

The Date of the Astronomical Almanac *Tab. Amst. inv. 1*

Tab. Amst. inv. 1 is a small wooden tablet containing a planetary almanac of a type well attested for Roman Egypt from the reign of Augustus to the middle of the third century⁽¹⁾. The primary function of such almanacs was to record the dates on which each of the five planets entered zodiacal signs, presumably so that an astrologer could easily determine the signs occupied by the heavenly bodies on an arbitrary date. The conventions followed by the present almanac are by now familiar. For each year, the sign entries for each planet are listed in the standard order Saturn, Jupiter, Mars, Venus, Mercury. Each line generally contains three numerals: the number of the Egyptian month, counting from 1 = Thoth; the day of the month; and the sign of the zodiac, counting from 1 = Virgo. Occasionally extra dates are listed for a planet while it is still within the same sign; these are sometimes identifiable as dates of planetary phases, e.g. first or last visibilities.

The editors proposed a date in the third century on palaeographical grounds. But experience with astronomical papyri has repeatedly shown that dating of numerical tables according to handwriting is extremely unreliable; letter forms in columns of numbers differ from those of connected writing, and the corpus of dated tables is still too small to furnish an adequate basis for comparisons. When the astronomical information in a table can be fixed to a specific date, the date when the table was compiled can be safely situated within a few decades after the date to which the contents refer. In the present instance, however, Neugebauer was unable to find any date for which the planetary positions were in adequate agreement with recomputation according to modern theory. As it turns out, he somehow eliminated from consideration some of the dates that satisfy certain of the criteria imposed by the information in the table. Among these is a unique date that gives an excellent fit for all the planets

(1) Edition, commentary, and photograph: O. Neugebauer, P.J. Sijpesteijn, and K.A. Worp, 'A Greek Planetary Table', *CE* 52 (1977) 301-310. For a list (now outdated) and description of similar almanacs, see O. Neugebauer, *A History of Ancient Mathematical Astronomy* (Berlin, 1975), 785-789.

except Mercury, the recorded positions of which seem to have been thrown off by a systematic error.

In order to facilitate comparison with modern astronomical theory, it will be useful to be able to convert dates in the table to approximate equivalents in the Julian calendar⁽²⁾. Other Greco-Egyptian almanacs use sometimes the old Egyptian calendar (with constant years of 365 days), sometimes the reformed Alexandrian calendar, which was the civil calendar during the Roman period. Only from the astronomical contents is it normally possible to determine which calendar was used in a particular almanac. Fortunately Neugebauer was able to deduce from the recorded positions of Venus and Mars the contemporary positions of the sun, from which the Julian calendar dates can be estimated. For example, line 72 reports a position of Venus about the middle of Aries on Pharmuthi 11 of Year 2, and comparison with neighbouring positions shows that this was very close to the planet's conjunction with the sun; and a solar longitude in the middle of Aries implies a date in early April. This concordance would fit the Alexandrian calendar for any year (Pharmuthi 11 = April 6), or the old Egyptian calendar near the beginning of the reign of Augustus, when the two calendars were synchronized. For simplicity we will assume in what follows that the calendar used was the Alexandrian.

The information in the table can now be reduced to the following:

- 1) Two years are covered in the preserved table; the second is called 'Year 2'. This might be a regnal year, but there may have been some other method of numbering based on astronomical criteria.
- 2) Saturn was in Virgo from the end of year 1 to the end of year 2.
- 3) Jupiter was in Virgo from the beginning to the end of year 2.
- 4) Mars's first stationary point occurred about Tybi or Mecheir, that is, late December to February of year 2, in Virgo.
- 5) Venus's inferior conjunction occurred about Pharmuthi 11 (early April) of Year 2 in Aries.
- 6) Mercury's inferior conjunction occurred about Phamenoth 5 (March 1) of Year 1 near the beginning of Virgo.

