The Miletos Inscription on Calendrical Cycles: IMilet inv. 84 + inv. 1604

Introduction

In their publication of the four fragments of Parapegma inscriptions, IMilet inv. 456A–D, found in the excavation of the theater of Miletos in 1902, Diels and Rehm included a fifth fragment, IMilet inv. 84,[1] which, according to its record sheet, had been discovered in 1899 built into a field wall near the church of Agia Paraskevi.[2] The four fragments IMilet inv. 456A–D exhibit characteristic parapegmatic features: drilled holes to accommodate a peg indicating the current date, statements of risings and settings of constellations, and statements of weather changes.[3] IMilet inv. 84 has none of these features, but it contains references to two summer solstices dated according to the Athenian calendar with archon year as well as according to the Egyptian calendar. Diels recognized the earlier solstice to be the one reported by Ptolemy (*Almagest* 3.1) as having been observed by "those around (οἱ περί) Meton and Euktemon" in 432 BC, while the later solstice was, according to the archon dating, that of 109 BC. He therefore interpreted the fragment as part of an introductory text of a parapegma inscription, providing the means of synchronizing the parapegma's contents, organized according to a solar year, with a civil lunisolar calendar regulated according to the 19-year intercalation cycles associated with Meton of Athens. On grounds of paleography and format Rehm had concluded that there were in fact two distinct parapegma inscriptions, with inv. 456A and 456D belonging to one and inv. 456B and 456C to the other.[4] In Diels's opinion the forms and sizes of inv. 84's letters indicated that it belonged to the same parapegma inscription as inv. 456B and 456C.[5]

This initial publication was based on squeezes of the fragments; but soon afterwards Rehm produced a second article incorporating remarks that Hiller von Gaertringen contributed following direct study of inv. 84 and inv. 456A–D, which had all meanwhile been brought to Berlin, as well as a squeeze and photograph of a new fragment, inv. 456N.[6] While confirming that inv. 456A, D, and N bore the same lettering and hence were probably from a single inscription, Hiller found that each of inv. 456B, inv. 456C, and inv. 84 had a distinct style of lettering. His inclination was to associate inv. 456C with inv. 456A, D, and N, and inv. 84 with inv. 456B, assuming a change of lettering style for esthetic reasons.[7]

[1] Diels–Rehm 1904, 95–96. Note that "IMilet inv." numbers, as assigned during the excavations, are not the same as the publication numbers assigned to the inscriptions when they were published in the series *Inschriften von Milet*; see Herrmann 1998, ix. Inv. 456A–D, inv. 456N, and inv. 84 were not republished in the series and hence lack series numbers. In the Packard Humanities Institute database, IMilet inv. 456A, 456C, 456D, and 456N (published in Rehm 1904, 756) are grouped together as McCabe Miletos 639, while inv. 456B is grouped with inv. 84 as McCabe Miletos 640. The most recent editions of all six fragments are in Lehoux 2005; those for inv. 456A–D are reeditions based on direct inspection of the fragments whereas those for inv. 456N and inv. 84 depend for their readings on the earlier publications.

[2] Information from the record sheet for inv. 84, Bayerische Staatsbibliothek Rehmiana Suppl. box 1 (nos. 1–300). The sheet is in the hand of Carl Fredrich, who was the epigraphical assistant at the excavations from 1899–1901, with annotation by Rehm. The map of Miletos and its environs in Wilski 1906 shows three ruined churches of Agia Paraskevi; it is not clear which one is meant, but all are several kilometers from the ancient city.

[3] On parapegmata see Rehm 1949, Lehoux 2007.

[4] Diels–Rehm 1904, 100–101.

[5] Diels–Rehm 1904, 96. Rehm's contribution to this article appears to have been written before Diels gained access to a squeeze of inv. 84.

[6] Rehm 1904; Hiller's notes are on pp. 752–753. Hiller says explicitly that he examined all the fragments inv. 84 and inv. 456A–D in the Pergamonmuseum in Berlin in March, 1904. The current location of inv. 456N is not known. A photograph of it exists in the archives of the Inscriptiones Graecae project. It is not known whether the squeeze consulted by Hiller von Gaertringen is still in existence.

[7] Lehoux 2005, 134 gives persuasive arguments that inv. 456C belongs with inv. 456A, D, and N. This parapegma inscription was almost certainly older, by about two decades or more, than the calendar inscription to which the present article is devoted. Inv. 456C preserves part of a dedicatory line with the name of the stephanephor Epikrates son of Pylon, whose year of office

No photograph of inv. 84 was ever published, and the fragment has not been located in the collection of the Antikensammlung of the Staatliche Museen zu Berlin where inv. 456A–D are preserved.[8] Hence in his 2005 reedition of the parapegma fragments, Daryn Lehoux reproduced its text as published in 1904, with a circumspect selection of supplements.[9] Lehoux's view was that it belonged to a third, nonparapegmatic inscription.

Fig. 1. IMilet inv. 84, squeeze in Inscriptiones Graecae archive, Berlin (photo Sebastian Prignitz)

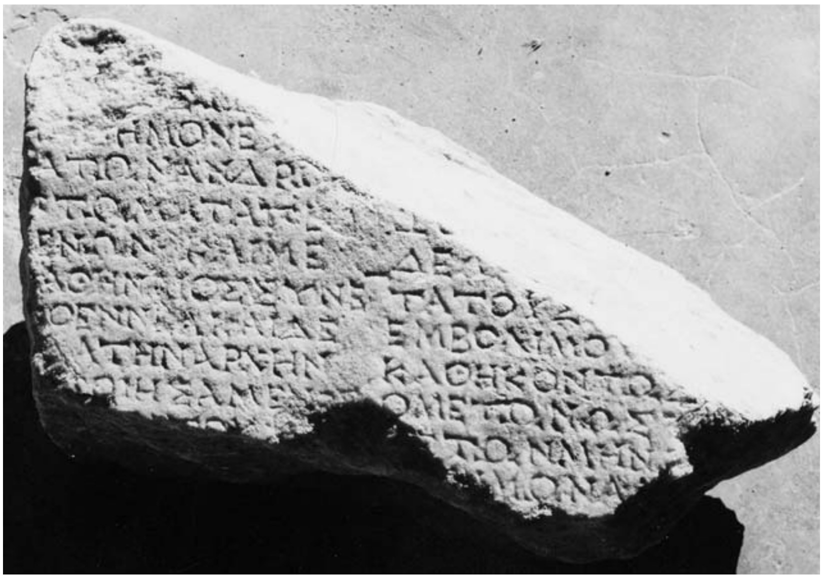

Fig. 2. IMilet inv. 1604 (photo Milet Grabung)

must have fallen within the long interval preceding 89/88 BC for which the inscriptional lists of stephanephors are missing (not *in* 89/88 as Lehoux states), and probably around 130 BC if we accept Rehm's plausible dating of the *floruit* of his son Apollonios to around 110 BC (Rehm, *IMilet* 1.9.331–332 in von Gerkan–Krischen 1928, 159–161 = Rehm–Herrmann 1997, 107–109).

[8] I am grateful to Dr. Sylvia Brehme for confirming this by personal communication. There does not appear to be a specific Museum inventory record for the accession of inv. 84.

