VETTIUS VALENS AND THE PLANETARY WEEK

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A very important testimony concerning the planetary week in the second century A.D. is that of Vettius Valens, a noted astrologer of Antioch, who was active during the reigns of Antoninus Pius (138-161) and Marcus Aurelius (161-180). His *Anthology*, an astrological treatise written in Greek, has been a valuable subject of study by scholars because of the astronomical and chronological data it contains. [1] Otto Neugebauer, noted expert in the mathematics of ancient astronomy, has worked out, with the collaboration of Henry B. Van Hoesen, the horoscopes recorded by that astrologer. In their book presenting their findings they say:

> The importance of the *Anthology* of Vettius Valens for our subject can be illustrated by the following figures. With its about 130 (partial or complete) horoscopes it contains twice as many examples of Greek horoscopes as all papyri combined. Without Vettius Valens (whose examples range from A.D. 37-188) we should have only five examples of 'literary' horoscopes before A.D. 380. [2]

The same scholars report:

> The fact that every one of these horoscopes can be shown to be astronomically correct for a date in the first or second century A.D. is therefore proof that Vettius Valens was using empirical material exclusively, collected either by himself or by his predecessors. [3]

[1] Franz Cumont, "The Frontier Provinces of the East," *The Cambridge Ancient History, XI* (New York, 1936), 643; *Astrology and Religion among the Greeks and Romans* (New York, 1912), pp. 36, 86, 87, 93; *The Oriental Religions in Roman Paganism* (New York, 1956), p. 171; F. H. Colson, *The Week* (Cambridge, Engl., 1926), pp. 47-52.

[2] Otto Neugebauer and Henry B. Van Hoesen, *Greek Horoscopes* (Philadelphia, 1959), p. 176. I gratefully acknowledge the kindness of Dr. Neugebauer for reading this paper and making helpful suggestions, although the conclusions reached are my own.

[3] *Ibid.*

They also say: "The *Anthology* contains some 40 explicit references to years of the Roman imperial period and about 100 horoscopes which do not quote their dates but which can be dated astronomically."[4] These horoscopes range from A.D. 37 to 188.[5] Moreover, "all evidence agrees that Vettius Valens must have worked for at least twenty years, from 154 to 174, on the composition of the *Anthology*."[6]

In his *Anthology*, Vettius Valens presents a chapter in which he tells how to find the day of the week on which a given birth date—the year, the month, and the day of the month—had fallen. This information was then deemed important in astrology, because each day of the week was supposed to be under the aegis of the planetary god after which it was named. Besides giving us his mathematical formula for that purpose, he presents an example showing how it worked. His style is terse, his jargon that of persons of his profession, and the mathematical short cut he employs in his formula a clever device. Here is the Greek text of his statement:

Περὶ δὲ τῆς ἑβδομάδος καὶ σαββατικῆς ἡμέρας οὕτως. τὰ ἀπὸ Αὐγούστου ἔτη πλήρη καὶ τὰς ἐμβολίμους ἀναλαβὼν πρόσθες καὶ τὰς ἀπὸ Θὼθ ἕως τῆς γενεθλιακῆς ἡμέρας καὶ ἐκ τούτων ἀφαίρει ὁσάκις δύνῃ ἑπτά, τὰς δὲ λοιπὰς ἀπὸ Ἡλίου· εἰς οἷον δ' ἂν καταλήξῃς ἀστέρα, ἐκείνου ἔσται ἡ ἡμέρα. ἡ δὲ τάξις τῶν ἀστέρων πρὸς τὰς ἡμέρας οὕτως ἔχει· Ἥλιος Σελήνη Ἄρης Ἑρμῆς Ζεὺς Ἀφροδίτη Κρόνος. ἡ δὲ τῶν ζωνῶν διάθεσις οὕτως· Κρόνος Ζεὺς Ἄρης Ἥλιος Ἀφροδίτη Ἑρμῆς Σελήνη· ἐκ ταύτης δὲ τῆς διαθέσεως αἱ ὧραι σημαίνονται, ἐκ δὲ τῶν ὡρῶν ἡ ἡμέρα τοῦ ἑξῆς ἀστέρος. οἷον ἔτος δ' Ἀδριανοῦ Μεχὶρ κατὰ Ἀλεξανδρεῖς ιγ' νυκτὸς ὥρα α'· τὰ ἀπὸ Αὐγούστου ἔτη πλήρη ρμη' καὶ ἐμβόλιμοι λϛ' καὶ ἀπὸ Θὼθ ἕως ιγ' Μεχὶρ ἡμέραι ρξγ'· γίγνεται τμζ'. ἀφαιρῶ ἑβδομάδας μθ', λοιπαὶ δ'· ἀπὸ Ἡλίου καταλήγει εἰς Ἑρμοῦ ἡμέραν, καὶ ἡ α' ὥρα νυκτὸς Ἑρμοῦ, ἡ δευτέρα Σελήνης, ἡ

[4] *Ibid.*
[5] *Ibid.*, pp. 176, 177.
[6] *Ibid.*, p. 177.

τρίτη Κρόνου, ἡ τετάρτη Διός, ἡ πέμπτη Ἄρεως, ἡ ἕκτη Ἡλίου, ἡ ἑβδόμη Ἀφροδίτης, ἡ ὀγδόη Ἑρμοῦ, ἡ ἐνάτη Σελήνης, ἡ δεκάτη Κρόνου, ἡ ἑνδεκάτη Διός, ἡ δωδεκάτη Ἄρεως· [ἡ] ἡμέρα α′ Ἡλίου, β′ Ἀφροδίτης, τρίτη Ἑρμοῦ, τετάρτη Σελήνης, πέμπτη Κρόνου, ἕκτη Διός, ἑβδόμη Ἄρεως, ὀγδόη Ἡλίου, ἐνάτη Ἀφροδίτης, δεκάτη Ἑρμοῦ, ἑνδεκάτη Σελήνης, δωδεκάτη Κρόνου. εἶτα ἑξῆς γίγνεται ἡ ἐπιοῦσα ἡμέρα τουτέστι Μεχὶρ ιδ′· ἔσται Διὸς καὶ ἡ α′ ὥρα.

A translation with explanatory words added in brackets to make the meaning clearer would read thus: "And concerning the week and [the] sabbatical day [the formula is] thus: Taking [the number of] full years and the [number of] intercalations from [the commencement of the Era of] Augustus, add also the [number of] days from [the first day of] Thoth to the birth date, and subtract from [the total of] these [numbers] seven as many times as possible, and [count] the remaining (days) from [that of the] Sun [Sunday]. And in this manner you may reckon the [planetary] star to which the day belongs. And the order of the [planetary] stars in relation to the days [of the week] holds thus: Sun, Moon, Mars, Mercury, Jupiter, Venus, [and] Saturn. But the arrangement of their orbits [around the earth is] thus: Jupiter, Mars, Sun, Venus, Mercury, [and] Moon. Moreover, by this [same] arrangement the hours [of each day] are designated; and by means of the hours [is indicated the] day of the next [planetary] star.

