The basis for the Egyptian dates

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Introduction

Egyptian chronology is based on combining several different systems.

The most reliable system, called "dead-reckoning", is based on counting regnal years documented from contemporaneous written sources. The principle is simply establishing the sequence of kings and establishing a minimum number of years for the reign of each individual king. This produces a minimum basis for the estimation of the date of accession and death of each king, and thus from a given point one can simply count backwards providing a reasonably reliable skeleton for a chronology. However, it is far from certain that the final year of a reign will be recorded in a dated inscription. Thus, these dates are only a minimum; other sources can be used to argue that reigns were actually longer than the final attested dates.[1]

There are also lists of kings preserved from various different periods, and some of these can be used to suggest possible sequences of kings and possible lengths of reigns. However, these lists were edited, and potentially contain copying errors. In general, the copies of such lists which survived until today are themselves copies of other copies, and the originals based on the actual documents are not preserved. Although not in themselves reliable sources, they can on occasion be used to see whether a particular solution might be compatible with the facts known from elsewhere.[2]

Thirdly, for certain periods one can also track the genealogy of private families through time, and relate these to the kings under whom they lived. Where members of such families can be related to one another and to regnal year dates, one can use these as a control for reigns where either the absolute chronology or the length of the reign is in dispute.[3]

The fourth system relies on synchronisms with rulers of Mesopotamia, Syria, and Anatolia. This method is based on philological sources and simply states that two rulers either ruled simultaneously (if they exchanged several letters, for example) or that they ruled at roughly the same time (if circumstances related to one king can be related to another).[4]

The fifth system depends upon archaeological typology and stratigraphy, linking objects which can be assigned relative positions in archaeological chronologies with the reigns of dated kings (*e.g.*, Middle Bronze Age Western Asian axes known from archaeological excavations and from dated paintings).[5] An abundance of monuments dating to a particular reign can also be used to argue that that reign may have been longer than the last date preserved if that date is rather low. Conversely, a paucity of remains can be used to support a shorter reign.

In some cases, archaeological objects which can

[1] This method is the basis of the calculations for the minimal dates in Hornung *et al.* 2006, 94–303.
NB. Along with Krauss, 1985, Hornung *et al.* 2006 is the reference guide for all the points discussed in this text (with the exception of the reign of Horemhab, and the ensuing implications for the absolute chronological dates of Dyn. XVIII, which were not known at the time that that work was compiled). For arguments about the chronology of the Middle and New Kingdoms of Egypt, see Bietak 2003a, 175–97; Bietak & Czerny 2007, 163–83.

[2] See, *e.g.*, Ryholt 2004.

[3] See Bierbrier in Hornung *et al.* 2006, 37–44 .

[4] See Klinger in Hornung *et al.* 2006, 304–24.

[5] See, *e.g.*, Warburton 2000.

be linked to royal names can also be radiocarbon dated, providing a range of possible radiocarbon years, and thus the sixth system.[6]

Together, these six systems provide some kind of foundation for a relative chronology.

Absolute chronologies can only be established using astronomical data, which is the seventh system. Egyptian astronomical data preserved in the written documentation is of two kinds: monthly lunar dates and Sothic dates. Astronomical events tend to repeat themselves at regular intervals, and thus the examination of ancient astronomical phenomena can provide a number of windows which can be assigned for certain kings. Dead-reckoning, synchronisms, archaeological evidence, and ^{14}C dates can be exploited to suggest which windows are more reasonable than others. However, the repetitions of astronomical events are not necessarily exactly regular, allowing one to favour certain events and discard others. On the other hand, however, the very irregularities themselves give rise to disputes. Furthermore, there is always a risk of recording errors. In general, however, using the basic framework to provide a minimum date, the choice of astronomical data does not leave much leeway, and thus the chronology can be straightened out at certain points.

A clarification

Egyptologists measure time in terms of the reigns of kings, and groups of kings called dynasties, and groups of dynasties called kingdoms. Thus, in principle, Dyns. IV–VIII are assigned the Old Kingdom, XI–XIII the Middle Kingdom and XVIII–XX the New Kingdom. The Old Kingdom was preceded by the Predynastic era and the Early Dynastic period (Dyns. I–III). The Middle Kingdom was sandwiched between the First (Dyns. IX–XI) and Second Intermediate Periods (Dyns. XIII–XVII, *SIP elsewhere in this volume* – note ed.). The New Kingdom was followed by a Third Intermediate Period (Dyns. XXI–XXV, TIP), itself followed by the Late Period (essentially Dyn. XXVI), which takes us into the Persian (525–332 BC) and Graeco-Roman Periods.

