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SOTHIC DATING OF THE EGYPTIAN OLD KINGDOM

Alexander Puchkov
PhD student
Department of World History
Oles Honchar Dnipro National University
72, Gagarin Ave., Dnipro, 49010, Ukraine
alexandr.puchkov@gmail.com
ORCID: 0000-0002-2881-4255

The Sothic chronology of the Old Kingdom has not yet been securely established because of the small number of suitable dates from this period. An analysis of the Old Kingdom dates associated with seasonal events (*wꜣgj* feasts, expeditionary activity, the Nile cycles) reveals that seasonal activity was shifted about a month and a half earlier than would be expected given the actual seasons. This observation suggests that, in conventional chronological reconstructions, the age of the Old Kingdom is underestimated by about two centuries. A comparison of the dates of expeditions to Wadi Hammamat during the Old and Middle Kingdoms indicates that the discrepancy is due to incorrect assumptions about the length of the First Intermediate Period. This conclusion is consistent with the results of a large-scale radiocarbon dating project by G. Bonani et al., which revealed an extensive anomaly in the age of most Old Kingdom monuments, while for the Middle Kingdom the results coincided well with expectations. The significant increase in the length of the First Intermediate Period calls for a new look at this epoch, traditionally viewed as a period of struggle for power between two royal houses and the rapid succession of one Herakleopolitan to another.
Keywords: Ancient Egypt; Old Kingdom; seasonal events; Sothic dating; 200-year-higher chronology

Verification of the conventional dates of the Old Kingdom (OK) is of particular interest because of the uncertainty in the length of the First Intermediate Period (FIP), which remains insufficiently investigated and chronologically unresolved by reason of a significant shortage of contemporary evidence. Unlike the Middle Kingdom (MK), the Sothic chronology of the OK has not yet been securely established because of the small number of suitable dates from this period.

The establishment of the Sothic chronology is based on the calculation of absolute dates from Egyptian civil dates of annual (emergence of *Sopdet* = heliacal rising of Sirius) and seasonal events (harvesting, quarrying expeditions, floods and low waters). Such a calculation is possible due to the peculiarity of the functioning of the civil calendar, which gave rise to two long cycles, one of which refers to the heliacal rising of Sirius, the so-called “Sothic cycle”; and the second one, slightly longer, relates to seasonal events (see section §3). It is important to note that in order to achieve greater accuracy in detecting seasonal patterns for such a distant epoch as the OK, Egyptian civil dates (Eg.) should be converted into Gregorian dates (Greg.), whereas Julian dates (Jul.) are still used in some recent publications.

The article analyzes the known OK dates of: heliacal risings of Sirius (section §1); movable *wꜣgj* feasts (section §2); quarrying expeditions (section §3); the Nile floods and low waters (section §4). J. von Beckerath’s middle estimates are used for the OK reigns [v. Beckerath 1997, *187–188*].

§1. Heliacal rising dates

The dates of the heliacal rising of Sirius form the core of the Sothic chronology, since they correspond to annual short-term events that can be calculated with fairly high accuracy. The set of texts mentioning the emergence of *Sopdet* previously included only two dates presumably dating back to pre-MK periods: 1) the date on an ivory tablet from the tomb of Djer, the king of the 1st Dynasty; 2) the date on a cylindrical jar discovered by M. Habicht et al. and attributed to an unidentified king of the 5–6th Dynasty [Habicht et al. 2015, *42–44*]. Back in 1958, the first of these two dates was confidently identified as referring to *Sekhat-Hor*, the form of *Hathor*, and therefore does not contain a Sothic reference [Godron 1958, *146–149*, *Fig. 1*]. The second date is recent and requires revision. The rest of this section is dedicated to it.

§1.1. Inv. 5821: Epigraphic dating

According to Habicht's et al. report, an ointment jar from the archaeological collection of the University of Zurich, inv. 5821, contains two columns of text:

> *gsw n zꜣ-rnp.t ꜣbd 4 pr.t ḫft*
> *pr.t spd.t ꜣbd 4 ꜣḫt* […] *pw ḫft wp.t -rꜥ*
> *Ointment made for the protection of the year, month 4, Peret-season, for*
> *the forthcoming of Sothis, month 4, Akhet-season it is, made for the first day of the month*

The authors did not provide a photo of the object; there is only a reproduction, so it is impossible to verify the reading, which for unknown reasons differs from the reproduction in detail (unreadable text in the second column; missing sign *n* in the first column). The translation is somewhat inaccurate. Particular attention should be paid to the fact that the term *prt Spdt* for the heliacal rising of Sirius is attested in the texts of the MK and later, but it does not appear during the OK, because the term *wpt rnpt* was used thereat to designate this event. Although it is not possible to ascertain when exactly the change in terminology occurred (the beginning of the MK is supposed), it is unlikely that it took place as early as the 5th Dynasty. This observation indicates a high probability that the artifact belongs to the MK, in accordance with its description by the auctioneer from whom it was purchased: "*An alabaster cylindrical jar* [...] *with additional two columns of hieroglyphs (repaired) 2 ¾ in. (7 cm.) high, Middle Kingdom"* [Habicht et al. 2015, *42*].

