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Some Mathematical Books 1. *Archimedis opera omnia cum commentariis Eutocii*. Iterum edidit J. L. Heiberg. Vols. I. and II. Pp. xi + 445, and xviii + 554. Teubner, 1910, 1913. 2. *Heronis Alexandrini opera quae supersunt omnia*. Vol. IV. Heronis Definitiones cum variis collectionibus, Heronis quae feruntur geometrica. Edidit J. L. Heiberg. Pp. xxix + 450. Teubner, 1912. 3. *Des Claudius Ptolemäus Handbuch der Astronomie aus dem griechischen übersetztj und mit erklärenden Anmerkungen versehen* von Karl Manitius. 2. Band. Pp. vi + 446. Teubner, 1913.

T. L. Heath

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τοὺς is exceptionable as (i) doubtful Greek (so a MS. note of Professor S. H. Butcher's); (ii) unsatisfactory sense. L. is not represented as disparaging the recipients of public grants generally, but as arguing sophistically from the case of a few unworthy to the whole system of public grants; *cp.* immediately below ἀνάξιοι τινες (whence the v.l. τινας of S and L) κατὰ τὸν τούτων λόγον εἰσὶν: ch. 38, ὅτι νῆ Δί' ἡσάν τινες . . . ἀνάξιοι: *cp.* ch. 56 *ad init.* On the other hand, τινας (i) could not give rise to v.l., τοὺς (ii) violates Blass's rules of rhythm, (iii) is weakly supported: probably a simplification by a corrector of the S text, suggested by ἀνάξιοι τινες below. I would suggest καταμεμφόμενον τοὺς <καὶ τοὺς> κ.τ.λ. —'disparaging such and such persons' —corrupted by haplography to τοὺς with loss of the intervening καί.

Ch. 139.—σκοπῶ δὲ καὶ τοῦτο καὶ μὴν οὐδ' ἐκείνου γ' ἀποστατέον τοῦ λόγου, ὅτι . . . So MSS. Editors delete σκοπῶ . . . τοῦτο, supposing a twofold recension with Blass—rather a far-sought theory—and unnaturally attributing to the jurors a wish to 'back out' of the speaker's arguments. Such a wish could, however, be reasonably expected of Leptines: so perhaps we should write—σκοπῶ δὲ καὶ τοῦτο—καὶ μὴν οὐδ' ἐκείνῳ γ' ἀποστατέον τοῦ λόγου—ὅτι . . . 'I also consider—and this is an argument that not even Leptines can afford to neglect—that. . . ' We cannot keep ἐκείνου, which clashes with τοῦτο if it refers forward, and can only refer backwards in violation of usage. On the other hand, ἐκείνῳ could easily be corrupted by assimilation to τοῦ λόγου.

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REVIEWS

SOME MATHEMATICAL BOOKS.

1. *Archimedis opera omnia cum commentariis Eutocii*. Iterum edidit J. L. HEIBERG. Vols. I. and II. Pp. xi+445, and xviii+554. Teubner, 1910, 1913.
2. *Heronis Alexandrini opera quae supersunt omnia*. Vol. IV. *Heronis Definitiones cum variis collectionibus, Heronis quae feruntur geometrica*. Edidit J. L. HEIBERG. Pp. xxix+450. Teubner, 1912.
3. *Des Claudius Ptolemäus Handbuch der Astronomie aus dem griechischen übersetzt und mit erklärenden Anmerkungen versehen von KARL MANITIUS*. 2. Band. Pp. vi+446. Teubner, 1913.

