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TABLE OF CONTENTS

DISCUSSIONS IN EGYPTOLOGY: GUIDELINES

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CAN THE GIZEH PYRAMIDS BE DATED ASTRONOMICALLY? LOGICAL FOUNDATIONS FOR AN OLD KINGDOM ASTRONOMICAL CHRONOLOGY *

Patrick F. O'Mara

I. On the Existence of Unlabeled Lunar and Sothic Dates

Re-examining a traditional fixed assumption: That there are no utilizable lunar or Sothic dates earlier than the middle of the 12th Dynasty; hence, no astronomical chronology is possible for the Old Kingdom.

The construction of a workable astronomical chronology, whether it be for NK, MK, or OK, requires two elements: (1) a group of lunar dates from designated regnal years; and (2) one or more near-lying Sothic dates to define the general era.[1] Thus, in the 12th Dynasty, a predicted celebration of the heliacal rising of Sirius in the 7th year of Sesostris III, datable to 1873±3 B.C., is immediately contiguous with a series of dated Egyptian New Moons from the reigns of Sesostris III and Amenemhet III. Although there remain several technical problems, such materials make the 12th Dynasty the most securely datable period of classical Egyptian history.

For the OK, no labeled Sothic date has ever been found, and we have only three psdntiw dates from the funeral temple of Neferirikare at Abusir. These latter, not positively identifiable by reign, exist in a temporal vacuum and can lead us nowhere. Whence the defeatist conclusion that no astronomically based chronology

* Ulrich Luft has recently (1987) advanced a powerful argument that the Egyptian day began at sunrise rather than at dawn (Fn. 4, below). The present study adopts this new perspective and is the first attempt to establish the logical foundations required by it for the construction of an astronomical chronology of the Pyramid Age.

1 A Sothic date marks the number of days that Sirius (its annual heliacal rising) has advanced across the Egyptian 365-day calendar. Since the natural year has 365¼ days, Sirius jumps ahead 1 day every 4 years. Thus a Sothic date I prt 1 would mark 120 days, or 480 years, 2293-89 B.C.

is possible for the OK. There is, it would seem, no solid point of departure from which to take even the first halting step toward a realistic chronology.

Where might we begin? This is the crux of the problem. In both the MK and the NK, internal points of departure are easily forthcoming in the heliacal risings of Sirius under Sesostris III and Amenophis I. But for the OK, in the absence of recognized Sothic and lunar materials, all models have perforce started from the deduced commencement of the 11th Dynasty at ca. 2134 B.C. (more recently, ca. 2129-2080). This jumping-off platform has itself been extrapolated with great uncertainty back from the 12th Dynasty's Sesostris III. Thence we have worked back to the OK by means of a precarious leap across the chasm of the First Intermediate Period, usually guessed to be only 25-40 years,[2] or by a guess as to the historical placement of Calendar Year 1 (2773 B.C.), usually assigned now to the broad middle of the 2nd Dynasty (Parker: Ny·Neter; von Beckerath: Hotepsekhemwy). The vagueness inherent in these conjectures has ruled out any possibility of an astronomical exploration of the era and has denied to all models such qualities as precision, logical rigor, testability and, ultimately, utility.

What is required is some sort of promising point of departure lying within the OK itself. And this requires the discovery or uncovering of stellar/lunar dates that are unlabeled as such. The notion that Egyptians may have dated important decrees and events to phases of the moon is not ephemeral. Many have thought so and Borchardt in particular calculated some dozen or so "unbenannte Mondtage" of Ramses II and Thutmose III.[3]

2 More recently lengthened to 70-100 years by Edward Brovarski's work at Naga-ed-Din (AJA, 89 (1985), 581-583: and Donald Spanel, GM, 78 (1984), 87-94, fn. 3.

3 Ludwig Borchardt, Die Mittel..., 49-57.

Although his results were unconvincing, his attempt held a valuable lesson. In accepting not merely the 1st and 15th days of the month but the 6th and 23rd as well, along with one-day errors of observation, he had permitted himself so many options that his findings were statistically meaningless. To be valid, our options must be limited to no more than <u>pśdntiw</u> and <u>śmdt</u>.