Neugebauer expressed suspicion of criteria (2) and (3) because the text gives more than one line for both Jupiter and Saturn in Virgo. However,

(2) For positions according to modern theory I have used B. Tuckerman, *Planetary, Lunar, and Solar Positions, 601 B.C. to A.D. 1* (Mem. Am. Phil. Soc. 56, Philadelphia, 1962), and *Planetary, Lunar, and Solar Positions, A.D. 2 to A.D. 1649* (Mem. Am. Phil. Soc. 59, Philadelphia, 1964).

since this also occurs among the data for the other planets, I think we can only infer that the lines in question are not necessarily dates of entry of the planets into Virgo, but merely records of positions *in* Virgo. Since conjunctions of Jupiter and Saturn occur only at intervals of about 59 years, the dates that more or less satisfy criteria (2) and (3) between 100 B.C. and A.D. 400 are the following: 84 B.C., 25-24 B.C., A.D. 35-36, 94-95, 153-155, 212-214, 272-273, 331-333, and 390-392. Neugebauer considered only A.D. 94, 153, and 213 as possible, presumably because he interpreted the first positions listed for year 2 as sign entries.

Criterion (5), as Neugebauer points out, is satisfied only for certain stretches of years at 8-year intervals. One such sequence begins with 48 B.C. and can be prolonged (barely) to A.D. 41. The next begins with 188 and can be continued no later than 276. If we also impose criterion (4), we eliminate all years except 24 B.C., A.D. 9, 41, and 276. Again Neugebauer admitted only A.D. 41 and 276, I do not know why. Comparing our list with the dates derived from the positions of Jupiter and Saturn, we find one year that satisfies criteria (2), (3), (4) and (5): 24 B.C. Criterion (6) is not well satisfied for the preceding year (the conjunction fell about January 17), but then it does not work for *any* of the datings obtained by combining either (2) and (3) or (4) and (5). A systematic error must have been made in computing or recording the positions of Mercury, and its testimony, contradicting all others', has to be disregarded.

There remains the question of what the year numbers in the table mean. The Alexandrian year 25/24 B.C. is year 6 of Augustus, and hence not a second regnal year (for that matter, none of the datings considered above is a second regnal year). On the other hand, 26/25 B.C. may have had a calendrical significance that would have justified counting years from it in an astronomical almanac: if the intercalations of the Alexandrian calendar were from the start made at four year intervals, then the inaugural year of the calendar, still coinciding with the old Egyptian calendar, was 26/25 B.C.⁽³⁾ Since both calendars were extensively used in astronomical contexts long after the reform of the civil calendar, the number of years since the reform would be a useful datum from which it would be easy to find the accumulated discrepancy between the two forms of reckoning.

(3) This is not the place to raise the vexed question of the early intercalations of the Alexandrian calendar. For discussion and references, see P. Brind'Amour, *Le Calendrier romain* (Ottawa, 1983) 11-15.

NOTES ON THE PLANETARY POSITIONS:

Saturn and Jupiter. Saturn crossed from Leo into Virgo about the beginning of December, 24 B.C. Our table (line 4) has it in Virgo before the end of Year 1, i.e. before September 1, 24 B.C. according to our dating. Since Saturn's longitude according to modern theory was about Leo 22° on September 1, its positions in the table must have been at least 8° ahead of modern equivalents. With such a shift, the dates given for Saturn in Virgo during year 2 could be dates of first and last visibility, especially if the date 'XII 5' in line 55 is a mistake for Epagomenal 5, as it certainly is in line 63. Actual first and last visibility occurred about September 3, 25 B.C. (Alexandrian I 6) and August 11, 24 B.C.(XII 18). For Jupiter, the first date in Year 2 should probably be read as 'I 1' rather than 'I 11', and merely indicates that Jupiter was already in Virgo at the beginning of the year. The second date, 'XII 23', is not close to any of the planet's phases. According to modern theory, Jupiter dipped very slightly into Libra between December, 25 B.C. and February, 24 B.C.