"For example: Year 4 [of the reign] of Hadrian, Mechir 13 according to [the calendation of the] Alexandrians, [and] hour 1 of night [are the birth date]. The full years from [the commencement of the Era of] Augustus [are] 148, and [the] intercalations [are] 36, and from [the first day of] Thoth to Mechir 13 [are] 163 days. They are [thus a grand total of] 347. Subtract 49 weeks [from this sum, and] there remain 4 (days). From [the day of the] Sun [Sunday] count to [the] day of Mercury [Wednesday], and the hour 1 of night [is that] of

Mercury; the second, [that] of [the] Moon; the third, [that] of Saturn; the fourth, [that] of Jupiter; the fifth, [that] of Mars; the sixth, [that] of [the] Sun; the seventh, [that] of Venus; the eighth, [that] of Mercury; the ninth, [that] of [the] Moon; the tenth, [that] of Saturn; the eleventh, [that] of Jupiter; the twelfth, [that] of Mars; [and] hour 1 of day [is that] of [the] Sun; the second, [that] of Venus; the third, [that] of Mercury; the fourth, [that] of [the] Moon; the fifth, [that] of Saturn; the sixth, [that] of Jupiter; the seventh, [that] of Mars; the eighth, [that] of [the] Sun; the ninth, [that] of Venus; the tenth, [that] of Mercury; the eleventh, [that] of [the] Moon; the twelfth, [that] of Saturn. Therefore the following day will be Mechir 14, and hour 1 will be [that] of Jupiter." [7]

In order to understand the mathematical formula presented by Vettius Valens for finding the day of the week on which a birth date had fallen, and to see how accurate that formula is shown to be by the example which he presents to illustrate the way it works, it is imperative that the data and the means he employed be clearly kept in mind. Hence we shall discuss them at this juncture.

1. Vettius Valens used a system of calendation that had been in vogue at Alexandria, Egypt, during the imperial period since the reign of Augustus.

Prior to the conquest of Egypt by Octavius and his making it a province of the Roman Empire, the Egyptian calendar year had consisted of twelve months of 30 days each, which amounted to 360 days. Five supplementary or epagomenal days, added to the 360, completed the calendar year and gave it a grand total of 365. No extra day was intercalated every fourth year to align the calendar year with the tropical solar year of 365.242 days. However, Egyptian savants had long been aware that their system of calendation was defect-

[7] Vettius Valens, *Anthologiarum libri*, V. 10. 10-33. The Greek text is given according to the edition of G. Kroll (Berlin, 1908), p. 26; the translation is mine.

ive, but the people of Egypt refused to accept any reform of their calendar. [8]

When Julius Caesar and his adviser, the Alexandrian astronomer Sosigines, [9] planned in 46 B.C. the reform of the Roman calendar, they assumed that the mean length of the tropical solar year was precisely 365.25 days and made this the mean length of the year of the new calendar introduced into use by the Roman government on January 1, 45 B.C. After three successive common years of 365 days each, every fourth year was to have 366 days by the intercalation of an extra day in February. By perpetuating this quadrennial cycle, that Julian calendrical system continued in vogue until A.D. 1582, when the reform introduced by Pope Gregory XIII was first adopted.

Because the old Egyptian calendar year of 365 days was one fourth (0.25) of a day shorter than the mean calendar year of 365.25 days in use among the Romans, the New Year's Day of the Egyptians came one full day earlier every four years in relation to the Julian calendar from 45 B.C. onward. As a result of this shifting, it would take 1,461 Egyptian calendar years ($365 \times 1{,}461 = 533{,}265$ days) to equal 1,460 Julian calendar years ($365.25 \times 1{,}460 = 533{,}265$ days). Thus the Egyptian New Year's Day slowly regressed, at the rate of one day every four years, through all the seasons of the natural year and through all the twelve months of the Julian calendar in a cycle of 1,460 Roman years or 1,461 Egyptian years. [10]

[8] Ptolemy III (Euergetes I), who reigned from 247 to *ca.* 222 B.C., and was noted as a generous patron of learning, attempted to reform the Egyptian calendar by his famous "Decree of Canopus," in 238 B.C., to provide for the regular intercalation of an extra (sixth) epagomenal day every fourth year, but his people would not accept it. See Duncan McNaughton, *A Scheme of Egyptian Chronology* (London, 1932), pp. 297-299; J. P. Mahaffy, *The Empire of the Ptolemies* (London, 1895), p. 234.

[9] Pliny the Elder, *Natural History,* II. 6 (Loeb ed., I, 192, 193); XVIII. 57 (Loeb ed., V, 322, 323).

[10] Censorinus, *De die natale,* 18 (F. Hultsch, ed. [Leipzig, 1867],

During a civil war among the Romans, Octavius defeated Mark Antony, assisted by Queen Cleopatra of Egypt, in a great battle near the Epirot town and promontory of Actium on the south side of the Ambracian Gulf. This engagement took place on September 2, 31 B.C., in the year when Octavius was consul for the third time, with M. Valerius Messala Corvinus as his colleague. [11] A Roman historian says:

> Such was the naval battle in which they [Augustus and Mark Antony] engaged on the second of September. I do not mention this date without a particular reason, nor am I, in fact, accustomed to do so; but Caesar now for the first time held all the power alone, and consequently the years of his reign are properly reckoned from that day. [12]

It was from that date—September 2, 31 B.C.—that the Romans reckoned their Actian Era, in commemoration of the victory of Augustus over Mark Antony in the battle of Actium. But *this is not the era of Augustus, and September 2, 31 B.C., is not the beginning of it, as employed by Vettius Valens in accordance with Alexandrian usage.*

After the battle of Actium, Mark Antony fled to Egypt, rejoined Cleopatra, and made preparations to defend that country against invasion by his adversary. As winter was approaching, Octavius passed through Greece and part of western Asia to the island of Samos. [13]

On January 1, 30 B.C. Octavius later known as Augustus, became consul for the fourth time, with Marcus Licinius Crassus as his colleague. [14] In mid-winter he sailed for Brun-

pp. 38, 39); Theon of Alexandria, *Commentaire sur les tables manuelles astronomiques de Ptolemée*, Abbé Halma, ed., I (Paris, 1822), 30.

[11] For the names of the Roman consuls in the year in which the battle of Actium was fought, see Valleius Paterculus, *The Roman History*, II. 84 (Loeb ed., pp. 226-228); Dio Cassius, *Roman History*, L. 10 (Loeb ed., V, 454-457).

[12] Dio Cassius, *op. cit.*, LI. 1 (Loeb ed., VI, 2-7).

[13] Suetonius, *The Lives of the Caesars*, "Octavius Caesar," 17 (Loeb ed., I, 147); Valleius Paterculus, *op. cit.*, II. 85 (Loeb ed., pp. 228-231); Dio Cassius, *op. cit.*, LI. 1-4 (Loeb ed., VI, 2-15).

[14] For the names of the Roman consuls for 30 B.C., see Dio Cassius, *op. cit.*, LI. 4 and 19 (Loeb ed., VI, 10-15, 50-55).

disium, where he settled complaints of disgruntled veterans. Having done this, he left for Greece on the 30th day after his arrival in Brundisium. From Greece he went to Asia via Rhodes. Moving quickly down through Syria, he invaded Egypt and laid siege to Alexandria, which he took on August 1, 30 B.C. [15] Mark Antony committed suicide by the sword, and Cleopatra later in the same month took her life by pressing a venomous asp to her breast. [16] Thus ended the long reign of the dynasty of the Ptolemies over Egypt. That country now became a part of the Roman Empire by conquest, and Gneius Cornelius Gallus, commander of one of the invading armies, became the first Roman governor of Egypt by appointment from Augustus. [17]

Clement of Alexandria, writing *ca.* A.D. 200, said:

> From the taking of Babylon to the death of Alexander, a hundred and eighty-six years. From this to the victory of Augustus, when Antony killed himself at Alexandria, two hundred and ninety-four years, *when Augustus was made consul for the fourth time.* [18]

Note that Clement places the death of Mark Antony, which occurred when Augustus took the city of Alexandria, in the year when he was consul for the fourth time. That was the year 30 B.C. Moreover, Clement states that the interval from the death of Alexander the Great to that of Mark Antony was 294 years. This agrees exactly with the computation given

[15] The date—"*K. Aug. . . . Aug. Alexan. recepit*" (On the Kalends of August [August 1]. . . . Augustus took Alexandria)— is found in an inscription of the ancient calendar of Antium. See *CIL*, Vol. X (1883), pt. 1, no. 6638, p. 664; Vol. I (1893), pt. 1, col. 3, p. 323; Paulus Orosius, *Historiae*, VI. 19 (*MPL*, XXXI, 1050, 1051), where the date is given as "*Kalendis Sextilibus*" (on the Kalends of August, or August 1), *Sextilis* being the original Latin name of the month now called August.

