Three Astronomical Tables from Tebtunis

The texts edited below were found among the papyri belonging to the Egypt Exploration Society at the Ashmolean Museum, in a box of unpublished papyri numbered 79 as if part of the sequence of unpublished Oxyrhynchus papyri excavated by Grenfell and Hunt. The papyri in box 79 are of the Roman period, primarily in Greek, but there are also a few bits of demotic and hieratic script. Most of the fragments in the box were inscribed by Grenfell and Hunt with a number preceded by the letter "T", which almost certainly signifies that they came from Tebtunis.[1] The provenance is certain for the first fragment below. There is no indication of how these papyri were acquired, but this fact in itself may imply that they were purchased, rather than excavated, during one of Grenfell and Hunt's seasons in Egypt.[2] I am grateful to the Egypt Exploration Society for permission to publish these texts.

Part of the interest of these tables is that they add to the significant body of Greek and Egyptian astronomical and astrological papyri from Roman Tebtunis, and in particular from its temple. Like the temple of Narmuthis (Medinet Madi), that of Tebtunis appears to have been a centre of astrological activity.[3] Aside from this, the second of our texts presents a familiar type of astronomical information in a new format, whereas the third text employs a familiar tabular format for a new, and so far unidentified, purpose.

1. E.E.S. inv. 79/82 (1), inscribed "T 203"

There are two pieces, the larger one 9 x 17.5 cm, and the smaller one 2 x 5 cm. Both preserve approximately 2.5 cm lower margin, but are broken on all remaining sides. From the contents it can be deduced that the small fragment was originally situated one or two cm to the left of the other, and in the transcription they are treated as a single fragment. The papyrus is easily identifiable as part of the same roll as the fragments of an astronomical almanac from Tebtunis now in Florence (time of Claudius), published by Manfredi and Neugebauer in *ZPE* 11 (1973) 101–114 and plate III. Such dispersal of parts of manuscripts from Tebtunis among different modern collections is a well known phenomenon. The astronomical almanac occupied the front side of this roll (along the fibres), while on the back, and across the fibres, are the remains of a demotic text in a Roman-period hand, of uncertain but perhaps mythological character.[4] There is no sign on the new fragments of the line of hieratic text that appears on the front side of some of the Florence fragments. The Greek astronomical table is entirely in one hand, apparently belonging to the second half of the first century A.D. Ruling is in black ink except for the horizontal lines separating the rows in each planetary table, which have a fainter greyish colour.

Neugebauer succeeded in determining the nature of the contents of the table in the Florence fragments, its structure, and the years to which it pertains. The new pieces do not add much to this knowledge, but do show that the table extended several years later than the last year formerly attested. The table is of a variety to which I have assigned the name, "monthly almanac."[5] Such an almanac is divided into tables describing the motion and visibility conditions for a specific planet during a single calendar year. In this table, twelve rows represent the months, and each row records the date of such events as the

[1] Dr. R. A. Coles informs me that Grenfell and Hunt used similar codes for papyri from other Fayum sites, using the initials sometimes of the ancient, sometimes of the modern town. Oxyrhynchus papyri were not so marked.

[2] Another parcel of Roman-period Tebtunis fragments, also acquired by the E.E.S. under unknown circumstances, was the source of *P. Tebt. Tait* (cf. the preface to that volume).

[3] D. Baccani, *Oroscopi Greci*, Ricerca Papirologica 1 (Messina, 1992), 49–54; A. Jones, "The Place of Astronomy in Roman Egypt" in T.D. Barnes, ed. *The Sciences in Greco-Roman Society*, *Apeiron* 27.4 (Edmonton 1994), 25–51, esp. 39–41.

[4] I am grateful to Dr Joachim Quack for examining the demotic text in the new fragment; for R. A. Parker's description of the Florence fragments, see Manfredi and Neugebauer (note 4), 102. I also thank Prof. Manfredi for confirming that the Florence and E.E.S. fragments can have belonged to the same roll.