SEARCHING FOR UNLABELED LUNAR DATES IN THE OK

<u>Underlying Assumptions</u>. All astronomical calculations for ancient Egypt depend upon the stance taken toward certain underlying problems:

(1) the definition of <u>Tagesbeginn</u>, whether at dawn (first light) or at sunrise (first flash). In the present study <u>Tagesbeginn</u> is assumed to lie at sunrise, requiring that all Egyptian dates be assigned one day earlier than that shown in the Egyptian-Julian conversion table. [4]

(2) the placement of Calendar Year 1 (hereafter, CY 1), the year in which Sirius rose heliacally on I <u>3ḫt</u> 1, herein assumed to lie experimentally at 2773 B.C. [5]

(3) criteria for probative qualities: given the extreme paucity of dated materials from the OK, if within any reign two Egyptian dates when calculated astronomically agree in placing <u>sp</u> 1 in the same Julian year, they are probably lunar in nature. Only New Moon (<u>pśdntiw</u>) and Full Moon (<u>śmdt</u>) may be used.

The usefulness of lunar dates is restricted by a li-

[4] The traditional "dawn day" is represented by Neugebauer (<u>Hilfstafeln</u>), Parker (<u>Calendars</u>), and Krauss (<u>Sothis- und Monddaten</u>); the more recent "sunrise day" by Barta (<u>SAK</u>, 7 (1979), 1-9, and Ulrich Luft, "Tagesbeginn in Aegypten," <u>Altorientalische Forschungen</u>, 14 (1987), 1-11; and more recently Christian Leitz, <u>Studien zur aegyptischen Astronomie</u> (Wiesbaden, 1989), 1-5. For an explanation: fn 23c, below (Appendix III, A).

[5] Neugebauer/Parker, derived from Censorinus: A.D. 139; Ingham and Krauss have calculated other possible dates. 2773 may be an "as if" date, nor is 2777 B.C. to be excluded (v. fn 23c, below (Appendix III, B - SIRIUS, last line).

mitation that must somehow be surmounted. They are all cyclical in nature. One of the peculiarities of the Egyptian 365-day calendar was that — by a fluke — any date that is psdntiw or śmdt in any given year will be so again exactly 25 years later, with an occasional error of no more than one day, generally acceptable as an error of observation due to ground mist or overcast.[6] Thus, unless or until they can be linked with a nearlying Sothic date, lunar reckonings can only be shown tentatively as 25-year lines extending over several centuries. They are no less valid as cyclical lines than as discrete points.

Unas. The late Klaus Baer ascribed to the reign of Unas two pieces lacking royal identification but bearing fully recorded dates.[7] The first, from the serdab of Rawer II, is dated to III prt 3 of sp 11. The 25-year psdntiw line for this date runs 2558... 2508...2458...2408...2383.[8] His first sp 1 would lie on the line 2578...2528...2478..., etc. Baer's other piece is an Abusir manuscript bearing the uncertain and controversial dating II šmw 17 of sp 14. The psdntiw line for this runs 2550...2500...2450...2400 ...2375, calculations which also place sp 1 along the line 2578...2528...2478..., etc. Despite awkward uncertainties, it is highly probable that the two pieces are from the same reign and are lunar in nature.

Pepi II. A pair of dates from the reign of Pepi II appear to meet the criteria for lunar dates. A graf-

6 In abstract theory, 500 years (365 x 500 = 182,500 days; 6,180 lunations x 29.530588 = 182,499.03 days). For 25 years: 25 x 365 = 9,125 days; 309 lunations = 9,124.95 dys. The shift of a day after 500 years is not precise but fuzzy, with a transition period of a century or more.

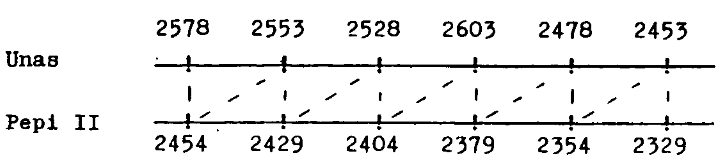
7 Klaus Baer, A Chronology of the Fourth, Fifth, and Sixth Dynasties (unpublished ms, Univ of Chicago), 43.