[9] Lehoux 2005, 136–138.

In 2013 I learned of a squeeze of inv. 84 in the archives of the Inscriptiones Graecae in Berlin (Fig. 1). Then in the following year, while consulting Otto Neugebauer's files concerning astronomical and astrological papyri which are kept in the Papyrology Collection of the University of Michigan, I was astonished to find a file containing a photograph and transcription of an unpublished inscription fragment from Miletos, IMilet inv. 1604, with indications that it probably belonged to the same inscription as inv. 84 (Fig. 2).[10]

The correspondence between Herrmann and Neugebauer explains why this file exists. Herrmann had spoken to Neugebauer about the inscription fragment during the autumn of 1974 when Herrmann was a Member of the School of Historical Studies at the Institute for Advanced Study, Princeton, and in a letter of February 12, 1975, Herrmann sent Neugebauer his transcription of it, adding that it had been deposited at the inscription depot of the Miletos excavations (from an unknown findspot) in the years after the Second World War.[11] In this letter he expresses his suspicion that the new fragment belonged to the same inscription as inv. 84, though he was unable to confirm this paleographically since inv. 84 had been published without photograph or measurements and neither the stone itself nor a squeeze of it could be located. Neugebauer replied cautiously on February 23 that he agreed that the new fragment belonged to the same *category* of text as inv. 84, but that precisely this fact made an integration (*Anpassung*) of the two fragments pretty well hopeless. (Perhaps he meant that too little text survived in inv. 84 to allow extrapolation of its context in the absence of parallels.) In a second letter of April 5, after he had received a photograph of inv. 1604 that Herrmann had obtained from the excavation's photographic archive in Frankfurt (sent accompanying a letter to Neugebauer on April 2), Neugebauer wrote that, although he now thought it was highly plausible that the two fragments belonged to one inscription, he and Gerald Toomer, with whom he had been studying inv. 1604, could find no direct connection between it and inv. 84. The correspondence apparently ended here.

In his letters Herrmann wrote that inv. 1604 was destined to be included in the volumes then in preparation of inscriptions from Miletos, though he invited Neugebauer, if he wished, to present it in a separate article. As things turned out, Neugebauer never mentioned inv. 1604 in print, nor did it appear in the three volumes of *Inschriften von Milet* that were eventually published between 1997 and 2006.[12] It is very fortunate therefore that Neugebauer spared his file on inv. 1604 along with his files concerning papyri when he destroyed most of his papers towards the end of his life. In the present article I offer the long-overdue edition of inv. 1604 based on the photograph and Herrmann's transcription, and a reedition of inv. 84 based on the squeeze.[13] In the commentary that follows, I attempt to interpret the contents and purpose of the text to which they belonged, arguing (in agreement with Lehoux) that it was a public inscription separate and distinct in purpose from the two parapegmata, and probably connected with the introduction of a scheme of regulation for the Milesian calendar according to a "Kallippic" 76-year cycle.

[10] I wish to thank the Michigan Papyrology Collection and in particular its collection manager, Monica Tsuneishi, for access to Neugebauer's files, to Prof. Norbert Ehrhardt (Münster) for providing me with Peter Herrmann's copy of the photographic print of inv. 1604, and to the Inscriptiones Graecae project of the Berlin-Brandenburgische Akademie der Wissenschaften and in particular Prof. Klaus Hallof and Dr. Sebastian Prignitz for access to the squeeze of inv. 84 and the correspondence between Herrmann and Neugebauer. (Herrmann's letters are also preserved in the Michigan file but without copies of Neugebauer's replies.)

[11] It was discovered no later than 1963, since Herrmann's copy of the photograph of it is inscribed with a negative number (63.531) indicating that year.

[12] Prof. Ehrhardt informs me that the parapegma inscriptions were not included in the *IMilet* series, as originally planned, because the editors were unable to enlist the assistance of a collaborator with expertise on the astronomical side; the same explanation presumably applies to inv. 84 and inv. 1604.

[13] I thank Paul Iversen for reviewing the readings against the photograph and squeeze and for offering many helpful suggestions, and Prof. Georg Petzl for several corrections to the text and commentary. Herrmann's transcription indicates some traces, reported in the apparatus, that I cannot see on the photograph. Since his letters seem to imply that he did not yet have the photograph when he sent the transcription to Neugebauer, it is possible that he had made it from direct inspection during a previous visit to Miletos, or from a squeeze. Herrmann had squeezes of practically all the Miletos inscriptions that he edited, and his inventory indicates that he made one of inv. 1604 (private communication by Prof. Wolfgang Günther), but it cannot be located among his collection, which is now in the Inscriptiones Graecae archives.

Transcription and translation

IMilet inv. 1604

i

— — —	— — —	— — —
]ΣΩ[	[ ]ΣΩ[	…
]Η ̣ ̣ΗΜΟΝΕΥ ̣[	[ ]Η μ̣ν̣ημονευ̣ ̣[	… memorial
]ΑΤΩΝΑΝΔΡΩ[	[ ]Α τῶν ἀνδρῶ[ν]	… of the men
]ΠΤΩΜΑΤΑΠΕ	[ ]πτώματα ΠΕ-	… defects(?) …
]ΕΝΩΝ*v*ΚΑΙΜΕ	[ ]ΕΝΩΝ. καὶ Μέ-	…. And
]ΑΘΗΝΑΙΟΣΣΥΝΕ	[των ὁ] Ἀθηναῖος συνε-	Meton of Athens estab-
]ΟΕΝΝΕΑΚΑΙΔΕ	[στήσατ]ο ἐννεακαιδε-	lished a 19-year
] ̣ΑΤΗΝΑΡΧΗΝ	[καετηρί]δ̣α, τὴν ἀρχὴν	cycle, making its
] ̣ΟΙΗΣΑΜΕΝΟΣ	[αὐτῆς] π̣οιησάμενος	beginning
] ̣ ̣Υ[	[ἀπὸ]Τ̣Ο̣Υ[	[from …] …
— — — — — —	— — —	

+1 Ω: complete in Herrmann’s drawing, bottom only visible in photograph
+2 H[1]: complete right half of letter in Herrmann’s drawing, only the horizontal and lower half of right vertical visible in photograph | ̣[1]: trace at baseline immediately right of preceding H, barely visible in photograph but shown as a sharply ascending diagonal in Herrmann’s drawing | ̣[2]: apparently a faint trace of the bottom of a serifed vertical immediately to the left of the following eta, not reported on Herrmann’s drawing | Υ: reported as complete in Herrmann’s drawing, only the serifed vertical visible in the photograph | ̣[3]: trace at baseline immediately right of preceding Υ
+5 *vacat*: one letter
+8 ̣: descending diagonal immediately left of following Α
+9 ̣: trace at top level immediately left of following Ο
+10 ̣ ̣: horizontal at top level, serifed at right end and either serifed or inflecting upward at left end, having the breadth of a tau; then the top of large loop | right of Υ, the photograph appears to show traces resembling the diagonal strokes of Σ, but according to the hand copy the surface is effaced here and no traces are reported

ii

— — —	— — —	— — —
ΖΟ[	ΖΟ[	…
ΔΕ ̣ ̣[	ΔΕΛ̣ ̣[	…
ΤΑΤΟΥΣ[	ΤΑΤΟΥΣ[	…
ΕΜΒΟΛΙΜΟΥ[	ἐμβολίμου[ς	intercalary (months) …
ΚΑΘΗΚΟΝΤΩΣ[	καθηκόντως [	suitably …
ΟΜΕΤΩΝΩΣΤ[	ὁ Μέτων ΩΣΤ[	Meton, so that(?) …
[̣] ̣ΤΩΝΜΗΝ ̣[	[̣]Ε̣ τῶν μηνῶ[ν τῶν ἐμ]-	… of the intercalary
[̣] ̣ ̣ΜΩΝΑ ̣[	[βο]λ̣ί̣μων Α ̣[	months …
— — —	— — —	— — —