[16] Dio Cassius, *op. cit.*, LI. 5, 9-13 (Loeb ed., VI, 14-17, 24-39); Suetonius, *op. cit.*, 17 and 18 (Loeb ed., I, 144-149); Valleius Paterculus, *op. cit.*, II. 87 (Loeb ed., pp. 232-235).

[17] Dio Cassius, *op. cit.*, LI. 17 (Loeb ed., VI, 46-49); Eutropius, *Abridgment of Roman History*, VI. 7 (J. S. Watson, ed. [London, 1886], p. 499).

[18] Clement of Alexandria, *Stromata*, I. 21 (*ANF*, II, 332).

in the *Canon* of the kings compiled by Claudius Ptolemy, the Alexandrian astronomer, earlier in the second century A.D.

The precise date when Augustus *completed* his conquest and occupation of Alexandria is not known. Though the city fell on August 1, as already shown, he spent some time there before Cleopatra ended her life and before he concluded his arrangements for the provisional administration of Egyptian affairs by the Romans. It was about the last of August that he left Alexandria and passed through Syria into Asia, to spend the winter there. [19]

In the meantime news of the conquest of Egypt and of the death of Antony and Cleopatra reached Rome. The senate and the people there were so highly elated by Augustus' success in bringing the civil war to a conclusion that they voted great honors for him. "The day on which Alexandria had been captured they declared a lucky day, and directed that *in future years it should be taken as the starting-point in their reckoning of time.*" [20]

Thus history records that the era of Augustus began in the year when that Roman ruler conquered Egypt by taking Alexandria, which was 30 B.C. It was this era, and not the Actian, that Vettius Valens used in his mathematical formula for ascertaining the day of the week on which a birth had occurred.

2. The twelve months of the Egyptian calendar were as follows: (1) Thoth, (2) Phaophi, (3) Hathyr, (4) Choiak, (5) Tybi, (6) Mechir, (7) Phamenoth, (8) Pharmuthi, (9) Pachon, (10) Payni, (11) Epiphi, (12) Mesore, followed immediately by five epagomenal days to make a total of 365. Thus Thoth 1 was the New Year's Day of the Egyptians. In his illustration of the way his formula works, Vettius Valens mentions the months of Thoth and Mechir. The era of Augustus according to the Alexandrians began with Thoth 1 of 30 B.C., and it is from that date that Vettius Valens reckoned

[19] Dio Cassius, *op. cit.*, LI. 18 (Loeb ed., VI, 48-50).
[20] *Ibid.*, LI. 19 (Loeb ed., VI, 52-55).

in making his calculations. To what month date of the Julian calendar did Thoth 1 correspond in 30 B.C.? The answer will be given below.

3. Vettius Valens speaks twice about "intercalations," indicating that he used the reformed Egyptian calendar, and not the old one which had no intercalation. This raises another question: When did the first intercalation of an extra day in the new calendar used at Alexandria begin? Evidence shows that it began in the reign of Augustus. Diodorus Siculus, writing during the early part of the reign of that Roman emperor, said:

> The Thebans say that they are the earliest of all men and the first people among whom philosophy and the exact science of the stars were discovered, since their country enables them to observe more distinctly than others the risings and settings of the stars. Peculiar to them is their ordering of the months and years. For they do not reckon the days by the moon, but by the sun, making their month of thirty days, and they add five and a quarter days to the twelve months and in this way fill out the cycle of the year. But they do not intercalate months or subtract days, as most of the Greeks do. [21]

Thus in the time of Diodorus Siculus provision had been made for the intercalation of the extra day as needed to make the mean calendar year of the Egyptians 365.25 days long.

Strabo in the early part of the reign of Augustus noted that the Egyptians

> ... reckon the days, not by the moon, but by the sun, adding to the twelve months of thirty days each five days each year; and, for the filling out of the whole year, since a fraction of the day runs over and above, they form a period of time from enough whole days, or whole years, to make the fractions that run over and above, when added together, amount to a day. [22]

The same writer refers to "the fractions of the day and

[21] Diodorus Siculus, *The Library of History*, I. 50 (Loeb ed., I, 174-177).

[22] Strabo, *Geography*, XVII. 1. 47 (Loeb ed., VIII, 124, 125).

night which, running over and above the 365 days, fill out the time of the true year." [23]

It is evident therefore that during the early part of the reign of Augustus the Alexandrians reformed their system of calendation by intercalating (adding) a sixth epagomenal day at the end of every fourth year. By this means they kept their calendar dates synchronized with the corresponding ones of the Julian calendar.

However, this does not mean that the Egyptians discontinued the use of their old system of calendation, which made no provision for the insertion of an intercalary day once in four years. The fact is that both the old and the new calendars were used simultaneously in Egypt throughout the Roman imperial period. It was chiefly at Alexandria, the seat of learning as well as the headquarters of the government of Egypt as a Roman province, that the reformed calendar was most appreciated and used. This is logical, because the Roman government officers there would hardly be in a mood to be inconvenienced by the instability of the old Egyptian calendar in their business transactions.

Theon, an astronomer at Alexandria during the reign of the Emperor Theodosius the Elder (379-395), wrote a valuable commentary on the astronomical works of Claudius Ptolemy, the noted astronomer at Alexandria during the reigns of Hadrian (117-138) and Antoninus Pius (138-160). In writing his works on astronomy, Ptolemy had used the old system of Egyptian calendation. Theon, in his commentary on the tables of the astronomical manuals of Ptolemy, explained how to convert dates given according to the old Egyptian system of calendation into their corresponding dates in the new system. In doing so, he speaks of the calendar year of the old system as "The Egyptian year," and of the calendar year of the new system as "the year of the Greeks, or of Alexandria." It must be remembered that Egypt had been incor-

[23] *Ibid.*, XVII. 17. 29 (Loeb ed., VIII, 84, 85).

porated into the Hellenistic Empire by Alexander the Great, after whom the city of Alexandria was named; and that the Macedonian dynasty of the Ptolemies ruled over Egypt for a period of about 294 years—from the death of Alexander the Great in 323 B.C. till the death of Queen Cleopatra in 30 B.C. Hence Theon says:

> Here, now, is the way of taking the month and the day of the Egyptians: Inasmuch as the year of the Greeks, or of Alexandria, followed by us is of 365 days and a quarter, and that of the Egyptians is of 365 days only, as we have said, it is evident that by the end of four years the year of Alexandria counts one day less than the Egyptian year, and that in 1,460 years it counts 365 days, that is, one Egyptian year, less. Alexandria and Egypt begin together the year, the months, and the days, in the manner of Egypt, but for one year only, and, at the beginning of the following year, the Egyptians begin to have one quarter of a day's advance, and so forth. Now this period of 1,460 years, commenced from a certain time, terminated *in the fifth year of the reign of Augustus*; so, *from this last epoch*, the Egyptians begin all over again to find themselves every year one quarter of a day in advance. Therefore, when at any time of the year of Alexandria, or of the Greeks, we want to know the month and the day counted then by the Egyptians, taking the quarter of the sum of the years *from the fifth of Augustus* until the year in question, because, as we have already said, they have one day more every four years, and omitting the residue, that never exceeds 3, we will thus have the number of the days that the Egyptian year is in advance of the years of Alexandria that they have called *tetraëterides*. [24]

A little farther on in the discourse Theon reminds his readers that "we have said that *the return of the coincidence of the year of Alexandria with that of Egypt occurred five years after the beginning of the reign of Augustus.*" [25]

The portions of Theon's statements, as italicized above by us to call attention to them, plainly state that the adoption of the new Alexandrian calendar took place in the fifth year

[24] Theon of Alexandria, *op. cit.*, I. 30. The *tetraëterides* was a four-year cycle by which one day was intercalated to make up the quarter of a day in excess of the 365 days of each calendar year of that period. Our present system of intercalating an extra day in February every fourth year similarly operates on the basis of a four-year cycle.