8 Calculations are shown in Appendix I, below (fn. 23a).

fito inscription from Hatnub by a local official bears the name Neferkare in a cartouche and a portrait of the king seated on his throne.[9] The date is I šmw 20 of the year after the 31st count (sp 31+), regnal year 62 or 63. The 25-year pśdntiw line lies 2393...2343...2293...2243...2218...2193, placing the sp 1 line along 2454...2404...2354..., etc.[10]

The well-known "pygmy letter" of the child Pepi to his expedition commander Harkhuf is highly suggestive of a Full Moon dating, inasmuch as its despatch was on the 15th day of the civil month: III 3ḫt 15 of sp 2.[11] Might this have been as well the 15th day (śmdt) of the natural lunar month, a sort of reinforcement of the symbolic date? Calculation shows that the 25-year Full Moon line for III 3ḫt 15 runs 2452...2402 ...2352...2302...2277, with sp 1 lying then along 2454...2404...2354..., etc. Both the Hatnub graffito and the "pygmy letter," when treated as lunar dating, agree in placing Pepi's first census year along the same line. The probabilities that they are lunar are overwhelming, particularly in light of the remarkable double dating of the 15th day.

A Preliminary Conclusion. Assuming that our deduced lunar dates for Unas and Pepi are valid, we can draw an important chronological conclusion from them. If we place the 25-year line of each against the other and ratchet them against each other, the separation between



9 Rudolf Anthes, Die Felsinschriften von Hatnub, Pl 12, 12a.
10 Calculations in Appendix II, below, (fn. 23b).
11 Sethe, Urk., I, 128.

them is of the order of 74...99...124...149... etc. years. Only two of these distances are practical in the light of what we know from our sources: either 99 or 124 years, depending upon whether or not we reject or accept our literary canons and the highest known year counts. One model is represented by Parker in his non-astronomical chronology of 1954;[12] the other by the present author.

TABLE 1

Relative Distance Between Unas and Pepi II

	A. Parker (99 yrs) (from regnal 1)		B. Self (124 yrs) (from sp 1)	
Unas	2371	30 (Tur)	...*	30 (Tur)
Teti	2341	14	...	30 (Man)
Userkare	2327	0		
Pepi I	2327	40	...	53 (Man)(sp 26+)
Merenre	2287	15 (Tur: 14)	...	11 (Hi sp: 5+)
Pepi II	2272		...	
	99 yrs		124 yrs[13]	

...* 25-yr lines only

SEARCHING FOR UNLABELED SOTHIC DATES

Re-examining a traditional and unchallenged paradigm: That Egyptians did not date sequentially, but only by the census counts or regnal years of each pharaoh: "No use was ever made of a continuous era" (Gardiner, Egyptian Grammar, 204

The Problem. For the entire classical period of ancient Egyptian history (Dynasties 3-20; ca. 2792-1050 B.C.) only one certain completely recorded Sothic date — accepted by all without controversy —

[12] Article "Egypt", Encyclopaedia Americana, 1957, et sqq.

[13] Or: 32 + 29 + 11 + 52 = 124, if we follow the demonstrable x: x+1 relationship between pTurin and Manetho (the author's "Manetho and pTurin: A Comparison of Old Kingdom Regnal Years" (pre-print in private circulation).

is known: that of IV prt 16 of the 7th year of Sesostris III.[14] A second date recorded in the Ebers Medical Papyrus as IV šmw 9 from the 9th year of Amenophis I has recently become controversial; its Sothic nature has been challenged and its utility is now problematical.[15]

Alas! It is not likely that any archaeological digs in the foreseeable future will turn up what a century of excavation has failed to yield: an OK Sothic date.[16] We are entirely dependent upon the slim hope that there might exist unlabeled Sothic dates analogous to the unlabeled lunar dates we have just examined. For this we are reduced to rummaging among already known materials by deductive and inferential processes; i.e., by the use of logic. In short, we have a piece of detective work on our hands.

The problem is rather like that faced by Mons. Dupin in Edgar Allen Poe's The Purloined Letter. After the police had failed to find the stolen letter in a most rigorous search of every nook and cranny in 3 apartment buildings, M. Dupin was able to locate it and claim the reward by applying logic. The reader will recall that the letter had (fiendishly) not been concealed at all. It lay in full view of everyone ... but folded inside out. Everybody had seen it; nobody had looked at it. I suggest that our missing Sothic

14 A labeled Sothic date from the reign of Thutmose III is complete except for the all-important regnal year; with a possible range of 106 years, it is useless to us.

15 Its validity has been challenged by Helck (GM, 67 (1983), 43-49, Barta (GM, 101 (1988), 7-12, and Luft (SAK, 14 (1987), 221-233: 222; defended by von Beckerath (SAK, 14 (1987), 27-33).

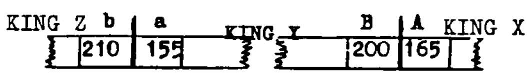
16 Borchardt discovered Sesostris' Sirius in the 1890's among the Illahun (Kahun) papyri: ZAS, 37 (1899), 99.

date — or dates, for hopefully there might be several — may not lie buried deep within some unexplored tomb but has long lain before our eyes, unlabeled and "folded inside out."

<u>"Surplus" Months and Days in the Turin Canon</u>. Let us look with Mons. Dupin's eyes at some well-known regnal data from the late MK. The Royal Canon of Turin (late 19th Dynasty), lists 5 kings at the top of Col. VI and VII, complete with years, months, and days of their reigns. They form a kind of crazy pattern:[17]

VI, 1 -	Amenemhet IV:	9 years, 3 months, 27 days
VI, 5 -	Rekhutowy:	2 years, 3 months, 24 days
VII, 1 -	Khahotepre:	4 years, 8 months, 29 days
VII, 2 -	Wahibre:	10 years, 8 months, 28 days
VII, 3 -	Merneferre:	23 years, 8 months, 18 days.

Such detailed data must in all likelihood have been drawn from a MK annals stone or stones as the ultimate source. Our only surviving early annals stone, the 5th Dynasty Palermo Stone, holds narrow columns at the beginning and end of the reigns — "moon spaces" — holding a varying number of months and days and forming a pattern something like this:



At each change-of-reign, the days in the two columns (A + B) total 365, prompting the modern assumption that the stone was recording the surplus months and days beyond the year-boxes of a reign. This, I concede, was also the view of the 19th Dynasty scribe of the Ur-Tu-

17 Conveniently transliterated and listed by Alan Gardiner, <u>Egypt of the Pharaohs</u> (New York, 1966), 440f.

rin Canon.

There is, however, another possibility that has been overlooked. 365 is also the number of quadriennia in the 1460-year Sothic cycle. Could the "moon spaces" be a form of Sothic dating — analogous to the later quadriennial Olympic dating of the Greeks — in which box B places the coronation at 800 q-years from CY 1 while box A shows that there are still ca. 660 years to go in the Great Era? Is there any evidence that this interpretation might be so?

Now, the chronological direction of annals stones and canons was not fixed. The Saqqara Stone lists the kings of the neighbouring 12th Dynasty in reverse order. Their numbering is: ...35, 36, 46, 45, 44, 43, 42, 41, 40, 39, 38, 37, 47, 48... The Karnak Stone of Thutmose III also reflects a reverse order of its MK kings; the left side makes sense only if we presume a reversal of direction.[18] This means that a NK scribe would have been hopelessly confused between the real days (or dating) of B and the converse days of a. Let us then rearrange Turin's kings so that the first bloc retains its correct order but records erroneously the converse number while the second bloc (presumably from a second annals stone) reverses the order of reading but retains the correct data, while misapplying it to the death of the king rather than to his accession:

[18] The Palermo, Saqqara, and Abydos Stones run in different directions chronologically, mute testimony of the confusion: leftward and down; rightward and down, rightward and up.

CONVERSE READING

VI, 1 - Amenemhet IV: 9 ys, 8 ms, 8 ds (248 Soth ds)
VI, 5 - Rekhutowy: 2 ys, 8 ms, 11 ds (251 Soth ds)

REVERSE ORDER

VII, 3 - Merneferre: 23 ys, 8 ms, 18 ds (258 Soth ds)
VII, 2 - Wahibre: 10 ys, 8 ms, 28 ds (268 Soth ds)
VII, 1 - Khahotepre: 4 ys, 8 ms, 29 ds (269 Soth ds)

The statistical chances that a mere direction-reversal of the data would produce a flawless sequence of days are virtually nil. Can these be other than "purloined" Sothic dates turned "inside out", so to speak, in that a NK scribe misinterpreted as "surplus" months and days what a MK annals carver had intended to be Sothic datings?[19] These are, of course, only raw q-dates (quadriennial) marking in each case a 4-year period. Unlike the Greeks, who could designate each year within their quadriennium (Ol. 57, 3), Egyptians could record only a 4-year range.

