

# *Okytokion*

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THE WORK of Apollonius of Perga called *Okytokion* is named in but one of the geometer's fragments. Eutocius,<sup>1</sup> commenting on estimates of the ratio of a circle's circumference to its diameter, states that Apollonius gave a different value from that of Archimedes, one that was more accurate. A second fragment<sup>2</sup> was ascribed to the *Okytokion* by Heiberg. It comes from a preface and invokes the Muses to sing the praises of Artemis.

*Ἄρτεμιδος κλείτε κράτος ἕξοχον ἐννέα κοῦραι.*

Pappus comments *τὸ δὲ κλείτε φησιν ἀντὶ τοῦ ὑπομνήσατε*<sup>3</sup> in repeating the verse. I am here concerned only with the title *Okytokion*.

It has long been recognized that, because *ὠκυτόκιον* means 'quick-delivery', a work so named was obviously intended to give a means of yielding large products by rapid multiplication; as an example of the method Apollonius gave the product of all the letter-numbers in his hexameter in the preface. But it has not been noticed, so far as I know, that the mention of Artemis in the verse and the name *Okytokion* both refer to *lunar* calculations. For *ὠκυτόκος* is an epithet of *σελήνη*, the moon (that is, Artemis). Thus we find her so named in a fragment of Timotheus of Miletus:<sup>4</sup>

*διὰ κυάνεον πόλον ἄστρον  
διὰ τ' ὠκυτόκοιο σελάνας.*

The purpose of the *Okytokion* was, then, astronomical. Nor is this surprising, for though Apollonius is chiefly known today for his work

<sup>1</sup> Eutoc. *In Archim.dimens.circ.*, in Archimedes ed. J. L. Heiberg III (*BT*, Leipzig 1915) p.258, 16ff.

<sup>2</sup> Pappus 2.22, ed. F. Hultsch I (Berlin 1876) p.24, 25ff (= Apollonius Pergaeus ed. Heiberg II [*BT*, Leipzig 1893] p.124, fr.37).

<sup>3</sup> Apollonius fr.49 Heiberg, *ad fin.* (= Pappus 2.17, ed. Hultsch p.20, 2). For *ὑπομνήσατε*, *ὑμνήσατε* gives better sense with *κλείτε*.

<sup>4</sup> fr.27, D. L. Page, *Poetae Melici Graeci* (Oxford 1962) p.418. See also Schwenn, *RE* 2A.1 (1921) 1139 s.v. *SELENE*.

on conics, by his contemporaries he was called Epsilon,  $\epsilon$ , because of the likeness of that letter to the figure of the moon, concerning which he made accurate researches, as Ptolemaeus Chennus reported.<sup>5</sup> Whether or not Apollonius' estimate of the moon's distance was given in the *Okytokion* we do not know—the alleged value, 5,000,000 stades, is anyway almost certainly corrupt in the texts.<sup>6</sup> Nor do we know that the tables of Apollonius for the moon and for lunar and solar eclipses<sup>7</sup> were prepared with the help of, or were given in, the *Okytokion*. Nor is the value of  $\pi$  used in that work recorded; all we are told<sup>8</sup> is that it was more accurate than the estimate,  $3\frac{1}{7} > \pi > 3\frac{1}{7}\frac{0}{1}$  of Archimedes, who himself gave a closer estimate in his *Plinthides and Cylinders*.<sup>9</sup> More accurate Indian estimates by Āryabhaṭṭa (*fl. ca.* A.D. 500) and Bhāskara,<sup>10</sup> though they may well come from Greek sources, do not help here. What is clear, however, is that the *Okytokion* was not simply a work on rapid computation; it was, as the title and the preface were meant to show, an aid to *astronomical* reckoning.

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<sup>5</sup> Photius, *Bibliotheca* ed. Bekker p.151b, 18–21. See also O. Neugebauer, "The Equivalence of Eccentric and Epicyclic Motion according to Apollonius," *Scripta Mathematica* 24 (1959) 5.

<sup>6</sup> Hippol. *Haer.*, in *Hippolytus Werke* ed. P. Wendland III (*GrChrSchr* 26, Leipzig 1916) p.41,13 (= Apollonius fr.60 Heiberg) and p.42,19. Cf. Tannery, *Mémoires de la Société des sciences physiques et naturelles* ser. II, 5 (Bordeaux 1883) 254 and T. L. Heath, *A History of Greek Mathematics II* (Oxford 1921) 195.

<sup>7</sup> These are mentioned by Vettius Valens, *Anthologiae* 9.11, ed. Kroll p.354,5ff.

<sup>8</sup> Eutocius, *loc.cit.* (*supra* n.1).

<sup>9</sup> Hero, *Metrika* 1.26. See Heath, *op.cit.* I.232–3.

<sup>10</sup> Cf. B. L. van der Waerden, "Ausgleichspunkt, 'Methode der Perser' und indische Planetenrechnung," *Archive for History of Exact Sciences* 1 (1961) 120–1.