

something meteorological or astronomical, apparently among portents seen in Gaul and reported by an embassy which returned in the second year of Anthemius (whose reign began on 467 April 12). We read of "another sun seen after sunset". Newt.1972, 510 thinks that the passage may refer to the partial lunar eclipse of 467 June 3. No other lunar eclipse was visible in Western Europe until the autumn of 469, although the comet of 467 seems to account for the remark. The sunspot maximum was uncertain (Schöve 1983a, Appendix B), so that an auroral corona is possible.

VOLCANIC DARKNESS

The darkness was ascribed by Count Marcellinus to an eruption of Vesuvius (see Stothers and Rampino 1983).

c.472

484

S.484 Jan.14 (Sat.) SOLAR ECLIPSE IN GREECE AND PERSIA

In the life of the Athenian philosopher Proclus, written, probably very soon after the death of Proclus, by his pupil and successor Marinus, an observed solar eclipse and a predicted eclipse are mentioned; Marini vita Procli, ed. J.F. Boissonade, 1814, Ch.37, p.29. "Portents occurred a year before his death, such as the solar eclipse, which was so considerable that night occurred in the daytime. For there was deep darkness and stars were seen. This happened in Capricorn near the rising point (of the Sun). The Almanac makers also noted another eclipse as due to occur about the end of the first year." Ginz.1899, 222 gives Greek text and German translation; Newt.1970, 119-120; 1972, 540, gives a first and a revised English translation, with comments; there is an English translation of the whole Life in L.J. Rosán, The Philosophy of Proclus, New York 1949, pp.13-35. Stephenson and Clark 1978, 4, give a revised translation and state that this is probably the most reliable of all solar eclipses reported in the Classics, adding "It is a pity that there is no precise mention of totality". We have credited it with 9 points for identification and 6 for the information contained. This eclipse is used by Newt.1979, 420, by Muller and Stephenson 1975, and by Muller 1975.

In Ch.35, Marinus says that Proclus died on April 17 in the 124th year after the rule of Julian. Here Marinus is counting his years for ideological reasons from the reign of Julian the Apostate, who became sole emperor on 361 Nov.3. We are aware of no reckoning which would

make Marinus put the death of Proclus outside the triennium AD 484-6; AD 485 is most commonly accepted. Marinus also gives the archon of Athens for the year as the younger Nicagoras, who appears to have functioned in 484-5.

In that period, or even one extended at both ends, the only solar eclipse which occurred in Capricorn was S.484 Jan.14, which did occur in Capricorn and around sunrise at Athens. As far as we know, the identification has never been challenged. The discussion in Ginz.1899, 222 and the re-discussion by Neugebauer (1931) argue respectively for totality actually at, and only near, Athens.

The earliest identification we have ourselves inspected is given in Ricc.1653, but this refers back a few years to the catalogue of Reinerius (Vincenzo Reinieri, d.1648).

The other eclipse, which is merely predicted, is usually considered to be S.486 May 19 (q.v.).

S.484 Jan.14 is best known in relation to Proclus, as above. But the track of totality, beginning at sunrise in or near Greece, travelled via approximately Southern Asia Minor, Syria and Mesopotamia to a noon point in Central Asia, and there is a correctly dated (though not contemporary) record from the Near East. "An 795. En lequel le soleil s'éclipsa le samedi 14 Kanūn II, à trois heures de la journée, et les étoiles apparurent. En ce temps-là, Piruz, roi des Perses, fut tué. (Hist. ecclés. de Barsohède de Karka)". The extant source is Elias 1910, 74. Seleucid 795 is AD 483-4, second Kanūn is January. According to Bury, Hist. Later Rom. Emp., 1, 1923, 397, Piruz fell in battle in 484 January. "At three hours of the day" sounds late for an eclipse which probably occurred an hour or so after sunrise, but no great accuracy was intended; the third, sixth and ninth hours may be regarded as a canonical division of the day into four parts. Barsohedes is described by Delaporte (p.xi) as a Nestorian writer of the commencement of the eighth century.