Mars. The preserved sign entries for Year 2 show excellent agreement with modern theory for 25/24 B.C. (Fig. 1), except for line 63 (already corrected from 'XII 5' to Epagomenal 5 by Neugebauer).

Venus. Agreement between the entries for Year 1 and modern theory for 26/25 B.C. is excellent (Fig.2). Line 26, at the bottom of the first column, probably should read 'IX 13 9', and is repeated at the top of the next column (line 27). The date '20' in the subsequent line is certainly incorrect; I suspect a miscopying of 'X 6'. In Year 2 (Fig. 3), line 73 reads 'IX 16 9' (not 'IX 20 9' as in the original edition), but this is probably a mistake for 'IX 16 8'. With this correction, lines 71-73 can be identified as Venus's evening station, conjunction, and morning station, and line 74 becomes the sign entry into Taurus. Line 75 should, and perhaps does, read 'XI 6 10' rather than the 'XI 6 9' of the original edition.

Mercury. The first four entries (lines 34-37) for Year 1 are in disorder, which I hesitate to repair (cf. Fig. 4). The remainder of the year exhibits a more or less consistent pattern of motion, in which the retrogradations fall about one month later, and at longitudes about one zodiacal sign higher, than actually occurred in 26/25 B.C. This could be the protracted effect of a single erroneously computed synodic interval preceding the dates covered by the table.

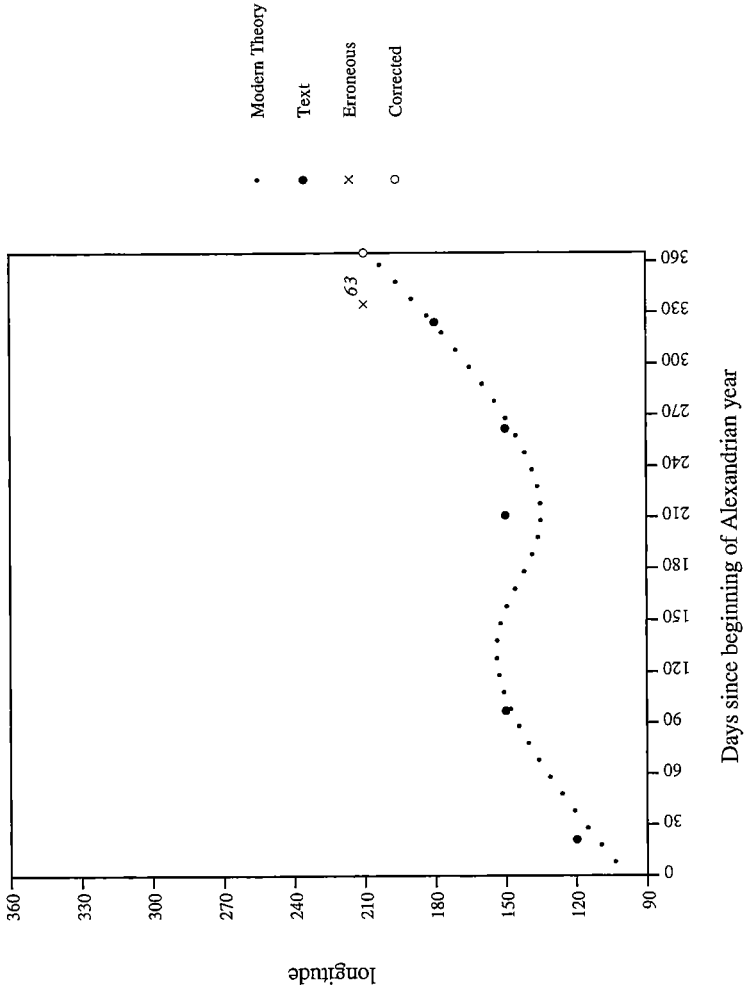


Fig. 1. Mars in Year 2 (25/24 B.C.)

