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Edited by Johan Ludvig Heiberg
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Archimedis Opera Omnia

Published in 1880–1, this three-volume edition of the extant works of the Greek mathematician Archimedes of Syracuse (c.287–c.212 BCE) was edited by the Danish philologist and historian Johan Ludvig Heiberg (1854–1928), whose *Quaestiones Archimedee* (1879) is also reissued in this series. He later discovered a medieval palimpsest containing lost works by Archimedes, which significantly expanded the canon, but the present collection was produced long before this and therefore contains the works known at the time of publication. Heiberg consulted a Florentine codex, which he painstakingly compared with other sources to produce his edition. This first volume contains *On the Sphere and the Cylinder* (in two books), *On the Measurement of a Circle* and *On Conoids and Spheroids*. The texts are given in the original Greek with parallel Latin translation, notes and introductory material.

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VOLUME 1

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ARCHIMEDIS
OPERA OMNIA

CUM COMMENTARIIS EUTOCHII.

E CODICE FLORENTINO RECENSUIT, LATINE UERTIT
NOTISQUE ILLUSTRUIT

J. L. HEIBERG

DR. PHIL.

VOLUMEN I.



LIPSIAE

IN AEDIBUS B. G. TEUBNERI.

MDCCLXXX.

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LIPSIÆ: TYPIS B. G. TEUBNERI.

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I. N. MADUIGIO

UIRO DOCTISSIMO, CLARISSIMO, HUMANISSIMO

EDITOR DISCIPULUS.

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PRAEFATIO.

Opus magnum et difficile, sed necessarium et ab omnibus, qui hanc partem litterarum adtigerunt, iam diu desideratum, ad quod dissertatione mea, quae inscribitur Quaestiones Archimedee (Hauniae MDCCCLXXIX), uiam, quantum potui, muniui, ut opera Archimedis tandem aliquando e legibus artis criticae ederentur et ita, ut philologis quoque non res modo, sed etiam uerba ipsa et quasi manum Archimedis requirentibus satisfaceret, id iam ipse efficere conabor. nam quod primum omnium faciendum erat, ut codex Florentinus praestantissimus denuo diligenter conferretur, id mihi Florentiae facere licuit mense Octobri anni MDCCCLXXIX, quo profectus eram pecunia Instituti Carlsbergici adiutus. quam ob liberalitatem iis uiris, qui huic instituto praesunt, gratias hoc loco ago quam maximas, in primis I. N. Maduigio, uiro doctissimo et clarissimo, praecceptoris meo, qui ceteris suis beneficiis hoc quoque adiunxit.

eodem itinere etiam codicem Uenetum inspexi et in Arenario totum contuli.

collato codice Florentino mihi persuasi, quaestionem de necessitudine et coniunctione codicum Archimedeorum, de qua egi Quaest. Arch. cap. VI, retractandam esse; quare de hac re ad finem huius editionis

uberius disputabo. hoc loco pauca tantum dicenda sunt de ea ratione, quam in hac editione comparanda secutus sum.

in uniuersum editionem Pappi, quam parauit Fr. Hultsch, uir doctissimus, tamquam exemplar omnium consensu comprobatum mihi imitandam proposui. itaque non modo notas criticas Graecis uerbis subiunxi, sed etiam interpretationem Latinam addidi, ad quam notae res mathematicas plerumque explicantes adcedunt.

Primum igitur quod ad adparatum, quem uocant, criticum adinet, eum ita comparauit, ut id maxime adpareret, quid quoque loco praeberet codex Florentinus, et sicubi emendanda erat scriptura eius, quis emendationis auctor esset. quare ubicunque a codice Florentino discessi, in notis eius scripturam primo loco posui, deinde adiunxi emendatae scripturae auctorem, ita ut, ubi nihil ultra additum est, omnes auctores tempore medios, ubi nonnullorum scriptura discrepans enotata est, ceteros certe cum codice Florentino consentire intellegendum sit. qua in re hoc tamen tenendum est, errores apertos codicum Parisiensium prorsus omissos esse. ubi sola scriptura codicis Florentini indicatur, errores eius iam in ceteris codicibus correcti sunt, si collationibus Torellianis fides habenda est; sed non dubito, quin in multis eius modi locis scriptura codicum Parisinorum parum diligenter enotata sit (Quaest. Arch. p. 111 sq.). in locis grauioribus*) codices Parisinos inspexit Henricus Lebègue mea causa rogatus a Carolo Graux, uiro doctissimo mihi que ami-

*) Scripturis codd. Parisin., de quibus me certiores fecit H. Lebègue, stellulam adfixi.

cissimo; sed in minutiis iis molestus esse nolui; sic quoque quae mea causa fecerunt, permagna sunt et summa gratia digna, quam me iis habere hoc loco testor. — scripturam discrepantem editionum Basileensis et Torellii totam recipere opus esse non putavi, sed quidquid ad uerba Archimedis emendanda inde sumi posse uidebatur, excerpti. ceterum saepissime codicem Florentinum secutus a Torellio tacite discessi, et in eiusmodi locis silentium pro testimonio scripturae codicis Florentini esto, sicut etiam ubi scripturam eius aliter, ac Bandinius in collatione sua ad editionem Basileensem facta, quae apud Torellium exstat, indicaui, mihi credi uelim.

in commentario critico his compendiis usus sum:

F = codex Florentinus Laurentianus plut. XXVIII, 4.

