eucl.*, p. 64.17). The author of the *Ancient medicine* also believed that medicine was discovered due to necessity and need.¹⁴² We find analogous notions on the origin of τέχνη in many classical writers.¹⁴³ The idea that geometry originated with the Egyptians has even more predecessors.¹⁴⁴ But whereas Eudemus follows Herodotus’ view concerning the practical origin of Egyptian geometry and shares Philip’s conviction that the Greeks bring to perfection all the knowledge they receive from the barbarians,¹⁴⁵ Aristotle points out that μαθηματικά τέχνηαι were first discovered in Egypt because the local priests were allowed to be at leisure (*Met.* 981b23). This remark clarifies the preceding passage, where he states that in every civilization practical τέχνηαι are born first, then appear the fine arts, and after them theoretical ἐπιστήμαι, for which, adds Aristotle, leisure time is needed.

It is noteworthy that the same historical scheme was known before Aristotle; some of his predecessors did notice the role of σχολή, whereas others did not.¹⁴⁶ It is possible therefore that in this case Eudemus followed the more simple version that occurs also in Aristotle.¹⁴⁷ The general line of the cognitive development from

¹⁴⁰ Chairemon: οὐκ ἔστιν οὐδὲν τῶν ἐν ἀνθρώποις ὅτι οὐκ ἐν χρόνῳ ζητοῦσιν ἐξευρίσκεται (*TGF* 71F21); Alexis: ἅπαντα τὰ ζητούμενα ἐξευρίσκεται (fr. 31 Kassel–Austin).

¹⁴¹ Cf. Isoc. *Paneg.* 10, *Nic.* 32, *Euag.* 7, *Antid.* 82, 185.

¹⁴² On the possible influence of Democritus or Protagoras, see Jouanna p. 34f., 45f.

¹⁴³ Democritus (68B144); Isocrates (*Bus.* 12–15, 21–23); Philip (*Epin.* 974D8f., 975C9f.); Aristotle (fr. 53 Rose = *Protr.* fr. 8 Ross; *Pol.* 1329b25f.; *Met.* 981b12–22, 982b22f.).

¹⁴⁴ Herodotus (II.109); Isocrates (*Bus.* 28, cf. 23); Plato (*Phaedr.* 274D1f.; *Leg.* 747A–C); Philip (*Epin.* 986D8ff., 987D9); Aristoxenus (fr. 23).

¹⁴⁵ κάλλιον τοῦτο εἰς τέλος ἀπεργάζονται (987E1) clearly corresponds to τελείωσις in Eudemus.

¹⁴⁶ Democritus (68B144), Plato (*Leg.* 677A–683B), and Philip (*Epin.* 974D3–977B8) do not mention σχολή. Cf.: Isocrates (*Bus.* 21–23), Plato (*Crit.* 110A).

¹⁴⁷ Fr. 53 Rose = *Protr.* fr. 8 Ross; *Pol.* 1329b25ff.

αἴσθησις το λογισμός and further to νοῦς, which is known from the *Catalogue* (p. 65.1f.) has quite obvious parallels in Aristotle.¹⁴⁸ In accordance with this scheme Eudemus stressed the practical *origin* of Egyptian geometry (but not its practical *character*), since even Thales, who borrowed this science (θεωρία) from Egypt, still proved some things αἰσθητικώτερον and others καθολικώτερον (p. 65.10). Thus, for Eudemus the real founder of theoretical geometry was not Thales, but Pythagoras (p. 65.15f.). In this opinion he hardly contradicts Aristotle, who writes in the same book of the *Metaphysics*: the Pythagoreans were the first to advance the mathematical sciences (985b23f.).

