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Translation of Heiberg's Prolegomena

Mario Spagnuolo, Francesco dell'Isola, Beatrice Gerber and Antonio M. Cazzani

2.1 Translators' preface

In this chapter, we present the translation of the main excerpts of Heiberg's Prolegomena to his Archimedes Edition. This text was originally written in Latin [Heiberg, J. L. (1910). *Archimedis Opera omnia cum commentariis Eutocii*: Vol. 1-3. In aedibus BG Teubneri.] and contains the evidence of interesting phenomena in the transmission of ancient scientific texts. Considering the nature of the present work, which is rather interested in problems concerning the transmission and degradation of scientific knowledge through the centuries, the following translation concerns mainly the pages in which issues related to this type of problem are addressed. We have, however, omitted the translation of extremely technical parts of the philologist's work, which are beyond the scope of the present work. The original page numbering is preserved and indicated by margin notes. Accordingly, the footnotes from the original text are within the running text. The footnotes of this chapter are used to annotate the translation in order to clarify certain passages.

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2.2 Prolegomena. On the Archimedean codices

VII

PROLEGOMENA. On the Archimedean codices

by

J. L. Heiberg

When two years ago I searched for Archimedes' codices to properly analyze them, and the last part of *Archimedes' Questions (Quaestiones Archimedeeae, Chapter VI, Copenhagen 1879)* is the most valuable about this analysis, I could not escape what the critic of the Torelliana Edition¹ (*Jenaer Literaturzeitung 1795 p. 610 sq.*) had already figured out, namely that the Florentine codex was the most excellent of all, connected with a very close link to the very ancient codex of Giorgio Valla². Having no information about the age of this codex, except that Bandinius³ had attributed it to the 13th century, I was inevitably persuaded by it to establish that the Florentine codex is itself as old as that of Valla, from which the Parisian codices B and C were copied. But difficulties remained both in the text of individual passages and especially in explaining how that codex had finally reached the Laurentian library; even that letter that was the premise of the first book *On the Sphere and Cylinder* seemed to be better preserved in codex B (*Quaest. Arch. p. 130*). So, I tried to explain these difficulties as well as I could (*Quaest. Arch. p. 132 sq.*). In fact, I was already beginning to doubt Bandinus' judgment even then. And after I had diligently examined and compared the Florentine codex by myself, I was persuaded that this codex in no way could be the same as Valla's codex, but rather his antigraph, copied with such diligence that the copyist reproduced the form even of the letters often with pedantic solicitude. So, I decided to correct this whole piece.

¹ Giuseppe Torelli (Verona, 1721-1781) is credited with a plentiful and meticulous edition of the Works of Archimedes in Greek and Latin, published in Oxford in 1792 by A. Robertson. Torelli's most important book is *Archimedis quae supersunt omnia, cum Eutocii Ascalonitae commentariis, ex recensione Josephii Torelli Veronensi cum nova versione latina (accedunt versiones variantes ex codd. Mediceo et Parisiensibus)*, "a typographically splendid work" [A. Frajese, 1974. *Archimede: Opera* (Italian). Turin: Unione tipografico-editrice torinese.]; Torelli also conducted a first, careful chronological reorganization of the Archimedean works. For more information about Torelli, one can refer to [Bagni, G. T. (1997). *Un'intuizione dell'infinitesimo attuale: De nihilo geometrico (1758) di Giuseppe Torelli.*].

² Giorgio Valla (1447-1500) was an Italian Humanist, presumably a relative of Lorenzo. He taught rhetoric in Pavia (1466-1477) and then in Genoa. Finally, in 1481, he moved to Venice. In 1496, he was arrested for politics, but he was later reintegrated into the professorship. He translated in Latin Greek philosophical and scientific works (Ptolemy, Galen, Alexander of Aphrodisia, Aristotle). He also collected many ancient codices and among them the codex A of Archimedes' works.

³ Angelo Maria Bandini (1726-1803) was an Italian religious, librarian and art collector, as well as a cleric, scholar and bibliophile. Nowadays, he is best known for his work as a librarian. In fact, as their director, he elevated the Biblioteca Marucelliana and the Biblioteca Medicea to very high cultural heights. For these libraries, he compiled a monumental catalog, to which Heiberg refers several times in his *Prolegomena*.

Let's start by describing the Florentine codex.

Well, the Florentine codex of the *Laurentian Medicean library plut. XXVII, 4* is made of parchment, it is written on thick parchments without any trace of strings, and it is very well preserved. It consists of 179 very large pages, which a recent hand has rather negligently marked with numbers; a previous hand had marked at the bottom right of the back page of each tenth sheet, the numbers of the fascicles and the first words of the following page. The codex quite clearly, though not very elegantly, has been written with many abbreviations; accents and spirits are omitted rather frequently; these, where they are present, have the square ʀ or ʁ shape, very rarely the curved one, as we use today; here and there both spirit and accent have been placed on the same syllable, but never joined with the same trait. The first page has been written with all the accents with a rather faded ink, the title and the initial A are red. The following topics are contained in this codex:

(i) *On the Sphere and Cylinder I-II*, (ii) *Measurement of a circle*, (iii) *On Conoids and Spheroids*, (iv) *On Spirals*, (v) *On the equilibrium of planes*, (vi) *The Sand-reckoner*, (vii) *Quadrature of the Parabola*, (viii) Eutocius'⁴ comments in the books II *On the Sphere and Cylinder*, in the booklet *Measurement of a circle* and in the books II *On the equilibrium of planes*, Heron's⁵ excerpts about the measurements. At the end of the book the title is always repeated; moreover, at the end of the book *Quadrature of the Parabola* it also has:

εὐτυχοίης λέον γεώμετρα
πολλοὺς εἰς λυκάβαντας ἴοις πολὺ φίλτατε μούσαις⁶

and at the end of Eutocius' comments in the books about the sphere and the cylinder

Εὐτυχίου πινυτοῦ γλυκερὸς πόνος, ὃν ποτ' ἔχεῖνος
γράφεν τοῖς φθονεροῖς πολλὰκι μεμψάμενος⁷

The mathematical figures were always drawn with the same hand as the rest of the codex; in his work the copyist used ruler and compass, he refrained from using tools with which to draw conical sections and spirals; the reason for which he drew the latter so roughly, as if they were arcs of circumferences, is that he depicted them

⁴ Eutocio of Ascalona (about 480-540?) was a Byzantine mathematician. Of his production, only few comments remain today on the books *On the Conics* of Apollonius of Perga and some works by Archimedes. These comments, especially those on the works of Archimedes, offer a very eloquent insight into Greek scientific development.

⁵ Heron of Alexandria (I-III century A.D.) was an ancient Greek scientist, very skilled in the study of Mechanics (among his most famous inventions there is the *Eolipila*, the first steam engine known). He was a teacher of technical disciplines at the *Museum of Alexandria*. Heron carefully studied the works of Euclid and Archimedes. A strong conviction of his was the need for a complete preparation, made of theory and practice. Heron's masterpiece is the treatise on *Mechanics*, in which he systematizes the theoretical and practical aspects of Mechanics.

⁶ "May you have a good fate, O Leo the Geometrician, and for many years you may proceed widely, beloved of the Muses." Leo the Mathematician (790-869) – also known as the Geometrician – was a Byzantine philosopher and mathematician. In the 9th century, he was responsible for producing three codices containing the works of Archimedes in Constantinople: codex A, codex B and codex C. The Valla's codex is recognized to be codex A. The vicissitudes of these three codices will be discussed in a further article.

⁷ By the wise Eutocius gentle work, that once that famous man wrote, strongly blaming the envious.

without any help in a very poor and extremely negligent way. At the end of the codex neither

- IX the word τἔλος [end] nor any other sign, showing that the code is finished, has been added; the last page is empty and is used as a cover. Cfr. *Bandinii catalogus II p. 14*.

I demonstrated that the Parisian codices 2360 (B) and 2361 (C) were copied from the ancient codex of Valla (Quest. Arch. p. 124 sq.) and, in this point, I will briefly recall the reasons.