+2 ̣[1]: shown as complete lambda in Herrmann’s drawing, but in the photograph the letter looks more like an indistinct omega | ̣[2]: trace at baseline, shown in Herrmann’s drawing as the beginning of a sharply ascending diagonal with the beginning of a horizontal at mid height, like the lower left part of alpha

+7 ̣[1]: horizontal at top height, inflected upwards at left and serifed at right, and short trace of horizontal stroke at mid height slightly left of right end of the upper horizontal | ̣[2]: trace at baseline immediately right of preceding N, and trace at top level slightly further right
+8 ̣ ̣: top of apical letter; then top of serifed vertical immediately left of following M | ̣: trace at top level, immediately right of preceding A

IMilet inv. 84

i

[̣]ΕΡΙΝΗΣΤΡΟ ̣ΗΣ ̣[̣]	[θ]ερινῆς τροπ̣ῆς γ[ε]-	(from the) summer solstice
ΝΟΜΕΝΗΣΕΠΙΑΨΕΥΔΟΥΣ	νομένης ἐπὶ Ἀψεύδους	occurring under Apseudes,
ΣΚΙΡΟΦΟΡΙΩΝΟΣ*v*Ι̅Γ̅*v*Η	Σκιροφοριῶνος ιγʹ ἥ-	Skirophorion 13, which
ΤΙΣΗΝΚΑΤΑΤΟΥΣΑΙΓΥ	τις ἦν κατὰ τοὺς Αἰγυ-	was according to the Egyp-
ΠΤΙΟΥΣΜΙΑΚΑΙΚ̅	πτίους μία καὶ κʹ	tians the 21st
[̣]ΟΥΦΑΜΕΝΩΘ*v*ΕΩΣ	[τ]οῦ Φαμενὼθ ἕως	of Phamenoth, until
[̣] ̣ΣΓΕΝΟΜΕΝΗΣΕΠΙ	[τ]ῆ̣ς γενομένης ἐπὶ	the one occurring under
[̣ ̣] ̣ΥΚΛΕΙΤΟΥΣΚΙ	[Πο]λ̣υκλείτου Σκι-	Polykleitos, Ski-
[̣ ̣ ̣ ̣ ̣ ̣]ΩΝΟΣ*v*Ι̅Δ̅*v*ΚΑ	[ροφορι]ῶνος ιδʹ, κα-	rophorion 14, and according
[̣ ̣ ̣ ̣ ̣ ̣] ̣ΣΑΙΓΥΠΤΙ	[τὰ δὲ το]ὺ̣ς Αἰγυπτί-	to the Egyptians
[̣ ̣ ̣ ̣ ̣] ̣ΝΙΤΗΙΙ̅Α̅	[ους Πα]υ̣νὶ τῆι ιαʹ	Payni 11,
[ ]ΗΣΙΟΝ	[ ]ΗΣΙΟΝ	…
[ ] ̣ ̣ ̣	[ ]Σ̣Α̣Ρ̣	…
– – –	– – –	– – –

1 ̣[1]: serifed bottom of vertical immediately right of preceding O, compatible with left vertical of Π, remainder of letter obliterated | ̣[2]: serifed bottom of vertical immediately right of preceding Σ
3 *vacat*[1]: 6 mm (less than half a letter) | Ι̅Γ̅: letters slightly shorter than normal (8mm), with serifed bar 12 mm above baseline | *vacat*[2]: 11mm (half a letter)
6 *vacat*: 7 mm (half a letter)
7 ̣: serifed top of vertical immediately left of following Σ
8 ̣: possible serifed right end of descending diagonal at baseline immediately below left end of upper left stroke of following Y
9 *vacat*[1]: 11 mm (half a letter) | Ι̅Δ̅: letters slightly shorter than normal (8 mm) and slightly elevated, serifed bar 12mm above baseline | *vacat*[2]: 10 mm (half a letter)
10 ̣: serifed right end of ascending diagonal at top height, immediately left of following Σ
11 ̣: probable serifed right end of ascending diagonal at top height, immediately left of following N | Ι̅Α̅: no *vacat* before numeral, letters about normal height, serifed bar 12 mm above baseline
13 ̣ ̣ ̣: horizontal at top height, descending slightly towards the right, met at the left by sharply descending diagonal preserved down to mid height, likely sigma (cf. sigma at end of ii 5) though epsilon or gamma cannot be ruled out; then top of apical letter; then top loop of rho or conceivably beta

ii

[	[	…
ΕΧΟ ̣[	ΕΧΟ ̣[	…
ΚΑΙΕ ̣[	καὶ ΕΧ̣[	…
ΔΕ*v*Ο*v* ̣[	δὲ ὁ ̣[ ]	…
ΚΑΙΣ ̣[	καὶ συ̣[νεστήσατο τὴν]	and [he established the]
ΕΚΚΑ[	ἑκκα[ιεβδομηκονταε]-	76-year period
ΤΗΡΙΔ[	τηρίδ[α περιέχουσαν ἡ̣]-	[containing]
ΜΕΡΑ[	μέρα[ς (μυριάδας) β̅ ͵ζ̅ψ̅ν̅θ̅ ἐν περι]-	[27759] days [in a]

ΟΔΩ[	ὁδω[ι τετραπλασίωι τῆς]	period [four times the]
ΕΝΝΕ[	ἐννε[ακαιδεκαετηρίδος]	[1]9-[year cycle]
ΚΑΙΠ[	καὶ Π[	and …
̣ΙΣ[	Λ̣ΙΣ[	…
– – –	– – –	

2 ̣: serifed bottom of vertical, slightly sloping to the right, immediately right of preceding O
3 ̣: diagonal descending from top height meeting diagonal ascending from baseline, both possibly continuing to form X but right half indistinct
4 *vacat*^{1}: 4 mm (half a letter) | *vacat*^{2}: 3mm (half a letter) | ̣: faint and indistict traces, with possible suggestion of the upper right corner of sigma
5 ̣: faint trace of diagonal descending from top height meeting top of a half-height vertical serifed at bottom
12 ̣: apical letter with apparent serif at lower right, no trace of horizontal at baseline or mid height