[5] For the nomenclature and description of this and other types of almanac, see A. Jones, "A Classification of Astronomical Tables on Papyrus", in N. M. Swerdlow, ed., *Ancient Astronomy and Celestial Divination* (forthcoming), and Jones, *Astronomical Papyri from Oxyrhynchus*, Memoirs of the American Philosophical Society (Philadelphia, forthcoming), I, 35–47.

planet’s crossing from one sign of the zodiac to a neighbouring one, first visibilities, last visibilities, stationary points, and oppositions to the sun, with the corresponding location of the planet in the zodiac. In the present almanac, tables are provided for each of the five planets Saturn, Jupiter, Mars, Venus, and Mercury (in the standard Greek order) for each successive year of the old (unintercalated) Egyptian calendar in the following arrangement:

Claudius 9 Saturn	**Claudius 9 Mars**	**Claudius 9 Mercury**	**Claudius 10 Jupiter**	Claudius 10 Venus	**Claudius 11 Saturn**	**Claudius 11 Mars**	**Claudius 11 Mercury**
Claudius 9 Jupiter	**Claudius 9 Venus**	**Claudius 10 Saturn**	**Claudius 10 Mars**	**Claudius 10 Mercury**	**Claudius 11 Jupiter**	**Claudius 11 Venus**	**Claudius 12 Saturn**

(continued)

Claudius 12 Jupiter	Claudius 12 Venus	Claudius 13 Saturn	Claudius 13 Mars	Claudius 13 Mercury	Claudius 14 Jupiter	Claudius 14 Venus	Nero 1 Saturn
Claudius 12 Mars	Claudius 12 Mercury	Claudius 13 Jupiter	Claudius 13 Venus	Claudius 14 Saturn	Claudius 14 Mars	Claudius 14 Mercury	Nero 1 Jupiter

(continued)

Nero 1 Mars	**Nero 1 Mercury**	**Nero 2 Jupiter**	Nero 2 Venus
Nero 1 Venus	**Nero 2 Saturn**	**Nero 2 Mars**	Nero 2 Mercury

In this schematic diagram, bold type indicates tables that are partially extant; those from the first two regnal years of Nero are in the E.E.S. fragments.

Transcription:

	i	ii	iii	iv	v
			] (*vac.*)	φα̣[ρμ	
		] (*vac.*)		πα[χ$^{\omega}$	
		] (*vac.*)		πα[υνι	
4	] ̣	$\overline{κς}$ κε	μ $\overline{κθ}$ α̣ρ (κ above)	επειφ [	
4a			$\overline{ο}$		
5	]	β̣ π̣αρθ ϲυν̄		μεϲ^{ο} [	
	]				
				β [∟	
8	]			θωτ [	
	]			φαω̄ [	
	]			αθυρ [	
	]			χοια̅ [	
12	]			τυβι [	
	] ̣			μεχ^{ε} [	
		]		φαμ̣[ε	
		]		φ[α]ρ̣μ̣[	
16		]		παχ$^{\omega}$ [	] ̣[
		]		παϋνι [	παρθ]^{ε} ϲυν̄ [
		]		ε̣πειφ [	] (*vac.*) [
		]		μεϲ^{ο}	ϛ̣ [ζ]υγ̄ ϲυν̄

Notes. For purposes of comparison with the data in the papyrus, I have calculated the dates and positions of planetary sign-entries and other phenomena using Ptolemy's *Handy Tables*.[6] One would find nearly the same dates using modern astronomical theory, e.g. from Tuckerman's tables:[7]

cols. i–iii

1–5. Right parts of the last rows of the table for Mercury's motion in the year Nero 1 (A.D. 54/55). Because of Mercury's comparatively fast motion through the zodiac and frequent appearances and disappearances as morning and evening star, there will often be two or three events recorded for this planet in a single month. Only the prediction of a second or third event would be visible on the preserved fragment.

1. Mercury enters Aries about Pharmuthi 13. Its first evening visibility takes place about the 27th, and its entry into Taurus about the 30th. If all three events were assigned to this month in the papyrus, we would expect traces in col. ii. Perhaps the entry into Taurus was predicted for early in the next month, or on the same day as the first visibility.

2. Mercury enters Gemini about Pachon 19.

3. Last evening visibility in Gemini about Payni 6; retrograde reentry into Taurus about the 11th; and first morning visibility in Taurus about the 27th. The absence of writing in cols. ii–iii suggests that Mercury's retrogradation was predicted as taking place entirely within Gemini. If so, there would also have been no predicted reentry into Gemini in the following row.

4. Reentry into Gemini about Epeiph 5; last morning visibility about the 15th at approximately Gemini 16°; and entry into Cancer about the 25th. In the papyrus, the last visibility is predicted for the 23rd, and at Gemini 25° 40'. However, it should be noted that the conditions and dates of Mercury's morning visibility are quite unstable when it is in Aries, Taurus, and Gemini.