In the Parisian codex B at the edge of page 120 the copyist has noted this: *These things are copied from that illustrious very ancient antigraph, former property of Giorgio Valla and that later became of the renowned sovereign Alberto Pio of Carpi⁸; this antigraph was, as we have said, very ancient and it had a great lack of clarity and not quantifiable because of the errors; moreover innumerable excerpts are not explained in any place. [...]*⁹

So, the B codex was copied from Valla's one. Also, in codex C we found this short preamble by George d'Armagnac¹⁰: "Do not be offended, diligent reader, to see this Author

- X without any recommendation for himself or any preface: so the condition of the first page in the old exemplar, from which it was copied, had been worn and consumed by old age, that not even the name of Archimedes could be recognized, nor at that time was there anything else left in Rome by which this πρόσωπον [front page] could be restored. Every sign of both accent and spirit was missing everywhere; in the remaining parts it is intact and clear except for the second page of the last sheet of the book on measurements ἤρωνος [by Heron], was entirely deleted such as the name of Archimedes. However, in order for Gallia to rejoice at such a recommendation from the Author, I preferred in any way that a copy of it be produced for you [reader] at my expense, albeit that to mathematical lovers my guilt appears more negligent in this part." And at the edge of the codex, the copyist wrote this note: *Here the German Christopherus Auverus ended the treatise on the first day of 1544, at the expense of the very respected bishop of Rodez George d'Armagnac who was ambassador to [the Pope] Paul III in the Holy Church diocese in Rome for Francis King of the Celts, who was highly praised and held in the highest esteem.* From this Greek text it is clear that the codex C of Rome was copied in 1544 by Christoferus Auverus

⁸ Alberto Pio, Prince of Carpi (1475-1531) was an Italian Renaissance prince and had a prominent role in the humanistic panorama. His education was directed by the humanist Giovanni Pico della Mirandola and the famous founder of Aldine Press in Venice, Aldo Manuzio. He played a leading role in the politics of relations between the Papacy and the Kingdom of France.

⁹ In the original, this text is in Greek. Examples of errors and misunderstandings that the copyist highlights follow and are omitted here.

¹⁰ Georges d'Armagnac (1501-1585), French Catholic cardinal and archbishop, was bishop of Rodez in 1530 and then was nominated ambassador to Venice (1536) and Rome (1540) and finally state councillor to Francis I. He was an important Maecenas for men of letters who put in communication with Francis I.

at the expense of George d'Armagnac. Already Guillaume Philandrier¹¹, who was, according to the letters, with George d'Armagnac and followed him both in Venice in 1541 and then in Rome, has in Vitruvius' edition (Lugdunum [Lion] 1552 and reprinted in 1586) these things on p. 357: "I had written these things, since, with the benevolence of Cardinal Pius Rodolphus of Carpi¹², I was given the ease of visiting and writing, while my Maecenas [i.e. George d'Armagnac] edited the volume on the sphere and the cylinder with the commentary of Eutocius, as an ornament in the future of the very august and well-stocked Library that You [Francis the First] established at the Fontainebleau. This volume had belonged to Georgius Valla and in it, because of the property of Doric language and the omission of spirits and accents, which would have produced any difficulty in reading, there are then notes of syllables and expressions, which are often not even recognized by the Greeks". So, there is hardly

any doubt that George d'Armagnac edited that codex of Valla, of which he made a copy for Philandrier, transcribing it to donate this antigraph to the Fontainebleau library. Consequently, it follows that codex C was also copied from Valla's codex, which is also confirmed by itself, since he arrived in the Paris library from the Fontainebleau one. XI

The Parisian paper codex 2360, once Medicean, contains the same works of Archimedes and the comments of Eutocius in the same order. After the book *Quadrature of the Parabola* presents the same verses. Some argue that it was written by Philandrier and hence attribute it to the 16th century; but this cannot be at all related to Philandrier's words attached above; in fact he says that he transcribed only from Valla's codex, i.e. he took note from it of those things that could be useful to him in the commentary to Vitruvius, and that if he had not copied everything, he would have remembered only the books *On the Sphere and Cylinder*; it seems that he only consulted these books and did not examine the others. Moreover, it appears from that inscription of the bookshelf, that the archetype codex, when codex B was copied from it, belonged to Albertus Pius; in fact, if already at that time it had been given to Rodolphus Pius, the name of him, not of Albertus, would have placed or certainly would have mentioned itself, too. For this reason, since Georgius Valla died in 1499, and Albertus Pius in 1531, it must be concluded that codex B was written between these years.

Paris codex 2361 (C) is made of Fontainebleau paper and has the same works of Archimedes and Eutocius in the same order, as well as Heron's measurements, such as the Florentine codex. From this codex, F. Hultsch¹³ has published the Heron's ones: *Heron, reliq. p. 188–207*. After the Heron's measurements, furthermore, two

¹¹ Guillaume Philandrier (1505-1563) was a French humanist and a friend of François Rabelais. He was also a cleric of Rodez. He became secretary of Bishop Georges d'Armagnac, whom he accompanied to Venice and Rome. He was involved in humanistic studies especially concerning Quintilian and Vitruvius.

¹² Rodolfo Pio di Carpi (1500-1564), cardinal and Italian archbishop, was Alberto's nephew.

¹³ Friedrich Otto Hultsch (1833-1906) was a German classical philologist and a historian of ancient mathematics. He studied and then lectured in Leipzig.

fragments follow *περὶ σταθμῶν*¹⁾ [on weights] and *περὶ μέτρων* [on measures], which he published from this codex (*Metrolog. Script.* 83–84. I p. 267–272; *cfr. praef. p. XVII*). All these same things are also found in the same order in the Florentine codex, except that the last fragment *περὶ μέτρων* which is a little longer in this last one.

1) In Hultsch it is reported *περὶ ταλάντων*, but in the codex there is *περὶ σταθμῶν*, according to Charles Graux, and in the same way it is reported in the Florentine codex.

XII Even so, it is likely that the Florentine codex and codices B and C are related, and this is proved by other very reliable documents. First of all, we have seen that the codex of Valla was mutilated at the beginning, and for this reason the codex C is lacking of the greater part of the cover letter preceding the first book *On the Sphere and Cylinder*. In the Florentine codex too, the first page is in a different handwriting and with many lacunas, and in B the same passage is equally corrupted (*cfr. vol. I p. 3 not.*); the copyist added: Ἄρχιμήδους τοῦ περὶ σφαίρας καὶ κυλίνδρου τὸ προοίμιον λείπει· ἡ πρώτη γὰρ σελὶς τοῦ ἀντιγράφου ἴφανῆς ἦν, ὡς ὀρᾶς¹⁴. Furthermore, in *vol. III p. 4, 18* there is a lacuna between *σύγκειται* and *τῆ ABΓΔ* in all codices; the copyist of codex B wrote: ἐν ὅλον σελίδιον ἢ καὶ δύο λείπει [at least one page or even two are missing]. Finally, the numbers of the propositions of the book *περὶ κωνοειδέων* [on conoids] are completely confused and reversed in the same way in all codices (*cfr. Quaest. Arch. p. 123 sq.*). Therefore, since the Florentine codex cannot have been copied by the Parisian codices, it remains established that Florentine codex is either the codex of Valla or derives from it. And I will explain why now I think this is true.

From the aforementioned note by George d'Armagnac taken from codex C, it becomes clear that the first and the last page of the codex of Valla indeed included written text but it could not be read because of their age and incomprehensibility. But in the Florentine codex, the first page is completely empty at the beginning, and eventually the omitted part of the cover letter has been added by another hand¹⁾, and there is neither any trace of an older script that has been obliterated, nor has anything ever been written in the lacunas. And the last part of Heron's fragments has been written brilliantly and plainly, like the rest of the codex, and after that nothing was written. I have said above that the last fragment in the Florentine codex is a little

1) Nicolaus Anziani, librarian of the Laurentian library, believes that the first page was written by the same hand as the rest of the codex. But the handwriting seems to me different, albeit not so much, and H. Menge and Charles Graux, who ascribe this part to XVI century, agree with me. For sure this fact is of interest, because in this part almost all accents and spiritus [rough or smooth breathing] are lacking.

XIII longer; therefore, the copyist could read [the text of] this codex a bit larger in the archetype than what the copyist of codex C could either read about fifty years later or believed to increase the value of the work. The fact that he was unable to read the archetype of the Florentine codex in its final part leads us to suppose that in

¹⁴ *The preface of the Archimedes' book "On the Sphere and Cylinder" is incomplete: in fact, the first page of the antigraph was lacking, as you can see.*

the Florentine codex nor [the word] τέλος [end] nor any other sign with which the copyists have the habit to mark the completion of the work is found.

