

## CHAPTER VII

### ARITHMETIC, A. D. 97, AMONG THE ROMANS

. . . 'Dicat  
Filius Albini, si de quincunce remota est  
Uncia, quid superat? — Poteras dixisse.'  
'Triens.' — 'Eu!  
Rem poteris servare tuam! — Redit uncia;  
quid fit?'  
'Semis.'

HORACE (65-8 B. C.), *Ars Poetica*, 325.

'Let Albinus' boy say, if from a five-twelfth an ounce be taken, what will remain? You know.' 'A third.' 'Very good! You'll be able to take care of your property! If an ounce be added, what will it make?' 'A half.'

ONE of the astonishing things noted in reading the book of Frontinus is the readiness with which he performs his arithmetical computations, without knowing anything of the Arabic or Indian system of notation, or of common or decimal fractions. To him fractions are entities having names, and represented by hieroglyphics. They have certain relations to unity, and to one another, indeed, but just how he keeps track of them all, and manages to use the lot, is as great a puzzle as the Chinese alphabet, which his set of fractions in some respects resembles.

After the first four of the larger fractions, they are all of the duodecimal order, the list being as follows:  $\frac{1}{2}$ ,  $\frac{1}{3}$ ,  $\frac{1}{4}$ ,  $\frac{1}{6}$ ,  $\frac{1}{12}$ ,  $\frac{1}{24}$ ,  $\frac{1}{36}$ ,  $\frac{1}{48}$ ,  $\frac{1}{72}$ ,  $\frac{1}{288}$ , with a name for each one. (Semis, Triens, Quadrans, Sextans, Uncia, Semuncia, Duella, Sicilicus, Sextula, Scripulus.) There are also symbols and names for  $\frac{5}{12}$ ,  $\frac{7}{12}$ ,  $\frac{2}{3}$ ,  $\frac{3}{4}$ ,  $1\frac{1}{12}$ , and  $1\frac{1}{2}$ . The division by twelve dates back, as is known, to a period of great antiquity, and has come down to us in the twenty-four hours of the day, and in the sixtieths of the hour, and the sixtieths of that, as used, together with duodecimals, by the Greeks; who, according to Herodotus, learnt them of the Babylonians,<sup>1</sup> the sixtieths being the modern minutes and seconds,

<sup>1</sup> Herodotus, ii. 109.

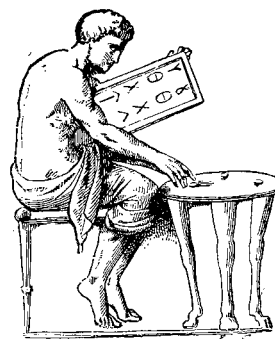
originally called "*partes minutae primae*" and "*partes minutae secundae*."<sup>1</sup>

The relation of the circumference and the area of the diameter of a circle is given by Frontinus with the use of  $\pi =$  as near  $3\frac{1}{7}$ , = about 3.1429, as the use of the clumsy fractions, just named, selected and added up, will permit of. Working with duodecimal fractions, it would have been far easier to take  $\pi = 3\frac{1}{8}$ , as had been done by Vitruvius,<sup>2</sup> only one hundred years before Frontinus. But he laboriously ploughs along with  $\pi = 3\frac{1}{7}$ , and is always pretty nearly right: — except when he, or some copyist, or translator, or printer, has made a mistake; which is not without example.

Thus, he tells us, the *quinaria* has an interior diameter of one digit and three unciae; or as we should say: 1.25 digits, the digit being  $\frac{1}{16}$  of a foot; "in circumference, three digits, a half, five unciae and three scripuli;" or, as we would say: 3.92709 + digits. Calculated on the basis of  $\pi = 3\frac{1}{7}$ , this figure would be 3.9285+, and for the ordinarily used value of  $\pi = 3.1416$ , it is 3.9270.

His areas are  $\frac{\pi d^2}{4}$  and he well knows that the areas are as the squares of the diameters. But when it comes to the conception of a cubic foot, he seems to avoid it, and appears to be in total ignorance of so much as a conception of the idea of a procession of such cubic feet passing a given point in a unit of time; or of what we ordinarily call cubic feet per second; in which respect he is equalled, however, as we have seen, by many men, some of them of considerable standing in the community, who are living at the present day.

Frontinus ascribes the name *quinaria* to the diameter of the finished pipe, being five quarter digits in diameter;<sup>4</sup> and he goes on call-



CALCULATOR.<sup>3</sup>

<sup>1</sup> Cantor, *Gesch. d. Math.* i. 445.

<sup>2</sup> *Agrimensoren*, 88.

<sup>3</sup> The ancients counted by means of small stones (*calculi*). The mathematician represented here, from a gem in the *Cabinet de France*, No. 1,858 of the Chabouillet Catalogue, arranged the *calculi*, while the reckoning tablet, covered with Etruscan characters, is in his left hand. Daremberg et Saglio, *Dict. des Antiq. grecq. et rom.*, under the word *Abacus*.

<sup>4</sup> *De Aquis*, 25.

ing a pipe of six quarter digits in diameter, a *sextaria*; and so on, only that at twenty quarter digits in diameter it becomes nearly the same, whether the name *vicenaria* be ascribed to quarter digits diameter, or to square digits of area. From this size upwards he names the pipes by their areas in square digits, stopping at a pipe of one hundred and twenty square digits area, nearly nine inches in diameter.<sup>1</sup>

<sup>1</sup> Pliny (xxx. 31) and Vitruvius (viii. 6, 4) name the pipes by their circumferences, instead of by their diameters, as is now customary. Rope is sold by circumference measure at the present day.

# END OF SAMPLE TEXT



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