It was in the year 1879 that, in his *Quaestiones Archimedeae*, a dissertation for the doctorate at Copenhagen University, Heiberg foreshadowed the issue of a new Greek text of Archimedes. The dissertation contained preliminary matter necessary to a critical edition, e.g. chapters on the contents and order of the separate treatises, on the MSS.

and editions, on the dialect of Archimedes, besides chapters on the life of Archimedes, his mechanical inventions, and on 'arithmetic in Archimedes'; it concluded with a text of the short treatise, the 'Sand-Reckoner,' with critical notes, offered as a sample instalment of the contemplated new edition. The edition itself followed at a very short interval, Vol. I. in 1880, and Vols. II. and III. in 1881. Since that time the editor has been steadily placing the student of Greek mathematics under greater and greater obligations by the issue, at surprisingly short intervals, of trustworthy texts of Euclid's *Elements*, with scholia, in five volumes (1883-1888), Apollonius of Perga in two volumes (1891-1893), Euclid's *Optics*, etc. (1895), Serenus Antinoensis (1896), Ptolemy in three volumes (1898-1907), and finally the fourth volume of the Teubner edition of Heron, to say nothing of Simplicius's commentary on Aristotle's *De caelo* in the Berlin series of commentators on Aristotle (1884), a total of achievement

on the part of one editor for which I suppose it would be extremely difficult, if not impossible, to find a parallel.

These editions were in each case the first which came up to the modern standard of textual criticism. When, at the revival of learning, the Greek mathematicians began to be studied and edited in the original Greek, they were edited by mathematicians rather than by scholars. The mathematical content being, from the editors' point of view, the important consideration, they based their texts upon the first MS. that offered, taking little or no trouble to collate others or to consider questions of relative authority. The *editio princeps* of Archimedes, published by Thomas Gechauff Venatorius at Basel in 1544, was based on the MS. known as N^a, a MS. written in the sixteenth century and only a copy at second-hand of the Florentine MS. of the fifteenth century originally called F by Heiberg and now D=*Cod. Laurent.* xxviii. 4. Torelli's edition, the only complete text before Heiberg's, followed the *editio princeps* in the main, though he collated V, now E=*Codex Venetus Marcian.* 305, of fifteenth century; the book was brought out after Torelli's death by Abram Robertson, who collated five more MSS., including F; but the collation was not well done, and the edition was not properly corrected when in the press.

The necessity for the second edition of Archimedes, of which Vols. I. and II. are now before us, arose through the discovery of important new sources. The first of these is the original Latin translation of the works of Archimedes made by William of Moerbeke, which was discovered at Rome in 1884 by Valentin Rose. The importance of this translation lies in the fact that it was made in the latter half of the thirteenth century, and followed word for word a Greek MS. of which no trace now remains, but which was much older than any we now possess. The second of the new sources is even more important. The story of its discovery in 1906 is almost romantic, and has now been more than once told by Heiberg himself (in *Hermes*, Vol. XLII., 1907, p. 235 f., and in the preface to the

present Vol. II.). His attention having been called to a notice in Vol. IV. (1899) of the *Ἱεροσολυμιτικὴ βιβλιοθήκη* of Papadopoulos Kerameus relating to a palimpsest of mathematical content, he at once inferred from a few specimen lines which were quoted from the MS. that it must contain something by Archimedes. This was confirmed when he inspected the MS. itself. With the exception of the last leaves, 178 to 185, which are of paper of the sixteenth century, it is of parchment, and contains writings of Archimedes copied in a good hand of the tenth century, in two columns. An attempt had been made (fortunately with only partial success) to wash out the old writing, and then the parchment had been used again, for the purpose of writing a Euchologion thereon, in the twelfth to thirteenth or thirteenth to fourteenth centuries. The importance of the palimpsest is due to the fact that it contains an entirely new treatise of Archimedes, called the *Method*, which was supposed to be lost. Until the discovery of the *Metrica* of Heron by R. Schöne at Constantinople, it was only known by name from an allusion to it by Suidas; but the *Metrica* quotes three propositions from it, and it was a remarkable stroke of luck that within a few years the propositions themselves should come to light in the new MS. The treatise is historically and intrinsically one of the most interesting of all the works of Archimedes. The MS. also contains a considerable portion of the Greek text of the work in two books *On Floating Bodies* (*περὶ ὀχυμένων*), hitherto only known in the Latin translation due to William of Moerbeke, as well as two short fragments, besides the preface, of a work called *Stomachion* (as it might be 'Neck-Spiel' or 'Quäl-Geist'), which treated of a sort of Chinese puzzle known afterwards by the name of 'loculus Archimedeus.' The text of the *Method* was originally published in *Hermes*, Vol. XLII., 1907, but since then Heiberg has been able to decipher more of the MS., so that, in the new edition, a number of gaps have been filled or reduced. Some two-thirds of the Greek text of the treatise *On Floating Bodies* are also now incorporated, besides the unimportant

fragments from the *Stomachion*. The new MS. has also been useful in other places; e.g. in it we have before us for the first time in full the preface to Book I. *On the Sphere and Cylinder*, for the old MS. no longer extant which formed the basis of the traditional text was in that place so rubbed as to be illegible. On all grounds we welcome the new edition and shall look forward to the appearance of Vol. III., which will contain Eutocius' commentaries and will complete the critical apparatus by the discussion of the MSS. in detail and their relation to one another.

Vol. IV. of the collected edition of Heron's works is an important addition to our texts of Greek mathematicians. Vol. I., by Wilhelm Schmidt, published in 1899, included the *Pneumatica* and *Automata* in Greek, with German translation, and Vol. II. (1900), by L. Nix and W. Schmidt, the *Mechanics* in Arabic and German, with the fragments of the original Greek which have survived in Pappus and Eutocius, and a fragment of the *Catoptrica*. Most important was Vol. III., edited by Hermann Schöne (1903), containing the *Metrica* and the treatise *De Dioptra*. The *Metrica* was supposed to be lost, but was found by R. Schöne in a Constantinople MS. of the eleventh century (*Codex Constantino-politanus palatii veteris*, No. 1). This and the discovery above-mentioned of the *Method* of Archimedes (also at Constantinople) constitute the most important finds made for many years from the point of view of the historian of Greek mathematics. But a new edition was much wanted of the works included by Hultsch in his *Heronis Alexandrini geometricorum et stereometricorum reliquiae . . . et anonymi variae collectiones ex Herone*, etc., published as long ago as 1864. Vols. IV. and V. of the new editions are to contain these works. These volumes were to have been edited, like the first, by W. Schmidt, but the work was interrupted by his illness and untimely death in 1905, and it was taken over by Heiberg, who of course had placed at his disposal all the material collected by Schmidt. Vol. IV. now issued contains two large divisions, the *Definitiones* and *Geometrica*.

As compared with Hultsch's edition it shows considerable changes of arrangement and substantial additions. The additions come mainly from the same Constantinople MS. which contain the *Metrica* and from V (= *Cod. Vaticanus Gr. 215*, of the fourteenth century). For the *Geometry* more use has been made of C (= *Cod. Paris. Suppl. Gr. 387*), to which Hultsch did not pay sufficient attention. The discussion of the MSS., their relations and relative authority, is postponed for the preface to Vol. V. The rearrangement above-mentioned was determined on by Heiberg, in view of the difficulty caused by the fact that the different MSS. contain partly the same and partly different matter. Hence he decided to make the whole of the geometrical portion and the whole of the stereometrical portion into two separate groups. Where the new MSS. used contain matter corresponding to that in the MSS. used by Hultsch, but in different form, he has put the two versions side by side on the same page with letters in the margin showing the MSS. from which they come. The greatest interest and weight will attach to the views of the editor already stated in the volume before us, or to be hereafter stated in Vol. V., as to the genuineness or otherwise of the various works attributed to Heron. Even the *Definitions* were suspected by Tannery, but Heiberg has no hesitation in attributing this work to Heron himself. On the other hand, of the other collections included by Hultsch, he omits the *Liber Geoponicus* as a whole, only incorporating a few chapters containing genuine extracts from the Heronian writings; these chapters are inserted in the *Definitions* and *Geometrica* in their proper places; cf. the interesting problems in indeterminate analysis now *Geom.* 24, 1-2 (= *Geopon.* 78, 79). The *Geodaesia* is also omitted because it contains little more than a few small extracts from the *Geometry*. On the other hand, some metrological chapters found in the MSS. have been inserted which were published by Hultsch, not in the Heronian collections, but in his *Metrologicorum scriptorum reliquiae*. The appearance of this Vol. IV. is altogether welcome, and we may be sure