The idea of the progressive growth of mathematical knowledge pre-dates Eudemus, of course. In the *Protrepticus* Aristotle refers to significant progress being achieved in mathematics in a very short time.¹⁴⁹ In Philodemus' passage the term ἐπίδοσις, designating progress, is used twice: first, with regard to all mathematical sciences (τῶν μαθημάτων ἐπίδοσις πολλή κατ' ἐκείνον τὸν χρόνον), and second, in connection with geometry (ἔλαβε δὲ καὶ ἡ γεωμετρία πολλὴν ἐπίδοσιν). Although ἐπίδοσις appears only once in Eudemus¹⁵⁰ the verbs from the same semantic group as ἐπιδιδόναι (αὐξάνειν, προαγαγεῖν, προέρχεσθαι) occur in the *Catalogue* very frequently.¹⁵¹ Incidentally, the term ἐπίδοσις and its synonyms were not the only means to express the idea of the progress of knowledge. From the time of Xenophanes (21A18) this idea was connected with two key notions, ζήτησις and εὔρεσις.¹⁵² It is with these words that the author of the Hippocratic treatise *On ancient medicine* describes the origin and development of his τέχνη. In his view, the history of medicine is the history of the inquiries and discoveries that increase our knowledge about human nature and the causes of diseases (VM 2–4). This history begins with the πρῶτοι εὔρεται, who discovered medicine itself.¹⁵³ The quest for

¹⁴⁸ *Met.* 981a12ff., *NE* 1139a17f. See: Wehrli p. 114.

¹⁴⁹ See above, n. 75. On the progress of knowledge, see *Soph. El.* 183b20f.; *De an.* 417b5f.; *EN* 1098a22f.

¹⁵⁰ *In Eucl.* p. 66.9. This passage of the *Catalogue* seems to me rather suspicious, since it describes Plato's role in the development of geometry.

¹⁵¹ ἐπαυξάνειν (p. 66.16), αὐξάνειν (p. 67.5), προαγαγεῖν (p. 67.7, 67.22) προέρχεσθαι (p. 66.17). See: Edelstein p. 92; Thraede (1965) col. 141f., 154.

¹⁵² Cf. Archytas (47B3).

¹⁵³ οἱ δὲ ζητήσαντές τε καὶ εὑρόντες ἱητρικὴν (5), οἱ πρῶτοι εὑρόντες (14).

πρῶτος εὔρετής, so popular in the sixth and the fifth centuries,¹⁵⁴ maintains its significance for many genres practiced by the Peripatetics. Some of them contributed to heurematography, having written books with the standard title περὶ εὑρημάτων.¹⁵⁵ Again, εὑρήματα as a standard topic of philosophical biography goes back to the originator of this genre, Aristoxenus (fr. 23–24). The same topic is widely presented in Dicaearchus' Βίος Ἑλλάδος as well as in Aristoxenus' and Dicaearchus' works on the history of poetry and music.¹⁵⁶ The principle of the πρῶτος εὔρετής was no less relevant for Theophrastus' doxography than for Aristotle's.¹⁵⁷

It is quite natural, therefore, that the question τίς τί εὔρεν underlines the entire work of Eudemus on the history of science, the more so as in this field the idea of priority was particularly important. Indeed, expressions connected with the idea of πρῶτος εὔρετής occur in almost every fragment of Eudemus' historical writings,¹⁵⁸ so that these writings can be conceived as a detailed answer to the question "who discovered what?" Yet, in spite of their closeness, the history of science was rather a by-product of the early heurematographic tradition than its direct heir. In itself, the question about πρῶτος εὔρετής does not entail a historical approach. Depending on the genre and context, every element of this question — "who," "discovered," and "what" — could receive primary significance or retreat into the background. For the history of poetry and music the personality of the πρῶτος εὔρετής was more important than for heurematography, which was interested not so much in the actual discoverers of the past, whose names were of course un-

¹⁵⁴ Kleingünther; Thraede (1962) col. 1191ff.

¹⁵⁵ Theophrastus (fr. 728–34 FHS&G), Heraclides of Pontus (fr. 152 Wehrli), Strato (fr. 144–47 Wehrli). Aristotle also wrote on this subject (fr. 382, 479, 501, 600, 602 Rose = fr. 924 Gigon).

¹⁵⁶ Aristox. fr. 78–81, 83, Dicaear. fr. 57. 75–76, 85.

¹⁵⁷ Theophr. *Phys. op.* fr. 1, 2, 4, 6a, 17 Diels = fr. 225, 226A, 227D–E, 228A FHS&G. Aristotle called Thales πρῶτος εὔρετής of natural philosophy (*Met.* 983b20), Socrates — of ethics (*Met.* 1078b17), Empedocles — of rhetoric, Zeno — of dialectic (fr. 65 Rose), the Pythagoreans — the founders of mathematics and number philosophy (*Met.* 985b23f.); see also fr. 72 Rose; Mansfeld (1990) p. 44f.