Dead -Reckoning

From the third millennium BC, the year of the Egyptian civil calendar consisted of 365 days; there was no leap year. (Whatever nuances there may be which touch the origins of the calendar in the fourth and third millennia, these have no impact on dates in the second millennium, which is our concern here). Dates were expressed in terms of the year (of the reign), month (of each of the three seasons), and the day (in terms of the 30-day months, and by the individual days for the epagomenai). Thus, in the Egyptian system, within a year, a date is expressed according to day, season and month; here, for your benefit, the days are numbered from 1 to 365.

Kings assigned each year of their reign a number. Over the millennia, there were a number of different methods of dealing with the actual year of the death of one king, and the accession of his successor. Thus in some epochs, the civil year is simply divided between two kings (as in the Middle Kingdom), so that neither the final year of one king's reign nor the first year of the next king's reign correspond to one entire Egyptian year. In others, the civil year and the regnal year are not identical (as in the New Kingdom), so that the first regnal year of a king is an entire year, while, obviously, the final "year" of the preceding king is not, since the new first regnal year is simply counted as 365 days from the accession, and is followed by a second year based upon the date of accession – and not the first day of the new year (as in the Middle Kingdom).

Obviously, this means that Egyptian years have no relationship to sidereal years, and Egyptian months in the civil calendar have no relationship to lunar months. It also means that over the millennia, there is room for doubt about a certain number of years. However, the advantage of dead-reckoning is that it offers an absolutely minimal framework.

Dead-reckoning Dyn. XXVI

The final era of Pharaonic history is linked to the history and chronology of Mesopotamia and Persia in the 6th century BC. The Babylonian

[6] See Manning in Hornung *et al.* 2006, 327–55.

chronology of the period is securely established. In 525 BC, Cambyses, King of Persia and Babylonia, defeated the Egyptian king Psametic III of Dyn. XXVI. The kings of this Dynasty are well known. The chronology of Dyn. XXVI rests on contemporaneous dates in royal inscriptions and in private documents such as contracts and letters. A speciality of Dyn. XXVI is the detailed biographical data contained in memorial stelae of priests and the bull god Apis.

For example, it is recorded that an Apis was born in regnal year 53, day 169, under Psametic I; and that this Apis died in regnal year 16, day 36, under Necho II; and that the age of the Apis at death was 16 years, 7 months, 17 days. From such data, we can span reigns even where original sources are absent.

In Dyn. XXVI, with the exception of the accession year of a king, regnal years and civil calendar years coincided (as was the case in the Middle Kingdom). Thus, even the historians of the late 19th century were able to establish the following reign lengths and also the first year of the dynasty in absolute chronology:

Psametic III	6 months	526/525 BC
Amasis	44 or 45 years	
Apries	19 years	
Psametic II	6 years	
Necho II	16 years	
Psametic I	54 years	

Thus Psametic I, year 1 = 663 or 664 BC

A single problem is left open – whether the reign of Amasis ended in regnal year 44 or 45. Thus, up to 663, it is a question of a mere year based in dead reckoning. The preceding five dynasties present different types of problems. Some of these dynasties were parallel (*e.g.*, the princes of Dyn. XXIII are of no chronological interest) and thus although there may be internal problems in the chronology of one dynasty, the overall scheme is relatively clear.

Dead-reckoning Dyns. XXII – XXV

The highest attested date for Taharqa of Dyn. XXV, predecessor of Psametic I is year 26, corresponding to 690 BC as year 1. The highest date for his predecessor Shebitqo is year 3, but an Assyrian inscription attests his year 1 or 2 already in 707 to 706 BC. Since his predecessor Shabaqa ruled at least 15 years, his rule started in 722 BC, at the latest. Shabaqa invaded Egypt in his first or second year and defeated Bocchoris of Dyn. XXIV. Dyn. XXII ended with Shoshenq V, as predecessor of Tefnakhte of Dyn. XXIV. The relative chronology of Dyn. XXII is well known; an exception is Shoshenq II who is only attested by his burial. Maybe he ruled a couple of months. The sequence and dates are relatively clear:

Taharqa	26
Shebitqo	(already ruled in 707/706 BC)
Shabaqa	15
Bocchoris	6
Tefnakhte	8
Shoshenq V	38
Pami	7
Shoshenq III & IV	52
Osorkon I	29
Shoshenq II	?
Takelot I	14
Osorkon I	33
Shoshenq I	21

Year 1 of Shabaqa = 722 BC or earlier, and thus the beginning of Dyn. XXII *c.* 930 BC. (As in all of the dates presented in this part, these are based exclusively on dead-reckoning; we will come back to the other systems which extend these dates).

Dead-reckoning Dyn. XXI

In Dyn. XXI there are no contemporary regnal years known for Amenemnisut, but the other kings are clear:

Psusennes II	19
Siamun	17
Osochor	6
Amenemope	10
Amenemnisut	-
Psusennes II	46
Smendes	26

There are reasons for assuming that Psusennes II and Siamun ruled longer than the 19 and 17 years respectively assigned to them, thus we could add some time to these dates.[7] Thus dead-reckoning takes us back to at least 1054 BC.