§1.2. Inv. 5821: Stylistic dating

Habicht et al. turned to stylistic dating and reported the resemblance of the jar to the types/objects from the two typologies:

1) B. Aston's typology [Aston 1994, *75–166*]: (a) type 34 (Shape: footed [prominent foot]; Date: 1–8th Dyn.; common form of the 5th Dyn.); (b) type 35 (Shape: concave to straight-sided beaker, wide foot and rim; Date: 5–11th Dyn.; leading form of the 6th Dyn.); (c) type 36 (Shape: concave-sided tapering beaker, < 13 cm ht.; Date: MK).
2) P. Günther and R. Wellauer's typology [Günther, Wellauer 1988]: (a) object Nr. 79 (Class III, main type A 1,2,3; Shape: rounded rim, concave body, foot slightly bent outwards; Date: 5th Dyn.); (b) object Nr. 81 (Class III, main type A 1,2,3,5; Shape: very prominent rounded rim, concave body, prominent foot; Date: 6th Dyn.); (c) object Nr. 82 (Class III, main type A 1,2,3,5; Shape: prominent rounded rim, slightly concave body, very prominent foot; Date: 6th Dyn.).

The jar was classified by Habicht et al. as Class III A 1,2,3,5 by Günther and Wellauer's typology, as it was concluded that it is closer to object Nr. 82 (is this the best fit?) from the 6th Dynasty by the foot shape. According to Aston's typology, the authors mistakenly prefer types 34 and 35, while it is clear that by its proportions – the ratio of Height : Rim Width : Foot Width (H : RW : FW ≈ 1.9 : 1.4 : 1; see Habicht's et al. reproduction), the jar better matches type 36 from the MK (H : RW : FW ≈ 2 : 1.5 : 1) than type 34 (H : RW :

FW ≈ 2.4 : 1.3 : 1; this type has a more slender body) or type 35 (H : RW : FW ≈ 1.5 : 1.3 : 1; this type has a much more prominent rim and foot).

It would also not be superfluous to recall that, according to the history of origin, the jar was purchased as part of a multiple lot, which included another jar, described as similar to the one under discussion, and bearing a cartouche of Pepi I, the king of the 6th Dynasty.

§1.3. Inv. 5821: Sothic dating

If the damaged parts of the text were read correctly, then the Sothic date in question is the complete date – IV *ȝḫt* 1, which corresponds to the heliacal rising of Sirius in the range of 2419–2406 BCE depending on observation conditions [Habicht et al. 2015, *47*], that is, to the conventional dates of the 5th Dynasty.

§1.4. Inv. 5821: Summation

Although the authors claim that the object originates from the 5th Dynasty [Gautschy et al. 2017, *71*], its stylistic features point either to the 6th Dynasty according to Günther and Wellauer's typology, if object Nr. 82 is the best fit, or to the MK according to Aston's typology, and the use of the term *prt Spdt* makes it doubtful that the inscription was carved before the MK. The sum of the facts leaves only two possibilities: a) reuse of the 6th Dynasty jar with the addition of an inscription during the MK (unlikely); b) the jar from the MK, but the text was read/interpreted incorrectly (likely)[1]. Since key features of the artifact cause dating controversy, it is not possible to benefit from this Sothic date, at least until a photo of the object becomes available.

§2. Movable *wȝgj* feast dates

Two instances of the *wȝgj* feast are known from the Illahun archive: a civil one, fixed on I *ȝḫt* 17/18; and a lunar one, which fell on the lunar day 17 of the second lunar month after the emergence of *Sopdet* [Puchkov 2023b, *102–103*]. Two incomplete OK *wȝgj* dates are known from the Abusir archive [Posener-Kriéger 1985, *35–43*], discovered in the funerary temple of Neferefre, the king of the 5th Dynasty. The seasonal nature of the lunar *wȝgj* makes it possible to apply Sothic principles to its dates.

§2.1. The seasonal nature of the lunar wȝgj

The idea about the connection of the movable *wȝgj* with the production of new wine goes back to A. Erman and is based on some Pyramid Texts spells [Erman 1934, *23*], for example PT 442, §820a: [*sȝḥ*] *nb jrpjj m wȝg(j)* ([*Sah*], Lord of wine[+making? (see: [*Wb* I, *115*, 13])] during the *wȝgj* [feast]). R. Krauss points out that the ripening of grapes in Pharaonic Egypt took place in June–July, and the production of new wine at the beginning of August – the beginning of September [Krauss 1998, *57*; 2006a, *375*], that is in line with data on sealing of wine jars during the New Kingdom [Hornung 1964, *77*; 2006, *206*]. Indeed, the movable *wȝgj* dates from the Illahun archive fell on this season (**Table 1,** last column):

King	Year		*prt Spdt* date		Jul.-into-Greg. correction, days	Movable *wȝgj* date	
	Regnal	BCE	(Eg.)	(Jul.)		(Eg.)	(Greg.)
[Senusret III]	[12]	1860	IV *prt* 18	18 July	-16	II *šmw* 22	4 Sep.
[Senusret III]	18	1854	IV *prt* 20	18 July	-16	II *šmw* 17	28 Aug.
[Amenemhat III]	9	1844	IV *prt* 22	18 July	-16	II *šmw* 29	7 Sep.