The compendium representing διδύμοιϲ also occurs in the Florence fragments, but that for καρκίνῳ occurs only here—perhaps motivated by the lack of space in col. iii, which also forced the scribe to write the following zero (degrees) below the line. *P. Oxy.* LXI.4175, an astronomical ephemeris for 24 B.C., has similar compendia for the names of zodiacal signs.[8] The planet's position at its last visibility is given in degrees and minutes. It is a mere accident that the ruling separating columns has divided the degrees from the minutes, as also occurs in the Florence fragments (fr. 3, lines 23 and 24; not understood by Neugebauer in Manfredi and Neugebauer, ZPE 11 [1973] 113).

5. Entry into Leo about Mesore 11; first evening visibility about the 24th; and entry into Virgo about the 28th. In the papyrus, the date of entry into Virgo seems to be a single digit, probably 2, which would have to mean an epagomenal. The abbreviation ϲῡν meaning "sign-entry" also occurs in col. v, lines 18 and 20, and often in the Florence fragments. In *P. Oxy.* 4175 (lines 2–6) sign-entries are indicated by ϲυνα, ϲυναψ, and apparently once ϲυνα]ψ̣ει. Hence the literal meaning must be "contact" rather than "conjunction" (ϲύνοδοϲ) as conjectured by Neugebauer (in Manfredi and Neugebauer, *ZPE* [1973] 110). This usage is unrelated to the astrological doctrine of ϲυναφή, which concerns the relative positions of planets and the moon.

6–7. The Florence fragments show that the space above a planetary table in the almanac was used to identify the planet concerned and the regnal year. The traces along the left edge of the papyrus ought to belong to such a title, but are in fact unrecognizable (one expects κρόνοϲ and β ∟).

8–19. The table for Saturn's motion in Nero 2 (A.D. 55/56). All that remains of this is the end of a diagonally descending stroke crossing the leftmost ruling in line 13 (col. i), which should belong to the prediction of an event in Mecheir. It is not clear what that event could have been, since according to the *Handy Tables* the nearest pertinent events for Saturn are second stationary point in Aries about Tybi 13 and last visibility in Aries about Pharmuthi 29.

19. The small curled stroke close to the bottom ruling of the table in col. iii has, so far as I can tell, no significance. It resembles the lower stroke in line 7.

cols. iv–v

1–5. The table for Jupiter in Nero 2. Only month names survive.

8–19. The table for Mars in Nero 2.

16. In Pachon Mars is in Leo, with no sign-entry or other event occurring. The small trace of a vertical stroke might belong to λεον]τ̣.

17. Entry into Virgo about Payni 4. For the abbreviation ϲυν¯ see on i-iii.5.

18. Mars remains in Virgo in Epeiph.

19. Entry into Libra about Mesore 3. For ϲυν¯ see on i-iii.5.

---

6 For visibility phenomena I used the limiting values tabulated in Ptolemy's *Almagest*. Ptolemy's tropical longitudes were converted to sidereal longitudes using Theon of Alexandria's "trepidation" formula.

7 B. Tuckerman, *Planetary and Solar Positions A.D. 2 to A.D. 1649 at Five-Day and Ten-Day Intervals*, Mem. Am. Phil. Soc. 59 (Philadelphia 1964).

8 Jones, *Astronomical Papyri from Oxyrhynchus* (forthcoming; note 5). For a list of astronomical Oxyrhynchus Papyri to be published by me and their Oxyrhynchus Papyri series numbers, already assigned, see *P. Oxy.* LXI, pp. 142-145.

2. E.E.S. inv. 79/82 (2), inscribed "T 202"

The fragment (6.5 x 7.5 cm) is broken on all sides except, perhaps, the top, where there is 1 cm vacant of writing above the ruling. The table is written along the fibres in a plain sloping hand (2nd century?), with ruling in red. The back is blank. The scribe's orthography is more erratic than usual in astronomical texts: note the frequent transposition of rho and omicron, and the omission of iota, in ϲκορπω.