At the beginning of Dyn. 21 Egypt was split in two, with two centres of power, each ruled individually. Kings reigned in Lower Egypt; at the same time the High Priests of Thebes assumed attributes which were reserved for a king. It is possible that the High Priests of Thebes who called themselves kings counted their own years of reign whereas from Amenemope onwards the dates refer to the Lower Egyptian kings. If there is a difference in the lengths of the reigns of the Theban High Priests and the parallel reigning Lower Egyptian kings Smendes, Psusennes I and Amenemnisut it would only amount to a few years.[8]

Dead-reckoning Dyn. XX

The only chronological question in Dyn. XX is whether Ramesses XI ruled for more than 28 years.

Ramesses XI	28
Ramesses X	4
Ramesses IX	19
Ramesses VIII	1
Ramesses VII	7
Ramesses VI	8
Ramesses V	4
Ramesses IV	6
Ramesses III	31
Sethnakhte	3

Thus we reach 1165 BC at the latest for year 1 of Sethnakhte.

Dead-reckoning Dyn. XIX

Dyn. XIX is also well documented and the regnal years in the Table represent the historical reign lengths.

Tewosret & Siptah	8
Sety II	6
Amenmesses	usurper (concurrent reign)
Merneptah	10
Ramesses II	66
Sety I	11
Ramesses I	2

On this basis we reach 1268 BC as the latest possible year 1 of Ramesses I.

Dead-reckoning Dyn. XVIII

For Dyn. XVIII there are a number of uncertainties about the reigns of several kings. We divide these into two tables, one for the early part of the dynasty, and another for the later part:

Horemhab	14 or 26? 27?
Aya	4
Tutankhamun	9
Ankhetkheprure	1 ?
Semenkhkare	2
Akhenaten	17
Amenhotep III	37

As was stressed at the workshop, very little new evidence comes to light which would extend the chronology. What has come up in recent years have been bits of evidence which imply that reigns should be shortened. An example of such is new evidence which indicates that King Horemhab's reign may have ended around year 14 or 15, rather than in year 27 or 28 which has been maintained.[9] At the Tenth International Congress of Egyptologists at Rhodes in May 2008, J. van Dijk reported that a large number of wine jars dating to the 14th year of the reign of Horemhab had been found in the Theban royal tomb of Horemhab.[10] None of the incompletely preserved dates allows a date after

[7] Payraudeau 2008 (esp. 297–298) has found a text that seems to confirm 19 full regnal years for Siamun.

[8] See Jansen-Winkeln in Hornung, *et al.* 2006, 218–33.

[9] Around 1990, Helck 1992 had argued in favour of a short reign for Horemhab. And two decades earlier, Harris 1968 had argued for a short reign.

[10] For now, *cf.* van Dijk 2008 (check the final publication of the conference).

year 14 to be postulated, and most of the jars can be assigned to years 13 and 14.

It would superficially appear to be probable that these jars should be assigned to Horemhab's own burial. His consort was ultimately buried in his private tomb in Saqqara, and thus it is possible, but unlikely, that the wine jars were intended for her burial. But, if they were, then there would be no data concerning Horemhab's own burial – and this would be quite odd, as the tomb was hurriedly prepared, with most of it in an unfinished state.[11] This would imply that the tomb was closed at his death. Thus, if the wine jars actually mark Horemhab's burial, the chronology of Dyn. XVIII must be corrected by about 12 years (in comparison to what was presented at Sandbjerg).

This in turn would mean that the arguments hitherto used to support a reign of 27 or 28 years for Horemhab must be disregarded. In the case of the date on the ostracon O. IFAO 1254, Janssen has already suggested that this was no more than a "curious error".[12] Thus, it cannot be used to argue for years 26 or 27. The graffito mentioning a year 27 on a statue in Horemhab's mortuary temple was always "contentious",[13] and can easily be assigned to the reign of Ramesses II. In the Ramesside inscription of Mes, a private individual, it has been assumed that the date of 58 or 59 assigned to Horemhab subsumed the regnal years of the "illegitimate" Amarna pharaohs, and that one could project a regnal year 28 for Horemhab on that basis (by subtracting 33 or 34 regnal years for the Amarna pharaohs).[14] However, this inscription was made a century or so later, and involved a complicated calculation: the date can easily be viewed as including a simple error of a mere 10 years. Furthermore, there are absolutely no synchronisms in the Amarna letters which are not compatible with lowering the dates of the Amarna kings by a decade (which is the consequence of reducing the reign of Horemhab), since the reigns of Burnaburiash II and Assur-Uballit I both lasted several decades.[15] (However, we will note below that the synchronisms demand that the chronology be extended back a bit from these dates based on dead reckoning).