Table 1. Conversion of the movable *wȝgj* dates from the Illahun archive (pBerlin 10165, pBerlin 10016, pCairo 58065) into Gregorian dates. J. von Beckerath's middle estimates [v. Beckerath 1997, *188*] are not adjusted to astronomically plausible ones. The *prt Spdt* dates (Eg.) are calculated using the 1456-year duration of the Sothic cycle[2]. The *prt Spdt* dates (Jul.) are from R. Gautschy's calculation [Gautschy 2011, *123*]; for simplicity, the Julian date of heliacal rising is taken as 17 July for dates higher than 2526 BCE and 18 July for dates in the range of 2526–1058 BCE. The Jul.-into-Greg. correction is from R. Parker's conversion table [Parker 1950, *8*, *Table 1*]. The movable *wȝgj* dates (Greg.) fall on the end of August – the first half of September.

It seems likely that the connection of *Sah* with the *w3gj* feast was due to the fact that during the period from the end of August to the middle of September, when new wine became available, the asterism of *Sah* (part of our Orion constellation) was in meridian transit just before sunrise, a remarkable event that the Egyptians could not overlook.

§2.2. Date from Posener-Kriéger's Document III (Vymazalová's Nf. 12a)

The date from Document III was reconstructed by P. Posener-Kriéger as I *3ḫt* [23/25/26/29] [Posener-Kriéger 1985, *40*], and by H. Vymazalová as I *3ḫt* [26] [Vymazalová 2008, *139–140*]. The date is in the heading, the beginning of which is lost (see Document IV for heading names), and the lines below list the distribution of linen to the funerary temple phyles on the occasion of the *w3gj* feast. Posener-Kriéger offers three possible explanations, preferring the latter: (a) the date refers to the civil *w3gj*, which in the OK fell on a date different from the date in the MK; (b) there was an interval of about a week between the civil feast and the delivery of the fabrics thereafter; (c) the OK feast was placed in the second (Parker's) lunar calendar [Posener-Kriéger 1986, *1137*]. L. Depuydt and H. Vymazalová prefer option (b) [Depuydt 2000, *174*; Vymazalová 2008, *140*].

First, the option that the examined date refers to the lunar *w3gj* should be immediately excluded, since, as shown in section §2.1, the dates of this feast must fall in the same lunar month, but there is at least a two-month gap (I *3ḫt* [26] and III […] 28) between two *w3gj* dates from the Abusir archive (for the second date see section §2.3). Second, the option that the date belongs to the civil *w3gj* is also doubtful, since the OK feasts were lunar. Third, A. Spalinger discarded the second lunar calendar [Spalinger 1995, *110–122*]. Fourth, there is no evidence that the date refers to *w3gj*. At this stage it must be admitted that the nature of the date is unclear, so it will be set aside for further consideration in section §6.

§2.3. Date from Posener-Kriéger's Document IV (Vymazalová's Nf. 11e).

The season name in the date from Document IV is lost: III [...] 28. U. Luft reconstructs the season as *3ḫt* [Luft 1994, *42*], suggesting the celebration of the feast in the first lunar month after the emergence of *Sopdet* instead of the second month, in order to reconcile the calculated dates with conventional expectations for the 5th Dynasty. Depuydt and Gautschy et al. allow two reconstruction options, *3ḫt* and *prt*, which produce a high and low chronology [Depuydt 2000, *173*, *183–184*; Gautschy et al. 2017, *79–80*]. Moreover, for the same reason as Luft, Depuydt proposes the first and third months after the heliacal rising, respectively, and Gautschy – the first and second months. Krauss reasonably supposes the second month in both options [Krauss 1985, *86–94*; 1998, *53*] and points out the discrepancy with the expected dates of the 5th Dynasty [Krauss 2006c, *446*], concluding that this date cannot be used because of insurmountable chronological contradictions [Krauss 2021a, *93*, *96*].

Let us calculate the years of creation of Document IV for three options for the reconstruction of the season name: *3ḫt*, *prt*, *šmw* and for the second lunar month after the heliacal rising of Sirius (47–76-day interval)[3], so that the dates fall at the time of sealing the wine jars, as was the case in the MK (**Table 2**).

Movable *w3gj* date (Eg.)	**Heliacal rising date (Eg.)**	**Year, BCE**	**Movable *w3gj* date (Greg.)**
	Min. / Max. possible (47–76-day interval)	Max. / Min. possible (47–76-day interval)	
III [*3ḫt*] 28	I [*3ḫt*] 12 / II [*3ḫt*] 11	2724 / **2605**	11 Aug. / 8 Sep.
III [*prt*] 28	I [*prt*] 12 / II [*prt*] 11	**2245** / 2127	16 Aug. / 13 Sep.
III [*šmw*] 28	I [*šmw*] 12 / II [*šmw*] 11	1767 / 1648	20 Aug. / 17 Sep.