485 S.485 May 29 USUAL (FALSE) DATE FOR GREGORY'S ECLIPSE

See 497.

486 S.486 May 19 SOLAR ECLIPSE IN SYRIA OR ARABIA

This eclipse is mentioned probably by Marinus and certainly by Elias. Apart from the observed solar eclipse of 484 Jan.14 (q.v.), the Vita

Procli mentions only a predicted eclipse (solar not stated, but probably meant). There is doubt, if only slight, about the identification of the predicted eclipse. The following possibilities arise.

The death of Proclus may have occurred on April 17 of (A) 484, (B) 485, or (C) 486. Strict regnal years of Julian point to (B). Year-beginnings on Jan.1 (consular) or in spring (before April 17), both unlikely, could give (A) or (B); summer or autumn year-beginnings could give (B) or (C).

The predicted eclipse may have been (1) S.485 May 29, (2) S.486 May 19, or (3) S.487 Nov.1. For (1), see above, under Gregory's first eclipse; Ginzl found it invisible at Athens, but it may still have been predicted. For (2), total in West Africa, Libya, Arabia, etc., Ginzl.1899 gave 0.68 as the magnitude of the partial eclipse seen at Athens. (3) was an annular eclipse, shown as traversing the length of the Mediterranean from the Pyrenees to Palestine (Oppolzer's rough track) or Lower Egypt (Ginzl.1899, Map XIV); it probably had a somewhat greater magnitude than (2) as a partial eclipse at Athens.

The time intervals to be considered are (i) between the observed eclipse and the death of Proclus, (ii) between the death of Proclus and the predicted eclipse. With regard to (i), what we have translated (with Rosán) as "a year before his death" is *πρὸ ἐνιαυτοῦ τῆς τελευτῆς*; this would presumably allow an interval differing from one year by a few months either way. Other translations are "for a year before his death" (Newt.1970, 1972) and "before the year of his death" (Ginz.). With regard to (ii), what we have translated as "about the end of the first year" is *πληρουμένου τοῦ πρώτου ἐνιαυτοῦ*; this is usually taken as meaning after the death of Proclus, and does strongly suggest an interval fairly close to one year.

The most likely combination is B2, i.e. death of Proclus on 485 April 17 and predicted eclipse S.486 May 19. On account of the comparative precision of (ii), the minor possibilities, in order of decreasing likelihood, appear to be A1, C3, A2. The likelihood of C3 is somewhat enhanced if "about the end of the first year" may be taken as referring to a year 'of Julian' beginning on 486 Nov.3 and ending on 487 Nov.2. See Newt.1972, 526, 540-1.

The above relates to eclipses within a year or two of the death of Proclus. There are also a queried horoscopic date of birth and an age at death to be accommodated. See Rosán (loc.cit. under S.484, 34) and Newt.1975 (2, 1032ff.) discusses the

horoscope in detail and confirms 412 Feb.8 for the birth of Proclus.

Elias 1910, 74 says: "An 797. En lequel le soleil s'éclipsa le lundi 19 'Ijar, à neuf heures de la journée, et les étoiles apparurent". Seleucid 797 is AD 485-6 (autumn to autumn in Elias), and 'Ijar is May, so that the date is correct. "At nine hours of the day" in Elias implies little more than that the eclipse occurred in the afternoon; this is doubtless true, as the noon point is in Libya (Map XIV in Ginz. 1899). The track continued approximately from West to East through Sinai and Northern Arabia. For this eclipse it happens that Elias, uncharacteristically, gives no source; but his sources in general include Arabic as well as Syrian authors.

493 S.493 Jan.4 SUNRISE ECLIPSE IN SYRIA (UNLIKELY RECORD)

recte

496/7

The 12th century Michael (ix, 7, t.II, Paris 1901 = Brussels 1963, p.154) mentions an eclipse of the Sun early in the reign of Anastasius I (491-518). This might refer to S.493 Jan.4; Oppolzer's track of totality begins at sunrise in Arabia, and on this basis the eclipse would be visible as a partial one at sunrise in Syria. Newt.1979, 386 assumed that it was the first year of the reign and thus considered 492 Jan.15 as a possibility.