[25] *Ibid.*, I. 32.

of the reign of Augustus as reckoned by the Alexandrians, who dated the era of Augustus from Thoth 1 (August 31) of 30 B.C. Five years later the adoption of the Alexandrian calendar began with Thoth 1 (August 30) of 26 B.C. Thoth 1 of both the old and the Alexandrian calendars then fell on the same date. In 25, 24, and 23 B.C., both fell on August 29. Though there was an accumulation of one fourth of a day per year for one of them, no *perceptible* divergence between the two systems of calendation was apparent during the first three years of that first four-year cycle for the Alexandrian system of calendation. But at the close of the fourth year of that first four-year period, a sixth epagomenal day was intercalated in the Alexandrian calendar year to give to each year of the four-year cycle a mean length of 365.25 days, while no such extra day was provided for the old calendar year still in use among the Egyptians. Consequently, whereas the last (fifth) epagomenal day of the year 23/22 B.C. fell on August 28, 22 B.C., for the old calendar, the last (sixth) epagomenal day fell on August 29, 22 B.C., for the Alexandrian calendar. As a result of this, Thoth 1 which followed immediately in the old calendar fell on August 29, 22 B.C., and Thoth 1 which followed immediately in the Alexandrian calendar fell on August 30, 22 B.C. [26] Thus one day of divergence between the two systems of calendation first became apparent in 22 B.C., two days in 18 B.C., three days in 14 B.C., etc. [27]

Albiruni, the Arab scholar (A.D. 973-1045), wrote in his notable work on chronology: "It was Augustus who caused the people of Alexandria to give up their system of reckoning by non-intercalated Egyptian years, and to adopt the system of the Chaldeans, which in our time is used in Egypt." [28] Also:

[26] The shift of one day for Thoth 1 from August 31 in 30 B.C. to August 30 in 26 B.C. was due to the fact that an extra day was intercalated in February of the Roman calendar in 29 B.C. because it was a leap year for the Latins.

[27] See the calendrical table in Appendix II.

[28] Albiruni, *The Chronology of Ancient Nations*, tr. C. Eduard Sachau (London, 1879), p. 33.

> They [the Egyptians], as we have mentioned, used the names of the thirty days till the time when Augustus, the son of Gajus [Caius Julius Caesar], ruled over them. He wanted to induce them to intercalate the years, that they might always agree with the Greeks and the people of Alexandria. Therefore *he waited till five years of his rule had elapsed, and then he ordered them to intercalate one day in the months every fourth year*, in the same way that the Greeks do. [29]

Thus Albiruni, like Theon, has stated that it was in the fifth year of the reign of Augustus that the (Alexandrian) calendar, with the intercalation of an extra day every fourth year, was adopted in Egypt. Theon says that the reason for the choice of that year—the fifth of the emperor's reign, which was 26 B.C.—was that a 1,460-year Sothic cycle had terminated then. Albiruni credits Augustus with having ordered Egypt to adopt the plan of intercalating an extra day every four years.

What we have presented above concerning the Alexandrian era of Augustus and the adoption of the Alexandrian system of calendation in Egypt is supported further by historical documents and by astronomical data, some of which we shall present now.

A papyrus document from the Roman imperial period presents a horoscope of a person born on "Phaophi 1, but according to the ancient reckoning Phaophi 11." [30] A difference of ten days is seen between the date Phaophi 1 of the new Alexandrian calendar and that of Phaophi 11 of the old calendar. Thus the Roman date was a September 28 during the years A.D. 15 to 18, in the reign of Tiberius. [31]

Another horoscope carries the double date of "Pharmuthi 6 . . . which the Romans call the kalends of April [April 1]"

[29] *Ibid.*, p. 58. During the Roman imperial period the Greeks also had a reformed calendar and were intercalating an extra day every fourth year. Albiruni refers elsewhere to the epagomenal days of the Egyptian calendars as "the small month."

[30] Bernard P. Grenfell and Arthur S. Hunt, eds., *The Oxyrhynchus Papyri*, II (London, 1899), 137, 138.

[31] See years 45 to 48 in the calendrical table in Appendix II.

in the third year of the Emperor Titus.[32] The date is Pharmuthi 6 (April 1) of A.D. 81, the third year of the reign of Titus and the year in which he died.

Another interesting feature of the Alexandrian calendar of Egypt was the way in which the intercalation of the sixth epagomenal day at the end of the fourth (last) year of the four-year cycle affected the relationship of Thoth 1 to its corresponding date in the Julian calendar. This extra epagomenal day actually was intercalated as the last day of the four-year cycle. Consequently the next day, which was Thoth 1 of the following year, fell one day later in relation to the Julian calendar. Thus Thoth 1 fell on August 30 in the first year, and on August 29 in the next three years, of the four-year cycle. But during the month of Mechir of the first year of the next four-year cycle, February of the Julian calendar was given an extra day, because it was a leap year for the Latins, and this compensated for the shift produced by the intercalation made at the close of the last year of the Alexandrian four-year cycle. The following shows the relation of each year of the new Alexandrian four-year cycle to the Julian calendar:

Year 1:	August 30 to August 28
Year 2:	August 29 to August 28
Year 3:	August 29 to August 28
Year 4:	August 29 to August 29
- - - - -	- - - - - - - - - - -
Year 1:	August 30 to August 28
Year 2:	August 29 to August 28

And so on *ad infinitum*

The intercalation was always made in the Alexandrian calendar of Egypt about six months before the intercalation was made in the Julian calendar. The first intercalation in the Alexandrian calendar of Egypt was made in 22 B.C.—

[32] Frederick G. Kenyon, ed., *Greek Papyri in the British Museum*, I (London, 1893), 132-139.

when the first four-year cycle ended—and the additional (sixth) epagomenal day corresponded to August 29 of that year insofar as the Julian calendar was concerned. About six months later, early in 21 B.C., the intercalary (bissextile) day was inserted between February 24 and 25 of the Julian calendar, and it corresponded to Mechir 30 of the Alexandrian calendar. The following table illustrates how this was done:

The Alexandrian Year 23/22 B.C.—Aug. 29 to Aug. 29

1.	Thoth	1-30	—	Aug.	29	to	Sept.	27
2.	Phaophi	1-30	—	Sept.	28	to	Oct.	27
3.	Hathyr	1-30	—	Oct.	28	to	Nov.	26
4.	Choiak	1-30	—	Nov.	27	to	Dec.	26
5.	Tybi	1-30	—	Dec.	27	to	Jan.	25
6.	Mechir	1-30	—	Jan.	26	to	Feb.	24
7.	Phamenoth	1-30	—	Feb.	25	to	Mar.	26
8.	Pharmuthi	1-30	—	Mar.	27	to	Apr.	25
9.	Pachon	1-30	—	Apr.	26	to	May	25
10.	Payni	1-30	—	May	26	to	June	24
11.	Epiphi	1-30	—	June	25	to	July	24
12.	Mesore	1-30	—	July	25	to	Aug.	23
	Epagomenae	1-5	—	Aug.	24	to	Aug.	28
	Epagomena	6	—				Aug.	29

The Alexandrian Year 22/21 B.C.—Aug. 30 to Aug. 28

1.	Thoth	1-30	—	Aug.	30	to	Sept.	28
2.	Phaophi	1-30	—	Sept.	29	to	Oct.	28
3.	Hathyr	1-30	—	Oct.	29	to	Nov.	27
4.	Choiak	1-30	—	Nov.	28	to	Dec.	27
5.	Tybi	1-30	—	Dec.	28	to	Jan.	26
6.	Mechir	1-29	—	Jan.	27	to	Feb.	24
	,,	30	—				Feb.	24b
7.	Phamenoth	1-30	—	Feb.	25	to	Mar.	26
8.	Pharmuthi	1-30	—	Mar.	27	to	Apr.	25
9.	Pachon	1-30	—	Apr.	26	to	May	25
10.	Payni	1-30	—	May	26	to	June	24
11.	Epiphi	1-30	—	June	25	to	July	24
12.	Mesore	1-30	—	July	25	to	Aug.	23
	Epagomenae	1-5	—	Aug.	24	to	Aug.	28

Having discussed at length the era of Augustus (established in 30 B.C.) and the new system of calendation (adopted in Egypt in 26 B.C.), let us now consider the mathematical formula of Vettius Valens for ascertaining the day of the week on which a given birth date fell, and his illustration of how it works.

Vettius Valens took Thoth 1 (August 31), 30 B.C., as the commencement of the era of Augustus and the primary point of reference in making his computations. The date fell on Sunday, the first day of the week. He knew this fact. For this reason he first added up all years from the beginning of the era of Augustus, the intercalated days, and the days lying between Thoth 1 and the birth date under consideration. From this total number he then subtracted as many sevens as possible and thus ascertained "the sabbatical day" (Saturday) which marked the end of the last full week before the one in which that birth occurred.

Another important factor is that Vettius Valens did not use the Roman civil day, which was reckoned from midnight to midnight. *He employed the day as reckoned from evening to evening.* When he mentions a day of the week or a day of the month, he is speaking of a day that began with the evening (about sunset) before the midnight marking the commencement of the civil day. This is shown by the fact that he counts the 24 hours of the day invariably from the first hour of night.

When one takes the Roman civil day (midnight to midnight) into account, Sunday, August 31, 30 B.C., was the beginning of the era of Augustus. But when one takes the day from evening to evening as Vettius Valens did, it is obvious that Sunday, Thoth 1, marking the beginning of the era of Augustus, actually began at sunset on Saturday afternoon of August 30, 30 B.C., according to Roman civil time. Thus, that date, as Vettius Valens used it, corresponded to Sunday, Thoth 1 (August 30/31), 30 B.C., Roman civil time. Therefore, Neugebauer and Van Hoesen, in their work on Vettius Valens, are correct in saying that dates of the Alexandrian calendar can be converted into Julian dates by the formula "Augustus 0 Thoth (I) 1 = —30 August 29." [33] Also:

[33] Neugebauer and Van Hoesen, *op. cit.*, pp. 2, 3.

> In the Alexandrian calendar a sixth epagomenal day is added every fourth year. Consequently the Alexandrian year remains in fixed relation with the Julian [Roman] year, the first of Thoth being for three years in succession August 29, then once August 30, etc. [34]

In the example which he gave to illustrate the working of his formula, Vettius Valens states that from the commencement of the era of Augustus to the commencement of the fourth year of the reign of Hadrian, according to the Alexandrian system of calendation, there were 148 full years. That is, 148 full years comprise the interval from Thoth 1 (August 30), 30 B.C., to Thoth 1 (August 30), A.D. 119. From Thoth 1 (August 30), 30 B.C., to the beginning of the Christian era there were 29 years, 4 months, and 1 day. From the commencement of the Christian era to Thoth 1 (August 30), A.D. 119, there were 118 years, 7 months, and 29 days. Thus the total number of years for the entire period was 148, as follows:

B.C. —	29 years,	4 months,	1 day
A.D. —	118 years,	7 months,	29 days
Total	148 years,	0 months,	0 days

The testimony of Vettius Valens is, therefore, historical proof that the era of Augustus, according to Alexandrian reckoning, began on Thoth 1 (August 30), 30 B.C. [35]

However, Vettius Valens says that 36 intercalations were made in the Alexandrian calendar during that period of 148 years of the era of Augustus. The 36 intercalations corresponded to 36 four-year cycles or 144 years ($4 \times 36 = 144$).

[34] *Ibid.*

[35] F. H. Colson, translator of the works of Philo Judaeus for the Loeb Classical Library, has well said: "There has been some controversy as to whether this was August 30th or 31st. Mommsen (rightly, I believe) decided in favor of the latter, though he does not seem to have known the passage in Valens, which, I think, must decide the controversy finally. For any one who takes the trouble, and it is no more, to calculate, will find that August 31st in that year actually was what we call Sunday" (*The Week*, pp. 52, 53). Colson erred in supposing that Mechir 13 of the fourth year of Hadrian's reign fell on February 7, A.D. 119 (*ibid.*, pp. 47-52).

Inasmuch as the thirty-sixth intercalation was made on the very last day of that 148-year period—that is, on August 29, A.D. 119—this means that the first four-year cycle of the 36 began 144 years previous—that is, on August 30, 26 B.C.; and that the first intercalation was made four years later—on August 29, 22 B.C. Thus the total number of years for the entire period of 36 four-year cycles was 144, as follows:

25 years,	4 months,	1 day
118 years,	7 months,	29 days
144 years,	0 months,	0 days

The horoscopes of Vettius Valens and his formula for ascertaining the day of the week on which a birth date fell are, therefore, historical proof that the adoption of the Alexandrian calendar began with Thoth 1 (August 30), 26 B.C., and that the first intercalation made in it took place on August 29, 22 B.C., according to the Julian calendar.

Why did Vettius Valens merely add 148 (the number of the full years) and 36 (the number of intercalations) and 163 (the number of days from Thoth 1 to Mechir 13 of the fourth year of the reign of Hadrian) together in order to find out how many days in excess of the total number of full weeks (*hebdomads*, "sevens") would remain? He knew that the year of 365 days contains one day in excess of 52 full weeks ($7 \times 52 = 364$). The number 148 was the total number of such excessive days for the 148 years at the rate of one day per year. However, he knew that 36 of those 148 years were leap years of 366 days each, and that he should allow an additional day of excess for each of them. So he needed to add 36 days more to the 148. Moreover, there yet remained the 163 days from Thoth 1 to Mechir 13 in the fourth year of Hadrian's reign, which formed only a part of a full year. They had to be taken into account. Thus, by adding together the 148, the 36, and the 163 days, he had a total of 347. Instead of dividing the 347 days by 7, he simply subtracted 343 days (49 weeks) from the 347 days, and had a remainder of only four days. This means that from Sunday, Thoth 1 (August

30/31), 30 B.C., to Mechir 13 (February 8), A.D. 120, minus four days comprised an even number of full weeks, and that Mechir 9 (February 4) of that year was "the sabbatical day" (Sabbath, day of Saturn, Saturday)—the last day of the last full week of that period. As there remained 4 days till Mechir 13—the birth date given—he needed only to count them by beginning thus: Mechir 10 (February 5) would be the day of the Sun (Sunday); Mechir 11 (February 6) would be the day of the Moon (Monday); Mechir 12 (February 7) would be the day of Mars (Tuesday); and Mechir 13 (February 8) would be the day of Mercury (Wednesday).