Table 2. Calculation of the creation dates of Document IV for three options for the reconstruction of the season name in the *w3gj* date. Egyptian dates are converted into Gregorian dates using the same values (heliacal rising dates, Jul.-into-Greg. correction) as in **Table 1**.

Option III [*šmw*] 28 should be excluded immediately, since it falls into the Second Intermediate Period. Reconstructing the date as III [*prt*] 28 gives the maximum low estimate of 2245 BCE for Djedkare's reign[4], some 100 years below expectations; and III [*3ḫt*] 28 gives the minimum high estimate of 2605 BCE for Neferefre's reign, up to 200 years higher than expected (see: [v. Beckerath 1997, *188*]).

There is currently no solution to fit this date into the existing chronological framework, but at this stage it is better to refrain from invalidating it and finish the section by concluding that the date from Document IV may indicate the problematic of the OK conventional dates based on assumptions about the length of the FIP.

§3. Dates of expeditions to the Eastern desert and Sinai

Since Predynastic times, the Egyptians had undertaken quarrying expeditions into the Eastern Desert, following the caravan route along the dry river bed, Wadi Hammamat; and to the Sinai Peninsula (Serabit el-Khadim, Wadi Maghareh) through the Gulf of Suez ports of Wadi al-Jarf and Ain Sokhna [Gardiner, Peet, Černý 1955, *3–11*]. A significant number of inscriptions, some of which contain civil dates of expeditions from different periods (**Table 3**), have been preserved at these sites. Contemporary reports (see: [Breasted 1906, *321–322*, *§733–736*; Simpson 1959, *23*]) indicate that this expeditionary activity was seasonal, so these data may be useful for Sothic dating of the OK.

King	Year	Source	Date (Eg.)	Date (Greg.)
Middle Kingdom (Wadi Hammamat)				
Mentuhotep III	8	CM 114 = S 426 = Gl XV	I *šmw* 3	15 Aug.
Mentuhotep IV	2	CM 110 = S 441 = Gl X.1 CM 113 = S 442 = Gl XII CM 191 = S 443 = Gl XIV CM 192 = S 444	II *ꜣḫt* 3 II *ꜣḫt* 15 II *ꜣḫt* 23 II *ꜣḫt* 27	16 Jan. 28 Jan. 5 Feb. 9 Feb.
[Senusret I]	2	Gn 77	IV *ꜣḫt* [12/20][5]	[18/26] Mar.
Senusret I	2	Gn 67	III *prt* 20	24 Jun.
	16	CM 123 = Gn 64	III *ꜣḫt* 3	5 Feb.
	38	Gn 61 CM 87	III *ꜣḫt* 25 IV *ꜣḫt* 4	22 Feb. 2 Mar.
Senusret II	2	CM 104	IV *ꜣḫt* 8	26 Feb.
Senusret III	14	CM 47	IV *ꜣḫt* 16	28 Feb.
Amenemhat III	2	CM 43 Gn 70	III *ꜣḫt* 1 III *ꜣḫt* (?)	13 Jan. 13 Jan. – 11 Feb.
	3	CM 96 = Gl X.2	III *ꜣḫt* 3	14 Jan.
	19	CM 48	I *prt* 15	22 Mar.
	20	CM 42	III *ꜣḫt* 12	19 Jan.
Middle Kingdom (Ain Sokhna, Serabit el-Khadim, Wadi Maghareh)				
Amenemhat I	7	CCIS 219	I *šmw* 6	13 Aug.
Senusret I	9	CCIS 220	I *prt* 10	14 Apr.
Amenemhat III	6	Sinai 90(w)	III *prt* (–)	11 May – 9 Jun.
Amenemhat IV	9	Sinai 122(e)	III *prt* 26	24 May
Old Kingdom (Wadi Hammamat)				
Pepi I	36/37	CM 107 = U 93.5	III *šmw* 27	15 Jan.
Jtj (8 Dyn.)	1	CM 169 = U 148.5 = S 14	IV *ꜣḫt* 2	30 Apr. ± 6 days[6]
[Neferkauhor]	1	CM 152 = U 258.12 = S 22 = Gl III.3	III *šmw* 2	21 Nov.
		CM 149 = U 259.5 = S 24 CM 147 = U 259.13 = S 23 = Gl II.4	IV *šmw* 3	22 Dec.
Old Kingdom (Ain Sokhna, Wadi Maghareh)				
Djedkare Isesi	13/14	CCIS 250	IV *šmw* 4	14 Feb.
Pepi I	36/37	Sinai 16 = U 91.17	IV *šmw* 5	23 Jan.