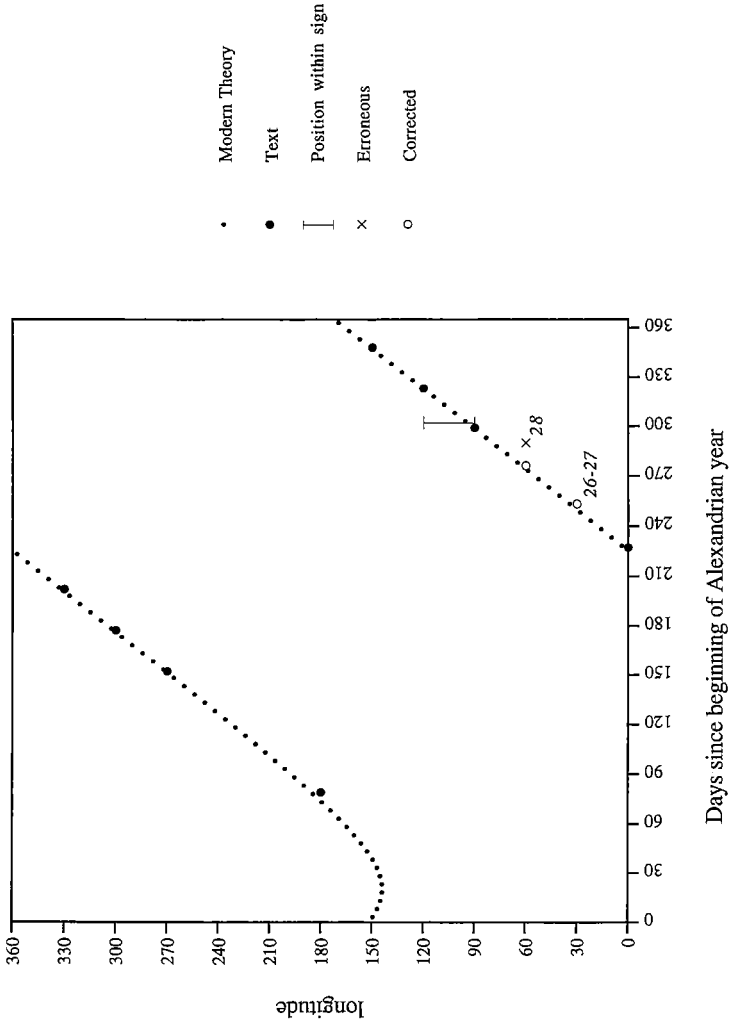


Fig. 2. Venus in Year 1 (26/25 B.C.)