That mathematical short cut used by Vettius Valens in his formula is a clever one indeed, perhaps novel to us. But we must remember that the decimal system of mathematics which we employ today is a great improvement over the clumsy numerals and arithmetic of the Greeks, in which the letters of the alphabet, and not the Arabic numerals such as we have, served as numbers. To see that the mathematical formula of the astrologer provided him with a correct answer, let us solve his problem another way:

There were 148 Alexandrian years from Thoth 1 (August 30), 30 B.C., to Thoth 1 (August 30), A.D. 119. But only 36 of those years were leap years, and 112 were common years. The 112 common years of 365 days each had a total of (112 × 365) 40,880 days. The 36 leap years of 366 days each had a total of (36 × 366) 13,176 days. Then there were 163 days in the fraction of a year from Thoth 1 (August 30), A.D. 119 to Mechir 13 (February 8), 120. Adding together the 40,880 days and the 13,176 days and the 163 days, we have a grand total of 54,219 days for the whole period from Sunday, Thoth 1 (August 30/31), 30 B.C. to Wednesday, Mechir 13 (February 8), A.D. 120. Dividing the 54,219 days by 7, we find that they consisted of 7,745 weeks plus 4 days. Therefore Mechir 13 (February 8), A.D. 120, was the fourth day of the week—Wednesday (Mercury's day)—as Vettius Valens has said.

Another interesting and important fact, in this connection, is that Mechir 13 in the fourth year of the reign of Hadrian, as a calendar date, figures in four different horoscopes in the *Anthology* by Vettius Valens, apart from his mathematical formula for ascertaining the day of the week on which a birth date had fallen. In all four instances Neugebauer and Van Hoesen have worked out the horoscopes and found that Mechir 13 in the fourth year of Hadrian was February 8, A.D. 120. [36]

In the example which he gives to illustrate his method of ascertaining the day of the week on which a birth date had fallen, Vettius Valens stated that it belonged to the fourth year of the reign of Hadrian, according to the Alexandrian system of calendation. The biographer of Hadrian indicated that he began to reign as emperor on August 11, and other evidence shows it was in A.D. 117. [37] However, evidence shows further that though Hadrian's reign began only 18 days prior to Thoth 1 (August 29), A.D. 117, that fraction of the Alexandrian year from Thoth 1 (August 29), A.D. 116, to Thoth 1 (August 29), 117, was reckoned as the first year of his reign. The Alexandrian year from Thoth 1 (August 29), A.D. 117, to Thoth 1 (August 29), 118, was counted as his second year as emperor. And the Alexandrian year from Thoth 1 (August 29), A.D. 118, to Thoth 1 (August 29), 119, was his third.

We are specific in this matter for a good reason. There is extant a

> . . . copy of a letter translated from the Latin which was posted in the commander's quarters at the winter camp of the third Cyrenaic and the Twenty-second Deioteiran legions in the 3rd year of Traianus Hadrianus Augustus Publius Aelius in his third consulship which he held with Rusticus as colleague. Dated the day before the Nones of August [August 4] or Mesore 11. [38]

That letter was the publication of a legal decision by Hadri-

[36] Neugebauer and Van Hoesen, *op. cit.*, pp. 180, 181, and Table 15. The four horoscopes referred to are Vettius Valens, *op. cit.*, I. 4, p. 20; 10, p. 26; 20, p. 36; V. 7, p. 215.

[37] Aelius Spartianus, *Hadrian*, 4 (Loeb ed., I, 12, 13).

[38] Allan Chester Johnson, *Roman Egypt to the Reign of Diocletian* (Baltimore, 1936), p. 678.

an concerning the heirship of children born to soldiers not legally married but while in military service. The document is not only doubly dated as having been issued "on the 4th of August which is the 11th of Mesore," [39] but names of the Roman consuls for the year—which is A.D. 119—are given too.

Mesore 11 of the Alexandrian calendar fell on August 4, A.D. 119, the year in which Hadrian was consul for the third time, with C. Junius Rusticus as his colleague. The double dating, which gives the month date according to the Alexandrian calendar and the month date according to the Julian calendar, together with the names of the Roman consuls for the year, testifies to the veracity of Vettius Valens in the use of calendrical data.

Claudius Ptolemy, the Alexandrian astronomer already mentioned, wrote an astronomical treatise called *The Mathematical Composition*, which is better known today as *The Almagest*, a title given to it by Arabian scholars. In that work he mentions 19 eclipses of the sun and moon. His *Canon* lists the reigns of kings successively, with the number of years they reigned individually and collectively, from noon of Thoth 1 (February 26), 747 B.C., down to his own time in the second century A.D. The astronomical observations made by him as recorded in *The Almagest* extend from A.D. 127 to 151. His life covered the reigns of Trajan (98-117), Hadrian (117-138), and Antoninus Pius (138-161). He considered Hipparchus (*ca.* 135 B.C.) his master in astronomy and often cited him as an authority on the subject.

Ptolemy mentions using in an astronomical problem a partial lunar eclipse which he had observed:

> We took that [lunar eclipse] observed in Alexandria in the year 9 of Hadrian, Egyptianwise Pachon 17-18 at 3 3/5 equatorial hours before midnight; and the moon was eclipsed likewise to the extent of 2 digits from the southern side. [40]

[39] Arthur S. Hunt and C. C. Edgar, eds., *Select Papyri*, II (Cambridge, Mass., 1956), 88, 89 ("Letter of Hadrian").

[40] Claudius Ptolemy, *The Almagest*, R. Catesby Taliaferro, ed., IV. 9, in "Great Books of the Western World," XVI (Chicago, 1939), 136.

Ptolemy used the astronomical day, which was reckoned from noon to noon. [41] Because the Egyptian civil day was reckoned from sunrise to sunrise, [42] and the Roman day from midnight to midnight, he was careful to indicate both of the civil days involved in each of the dates he gave for the eclipses he observed. Though he states that the moon was partially eclipsed on Pachon 17-18, yet the fact that he reports that it occurred "before midnight" shows that it actually occurred on Pachon 17 according to old Egyptian count. Pachon 17 of the old Egyptian calendar corresponded to Pharmuthi 10 (April 5) of the new Alexandrian calendar in the ninth year of Hadrian, which was from Thoth 1 (August 29), A.D. 124, to Thoth 1 (August 29), 125. Thus the eclipse of the moon took place on April 5, A.D. 125, [43] according to the Julian calendar.

Another document from that period is a birth certificate of Nerenius Gemella, a girl born in the year when Nonius Torquatus Asprenate was consul for the second time, and M. Annius Libone was consul for the first time, "on April 13 in the twelfth year of the Emperor Caesar Trajan Augustus, which was Pharmuthi 18 in Alexandria for the Egyptians." [44] This double dating, with the names of the Roman consuls for the twelfth year of the reign of Hadrian, one of whose names was Trajan, means that the birth occurred on Pharmuthi 18 (April 13), A.D. 128, according to the Alexandrian calendar.