Moreover, that cover letter contains a disagreement with codex B, which cannot have been copied in this part from codex F; see firstly *vol. I p. 4, 6*: [...] ¹⁵; and in all these passages the writing of codex F is so clear that there is no doubt about this matter. Therefore, it had to be stated that that lacuna in codex F has finally been filled out later, when codex B was copied from it. This can be a casual independent event; but it is, nevertheless, verisimilar that the copyist of codex B, who in so many words deviates from the sources from which he is transcribing, then wrote that he had taken the preface from another copy, especially because he wrote this preface: Ἀρχιμήδους τοῦ περὶ σφαίρας καὶ κυλίνδρου τὸ προσίμιον λείπει, ὡς ὄραϊς [the preface of the book *On the Sphere and Cylinder* by Archimedes is incomplete¹), as you can see]. I do not believe that these words could be taken by any other manuscript than that antigraph, which he has followed throughout the book.

Finally, certain passages among those that Valla translated from his codex into Latin are found, where Valla obviously did not have a corrupted writing of the Florentine codex but a good one of the codices B and C before his eyes:

[...] ¹⁶

1) I.e. it is incomplete (not: it is lacking), as it appears from the added words ὡς ὄραϊς; in fact, the preface is written by the same hand as the rest. Cfr. *Quaest. Archim.* p. 121 not.

Having Valla himself barely reconstructed these passages by conjecture, what will be understood by those who have enlightened the errors repeated by him, from evidences in Valla and from the union of the B C codices, it follows that in these passages the text in Valla's codex was different and also more correct, as it is in the Florentine codex (*de III p. 76, 26; 124, 22 u. infra*) ¹⁷.

XIV

Even from those abbreviations, which are said to be obvious in Valla's codex by the copyist of codex B, a very strong evidence can be obtained, from which one can prove what we have proposed. There, in fact, (p. IX) instead of the syllable -οις this abbreviation Ϛ is indicated; but in the Florentine codex this [abbreviation] of this form is not found anywhere, instead a vertical and round ϑ, which is a more recent form of this abbreviation (*O. Lehmann: Die Tachygraphischen Abkürzungen der Griechischen Handschriften (1880) p. 70–71*).

And although generally this is the nature of those passages, in which B C codices offer better writing than F code, so that it cannot be said that the copyists of B C codices could not have corrected a manifest and easy error on their own initiative in the same way, however, not only those better versions, which are frequent enough, can be found quite easily, if we establish that B C codices were derived from the same source as F codex, but there are also certain passages where the correction was more difficult and not such that two not too much cultured copyists seemed to have come across it by chance; such as in codex F at *I p. 6, 11* there is *τοτε αξιωμα*, but

¹⁵ It follows a list of discrepancies between the two codices.

¹⁶ It follows a list of comparisons between codices B C and F.

¹⁷ The Translator's Note in footnote 29 on page 84 refers to the previous sentence.

codices B and C report the right form (τά τε ἀξιώματα); at I p. 8, 11: in codices B and C it can be read τομέα δὲ στερεὸν καλῶ, instead in codex F it appears that in a first stage there was only τομε; later, the same hand, which added the cover letter to the first page, filled the lacuna except that στερεὸν is omitted leaving a small lacuna.

Finally, we must remember (in fact, this way of demonstrating especially in this codex is misleading and uncertain) that the form itself of the letters sometimes indicates a more recent origin. With regard to this, I, first of all, rely upon the judgment of Charles Graux¹⁸, who, having diligently examined a photographic image, from which the table added to volume II was printed, of our codex so judged: *what seems to me the most probable thing at*

XV *the moment is that the [codex] Laurentino in question is the product of a 15th century copyist who had a ninth or tenth century manuscript as a model and tried to imitate it scrupulously even in the form of the letters*¹⁹. So, I found elsewhere the same statement that I also had deduced myself having progressed in other ways. But on the contrary, Guilelmus Gardthausen²⁰, to whom I had passed on the same image, did not think that this statement was to be rejected, although he himself preferred to attribute the codex to the 11th century from the form itself of the letters, unless documentary evidences could be obtained from another place to confirm that opinion; which I seem to have done here. The most important impediment, as both of those expert palaeographers pointed out, is the form of the letter φ, as it appears to have been written in a single line (see table, lines 1, 3, 4, 5, 6, etc.), which, apart from the ϕ form, does not appear before the 15th century (Gardthausen: Griech. Paleogr. p. 208)²¹. Moreover, this fact is also favorable to this opinion, namely that the writing, which at the beginning of the codex is very diligent and very sharp, becomes rather negligent towards the end and offers a less ancient appearance, and the accents, which are generally omitted, here and there, and indeed especially towards the end, are more frequent, just as the custom of the copyist seems to have meanwhile overcome the will to transmit the antigraph reliably. Finally, also the parchments reveal both by typology and by species a more recent time.

After examining all these things, we must admit that the Florentine codex is not the Valla's codex, but the latter is the common source of F B C codes. Then about our F codex itself we must acknowledge that Angelo Poliziano²² wrote in Venice in 1491 to Lorenzo de' Medici (u. *Fabronius: vita Laurentii II p. 285*): *in Venice, I found some books by mathematicians Archimedes and Heron, which we lack ... and other*

¹⁸ Charles Graux (1852-1882) was a French scholar in the field of classical and humanistic disciplines. He published important critical editions of works by Xenophon and Plutarch and pioneering, descriptive catalogs of the medieval copies of ancient Greek texts preserved in the libraries of Spain and Denmark. *Source Wikipedia*.

¹⁹ This text is in French, in the original Heiberg's essay.

²⁰ In the opinion of the translators, here Heiberg refers to Victor Emil Gardthausen (1843-1925), ancient historian, palaeographer, librarian.

²¹ This piece on the form of the letter φ shows that Valla's codex should not be the Florentine codex.

²² Angelo Ambrogini, known as Poliziano (1454-1494), was an Italian poet, humanist and philologist. He is generally considered the greatest of the Italian poets of the 15th century. He was also the author of works in Latin, Greek, and achieved extensive philological expertise.

good things. So much so that Papa Janni²³ has something to write about for a piece²⁴. Since Giorgio Valla from 1486 to 1499 was teaching in Venice (Neue Jahrb. Suppl. XII p. 377), and Valla's codex, as we have recognized above, besides Archimedes also contained some fragments of Heron, we can hardly doubt that Angelo Poliziano

dealt with describing Valla's codex. But this means that Joannes Rhosos¹⁾ would have copied Archimedes' codex, copy that was not actually done. In fact, the codex F could not have been written by him, as it seems clear having compared some other codices²⁾ written by him, which are very numerous, with our photographic table. XVI

So, the F code was copied from Valla's own codex in 1491 or shortly after, while the B C codices were copied not much earlier. It therefore remains to be understood which of these three quasi-sister versions should be believed to be more correct than the others.

Then, I have demonstrated with documentary evidences, which I believe are quite robust in (*Quaest. Arch. p. 128–30*), that the B code has been copied by an educated copyist, who would have corrected many errors, many others would have tentatively corrected rather badly, and many errors are occurring on almost every page [...] ²⁵.

But we can clearly demonstrate that the F codex has been copied more accurately than the others. There are in fact certain passages in which we know by the interpretation of Valla himself²⁶ that in his codex there were the same foolish errors that were in the codex F, but that they were corrected in BC:²⁷

1) In fact, he is "Papa Janni", as N. Anziani advised me. About Joannes Rhosos Cretean presbyter, very active copyist, it can be read Gardthausen p. 326 sq.

2) In Florence, I compared Laurentian codices XXXII, 6; LV, 9; LXXXI, 23; LXXXVI, 18, with the F codex itself.

[...] ²⁸

From these passages, one can understand how great and how pedantic the diligence of the copyist of codex F was; in fact, although this is hardly credible, it is clear that he could not correct these silly mistakes, as instead the copyists of B C codices did, because he wanted to return the archetype with the utmost fidelity. Therefore, it is clear that even where B C agree against the authority of the F codex, we must judge very cautiously about the scripture of the archetype from the latter, and that the Florentine codex also now must be considered the main source. XVII

²³ Papa Janni, a Greek copyist, following the opinion of T. C. Dandolo, "*Firenze sino alla caduta della Repubblica: studii*", Milano, Ubicini 1843 (p. 381). In the following note, Heiberg identifies Papa Janni as John Rhosos.