Michael's eclipse is probably that of 497 (or 496), recorded in the earlier source Marcellinus Comes. Probably Vasiliev, in his translation of Agapius (PO 8(3), 1912, 425) does not really mean to imply identification as S.512 June 29; he refers to "Mich. le Syr., II, 154", but in his context this appears to be an inadvertent reference to the wrong eclipse passage; for 154 read 168.

The solar eclipse in CS under "493" really belongs to 497 (or 496).

496 S.496 Oct.22 SOLAR ECLIPSE IN S.W. ASIA (NO CLEAR RECORD)

The eclipse of this date would have been visible in S.W. Asia and a possible reference to it occurs in John of Asia (mid 6th century) (p.463), "In the year 811 (which should convert to AD 500), Saturday, October 23, the sun was obscured up to the 8th hour". However, as we explain under 497, the magnitude in even Armenia would be insufficient to cause darkness. A similar report in the contemporary Chronicle of Edessa (AD 499) suggests that the event was meteorological and three or four years later.

496-7 S.497 April 18 SOLAR ECLIPSES OF MARCELLINUS (S.E. MEDITERRANEAN)
(or 496 Oct.22)

S.497 April 18 (more probable than S.496 Oct.22).

There is a reasonably contemporary record (prima facie under 497) from Byzantium, and from Ireland there are records (ostensibly under 496)

which are derivative. We shall see that all probably refer to S.497, but that S.496 cannot be ruled out. We shall consider first the Byzantine record, then the Irish records.

(i) The Byzantine record.

This occurs in Marcellinus Comes, Chronicle, Chr.Min. 2 = AA 11, 1894, 94. The account is a mere "Solis defectus apparuit" (An eclipse of the Sun occurred). It is placed in (editorial) year AD 497, in the fifth indiction (496-7), in the second consulate of the emperor Anastasius I (without colleague). Similarly in PL 51, 1861, 935.

The usual identification, S.497 April 18, goes back at least to Calv.1620, 448. For Constantinople he found greatest phase at 6.05 p.m. and greatest magnitude 0.66 (given sexagesimally as 7.57 digits, and misquoted in at least one edition of Struyck-Ferguson as 17.57). For the same eclipse Ginz.1899, 223 found, again for Constantinople, maximum phase at 5.42 p.m. and maximum magnitude 0.68. Boll 1909, 2364 adopted the same identification.

Newt.1972, 541 regards S.496 Oct.22 as a possible, if less probable, identification of the record in Marcellinus, which he consequently considers cannot be identified safely.

The central line for S.496 Oct.22 runs from Northern Scandinavia via Russia to a noon point in Central Asia. Oppolz. gives it as total in his tables but as annular on his map. Newt. estimates the magnitude as only about 0.7 in Constantinople or Illyria, the native land of Marcellinus.

The central line for the annular S.497 April 18 runs from a noon point in the Atlantic and then by North Africa and Egypt to Arabia. From the map, Newt. estimates magnitude perhaps 0.8 at Constantinople and somewhat less in Illyria. We have seen that Ginz. found less than 0.7 at Constantinople. He plots the final stretch from Algeria to Arabia.

Note that both S.496 Oct.22 and S.497 April 18 fell in the fifth indiction (so also did S.512 June 29, mentioned by Marcellinus in rather similar words). Thus the annalistic decision is left to the consular year. If Marcellinus put the eclipse in the correct consular year, and this is correctly equated with AD 497, then the eclipse was S.497 April 18. But if there is doubt on either score, then the eclipse identification becomes doubtful. However, there is a non-annalistic consideration. While the two eclipses had rather similar magnitudes (0.7, more or less) at Constantinople, under conditions about equally favouring visibility (that of 496 not long after sunrise, that of 497

not long before sunset), the central line in 496 ran far north of Constantinople and in 497 far south. Now (as references to Antioch that follow in Marcellinus confirm) the contacts of Byzantium were stronger with the south than with the north. Consequently, while allowing S.496 Oct.22 as a possibility, we consider the traditional identification of the Byzantine record, namely S.497 April 18, as correct, but consider the place of observation likely to have been Syria or Egypt.

(ii) The Irish records.

The chief surviving record is contained in the Annals of Ulster (1887, 32-3) under manuscript year 495 (which would normally mean true 496). The wording is "Solis defectus apparuit", just as in Marcellinus. The eclipse is indexed as S.496 Oct.22 (AU 4, 1901, 140). Similar brief mention occurs in AT and CS. In AT, 1896, 122, the annal has no explicit year number of its own, but the ferial "K.ii" (i.e. Jan.1 fell on Monday) is consistent with AD 496. In CS, 1866, 32, the mention appears under editorial "493"; but although Hennessy (p.xlvi) gives the general systematic error at this period as zero, his comments on this particular annal point to 496, and in fact the annal has similar content to AU "495" (496). J. O'Donovan, in his Introduction to Annals of the Four Masters (1, Dublin 1851, xlviii), quotes AU as 495 (496). A.O. Anderson (Early Sources of Scottish History, London 1922, p.1) identifies the eclipse as perhaps S.496 Oct.22, visible at Rome at 8 a.m.

It will be seen that S.496 Oct.22 was long the standard identification. But, as explained in Schöve, 1954, 37-43, it is now thought that the eclipse report may be copied from Marcellinus. We have already seen that S.497 April 18 is the more probable identification of that Byzantine record.

The difficulty about regarding the report as really originating from Ireland is that both eclipses were so unremarkable there. S.496 Oct. 2 cannot, with centrality in Scandinavia, have been at all striking in Ireland. Eddington (see Schöve 1954, 40) found maximum magnitude 0.10 for Ireland; even allowing for the helpful effect of possible mist at sunrise, the magnitude is not enough. For S.497 April 18, O'Connor 195 gave, for mid-Ireland, maximum magnitude 0.31 at 2.40 p.m.; such an eclipse in broad daylight would not have been noticed.

497
or
485? S.497 April 18 GREGORY'S FIRST SOLAR ECLIPSE (N. AFRICA?)
(or 485 May 29)

The first eclipse in Gregory of Tours (485? 497?). "Then the Sun appeared hideous (teter), so that scarcely a third of it gave light; I believe (this occurred) on account of such crimes and the shedding of innocent blood." Gregory (Book 2, Ch.3, *StrM* 1(1), 1884, 66, or 1951, 45; Latouche 1963, 84). Unlike the other eclipses in Gregory's famous work, this one took place well before his own lifetime, in a period about which his sources failed to inform him satisfactorily. His arrangement is not designed to be strictly chronological, and is even less so than he intended. Except for the eclipse, whose place of observation is not stated, Ch.3 of his second book deals entirely with the Vandals in Africa, and covers the whole period from their crossing to Africa in 429 to the extinction of the Vandal state in 534. Gregory's chronological weakness in this chapter goes beyond the omission of dates; he does not even know the correct order of succession of the Vandal kings.

Thus although the identification of the eclipse as S.485 May 29 has been standard, a revision is suggested below. Oppolz. shows S.485 May 29 as total in the far North, with central track going approximately by Kamchatka, the polar regions, North Greenland, and Central Scandinavia. Ginz.1899, 223 finds magnitude only 0.73 at Clermont, and the eclipse would agree well enough with the record almost anywhere in France (if that is indeed the region in which it was seen). Ginz. finds the same magnitude, 0.73, at Rome. The identification goes back at least as far as Calv.1620, 445. Ginz.1899's quotation of the Paschale Campanum in connection with S.485 May 29 is wrong; the passage refers to S.512 June 29 (q.v.).