Descriptions and relative placement of the fragments

IMilet inv. 84 is broken on top and bottom as well as both sides. Its dimensions are given in the record sheet as height 21 cm, width 24 cm, thickness 21 cm.[14] These figures must be too small, however, since the inscribed surface, measured from the squeeze, is approximately 220 mm height by 255 mm width. Parts of two columns of text are extant. Thirteen lines of col. i are at least partly preserved, lines 2–5 being complete. The average line-to-line spacing measured between the baselines of lines 1 and 12 is approximately 16 mm, with average letter height about 10 mm. Line 1, extant only in col. i, was evidently the original top line since there are about 7 mm of vacant surface preserved above the first part of the line, increasing to about 18 mm above the letters TPO. In col. ii the beginnings of eleven lines are preserved, beginning with what must have been the second line of the original column. Average line spacing (measured between the baselines of lines 2 and 12) and letter height are approximately the same as in col. i, though because the spacing diverges from the average in both columns, corresponding lines are not consistently aligned; for example col. ii line 9 is about half way between col. i lines 8 and 9 whereas col. ii line 11 has nearly the same baseline as col. i line 11. The horizontal interval between the left margins of cols. i and ii is approximately 195 mm, and col. i lines 1–11, as restored below, average about 15 letters per line (not counting a few narrow *vacats*), with the shortest line comprising 13 letters and the longest 18. The intercolumniar gap tends to be about the width of one letter, but varies from as much as three letters' width to no gap at all. Line ends follow syllabic division.

IMilet inv. 1604 too is broken on all sides. Its reported dimensions are 20 cm height, 32 cm width, 15.5 cm thickness.[15] Parts of two columns are extant, with col. i represented by ten partial lines, mostly preserving the line ends, and col. ii by eight partial lines, mostly preserving the line beginnings. Line breaks follow syllabic division. Since we do not know how many lines, if any, are lost at the top, we number the lines in each column as +1 etc. starting with the first preserved line. Col. ii line +1 is more or less aligned with col. i line +4. Letter height is reported as ranging from 8 to 10 mm, with interlinear gaps from 3 to 8 mm. Calibrating the photograph according to the reported dimensions of the fragment, however, I estimate that the letter height ranges from 10 to 13 mm, and that the average line spacing (measured between the baselines of col. i lines +1 and +9, and between those of col. ii lines +1 and +8) is approximately 15 mm. The beginnings of col. i lines +6 through +9 can be restored with confidence, and imply roughly 200 mm for the horizontal interval between the left margins of col. i and col. ii.

[14] See note 2 above. Hiller reports the thickness as 22 cm (Rehm 1904, 753).

[15] From the transcription card of the fragment in Neugebauer's file.

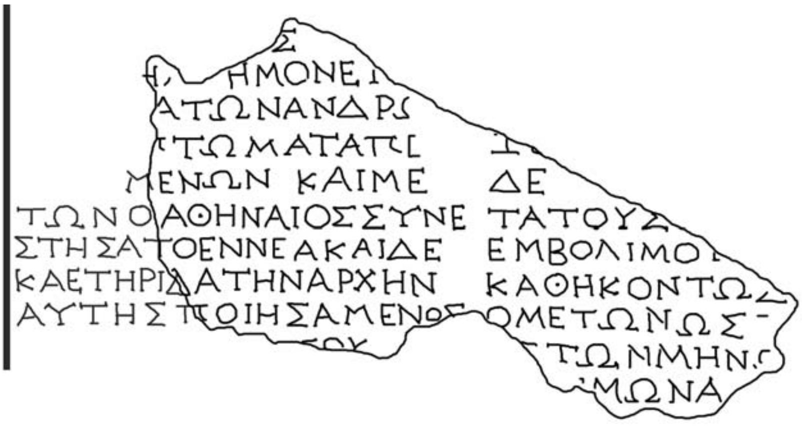

Fig. 3. Location of left margin of IMilet inv. 1604, col. i

The letter sizes and layout in the two fragments are sufficiently alike to support the assumption that they belong to a single inscription, especially when allowance is made for the less than optimal basis of the measurements for inv. 1604. Their letter forms also appear to be the same. But it is of course the contents that provide the principal evidence that we are dealing with a single text. In inv. 84, i 1–6, we are given a date of a summer solstice in 432 BC that is known from other sources to have been associated with the astronomer Meton of Athens. In inv. 1604, i 5–9 (name partly restored, cf. ii 6), Meton is cited as the inaugurator of the 19-year calendrical cycle that is also ascribed to him in other ancient sources. The interval between the first and second solstice dates in inv. 84, col. i is 323 years, which amounts to exactly seventeen 19-year cycles. Given the comparative rarity of Greek astronomical inscriptions, the connections between the two fragments are too close to be coincidental.

The inscribed surfaces of the two fragments were not physically contiguous, and their relative configuration as parts of the original inscription cannot be determined with certainty. We may safely assume that inv. 1604, col. i, which introduces Meton of Athens, preceded inv. 84, col. i, which cites Meton's solstice date. Since inv. 1604, i 6–9 was leading to a statement of the epoch date of Meton's 19-year cycle, and that epoch date is recorded by Diodoros 12.36 as being the 432 BC solstice date, it would be tempting to suppose that inv. 1604, col. i was towards the bottom of the text column immediately to the left of the one of which inv. 84, col. i gives the top lines (so that inv. 1604 col. ii would be the continuation of the same column as inv. 84 col. i); but it is not easy to see a way in which relatively short bridging passages between inv. 1604, i 9 and inv. 84, i 1, and again between inv. 84, i 11 and inv. 1604, ii 1 would have produced a plausible continuity of subject matter. The chief difficulty is that the sequel of inv. 1604, i 9 ought to have been a simple statement of the epoch date, whereas inv. 84, col. i presents the *interval* (two dates linked by ἕως) between the epoch date and a later date. I believe, therefore that inv. 84, col. i followed inv. 1604, col. ii, perhaps (but not necessarily) with one or more intervening lost columns.

Adopting this order, we can see in inv. 1604, i 1–5 the conclusion of an introductory passage apparently alluding to the remembrance (μνημονευ-) of men of the past who had made some beneficial contribution to knowledge or life, which from what follows would seem to be the devising of orderly calendar cycles. Meton is named first for his institution of a 19-year lunisolar cycle, and col. ii said something about Meton's distribution of intercalary (13-month) years in this cycle. Further along, inv. 84, col. i speaks of the interval of 323 years between the epoch solstice of Meton's cycle and a solstice inaugurating the 19-year cycle during which the inscription was erected. The last preserved column introduces the 76-year cycle, a refinement of the 19-year cycle attributed in other sources to Kallippos. We have no way to know whether the text continued with discussion of other cycles such as the 304-year cycle devised by Hipparchos.

As augmented by the new fragment, the text no longer makes sense as an introduction to a parapegma; there is too much about the development of calendrical cycles, and nothing recognizable relating to the coordination of solar with lunisolar years. This is subject matter that would appropriately be found in a scientific treatise; in fact it is closely paralleled by the chapter "on months" in Geminos's *Introduction* *to the Phaenomena*, which date from only a few decades later than the inscription. I suggest that the most probable occasion for erecting a public inscription recounting the history of calendrical cycles would have been an institution or revision of a system of regulation of the civil calendar of Miletos. This hypothetical event, and the inscription commemorating it, can be dated to between 109 and 90 BC, since after 90 the summer solstice of 109 would no longer have been the most recent one following Meton's by a multiple of nineteen years.