²⁴ From Poliziano's Italian, in the original Heiberg's essay.

²⁵ Here Heiberg gives examples of such errors.

²⁶ Giorgio Valla, selected pieces from "*De expetendis et fugiendis rebus opus*", Venice 1501.

²⁷ In footnote 4), Heiberg cites his work where this point is fully discussed. Together with Henri Lebègue, he finds many errors in the Giuseppe Torelli's edition of the Archimedes' works *Archimedis quae supersunt omnia, cum Eutocii Ascalonitae commentariis, ex recensione Josephii Torelli Veronensi cum nova versione latina (accedunt versiones variantes ex codd. Mediceo et Parisiensibus)*.

²⁸ Here Heiberg reports various examples of errors.

In short, the interpretation of Valla²⁹ coincides with F completely except in a few passages that I reported above on p. XIII. But also from other hints, we can conclude how much the codex F expresses an accurate image of the archetype. In fact, first of all most of the letters show a form far older than the 15th century, as can be understood from our photographic table, which represents a page taken from the first part of the codex (*I p. 156, 10–160, 11 editionis*). And the usage of abbreviations, the omission of accents and spiritus, their square form where they are present,

XVIII all these things suggest that the codex is ancient and [these circumstances] agree with [the hypothesis that] the transcription of Valla's codex was done by the copyist of the codex B in a very accurate way. Then, the mutilated part of the cover letter placed before the first book on the sphere and on the cylinder (I p. 2–6, 6), which was consumed in the first page of the archetype for usage and age, also in codex F is placed on the first page neither more or less [...] ³⁰.

Then, the copyist of the codex F with the same diligence, with which he imitated the form of the letters, he seems to have followed also the features of the antigraph, exactly as he made so that there was a correspondence page by page and even line by line.¹⁾

Thus, it may be possible that with the richness of these three codices, first of all the Florentine one, we recompose a certain [faithful] image of that archetype

1) See also what Jordan Hermes wrote about the Marciano codex 247 copied with similar diligence from the Marciano codex 246, XIV p. 264 sq.

XIX once owned by Giorgio Valla. Undoubtedly it [Valla's codex] was written in the 9th or 10th century, as Charles Graux¹⁾ conjectures from the clues given by the ancient form of the letters observed in F, moreover it was very similar to the Oxonian³¹ codex of Euclid (*Bodleian. d'Orville ms. X, 1. Inf. 2. 30*; examples of it have been published in Paleographical Society tab. 65–66) with all the habits then in use in the summaries. It was copied quite diligently from an exemplar [written by] some man who was not inexperienced in mathematics; and in fact, those scholia found in almost all books are not added in the margin, [and are] especially very often present in in the books *On the Sphere and Cylinder*²⁾. Those things that show a greater knowledge of mathematics than those that were known at the time could be improved by this copyist himself of the codex. It [Valla's codex] was provided with mostly excellently and diligently copied figures, but it was often wrong in the letters affixed to the figures and also in the figures and words themselves of Archimedes, which fact the copyist of the codex B (p. IX) noticed; examples from the codex F can be collected *Quaest. Archim. p. 125 sq.*, and several can be added. [...] ³²

²⁹ See the sentence preceeding footnote 17 on page 81 .

³⁰ From here on various examples of comparisons of F codex and B C codices, where, in particular, the discrepancies with Torelli's edition are reported. This technical analysis is necessary for supporting Heiberg's conclusions.

³¹ From Oxford.

³² A list of this kind of errors then is included in Heiberg's text to support the last statement. In particular, Heiberg remarks that the text of demonstrations is corrupted by repetition and homoteleutic words.

1) In this regard the Valla's codex is called *πᾶλαιότατος* [the most ancient] by the copyist of the codex B (u. supra p. IX), what he could not state about the Florentine codex itself.

2) However, it seems to me at least likely that these additions do not all come from the same man. I consider more ancient the additions that, being most of them in Doric, are inserted in the books on conics and spirals; the books on the sphere and the cylinder and on the measure of the circle seem to have been translated into a more standard [Greek] language and at the same time polluted by numerous additions only in a more recent period.

[...] ³³

XX

This codex therefore, once Giorgio Valla (1499) died, passed to Alberto Pio di Carpi who also acquired the other codices of Valla and probably his entire library, as it is clear from the inscription of a certain Scorialensis³⁴ codex (Miller: *Catalogue de mss. grecs Escur.* p. 454): *Donato*

*Bonturello*³⁵ copied from the antigraph, which, previously owned by Giorgio Valla (and in fact he copied by his own hand), later became of the illustrious sovereign Alberto Pio of Carpi [the Greek text continues in the narration of the passages of the Valla's codex]. About the destiny of the library of Alberto [Pio di Carpi], Stefano Borgia (*Anecdot. litterar. Romae 1773 ff. I p. 81*) passes the following information on. Alberto himself gave it as a gift to Agostino Steuco Eugubino, whose brother Fabio gave part of it to Cardinal Marcello Cervinio. It came from him by testament to Cardinal Guglielmo Sirleto, and since he died it was bought by Cardinal Ascanio Colonna. Then, through the hands of many, it finally was acquired by the Vatican. But it appears clearly that our codex had a different fate¹); we see in fact that in 1544 it was owned by Rodolfo Pio, son of Alberto's brother, and in the catalogue of Sirleto's library (*Miller p. 323–324*) there is no mention of Archimedes' codex. Thus, perhaps because of its singular antiquity, it was kept in the Pious family. But we do not know where it would later arrive, nor one knows whether it was lost or happened to be in some library in Italy, which seems to me quite likely.

XXI

By now we see what relationship there may be between the other critical works and the Valla's and Florentine codices.

First, therefore, it appears that Pope Niccolò V had a codex of Archimedes, which he had taken care to have translated into Latin. In fact, Cardinal Nicola Cusano writes to him as follows (*Opera* p. 1004): “*You have in fact given me in these previous days the Geometry of the great Archimedes presented to you in Greek and thanks to your*

³³ Before this text here, the page continues with a list of errors and writing conventions including: the repetition of the same words, the exchange of apparently similar abbreviations, the omission of abbreviations, the very frequent permutation of vowels and syllables, the frequent confusing replacement of the connective particles *δέ* [but] and *δη* [therefore] in mathematical demonstrations, the presence of some abbreviations omitting terminal letters, the frequent short notations for double consonants. Finally, Heiberg remarks that the copyist of Valla's codex pertinaciously repeats the same errors many times in all his manuscripts.

³⁴ Scorialensis – The library of the Royal site of San Lorenzo de El Escorial.

³⁵ Donato Bernardino (Bonturello), 1483-1543, lived and worked at the court of the Pious in Carpi. He was preceptor of Rodolfo Pio and transcribed various Greek codices.

care translated into Latin". Who was Nicola's translator, we find out from the preface of the Basel edition (fol. 2 verso)³⁶:

1) Also, Ambr. Morandus in its life of Steuchio (Steuchii opera. Venet. 1591, I praef. fol. 4 verso) does not tell that Alberto had given all the books to Steuchio. In fact, his words are: Fabio brother of Steuco, who had received it as a gift from Alberto Pio prince of Carpi, gave this magnificent library in great part to Marcello Cervino.