Table 3. Compilation of known dates from the Eastern Desert quarry region of Wadi Hammamat, the Red Sea port of Ain Sokhna and the Sinai Peninsula turquoise quarries of Serabit el-Khadim and Wadi Maghareh. Source legend: Gl = [Golenishchev 1887]; CM = [Couyat, Montet 1912]; Sinai = [Gardiner, Peet 1917]; U = *Urk.* I; Gn = [Goyon 1957]; S = [Schenkel 1965]; CCIS = [Tallet 2012]. Conversion of Egyptian dates into Gregorian dates is based on Jong's

calculation of the summer solstice dates [Jong 2006, *438*, *Table III. 9.2*]. The dates for Jtj, the unplaced king of the 8th Dyn. (see: [Schenkel 1962, *136–139*; v. Beckerath 1984, *60*; Schneider 2002, *138*]), and Neferkauhor, the penultimate king of the 8th Dyn. were calculated for the middle (≈ 2168 BCE) and end (≈ 2149 BCE) of the 8th Dyn., respectively. For the attribution of CM 147, CM 149, CM 152 to Neferkauhor and for two expeditions in his Year 1, see: [Mostafa 1987, *174–182*; Farout 1994, *158–160*]. If several dates are known for the same expedition, only the earliest date (arrival date or closest to it; marked in black in the last column) is selected for analysis.

The left side of **Table 4** below demonstrates the distribution of dates from **Table 3** by Gregorian months:

- the MK dates from Wadi Hammamat (col. 3) show a clear seasonality, clustering within a two-and-a-half-month range, from mid-January to the end of March, which roughly corresponds to the time when the Nile water was decreasing, but the hot season has not yet arrived. Summer expeditions are rare (only 2 out of 12 discovered);
- the MK expeditions to Sinai in the analyzed dataset take place from mid-spring to the end of summer (col. 4), with the summer months characterized as unsuitable;
- the OK dates from Wadi Hammamat cluster in a two-month range, from the end of November to the end of January, with a single date in the end of April (col. 1);
- the OK expeditions to Sinai fall in the second half of winter (col. 2).

	OK (conv.)		**MK**		**OK (conv. + 200 years)**	
	Hammamat (col. 1)	Sinai (col. 2)	Hammamat (col. 3)	Sinai (col. 4)	Hammamat (col. 5)	Sinai (col. 6)
Jan.	1	1	4		1 [21 Nov.–>8 Jan.]	
Feb.		1	4		1 [22 Dec.–>8 Feb.]	
Mar.			2		1 [15 Jan.–>4 Mar.]	1 [23 Jan.–>12 Mar.]
Apr.	0.5			1		1 [14 Feb.–>3 Apr.]
May	0.5			1.7		
Jun.			1	0.3	1 [30 Apr.–>17 Jun.]	
Jul.						
Aug.			1	1		
Sep.						
Oct.						
Nov.	1					
Dec.	1					

Table 4. Distribution of dates from **Table 3** by Gregorian months (left side; fractional values correspond to dates distributed between two adjacent months). The period of expeditionary activity in the OK (conventional) falls approximately one and a half months earlier than in the MK. The calculation for the 200-year-higher chronology (right side) aligns these periods (compare col. 3 and col. 5; col. 4 and col. 6).

Analyzing the distribution of dates in **Tables 3** and **4**, one can notice that the duration of periods of activity in the Eastern Desert during the MK and OK is approximately the same and is about 2.5 and 2 months, respectively, but in the first case this is the second half of winter – first month of spring, and in the second case – the first half of winter, i.e., it starts 1.5 months earlier. A similar shift to an earlier season is observed in the case of the Sinai expeditions: the second half of spring for the MK and the second half of winter for the OK.

The shift in seasonal activity can be explained by either (a) climate change, or (b) incorrect estimates of the age of one of the periods. Since global climate change in Egypt over the supposed one and a half century period between the end of the 8th Dynasty and the end of the 11th Dynasty is unlikely (see: [Maravelia, Shaltout 2020, *227–229*]), it remains to test option (b), given that the MK has a firm Sothic reference, therefore any doubts about the age should be attributed solely to the OK.

Because the Egyptian civil year (365 days) was almost a quarter of a day shorter than the tropical year (365.242 days), seasonal events moved forward in civil dates throughout the history of dynastic Egypt, completing the cycle in 1508 years[7] (not to be confused with the 1456-year[8] Sothic cycle, which refers to the heliacal rising of Sirius). A one-day advance accumulated every 1 : (365.242 – 365) = 4.13 years, so the observed shift of the OK expedition dates by about a month and a half (45 days) to an earlier season would correspond to a 45 × 4.13 = 186 years higher age of this period. Summing this observation with two options for reconstruction of the *w3gj* date from section §2.3, the low OK chronology (conventional – 100 years) can be confidently excluded from consideration and the high one (conventional + 200 years) comes into focus.

The calculation for the high OK chronology (see **Table 4**, col. 5 and col. 6) shifts the dates of the OK expeditions into the same seasons in which the MK expeditions took place: mid-January – late March, with a single event in June, for the Eastern Desert; spring for the Sinai expeditions. As a result, the data from both eras become completely synchronized.

Could the conventional chronology be wrong in the age of the OK by two centuries, or could the discovered shift in seasonal expeditionary activity be caused by some other unaccounted factors? To exclude the possibility of an incorrect conclusion due to the small number of the OK expedition dates, additional verification is necessary.