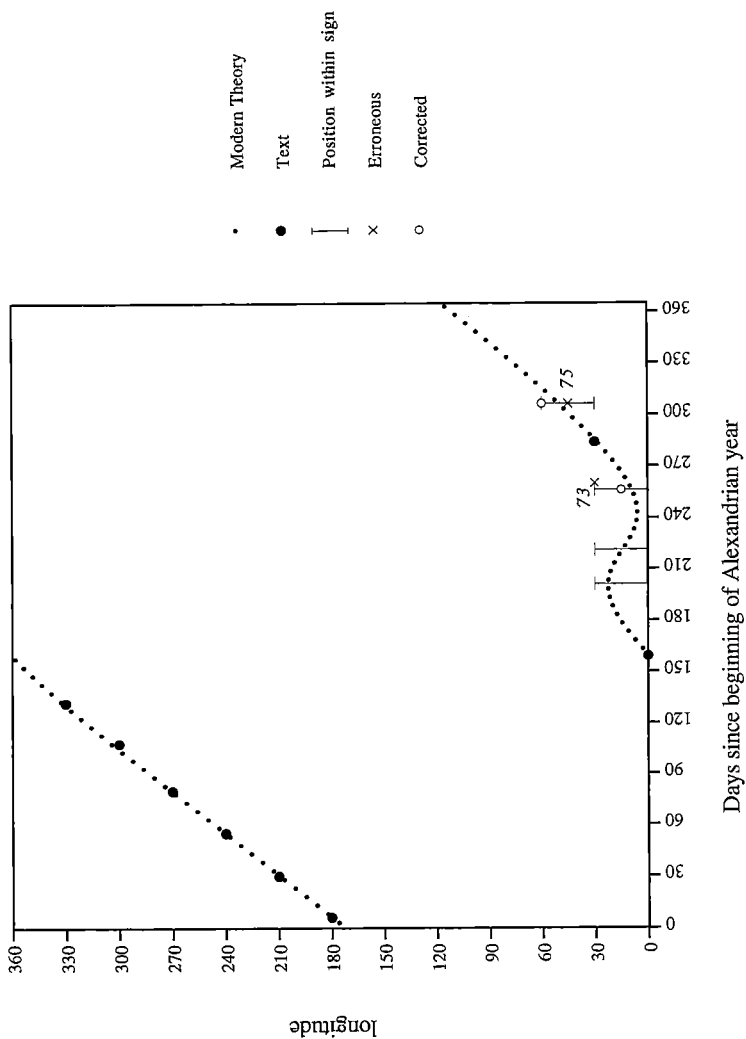


Fig. 3. Venus in Year 2 (25/24 B.C.)

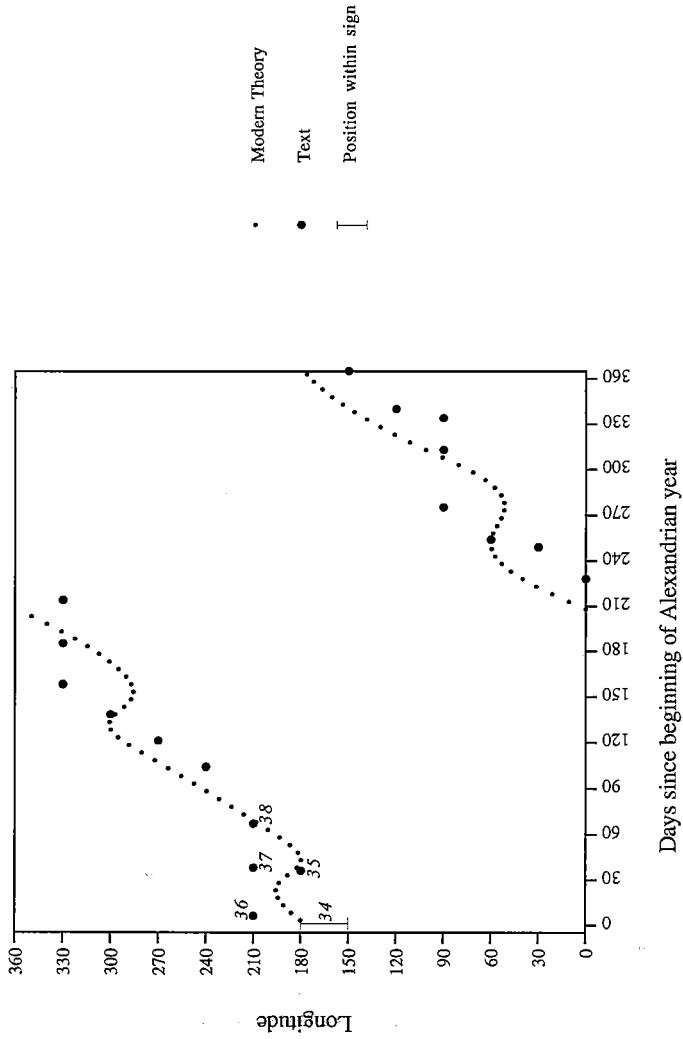


Fig. 4. Mercury in Year 1 (26/25 B.C.).