XXII "He (Regiomontanus³⁷) freely accepting his first invitation in Italy as soon as he reached a great fame of his name, saw many Greek books stolen during the defeat of Constantinople and copied out many by his own hands. Then, among others, [Regiomontanus] diligently copied Archimedes' books, which had been given to him by some friends, on the sphere and the cylinder, on the measure of the circle and on other things not only useful but also necessary for mankind, as it is clear from reading these books, that Iacopo Cremonese³⁸, because the demand of Niccolò V Roman Pontiff, had already since long translated into Latin. [Iacopo Cremonese was] a man at those times worthy of double honor, being learned in Greek, since he seemed [to Pope Niccolò V] the only one who could absolve this work helped by [his] practice of languages. [Regiomontanus placed] many additions to the margins in Greek (since he also had a copy of the codices in Greek), where Cremonese's translation seemed him either to have been translated rather difficultly or to have been somehow corrupted in the copy"³⁹. This translation by Iacopo Cremonese was recovered in the Basel edition, as its same title alludes to: "Works ... by Archimedes, which undoubtedly are better than all the others, once already donated to Latinity and now published for the first time". For this reason, it is therefore legitimate to speculate about the codex of Pope Niccolò V. Right at once it seems clear that it was closely linked to Valla's codex; in fact that same lacuna vol. III p. 4, 18, which originated in that place as attested by the copyist of the codex B (see *supra* p. XII), since one or more sheets of Valla's codex had been lost (nor could it happen that that copyist hesitated in understanding such an easy thing, since the latter himself had in his hands Valla's codex), this lacuna, I said, was at this point in Niccolò V's codex. In fact, in Iacopo Cremonese's translation on p. 2 it is written: "*unam autem lineam in plano quocunque modo connexam quamvis sive ex rectis pluribus connectatur [sive ex curvis sive ex rectis pluribus connectatur ex ea connexione postulat appellari]*"⁴⁰

³⁶ Heiberg refers to the *editio princeps* published at Basel in 1544 by Thomas Gechauff Venatorius.

³⁷ Regiomontanus, pseudonym of Johannes Müller of Königsberg (1436-1476), was a German mathematician, astronomer and astrologer.

³⁸ Iacopo da San Cassiano, also known as Iacobus Cremonensis, (between 1395 and 1413-1453/1454), was an Italian humanist and mathematician. He translated into Latin the corpus of the writings of Archimedes.

³⁹ This preface excerpt seems written by using a Latin style which is anticipating Baroqueism, so that we have split into three parts a single sentence which occupied in the original text sixteen lines.

⁴⁰ Here Heiberg reports a truncated and reconstructed sentence in Cremonese's translation at the end of which Cremonese writes "Here a page in the Greek exemplar is lacking." A possible translation of the reconstructed sentence is "whereas a single line in the plane connected in any way either by numerous lines [or by curves or by numerous lines is connected, he postulates that it is named after that connection]."

From here it necessarily follows that Niccolò's codex either was Valla's codex itself, a fact which had been suspected in *Quaest.*

Arch. p. 139–140, or had been copied from that.¹⁾ This last statement now seems to me verisimilar, since those words which in the previous text⁴¹ were closed in parentheses, with which I do not know who tried to fill the lacuna, had preserved traces of the Greek text origin; in fact, “*eam ex ea connexione*” seems to be a word by word translation of the Greek words τῆν ἐκ τῆς συνάψεως. And for this reason, the copyist of Pope Niccolò's codex added these words to fill the lacuna in Valla's codex up to a certain point.

XXIII

A copy of Iacopo Cremonese's translation was copied by Regiomontanus with his hand, this circumstance is referred by Venatorius⁴² (u. supra p. XXII) and by Regiomontanus himself in presence of Gassendi (*Opera* V p. 469: the translation is by Iacopo Cremonese, but corrected in some passages), and this copy is still in the library of the city of Nuremberg. Heinrich Menge was the first to warn about this fact (*Neue Jahrb. f. Philologie* 1880 p. 110). Later, myself examined this codex, having the Nuremberg Senate allowed without any restraint that it was sent to me to Copenhagen. The codex is made of paper centur. V, 15, and contains Archimedes' books and Eutocius' comments in this order: Archimedes' books *On the Sphere and Cylinder* I-II, *Measurement of a circle*, *On Conoids and Spheroids*, *On Spirals*, *On the equilibrium of planes* I-II, *Quadrature of the Parabola*, the *Sand-reckoner*, Eutocius' comments on the books *On the Sphere and Cylinder*, *Measurement of a circle*, *On the equilibrium of planes*. Greek words were noted on the margins in many places, just as we noticed that Venatorius had said (supra p. XXII). On the first page we read “*I belong to Thomas Venatorius*” and on the last page it is written by Venatorius “*Ioannes de Monte Regio was born in the year 1436 on the 6th of June at 4 and 40 minutes ... in the afternoon. Moreover, Regiomontanus dies in the year 1476 almost on the 8th of July*”. In addition to Greek words Regiomontanus

1) And the translation is clearly, in the discrepancy of the writing, in accordance with the Florentine Codex. When this accordance does not happen, the circumstance is to be attributed either to the copyist of Niccolò's codex, who, as we shall see, does not abstain from interpolation, or to Regiomontanus. As an example of the accordance is the fact that the dittography of the codex F III p. 172, 17, which B C had corrected, was also before Cremonese's eyes p. 36, 7.

⁴¹ See the sentence in Latin on page XXII.

⁴² Thomas Gechauff, also known as Venatorius (1488-1551) is a Protestant geometer and theologian. Friend of the imperial adviser Pirckheimer, he edited the works of Archimedes.

XXIV not infrequently added on the margin corrections of Latin words, which were all accepted by Venatorius, which from this same codex generated the Latin translation added to its edition (Basel 1544).

From those passages that Regiomontanus annotated from his Greek codex, I suspect, as I proposed in *Quaest. Archim. p. 138*, it is strongly confirmed that Regiomontanus, friend of Bessarione⁴³, used our Venetian codex, which was once Bessarione's (u. infra). In fact, since it is not possible to conclude anything about Bessarione's codex from the many passages extracted from it by Regiomontanus, since the words used there are the same of all or many of our codices, in no passage, however, the errors proper to this class of codices, of which the Venetian codex is the main one, are also recurring in Regiomontanus' edition. And I will report these errors:

[...]⁴⁴

And sometimes Regiomontanus alludes with [the following] clear words to the exemplars of Bessarione, as he annotated with regard to the book *On the equilibrium of planes II*, 8: “so it is written in the exemplar of the Cardinal [Bessarione] and it is likely that it was translated from Greek. But it was done badly”; with regard to the book *On the equilibrium of planes I*, 15 [Regiomontanus writes]: “it is bad. See the exemplar in both Latin and Greek by “dominus Nicenus”. See also the ancient exemplar that is with Magister Paulus”¹⁾. In fact,

1) In these passages, my collection of sources has been partly confirmed and partly corrected with benevolence by Frommannus, prefect of the Germanic Museum of Nuremberg, as I solicited him.

XXV the “dominus Nicenus” is Bessarione, who appears to have obtained the archbishopric of Nicea in 1436. His exemplar, of which Regiomontanus speaks, is in Latin and is preserved in Venice; it is the Latin codex CCCXXVII of the 15th century (“once of Bessarione”, cf. *Marci bibliotheca codd. Mss. paraeside L. Theupolo. Venet. 1741 p. 140*), which contains Archimedes' books *On the Sphere and Cylinder I-II* with the presentation of Eutocius, *Measurement of a circle* with the presentation of Eutocius, *On Conoids and Spheroids*, *On Spirals*, *On the equilibrium of planes* with Eutocius, *Quadrature of the Parabola*, the *Sand-reckoner*. Although the name of the translator is omitted in said codex, it cannot be doubted that it is the apograph of the translation of Iacopo Cremonese; in fact, an order of books like this is found only in the translation of Iacopo Cremonese; in all other sources the booklet *The Sand-reckoner* is placed before the book *Quadrature of the Parabola*. One might therefore have believed that Regiomontanus had copied this same codex; in reality it seems that he used another copy, of which he then brought together the apograph with Bessarione's Latin codex. In fact, in the book *Quadrature of the Parabola* 14 words “sicut autem ba ad bf, ita mensula de ad spacium q. spacium igitur q spacio r maius est. Nam hoc ostensum est”, which are missing in the Greek codices, in the Basel translation on p. 149 are instead enclosed in brackets; Regiomontanus also enclosed

⁴³ Bessarion, born perhaps Basil (1403-1472), was a Byzantine cardinal, humanist, and philosopher.