Ptolemy says:

> Since, of the first equinoxes observed by us, one of the most accurate occurred as the autumn equinox in the year 17 of Hadrian,

[41] See note 45 below for data concerning Ptolemy's use of the astronomical day (noon to noon).

[42] Richard A. Parker, *The Calendars of Ancient Egypt* ("Studies in Ancient Oriental Civilization," XXVI; Chicago, 1946), p. 10.

[43] This lunar eclipse is listed as No. 2058 in Theodor R. von Oppolzer's *Canon of Eclipses* (New York, 1925), p. 345, the date given as April 5, A.D. 125.

[44] John G. Winter, ed., *Papyri in the University of Michigan Collection*, III (Ann Arbor, 1936), 149, 150.

> Egyptianwise Athyr 7, very nearly 2 hours after midday—it is clear that at that time the sun was 116° 40' in mean movement on the eccentric circle, away from the apogee in the direction contrary to the movement of the heavens. But from the reign of Nabonassar to the death of Alexander [the Great] amounts to 424 Egyptian years; and from the death of Alexander to the reign of Augustus, 294 years; and from the year 1 of Augustus, Egyptianwise Thoth 1, midday (for we establish the epochs from midday) to the year 17 of Hadrian, Athyr 7, 2 hours after midday, amounts to 161 years, 66 days, and 2 equatorial hours. And therefore from the year 1 of Nabonassar, Egyptianwise Thoth 1, midday, to the time of the autumn equinox just mentioned amounts to 879 years, 66 days, and 2 equatorial hours. [45]

As Ptolemy was using the old Egyptian calendar, but reckoning the day from noon to noon, the date of that autumnal equinox has been computed as September 25, A.D. 132, in the seventeenth year of the reign of Hadrian according to the Alexandrian reckoning. And note that he adds the important observation that "from the year 1 of Augustus, Egyptianwise Thoth 1, midday (for we establish the epochs from midday) to the year 17 of Hadrian, Athyr 7, 2 hours after midday, amounts to 161 years, 66 days, and 2 equatorial hours." This means that the autumnal equinox of September 25, A.D. 132, in the seventeenth year of Hadrian's reign, took place in the 162d year of the era of Augustus, according to the Alexandrian system of calendation. This shows conclusively that by the Alexandrian reckoning the era of Augustus began with Thoth 1 (August 30/31) 30 B.C., as Vettius Valens has indicated. And it should be remembered that Vettius Valens and the Emperor Hadrian were contemporaries of Claudius Ptolemy.

Concerning another astronomical problem Ptolemy says:

> Again of the three eclipses we have chosen from those most carefully observed by us in Alexandria, the first occurred in the

[45] Claudius Ptolemy, *op. cit.*, III. 7. This statement shows that Ptolemy used the astronomical day, reckoned from midday to midday, not only in making astronomical observations, but also in reckoning the years of the kings since the first year of Nabonassar, king of Babylon, which began on Thoth I (February 26), 747 B.C., according to the Alexandrian reckoning.

year 17 of Hadrian, Egyptianwise Payni 20-21; and we accurately calculated the middle of it to have occurred 3/4 equatorial hour before midnight. And the eclipse was total. [46]

That total eclipse of the moon occurred during the night of May 6, A.D. 133, in the latter part of the seventeenth year of the reign of Hadrian according to the Alexandrian reckoning. [47]

The same Alexandrian astronomer says:

> "The second [lunar eclipse] occurred in the year 19 of Hadrian, Egyptianwise Choiac 2-3; and we calculated the middle of it to have occurred 1 equatorial hour before midnight. And there was an eclipse to the extent of 1/2 + 1/3 of the diameter from the southern side." [48]

That partial lunar eclipse occurred on October 20, A.D. 134, in the nineteenth year of the reign of Hadrian according to the Alexandrian reckoning. [49]

Ptolemy goes on to say:

> "The third of the [lunar] eclipses occurred in the year 20 of Hadrian, Egyptianwise Pharmuthi 19-20; and we calculated the middle of it to have occurred 4 equatorial hours after midnight. And there was an eclipse to the extent of 1/2 of the diameter from the northern side." [50]

That partial eclipse of the moon occurred on Pharmuthi 20 (March 6), A.D. 136, in the twentieth year of Hadrian's reign according to the Alexandrian reckoning. [51]

In three respects the calendation used by Vettius Valens, insofar as the days of the week and the 24 hours of the day are concerned, differs significantly from that depicted in

[46] *Ibid.*, IV. 6. 2.

[47] That lunar eclipse of May 6, A.D. 133, is listed as No. 2071 in von Oppolzer's *Canon*, p. 345.

[48] Claudius Ptolemy, *op. cit.*, IV. 6. 2.

[49] That lunar eclipse is listed as No. 2074 in von Oppolzer's *Canon*, p. 345.

[50] Claudius Ptolemy, *op. cit.*, IV. 6. 2.

[51] That lunar eclipse is listed as No. 2075 in von Oppolzer's *Canon*, p. 345.

the astrological calendars used in the West during the period in which he wrote. He placed Sunday (the day of the Sun) first in the order of the days of the week. The astrological calendars of the West placed Saturday (Saturn's day) first. [52] He began the 24 hours of the day with the first hour of night, thus reckoning the day from evening to evening. In this respect he was in accord with the Athenians, for both Varro [53] and Pliny the Elder [54] state that in their time the day was counted from sunset to sunset by the people of Athens. Too, the Jews and the early Christians did likewise. Moreover, he assigned the first hour of the night to the planet for which that day is named. The astrological calendars of the West during that period assigned the first hour of the morning (the sunrise hour) to the planet for which the day was named. [55]

Significant is the fact that in his astrological formula Vettius Valens, who undoubtedly was a pagan, used the week of seven days, reckoned the seven-day week as beginning with the day of the Sun (Sunday) and ending with "the sabbatical day" (Sabbath day), and reckoned the 24-hour day from evening to evening. This suggests that such usage may have been more widespread throughout the Roman world during the second century A.D. than some church historians in modern times have suspected. [56]

[52] Robert L. Odom, *Sunday in Roman Paganism* (Washington, D.C., 1944), pp. 56-59, 64, 115-121, 204-217.

[53] Varro, quoted by Aulus Gellius, *Attic Nights*, III. 2 (Loeb ed., I, 238-241).

[54] Pliny the Elder, *op. cit.*, II. 79 (Loeb ed., I, 318-321). See also Censorinus, *op. cit.*, 23 and 24.

[55] Odom, *op. cit.*, pp. 201-217.

[56] Writing shortly before the beginning of the second century A.D., Josephus said, in reply to an attack on the Jews by the learned grammarian, Apion of Alexandria: "The masses have long since shown a keen desire to adopt our religious observances; and there is not one city, Greek or barbarian, nor a single nation, to which our custom of abstaining from work on the seventh day has not spread" (*Against Apion*, II. 39 [Loeb ed., I, 405, 407]). Theophilus, bishop of Antioch (168-181), wrote, "concerning the seventh day, which all men acknowledge; but the most know not that what among the Hebrews is called

In conclusion, the work of Vettius Valens certainly provides conclusive evidence that the era of Augustus began on Sunday, Thoth 1 (August 31, midnight to midnight; or August 30/31, evening to evening), 30 B.C., [57] and that the continuity of the cycle of the seven-day week suffered no disruption whatever from that date down to Wednesday, Mechir 13 (February 8), A.D. 120, in the fourth year of the reign of Hadrian, *as reckoned by the new Alexandrian system of calendation.* He provides evidence that the adoption of the Alexandrian calendar in Egypt began with Thoth 1 (August 30), 26 B.C., and that the perceptible divergence between this new calendar and the old one first occurred on August 29, 22 B.C., when the sixth epagomenal day was first intercalated at the end of the first four-year period of the new calendar. Historical documents and astronomical records of that period confirm the testimony of Vettius Valens concerning that matter.