Transcription:

		ι	ιι	ιιι
	]	ζυ]γ̣ω̣	[κ]ς	ϲκρο̣π̣ω
	]	ϲ]κ̣ο̣ρ̣π̣[ω]		
	]	ϲ]κ̣ρ̣οπ̣[ω]		
4	]	ϲ]κ̣ορ[πω]	̣δ	ζυγω
	]	ζ̣υγω̣		
	]	ζ̣υγω̣		
	]	ζ]υγω	κ̣θ	ϲκορ̣πω
8	]	ζυγω	κ̣δ	ϲκορ̣π̣ω̣
	]	ϲ̣κροπω		
	]	ϲκορπω		
	]	ζυγω		
12	]	ζυγω		
	]	ζυγ̣ω		
	]	ζυ̣γ̣ω̣	κζ	[ϲκ]ο̣[ρπω
	]	ζυ̣γω	κα	[ϲκορπω
16	]	ϲκ̣ο̣ρ̣πιω		[
	]	ϲκ̣[ο]ρπι̣ω̣	[	
	]	ζυ̣γω	[	
	]	ζυγωι	[	
20	]	ζυ̣γ̣ω	[	
	]	ζυ]γ̣[ω		

Comment

Superficially, the table has the following characteristics. It is laid out in groups of seven lines or rows of data, separated by rulings. In each row there is always the name of a sign of the zodiac in col. i, usually Libra, otherwise Scorpio. Cols. ii and iii, when not left vacant, contain respectively a numeral and a zodiacal sign. In most instances the sign in col. iii is Scorpio, always in a line where col. i has Libra; but in line 4 col. i has Scorpio and col. iii Libra.

Each line, taken by itself, resembles the contents of a row of data in a monthly almanac.[9] The zodiacal sign in col. i would be the first sign entered by one of the planets during the month in question (or the sign occupied at the beginning of the month if the planet remains in it for the whole month), and the subsequent columns would indicate the day of the month when the planet crosses into a neighbouring sign, if it does so. Broken off to the left of col. i would be a column giving the date of the sign-entry recorded in col. i. But in a monthly almanac the successive rows represent consecutive months in a particular year—and no planet moves back and forth so often between just two signs for more than twenty months.

The solution to this puzzle is that the rows in the table represent years, not months; that is, each row describes the planet's motion during the course of the same month one year later than the row above.

[9] See note 5. The closest parallels are *P. Tebt.* II.274, covering A.D. 107–115, and *P. Lund* V.35b, covering A.D. 119–120.

Two planets, Mercury and Venus, are always within a limited range of degrees from the sun's position, and hence stay about the same part of the zodiac in any particular month from year to year. As it turns out, the pattern of motion in the papyrus fits Mercury very well. To show this, the following table compares the data in the papyrus with the sign-entries of Mercury for the month Phaophi in the civil Egyptian (or "Alexandrian") calendar for the years A.D. 36/37 through 56/57, calculated using Ptolemy's *Handy Tables*:

		Handy Tables					Papyrus	
year	day	sign	day	sign		sign	day	sign
36/37	6	Libra	24	Scorpio	]	Libra	[2]6	Scorpio
37/38	17	Scorpio			]	Scorpio		
38/39	10	Scorpio			]	Scorpio		
39/40	3	Scorpio			]	Scorpio	[x]4	Libra
40/41	—	Libra			]	Libra		
41/42	—	Libra			]	Libra		
42/43	10	Libra	29	Scorpio	]	Libra	29	Scorpio
43/44	3	Libra	21	Scorpio	]	Libra	24	Scorpio
44/45	13	Scorpio			]	Scorpio		
45/46	7	Scorpio			]	Scorpio		
46/47	3	Scorpio	28	Libra	]	Libra		
47/48	—	Libra			]	Libra		
48/49	11	Libra			]	Libra		
49/50	7	Libra	26	Scorpio	]	Libra	27	Scorpio
50/51	1	Libra	18	Scorpio	]	Libra	21	Scorpio
51/52	10	Scorpio			]	Scorpio		
52/53	4	Scorpio			]	Scorpio		(*broken*)
53/54	—	Libra			]	Libra		(*broken*)
54/55	—	Libra			]	Libra		(*broken*)
55/56	10	Libra	30	Scorpio	]	Libra		(*broken*)
56/57	4	Libra	22	Scorpio	]	Libra		(*broken*)

The only noteworthy discrepancies between the recomputed sign-entries and the data in the papyrus are in the years 39/40 and 46/47. In both these years, Mercury made a retrogradation in Phaophi, and this is the stage of its motion where we most expect to find inaccuracy in ancient calculated positions.

Since there would have been no special interest in Mercury's positions in only a single month of the year, we can presume that the complete table had sets of columns for all twelve calendar months, so that an entire row would comprise the same information as twelve rows of a conventional monthly almanac. The entire table would have had to be close to a metre in breadth. Incidentally we can now see the reason why the table is ruled after every seven lines: the pattern of Mercury's sign entries comes close to repeating every seven lines in the table. This is a consequence of the fact that seven years is less than eight days longer than 22 of Mercury's synodic periods (i.e. its cycles of appearances as evening and morning star).