Let us now consider the degree of validity of this common identification. Gregory appears to narrate the eclipse most closely in the context of

- (i) miracles performed by African Catholic bishops Eugenius, Vindimial, and Longinus,
- (ii) anger of Arian king Huneric,
- (iii) deposition and exile of Eugenius,
- (iv) martyrdom of Vindimial, Octavian, and many others.
- (v) apostasy of bishop Revocatus from the Catholic faith,
- (vi) death of Huneric.

Since Huneric is believed to have succeeded in 477 and to have died on

484 Dec.23, and one exile of St. Eugenius to have lasted from 484 to 488, and the persecution under Huneric to have occurred especially in 483 and 484, the standard identification of the eclipse appears, in these respects, reasonable. But after the persecuting king Huneric, there followed a more tolerant king Gunthamund (omitted by Gregory), and then another king Thrasamund (seriously misplaced by Gregory), under whom there was further persecution about 498. Eugenius was finally exiled in 497. We notice that a considerable authority gives "about 498" for the martyrdom of Vindimial and Octavian (also, apparently, Longinus); P. Monceaux, *Histoire Littéraire de l'Afrique Chrétienne*, Tome 3, Paris 1905 (reprint Brussels 1963), pp.543-551. Such a date leads naturally to the consideration of the solar eclipse of 497 April 18, whose track of annularity runs the whole length of North Africa from south of the Canaries to Egypt. We regard S.497 April 18 as the probable identification of Gregory's first eclipse; this eclipse is mentioned (see under 497) also in Marcellinus Comes and in Irish Annals, but the primary source has not been traced.

429 429 Dec. 12

"6th year of the Yuan Chia reign period, 11th month, day chi-ch'ou, the 1st day of the month, the Sun was eclipsed; it was not complete but was like a hook; at the time of the eclipse a star was/stars were seen; at the hour pu (3 - 5 p.m.) it was over; in Ho-pei the Earth was dark." This account is from the Treatise on the Five Elements in the Sung-shu (chapter 34). It would seem that the main observation was made in the Sung capital Nan-ching (computed magnitude 0.92); Venus would probably be the only object seen. The computed track runs to the north of Nan-ching; the wide belt of totality would cover most of the Ho-pei province. (Contribution by R. Stephenson.)

S.447 Jan.2

S.462 Mar.17

M.474 Jan.19

In Mesoamerica at this time Maya astronomers were able to predict lunar eclipses with great accuracy. Their medieval Dresden Codex includes a Lunar or Eclipse table for predictions up to 33 years ahead. In its extant form this is built up from three bases relating to the eclipse month beginning with 842 March 15 (AD 756 in the usual conventional chronology as we explain in our Appendix C). The table betrays evidence for a prototype and three 5th century dates in the Codex are structurally related to visible eclipses. One date is 462 Mar.14, 380 years before the first base, and 3 days before a calculated solar eclipse and 12 days after a visible total lunar eclipse. The other two dates are in 447 and 474, both years of visible solar eclipses; the dates are incorrect as they convert to Jan.23 and Jan.28, whereas the solar eclipses were respectively Jan.2 and Dec.24; however, the second date was only 9 days after the total lunar eclipse of 474 Jan.19 at node passage. Some of the Maya dates were adjusted to fit solar and lunar cycles (e.g. the 11,960 day cycle) and to avoid dates that were unlucky. These relationships are explained in Schöve 1983 and the new correlation in Schöve 1982/4

C.H. Smiley in ed. A.F. Aveni 'Archaeoastronomy' 1975, 253 (Austin, Texas) had a different correlation, but he pointed out that in the "interval AD 477 to 510, not a single solar eclipse occurred anywhere on earth without warning (in the table), nor was there a single false warning". The Maya were certainly successful in predicting solar eclipses, as 11th century dates in the same Codex confirm. Probably observations of solar and lunar eclipses in the 5th century helped to provide the empirical basis for the Dresden Table.