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(*b*. Bithynia, second half of the second century b.c.),

mathematics, astronomy.

Theodosius was the author of *Sphaerics*, a textbook on the geometry of the sphere, and minor astronomical and astrological works. Strabo, in giving a list of Bithynians worthy of note in various fields, mentions "Hipparchus, Theodosius and his sons, mathematicians."[1] Vitruvius mentions Theodosius as the inventor of a sundial suitable for any region.[2] Strabo's references are usually in chronological order in their respective categories; and since Hipparchus was at the height of his career in 127 b. c., while Strabo and Vitruvius both flourished about the beginning of the Christian era, these statements could refer to the same person and probably do. They harmonize with the fact that Theodosius is quoted by name as the author of the *Sphaerics* by Menelaus (fl . a.d. 100). To allow sufficient time for his sons to be recognized as mathematicians in their own right before Strabo, Theodosius may best be regarded as a younger contemporary of Hipparchus, born in the second half of the second century B .C. and perhaps surviving into the first century; indeed, it is unlikely that such a work as the *Sphaerics* would have been written long after the development of spherical trigonometry by Hipparchus, for this development makes it look old-fashioned.

Confusion has been created, however, by the notice or notices in the notoriously unreliable *Suda Lexicon*. The passage reads:

Theodosius, philosopher, wrote *Sphaerics* in three books, a commentary on the chapter of Theudas, two books *On Days and Nights*, a commentary on the *Method of Archimedes, Descriptions of Houses* in three books, *Skeptical Chapters*, astrological works, *On Habitations*. Theodosius wrote verses on the spring and other types of works. He was from Tripolis.[3]

It seems probable that the first sentence in this passage confuses the author of the *Sphaerics* with a later skeptical philosopher, for Theudas flourished in the second century of the Christian era;[4] and it also is probable that the second and third sentences should be regarded as a separate notice about a third Theodosius. This would be unimportant if the third sentence had not given rise to the belief that the author of the *Sphaerics* was born at Tripolis in Phoenicia, and in almost all editions until recently he has been described as Theodosius of Tripolis.[5]

Spherics, the geometry of the sphere, was needed for astronomy and was regarded by the ancient Greeks as a branch of astronomy rather than of geometry. Indeed, the Pythagoreans called astronomy "spherics"; and the stereometrical books **XII** and **XIII** of Euclid's *Elements*, which lead up to the inscription of the regular solids in a sphere, contain nothing about the geometry of the sphere beyond the proof that the volumes of spheres are in the triplicate ratio of their diameters. Euclid treated this subject in his *Phaenomena*, and just before him Autolycus had dealt with it in his book *On the Moving Sphere*. From a comparison of propositions quoted or assumed by Euclid and Autolycus, it may be inferred that much of Theodosius'

Sphaerics is derived from some pre-Eu-clidean textbook, of which some have conjectured that Eudoxus was the author.[6] There is nothing in it that can strictly be called trigonometry, although in **III** .11 Theodosius proves the equivalent of the formula tan *a* = sin *b* tan *A* for a spherical triangle right-angled at *C*.

Two of the other works mentioned by the *Suda* have survived. *On Habitations* treats the phenomena caused by the rotation of the earth, particularly what portions of the heavens are visible to the inhabitants of different zones. *On Days and Nights* studies the arc of the ecliptic traversed by the sun each day. Its object is to determine what conditions have to be satisfied in order that the solstice may occur in the meridian at a given place and in order that day and night may really be equal at the equinoxes.

One reason why these three works have survived must be that they were included in the collection that Pappus called "The Little Astronomy"[7]–in contrast with "The Great Astronomy" or *Almagest* of Ptolemy. Pappus also annotated the *Sphaerics* and *On Days and Nights* in some detail.[8] All three works were translated into Arabic toward the end of the ninth century.[9] The translation of the *Sphaerics* up to **II** .5 is by Qustā ibn Lūqā and thereafter by Thābit ibn Qurra. The *Sphaerics* was translated from Arabic into Latin in the twelfth century by Plato of Tivoli and Gerard of Cremona.