Although the sequence of years starting with A.D. 36/37 fits the entries in the papyrus, we cannot safely conclude that these were the years covered by the almanac. Almost identical patterns occur 46 years later, and reasonably similar ones at more frequent intervals. It is possible that the table was intented to be perpetual, that is, that after a cycle of (probably) 46 years one went back to the top row. On the other hand, our tacit assumption that the dates in the papyrus are in the civil Egyptian calendar (so that the month in question must be Phaophi) must be correct. For in the old Egyptian calendar, which employed years invariably of 365 days with no intercalations, the dates of sign-entry into Scorpio in lines 1, 8, and 15 would have receded in steps of just one or two days instead of two or three.

3. E.E.S. inv. 79/1 (1)b, inscribed "T 43"

Three non-contiguous scraps (from top to bottom, 5 x 11, 2.5 x 3.5, and 4.5 x 13 cm) can be situated relative to each other according to their contents to make up a composite fragment with dimensions approximately 5 x 28 cm. The bottom 1.5 cm of the lowest scrap seems to be vacant; all other sides are broken. The astronomical table is written along the fibres on the front in a fairly large, practised informal hand (2nd century?), and is in very poor condition because of abrasion and perforation. The ruling is in black ink. On the back are faint traces of ink, some of which are suggestive of demotic script.

Transcription. Wider spacing is used in lines 11–13 so that the letters can appear approximately where they are on the papyrus, relative to the vertical rulings:

	i	ii	iii	iv	v
		]	ọ̄	[	
		]	ν̣ε̣		. [
		]	ν	οε	ζ̣ [
4		]	μ̣ε̣		ζ̣ [
		] . .	μ		[
		] .	λε		ζ̣ [
		]	λ̣		ζ̣ [
8	] ς̣	[ ]	κε	π	ζ̣ [
	] ς̣	[ ]	κ		. [
	] ς̣	. .	ι̣ε̣	πβ	. [
	] τ̣ η	ϲ κ	ε ι ν	η ϲ̣ [	
12	] α	ε̣ ω	ϲ	ϊ χ̣ [θ υ	ω ν
	] α̣	π ο	δ ι δ	υ μ̣ [ω ν	
		]η̣		[	
	]	ō	μγ		[
16	δ]	λ	λ̣[ζ]		[
	δ]	λ̣α	κ̣		[
	[δ	λβ	γ		]
	δ	λ]β̣	μ̣ς̣		[
20	δ	λ]γ̣	κθ	ε	[
	δ	λ]δ̣	ι̣β̣		[
	δ	λδ	ν]ε		[
	δ	λε]	λ̣η̣		[

continued

	i	ii	iii	iv	v
24	δ	λς	κ]α̣		[
	] δ̣	λζ	δ	ι	ọ̄ [
	] δ̣	λζ	μ̣ζ̣		ọ̄ [
	] δ̣	λη	λ̣		ō [
28	] δ	λθ	ι̣γ̣		ō [
	] δ̣	λ̣θ	νς		α [
	δ]	μ	λ̣θ̣	ι̣ε	α [
	δ]	μ̣α̣	κβ̣		α̣ [
32	δ	μ]β̣	ε		α [
	δ]	μβ	μ̣η̣		α [
	δ]	μ̣γ̣	λ̣α		α [
	] δ	μ]δ	ι̣ δ̣	κ	α [
36	] δ̣	μ̣δ̣	ν̣ζ̣		α [
	] δ̣	μ̣[ε]	μ		α [
	] δ̣	μ̣ς̣	κ̣[γ]		α [
	] δ	μ̣ζ̣	[ς]		α [
40	] δ	μζ	[μ]θ̣	κε	α [
	] δ̣	μη	λβ		β [
	] δ̣	μ̣θ̣	ι̣ ε		β̣ [
	] δ̣	μ̣θ̣	ν̣η̣		β̣ [
44	] δ̣	ν̣	μ̣α̣		[
	] δ̣	ν̣α̣	κ̣δ̣	[λ]	[

Comment

Notwithstanding the unbroken vertical tabular rulings, there appear to be two distinct tables here: a first one occupying lines 1–10, and after a new heading (11-15) a second one in lines 16–45. The second table is in a better state of preservation, so we will begin by considering its contents.