A further problem is that we have a great many year dates from Amarna, Akhenaten's capital, but not all of them can be assigned a specific king with certainty. However, due to the changing titles of vintners we can distinguish two succeeding reigns, after Akhenaten's. Thus we reach 1352 BC as the absolute minimum for year 1 of Amenhotep III, if Horemhab ruled for 14 or 15 years; had Horemhab ruled for 27 years the absolute minimum for year 1 of Amenhotep III would have been 1365 BC.

Early Dyn. XVIII

Thutmose IV	8
Amenhotep II	26
Thutmose III	54
Thutmose II	1
Thutmose I	4??, 8? 9?
Amenhotep I	21
Ahmose	22

Early Dyn. XVIII is well documented with the exception of Thutmose I and II in which cases the record seems to be incomplete. Thus, we end up with 1488 or 1492 (depending upon the interpretation of the data from the reign of Thutmose I)[16] as the absolute minimum for year 1 of Ahmose, if Horemhab ruled for *c.* 15 years only (1501 or 1505 BC if Haremhab ruled for 27 years).

Dead reckoning for the Second Intermediate Period and Middle Kingdom

Ahmose, the first king of Dyn. XVIII, defeated the Hyksos of Dyn. XV and conquered their capital Avaris in Lower Egypt. The Hyksos rule in Lower Egypt lasted for perhaps a century – but nobody knows exactly how long.

Between the defeat of the Hyksos by Ahmose and the end of the Middle Kingdom, there is

[11] Hornung 1971.
[12] Janssen 1984.
[13] Hornung in Hornung *et al.* 2006, 209.
[14] Hornung in Hornung *et al.* 2006, 209.
[15] See Gasche *et al.* 1998, fold-out table.
[16] Hohneck 2006 suggests that the year 4 date is modern. This does not change the 8, however.

not much documentation. There are very few contemporaneous documents with regnal years, and it is futile to reconstruct a chronology by adding up the accidentally preserved highest regnal years. According to historical reconstructions, the Hyksos put an end to the rule of Dyn. XIII. The Turin Canon listed about 57 kings for Dyn. XIII. For 21 kings altogether 105 years are preserved, 84 years in the Turin Cannon, 21 years in contemporaneous documents:

Sobekhotep IV	8
(Sobekhotep II)	5
Khendjer	4
Sonbef	4
Sobekhotep I	3

Obviously, there is not much to build on here. By contrast, late Dyn. XII is well documented.

Nofrusobek	4
Amenemhet IV	10
Amenemhet III	46
Sesostris III	19

Thus, as we simply cannot estimate the years based on dead-reckoning, we are compelled to introduce alternative arguments. Fortunately, for our purposes, these later kings of Dyn. XII suffice, since the chronologically relevant data is preserved in documents of Sesostris III and Amenemhet III. However, these kings allow us to build a chronology back to the beginning of Dyn. XII, and thus we add these rulers as well:

Sesostris II	9
Amenemhet II	35
Sesostris I	45
Amenemhet I	30

In the next sections of this paper, we will present various control mechanisms which will allow us to gain more certainty than that offered by the dead-reckoning hitherto employed. This is particularly relevant because this is the only means of bridging the gap between the well documented reigns of the New and Middle Kingdoms, and it was somewhere in this period that the Minoan eruption of Santorini took place. However, none of these devices offers a satisfying solution for any of the reigns before Dyn. XII – and the era before Dyn. XII is in any case irrelevant to the dating of the Minoan Santorini eruption. Thus, we stop with the reigns at this point, and turn to the controls.[17]

Synchronisms

The most significant indicator that the dates for the Pharaohs of Dyn. XVIII must be raised beyond the data available from the dead-reckoning of the reign count are the synchronisms with the Near East. Although these touch only a few reigns in a significant fashion, they have an impact on the parameters determining the beginning of Dyn. XVIII, and thus the end of the Second Intermediate Period.

The most important synchronisms for building up a chronology for the period under review are those between the Egyptian kings and their Near Eastern neighbours, the Hittites, Assyrians and Babylonians. Unfortunately, the chronology of the Hittite kings is itself dependent upon the chronology of the Egyptian and Mesopotamian kings, so that effectively, for detailed chronological reconstructions, we can really only work with the Mesopotamian kings. Fortunately, the most important problem in Mesopotamian chronology lies before 1500 BC and thus before the New Kingdom, so that the kinglists from Babylon and Assyria provide a sufficient basis to buttress the Egyptian chronology of the New Kingdom.[18]

It was during the reigns of Akhenaten and his father Amenhotep III that the Amarna letters were received and stored. Those which have been recovered were found at Akhenaten's capital at Amarna. The chronologically important Amarna letters were written by the rulers of Babylonia,

[17] Those requiring further data can consult Hornung *et al.* 2006.