There is no reason to doubt that the Theodosius who wrote the *Sphaerics* was also the author of the commentary on the *Method* of Archimedes mentioned by the *Suda*, for the subject matter would be similar. It may be accepted also that he wrote astrological works. It is tempting to think that the Διαγραφὰι οἰκιῶν, *Descriptions of Houses*, mentioned in the *Suda*, dealt with the "houses of the planets"; but the latter term is always οἶκοι, not οἰκίαι. It must be considered an architectural work, which could, however, be by the author of the *Sphaerics*. The other works mentioned in the *Suda* must be regarded as by another person of the same name. Theodosius' discovery of a sundial suitable for all regions– πρὸς πᾶν κλίμα – may have been recorded in a book, but nothing is known about it.

NOTES

1. Strabo, *Geography***XII** , 4, 9 c 566, A. Meineke, ed. (Leipzig, 1853), **II** , 795, 13–14.

2. Vitruvius, *De architectura***IX** , 8, 1, F. Krohn, ed. (Leipzig, 1912), p. 218.7.

3.*Suda Lexicon*, under θεοδοjσιοζ, Ada Adler, ed., **11** (Leipzig, 1931), θ 142 and 143, p. 693.

4. Diogenes Laërtius, *Vitae philosophorum***IX** , 116, H. S. Long, ed. (Oxford, 1964), **II** , 493.14. He was, according to Diogenes, the fifth skeptical philosopher in succession to Aenesidemus, who flourished at the time of Cicero.

5. Even the definitive ed. by J. L. Heiberg (1927) is entitled "Theodosius Tripolites Sphaerica" but the first entry in the corrigenda (p. xvi)is "Tripolites deleatur ubique."

6. The following propositions in the *Sphaerics* are certainly pre-Euclidean; bk. **I** , props. 1,6,7,8,11,12,13,15,20; bk. **II** , props. 1,2,3,5,8,9,10,13,15,17,18,19,20; bk. **III** , prop. 2.

7. 'Ο μικροζ ἀστρουομουμευος, Pappus, Collection **VI** titulus, F. Hultsch, ed., *Pappi Alexandrini Collectionis quae supersunt*, **II** (Berlin, 1877), 475.

8.*Sphaerics, ibid*., **VI** .1–33, props. 1–26, F. Hultsch, ed., 475–519; *On Days and Nights, Ibid*., **VI** . 48–68, props. 30–36, F. Hultsch, ed., **II** , 530–555.

9.*H. Wenrich, De auctorum Graecorum Versionibus et commentarüs Syriacis Arabicis etc*. (Leipzig, 1842), 206; H. *Suter, Die Mathematiker und Astronomen der Araber und ihre Werke* (Leipzig, 1900), 41.

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The Greek enunciations of *On Habitations and On Days and Nights* were included by Dasypodius in his ed. (Strasbourg, 1572) and Latin translations of the two texts were published by J. Auria (Rome, 1587 and 1591, respectively), but the Greek texts were not printed until the definitive ed. by R. Fecht, "Theodoii *De habitationibus liber De diebus et noctibus libri duo,"* in *Abhandlungen der Gesellschaft der Wissenschaften zu Göttingen*, phil.-hist, **Kl** n.s. **19** , no. 4 (1927), which contains notes (1–12), text and Latin trans. of *On Habitations (13–43), scholia on Habitations* (44–52), text and Latin trans. of *On Days and Nights* (53–155), and scholia on *Days and Nights* (156–176). The scholia were first edited by F. Hultsch, "Scholien zur Sphärik des Theodosios," in *Abhandlungen des philosohisch-historische Classe der K. Sächsischen Gesellschaft der Wissenschaften*, **10** , no. 5 (1887).

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Ivor Bulmer-Thomas