that, when Vol. V. is published, we shall have the advantage of all that modern textual criticism can do towards settling the vexed question of the genuineness or otherwise of the various collections going by the name of Heron and providing a thoroughly trustworthy text of those works which satisfy the test.

Heiberg's texts of the Greek mathematicians have in general been accompanied by Latin translations, with all necessary notes, which have not only shown that he has a thoroughly competent knowledge of mathematics, but have probably brought it within the power of most mathematicians to read the treatises for themselves; in the case of Heron, Vol. IV., the translation is in German, doubtless for the sake of uniformity with Vols. I.-III. But in the case of Ptolemy's *Syntaxis* the Greek text appeared alone, without any translation. There was naturally some disappointment on the part of mathematicians, which found amusing expression in the review of the first volume by M. Cantor (*Zeitschrift für Math. u. Physik*, Vol. XLIV., 1879, Hist.-litt. Abt. p. 62-63, who observed that the smile of pleasure with which he greeted the appearance of the volume soon gave place to a more serious expression when he observed the absence of the Latin translation which he had been accustomed to look for in Heiberg's editions.

Heiberg himself in his preface gave the modest explanation that, in view of the difficulty of the subject, he had not ventured to add a translation, either in Latin or in a modern language; astronomers must see to the matter and do it

for themselves if they required a translation. To which Cantor replied by the despairing question, Where is the living astronomer who knows enough Greek, or the Greek scholar (except Heiberg) who knows enough astronomy, to undertake the work? Fortunately the translator has now appeared, and the omission is repaired. The translation is in German, and not in Latin, but that is no real drawback; and as to the competence of the translator no one will feel any doubt who has made the acquaintance of the Greek astronomical works already edited by him, namely, Geminus' *Εἰσαγωγή εἰς τὰ φαινόμενα* (or *Elements of Astronomy*) and Proclus' *Hypotyposis astronomicarum positionum* (Teubner, 1898 and 1909 respectively). The translation endeavours, where possible, by the use of modern notation, instead of the cumbrous Greek terminology, to make the book more readable by mathematicians. The figures of Heiberg are improved and new ones added where a difficult passage could be better elucidated by a figure than by verbal explanations; occasionally sentences are inserted in brackets to make the connexion clear, short notes are added at the foot of the page, and there are longer notes, where necessary, in appendices at the end of the volumes, besides a list of the passages where the text of Heiberg has been departed from. We may say without hesitation that no one could usefully attempt to follow Ptolemy's exposition without having this translation before him; it is therefore with gratitude to the editor and the publisher that we greet its appearance.

T. L. HEATH.

THE ANIMALS OF THE ANCIENTS.

Die Antike Tierwelt. Von OTTO KELLER. Zweiter Band: Vögel, Reptilien, Fische, Insekten, u.s.w., mit 161 Abbildungen im Text und zwei Lichtdrucktafeln. Large octavo. Pp. xv + 617. Leipzig: Engelmann, 1913. M. 17; cloth, M. 18.50.

HOFRATH OTTO KELLER, formerly a Professor in the Universities of Freiburg, Graz, and Prag, and now residing at Stuttgart, is well known as one of the editors of Keller and Holder's critical recension of Horace. He is a leading authority, not only on the textual criti-