[18] For the reliability (with decades at the most) of the chronology of the Mesopotamian kings until before the synchronisms of the Amarna period, see Hunger, this volume.

Mitanni and Assyria. The letters were written to Amenhotep III, the father of Akhenaten, and to Akhenaten himself.

According to the documentation in the archive, Burnaburiash II of Babylon became king and wrote his first letter to Egypt between regnal year 31 and 36 of Amenhotep III.[19] For Burnaburiash II, Brinkman gives 1359–1333;[20] Klinger, 1349–1323 ± 5 years BC;[21] and Gasche *et al.* 1354–1328 BC.[22] According to dead-reckoning, as presented above, year 1 of Akhenaten would have been 1317 BC. Fortunately, Burnaburiash also wrote letters to Akhenaten, and thus it follows that the reigns need to be raised, possibly by as much as a couple of decades.

Thus, there can be little doubt that the reigns of the Egyptian kings up to the Amarna period must be adjusted from the dead-reckoning calculations presented above to match their Mesopotamian counterparts with whom they exchanged letters. This is hardly surprising, but merely an indication of the degree of variability.[23] However, dead-reckoning and other calculations become important for the details again later, when specific dates are proposed. Thus, we must now turn to further internal control mechanisms.

Kinglists

What should be the most important single source which could aid us in making the leap between Dyn. XVIII and Dyn. XII are the kinglists. Given the paucity of contemporary sources for the Hyksos kings of Dyn. XV and the preceding Egyptian kings of Dyn. XIII, Egyptologists have tended to fall back on the so-called Royal Canon of Turin. Unfortunately, this kinglist was copied on papyrus under Ramesses II from another kinglist, also on papyrus – but with a different page format, leading to copying errors. Thus, the final document is too far removed from the Second Intermediate Period and the Middle Kingdom to be accepted at face value, and secondly, it is very badly preserved.

Yet, as noted, there is an enormous discrepancy between the actual dates which are preserved and the years which might be won from the Royal Canon of Turin. Yet, we have little else. On the basis of the Royal Canon of Turin we reckon with 6 great Hyksos kings. The papyrus fragment with the summation of their reign lengths is partially preserved. Ryholt now reads 140 years plus some possible digits. Earlier, Gardiner had read 108 years.[24] On the basis of contemporaneous documents we can only say that the Hyksos Apophis ruled at least 33 years, since P. Rhind is dated to this year.

Typology & stratigraphy

At Amarna, materials which are arguably both LH IIIA and IIIB were found, and thus we can link (at least) the latest phase of LH IIIA Greece with Egypt, since the transition must have taken place at roughly the time of the reign of Akhenaten. Thus, in principle, one could date the Amarna period by using the Greek sources. However, the chronology of Greece is dependent upon Egypt for precision and thus this method cannot help. Instead, establishing a date for Amarna would add Greek chronological precision.

[19] Beckerath 1997, 66.

[20] Brinkman 1976, and later.

[21] Klinger in Hornung *et al.* 2006.

[22] Gasche *et al.* 1998.

[23] A promising new avenue is opened with Miller's (2007, 2008) proposition that one can link the reigns of the Hittite King Mursili II and the Egyptian pharaoh Horemhab (before ascending to the throne). The arguments are complicated, involving both linguistic and historical assumptions. However, both Klinger (pers. comm.) and the editor have noted that a solar eclipse could potentially be added to the arguments. Although it supports his own argument rather than the editor's, Miller (pers. comm.) was non-committal on the issue. In the near future, this could have consequences for our reconstruction of the Amarna synchronisms. Given the proposed change in the reign of Horemhab, the consequences for the reliability of a new set of synchronisms could be significant, should Miller prove to be correct. (However, the current editor had other obligations which prevented him from exploring this fully, thus it is distressingly and regretfully left in the air here).

[24] Gardiner 1963, 442 noted: "The 100 certain, the 8 less so".

Radiocarbon

From the data, we can see that Akhenaten must have ruled in the second half of the 14th century BC. In the 1920s, a sample of beeswax was removed from the inlaid eye of the famous bust of Nefertiti, the consort of Akhenaten. This sample was taken to determine the materials and technique of the inlaid eye. However, almost two decades ago, a sample of this beeswax from the Berlin bust of Nefertiti was AMS dated by Stulik and Donahue. According to their results, the sample is to be dated to the years between 1390 and 1030 BC with a probability of 95%.[25]

There are also samples from more recent work at Amarna. Using modern methods, Manning still arrives at dates of 1388–1260 BC with 95% probability. Obviously, our problem here is a couple of decades, rather than centuries, and thus documents are clearly more helpful for fixing the chronology of Egypt.[26]

Lunar dates

Thus, our most useful documentation records dates in terms of regnal years, using the civil calendar. Some dated documents also refer to the observation or prediction of the heliacal rise of Sothis, while other sources reveal that the Egyptians also observed the phases of the moon, and used these to determine the dates of at least some of their festivals. On occasion, a lunar date can be related to an historical date, either due to the use of the civil calendar or because the date can be estimated for some other reason.