⁴⁴ Here Heiberg reports the comparison between the texts of the Regiomontanus edition, of the Venetian codex and of the Torelliana edition.

them in brackets and then in the margin wrote “*there is a void*”¹⁾ and just below “*in the exemplar of the dominus [Nicensus] there was an addition*”, something that was undoubtedly taken from the Latin codex, not from the Greek one of Bessarione, as well as “*exemplar of Cardinal B*” in the above note (in *plan. aequil. II, 8*). The same thing can be deduced from the note in *pl. aeq. I, 15*. But above, on p. XXII, we see that Regiomontanus, according to the testimony of Venatorius, had a copy of several Greek codices, and this is confirmed by that annotation we have recalled on p. XXIV. A subsequent part of it [he reports]: “*see also an ancient exemplar belonging to magister Paulus*” is certainly written by Regiomontanus’ hand, but with a different kind of ink

1) I take this from the Greek codices.

and very clearly added quite a bit later. With the same ink, with which this addition was made, other numbers of the propositions, beginning with proposition 18, were added to the book on spiral lines. Here in the margin Regiomontanus annotated: “*those notes of the propositions from the new¹⁾ Greek exemplar*”. [...] ⁴⁵ Since all these [substitutions in the numbering] completely match the numbers of the Florentine codex (with regard to the other codices, here we know nothing for sure; in the published ones the series of numbers has been corrected, except in the Cremonese translation [where] the number 19 is omitted), as will be clarified by our annotations, it is legitimate to suspect that that old exemplar of Magister Paulus was the same codex of Valla. And if this conjecture is true, from here we obtain a new evidence about the destiny of Valla’s codex, that is, that before it came into Valla’s possession, it belonged to “magister Paulus”. He can hardly be any other than Paulus (Albertini) Veneto, born around 1430, died in 1475, a monk not unknown at that time, who also in a commemorative medal is called “M.”, that is magister (Tiraboschi: *Storia della letterat. Ital. VI p. 288 sq.*).

XXVI

Now we go to the codices in worse conditions. These codices are:

Codex Veneto Marciano CCCV on parchment, XV century (V) containing the same books of the Florentine codex and in the same order; after Archimedes and Eutocius it follows the same fragment of Heron (see Morellius: *Biblioth. Manusc. I p. 186*). On the first page we read *κτῆμα βησσαρίωνος καρθηναλέως* [property of Cardinal Bessarione], and Bessarione corrected the most serious errors here and there, but numerous corrections seem to have been made by the copyist himself. Near the scholio *περὶ ἐλίχ.* 10 Bessarione added: *σῆ. τοῦτο σχόλιόν*

1) This means without doubt “from the Greek codex that I examined later”; in fact, it cannot be referred to the age of the codex

ἐστὶ εἰς τό ι θ(εὐόρημα) ὠραῖον πάνυ. In Eratosthenes’ epigram the same verse is different, above he wrote *στίχοι ἠρωελεγεῖοι*, then in volume III p. 114, 3 he corrected *συνημῶν* in *συνηβῶν*. The figures were perhaps added later by Bessarione himself.

XXVII

The Parisian codex 2359, made of paper, once Medici, dates back to the 16th century (A); it contains the same works of Archimedes and Eutocius as contained

⁴⁵ In the following sentences Heiberg lists the propositions with the new numbering.

in the Venetian codex. This codex was written by the hand of two copyists, one of whom, starting from sheet 33, according to the testimony of Charles Graux is Nicolaus Murmuris, who around 1541-42 copied many codices in Venice.

The Parisian codex 2362, made of paper, [from the Library of] Fontainebleau, dating back to the 16th century (D), contains the same texts as codex A.

If we first rightly established that the Florentine codex was written precisely in 1491, it cannot happen that the Venetian codex, as I had previously believed, was copied from it, since Bessarione had already died in 1472 and the Venetian codex had arrived with all his Library in the Marciana Library in 1468. So, one must believe that the enormous similarity between these codices was forcefully caused by the fact that both codices are derived from the same archetype, that ancient codex by Giorgio Valla, so that from here it would be confirmed the reliability of the copyist of codex F in returning the antigraph not in a mediocre way. [...]⁴⁶

XXVIII [...] ⁴⁷

So at least it can be questioned whether the F codex also in these parts of the text translated the archetype more reliably than all the other codices, although it may happen that the writing of Valla's codex was certainly authentic. Yet there are circumstances that confirm that the Venetian codex was not copied from the F codex itself. First of all it must be remembered that the fragment of Heron or rather of Epiphanius, added to it also in the Venetian codex as in the Parisian codex C (p. XI), is slightly shorter than in codex F (but nevertheless four words longer than in codex C); for this reason the copyist of codex V was not even able to elaborate an explanation to remove the difficulties in this part of the deteriorated archetype as much as the one who copied codex F. In fact, if the Venetian codex had been copied from codex F, it is not clear why the last part, equally easy to read as the others, was not transposed into the Venetian codex. [...] ⁴⁸

XXIX So, we must conclude that the V codex does not derive from the codex F, but from its antigraph.

I already proved in *Quaest. Archim. p. 133* that the Parisian codices A and D, due to their many common lacunae, derive from code V. It remains questionable whether codex D was copied directly from codex V, which fact I now consider plausible, or from codex A; see *H. Menge: Neue Jahrbücher 1880 p. 111–112; Quaest. Archim. p. 137*. A diligent comparison of the V, A and D codices will settle this matter, if this question is worth of work. The following fact can certainly be considered sure, namely that codex A is the apograph of codex V, and it is of absolutely no value that the Parisian codex D was copied from codex V or from codex A.

In what follows it is presented the discussion about the codices of Tartaglia.

⁴⁶ Here Heiberg reports some examples of the versions given by the Venetian codex and the F codex.

⁴⁷ The examples started on the previous page continue here.

⁴⁸ Here Heiberg reports a series of examples in order to show that the V codex does not derive from the F codex but directly from the antigraph.

Niccolò Tartaglia, from Brescia, a very famous mathematician († 1557) published in Venetia in the year 1543 the Latin translation of many works of Archimedes (*On the centers of gravity* or *aequerepentibus* I-II, *Quadrature of the Parabola*, *Measurement of a circle* and the *De insidentibus aquae* I⁴⁹), in whose preface he wrote on the second page⁵⁰: “When by some chance certain books written in Greek of that very famous Philosopher Archimedes came into my hands, books which were broken and barely legible, I tried hard and carefully to the aim that the readable parts could be translated into our language, aim which was quite difficult. In fact, because of their age and of the negligence of those who held these books, I would like you to know that several mistakes have had to be corrected. Having seen the titles of these books and having examined all the work of this Philosopher, I knew that he had been considered by great and constant fame to be very outstanding, but now he is believed even more famous. That is why (as I have said) I looked greedily through these books, I went¹) through them systematically and finally examined everything very carefully,

1) [In the original text *procurri*]. Typographical error; it stands for: *percurri*. In general, Tartaglia’s book is full of such errors, as can be seen from my note to the books *περὶ ὄχουμένων*. To amuse, I’m just going to add two examples here: fol. 2^v: *valde aequerepentibus* stands for: *vel de aeq.*; fol. 19: *de centrum gravitatis vel duplationis aequerepentibus*. Below it says “oppositis” instead of “appositis”.

but when I found many distorted passages and certain inappropriate figures, which had nothing to do with it, I was almost forced to stop my plan. But I was consumed with an incredible desire to examine this work in order to purge it largely of errors, and I thought it worthy of seeing the light once I had adapted myself the figures and the words which seem to be particularly contradictory, and mainly I considered this part [of the work] to be worthy of seeing the light, part which I had made clear with words and examples as well as I could, instead the whole work, which will be done by me in a short time (I hope), will be wholly free of mistakes.” Then, in 1565, two books *On the equilibrium of planes* from the notes of Tartaglia were published by the Venetian book seller Curzio Troiano (from the preface: *for this reason, because I [Curzio Troiano] still have with me the Archimedes’ book “De insidentibus aquae” as made known by Niccolò himself and, as well as he [Tartaglia] could improve the manuscript, amended it from the mistakes of the copyist and, finally, made it vivid with his lucubrations, it seems to me to defraud all scholars of its possession until I have published all the things I still have of this ingenious man*). Both books are preceded by a separate title page in this edition and show the signature of the typographer and the same preface is preceding both books. The first book has been completely formatted as [done] by Tartaglia himself, except that the beginning and the end of the pages are not always the same because of larger figures (nevertheless, both books are bound together with four and a half pages); moreover, in the Tartaglia’s edition the title is: Archimedes’ book “*De insidentibus aquae*” (in the end: it is explicitly

XXX

⁴⁹ In Greek it is *περὶ ὄχουμένων* – On floating bodies

⁵⁰ Heiberg reports this excerpt from the preface also to have the possibility of statuing that Tartaglia did not know Latin language well enough.

written *de insidentibus aquae liber*), instead for Curzio: Archimedes' first book "De insidentibus aquae" (in the end: it is explicitly written *de insidentibus aquae liber primus*). Nothing is changed in the book itself except for some further mistakes made by the typesetter.