That these datings represent, because of the erroneous backward reading and general confusion, the end of a reign rather than the intended accession of its successor is shown by the dating for Khahotepre (VII, 1). His reign of 4 years ought to be represented by 1 Sothic day. Indeed, it is.

Support for all these interpretations is furnished by the dating of Amenemhet IV's death by three major chronologers of the 12th Dynasty. The converse reading of 8 months and 8 days reflects the passage of

[19] OK and MK credited a dead king with the entire year of his death; "surplus months" is an oxymoron. But in the NK regnal dating was realistic; his death was followed immediately by his successor's accession. "Surplus" months and days was essential to properly recording the reign.

992-995 years. Parker's placement is at 984 years (2773 - 1790 B.C.); Barta's at 989 years (2773 - 1785 B.C.); and Krauss' 1981 placement at 994 years (2738 - 1745 B.C.), his 1984 placement at 980 years.[20]

These datings tend to corroborate Weill's challenge of many years ago to the integrity of Turin's 13th Dynasty list.[21] When blocked out, there is a gap of 5-11 years between Sobeknofru and Rekhutowy, the supposed founder of the 13th Dynasty,and a gap of 27-33 years between the ostensibly contiguous reigns of Merneferre and Wahibre. Some two dozen names (VI, 6-27), most of them dubious, must be compressed within a gap of no more than 8 years.[22]

Conclusions. The existence of unlabeled Sothic dates in the MK would seem to be established beyond a reasonable doubt. One may hope optimistically that a similar search for them in the OK might be productive.

It has long been an axiom, virtually a paradigm, that Egyptians never dated sequentially but could only date by means of census or regnal years within individual reigns. But Romans (A.U.C.), Greeks (Olympiads), Hebrews (years from Flood or Creation), and early Christians (B.C.-A.D.) all developed systems of sequential dating alongside local or regnal dating formats. Is it not unreasonable to suppose that the builders of the Pyramids were somehow incapable of realizing the utility of Sirius in dating the flow of their history?

If the materials analyzed above are not Sothic da-

20 For Barta and Krauss: fn. 4, above.

21 Raymond Weill, La fin du Moyen Empire égyptien (Paris, 1918), 584-605.

22 The gaps are clearly blocked out in the author's article in DE, 10 (1988), 41-54: 49, Table 1.

datings, what then are they? And if we <u>are</u> looking for evidence of sequential dating, what form would the evidence subsume if not under the guise of the months and days for our 5 kings and in the change-of-reign "moon spaces" in the Palermo Stone?

23a **Appendix I. Calculations for Unas**

YR	CONV. TABLE	CONJUNCTION	PSDNTIW	EGYPT. DAY
		A. UNAS: III prt 3 of sp 11		
2558	23 Nov	25 Nov: 9:30 AM	24 Nov	23 Nov - exact
		(OC Insuff)	(III prt 4)	(III prt 3)
2508	10 Nov	12 Nov: 9:58 PM	12 Nov	11 Nov - 1-day
			(III prt 5)	(III prt 4)
2458	29 Oct	31 Oct: 6:23 AM	30 Oct	29 Oct - exact
		(OC Insuff)	(III prt 4)	(III prt 3)
2408	16 Oct	17 Oct: 9:36 PM	17 Oct	16 Oct - exact
			(III prt 4)	(III prt 3)
2383	10 Oct	12 Oct: 5:21 AM	11 Oct	10 Oct - exact
		(OC Insuff)	(III prt 4)	(III prt 3)

Conclusion: Sp 1 line at 2578...2528...2478...2403...

YR	CONV. TABLE	CONJUNCTION	PSDNTIW	EGYPT. DAY
		B. UNAS: II šmw 17 of sp 14+		
2550	5 Mar	6 Mar: 6:55 PM	6 Mar	5 Mar - exact
			(II šmw 18)	(II šmw 17)
2500	20 Feb	21 Feb: 1:12 AM	20 Feb	19 Feb - 1-day
		(OC Insuff)	(II šmw 17)	(II šmw 16)
2450	8 Feb	9 Feb: 8:16 AM	9 Feb	8 Feb - exact
		(OC Suff)	(II šmw 18)	(II šmw 17)
2400	26 Jan	27 Jan: 2:47 PM	27 Jan	26 Jan - exact
			(II šmw 18)	(II šmw 17)
2375	20 Jan	21 Jan: 5:46 AM	21 Jan	20 Jan - exact
		(OC Suff)	(II šmw 18)	(II šmw 17)

Conclusion: Sp 1 line at 2578...2528...2478...2403...