The plan of the second table is that of a "template," which is a variety of table found frequently on papyrus.[10] The purpose of a template is to describe the day-by-day progress of a planet (or the moon or sun) through the zodiac starting from a significant "epoch date" such as the date of the planet's first visibility (see the heading in lines 11-13). The underlying assumption is that the pattern of motion is always the same after every such event, or at least after all such events that take place in particular regions of the zodiac. Hence one can calculate the position of the planet for a given date by (1) counting the

[10] O. Neugebauer, *A History of Ancient Mathematical Astronomy* (Berlin etc. 1975), 790–792 and 822–823, and the references in note 5.

number of days since the immediately preceding epoch date, (2) looking up the corresponding progress since the epoch date in the template, and (3) adding this number to the position on the epoch date, which is found from a different table.

Each consecutive line in a template represents one more day since epoch, and the days are counted in an index column, normally every five lines. In our papyrus, col. iv is the index column. The corresponding progress through the zodiac is expressed as degrees, minutes, seconds, and sixtieths of seconds ("thirds"), i.e. four numerals separated by spaces or tabular rulings. In some situations it is assumed for the sake of computation that the planet is moving at constant speed, so that the progress increases (or decreases) from line to line by constant differences. In other situations, the line-to-line differences themselves change by fixed steps to describe an acceleration or deceleration. For example, during the days following a planet's second stationary point the planet will accelerate steadily from zero degrees per day to some maximum speed. Many templates include columns for both the accumulated progress since epoch and the line-to-line differences; typically the differences are placed to the left of the index column, and the running totals to the right.

In the papyrus cols. i–iii contain numerals that we can tentatively interpret as the minutes, seconds, and thirds belonging either to the line-to-line differences or to the running totals. At this point we do not know what numerals were written in the presumed column for degrees that should have been to the left of col. i, and it is also conceivable that the 4s legible in many lines of col. i were preceded by letters representing tens of minutes. What is clear is that the numbers, so far as they can be read, increase from line to line by a constant 43 thirds, starting from 4' 30" 43''' on "day 1" (line 16). The constant increment is actually written on line 15, immediately above the table.

Let us also suppose that the number of whole degrees was zero throughout the table, and that the number of minutes was 4 throughout (and not, say, 14, 24, etc.). Then the numbers and their running totals would be as follows:

day	°	'	"	'''	°	'	"	'''
1	0	4	30	37	0	4	30	37
2	0	4	31	20	0	9	1	57
3	0	4	32	3	0	13	34	0
4	0	4	32	46	0	18	6	46
5	0	4	33	29	0	22	40	15
6	0	4	34	12	0	27	14	27
7	0	4	34	55	0	31	49	22
8	0	4	35	38	0	36	25	0
9	0	4	36	21	0	41	1	21
10	0	4	37	4	0	45	38	25
11	0	4	37	47	0	50	16	12
12	0	4	38	30	0	54	54	42
13	0	4	39	13	0	59	33	55
14	0	4	39	56	1	4	13	51
15	0	4	40	39	1	8	54	30
16	0	4	41	22	1	13	35	52
17	0	4	42	5	1	18	17	57
18	0	4	42	48	1	23	0	45
19	0	4	43	31	1	27	44	16
20	0	4	44	14	1	32	28	30
21	0	4	44	57	1	37	13	27
22	0	4	45	40	1	41	59	7
23	0	4	46	23	1	46	45	30

24	0	4	47	6	1	51	32	36
25	0	4	47	49	1	56	20	25
26	0	4	48	32	2	1	8	57
27	0	4	49	15	2	5	58	12
28	0	4	49	58	2	10	48	10
29	0	4	50	41	2	15	38	51
30	0	4	51	24	2	20	30	15

Note that the whole number of degrees in the running totals changes from 0 to 1 on day 14, and from 1 to 2 on day 26, which is precisely what we find in col. v of the papyrus (lines 29 and 41). This establishes that col. v and three subsequent columns, now broken off, contained the running totals of the numbers in cols. i–iii, and also that no non-zero digits have been lost before the 4s in col. i. So far it appears that we are dealing with a typical template. The text above the table, in lines 11–13, would seem to have specified the parts of the zodiac in which the template was applicable; and above this was another template in which the total progress reached seven or eight degrees by day 82.

The difficulty is that a pattern of motion that starts at a rate of approximately 4 1/2 minutes per day and accelerates so slowly that it would take about 83 days to increase the speed by 1 minute per day does not resemble any stage of the motion of any of the heavenly bodies. In spite of the various clues furnished by the numbers and zodiacal signs preserved on the papyrus, I have to confess to being unable to identify the astronomical meaning of the tables.

University of Toronto Alexander Jones