Because Tartaglia has added book 1 "De insidentibus aquae" to the other books that he claims to have taken from the Greek codex without any reference to a new source, you could rightly believe that he found it in that old codex as well. But that is why we doubt this statement. In fact, at first, although the translation of the first book On floating bodies *περὶ ὀχουμένων*, if you look at it at the beginning, is similar to the translation of the rest of the books both in its whole style and in the reproduction of single words in Greek and Latin, the

XXXI Greek codex, nevertheless, seems to add something of its own; firstly, the Greek syntax, whose in the remaining books hardly a trace is discovered, is very accurately observed here, such as the genitive after a comparative instead of the ablative and similar things.¹⁾ Moreover, it is clear that Tartaglia had in his hands no Greek codex eight years later; in fact, in the book "*Reasonings about his troubled invention*" [*Ragionamenti sopra la sua travagliata inventione*] (Venice 1551) it is written⁵¹: "*Since Your Lordship, o magnificent lord Count, in the last few days reasoned with me about the work of Archimedes Syracusan published myself and especially about that part, which is entitled "de insidentibus aquae", that part whose [Your Lordship] told me he was very eager to find and see the Greek original, from which that part was translated. For this reason, I understood that Your Lordship was looking for this original because of the darkness of the text, which is amplified in the aforementioned Latin translation. In order to avoid Your Lordship this effort to search for the Greek original (which perhaps you would find darker and more incorrect than the aforesaid Latin translation) I have clarified and detailed this part in this first reasoning of mine.*" Although it cannot be concluded with certainty that Tartaglia himself never had in his hands a Greek codex of this book, we cannot be surprised that this codex is so completely forgotten, after such a small period of years, that Tartaglia himself could not indicate to his patron, who seemed to ask for it very eagerly, the source of his translation. Moreover, the words: *which perhaps you would find darker and more incorrect*⁵² would be rather surprising, if he himself had taken his translation from this Codex. The whole passage seems to me to be explainable quite simply if we have conjectured

1) In fact, it can be stated without any doubt that this and the other books edited by Tartaglia have been translated from Greek and not from the Arabic language, as someone might believe, since in sheet 11 we read "Archimendis", a form of the name propagated by the Arabs through many medieval Latin translations. But the language and form of these books is such that it is to be believed that they necessarily flowed from a Greek source, as Tartaglia says.

⁵¹ We completely agree with Bernardino Baldi [Cronica de matematici: overo Epitome dell' istoria delle vite loro, Urbino, Angelo Antonio Monticelli, 1707] where he states that the use of the Italian language by Tartaglia "*move a riso talhora chi legge le cose sue*" that is "*causes sometimes amusement in those who read his works*". We find Tartaglia's Italian to be rather dialectal also when compared to his contemporary authors.

⁵² Italian text in the original: *qual forsi piu oscuro e incorretto lo ritrovaria.*

that Tartaglia never had, at least this part of, the Greek codex in his hands. It is also worth mentioning that Tartaglia speaks about this book in such a way that he makes it clear that he obtains his Greek text from his own source and from others different place (*l'original greco, dove che tal parte era stata tradotta* [Italian text]). Moreover, to this evidence it is added the witnessing of Fr. Commandino, who was a man extremely educated in Greek mathematics and tirelessly searched the codices of this kind. Not so many years later (Bologna 1565), in the preface to the edition of the books *On floating bodies* *περὶ ὀχουμένων* on the second page, he writes the following: “*When, in fact, the Greek codex of Archimedes had not yet come to light, not only the translator who gave it to Latinity was wrong in many places, but also the codex itself has been corrupted and is lacking [parts] for the old age, as also the translator confesses.*” It is evident that these words, which I have taken from Commandino’s preface above, refer to Tartaglia and to the transcribed copy of the codex used by Tartaglia, and we wonder why Commandino did not name Tartaglia. Moreover, it can be concluded from the aforementioned passage that Commandino believed that the books *On floating bodies* could be found in the same codex together with the other works. But even if this fact were true, one can conclude that Tartaglia did not know the Greek codex even from hearsay. By all these facts, I would be leaning rather towards believing that it was Tartaglia himself that translated the remaining books into Latin from that very ancient and broken Greek codex, but the first book of the “*De insidentibus aquae*”, as well as the second, were offered to him already translated from Greek into Latin I do not know in which way.¹⁾ If this opinion is true, we must evidently suspect that that codex, which Tartaglia speaks about, was the codex of Valla, which was roughly copied at about the same time (1544) by the writer of codex C (supra p. X). In fact, it is not enough verisimilar,

1) Regarding the origin and authoritativeness of the fragment published by Angelo Mai, it is a difficult question to judge. At least it is certain that the translation of Tartaglia was not made from this form of the text, but from a much better one. I would consider that fragment to be insignificant and that the one who included propositions alone without demonstration, apart from the first one, did try to translate backwards into Greek the Latin translation of some learned man of the Middle Ages, the same thing which was attempted by Rivalto himself. Thurot’s opinion seems identical.

that there were two codices of Archimedes in Italy at the same time, both of which were corrupted by age and partly difficult to read¹⁾, and both having been completely lost in our time²⁾, especially because between Valla’s codex and that of Tartaglia the commonality and affinity of the spelling mistakes is great. I will give some examples of this commonality and affinity:

[...] ⁵³

1) Even though it appears that Tartaglia, in the books to be chosen to be published first, preferred the shorter one, it is verisimilar that the lacuna at the beginning of Book I on the sphere and the cylinder also dissuaded him from publishing these books, since he himself says he published those parts that could be read with the least effort.

2) Regarding the corrupted figures in Valla’s codex, information that Tartaglia has transmitted about his codex (p. XXXI), even the copyist of the codex B complains about it (see supra p. IX).

⁵³ Examples of the affinities between the codex of Valla and the codex of Tartaglia as reconstructed by Heiberg.

Also, in Tartaglia, as well as in our codices, the propositions 1-2 of the book I *On the equilibrium of planes* read without numbers, so that the numbers of the propositions throughout the book are by two less.

In the books *Quadrature of the Parabola* and *Measurement of a circle*, Tartaglia caught another translation, although he does not even mention this fact with a single word (this fact creates the belief that he may have used a different source from the one used for the other books *On floating bodies*, even though he does not mention this circumstance clearly). In fact, the books *Quadrature of the Parabola* and *Measurement of a circle* had already been published in 1503 by Luca Gaurico⁵⁴ in Latin (Tetragonism⁵⁵ i.e. the quadrature of the circle discovered by Campano [Giovanni Campano da Novara], Archimedes of Syracuse and Boetius, who were very gifted in mathematics. In the preface [one finds]: Luca Gaurico of Gifuni from the Kingdom of Naples hails the scholars of mathematics: [datum in] given in the University of Padua [Almo Studio Patavino] 1503, 15 Kal. of August (July, the 17th). In the end of the book [one finds]: printed in Venice by Ioan. Bapt. Sessa a.D. 1503 August, the 28th.), and Tartaglia seized this translation literally keeping both the extremely inept mistakes and the perverse punctuation. He filled very few gaps and changed¹⁾ partly the figures and letters of the figures. From this source, Tartaglia seized the title on the 19th page: *The Tetragonism of Archimedes*, which title in the translation of Gaurico

1) Only, to my knowledge, Mazzucchelli recalled this fact: *Notizie storiche intorno alla vita, alle invenzioni ed agli scritti di Archimede siracusano* [Historical facts on the life, the inventions and the works of Archimedes of Syracuse], Brescia 1737. 4. p. 95. After I came across this passage so long consigned to an unworthy oblivion, I myself became aware of a specimen of this very rare book, owned by the Royal Library in Copenhagen.