Lunisolar calendrical cycles

In a lunisolar calendar, the beginnings of months are tied, at least approximately, to a specific phase of the Moon, and the beginning of the first month of the calendar year is kept at least roughly at the same stage of the natural seasons. A specific lunisolar calendar is defined by certain conventions including the names assigned to the months and their order, the stage of the natural year when the first month of the calendar year is supposed to fall, and the way in which the days are named within the months. As we shall use the term in this article, the conventions that define a specific calendar do not include the methods by which it is regulated in practice, that is, how the decision is made that the right time has come for a new month or a new year to begin. For example, a lunisolar calendar that employs the month names Hekatombaion, Metageitnion, Boedromion, etc. with a year start following the summer solstice can be called the Athenian calendar for our purposes whether the beginnings of the months and years were determined by direct observation, by some kind of computation, by a fixed repeating pattern, or by arbitrary decisions of the magistrates.

Given ideal observing conditions, the specific lunar phase associated with the beginning of the calendar month, if always watched for at the same time of day or night, should recur at intervals of either 30 or 29 days, making the preceding lunar month respectively "full" or "hollow". If the beginning of the calendar year is determined by observation as the first occurrence of the critical lunar phase following an observed annual event such as a solstice or the first appearance of a particular star in the predawn sky, calendar years should always comprise either 12 months ("ordinary year") or 13 months ("intercalary year"). A calendrical cycle is a set of rules prescribing a fixed repeating sequence of ordinary and intercalary years ("y-m cycle") or a fixed repeating sequence of full and hollow months ("m-d cycle") or both ("y-m-d cycle"). The sequence would normally distribute the shorter and longer years or months as evenly as possible over the entire period.

The total number of months in a y-m cycle (i.e. twelve times the number of regular years plus thirteen times the number of intercalary years) divided by the number of years in the cycle represents an approximation of the mean length of the year in lunar months, and the long-term accuracy of the cycle depends on how close this quotient is to the actual value (which is approximately 12.3683 if the years are supposed to be tied to observed solstices or equinoxes). Similarly, the total number of days in an m-d cycle (i.e. thirty times the number of full months plus twenty-nine times the number of hollow months) divided by the total number of months represents an approximation of the mean length of the lunar month in days, which in reality is approximately 29.5306 days. A y-m-d cycle obviously also implies an assumed value for the mean length of the year in days.

As an example of a y-m cycle, consider a cycle of the kind designated in Greek as an ὀκταετηρίς, which (as described in detail by Geminos, 8.27–33) distributes ordinary (O) and intercalary (I) years in a cycle of eight, say IOIOOIOO, making a total of 99 months in the cycle, and implying that the mean year is 12.375 lunar months. Someone using this cycle to regulate a calendar would still have to determine either the beginnings of the months or the beginnings of the years by observation or by some form of calculation independent of the cycle. Suppose the principle of the calendar in question was that years began with the first appearance of the new Moon crescent in the evening sky following summer solstice. Since it is much easier to watch for a new Moon crescent than to determine a date of a summer solstice by observation, our hypothetical person would probably observe the new Moons, inaugurate a cycle with, say, a new Moon observed soon after a single observed solstice, and thereafter let the cycle dictate which years will have twelve or thirteen months. In the short term, discrepancies between year starts determined by this method and by repeatedly observing the solstices would be comparatively rare. However, because the mean year length implied by the eight-year cycle is significantly too great, year starts determined by the cycle will fall one month too late with increasing frequency as time passes, and unless a correction is made, the calendar as regulated by the cycle will progressively lag further and further behind the calendar as regulated entirely by observation with respect to the year starts and the sequence of months, but the months will remain aligned with the Moon's phases because the beginnings of the months are determined by observations.

An extremely simple example of an m-d cycle (also described by Geminos, 8.34–35) is the assumption that full and hollow months strictly alternate, so that two months are equated with fifty-nine days and the mean month is 29.5 days. When using an m-d cycle, one obviously "observes" the days, inaugurating the cycle at a single observed lunar phase of the appropriate kind, and thereafter the cycle dictates the beginnings of the months. In the short term discrepancies of one day in either direction will frequently occur between month beginnings generated by the cycle and determined by observation, while in the long term the fact that the cycle's mean month is significantly too small means that the generated month beginnings will fall progressively further and further in advance of observed month beginnings.

The Miletos inscription discussed at least two calendrical cycles, the 19-year cycle (ἐννεακαιδεκαετηρίς) and the 76-year cycle (ἑκκαιεβδομηκονταετηρίς). Several ancient sources including Diodoros 12.36.2 ascribe the discovery of the 19-year cycle to Meton of Athens, without giving any details of the cycle; hence the modern expression "Metonic cycle" for a 19-year cycle. On the other hand, Geminos 8.50–56 provides a detailed description of a 19-year y-m-d cycle which he associates with "the people around" Euktemon, Philippos, and Kallippos (but not Meton). One period comprises nineteen calendar years (twelve ordinary and seven intercalary), 235 months (110 hollow and 125 full), and 6940 days. Geminos does not spell out the pattern of distribution of ordinary and intercalary years in the cycle; to obtain the optimal spread of intercalations it ought to have been IOIOOIOOIOIOOIOOIOO, starting the cycle with the year whose first month falls earliest relative to the natural year. For the specification of full and hollow months, he gives the following rule. Each of the 235 months is considered nominally to comprise thirty days. However, every sixty-fourth day counting from the beginning of the cycle is to be omitted in practice (ἐξαιρέσιμος), without modifying the numbering of the surviving days within the resulting hollow month. For example, if the sixty-fourth day of the cycle is chosen to be omitted, then the second month of the first year of the cycle is hollow and its days are designated as the 1st through the 3rd of the month, immediately followed by the 5th through the 30th. The next omitted day will be the eighth day in the fourth month of the first cycle year, and the days of this month will be designated as the 1st through the 7th, immediately followed by the 9th through the 30th; and so on. This rule will result in exactly 110 hollow months separated usually by one full month but occasionally by two.

The inscribed scale of the main upper dial of the Antikythera Mechanism's rear face presents a 19-year y-m-d cycle applied to a specific calendar that has been identified as the calendar of Korinth, otherwise attested chiefly from inscriptions from northwest Greece.[16] About a third of the scale, which took the form of a spiral of exactly five turns, is extant. The complete scale comprised 235 cells inscribed with month names and, in the cells corresponding to the first month of the calendar year, year numbers from one through nineteen. The surviving cell inscriptions are consistent with the IOIOOIOOIOIOOIOOIOO pattern of ordinary and intercalary years, beginning with the year whose first month falls earliest relative to the natural year. An additional scale inscribed inside the innermost turn of the spiral specifies a pattern of omitted days that is similar but not identical to Geminos's. In this scheme, each turn of the spiral, comprising exactly 47 months, constitutes a mini-cycle of full and hollow months, within which twenty-two days are omitted at intervals of 64 or, occasionally, 65 days.

Considered simply as a y-m cycle, the 19-year cycle is remarkably accurate. If the year starts of a calendar were regulated according to the cycle, with month beginnings established from direct observation of the Moon's phases, the year starts generated by the cycle would fall later relative to the solstices and

[16] Freeth–Jones–Steele–Bitsakis 2008.

equinoxes by a theoretical average of less than 0.09 days per cycle, a shift that would only become apparent after several centuries had elapsed. It was as a y-m cycle that the Babylonians used a 19-year cycle to regulate their lunisolar calendar beginning early in the fifth century BC; the lengths of the months in days were established either by observation of the new Moon crescent or by a calculation independent of the cycle. Treated as a y-m-d cycle, it is less satisfactory, because the implied mean lengths of the month and the year, respectively 29.5319… days and 365.2631… days, are significantly too long. If a calendar was regulated according to the cycle using the day count as the independent, observed element, the month starts generated by the cycle would fall later relative to the Moon's phases by a theoretical average of over 0.31 days per cycle, and the year starts by a theoretical average of almost 0.40 days, discrepancies that would become noticeable within half a century.

The 76-year cycle (ἑκκαιεβδομηκονταετηρίς) is described rather tersely by Geminos 8.59–60, who ascribes it to "those around" Kallippos. According to his account, it was simply a quadrupling of the 19-year y-m-d cycle as previously described but with a single further day removed in each seventy-six years, so that the cycle comprised 441 hollow and 499 full months, for a total of 27759 days. The mean year is thus exactly 365.25 days (obviously the parameter for the sake of which this cycle was chosen), and the mean month approximately 29.5309 days. Geminos does not say whether the deletion of ἐξαιρέσιμοι days at 64-day intervals is to be carried out continuously through the cycle, which would result in the desired total of 441 skipped days if the first one was one of the first forty days of the cycle, or each of the component 19-year cycles was to have the identical pattern of skipped days, with one more day removed from (say) the last of the four. The so-called Back Cover Inscription of the Antikythera Mechanism refers to a subsidiary dial, no longer extant, within the calendrical spiral dial, which was divided into four sectors and displayed the current "19-year cycle of the 76-year cycle" (τὴν τῆς οϛL ιθL, to be interpreted as τὴν τῆς ἑκκαιεβδομηκονταετηρίδος ἐννεακαιδεκαετηρίς). Thus the structure of the 19-year cycle defined by the scales of the spiral dial was to be understood as repeating four times in a 76-year cycle, with an additional day number skipped over at some point. A 76-year cycle also must have regulated the so-called Kallippic calendar, which was a system of dating according to the months and days of the Athenian calendar but with years numbered sequentially within numbered Kallippic Periods (περίοδοι κατὰ Κάλλιππον), such that the first year of the first Kallippic Period began immediately after the summer solstice of 330 BC. Dates according to the Kallippic calendar are attested only in astronomical contexts, chiefly in observation reports in Ptolemy's *Almagest*, the earliest examples being from 295 BC (1st Kallippic Period, year 36, observations by Timocharis in *Almagest* 7.2) and the latest from AD 56 (6th Kallippic Period, year 6, predicted lunar eclipse in *POxy astron*. 4137).[17]

Censorinus, *De die natali* 18.9, mentions a "great year" of Hipparchos comprising 304 years and 112 intercalary months, i.e. 192 ordinary and 112 intercalary years for a total of 3760 months. These figures defining the y-m relation are simply sixteen times the corresponding ones for the 19-year cycle or four times the 76-year cycle, and they would only be meaningful thus scaled up if this 304-year cycle was also equated with a number of days different from sixteen times the 6940 days of the 19-year y-m-d cycle or four times the 27759 days of the 76-year y-m-d cycle. One can hardly doubt that this cycle was proposed in the lost work that Hipparchos composed not earlier than 128 BC, *On Intercalary Months and Days*, from which Ptolemy, *Almagest* 3.1, quotes him as writing:

> We find the same number of whole months comprised in 19 years as they (*scil*. Meton and Kallippos) did, but the year as taking an amount (over whole days) less than one quarter of one day by a three-hundredth, so that in 300 years it falls short five days relative to Meton, and one day relative to Kallippos.

In other words, having determined that the mean tropical year was approximately 365 $^1/_4$ – $^1/_{300}$ days, Hipparchos devised a y-m-d cycle that reflected this new parameter almost exactly by quadrupling the 76-year cycle with a single full month of the new cycle changed to a hollow month, so that his cycle had the same

[17] Jones 2000.

relation to the 76-year cycle as the 76-year cycle had to the 19-year cycle. We have no evidence, however, that anyone attempted to implement a Hipparchian 304-year cycle.

The role of cycle-based regulation of Greek civil calendars remains very imperfectly understood. It is now widely accepted on good evidence that the Athenian calendar's sequence of ordinary and intercalary years mostly conformed to a 19-year cycle from the mid fourth century BC onwards, though this appears to have been a comparatively weak type of y-m cyclic regulation that did not, for example, determine which months of intercalary years were to be repeated.[18] Comparable evidence of intercalation patterns does not exist for any other Greek lunisolar calendar. On the other hand, sources from the first century BC appear to attest to heightened awareness and adoption of cyclic calendar regulation. Geminos's entire discussion of lunisolar calendar cycles (8.25–60) is offered as an explanation of civil calendrical practices, and we have Diodoros's express statement (12.36.3) that "down to our time most of the Greeks, in employing the 19-year cycle, do not err from the truth".[19] The y-m-d cycle of the Antikythera Mechanism, while it does not prove that the calendar of Korinth was regulated by this cycle in whatever locality the Mechanism's intended owner resided, at least demonstrates that such regulation was seen as feasible; the date of construction of the Mechanism has been much disputed, but its archeological context strongly favors the first half of the first century BC, with a *terminus ante quem* of 60 BC ± 10 years.[20] Our Miletos inscription, erected within a decade of 100 BC, thus appears to be the oldest witness to a late Hellenistic movement towards increased calendar regulation and coordination.[21]

Commentary

inv. 1604, col. i

2–5. The vacat in line 5 evidently marks a break between an introductory passage and the account of Meton's cycle. The restorations of the beginnings of lines 6 and 8, which are secure, as well as the probable restorations of lines 7 and 9, allow us to determine the location of the column's left margin rather precisely (Fig. 3), the more so because a significant displacement of the margin from the position we hypothesize would result either in implausibly wide letter spacing in 6 or implausibly tight spacing in 8. We can thus estimate that 4–5 letters are lost at the beginning of line 2; probably 5 at the beginning of line 3; 4–5 at the beginning of line 4; and probably 5 at the beginning of line 5.

The syntax of lines 3–5 is ambiguous; -πτώματα is presumably the object of the participle πε--μένων, but it is not clear whether the participle modifies ἀνδρῶν, or ἀνδρῶν is dependent on τὰ (?)… -πτώματα. In the former case, the phrase would mean something like "a memorial of the men who did something to (the?) -πτώματα", whereas the latter would mean "a memorial of those who did something to the -πτώματα of the men". I am also unable to offer a persuasive interpretation of -πτώματα fitting the context. παραπτώματα in the sense of "errors" seems the most plausible word; if it is correct, no further letters are to be restored at the beginning of line 4.