In principal, a lunar month lasts 29 or 30 days. The Egyptian day 1 of a lunar month is defined as the first day of the moon's invisibility. On the last day of the lunar month (which is simultaneously the day before the first day of the following lunar month), the waning moon was seen for a last time, just before sunrise. Thus, if the moon was visible on the morning of Lunar Day 30, then the next lunar month would start the next day. If it was invisible, the new lunar month had already started.

Thus, in principle, one should be able to examine a given lunar date tied to an historical date using the civil calendar, and establish whether or not a crescent was visible on that day. Furthermore, the lunar months can be arranged in 25–year cycles and thus even longer chronological units can be isolated.

However, there are two completely different complications which intervene into our chronological calculations. The first is the simple matter of erroneous observations: a crescent which was present could have been obscured by clouds or haze, or the observer might have made a recording error. Fortunately, aside from the Egyptian observations and astronomical calculations of lunar movements, Babylonian lunar observations are available, and remarkably, these confirm the Egyptian data. Significantly, in all of the material one of us (Krauss) has analyzed, there is not one single case of an error resulting in the recording of the observation of a crescent which should not have been visible. The "error" that does appear in the documentation of the roughly 300 dates studied is that crescents which should have been visible were not recorded as "observed".

The second complication is related to the fact that in principle 25 Egyptian years = 309 synodic months = 9125 days. Thus any given lunar date could be repeated after exactly 25 years, meaning for example that two different texts mentioning instances of the same lunar-based festival in different reigns can be related, and an interval proposed.

The difference between cycles of 309 synodic lunar months and 25 Egyptian years consists of 1 hour, 7 minutes, so that most cycles last 9125 days. Because the difference is small, one might suppose that after 25 Egyptian years one and the same lunar phase falls on the same Egyptian calendar day. But in reality no lunar month lasts 29.53059 days; rather, there are lunar months of a full 29 or a full 30 days. Over 309 synodic lunar months, there are often 164 months of 30 days and 145 months of 29 days. Because of the irregularity of the movement of the moon it can happen that in a sequence of 309 lunar

[25] Krauss & Wiedemann 1998.

[26] In Hornung *et al.* 2006, 335–8.

months there are 165 months with 30 days each and 144 months with 29 days. In such a case, a lunar day does not coincide with the same calendar day after exactly 25 Egyptian years, but rather it falls on the next calendar day. If, by contrast, there were 145 lunar months with 29 days and 164 lunar months with 30 days, then after 25 Egyptian years, the given lunar day fell on the previous day of the calendar (in comparison to the date 25 years earlier).

The principles of lunar based chronology are clear, and thus we will now return to the lunar dates as a means of checking the system of dead-reckoning. Fifty years ago, Richard Parker published a text according to which in year 12 of Amasis an oath was to be taken on civil day 283, corresponding to a lunar day 15. According to the calculations introduced above, year 12 of Amasis corresponded either to 559 or 558 BC. Thus Egyptian civil day 283 corresponded to the Julian calendar day October 20 for the last time in 562 BC. For the following 4 years it corresponded to October 19 and changed in 557 BC to October 18.

If October 19 coincided with a lunar day 15, then lunar day 1 occurred around October 5. On October 4 the crescent was visible high above the horizon at sunrise, if the weather allowed it. On the following day, the lunar crescent had moved further down to just above the visibility borderline. The visibility borderline is defined by the distance between the crescent and the sun at the moment when the center of the sun is in the mathematical horizon.

We can get some useful results by computing the situation on October 19 in the years shortly before and after 559 BC. One and only one possibility is forthcoming for civil day 283 being close to or coinciding with a lunar day 15, namely October 19 in 559 BC. Under these premises it follows that Amasis reigned until a year 45 and thus year 1 of Dyn. XXVI corresponded to 664 BC.

There are also lunar dates which allow the fixing of year 1 of Shoshenq III to 841 BC and of year 1 of Shoshenq I to about 943 BC. Other lunar dates allow the fixing of year 1 of Osochor to 992 BC which results in 1074 BC as the latest possibility for year 1 of Smendes. Thus, the dead-reckoning gave a result of 1054, whereas the actual date was 1074. This means that all of the minimal dead-reckoning estimates proposed above need to be projected back two decades.