APPENDIX I

THE NEW (ALEXANDRIAN) CALENDAR OF EGYPT

Month	*Days*	*Corresponding Roman Date*
1. Thoth	1-30	Aug. 29(30) — Sept. 27(28)
2. Phaophi	1-30	Sept. 28(29) — Oct. 27(28)
3. Hathyr	1-30	Oct. 28(29) — Nov. 26(27)
4. Choiak	1-30	Nov. 27(28) — Dec. 26(27)
5. Tybi	1-30	Dec. 27(28) — Jan. 25(26)
6. Mechir	1-30	Jan. 26(27) — Feb. 24b
7. Phamenoth	1-30	Feb. 25 — Mar. 26

the 'Sabbath,' is translated into Greek the 'Seventh' (ἑβδομάς), a name which is adopted by every nation, although they know not the reason of the appellation" (*To Autolycus*, II. 12 [*ANF*, II, 99]). It is not strange, therefore, that Vettius Valens of Antioch, though he was a pagan, should refer to the seventh-day Sabbath in Greek as "the sabbatical day."

[57] From Thoth 1 (August 29), A.D. 284, and long thereafter the era of Augustus was called "the era of Diocletian." This was done in honor of Diocletian, who became emperor on September 17, 284. After his death, some ecclesiastical writers referred to it as "the era of the Martyrs," because of the terrible persecution which the Christians suffered under the reign of that ruler.

	Month	Days	Corresponding Roman Date
8.	Pharmuthi	1-30	Mar. 26 — Apr. 25
9.	Pachon	1-30	Apr. 26 — May 25
10.	Payni	1-30	May 26 — June 24
11.	Epiphi	1-30	June 25 — July 24
12.	Mesore	1-30	July 25 — Aug. 23
	Epagomenae	1-5(6)	Aug. 24 — Aug. 28(29)

Note: A sixth epagomenal day was intercalated (added) at the end of every fourth year of the four-year cycle, and thus was August 29 of that year. For this reason Thoth 1 of the first year of every four-year cycle always fell on August 30. But because an extra February 24 was intercalated as a "bissextile day" between February 24 and 25 of the Julian calendar once every four years, Thoth 1 fell on August 29 during the last three years of the four-year cycle. During the first centuries of the Christian era the intercalary day of the Julian calendar was not added as February 29 as is customary to do now.

APPENDIX II

THE TWO CALENDARS OF EGYPT DURING THE ROMAN IMPERIAL PERIOD

This table shows the correspondence between the new (reformed) and the old calendars used in Egypt during the Roman imperial period after that country was incorporated into the Roman Empire in 30 B.C., and also their relationship to the Julian calendar.

Column 1 lists the years of the era of Augustus according to the Alexandrian reckoning, beginning with 30/29 B.C.

Column 2 lists the Egyptian years as they corresponded to the Julian years, the portion in *italics* indicating where the intercalation was made in each leap year of the new (reformed) calendar of Egypt, and the portion in **bold** indicating where the intercalation was made in each leap year of the Roman calendar.

Column 3 shows the count of the leap year intercalations of the new (reformed) calendar of Egypt from 22 B.C.

Column 4 shows the Julian date on which Thoth 1 of the new (reformed) calendar of Egypt fell each year.

Column 5 shows the Julian date on which Thoth 1 of the old calendar of Egypt fell each year.

Column 6 shows the number of days of divergence between the Julian dates on which Thoth 1 of the new (reformed) calendar and Thoth 1 of the old calendar of Egypt fell from 22 B.C. onward.

This Table, prepared primarily for use with the preceding article, covers only the 60 Egyptian calendar years of the Roman imperial period from 30 B.C. to A.D. 31. It is a simple matter to extend the coverage further into the Christian era.

1. Years of Augustan Era	2. Corresponding Roman Years	3. Intercalations	4. Thoth 1 in New Calendar	5. Thoth 1 in Old Calendar	6. Days of Divergence
1	30/**29** B.C.	—	— —	Aug. 31	—
2	29/28 ,,	—	— —	,, 30	—
3	28/27 ,,	—	— —	,, 30	—
4	27/26 ,,	—	— —	,, 30	—
5	26/**25** ,,		Aug. 30	,, 30	—
6	25/24 ,,		,, 29	,, 29	—
7	24/23 ,,		,, 29	,, 29	—
8	23/*22* ,,	1	,, 29	,, 29	—
9	22/**21** ,,		,, 30	,, 29	1
10	21/20 ,,		,, 29	,, 28	1
11	20/19 ,,		,, 29	,, 28	1
12	19/*18* ,,	2	,, 29	,, 28	1
13	18/**17** ,,		,, 30	,, 28	2
14	17/16 ,,		,, 29	,, 27	2
15	16/15 ,,		,, 29	,, 27	2
16	15/*14* ,,	3	,, 29	,, 27	2
17	14/**13** ,,		,, 30	,, 27	3
18	13/12 ,,		,, 29	,, 26	3
19	12/11 ,,		,, 29	,, 26	3
20	11/*10* ,,	4	,, 29	,, 26	3
21	10/**9** ,,		,, 30	,, 26	4
22	9/8 ,,		,, 29	,, 25	4
23	8/7 ,,		,, 29	,, 25	4
24	7/*6* ,,	5	,, 29	,, 25	4
25	6/**5** ,,		,, 30	,, 25	5
26	5/4 ,,		,, 29	,, 24	5
27	4/3 ,,		,, 29	,, 24	5
28	3/*2* ,,	6	,, 29	,, 24	5
29	2/**1** ,,		,, 30	,, 24	6
30	1/1 A.D.		,, 29	,, 23	6
31	1/2 ,,		,, 29	,, 23	6
32	2/*3* ,,	7	,, 29	,, 23	6
33	3/**4** ,,		,, 30	,, 23	7
34	4/5 A.D.		Aug. 29	Aug. 22	7
35	5/6 ,,		,, 29	,, 22	7
36	6/*7* ,,	8	,, 29	,, 22	7
37	7/**8** ,,		,, 30	,, 22	8
38	8/9 ,,		,, 29	,, 21	8
39	9/10 ,,		,, 29	,, 21	8
40	10/*11* ,,	9	,, 29	,, 21	8
41	11/**12** ,,		,, 30	,, 21	9
42	12/13 ,,		,, 29	,, 20	9
43	13/14 ,,		,, 29	,, 20	9
44	14/*15* ,,	10	,, 29	,, 20	9
45	15/**16** ,,		,, 30	,, 20	10
46	16/17 ,,		,, 29	,, 19	10
47	17/18 ,,		,, 29	,, 19	10
48	18/*19* ,,	11	,, 29	,, 19	10
49	19/**20** ,,		,, 30	,, 19	11
50	20/21 ,,		,, 29	,, 18	11
51	21/22		,, 29	,, 18	11
52	22/*23* ,,	12	,, 29	,, 18	11
53	23/**24** ,,		,, 30	,, 18	12
54	24/25 ,,		,, 29	,, 17	12
55	25/26 ,,		,, 29	,, 17	12
56	26/*27* ,,	13	,, 29	,, 17	12
57	27/**28** ,,		,, 30	,, 17	13
58	28/29 ,,		,, 29	,, 16	13
59	29/30 ,,		,, 29	,, 16	13
60	30/*31* ,,	14	,, 29	,, 16	13