23b **Appendix II. Calculations for Pepi II**

YR	CONV. TABLE	CONJUCTION	PSDNTIW	EGYPT. DAY
		A. PEPI II: I šmw 20 of sp 31+		
2393	28 Dec	30 Dec: 12:53 PM	30 Dec	29 Dec - 1-day
			(I šmw 22)	(I šmw 29)
2343	16 Dec	17 Dec: 6:31 PM	17 Dec	16 Dec - exact
			(I šmw 21)	(I šmw 20)
2293	3 Dec	4 Dec: 10:01 PM	4 Dec	3 Dec - exact
			(I šmw 21)	(I šmw 20)
2243	21 Nov	23 Nov: 4:54 AM	22 Nov	21 Nov - exact
		(OC Insuff)	(I šmw 21)	(I šmw 20)

2218	14 Nov	16 Nov: 9:02 PM	16 Nov (I šmw 22)	15 Nov - 1-day (I šmw 21)
2193	8 Nov	9 Nov: 12:28 PM	9 Nov (I šmw 21)	8 Nov - exact (I šmw 20)

Conclusion: Sp 1 lies at 2454...2404...2354...2304...

B. PEPI II: III 3ḫt 15 of sp 2; PSDNTIW: III 3HT 1

2452	27 Jun	28 Jun: 5:59 AM (OC Suff)	28 Jun (III 3ḫt 2)	27 Jun - exact (III 3ḫt 1)
2402	15 Jun	16 Jun: 00:42 AM (OC Insuff)	15 Jun (III 3ḫt 1)	14 Jun - 1-day (II 3ḫt 30)
2352	2 Jun	3 Jun: 4:32 PM	3 Jun (III 3ḫt 2)	2 Jun - exact (III 3ḫt 1)
2302	21 May	22 May: 4:57 AM (OC Suff)	22 May (III 3ḫt 2)	21 May - exact (III 3ḫt 1)
2277	14 May	14 May: 8:49 PM	14 May (III 3ḫt 1)	13 May - 1-day (II 3ḫt 30)

Conclusion: Sp 1 lies at 2454...2404...2354...2304...

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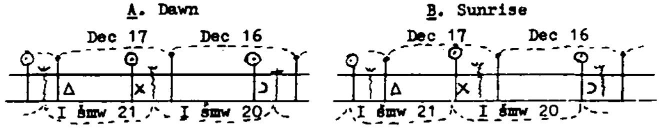
23 c Appendix III. Calculating the Sunrise-Day

The hypothesis of a sunrise-day creates a 1-day displacementon the Julian/Egyptian concordance table, for both lunar and Sothic dates.

A... LUNAR. Inscription: ""pśḏntiw, I šmw 20." Testing 2343 B.C.

⊙ Sunrise. ⚲ Dawn. ⚲ Midnight. ☽ Old Cresc.
△ Conjunction. X Invisibility (pśḏntiw). S Sirius.

A. Dawn | B. Sunrise

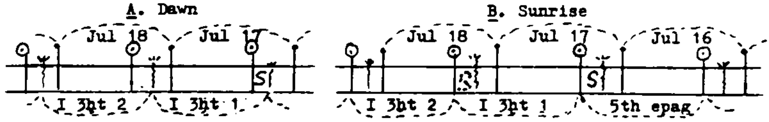


A. Dawn-day. Jul/Egp conv. table: I šmw 20 = Dec 16
Conj & pśḏ: Julian Dec 17 — 1-day error

B. Sunrise-. Jul/Egp conv. table: I šmw 20 = Dec 16
Conj & pśḏ: I šmw 20 (Dec 16) — exact

B... SIRIUS. Objective: Calendar Year 1; i.e., I 3ḫt 1

A. Dawn | B. Sunrise



A. Dawn-day. Jul/Egp conv. table: I 3ḫt 1 = Jul 17, 2773-70

B. Sunrise-. Jul 17 = 5th epagonal day, not I 3ḫt 1
Adjustment: I 3ḫt 1 = Julian 18

On the Jul/Egp conv. table, I 3ḫt 1/Jul 18 = 2777-74 B.C.