V = codex Uenetus St. Marci CCCV.

A = codex Parisiensis Nr. 2359.

B = codex Parisiensis Nr. 2360.

C = codex Parisiensis Nr. 2361.

D = codex Parisiensis Nr. 2362.

ed. Basil. = editio Basileensis 1544 fol.

Cr. = interpretatio Iacobi Cremonensis ei addita.

uulgo = significat consensum omnium auctorum praeter eos, qui diserte nominati sunt.

corr. = correxit.

comp. = compendium.

Qui recentiore tempore de Archimede scripserunt uiri docti, haud ita multi sunt, neque ad scripta eius emendanda multa contulerunt. quibus uti potui subsidiis, haec sunt:

Riualtus — Archimedis opera. Parisiis 1615 fol.

Torellius — Archimedis opera. Oxonii 1792 fol.

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- Commandinus — A. opera nonnulla latine. Uenetiis 1558 fol.
- Wallis — A. arenarius et dimensio circuli. Oxonii 1678. 8. — Opera III p. 509 sq.
- Sturm — Des unvergleichlichen Archimedis Kunstbücher, übersetzt und erläutert. Nürnberg 1670 fol.
- Barrowius — Opera Archimedis methodo novo illustrata et demonstrata. Londini 1675. 4.
- Hauber — A. über Kugel und Cylinder und über Kreismessung, übersetzt mit Anmerkungen. Tübingen 1798. 8.
- Gutenäcker — A.'s Kreismessung griechisch und deutsch. Würzburg 1828. 8.
- Nitze — A.'s vorhandene Werke, übersetzt und erklärt. Stralsund 1824. 4.
- Censor Jenensis (Jen.) — Uir doctus ignotus, qui de editione Torellii censuram proposuit Jenaer Litteraturzeitung 1795 Nr. 172—73 p. 610—23.
- Wurm — Fr. Wurmii censura editionis Gutenäckeri Jahns Jahrbücher XIV p. 175—85.
- emendationes nonnullas ipse proposui Quaest. Arch. cap. VII et in editione Arenarii ei libro adiuncta, quarum partem nunc improbau, plerasque recepi. in Eutocio quaedam emendare conatus sum Neue Jahrbücher für Philologie und Pädagogik, Supplementband XI p. 375—83.

In interpretatione Latina, quam totam de meo conscripsi, id maxime secutus sum, ut ubique sensus satis dilucide adpareret, et Archimedeae orationis forma et demonstrandi ratio quam maxime seruaretur, ita tamen ut, ubi fieri posset, ea, quae Archimedes uerbis

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PRAEFATIO.

IX

exposuerat, signis, quibus nostri mathematici utuntur, exprimerem. quod ut fieret, interdum ab usu linguae Latinae longius discedere coactus sum, maxime in colloca-tione uerborum, et parum Latine loqui, ne aut obscura esset interpretatio aut a Graecis uerbis nimis discreparet. in multorum uerborum interpretatione Hultschium secutus sum, uelut, eo prae-eunte pro Graecorum διπλάσιος cett. sequente genetiuo dixi: duplo maior quam, cett. (Hultsch: Pappus I p. 59 not. 1); sed ubi haec orationis forma minus apta erat, uelut pro Graeco διπλασίονα λόγον ἔχειν, scripsi: duplicem rationem habere quam, et similia (cfr. Lilius XXXIV, 19, 4; Columella I, 8, 8; Plinius h. nat. XIX, 9; Quintil. II, 3, 3).¹⁾

In notis interpretationi adiunctis maxime id studui, ut supplerem, quae ab Archimede in demon-stratione omissa erant, et locos obscuriores illustrarem. in libris de sphaera et cylindro et libello de dimen-sione circuli in notis indicaui, quaecun-que de genuina scriptura Archimedis suspicari licet. hi enim libri non modo dialecto Dorica spoliati sunt, sed etiam plurimis locis reficti, cum transscriptor et adderet, quae ei necessaria uiderentur, et omitteret, quae abesse posse putaret, et omnino suae aetatis sermonem et rerum mathematicarum nomina, quae tum in usu erant, inferret. itaque cum intellegerem, in his libris ma-num Archimedis restitui non posse, satius duxi recen-sionem posteriorem sequi et tantum modo apertissimos scribendi errores corrigere. sed praeter quam quod,

¹⁾ Hos locos indicauit mihi O. Siesbyeus, uir doctissimus.

ut dixi, in notis indicavi genuinam Archimedis scripturam, ubicunque aut constabat aut probabili coniectura restitui poterat, etiam additamenta plurima in Graecis uerbis uncis [] inclusi, in interpretatione omisi; in interpretatione contra uncis [] inclusa sunt, quae ipse addidi ad Archimedis uerba et demonstrationis rationem illustranda. de additamentis illis cfr. quae scripsi Quaest. Arch. p. 69—78 et Neue Jahrbücher Suppl. XI p. 384—398. in iis locis, quos postea subditiuos esse intellexi, semper causam in notis breuiter indicavi; de ceteris satis esto semel hic illas duas disputationes citasse. unum locum tamen, in quo longiore disputatione opus est, hic uberius tractare libet.