XXXV is the common title of both books; hence, the titles of the individual books in both Gaurico and Tartaglia are as follows: Incipit Archimenidis (“Archimedis” in Tartaglia) quadraturae parabolae, et: Archimedis Syracusani liber. What code he had followed, Gaurico does not specify; in the preface on the second page, he only writes the following: since the proof of Campano⁵⁶ and Archimedes about the tetragonism of the circle has come into our hands, I do not believe that it should be concealed. Therefore, it is not even clear whether he himself had translated these books from Greek or found a Latin translation. However, despite this, it is clear that his translation, which is by far worse than that of Iacobus of Cremona and follows so carefully the Greek [version] that he often deviates not only from the use of the Latin language but from any sense, is derived from a codex that is very similar to the codex of Valla, or exactly from it. In fact, not only in its archetype, as in the F codex and undoubtedly in Valla’s codex, the propositions of the book on the quadrature of

⁵⁴ Luca Gaurico (1475-1558) was an Italian Catholic bishop and astrologer.

⁵⁵ Whose title was in Latin “Tetragonismus id est circuli quadratura”

⁵⁶ Campano di Novara, or Giovanni Campano (1220-1296), was an Italian mathematician, astronomer and astrologer. One of the most important scientists and mathematicians of the 13th century.

the parabola had absolutely no numbers, indicating that he very often divided the chapters very badly by connecting two and split one into two or more (Tartaglia has added the numbers of the chapters and has mostly followed the divisions of Gaurico, who only marked them in capital letters); but also most errors of Valla's codex are repeated here, such as:

[...] ⁵⁷

[...]

XXXVI
-XLIV

XLV

Codex Vallae	Gauricus	Tartalea	Cremonensis
II p. 310, 26: ποτι τὸ Ζ· ὥστε μείζόν ἐστι τὸ Ζ τοῦ Κ.	quam ad spa- tium z quam spatium k.	quam ad spa- tium z. ergo spatium z ma- ior est quam spatium k.	quam ad f. qua- re f spacium ipso k maius existit.

In the last listed comparison, in Gaurico for a mistake of the typograph it is corrupted the sentence: “quare maius est spatium z” due to the homeoteleuton⁵⁸; Tartaglia filled the lacuna clearly without having the Greek code in his hands (in fact the order of the words is different), and in this he made a mistake (maior⁵⁹) shameful even for a child. For this reason, it must be deduced that even in the other corrections to Gaurico's errors Tartaglia did not use his codices, but he relied on his intuition¹).

Now, we go back to Tartaglia's codices. If, as it was done above on p. XXXII, we have suspected that the codex “damaged and barely legible”, of which Tartaglia speaks, was the same as Valla's codex, then it must be admitted that Tartaglia is the first to complain about the nature of the codex too much, as it appears by comparison with the Parisian codex C, which was correctly copied at about the same time by the same archetype; but perhaps Tartaglia was poorly versed in reading Greek codices. Thereupon, Tartaglia for his codex did not use the care and conscientiousness as he ought to have done, since in the book on the equilibrium of plane surfaces II, 9, instead of a presentation of a true [translation], he caught a manipulated and shortened Eutocius' paraphrase, as if it was originated from a true Archimedes' text (Quaest., Arch., p. 97)²). Finally, Tartaglia corrected and changed many text passages, for doing that he seems to have used some other codex which he only mentioned clearly in one place; in fact,

⁵⁷ Here there starts a list of errors repeated in the book edited by Gaurico and in Valla's codex. This list continues for many pages, between page XXXVI and page XLIV. We omit this list.

⁵⁸ The homeoteleuton (in the original text, this word is in Greek) is the repetition of the ending of consecutive words. The sentence is replaced by “quam ad spatium z quam spatium k”. The Cremonensis' translation is the most faithful to the Greek original.

⁵⁹ Here Heiberg quickly refers to the previously reproduced comparative table. Tartaglia uses the adjective “maior” i.e. “greater than” without inflecting it, an error which is by illiterates. In his work Cronica [Cronica de matematici: overo Epitome dell' istoria delle vite loro, Urbino, Angelo Antonio Monticelli, 1707], Bernardino Baldi writes “Attese nondimeno così poco alla bontà della lingua, che move a riso talhora chi legge le cose sue” (He studied so little to learn languages, that sometimes he provokes laughter to those who read his works).

1) In addition, Tartaglia at the beginning of the book *Quadrature of the Parabola* for two times in place of “Archimedes” (in Gaurico) wrote “Archimedes”, and in place of “mathematicam” II p. 294, 11; 298, 2 “mecanicam”.

2) Perhaps the faithful presentation in Valla’s codex seemed to Tartaglia more difficult to read; what certainly results is that this codex gave him no reason to confuse Eutocius’ presentation with the real one.

XLVI in the book *On the equilibrium of planes* II, 9 after the recovered demonstration of Eutocius on page 16^v it is added: “In another Greek copy one could read in this way”. But before we carefully investigate this codex, we must say some few things about the Greek codex of Nuremberg cent. V app. 12 fol., whose existence I knew at first due to Menge (*Neue Jahrb.* 1880 p. 110); but after that I knew about it, I managed to bring it with me to Copenhagen. It is a codex of paper written in the 16th century, containing the same writings of Archimedes and Eutocius as codex F and in the same order. Venatorius, who corrected many mistakes with his own hand, partly on the margin, partly with strips of paper glued to the edge, used this codex to produce the main edition; moreover, he has improved many things to smartly change the script of the codex by scraping, adding lines or extending; for this reason, the corrections of this kind were very difficult to find and very often they took away the older writing altogether; some of them, however, seem to have been made by an older hand and perhaps the first hand who wrote the codex. In between, Venatorius has also written down notes that the typographer must read, so that it appears that this codex itself was in the hands of the typographers. In order to know the nature of these comments, an example should suffice; I p. 22–24, where the propositions in codex N^a are divided in the same way as in codex F, he wrote on a strip of paper: “ὁμοίως [similar] paragraph. φανερόν δέ [clear indeed] paragraph. δευτέρον δέ [to be proven indeed] demonstration of a new proposition. The note of the number ζ should be prefixed”, and this has been done in the edition Basil. p. 4. This codex N^a was written in Rome or has certainly come to Nuremberg from Rome to Bilibaldus Pirckheymerus (ed. Basil. On the second page of Preface one reads: *Bilibaldus Pirckheymerus, whom you have experienced, as long as he lived, could not be difficultly admitted to be the most scholarly amongst the scholars, as he was a man of outstanding talent, having received a Greek writing copy of our Archimedes in Rome from some friend after a long expectation, he let the codex live as a guest of honor in his house*).

The codex N^a shows to be of the same class as the other codices for the lacuna at the beginning of the first book *On the Sphere and Cylinder* and there is also a match of all the most serious errors altogether (Cfr. *Quest. Arch.* p. 138).

XLVII
–LXXXIX *On these pages a technical philological analysis of many Archimedean codices is presented. This analysis seems to prove without doubt that Tartaglia did not master the subject to be a reliable editor and translator. Here Heiberg gives evidences that are used by Clagett [Clagett, M. *The Use of the Moerbeke Translations of Archimedes in the Works of Johannes de Muris Isis*, Vol. 43, No. 3 (Sep., 1952), pp. 236–242, p. 237] to state that: “Heiberg further observed that the Moerbeke translations of the *Dimensio circuli* and the *De quadratura parabolae* were published by Gauricus in Venice, 1503. These same two translations and those of the *De centrīs gravium* and Book I of the *De insidentibus aquae* were published by Tartaglia in*

Venice in 1543. Tartaglia leaves us with the distinct and erroneous impression that the translation is original with him. We can note finally the publication in 1565 of the Moerbeke translation of the whole of the De insidentibus aquae by Trojanus Curtius in Venice and by Commandino in Bologna". Moreover, also adding his own philological analysis to the enormous work by Heiberg, Clagett [Vol III Chapt. 4 Sect. 2 p. 540] concludes that: "The central thrust of my argument on Tartaglia's role in Archimedean studies is that Tartaglia's knowledge of the works of Archimedes primarily derived from the translations of William of Moerbeke, although he certainly was familiar with the various extracts that appeared in Giorgio Valla's "De expetendis et fugiendis rebus" and no doubt also with the Cremonensis translations either in the Venice manuscript or in the edition princeps of Basel, 1544."

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