5–9. The wording is curiously similar to that of Diodoros 12.36: ἐν δὲ ταῖς Ἀθήναις Μέτων ὁ Παυσανίου μὲν υἱός, δεδοξασμένος δὲ ἐν ἀστρολογίᾳ, ἐξέθηκε τὴν ὀνομαζομένην ἐννεακαιδεκαετηρίδα, τὴν ἀρχὴν ποιησάμενος ἀπὸ μηνὸς ἐν Ἀθήναις Σκιροφοριῶνος τρισκαιδεκάτης. Could there have been a common textual source? The inscription's verb, on the other hand, is paralleled by Geminos, 8.50: ἑτέραν περίοδον συνεστήσαντο τὴν τῆς ἐννεακαιδεκαετηρίδος οἱ περὶ Εὐκτήμονα καὶ Φίλιππον καὶ Κάλλιππον ἀστρόλογοι.[22] (It is incidentally surprising that Geminos does *not* name Meton here, or indeed anywhere in his book, whereas he names Kallippos both here and later in connection with the 76-year cycle.)

[18] Morgan 1996.

[19] For Geminos's date, see Jones 1999.

[20] Jones 2012, 19.

[21] See "Note added in proof" at the end of this article.

[22] Geminos employs the same verb in introducing other calendar cycles at 8.27 and 8.59.

10. In the corresponding passage, Diodoros gives the full Athenian date of Meton's inaugural solstice. The inscription presents this date at inv. 84, col. i, 1–3, so possibly the information provided here was less precise. The surviving traces are insufficient to establish anything except that the text cannot have been identical to Diodoros's dating formula. A restoration along the lines of [ἀπὸ τῆς ὑπ' αὐ]τ̣οῦ [τετηρημένης θερινῆς τροπῆς …] is conceivable.

inv. 1604, col. ii
The column is too poorly preserved to allow any detailed restoration of the sense. The remains of lines 4 and 6 suggest that the text was discussing the distribution of the seven intercalary months in Meton's 19-year cycle, which was presumably at intervals of two and three years so that the Athenian calendar year always began with the first month following the summer solstice.

8. Neugebauer (manuscript note in file) proposed restoring the name of Euktemon. This cannot be excluded: the traces of tops of one or two letters preceding ΜΩΝ could be reconciled with eta, and the space at the beginning of the line is about right for (ΕΥ-) ΚΤΗΜΩΝ.

inv. 84, col. i
1. The end of the preceding column must have provided the expected ἀπὸ τῆς. If the date of the solstice of 432 BC had already been given in the continuation of inv. 1604 col. i, one might wish to restore something like ἀπὸ τῆς προκειμένης.

1–6. The 432 BC date is transmitted in varying ways in ancient sources. Diodoros 12.36.2 gives the archon year and Athenian calendar month and day as the inaugural date (ἀρχή) of Meton's 19-year cycle, without identifying it as a summer solstice. Ptolemy, *Almagest* 3.1 (ed. Heiberg 1.205), gives the archon year and the Egyptian calendar month and day, further specifying daybreak (πρωίας), as an observation of the moment of summer solstice made by "those around" (οἱ περί) Meton and Euktemon, without connecting it with the 19-year cycle. A scholion to Aristophanes, *Birds* 997 cites Philochoros for the statement that Meton erected a solstice-observing instrument (ἡλιοτρόπιον) against a wall on the Pnyx in the archonship of Apseudes (*FGrH* 328 F 122). The present inscription alone gives both the Athenian and Egyptian calendar dates, and alone both connects it with the 19-year cycle and identifies it as a summer solstice, though the surviving text does not say that it was established by observation.

The Athenian calendar month and day are presumably the original form in which the date was handed down. The equation of this date with Egyptian Phamenoth 21 can hardly have been established before Hellenistic times, though obviously it antedates 109 BC. The motivation of translating the Athenian date into the Egyptian calendar was probably the convenience of the constant 365-day Egyptian years for calculating exact intervals in days between widely spaced dates. It is likely that both forms of the date were already given by Hipparchos in his book *On the Displacement of the Solstitial and Equinoctial Points*, which was written in or after 128 BC and which Ptolemy discusses at length in *Almagest* 3.1; we may even speculate that Hipparchos himself established the equation.[23] It could have been done in two ways: either one might have extrapolated a lunisolar calendar cycle whose synchrony with the Egyptian calendar was known for dates in say the second century BC back to 432 BC, on the assumption that this cycle was consistent with Meton's Athenian calendar reckoning, or one might have attempted to calculate the Egyptian calendar date of the beginning of the month Skirophorion in 432 BC using astronomical tables or theories of motion for the Sun and Moon.

However the equation was established, we do not know whether it was correct. Accepting it leads, in fact, to difficulties with respect to both the solstice and the beginning of the month Skirophorion. The (pro-

[23] Hipparchos appears to have regularly expressed the dates of solstices and equinoxes in both the Athenian calendar (specifying the Athenian calendar year according to the Kallippic period for dates after 330 BC) and the Egyptian calendar, but in summarizing his work Ptolemy omitted the Athenian month and day; see Jones 2000, 148–150, and for other instances of Ptolemy's selectivity in reporting Hipparchos's arguments, Jones 2005, 27.

leptic) Julian equivalent of Phamenoth 21 in 432 BC is June 27, whereas the actual moment of solstice was on the morning of June 28, a full day later than the transmitted date if we take seriously Ptolemy's specification that the solstice was determined as taking place at daybreak. This discrepancy is not a compelling basis for doubting the Athenian-Egyptian date equation. We know nothing definite about the observational and analytic methods that went into determining a solstice date in the fifth century BC, but they were surely much less refined than Hipparchos's in the second century BC, which appear to have enabled him to estimate the time of a summer solstice within a fraction of a day of the true moment.

More problematic is the equation of the Athenian date Skirophorion 13 with June 27, which implies that the first day of the month coincided with June 15. It is usually assumed that in Greek lunisolar calendars in general, and in that of Athens in particular, the beginning of the month was, at least nominally, the day of first visibility of the new Moon crescent. According to modern astronomical theory this event should have occurred on the evening of June 17 (with a maximum error of one day), while the preceding last visibility of the waning Moon was on the morning of June 15. However, we have some evidence, including the remark of Geminos 9.14 that the new Moon crescent can make its appearance anywhere from the first to the third day of the month, indicating that Greek calendar months were not necessarily or even normally regulated by direct observation of the Moon's phases, and that whatever the criterion was for the beginning of a new month, it tended to precede the first visibility.[24] In any event, the astronomer who established the Athenian-Egyptian date equation must have assumed such a temporal lead.

7–11. The Athenian archon year of Polykleitos is securely established as 110/109 BC.[25] Combining this with the Egyptian calendar date Payni 11, we have the Julian equivalent of the Egyptian date as 109 BC, June 26. The actual moment of solstice was in the morning of June 25, so the date in the report is one day too late. In this instance we are dealing with a report that in all probability expressed the date in both the Athenian and Egyptian calendars from the outset, so the error is one of determination of the astronomical phenomenon, not of retrospective calendar conversion. The attested Athenian date, Skirophorion 14, implies that the first day of Skirophorion was equivalent to June 13, whereas according to modern theory the first visibility of the new Moon crescent should have been on the evening of June 15 (plus or minus a day at most) and the preceding last visibility on the morning of June 12. Thus we again encounter an Athenian month apparently beginning in advance of the visible new Moon.