We can also make use of three lunar dates of Dyns. XIX and XX. There is a calendric inscription of Ramesses III according to which in each year around civil day 300, the statue of the god Amun was brought from the east bank of the Nile to the funerary temple of the king on the west bank. The crossing of the Nile took place on lunar day 1. The god rested in the funerary temple of the king on lunar days 1 and 2. Attendants of the ceremony on the Theban west bank left inscriptions in year 7 of Ramesses III on day 309, when Amun rested in the funerary temple of Ramesses III. A few years earlier, in year 7 of Queen Tewosret, Amun rested in the funerary temple of the Queen on civil day 298. Both resting days ought to have been either a lunar day 1 or 2. These lunar dates are only compatible with either year 1 of Ramesses II = 1304 or 1279 BC.

Incidentally we gain a significant detail from to a ship's log recording a first lunar day coinciding with civil day 177 in year 52 of Ramesses II. If year 1 of Ramesses II = 1304 or 1279 BC the observer would have missed the old crescent on day 177 in the corresponding year 52 of Ramesses II and would have reported day 176 as old crescent day. There are indications that this type of mistake occurred in about 15% of all old crescent observations.

The other date for the accession of Ramesses II which has been proposed is 1290 BC. In the corresponding year 52 of Ramesses II, the crescent was just below the visibility line on day 176; old crescent would have been observable on day 175. By reporting day 176 as old crescent day the observer would have recorded the observation of a crescent which was actually not visible. As remarked above, there are no indications that this kind of mistake occurred. Thus 1290 BC is not a likely candidate for year 1 of Ramesses II.

Thus, the alternatives are 1304 and 1279 BC. If year 1 of Ramesses II corresponded to 1279 BC, then about 3 regnal years would be missing from our records between 992 BC as year 1 of Osochor in Dynasty 21 and the end of the reign of Ramesses II in 1213 BC. Such a gap in our documentation is

quite acceptable. If we were to take 1304 BC = year 1 of Ramesses II, this would mean that about 28 years would be missing in our records, which seems to be impossible. Thus 1279 BC is the only feasible possibility for year 1 of Ramesses II if lunar dates are taken into consideration as a means of achieving an absolute date. One recently discovered date related to Sethnakhte would be compatible with these dates "provided he died early" in his year 4, as Bennett put it.[27] Thus, 1279 is compatible with the evidence.

There are two lunar dates from the reign of Thutmose III. The first is the date of the Battle of Megiddo which reportedly took place exactly on a first lunar day; the other concerns preparations for the founding of a temple at Karnak on a first lunar day. In principle, Egyptologists have considered two astronomical possibilities: either year 1 of Thutmose III corresponds to 1504 BC or to 1479 BC. If year 1 were 1504 BC then the observer would have missed an old crescent and he would have recorded an old crescent which was not actually visible. Thus 1504 BC as year 1 of Thutmose III does not work astronomically. If year 1 were 1479 BC, then either both observations were correct, or perhaps the observer missed one old crescent which he could have seen under better meteorological circumstances.

It thus follows that 1479 BC could be reasonably proposed as year 1 of Thutmose III, if Horemhab reigned 27 years. If, however, Horemhab reigned for only about 15 years, then, this would necessarily shift year 1 of Thutmose III to around a decade later, since there is no means of accounting for an entire decade of "missing years" in any of the known reigns between Ramesses II and Thutmose III. Both of the lunar dates mentioned for Thutmose III are compatible with a year 1 of 1468 BC, as they can only be placed 11 years later. A shift of 12 or 13 years is impossible, as a 12 year shift would entail a change in the lunar date of +20 days, and a 13 year shift, a change of +9 days.

A shift of 11 years would ordinarily mean that on average the calendar day of a given lunar phase would fall a day later. However, due to the irregularity of the movement of the moon, this is not invariably the case. If year 1 were 1468 BC, then the date of the Battle of Megiddo occurred on lunar day 1. The date on the *Akh-Menu* monument at Karnak states that in year 24, Thutmose III had the preparations commence for a foundation ritual on civil day 180 anticipating a first day of a lunar month. If year 1 of Thutmose III is shifted from 1479 to 1468 BC, then the first day of a lunar month would have been civil day 182. The king would thus have made his arrangements on the 28th day of a lunar month, which would have been a day earlier than actually required.

If 1468 BC was year 1 of the reign of Thutmose III, the regnal years between Thutmose III and Horemhab would thus have to be shifted accordingly. There is some freedom as it is unclear whether Tutankhamun ruled for 9 or 10 years, and likewise whether Ramesses I may have ruled for 3 years, or indeed whether Sety I ruled for 12 rather than 11 years. However, under these conditions and circumstances, we can propose the following chronology for the latter part of Dyn. XVIII and early Dyn. XIX.