§4. Flood and low water dates

There are two known OK sources that provide dates for the specific Nile water levels. The first of these is a well-known passage containing the low water date and describing the delivery of an altar for the pyramid of Merenre [Meyer 1904, *178–179*; Schott 1950, *917–918*; Krauss 2006a, *369–370*]. Weni, the 6th Dynasty official, reported that he was able to deliver the cargo from Hatnub to the king's pyramid at Saqqara within 17 days of III *šmw*, although there was no water on the *ṯzw*, sandbanks (see: [*Wb* V, *401*]; see also: [Meyer 1908, *20*, *n. 1*]). This statement challenges modern chronologists, since for the generally accepted dates of Merenre's reign, III *šmw* 17–30, in which Weni could have landed at Saqqara, corresponds to the first half of January (Greg.) (**Table 5**), while the decline of the Nile waters began about a month later, from mid-February, and intensified towards the beginning of March [Meyer 1904, *179*]. The calculation of Gregorian dates for the 200-year-higher chronology shifts III *šmw* 17–30 to the second half of February, which fits well with the statement about the problematic water level to reach the destination.

The second relevant date became known recently as a result of the discovery of the Wadi al-Jarf papyri. According to the text of Papyrus A, the only one discovered preserving information about the month of the events described, i.e., I *3ḫt*, Merer's team transported limestone blocks from Tura to Khufu's funerary complex in the first ten days (days 3 to 10 are preserved) of the month, and they took part in the opening of a seasonal canal leading to Khufu's artificial lake in the second ten days (days 11 to 18 are preserved) (see: [Tallet 2017b, *13*]). It is clear that these events could only take place during the annual flood[9], just before the water rose to a level sufficient to use the artificial basin. Contrary to P. Tallet's erroneous calculation[10], I *3ḫt* fell in May (Greg.) for the expected reign of Khufu at the end of the first half of the 26th century BCE. In the second ten days of May, the Nile in the Memphis area should have been at its lowest level[11], so there can have been no question of putting a seasonal canal into operation. However, for the 200-year-higher chronology, I *3ḫt* fell in the period from 19 June to 18 July (Greg.)[12], when the Nile began to rise but was still far from its highest level. The second ten days in this case correspond to the beginning of July, which fits well with the expected time for opening a seasonal canal.

King	Source	Year	Date (Eg.)	Date (Greg.)	
				OK (conv.)	OK (conv. + 200)
Khufu	Wadi al-Jarf Papyrus A	25/26[13]	I *ꜣḫt* 11–18	12 May – 19 May	29 Jun. – 6 Jul.
Merenre	Weni's tomb at Abydos	–	III *šmw* 17–30	1 Jan. – 14 Jan.	18 Feb. – 3 Mar.

Table 5. Known OK flood (first row; for details, see: [Tallet 2017a, *34–48*]) and low water (second row; for details, see: [Mariette 1880, *40–41*, *233* and *Pl. 45*, *45–46*; *Urk*. I, *108.6–8*]) dates. For the conventional OK chronology, they both occur too early to fit the corresponding seasons, whereas for the 200-year-higher chronology the match is good.

While one can assume that the events discussed occurred during extremely early(/low)-flood years, it is unlikely that this would have been the case for both of the two known relevant dates.

The identical peculiarity of the dates analyzed in sections §2–4 to be about one and a half months earlier than would be expected given the actual seasons justifies the conclusion that, in the conventional chronological reconstructions, the age of the OK is underestimated by about two centuries. Seasonal or lunar data do not help to calculate a more accurate value: the former due to their imprecise nature; the latter due to their cyclical nature[14]. To obtain the accurate age of the OK, one needs to turn to archaeoastronomy.

§5. Accurate dating using a pattern in the azimuth data of the OK pyramids

As shown in my recent article on the astronomical orientation of the OK pyramids [Puchkov 2023a, *3–68*], the gradients of the two trends in the azimuth data of the pyramids help to detect the range of sky positions in which the procedure for orienting the pyramids' bases could have been carried out. Analysis of texts and iconographic sources suggests that the precise temporal marker in the orientation procedure was the specific configuration of *Meskhetiu* (our Big Dipper or Plough asterism), namely the horizontal alignment of its two outer stars, Dubhe (α UMa) and Alkaid (η UMa). This alignment brought *Meskhetiu* into a "state of balance", which the Egyptians could identify with the help of two poles and a looped cord in the "stretching of the cord" ceremony. At the moment of "balancing" of *Meskhetiu*, an observer with *merkhet* determined the azimuth of the target circumpolar star, the choice of which was religiously justified.

A comparison of data on the precessional drift of "imperishable stars" in this position of the celestial sphere with the azimuth data of the pyramids reveals that the age of the OK is underestimated in conventional chronological reconstructions by more than two centuries (≈ 230 years compared to v. Beckerath's middle estimates).