The interval of 323 years separating the two solstices in the inscription, as noted already by Dessau soon after the text of inv. 84 was published, is exactly seventeen 19-year cycles, so that it is apparent that whatever the inscription was saying about the two dates had something to do with Meton's 19-year cycle as it has been described in the preceding columns. One possibility is that the cycle was being invoked to determine the solstice date in 109 BC from the solstice date in 432 BC. But this does not seem to be the correct explanation, because a characteristic property of a lunisolar calendrical cycle is that it fixes the dates of the solstices and equinoxes for every year of the cycle. In other words, using the 19-year cycle to project summer solstice dates should result in Skirophorion 13 in every year that is a multiple of nineteen years after the archon year of Apseudes.

I believe that the most plausible reconstruction of the argument in the inscription is that the recorded solstice date in the archon year of Polykleitos is supposed to be an *observed* date, and the comparison with the date reported for the archon year of Apseudes was a test of the 19-year y-m-d cycle. In this test it is the Egyptian calendar dates that matter, because they lead directly to a count of the total number of days between the two dates, namely 323 times 365 plus 80 days (or 117975 days). Assuming the mean year of the 19-year y-m-d cycle, 365 $^{5}/_{19}$ days, one would expect the interval to be 323 times 365 plus 85 days, a substantial discrepancy. On the other hand, the mean year of the 76-year y-m-d cycle, 365 $^{1}/_{4}$ days, would lead

24 Stern 2012, 26–29.

25 Van der Waerden 1960, 179–180 (reasserted in van der Waerden 1984, 124) proposed to date Polykleitos's archonship to 107/106 BC so that the solstice date in the inscription could be consistent with his reconstruction of the Kallippic calendar system. So far as I can tell, he misunderstood Diels's discussion of the date in Diels–Rehm 1904, 93–96 and was unaware that the year of Polykleitos's archonship was known independent of the inscription.

to an interval of 323 times 365 plus 80 $^{3}/_{4}$ days, which could have been seen as near enough to the interval obtained from the Egyptian dates. Hence the comparison would have motivated the transition to discussion of the 76-year cycle in the next column of the inscription. The mean year of the Hipparchian 304-year cycle, 365 $^{1}/_{4}$ – $^{1}/_{300}$ days, would yield an interval of 323 times 365 plus approximately 79.673 days, still closer to 80, but we have no indication that the author of the inscription knew about Hipparchus's cycle.

12. Diels suggests restoring [κατὰ δὲ τὸ Μιλ]ήσιον, introducing an equivalent date in the calendar of Miletos. The available space is about right, and the expression perhaps sufficiently idiomatic (though κατὰ Μιλησίους would be more so), but it is not clear why the argument would have called for a translation of the second solstice date (but not the earlier one) into the local calendar. Other candidates for the final word of the line include ἐτήσιον or simply πλησίον.

inv. 84, col. ii

4–10. In restoring 5–7 and the first word of 8, I follow the suggestions of Dessau 1904, except that he offers a plural verb, συνεστήσαντο on the model of Geminos 8.59: δι' ἣν αἰτίαν οἱ περὶ Κάλλιππον γενόμενοι ἀστρολόγοι διωρθώσαντο τὸ πλεονάζον τῆς ἡμέρας καί συνεστήσαντο τὴν ἑκκαιεβδομηκονταετηρίδα συνεστηκυῖαν ἐκ τεσσάρων ἐννεακαιδεκαετηρίδων, αἵτινες περιέχουσι μῆνας μὲν ϡ̅μ̅, ὧν ἐμβόλιμοι κ̅η̅, ἡμέρας δὲ β̅ (μυριάδας) ͵ζ̅ψ̅ν̅θ̅. The inscription is less verbose than Geminos, and comparison with inv. 1604 i 5–6 and ii 6 suggests that it gave a simple name (perhaps just ὁ Κάλλιππος) where Geminos has the periphrastic οἱ περί ("those around").

Dessau's restoration of 6 is a certainty, so we know that the text turned to consideration of the 76-year cycle following the discussion of the two solstice dates. Lehoux expresses scepticism of Dessau's supplements in 5 and 7, but inv. 1604 i 6–7 strongly supports συνεστήσατο, while περιέχουσαν expresses the necessary connection between the cycle and days as well as being a word of the required length. There must have been a second verb before 4 to justify the καί, with a construction along the lines of [διωρθώσατο] δὲ ὁ [Κάλλιππος αὐτὴν] καὶ σ[υνεστήσατο …].

Dessau does not continue his reconstruction in the obvious way with the numeral for the number of days. My supplements for the remainder of lines 8 through 10 (incorporating Dessau's guess that 10 made a further reference to the 19-year cycle) are offered merely as a plausible reconstruction.

Note added in proof

John D. Morgan draws my attention to neglected evidence that renders false my assertions in the final paragraph of my foregoing discussion of lunisolar cycles that "Comparable evidence of intercalation patterns [*scil.* to that relating to the Athenian calendar] does not exist for any other Greek lunisolar calendar" and that IMilet inv. 84 + inv. 1604 is the oldest witness to increased calendar regulation and coordination in the Hellenistic period. As was recognized over a century ago by Alexander Nikitsky[26] and August Mommsen,[27] and a few decades later by Eugène Cavaignac,[28] the attested intercalary years in the Delphic calendar in the 2nd century B.C. coincide with intercalary years in the Metonic cycle generated by following the rule of beginning the new year with the first new moon after the summer solstice (Plato, *Laws* 767C), as was the case at Athens (with only a few exceptions) throughout the late classical and the Hellenistic and Roman periods. Moreover, the unvarying correspondences of months in the Delphic calendar with months in the calendars of Aetolia, Phocis, and Ozolian Locris indicate that these states had coordinated their calendars with the Delphic calendar. Furthermore, Plutarch's report at *Agis* 16.1 that the ephor Agesilaus inserted a thirteenth month, although it was not then required by the περίοδος, contrary to the customary

[26] Nikitsky 1895, 352.

[27] Mommsen 1901.

[28] Cavaignac 1938.

ordering of times, and exacted taxes during it,[29] implies that in the middle of the third century BC the Spartans were employing a prearranged cycle of ordinary and intercalary years, which is likely to have been not the archaic ὀκταετηρίς but a Metonic ἐννεακαιδεκαετηρίς. This evidence from Athens and Delphi and elsewhere substantiates Diodoros's statement (12.36.3) that "down to our time most of the Hellenes, in employing the 19-year cycle, do not err from the truth".

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[29] Plutarch, *Agis* 16.1: ὁ γὰρ Ἀγησίλαος ἐφορεύων … μῆνα τρισκαιδέκατον, οὐκ ἀπαιτούσης τότε τῆς περιόδου, παρὰ τὴν νενομισμένην τάξιν τῶν χρόνων ἐνέβαλε τοῖς τέλεσι καὶ παρέπραττε, …