¹⁵⁸ Fr. 135–41, 144–48. See also Procl. *In Eucl.* p. 64.18, 65.7f., 65.21, 66.4f., 67.2f., 67.20f., 213.7f., 250.20f., 283.7f.; Eutoc. *In Archim. De sphaer.* III, p. 88.18–23, *Schol. in Eucl.* p. 273.3–13, and my discussion above, p. 272–75. Cf. the subtitle for the abridged version of his *History of astronomy*: τίς τί εὔρεν ἐν μαθηματικοῖς; (Ps.-Heron. *Deff.* IV, p. 167.9 Heiberg = Eud. fr. 145).

known, as in the cultural innovations ascribed to them. As a result, more than half of the *πρῶτοι εὕρεταί* mentioned in the ancient "catalogues of discoveries" are gods and heroes, and the catalogues themselves resemble dry inventories, lacking even systematic, to say nothing of chronological order. In doxography, the references to *πρῶτος εὕρετής* are built into the chronological-systematic scheme and are used only as supplementary classifying signs. As for Eudemus, in attempting to express the dynamics of development of the exact sciences, he bases his inquiry not on systematics of discoveries but on the chronology of their authors, which gives his works a historical perspective.

5

The most difficult question concerns the origin of Eudemus' information on the mathematicians before the middle of the fifth century. All that I have to say here has a preliminary character. Eudemus evidently used the works of Oenopides, Hippocrates, Archytas, Theaetetus, Eudoxus, and his students, but it is hard to say definitively whether they contained any historical information. In principle, this does not seem impossible: we know that Archytas approvingly refers to the views of his Pythagorean predecessors (*οἱ περὶ μαθήματα*, 47B1) and mentions Philolaus' student Eurytus (A13). One could guess that Hippocrates too referred to the Pythagorean mathematical compendium, preceding his *Elements* and comprising the basis of the first four books of Euclid.¹⁵⁹ Such a guess is indirectly confirmed by the notice, going back to Eudemus, that the whole book IV of the *Elements* belongs to the Pythagoreans.¹⁶⁰ Eudemus obviously could not refer to the fourth book of Euclid's *Elements*, but it is very likely that this book, devoted to the relations between regular polygons and a circle, took up the same place in the *Elements* prior to Euclid.¹⁶¹

Eudemus' other possible source was the book *On the ancient poets and musicians* by Glaucus of Rhegium, a contemporary of Democritus. Glaucus can be viewed as a predecessor of Eudemus in the history of Greek music and poetry: he gives a chronological sketch of these arts,

¹⁵⁹ See: Neuenschwander p. 357ff., 378; van der Waerden (1978) p. 354ff.

¹⁶⁰ See above, n. 20.

¹⁶¹ According to Neuenschwander (p. 374f.), the fourth book was compiled by the Pythagoreans before Hippocrates, who used it in his quadrature of lunes, and was subjected later to very minor changes.

relying mainly on the *εὕρηματα* of the musicians. Glaucus' book was used by Aristoxenus (fr. 91), so it must have been known to Eudemus. It is hardly by chance that his histories reveal the same pattern of organizing material according to the chronology of the *πρῶτοι εὕρεταί*, as in Glaucus. We know that Glaucus has not limited his book to the musicians: he mentioned, e.g., Empedocles and the Pythagorean teachers of Democritus (frs. 5–6 Lanata), whereas Aristoxenus referred to Glaucus in his description of Hippasus' acoustical experiment, based on mathematical proportions (fr. 90). Thus, Glaucus' book could have been a source of information not only on Hippasus, but also on the early theory of proportions, which from its very beginning was closely connected with harmonics.¹⁶²

Hippias of Elis, to whom Eudemus' reference to Mamercus (*In Eucl.*, p. 64.11f.) can be traced, is considered to be one of his main sources. Judging by the context of Hippias' book on "related ideas," recently investigated by A. Patzer, this reference was hardly isolated. Since Hippias played a very important role as a transmitter of Thales' *δόξαι*, it is more probable that he named Mamercus along with the other famous geometers of the sixth century, Thales and Pythagoras. But while Patzer believes that geometry also belongs to the *Themenkreisen* examined by Hippias,¹⁶³ his own reconstruction of Hippias' book leaves barely any room to suppose that it contained particular mathematical material. Now, it would be worthwhile to make more precise what is meant here by "geometry." Hippias quite likely wrote that Thales, Mamercus, and Pythagoras became famous for their studies of geometry, and that among the barbarians the Egyptians are well known for their geometrical knowledge. I would not exclude the possibility that he even made references to some particular problems studied by the early mathematicians. What seems to me highly improbable is that Hippias quoted geometrical propositions at length, including their proofs, e.g., the Pythagorean proof of the theorem that the sum of the interior angles of a triangle is equal to two right angles.¹⁶⁴ Eudemus clearly knew substantially more about the proofs offered by Thales and