The foundation date of Khufu's pyramid in 2810 ± 5 BCE[15] should be taken as the "anchor" point for the OK. Precise dating (± 5 years) is possible due to the high accuracy of the alignment of the bases of the two largest pyramids at Giza and the strict rules governing the movement of celestial bodies. Dates for other reigns can be calculated based on the known relative chronology of the period. Recalculation of **Tables 3** and **5** for 230-year-higher chronology further improves the fit of events into the expected seasons[16].

§6. Possible interpretation of the date from Document III of Neferefre's archive

Now that the dates of Neferefre's reign in the high chronology can be estimated, the date from Document III needs to be re-examined. Recall that it was reconstructed by Posener-Kriéger as I *ꜣḫt* [23/25/26/29], and by Vymazalová as I *ꜣḫt* [26] (see section §2.2). In the reign dates of Neferefre in the high chronology (≈ 2662–2651 BCE), the emergence of *Sopdet* occurred on I *ꜣḫt* 27–30, thus was in close connection with the date in question. If this connection is not accidental, then the date may mark (a) the beginning of the Sirius-based lunar year of temple service (the first day of the first lunar month after the heliacal rising) or (b) the heliacal rising itself.

If one of these options is the case and Vymazalová's reconstruction is correct, then the document could not have been compiled later than (a) 2669 BCE (heliacal rising at I *ꜣḫt* 25) or (b) 2665 BCE (rising at I *ꜣḫt* 26) and the interval between Khufu and Neferefre is overestimated by v. Beckerath by at least several years. The smaller than expected gradient of the second trend line in the pyramid azimuth data for v. Beckerath's chronology [Puchkov 2023a, *64*, *Fig. SM5*] indicates that the overestimation is about 15–20 years and therefore Document III was compiled during the reign of Nyuserre Ini.

§7. Chronological consequences

To what period can the two "lost" centuries be attributed? Data from **Table 3** on the expeditions to the Eastern Desert by Neferkauhor of the 8th Dynasty, and Mentuhotep IV of the 11th Dynasty, indicate that the "excess" discovered must be inserted somewhere between these two kings. This conclusion is supported by the results of a large-scale radiocarbon dating study of Egyptian monuments [Bonani et al. 2001, *1297–1300*, *Fig. 1*], which revealed an extensive anomaly in the age of the OK samples. The anomaly affects most of the collected materials, including the 8th Dynasty sample from the pyramid of Qakare Ibi, but it disappears in the 12th Dynasty samples from the pyramid of Senusret II [Puchkov 2023a, *39–40*].

If Qakare Ibi and Neferkauhor were correctly placed at the end of the 8th Dynasty, then the discovered two centuries should mainly be attributed to the kings of the 9–10th Herakleopolitan Dynasties[17]. They reigned for about 125 years according to conventional views, that is, taking into account the coexistence with the 11th Theban Dynasty for about 100 years, they got only 25 years of sole rule. According to Manetho, this period, during which a total of 23 (Eusebius) to 38 (Africanus) kings reigned, was much longer and amounted to 285 (Eusebius) / 594 (Africanus) years, but these figures were significantly reduced by chronologists based on arguments of different persuasiveness (for analysis, see: [Puchkov 2023a, *35–37*]).

The proposed correction extends this period to about 200 years of Herakleopolitan's sole rule and brings the average length of their individual reigns close to that of the contemporary Thebans[18].

Such a significant increase in the length of the FIP and the average duration of its reigns forces one to reconsider the traditional view of the FIP as a period of struggle for power between two royal houses and the rapid succession of one Herakleopolitan to another. The reasons why the rulers of this epoch left so little archaeological heritage need further clarification.

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[1] Krauss (private communication), who gained access to inv. 5821, asserts that "*it is genuine and without a doubt from the MK*". Belmonte and Lull propose two translation options, according to which the jar may originate from the 6th Dyn. or from the MK [Belmonte, Lull 2023, *sect. 5.7*].

[2] The Sothic cycle with the following parameters was used for calculations: 1456-year duration; beginning in 2768 BCE; observations at Memphis; *arcus visionis* 9° (see: [Gautschy 2011, *120–122*]).

[3] The interval consists of the variable remainder of the lunar month in which the heliacal rising occurred (1–29 days), the full first lunar month (29–30 days) and 17 days of the second lunar month, for a total of 47 to 76 days.

[4] Posener-Kriéger, Verner and Vymazalová conclude that "*documents are certainly posterior to Raneferef and very probably date from the reign of Djedkara*" [Posener-Kriéger, Verner, Vymazalová 2006, *222*].

[5] 12th day: [Obsomer 1993, *136*]; 20th day: [Simpson 1959, *34*].

[6] The 8th Dyn. lasted about 46 years according to v. Beckerath. This gives 46 : 4 = 11.5 days (or ± 6 days for the mid-8th Dyn.) uncertainty to the calculated Gregorian date.

[7] 365.242 [tropical year] : (365.242 [tropical year] – 365 [civil year]) = 1509.26 civil years or 1508.26 tropical years (= 1508.23 Julian years of 365.25 days).