de sphaera et cylindro I, 41 (apud Torellium I, 47) p. 172, 8: *καὶ ὡς ἄρα τὸ πολύγωνον πρὸς τὸ πολύγωνον, ὁ Μ κύκλος πρὸς τὸν Ν κύκλον*] sint spatia rectangula lateribus polygonorum (P, p) et lineis angulos iungentibus comprehensa S, s ; quae aequalia sunt radiis (R, r) quadratis circulorum M, N . et circulis N, M aequales sunt superficies figurarum circumscriptae et inscriptae (O, o). iam Archimedes inde, quod est

$$S : s = EK^2 : AA^2,$$

concludi uult $O : o = EK^2 : AA^2$. si genuina essent uerba illa, hoc sic efficeret: $S : s = EK^2 : AA^2$, sed $S : s = R^2 : r^2 = M : N$, et $EK^2 : AA^2 = P : p$; quare $P : p = M : N$; sed $M : N = O : o$ et $P : p = EK^2 : AA^2$; quare $O : o = EK^2 : AA^2$. quod quam prauum sit, nemo non uidet; nam polygonorum prorsus peruerse mentio iniecta est, cum deberet sic concludi:

$$S : s = R^2 : r^2 = M : N = O : o;$$

sed $S : s = EK^2 : AA^2$; quare $O : o = EK^2 : AA^2$.

augment malum uerba sequentia lin. 13: τὸν δὲ αὐτόν, ὃν καὶ τὸ πολύγωνον (debebat esse τὰ πολύγωνα), quae praecedere debebant uerba: διπλασίονα λόγον ἢπερ ἡ EK πρὸς AA , cum hoc ex illo concludatur. adparet igitur, hos duos locos subdituios esse. sed repugnare uidetur Eutocius, qui haec habet: ἐπεὶ δέδεικται, ὅτι ἐστὶν ὡς τὸ πολύγωνον πρὸς τὸ πολύγωνον, οὕτως ὁ M κύκλος πρὸς τὸν N . sed puto, eum minus proprie loqui et ad ipsam rationem ab Archimede in priore parte propositionis demonstratam $O : o = EK^2 : AA^2$ respicere. nam cum $O : o = M : N$ (ex hypothesi) et

$$EK^2 : AA^2 = P : p \text{ (Eucl. VI, 20),}$$

hinc ratio $P : p = M : N$ tam facile sequitur, ut Eutocius recte dicere possit, hanc rationem simul cum illa demonstratam esse. eodem modo Archimedes dicit: ἐδείχθη δὲ ὡς ἡ EK πρὸς AA , οὕτως ἡ ἐκ τοῦ κέντρου τοῦ M κύκλου πρὸς τὴν ἐκ τοῦ κέντρου τοῦ N κύκλου (p. 174, 13), cum tamen hoc tantum demonstrauerit: $O : o = EK^2 : AA^2$, unde facile concluditur $R : r = EK : AA$. subditua esse uerba illa, hinc quoque adparet, quod Archimedes prop. 42 p. 176, 25 hanc ipsam rationem $O : o = P : p$ proponit his uerbis additis: ἐκάτερος γὰρ τῶν λόγων διπλασίος ἐστὶ τοῦ, ὃν ἔχει ἡ τοῦ περιγεγραμμένου πλευρὰ πρὸς τὴν τοῦ ἐγγεγραμμένου πλευρὰν (h. e. $EK : AA$). haec uerba sine dubio in prop. 41 addidisset, si ibi quoque hac ratione uti uoluisset; et praeterea Eutocius ad prop. 42 uerba ἐκάτερος γὰρ κτλ. illustrat, cum tamen satis esset uerba ipsius Archimedis ex prop. 41 adferre. quare puto, uerba illa a transcriptore ad similitudinem propositionis 42 interposita esse. hoc

ideo quoque pluribus uerbis exposui, ut uno saltem exemplo additamentum manifeste argueretur, qualia in his libris plurima occurrunt.

in his igitur libris dialectum Doricam restituendam non esse putavi, in ceteris uero in uniuersum eam tenui rationem, quam proposui Quaest. Arch. p. 78 sq., sed eam aspere exigendam esse non censui, ut potius cautior essem, quam ut in contrarium uitium incidere.

Quibus subsidiis in epigrammate et iis libris, qui Latine tantum exstant, usus sim, suis locis dicetur. nunc finem faciam, cum ante gratias egero Nicolao Anziani, uiro doctissimo, praefecto bibliothecae Laurentianae, cuius humanitatem egregiam Florentiae cognoui.

haec habui, quae dicerem de consilio meo in hac editione paranda. utinam ne uires meae tanto oneri nimis impares sint!

Scripsi Hauniae Id. Decemb. MDCCCLXXIX.