¹⁶² See above, p. 271f., nn. 31–32, cf. 47B2 (Archytas) and Eud. fr. 142. Glaucus' origin in Rhegium might point to his Pythagorean connections.

¹⁶³ Patzer p. 106f.

¹⁶⁴ Eud. fr. 136. Cf. the other ancient proof that probably goes back to Thales (Arist. *An. Pr.* 41b13–22).

by the other early mathematicians than could be included in Hippias' *Συναγωγή*.¹⁶⁵

In the passage excerpted by Philodemus it is easy to discern several ideas familiar to us from Eudemus' works: the notion of scientific progress, the idea that it was especially rapid in the last decades, the replacement of old theories by new ones (with a reference to the authors of these theories), the appearance of new methods (analysis and diorism), and even the idea of approaching perfection (τὰ περὶ μετρολογίαν ἦλθεν ἐπὶ κορυφὴν). It is very possible that Eudemus knew the work quoted by Philodemus, but what could he borrow from it? This "biography" of Plato touched the exact sciences only in passing, in connection with his influence on the progress of geometry and the other sciences. Earlier, Aristotle also mentioned rapid progress in mathematics, indeed, without naming Plato,¹⁶⁶ and Eudemus certainly shared his attitude. As for the specific facts mentioned in the papyrus passages, Eudemus had to know of them at first hand, and not from the book on Plato.

Hermodorus' book *Περὶ μαθημάτων* was probably a more widely oriented work. Regrettably, one can only guess about its subject matter: in the two short citations from it, it is not mathematics but Zoroaster and the Persian Magi who are mentioned.¹⁶⁷ Not much more is known about the other academic treatises, which, judging from their titles, could contain some information on the history of the exact sciences.¹⁶⁸ There is too little evidence to consider Speusippus and Xenocrates to be the sources and/or predecessors of Eudemus,¹⁶⁹ apart from every-

¹⁶⁵ We can more confidently consider the *Συναγωγή* as one of the sources for Eudemus' *History of theology*.

¹⁶⁶ See above, n. 75.

¹⁶⁷ D.L. I.2 and 8. And yet, it is worth noting that Diogenes mentions Hermodorus in the context of discussion of the origin of philosophy, and that next to him he quotes the opinions of Aristotle and Eudemus about the Magi (I.8–9 = Arist. fr. 6 Rose, Eud. fr. 89). Aristotle's opinion comes from his dialogue *De philosophia* that traced the barbaric origins and further development of philosophy; that of Eudemus comes most probably from the *History of theology* (fr. 150), and not from the *Physics*, as Wehrli thought. Relying on the analogies (for we have nothing else in this case), one can guess that Hermodorus' book too was devoted to the history of scientific, especially mathematical knowledge, beginning from its origin in the Orient.

¹⁶⁸ See above, p. 279, nn. 69, 72.

¹⁶⁹ A fragment from Speusippus' book *On the Pythagorean numbers* (fr. 28 Tarán) contains some information on the Pythagorean arithmetic, which is, however, inter-

thing else, they seem to be unconcerned with the actual mathematical problems of their time. Although it would be unfair to say that the Academicians were interested in the history of science *only* to the extent that it was connected with Plato's activity, they nevertheless wrongly attributed to him the role of the "architect of the exact sciences."¹⁷⁰ Therefore, we can suppose that the academic writings were not so much a basis for Eudemus' work, but rather a stimulus to him in elaborating his own conception of scientific development. It is thus no surprise that in his history of the exact sciences there was no place left for Plato.

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mingled with his own arithmological interpretations. The only thing that can be found in Xenocrates is his reference to Pythagoras' discovery of harmonic intervals (fr. 87 Isnardi Parente).

¹⁷⁰ For further instances, see Zhmud (1998) p. 215ff.

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