[8] 365.25068 ["Sirius" year] : (365.25068 ["Sirius" year] – 365 [civil year]) = 1457.04 civil years or 1456.04 "Sirius" years (= 1456.04 Julian years of 365.25 days). The Sothic cycle slowly shortens over time because of the high proper motion of Sirius (see: [Ingham 1969, *39–40*]).

[9] See: [Petrie 1888, *19–20*, *§28*] about transportation of quarry stone during inundation.

[10] Tallet uses the estimate given by Hornung, Krauss and Warburton for the last years of Khufu's reign (the beginning of the 25th century BCE), and incorrectly calculates the correspondence of Egyptian months to Julian months [Tallet 2017a, *8–10*, *Tableau 1*], since he *adds* the difference in days (= difference in years divided by 4) to the date of the heliacal rising of Sirius (Jul.), whereas in the case of earlier periods this value must be *subtracted*. He also uses Julian dates instead of Gregorian dates, while the former accumulate a difference of about 3 weeks with the actual seasons of the OK. It is noteworthy that the correspondence which he believed to be correct for the seasonal actions of Merer's team (I *3ḫt* ≈ July; etc.) is valid for the 230-year-higher chronology proposed by the current author (see section §5 and n. 16 below).

[11] Parker considers late May – early June to be the average beginning of the annual flood at Aswan [Parker 1950, *32*, *§156*], suggesting 10-day delay between Aswan and Memphis [Parker 1950, *74*, *n. 22*]. Krauss' compilation of the 19th-century Nile minima dates at Aswan [Krauss 2017, *79*, *Table 1*] gives an average of about 1 June, with the earliest minima at 5 May (Willcock's 1903 data is incorrect; see n. 117).

[12] Alignment of the beginning of the calendar flood season with the actual commencement of the flood shortly after the heliacal rising of Sirius (second half of June) is possible only near the beginning of the Sothic cycle.

[13] See: [Jüngling and Höflmayer 2023, *197*, *n. 104*].

[14] Lunar data can be useful primarily for refining dates in the 25-year range, if it is known for certain, since about 70 % of lunar phases repeated on the same civil days due to the existence of a 25-year lunar cycle (see: [Parker 1950, *15*; Krauss 2006b, *404–406*]).

[15] Based on data from Sky Charts 4.2.1 (see: [Puchkov 2023a, *27–34*]).

[16] Earliest Old and Middle Kingdom expeditions to Wadi Hammamat in mid-January (Greg.); Weni's arrival from 25 Feb. to 10 Mar.; Merer's activities in I *3ḫt* = 26 June – 25 July.

[17] A number of local administrators of Upper Egypt dating from the end of Pepy II's reign to the end of the 8th Dyn. [Brovarski 2014, *22–33*], as well as a large number of burials in the Qau and Badari cemeteries from the same period ("*Each of the three great divisions of the VIth, VII–VIIIth, and IX–Xth dynasties represents a period of from 170 to 200 years, possibly less. The number of burials recorded is 497, 392, and 384 respectively*" [Brunton 1923, *8*]), may also indicate a longer final part of the OK.

[18] According to the Turin Canon, the single Herakleopolitan dynasty consisted of 18 kings, thus ≈ (200 [sole rule] + 100 [parallel rule with the 11th Dyn.]) : 18 = 17 years on average for each of them. This value is close to 143 : 7 = 20 years/reign for the contemporary to them 11th Dynasty Thebans (or 73 : 4 = 18 years/reign before the unification of Egypt). Based on a weak argument of the paucity of archaeological traces (as correctly pointed out by [Seidlmayer 2006, *165*]), the conventional chronology suggests a significantly shorter average Herakleopolitan reign of ≈ 125 : 18 = 7 years (see: [v. Beckerath 1997, *144–145*]).

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О. В. Пучков

Сотічне датування єгипетського Давнього царства

Сотічна хронологія Давнього царства ще не була надійно встановлена через невелику кількість відповідних дат цього періоду. Аналіз дат Давнього царства, пов'язаних із сезонними подіями (свята *w3gj*, експедиційна діяльність, цикли Нілу), показує, що сезонна активність була зміщена приблизно на півтора місяця раніше, ніж можна було б очікувати, зважаючи на фактичні пори року. Це спостереження свідчить про те, що в загальноприйнятих хронологічних реконструкціях вік Давнього царства є недооціненим приблизно на два століття. Порівняння дат експедицій до Ваді Хаммамат за часів Давнього та Середнього царств приводить до висновку, що розбіжність обумовлена неправильними припущеннями щодо тривалості Першого перехідного періоду. Цей висновок узгоджується з результатами масштабного проєкту радіовуглецевого датування Г. Бонані та ін., який виявив значну аномалію у віці більшості зразків Давнього царства, тоді як для Середнього царства результати добре збіглися з очікуваннями. Значне збільшення тривалості Першого перехідного періоду потребує нового погляду на цю епоху, яка традиційно вважається періодом боротьби за владу між двома царськими династіями та швидкої заміни на престолі одного Гераклеополіта іншим.

Ключові слова: висока хронологія; Давнє царство; Стародавній Єгипет; сезонні події; сотічне датування

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