Thutmose III	May 1468 – Nov 1415 BC
Amenhotep II	Nov 1415 – Sept 1389
Thutmose IV	Oct 1389 – May 1379
Amenhotep III	June 1379 – Nov/Dec 1342
Amenhotep IV	Nov/Dec 1342 – Aug/Sep? 1325
Semenkhkare	1324 – 1322
Ankhetkheprure	1322/21
Tutankhamun	1321/20 – Feb 1311 (buried before vintage of year 10)
Aya	March 1311 – at least March 1307
Horemhab	1307? – 1292? (buried before vintage of year 15)
Ramesses I	1293? 1292? – May 1291? 1290?
Sety I	May 1291? 1290? – May 1279
Ramesses II	May 31, 1279 – June 1213

Thus, lunar dates can aid us in creating a framework back to the reign of Thutmose III. To proceed back to the end of the Hyksos era we can use dead-

[27] Bennett 2008, 120 n.39.

reckoning. Yet, as noted, here we meet a gap in our documentation, and are thus obliged to use other means.

Sothic dates & solar years

As noted above, the Egyptian year is 365 days long whereas the solar (tropical) year is 365.24 days long. Thus their years were not the same as ours. Today, our year is based on the Gregorian calendar, as in 1582 Pope Gregory XIII reformed the Julian calendar and replaced it with the familiar Gregorian calendar still in use today. However, historians and astronomers reckon events before AD 1582 in the Julian calendar, where the year is assigned an average length of 365.25 days, and in four years, three years are 365 days long, and one leap year is 366 days long.

The correlation between the Julian and Egyptian calendars is known because the astronomer Claudius Ptolemy used the Egyptian 365 day calendar for dating astronomical observations. Using Ptolemy, it is possible to convert any Egyptian date in a given or chosen year into the Julian calendar equivalent, bearing in mind that the Julian calendar has a leap year and the Egyptian civil year does not.

The heliacal rising of the fixed star Sirius (Egyptian: Sothis) was the only astronomical event which was correlated to the 365-day civil calendar. On the day of its heliacal rising, Sirius is visible again for the first time in the morning just before sunrise, after having been invisible for about 70 days. In the Greek and Roman periods, Memphis is attested as the reference point for the observation of the calendric rising of Sothis; for the Pharaonic period the geographical reference is debated.

For centuries, the heliacal rising of Sirius occurs three times at an interval of 365 days, the fourth time in succession, however, it occurs only after 366 days. Because the Egyptian civil calendar had a uniform length of 365 days and lacked a leap year, the date of Sothis's heliacal rising shifted by 1 day every 4 years. In 1460 years the rising of Sothis will thus have fallen on every different day of the civil year. The concept of a Sothic cycle is first documented in the Hellenistic Period. The orator Censorinus noted in AD 238 that the civil New Year's Day and the heliacal rising of Sirius had coincided in AD 139. It was immediately appreciated by early Egyptologists that simple arithmetic would allow similar conjunctions to be "predicted" in the past as repeating themselves every 1460 years. Thus, the dates of 139 AD, 1317 BC and 2773 BC presented themselves. On this basis it was estimated that the rising of Sothis on day 226 in regnal year 7 of Sesostris III was in the year 1877 BC.

The value of the Sothis observations and predictions is relative. It is now clear that (a) there is no way of knowing that 139 AD was the first or last of the four years, and (b) the date depends upon the observation point (whether Alexandria, Memphis, Thebes or Aswan). Last but not least, it is not clear (c) whether the preserved Sothis dates relate to actual observations or to schematic calculations. The time between two heliacal risings of Sirius is not constant, but changes because of precession. In pharaonic times the Sothic year was always longer than the Julian year. When, over a long period, the difference added up to a quarter of a day, then the rising of Sothis fell for only three, rather than for four, years on the same Egyptian calendar day. If the Egyptian calendar was dependent upon the annual observation of the rising of Sothis, then the occasional shift of the rising should have been accounted for in triennia. It is however possible that the calendar dates of the rising depended upon a series of observations made only before and shortly after the introduction of the calendar. Subsequently, the Sothic date was schematically shifted one day every four years. The data supplied by Censorinus and other classical writers imply that the day of Sothis's rising was shifted schematically one day every four years. According to a copy of a letter preserved on a papyrus in the temple diaries from Illahun it was announced (at the latest) on civil day 204 that Sothis would rise on day 226 in regnal year 7 of Sesostris III.[28] This indicates that the rising date was schematically reckoned in the Pharaonic period as well.

There is a further problem with day 226 insofar as the temple diary preserves the entry for day 227.

[28] See Krauss in Hornung *et al.* 2006, 448.

On that day the offerings for the rising of Sothis were received, but offerings were usually received on the day *before* they were due. