BRILL

The *Catalogus geometrarum* from the *Corpus Agrimensorum*

Part I: Text, Translator, and the Aratean Tradition

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Abstract

An overlooked fragmentary Latin text preserved in the Corpus of Roman Land Surveyors proves to be a translation of a lost branch of the Aratean commentary tradition. Stripped of the classicizing veneer mistakenly applied by earlier editors, the fragment can be recognized as the work of an unknown and inept late-antique Translator, perhaps working within a generation of the fragment's earliest manuscript witness, the Codex Arcerianus. The branch of the commentary tradition used by this Translator made use of Euclid 'the Sicilian', an authority now absent from the surviving tradition: if this Euclid is identical with the famous geometer, as argued here, we may have radical new evidence for his homeland, hitherto unknown. The Aratean manuscript used by the Translator was equipped with interlinear Latin glosses and with illustrations of a type otherwise unattested in the surviving Aratean tradition.

Keywords

1 Introduction

The Codex Arcerianus,[1] our oldest witness to the collected treatises of the Roman land surveyors or *Corpus Agrimensorum Romanorum* (henceforth *CAR*), consists of two parts, *A* and *B*.[2] Part *A*, which probably dates to the early sixth century,[3] preserves at the bottom of f. 83r (see fig. 1) three items:[4]

1. A list of authors—in Latin—that closely resembles two Greek catalogues found in the Aratean commentary tradition.[5]
2. A Latin translation of an otherwise unattested comment attributed to Pyrrhus of Magnesia (not in Pauly-Wissowa) on the opening of Aratus's *Phaenomena*.
3. A reference to a Sicilian Euclid which may have introduced a (now lost) quotation.

These three items, given the misleading title *Catalogus geometrarum* by Carl Thulin (henceforth *CG*),[6] were relegated to the apparatus of Karl Lachmann's edition of *CAR*,[7] and have occasionally been noted by scholars of the textual
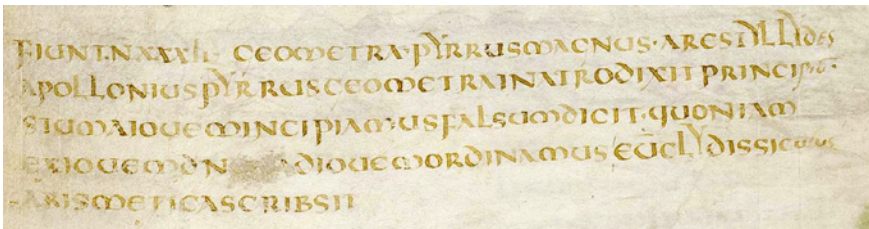

FIGURE 1   The *catalogus geometrarum* in *A* (Wolfenbüttel, Herzog August Bibliothek, MS Guelferb. 36.23), f. 83r
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1   Wolfenbüttel, Herzog August Bibliothek, MS Guelferb. 36.23.
2   Toneatto 1994-1995, MS nos. 001 and 002.
3   Thulin 1911a, 10-32; Lowe 1959, 1374a; Butzmann 1970, 11-34 (beginning of the sixth century); Petrucci 1971, 107-110 (mid-sixth century); Bischoff 1974 (early sixth century). Tosi 1985, 118-122 stands somewhat apart (first half of the seventh century). Carder 1978, 206-208 provides an overview of the dating issue. The hypothesis of Beeson 1928 that the collection relies on an Insular archetype (and consequently that *A* belongs to a later date) is refuted by Josephson 1950, 87-100.
4   In the following article, references to the Arcerianus and other manuscripts of *CAR* follow the foliation used in Toneatto 1994-1995.
5   Maass 1892, 121-123; Martin 1956, 14-15, 186-191.
6   Thulin 1911a, 18.
7   Blume, Lachmann, and Rudorff 1848-1852, vol. 1, 251.

tradition of the corpus.[8] To date, however, *CG* has chiefly interested scholars of the Aratean tradition.[9]

An additional item should be added to *CG*. A diagram found in the 'mixed' manuscript family of *CAR* clearly belongs to the same source as *CG* because of its caption and relative position in the corpus:

4. An astronomical diagram of two or four concentric circles surrounding the sun and moon (and other heavenly bodies?) captioned *Polum collectum* (see figs. 2-4).

This diagram (previously unpublished) has been overlooked by Aratean scholarship.

CG 3 identifies a mathematician, Euclid, using the ethnic epithet *Siculus* ('the Sicilian'). If this individual is identical with the famous geometer, no other ancient source records his homeland, but the testimony of *CG* has been ignored by Euclidean scholarship. The potential importance of this discovery will be considered in Part II of this study.
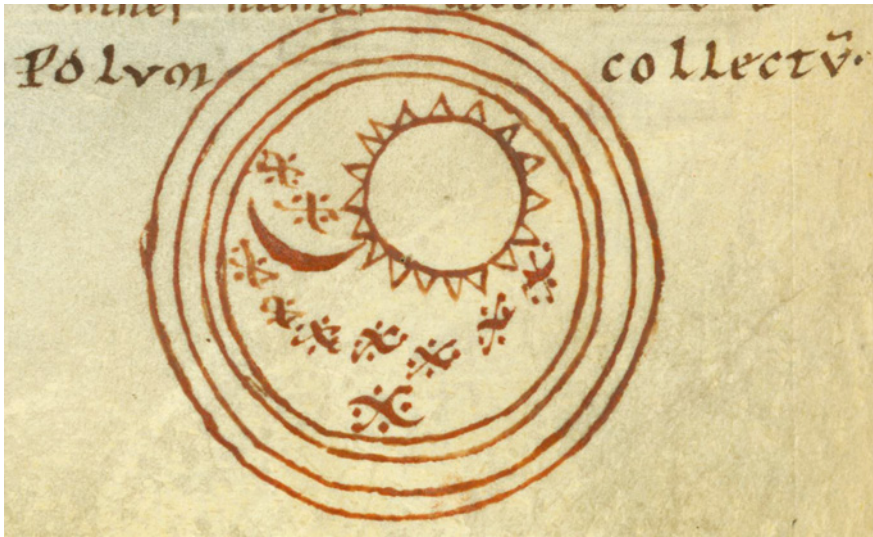

FIGURE 2   *Polum collectum* diagram in *E* (Erfurt, Universitätsbibliothek, MS Amplon. 4º 362), f. 74v

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8   Thulin 1911a, 18; Bubnov 1899, 432.
9   Maass 1892, 121-123; Martin 1956, 14-15, 186-191.

FIGURE 3   *Polum collectum* diagram in *F* (Florence, Biblioteca Medicea-Laurenziana,
             MS Plut. 29.32), f. 9r
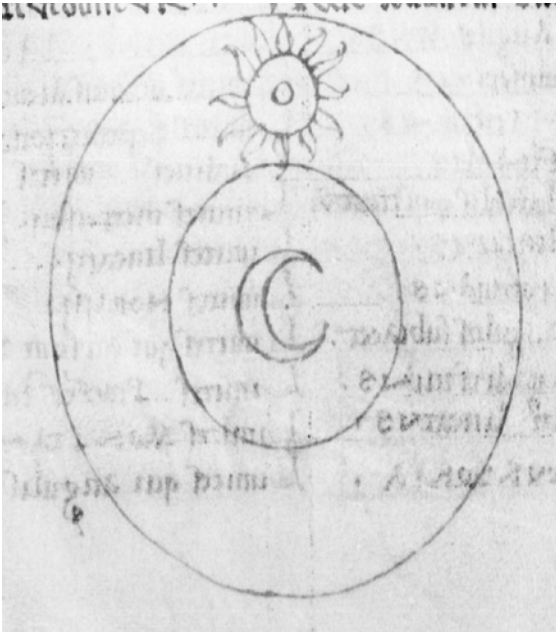
FIGURE 4   Uncaptioned diagram in *N* (London, British
             Library, MS Add. 47679), f. 25v

2 The Textual Witnesses to *CG*

The manuscripts of *CAR* are divided into three classes.[10] The first consists of *A* and *B*, bound together (since antiquity) as the Codex Arcerianus. Though their contents often overlap, *A* and *B* follow different archetypes.[11] Only *A* transmits *CG* 1-3 (f. 83r).

CG 1-3 is also missing from two humanist apographs of the Arcerianus, *J* (ca. AD 1500-1525)[12] and the slightly later *V*.[13]

The second manuscript class is represented by *P* (middle of the ninth century)[14] and *G*, a slightly later indirect copy of *P*.[15] *CG* is not found in this class.

The third or 'mixed' class is represented by *E* (eleventh or twelfth century),[16] *F* (ca. AD 800),[17] and *N* (twelfth century).[18] This class relies in part on a manuscript like *A*, but more complete, and elsewhere on a manuscript resembling *P*. Manuscripts *EF* share a lost intermediary, η (*F* is the more faithful copy). *Nη* share an hyparchetype, θ (the ancestor of the mixed class), though *N* is an indirect and rather careless descendant.[19] *EFN* do not transmit *CG* 1-3, but do preserve *CG* 4, the astronomical diagram (*E*: f. 74v; *F*: f. 9r; *N*: f. 25v): see figs. 2-4.[20]

Before introducing the edition, a peculiar habit of the scribe of *A* should be noted. At line ends, *A* frequently switches to a smaller, more cursive script to avoid word divisions.[21] This inadvertently gives the impression that several word endings (*Arestylli/y-des*, *princi-piu(m)*, *Sic-ulus*) are later supplements (see fig. 1). To reinforce this mistaken impression, *Arestylli* and *sic* also happen

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10   On the textual tradition of the corpus, see Mommsen 1895 (= 1909); Bubnov 1899, 401-493; Thulin 1911a; 1911b; 1911c; Josephson 1950, 72-150; Carder 1976, 4-35; Reeve 1983; Toneatto 1982; 1983a; 1983b; 1988; 1992; 1994-1995, 1, 13-17.

11   Thulin 1911a, 24-32.

12   Jena, Thüringer Universitäts- und Landesbibliothek, MS Prov. f. 156 (= MS 046: Toneatto 1994-1995).

13   Vatican, Bibliotheca Apostolica Vaticana, MS lat. 3132 (= MS 056: Toneatto 1994-1995).

14   Vatican, Bibliotheca Apostolica Vaticana, MS Pal. lat. 1564 (= MS 009: Toneatto 1994-1995).

15   Wolfenbüttel, Herzog August Bibliothek, MS Guelferb. 105 Gug. lat. 2º (= MS 010: Toneatto 1994-1995).

16   Erfurt, Universitätsbibliothek, MS Amplon. 4º 362 (= MS 022: Toneatto 1994-1995).

17   Florence, Biblioteca Medicea Laurenziana, MS Plut. 29.32 (= MS 004: Toneatto 1994-1995).

18   London, British Library, MS Add. 47679 (= MS 032: Toneatto 1994-1995). Sometimes identified by the siglum *H*.

19   On the mixed class see Folkerts 1969 (identifying *N*); Toneatto 1983a, 28-29, 36-37; 1983b, 146-151; 1994-1995, vol. 1, 14-16 (for stemma).

20   Toneatto 1994-1995, vol. 1, 171 (= 004.11), 363 (= 022.11), 467 (= 032.5).

21   Thulin 1911a, 25-26.

to make grammatical sense. Thulin rightly terms the effects of this habit "sehr störend"; even Lachmann was occasionally deceived.[22]

If, prior to Thulin, the -*ulus* in *Siculus* was assumed to be a later supplement, this may explain the strange silence of Euclidean scholarship concerning *CG* 3. However, as the matter seems not to have been discussed in print, this explanation must remain speculative.

3   The Text of *CG*

Lachmann provided a transcription of *CG* with emendations in parentheses.[23] In a study of the Greek catalogues Ernst Maass provided two texts of *CG*: Lachmann's and a "fair copy";[24] the Pyrrhus scholium (*CG* 2) was also printed (without apparatus) in his subsequent edition of the Aratean commentaries.[25] Thulin's more diplomatic edition follows Lachmann by providing corrections in parentheses, but also punctuates the text and adds the supplement ⟨i⟩*stum*.[26]

The following edition excludes extraneous text mistakenly defended by Maass (see apparatus and commentary) and restores *dixit*, incorrectly deleted by Maass but retained by Thulin.[27] The Translator's own Latin and limited understanding of Greek are no longer obscured by misplaced attempts to make the text conform to Classical literary standards. Readings from *A* are based on careful examination of digital images.[28]

The Translator's grasp of Greek was poor. The accompanying English translation departs from the Latin—signalled by (!)—to give, where necessary, the correct sense.

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1.   Geometra Pyrrus Magnus. Arestyllydes. Apollonius.
2.   Pyrrus geometra in atro dixit: "principium stum 'a Iouem incipiamus' falsum dicit, quoniam ex Iouem, non a[d] Iouem ordi[n]amur ⟨***⟩".

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22   Thulin 1911a, 25-26.
23   Blume, Lachmann, and Rudorff 1848-1852, vol. 1, 251.
24   Maass 1892, 122.
25   Maass 1898, 334.
26   Thulin 1911a, 18.
27   Thulin 1911a, 18.
28   Available via the Wolfenbütteler Digitale Bibliothek portal (image 00227): http://diglib.hab.de/mss/36-23-aug-2f/start.htm?image=00227 [accessed 31st August 2021]. See fig. 1.

3.   Euclydis Siculus Arismetica scribsit ⟨***⟩.
4.   Polum collectum.
      (*fig.*)

1 geometra] fiunt n. XXXII geometra *A* (fiunt numero XXXII geometrae
Maass), *sed* fiunt n. XXXII *ad antecedentia pertinere uidetur* | magnus]
A: Magnes *Lachmann* | arestyllydes] *A*: aristylli duo *Lachmann* | atro]
A: Arato *Lachmann* | dixit] *A*: *del. Maass* | stum] *A*: istum *Thulin* istud
Lachmann | a Iouem] *A*: ex Ioue *Lachmann* | ex Iouem] *A* (iouemd *ante
corr.*): a Ioue *Lachmann* | non a Iouem] no̦///a̦d Iouem *A*: non ex Ioue
Lachmann | ordiamur] *Lachmann*: ordinamus *A* | *post* ordiamur *lacunam
pono, suppl. e.g.* ⟨dicimus⟩, ⟨dicere debemus⟩, ⟨dicendum est⟩ | 3 eucly-
dis] *A* (*uirgulam super litteram* 'u' *et uerbum* 'euclides' *in margine scripsit
manus medii aeui*): euclides *Maass* | arismetica] *A*: arithmetica *Maass* |
post scribsit *lacunam pono, u. infra* | 4 polum collectum] *EF*: *om. AN*

1.   The geometer Pyrrhus of Magnesia (!). The two Aristylli (!). Apollonius.
2.   Pyrrhus the geometer said on Aratus (!): "This opening, 'Let us begin out
      of (!) Juppiter', he (sc. Aratus) says incorrectly, because ⟨***⟩[29] 'Let us
      begin from (!) Juppiter', not 'out of (!) Juppiter'".
3.   Euclid of Sicily in his *Arithmetica* wrote ⟨***⟩.
4.   The revolving pole (!).
      (Cf. figs. 2-4)

4   **The Translator**

As noted by Maass,[30] *CG* 2 agrees with an anonymous scholium on the open-
ing line of Aratus's *Phaenomena*. Aratus had written ἐκ Διὸς ἀρχώμεσθα:

They find fault with him (sc. Aratus) for using the preposition ἐκ in place
of ἀπό ('from'); for one should, they claim, say 'from Zeus'. But they are
ignorant of the fact that Pindar also uses this phrase ... and Alcman ...'
(ἐπικαλοῦσι δὲ αὐτῷ τὴν 'ἐκ' πρόθεσιν ἀντὶ τῆς 'ἀπό' παρειληφότι. ἔδει γάρ,
φασίν, εἰπεῖν 'ἀπὸ Διός'. ἀγνοοῦσι δὲ ὅτι καὶ Πίνδαρος κατεχρήσατο τῷ ἔθει
τούτῳ ... καὶ Ἀλκμάν ...).[31]

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29   Supply e.g. 'we say', 'we should say'.
30   Maass 1892, 22.
31   Σ *Arat.* 1, 41.6-12 Martin.

Greek ἐκ/ἐξ is translated above by Latin *a*, and ἀπό by *e*/*ex*, in a reversal of ordinary usage.[32] It is likely no coincidence that confusion between ἀπό and *e*/*ex* is also found in the bilingual glossary tradition,[33] probably compounded by the collapse in the distinction between the prepositions ἀπό and ἐκ / ἐξ in later Greek.[34]

The errors *magnus* (for Μάγνης / *Magnes*), *Arestyllydes* (for Ἀρίστυλλοι δύο / *Aristylli duo*), and *Atro* (for Ἀράτῳ / *Arato*) have been retained above as they seem to be the fault of the Translator rather than a later copyist. Though each might be explained as a copyist's error,[35] the discovery of so many in such proximity is alarming. Two appear to be misguided attempts to find Latin words that resemble the original Greek in shape and make some sort of grammatical sense: thus Pyrrhus is 'the Great' (*magnus*) rather than 'the Magnesian' (*Magnes*), and apparently wrote 'in black (ink?)' (*in atro*), not about Aratus. A doubtful case is *Arestyllydes*, which seems marginally more likely to have arisen from ARESTYLLIDUO than ΑΡΙΣΤΥΛΛΟΙΔΥΟ (cf. Catalogue A no. 1, quoted below). However, as the Translator plainly could not recognize Greek proper nouns, it seems no injustice to attribute *Arestyllydes*—not a Greek name—to the same individual.

Considered together, the most likely explanation for these errors is that they arose from the Translator's dependence on a Greek text provided with interlinear Latin glosses that ignored proper nouns. The glosses themselves were plainly of poor quality, as also implied by the nonsensical *Polum collectum* caption (discussed below). Greek manuscripts equipped with interlinear word-for-word 'translations' must have been relatively common in the late-antique West,[36] and at least one other such manuscript is definitely attested in the Aratean tradition: the notorious *Aratus latinus* 'translation' was created from the interlinear Latin glosses of a Greek Aratus manuscript at Corbie, ca. AD 750.[37] Significantly, this translation is also frequently gibberish.[38]

Unconnected with the quality of the translation *per se*, a striking feature of the Translator's Latinity is the apparent use of accusatives with *a* and *ex* in

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32 For *a* = ἀπό, see e.g. *TLL*, 1.0.2.20; for *ex* = ἐκ / ἐξ, *TLL* 5.2.1082.80.
33 Cf. *CGL* 2.57.37 (*e*: ἀπό), 2.288.23 (*ex*: ἐξ).
34 See Bortone 2010, 184-185, 211-212.
35 E.g. Μάγνης > *Magnis* (cf. *Euclydis*) > *Magnus* (through association with *Pyrrus* / *Pyrrhus*).
36 As implied by finds of Latin papyri with Greek glosses: for examples, see Gaebel 1970. For an early-medieval translation of Euclid prepared from interlinear glosses, see Geymonat 1967.
37 See Le Bourdellès 1985.
38 Kidd 1997, 52.

place of ablatives.[39] The tendency to use the accusative as the general prepositional case is initially a feature of sub-literary Latin, and is already attested in the Pompeian graffiti.[40] From the late fourth century the usage begins to appear in literary contexts, though infrequently and often alongside standard ablative constructions.[41] Some of the first examples are attested in other portions of *CAR*.[42]

Other features of the Translator's Latin also suggest a late date:

1. The use of *stum* in place of *istum*: omission of initial *i-* in this pronoun is attested in inscriptions and occasionally encountered among lower literary registers in Late Antiquity; the form is also imposed on earlier authors as a scribal hypercorrection.[43]

2. The 'mixed gender' structure *principium istum* (neut. acc. + masc. acc.), where *istud* (neut. acc.) would be expected in Classical Latin. This reflects the collapse of the neuter gender in spoken registers of the language:[44] the Translator may well have written *principius* for the nominative.[45]

3. The spellings *-is* for *-ēs* in *Euclydis*,[46] possibly *-es-* for *-is-* in *Arestyll-* (though note the name itself is erroneous), and *arismetica* for *arithmetica*.[47]

The spelling *ordinamur* for *ordiamur* is merely an orthographic mistake, prompted by confusion with *ordinare* ('to order').[48]

In sum, the language of *CG* suggests it was created not long before manuscript *A* itself (certainly within the previous century) by someone with a weak grasp of Greek and the norms of literary Latin, probably working from a Greek manuscript equipped with interlinear Latin glosses. Given these signs of limited learning, was the Translator a student? In general terms, some elementary astronomy was clearly felt to be useful for a surveyor's education: the treatise

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39 Apparent, because final *-m* is also added arbitrarily in non-standard usage. See Diehl 1899; Adams 1977, 36-37.

40 Väänänen 1981, 112. Additional epigraphic evidence in Diehl 1899, 12-16 (*a*), 31-34 (*ex*).

41 See *TLL* 1.0.40.20-32 (*a*); 5.2.1127.6-43 (*ex*).

42 See e.g. Ps. Agg. Urb., *Comm. ad Front.* 3.24 La. = 54.9 Th. = 52.16 Ca. (sixth century? Thulin 1913, 113; Campbell 2000, xxxiv); *Casae litterarum I*, 313.20 La. (late fifth/early sixth century: Josephson 1950); *Auctores*, 344.1 La. = 250.4 Ca. (likewise late). For this usage in the *Casae litterarum*, see Josephson 1950, 183-186.

43 See *TLL* 7.2.494.60-68; Adams 2013, 464.

44 See Väänänen 1981, 101-103; Adams 2013, 425-431.

45 Note the prevalence of nominative singular forms in *-us* of original second declension neuter nouns in the Oribasius translation (sixth century): Mørland 1932, 64-66.

46 See Väänänen 1981, 36 (with Löfstedt 1961, 21-37). Cf. Josephson 1950, 85-86.

47 Birt 1925.

48 Cf. *TLL* 9.2.947.35-36.

of Hyginus demonstrates that an annotated copy of Aratus would not be out of place in a surveyor's library.[49]

5   The Place of *CG* within *CAR*

In manuscript *A*, three *cippi* or boundary stones are illustrated immediately above *CG* on f. 83r: two are blank and one has an inscription purporting to be from the reign of Antoninus Pius.[50] A further twenty-one unlabelled illustrations of *cippi* are provided on what is now the preceding folium (f. 82v). Immediately after the catalogue at the bottom of f. 83r is an explicit in red: EX̅P. NOMINA LAPIDUM FINALIUM FELICITER ('here properly end the names of boundary stones').[51] In manuscript *A*, these *nomina* or names have been lost together with the two folia that were cut out of *A* between ff. 82 and 83.[52] Fortunately, the full list of names and corresponding incipit—EX LIBRO BALBI NOMINA LAPIDUM FINALIUM ('From the book of Balbus: names of boundary stones')—can be restored from the 'mixed' branch of the tradition.[53]

Lachmann printed these names and two adjacent lists of boundaries and fields as a kind of appendix to the *Liber coloniarum I* (an annotated list of colonial foundations in Italy) on the basis of a perceived similarity of theme. However, these lists are physically far removed from the *Liber coloniarum I* in the manuscripts and ought to be treated as separate entities.[54] The lists have nothing to do with *CG* 1-4, but their presence in *EFN* immediately before the astronomical diagram (*CG* 4) provides a shared point of reference with *A*.

Underneath the three *cippi* in *A* (and presented as though part of *CG* 1) are the words *fiunt n. XXXII* (see fig. 1). Maass suggested the reading *fiunt n(umero) XXXII geometra⟨e⟩* ('the geometers are thirty-two in number'), comparing the tally that concludes one of the related Greek catalogues.[55] In this he was followed by Jean Martin, despite the problem that the total only coheres with the Greek catalogues by resorting to creative accounting.[56] In reality, this

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49 Cf. Hyginus Gromaticus *De condicionibus agrorum* 183.17-188.13 La. = 147.17-152.3 Th. = 146.7-148.25 Ca. See Dilke 1971, 61-63; Alexandratos 2009.

50 [*Liber coloniarum I*], 251.1-17 La. = 246.32-48 Ca.

51 I have adapted the translation of Campbell 2000, 247.37.

52 Toneatto 1994-1995, vol. 1, 159.

53 [*Liber coloniarum I*], 249.1-250.33 La. = 244.29-246.19 Ca.

54 Grelle 1992, 67; Campbell 2000, xli n. 119, 443 n. 1.

55 Catalogue B: see below.

56 Martin 1956, 186.

reckoning relates to the *nomina* referred to in the explicit of *A*:[57] these are thirty-two in number (not thirty-three: *Isosc(a)eli* is erroneously repeated), and similar tallies conclude the lists of boundaries and field-types on f. 82r in *A*.[58] The emendation *geometra⟨e⟩* is thus unnecessary: *geometra* is in apposition with *Pyrrhus Magnes*. This epithet is missing from the Greek catalogues and may have begun life as a gloss in the Greek source-text, derived from the corresponding scholium (cf. *CG* 2).

The astronomical diagram found in *EFN* (but not *A*) is found after the same names of boundary stones, boundaries, and fields that precede *CG* 1-3 in *A*.[59] As noted by Thulin, the relative position and caption of the diagram suggest that it ultimately derived from the same source as *CG* 1-3.[60] In *E* this diagram takes the form of four concentric circles surrounding the sun, moon, and ten stars (fig. 2). In *F* only the circles have been drawn (on a much grander scale), with space left for additional illustrations that were never completed (fig. 3). In *N*, the diagram consists of two concentric circles with the moon in the centre, the sun between the inner and outer circles (fig. 4).

Why *CG* 1-4 came to be appended to a list of boundary stones is a difficult question to answer, as no obvious connection can be drawn between the two. However, *CAR* is a much less homogenous collection than its title (or modern editions) suggest: besides the texts of the land surveyors, *A* also incorporated much mathematical material, including extensive excerpts from the otherwise unknown Epaphroditus and Vitruvius Rufus (not printed by Lachmann),[61] and Varro's *De geometria*, now lost.[62] *B* transmits further arithmetical and geometrical fragments,[63] while *P* provides a different selection of surveyors' treatises, extracts from a mysterious group of *auctores* ('authorities'), and various legal excerpts. The texts of the land surveyors themselves, even in the Arcerianus, are transmitted in a fragmentary and thoroughly disturbed state. The second treatise in *A* ends mid-sentence, even though no pages are missing from the manuscript at this point.[64] Only the work known as Hyginus 2 appears in all three manuscript families.[65]

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57   Thulin 1911, 18.
58   [*Liber coloniarum I*], 249.30 La. = 244.25 Ca.: *sunt limites n. XXVIIII. agrorum n. XVIIII.*
59   Toneatto 1994-1995, vol. 1, 170-171 (= 004.8-10), 362-363 (= 022.8-10), 466-467 (= 032.2-4).
60   Thulin 1911a, 80-81.
61   Ed. Bubnov 1899, 518-551; Guillaumin 1996, 138-196.
62   Simon 1964.
63   Ed. Bubnov 1899, 504-508.
64   Toneatto 1994-1995, vol. 1, 153 (= 002.2).
65   Campbell 2000, xxi.

For these reasons, Lucio Toneatto has questioned whether *CAR* can ever have depended on a single archetype, and instead suggests that each family may represent an amalgam of several different late-antique pamphlet collections.[66] *CG* 1-4 may have been inadvertently swept into one of these collections in the process of its creation, and subsequently mixed with a list of boundary stones in the churn of history. The early codices of the tradition(s) were evidently much used and poorly bound.

This portion of *A* certainly shows other signs of dislocation: on f. 82r intruded text (in bold), copied in large capitals of contrasting colours, has likewise been incorporated into an explicit: SVNT LIMITES N̄. XXVIIII. **IDEOQ. LIMES AGRO POSITVS LITEM VT DISCERNERET AGRIS. NAM ANTE IOBEM**[67] LIMTE NON PAREBANT QVI DIVIDERENT AGROS. EX̄P. NOMINA LIMITVM ('The boundaries are 29 in number. **Likewise** [Verg. *A*. 12.898]**: "Set up as a boundary in the field, to settle land disputes". For before Juppiter, boundaries did not exist to divide fields.** Here end the names of boundaries.'). This seems to be a fragment from a lost collection of gromatical maxims:[68] a more complete version is transmitted at the beginning of *G* (reporting the lost opening of *P*), but mixed up with the initial sections of the treatise of Balbus.[69] On a much grander scale, *A* treats an extensive excerpt from a legal text, provided with its own (erroneous) title in larger red capitals on f. 66r (LEX MAMILIA ROSCIA PEDVCEA ALIAENA FABIA K. L. III, 'The Lex Mamilia Roscia Peducaea Alliena Fabia: Chapter 3 of the law') as an appendix to the *Constitutio limitum* of Hyginus Gromaticus: the explicit to this work follows the excerpt on f. 67r: EX̄P HYGYNI GROMATICI CONSTITVTIO FELICITER ('Here properly ends the *Constitutio* of Hyginus Gromaticus').[70]

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66   Toneatto 1983a, 43-45.

67   The letters 'V' and 'B' are frequently confused in *A*; the correct reading, *Iouem*, is preserved in *G* (n. 69 below).

68   Bubnov 1899, 446, 460.

69   Thulin 1911a, 18 (cf. Blume, Lachmann, and Rudorff 1848-1852, vol. 1, 95 *app. crit.*) = Toneatto 1994-1995, vol. 1, 251 (= 010.2): 'All this measurement must be diligently and faithfully sought out. Likewise we warn that each person should hold onto his own boundaries, not challenge those of others. For this reason, that "Boundaries were set up in a field, to settle land disputes". For before Juppiter, boundaries did not exist to divide fields (*nam ideo 'limes agro positus est, ut litem discerneret aruis'. nam ante Iouem limites non parebant, qui diuiderent agros*). Follow the examples of those near by, whence you can render decisions without blame. For this reason a field is measured in feet, so that the truth might be revealed'. Cf. 'The Prophecy of the Nymph Vegoia', 350.17-351.11 La. = 256.33-257.10 Ca.

70   See Crawford 1989.

Perhaps of greater significance, f. 83 now marks the end of manuscript A; whether there was any more in antiquity must remain an open question.[71] Folio 83v is completely filled with illustrations of boundary markers (trees, roads, rivers etc.); the first folio of B (f. 84r) immediately follows in the modern binding.[72] Clearly more of *CG* was once to be found in the archetype, as demonstrated by *CG* 4. Now, *CG* may once have started life as stray notes copied into the bottom of a list of boundary stones. But it may also have begun life as an independent text following that list of boundary stones, from which, after severe mutilation to the end of the manuscript, a later scribe copied all that could be read and placed this neatly into the explicit of the previous work, 'bracketing' it as other textual intrusions are also bracketed in *A*. Such mutilation might explain, incidentally, why the ancestor of the 'mixed' group only selected the diagram, *CG* 4, for preservation.[73] Although *CG* could have begun life as a complete 'translation' (like the Aratus latinus), it seems more likely that it was always simply a series of notes jotted down from a student's reading of a glossed Greek manuscript: although it cannot definitively be determined whether these notes were mere marginalia or a more extensive series of 'translated' excerpts with an independent physical existence, their discovery at the end of *A*, following a completely unrelated text but without the related *CG* 4 illustration, may be arguments in favour of the latter supposition.

6   *CG* 1 and 2: Sources

As noted earlier, *CG* 1 is closely related to two catalogues of astronomical authors preserved in the Aratean commentary tradition:[74]
1. Catalogue A, transmitted by three manuscripts (Vatican, Bibliotheca Apostolica Vaticana, MSS gr. 191 and gr. 381; Modena, Biblioteca Estense, MS U 9 20), concludes an introductory essay on the *Phaenomena* known as Anonymous II.1.[75] This essay was composed as part of a new 'popular' edition

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71   Thulin 1911a, 18. The final quire lacks a folio (see the convenient chart in Carder 1978, 11), but if f. 83 does mark the end of *A*, this may have been intentionally discarded.
72   As I soon hope to demonstrate, the notion that this reverses the ancient order (see Reeve 1983, 1-2) is not tenable.
73   *CG* 4 is immediately followed in the 'mixed' group by an intruded fragment of Agennius Urbicus, *De controuersiis agrorum* (90.3-21 La. = 50.5-51.3 Th. = 46.24-48.3 Ca.); the 'complete' text is found in *A* at ff. 67r-76r.
74   On these catalogues, see Maass 1881; 1892, 121-164; Martin 1956, 182-191. For a brief overview of the Aratean commentary tradition see Dickey 2007, 56-60.
75   Ed. Maass 1898, 102-133.

(Φ) of the *Phaenomena* and related commentary which was already extant ca. AD 300.[76] 2. Catalogue B (also transmitted by Vat. gr. 381) is found before extracts from a treatise on the universe by a certain Achilles (third century AD), also used as an introduction to the poem.[77]

Parallels with *CG* 1 are marked with bold type:

A. Authors who have written on the poet (sc. Aratus).

1. Attalus of Rhodes. Aristarchus of Samos. **Apollonius** the Geometer (Ἀπολλώνιος γεωμέτρης). Antigonus the Grammarian. Agesianax. **The Aristylli, two Geometers** (Ἀρίστυλλοι δύο γεωμέτραι). Boethus. Geminus. Diodotus. Didymus of Knidos. Eratosthenes. Hermippus. Euainetus. Zenon. Heliodorus the Stoic. Thales. Hipparchus of Bithynia. Crates. **Pyrrhus of Magnesia** (Πύρρος Μάγνης). Parmeniscus the Grammarian. Sminthes. Timotheus.

2. **Apollonius** the Grammarian. **Aristyllus** the Great. **Aristyllus** the Small (Ἀπολλώνιος γραμματικός. Ἀρίστυλλος μέγας. Ἀρίστυλλος μικρός). Aristarchus the Grammarian. Aristophanes. Alexander of Aitolia. Alexander of Ephesus. Didymus the Bad. Another Euainetus. Hermippus the Peripatetic. Callimachus of Cyrene. Kleostratus of Tinos. Numenius the Grammarian. Parmenides.[78]

B. Authors who have written on the celestial sphere.

1	Apollodorus	2	Geminus	3	Euainetus	4	Krates
5	**Aristyllus** (Ἀρίστυλλος)	6	Diodotus	7	Menodotus	8	Zenodotus
9	Attalus	10	Didymus	11	Zenodorus	12	**Pyrrhus** (Πύρρος)
13	Aristarchus	14	Diodorus	15	Hegesianax	16	Parmeniskus
17	**Apollonius** (Ἀπολλώνιος)	18	Eudorus	19	Theodorus	20	Sminthes
21	Antigonus	22	Eratosthenes	23	Thales	24	Timotheus
25	Boethus	26	Hermippus	27	Hipparchus		Twenty-seven in all.[79]

Catalogues A1 and B are obviously closely related: only Zeno and Heliodorus the Stoic are missing from B, while B names Apollodorus, Diodorus, Eudorus, Zenodorus, Zenodotus, Theodorus, and Menodotus, absent from A1. Despite the title appended to Catalogue A, 'Authors who have written on the poet' (Οἱ περὶ τοῦ ποιητοῦ συνταξάμενοι), the title of Catalogue B, 'Authors who have

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76   See: Martin 1956, 35-126; 1998, 1, cxxvi-cxxx; Dickey 2007, 57-59. The *terminus ante quem* of ca. AD 300 is provided by Lactantius, who quotes scholia from Φ: Martin 1956, 41.

77   Maass 1898, xvii.

78   Maass 1892, 121.

79   Maass 1892, 123.

written on the celestial sphere' (Οἱ περὶ τοῦ πόλου συντάξαντες) seems a far more suitable label for both lists, and is presumably the original.[80]

Catalogue A2 is subtly different in character and was clearly intended to supplement A1: epithets have been added to some authors (Aristyllus the Elder, Aristyllus the Younger, Hermippus the Peripatetic), along with a second Euainetus (distinguished simply as 'the other'). A2 also adds new literary figures such as the poet Callimachus and the Alexandrian grammarians Aristarchus and Aristophanes of Byzantium.

All three catalogues share similarities with two biographical introductions to Aratus known as *Vita I* and *Vita II*, and a scholium on Saint Basil's *Hexameron* found in Oxford, Bodleian Library, MS Barocci 85, f. 118r.[81] Based on the parallels between these texts and *CG* 1, Jean Martin recognised that all depend on a lost ancestor that formed part of a general introduction to the *Phaenomena*, one that included an outline of elementary astronomy.[82] This ancestor is most faithfully represented by *CG* 1 and Catalogue A1 (the additional names in Catalogue B are thus later supplements), and must have belonged to the commentary tradition before the creation of the Φ edition: the scholium of Pyrrhus still present in *CG* was subsequently removed from Φ.[83] The Greek source text of *CG* 1-2 (the catalogue and Pyrrhus scholium), in other words, has an ancient pedigree that antedates the fourth century AD and is likely considerably earlier.

Just how early is difficult to say: the latest identifiable individual in the Greek catalogues—Geminus—belongs to the latter half of the first century BC.[84] However, even Geminus may only represent the most recent stratum laid atop a deep bed of bibliography (note the additions to Catalogue B above): it is perfectly possible that the antecedent of all these catalogues belonged to the Hellenistic period. Unfortunately, the dates of the three individuals named in *CG* 1 are non-diagnostic for dating purposes: Pyrrhus of Magnesia is otherwise unknown, and the Aristylli and Apollonius (clearly the geometer rather than the grammarian, given the line of descent sketched above) belong to the early Hellenistic period. Although the latest common ancestor of the *Greek*

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80   Von Wilamowitz-Moellendorff 1881, 339 (*contra* Maass 1881, 389). For the identities of the individuals named in these catalogues, see Maass 1892, 149-163.

81   See the table in Martin 1956, 184-185.

82   Martin 1956, 182-191.

83   Martin 1956, 189-190.

84   This date is defended with new evidence by Jones 1999 against Neugebauer 1975, 579-581. See also Evans and Berggren 2006, 17-22.

catalogues was created in or soon after the first century BC, it is unknowable whether *CG* represents a branch of an even earlier tradition.[85]

7   *CG* 3: Euclid and the Aratean Tradition

The simplest explanation for the origin of *CG* 3—the reference to *Euclides Siculus*—is that it also came from an Aratean source: it is accompanied by two certain fragments of the Aratean commentary tradition and closely associated with an astronomical diagram. Euclid is not named in the surviving Aratean tradition, but this is hardly a decisive objection. Besides *CAR* our only evidence for the existence of Pyrrhus of Magnesia is provided by Catalogues A1 and B.

Euclid seems an obvious omission from a catalogue titled 'Authors who have written on the celestial sphere' (Catalogue B). Euclid and Aratus share a book title: *Phaenomena*.[86] Euclid's work, whose title is securely attested as early as the second century AD,[87] provided new mathematical insights into problems concerning spherical astronomy.[88] By the first century BC, Euclid's name was already synonymous with geometry,[89] and (somewhat unusually for such a highly technical author) he is also named and quoted by non-specialists including Plutarch, Galen, Aelian, Eusebius of Caesarea, and Gregory of Nyssa.[90] His supposed likeness may even have entered the pattern books of the mosaicists.[91]

Whether or not Euclid's name has dropped out of the catalogues,[92] *CG* 3 evidently did not come from such a source: the catalogues are simply lists of names and epithets. As the reference to Euclid in *CG* follows Pyrrhus of Magnesia's comment on the opening words of Aratus's poem, it is a reasonable hypothesis that it was also once associated with a comment on the text of Aratus's poem: thus the lacuna posited in the edition above. This hypothesis is strengthened by the associated diagram, which, as we will see below, likely belongs with *Phaen.* 19-26.

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85   Cf. Martin 1956, 190 (the catalogues' common ancestor is inseparable from the pre-Φ Alexandrine edition but may not have formed an original part of that edition).

86   On the term φαινόμενα (*Phaenomena*) see Kidd 1997, 160; Gee 2013, 7-12.

87   Gal. *PHP* 8.1.19.

88   Ed. Menge 1916. See also Berggren and Thomas 2006.

89   Cf. Cic. *De orat.* 3.132.

90   Plu. *Mor.* 1093e6; Ael. *NA* 6.57.6; Gal. *UP* 3.830.7-13 Kühn, *PHP* 8.1.19, *Adu. typ. scr.* 7.511.10 Kühn, *Inst. Log.* 16.6.4-5, *Hipp. Art.* 18a.466.15 Kühn, *Pecc. Dig.* 5.59.13 Kühn; Euseb. *Hist. Eccl.* 5.28.14; Greg. Naz. *Or.* 7.20.4 (= *PG* 35.780d). See Vitrac 2008, 267-268.

91   Studemund 1890, 2-3.

92   Note e.g. Zeno and Heliodorus, named in Catalogue A no. 1, are missing from Catalogue B.

The fragment itself—*Euclydes Siculus arismetica scribsit*—might be construed in three ways:

1. Euclides Siculus *Arithmetica* scribsit.
   Euclid the Sicilian wrote an *Arithmetica*.
2. Euclides Siculus "arithmetica", scribsit, "⟨***⟩".
   Euclid the Sicilian wrote: "Arithmetic ⟨****⟩".
3. Euclides Siculus ⟨in⟩ *Arithmetica* scribsit "⟨***⟩".
   Euclid the Sicilian wrote in his *Arithmetica*: "⟨***⟩".

Although the first interpretation is perfectly reasonable in isolation, it is extremely hard to justify its adoption when set against the rest of *CG*, which is clearly Aratean in character. Euclid the geometer is not known to have written a work titled Ἀριθμητική;[93] unless a reference to some lost (spurious) work is suspected, an otherwise unknown Euclid must be hypothesized (we might then imagine that this individual was given the epithet *Siculus* to distinguish him from his more famous namesake). However, an isolated note that merely attests to the quondam existence of an unknown author's inconsequential treatise on arithmetic has no obvious connection with the *Phaenomena*.

The second interpretation is also unlikely. The word ἀριθμητική (Latin *arithmetica*) is absent from both the poem of Aratus and the wider commentary tradition. Euclid the geometer nowhere in his surviving works uses the term; though we might hypothesize, once again, a quotation from the pen of our unknown Euclid, this is hardly a promising beginning for a comment on the *Phaenomena*.

The third interpretation raises greater possibilities, including a means of fully integrating *CG* 3 within the rest of the Aratean tradition. I set aside at the outset the enduring possibility that this is a reference to some unknown Euclid's lost *Arithmetica*, which advances us no further than the first interpretation and can be dismissed using more or less the same argument. It must be admitted, however, that this may well be the *correct* interpretation, if only because it offers unknown Euclid an unlimited opportunity to make himself relevant to the elucidation of the *Phaenomena* in some now-unrecoverable way. Sadly, the evidence offered by *CG* offers no hope of certainty.

If we entertain the possibility that we are dealing with a reference to the famous geometer—I return to the significance of the epithet *Siculus* in Part II—, we can provide a plausible explanation for the presence of *CG* 3

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93 On the Euclidean canon see Heiberg 1882, 28-55; Heath 1926, 1, 7-18; Bulmer-Thomas 1971, 425-431; Vitrac 2000, 256-261.

in *CAR*, one that is tied closely to *CG* 4. First, however, we must account for the presence of *Arithmetica/arismetica* in the Translator's reference: as noted above, Euclid wrote no such treatise. Either Ἀριθμητική stood in the Translator's source text, and must be considered a variant appellation for one of Euclid's known works (or a part of one of those works), or *Arithmetica/arismetica* is an error introduced by the Translator (or a copyist).

The first option seems rather remote, though is not wholly without parallel. Extensive searches reveal three analogous references. The first is found in John Philoponus (sixth century AD):

> The highest part of mathematics is easy to distinguish and separated from the study of nature; examples are Theodosius' work On Spheres and Euclid's thirteen books on arithmetic (οἷά ἐστι τὰ Θεοδοσίου Σφαιρικά, τὰ Εὐκλείδου ιγ′ βιβλία, τὰ ἀριθμητικά), for in these there is absolutely no mention of matter.[94]

The work in thirteen books must be Euclid's *Elements* (Στοιχεῖα in Greek), but the characterisation of the *Elements* as a work on arithmetic is highly idiosyncratic: only books 7-9 can be described as arithmetical: the rest concern geometry. Philoponus elsewhere refers to the work either by its usual title or as 'Euclid's geometry'.[95] The change here was presumably made for local rhetorical effect.

The second reference is provided by a suspect lemma on Euc. 10.prop.9 (p. 30.20 Heiberg): δέδεικται ἐν τοῖς ἀριθμητικοῖς, ὅτι … ('It was demonstrated in the arithmetical books that …'). Though spurious, the lemma probably entered the tradition before Pappus (early fourth century AD).[96] The formula ἐν τοῖς ἀριθμητικοῖς refers to content found in Euc. 8.prop.26, i.e. the part of Euclid's treatise that concerns arithmetic. This usage is perfectly reasonable and unambiguous in the context, but is, of course, framed as an internal reference.

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94   Phlp. *in Ph.* 16, 220.14-17 Vitelli (Trans. Lacey 1993, 33).
95   Phlp. *in APo.* 73.15 Wallies: ἐν τῷ ἑβδόμῳ βιβλίῳ τῶν Εὐκλείδου Στοιχείων ('in the seventh book of Euclid's *Elements*'); *in APo.* 377.1 Wallies: Εὐκλείδης ἐν τῷ τρίτῳ τῆς γεωμετρίας ('in the third of Euclid's geometry'). For the referential formulae applied to Euclid's works in antiquity, see Vitrac 2000, 257-262.
96   Heiberg 1883, 35 n. 1 and Heath 1926, 3, 31-33 associate this lemma with Euc. 10.prop.10, likewise a later insertion but accepted as genuine by Pappus (cf. Junge and Thomson 1930, 66-67, 87, 88).

The third reference is provided by the *Scholia Marciana* on Dionysius Thrax,[97] a commentary assembled in or after the later ninth century.[98] This uses the same formula (ἐν τοῖς ἀριθμητικοῖς) to refer to Euc. 7.def.22, another of the arithmetical volumes.[99]

The less doubtful formulae are plural but the Latin is singular (we should expect *Arithmeticis* in our translation), and books 7-9 of Euclid's *Elements* provide no obvious points of contact with the text of Aratus: they offer an exceedingly technical treatment of arithmetical problems. The only part at all attractive to a commentator would seem to be the introductory definitions (Euc. 7.def.1-22) of concepts such as 'unit', 'number', 'odd number', 'cube (number)' etc. (compare the *Scholia Marciana* above). Unfortunately, I can find no plausible point where one of these rigorous mathematical definitions could have entered the Aratean tradition via a direct comment on the text of the poem: there is certainly no suitable overlap in vocabulary. If we knew for certain that *CG* 3 did refer to some passage in *Elements* VII-IX, then we would have to suppose that it elaborated upon a digression.

As we cannot say with any certainty that the citation *does* refer to the *Elements*, then the second option outlined above also deserves consideration (i.e. that *Arithmetica* is an error introduced by the Translator).

Rather than work from Euclid's corpus towards Aratus, a more fruitful approach at this juncture is to work from Aratus towards Euclid. Although Euclid's treatises are extremely technical and offer few, if any, passages that might illuminate Aratus's verse, there is a plausible point at which a citation from Euclid could have enriched the commentary tradition. Much of Aratus's *Phaenomena* is concerned with constellations (26-461), the passage of time (462-757), and weather signs (758-1141), but the poem begins with a few remarks about the spherical model of the cosmos (19-26). Not only do these remarks overlap with Euclid's interest in geometrical astronomy, but they can also be linked to the astronomical diagram (*CG* 4).

The Euclidean connection will be investigated first. Aratus had written:

οἱ μὲν ὁμῶς πολέες τε καὶ ἄλλυδις ἄλλοι ἐόντες
οὐρανῷ ἕλκονται πάντ' ἤματα συνεχὲς αἰεί·   20

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97   Ed. Hilgard 1901, 292-442.

98   The scholiast used George Choeroboscus (Uhlig 1883, xxxiv), now securely dated to the ninth century: Theodoridis 1980; Kaster 1985, 394-396.

99   Σ *Marc. in D.T.* 346.3-6 Hilgard: τέλειος γὰρ ὁ ἓξ ἀριθμός, καθὼς καὶ Εὐκλείδης ἐν τοῖς ἀριθμη-τικοῖς ὡρίσατο εἰπών ... [Euc. 7.def.22] ('For six is a perfect number, as Euclid defines in his arithmetical books ...').

αὐτὰρ ὅ γ' οὐδ' ὀλίγον μετανίσσεται, ἀλλὰ μάλ' αὔτως
ἄξων αἰὲν ἄρηρεν, ἔχει δ' ἀτάλαντον ἀπάντη
μεσσηγὺς γαῖαν, περὶ δ' οὐρανὸν αὐτὸν ἀγινεῖ.
καί μιν πειραίνουσι δύω πόλοι ἀμφοτέρωθεν·
ἀλλ' ὁ μὲν οὐκ ἐπίοπτος, ὁ δ' ἀντίος ἐκ βορέαο   25
ὑψόθεν ὠκεανοῖο ...[100]

The numerous stars, scattered in different directions, sweep all alike
across the sky every day continuously for ever. The axis, however, does
not move even slightly from its place, but just stays for ever fixed, holds
the earth in the centre evenly balanced, and rotates the sky itself. Two
poles terminate it at the two ends; but one is not visible, while the oppo-
site one in the north is high above the horizon ...

This brief summary proved to be quite controversial. The transmitted reading
οὐρανὸν αὐτόν (line 23) makes perfect sense, but several variants also circulated
in antiquity, including οὐρανὸς αὐτόν,[101] which gave rise to debate:

Here the astronomers and the grammarians had extensive and differing
inquiries about the reading. The grammarians said from ignorance: 'the
sky rotates the axis' (περιάγει ὁ οὐρανὸς τὸν ἄξονα). But this is a crowning
absurdity, for if we have defined the axis as motionless (Aratus himself
openly says [21-22]: 'The axis, however, stays for ever fixed'), how can
they say that it rotates? (ἀλλὰ μάλ' αὔτως ἄξων αἰὲν ἄρηρεν, πῶς αὐτόν φασι
περιάγεσθαι;) Instead the astronomers aspirate αυτόν in order that it may
become ἑαυτόν. The sense is this: 'the sky moves and revolves round the
axis' (περὶ δὲ τὸν ἄξονα ἄγει καὶ στρέφει ὁ οὐρανὸς ἑαυτόν).[102]

Note also:

Another explanation: the axis, he says (sc. Aratus), turns the heavens
(περιάγει ... ὁ ἄξων τὸν οὐρανόν). However, this is not so, because the
heavens wheel by themselves. But, just as we say that time carries away
everything, and the road carries travellers, so too (might we say) the axis
carries the heavens.[103]

100   Arat. 19-26 (ed. and trans. Kidd 1997).
101   See Kidd 1997, 173-174; Martin 1998, 2, 155-157.
102   Σ *Arat.* 23 (ed. Martin 1974, 68.14-69.6); trans. Luiselli 2015, 1232.
103   Σ *Arat.* 23 (ed. Martin 1974, 69.7-10); trans. Berggren and Thomas 2006, 46.

The preface of Euclid's *Phaenomena*, a more reader-friendly introduction to the main work, succinctly states the argument underlying the variant proposed by 'the astronomers' in the first scholium:

> For all these reasons then, the cosmos is spherical and turns uniformly about its axis (στρέφεται ὁμαλῶς περὶ τὸν ἄξονα), one pole of which is above the earth, visible, and the other below the earth, invisible (οὗ ὁ μὲν εἷς πόλος ὑπὲρ γῆν, φανερός, ὁ δὲ εἷς ὑπὸ γῆν ἀφανὴς ὤν).[104]

Was this passage brough to bear in some lost commentary? My suggestion is clearly conjectural and relies on the—admittedly fair—possibility that the preface of Euclid's *Phaenomena*, the authority of which has been questioned by modern scholars, was already circulating (and accepted as genuine) by the Imperial period.[105] If not this passage, other authoritative pronouncements on the sphere and axis (considered geometrically rather than cosmologically) can also be found in Euclid's *Elements*.[106] Might one of these definitions have been pressed into service?

Putting the above conjectures to one side, the questions raised by the commentators concerning the spherical model of the cosmos adopted by Aratus provide a reasonable context for the citation of Euclid, even if the limitations of our evidence only allow speculation. It would be useful to know, for instance, whether actual authorities stand behind a handful of references to οἱ γεωμέτραι found in another late-antique introduction to Aratus based on the work of the third-century author Achilles,[107] or if the references are merely generic.[108]

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104   Euc. *Phaen.* p. 6.11-14 Menge; trans. Berggren and Thomas 2006, 46.

105   See Neugebauer 1975, 756; Berggren and Thomas 2006, 8-13. Galen (late second century AD) certainly knew the main body of the treatise (*PHP* 8.1.19); Plutarch (early second century AD) refers to Euclid's use of a dioptra (*Mor.* 1093e.6), an instrument used to prove the first theorem (Euc. *Phaen.* p. 10.16 Menge).

106   Euc. 11.def.14-17.

107   Ed. Di Maria 2012.

108   Ach. Tat. *Introductio in Aratum* 25.10, 'They call the five circles (sc. zones of the heavenly sphere) parallel from the parallel lines of the geometers'; 22.1-2, 4, 'There are eleven circles, the two largest being outside the sphere: the horizon and meridian ... It is called the horizon, because it separates (ὁρίζει) the hemisphere under the earth from that above ... The philosophers and geometers call it the horizon ...' (cf. Euc. *Phaen.* pp. 6.15-18, 8.16-28); 28.1-3, 'The axis extends from the centre of the arctic circle, through the centre of the sphere, until the centre of the antarctic circle ... Aratus does not tell us about its substance ... The geometers suppose that it is a straight line passing from the centre of the arctic circle until the antarctic, as has been said ...' (cf. Euc. *Phaen.* pp. 2.19-6.14).

So, might *Arithmetica* be an error for *Phaenomenis*? Although one shudders to think so, *magnus*, *Arestyllydes*, and *atro* attest to the fact that the Translator was ignorant of Greek proper nouns; if the titles of treatises were also unglossed in his source text, these are likely to have caused similar serious difficulties. Φαινόμενα was never naturalised in Latin,[109] and the substantival use of the Greek present middle/passive participle—a grammatical form without parallel in Latin—may have caused the hapless Translator deeper confusion.[110] As the example of *Pyrrus … in atro* demonstrates, the term *arithmetica* need not have any close association with the original Greek reference. Although ΕΝ ΤΗΙ ΑΡΙΘΜΗΤΙΚΗΙ / ΕΝ ΤΟΙΣ ΦΑΙΝΟΜΕΝΟΙΣ are markedly dissimilar in palaeographical terms, an indistinct Φ (plus scribal abbreviation?) may have been all the prompting necessary to send the Translator flailing down the wrong path; otherwise, the mathematical associations of the name Euclid might account for an absolute *lapsus calami*.

Even though we cannot be sure whether the Translator's *arismetica* stands for the *Phaenomena* (or even some portion of the *Elements*), there is another reason for thinking that a Euclidean citation was indeed tied to Arat. 21-26. These lines also contain the poem's only mention of the celestial poles (24), which establishes a close connection between this portion of the text and *CG* 4.

8   *CG* 4: The Astronomical Diagram

The caption associated with the diagram, *Polum collectu(m)* (figs. 2-3), was conjectured by Bubnov to be a faulty calque on Greek Πόλου σύνταξις, 'Arrangement of the celestial sphere',[111] in an attempt to establish a link with the title of Catalogue B, Οἱ περὶ τοῦ πόλου συντάξαντες. This link is problematic on several counts. Firstly, it is unclear how σύνταξις can be glossed as *collectum*.[112] Secondly, the original Greek catalogue plainly had no need of an illustration (unless in the form of a portrait gallery): its contents are completely unrelated to the astronomical diagram as transmitted. Finally, it is unclear why the Translator should have changed the structure of the Greek from a pair of

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109   Cf. *TLL* 10.1.1992.37-57.

110   In the glossaries, *alluceo, declaro, luceo, pando*, and *pareo* are treated as equivalents of φαίνω, and *appareo, consto, dinosco (-or), existo, pando (-or), pareo, perspicio, polleo*, and *video (-or)* as equivalents of φαίνομαι: see *CGL* 7.672, s.v.

111   Bubnov 1899, 424 (followed by Thulin 1911a, 81). For this sense of πόλος see *LSJ*, s.v., A3.

112   Did Bubnov misread *CGL* 2.444.11, *collectum*: σύναξις ('gathering, assembly') for σύνταξις?

substantives (nominative plus genitive) to a substantive in the accusative with an adjective in agreement.

The first question to tackle is that of the grammatical gender of *polum*. In Classical Latin, the naturalised form of πόλος, a Greek masculine noun, is *polus*, also masculine.[113] Ordinarily, *polum collectum* would thus be understood as an accusative (object) phrase, even though this makes no sense in the context. However, the late-antique bilingual glossaries translate πόλος as both *polus* (masc.) and *polum* (neut.); the latter form is also the preferred headword in the monolingual Latin glossaries.[114] If the Translator assumed that *polum* was a neuter noun (just as *principium* was apparently assumed to be masculine), then the difficulty of the grammatical case is removed: the caption is actually in the nominative.

In a general sense, πόλος/*polus* (*-um*) can be used of the 'heavenly vault, celestial sphere, sky' (so Bubnov),[115] while *collectum*, formed from the perfect passive participle of *colligere* (< *con-* + *lego*), indicates something 'gathered together, collected'. When read with the contents of the diagram, 'The collected sky' does make a certain amount of sense, but it is unclear why the caption should include a reflexive (and clearly quite redundant) comment on the act of schematization.

However, if we take the context of *CG* 4 into account and turn to the poem of Aratus, we find at *Phaenomena* 24 the only occurence of πόλος in the entire poem, where the term is used with a much narrower, technical sense: 'pole (of the celestial sphere)'.[116] Unfortunately, this raises a new difficulty: the apparent meaning of the caption, 'The collected pole', is rendered entirely nonsensical.[117]

Putting aside Bubnov's σύνταξις, the late-antique bilingual glossaries provide several Greek translations for *colligo/colligit*:

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colligo	*CGL* 2.441.29, 3.79.37	συλλέγω	'bring together, collect'
	CGL 2.443.38	συνάγω	'bring together, unite'
	CGL 2.443.42	συναθροίζω	'gather together, assemble'
	CGL 2.447.55	συνστρέφω	'roll up, compress, wheel'
colligit	*CGL* 2.103.26	συνάγει, συλλέγει	'he collects, unites'
	CGL 2.103.52	συνάγει, συν⟨σ⟩τρέφει	'he collects, rolls up'

Of these, συνστρέφω/συστρέφω (συν- + στρέφω, literally 'turn together') makes most sense in the context. Συστρέφω can also mean 'collect', 'gather together', and so shares a semantic field with *colligo* (thus the confusion of the glossator?). Though usually a synonym for 'compress', 'condense' in the Aratean commentaries,[118] in at least one place the middle voice has the unmistakable sense of 'revolve' and glosses εἰλοῦμαι ('turn around')[119]: Σ *Arat.* 223 (183.16-17 Martin), 'αὐτὰρ ὁ Ἵππος': ὁ δὲ Ἵππος ἐν τῷ οὐρανῷ εἰλεῖται, ἀντὶ τοῦ κύκλῳ συστρέφεται … ('*But the Horse constellation*: the Horse turns around in the heavens; in other words, it revolves in a circle').[120]

It is worth reminding ourselves here what Aratus says about the poles (Arat. 22-26): 'The axis, however, does not move even slightly from its place, but just stays for ever fixed … and rotates the sky itself. Two poles terminate it at the two ends; but one is not visible, while the opposite one in the north is high above the horizon'.[121] This passage explains why the caption is in the singular (i.e. *polum collectum*, not *pola collecta*): evidently, only the visible (north) pole is depicted. We also find here a plausible explanation for *collectum*: the Greek caption originally read ὁ πόλος συστρεφόμενος ('The revolving [with respect to itself] pole'),[122] taking its cue from Aratus.

This explanation fits the meagre evidence available, and is consistent with what the diagram actually depicts. In θ (the common ancestor of *EFN*) the diagram will have consisted of two concentric circles, thus resembling *N* (fig. 4): the scribes of *E* and *F* habitually draw diagrams with double lines for emphasis where the scribes of *A* and *N* draw only one. The diagram in θ was also likely decorated with the sun and moon and possibly other heavenly bodies (cf. figs. 2 and 4). The diagram depicts the visible (north) celestial pole at the centre of

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118 Σ *Arat.* 785, 841, 844, 892, 893, 938, 944 (393.8, 415.18, 416.6, 434.4, 13, 453.14, 457.5 Martin).

119 See *LSJ*, s.v. 'εἴλω', C.

120 For this sense of συστρέφω (not in *LSJ*), see e.g. Hero, *Dioptr.* 34 (= 300.7-9 Schöne), ὥστε στρεφομένου τοῦ τυμπάνου σὺν τῷ ἄξονι συστρέφεσθαι καὶ τὸ μοιρογνωμόνιον ('Therefore, as the wheel turns, the pointer rotates with its axis').

121 Trans. Kidd 1997, 73-75.

122 Cf. Σ *Arat.* 23 (= 69.8 Martin), ὁ γὰρ οὐρανὸς ἀφ' ἑαυτοῦ στρέφεται (quoted above).

the heavens: the sun and moon (and potentially other heavenly bodies) are provided only for context. The outer circle will represent the great circle of the celestial Equator (Arat. 511-524), while the inner circle should represent either the celestial Tropic of Capricorn (Arat. 480-500) or the Ever-visible circle, i.e. the portion of the sky around the pole in which the stars never set. This agrees closely with a construction of the celestial sphere as described by Ptolemy:

> We assume the equator is circle ABGD, and that it is around center E ... We imagine ... point E (sc. in the centre of circle ABGD) as the north pole, because it is not possible to place the other pole on a plane surface ... Clearly, the circles parallel to the equator that are north of the equator (sc. the Tropic of Cancer and Ever-visible circle) should be drawn inside circle ABGD....[123]

Unfortunately, it is impossible to tell whether any attempt was made to represent the interval between the inner and outer circles accurately: the identity of the inner circle must therefore remain indefinite.

The discovery of this diagram marks an important step in the reconstruction of the earliest (pre-Φ) stage of the illustrated Aratean tradition. The illustrative programme of Φ itself can be partially recovered by comparing the illustrated Latin Aratean tradition with illustrations independently preserved by a Greek manuscript (Vat. gr. 1087).[124] This programme included complex celestial maps (planispheres and celestial hemispheres) and a cycle of constellations.[125] Until now, however, the illustrations preserved by Φ also presented the only opportunity to glimpse the pre-history of the illustrated tradition (via a handful of illustrations than can be dated on astronomical and/or iconographical grounds to the Hellenistic rather than Imperial period).[126]

The *CG* diagram is our first independent witness to the illustrations found in the pre-Φ tradition. Its significance in this regard cannot be understated: it demonstrates that Φ made only selective use of existing illustrative traditions, that the existing illustrations were more 'granular' (i.e. characterised by a higher degree of specificity), and that they were included even when their presence was not directly required for the elucidation of the text. The diagram of the pole seems, in fact, to fulfil a fairly basic educational purpose (that of

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123   Ptol. *Planisph.* 1.2 (ed. and trans. Sidoli and Berggren 2007, 82).
124   See Martin 1956, 38-46; Haffner 1997; Blume, Haffner, and Metzger 2012, 23-79; Guidetti 2013; 2017; 2018, 68-74; Santoni 2013; 2014.
125   Guidetti 2013.
126   See Dekker 2013, 116-180; Guidetti 2013; Santoni 2013; 2014.

illustrating one of the fundamental propositions of celestial geometry):[127] it is no coincidence that the poem was a core school text in Greco-Roman education.[128]

In 2012, Anna Santoni drew attention to a number of still-unresolved questions regarding the role of illustrations in the early Aratean tradition: "was it truly common to illustrate Aratus? Did the poem need illustration? How much of the rich series of images illustrating the manuscripts of the Latin Aratea could we say to come from editions of the Greek Aratus?"[129] Our diagram cannot, of course, answer the last question, but it does demonstrate that the illustrations associated with the pre-Φ tradition were far richer in number and in type than those preserved today, and that some, at least, were designed to increase the pedagogic utility of the poem as an astronomical textbook in the classroom.[130]

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This study is continued in part II, 'The Biography of Euclid the Mathematician'.

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127   Cf. the prolegomena of Paris, MS Suppl. Gr. 607a (one of the anonymous school texts based on the poem), which provides definitions for 'sphere', 'circle', 'point', 'pole', 'axis', etc., in the question-and-answer format of the teacher (ed. Martin 1974, 23-31).

128   See Weinhold 1912; Marrou 1956, 184-185; Lewis 1992, 113-117; Volk 2015.

129   Santoni 2014, 36.

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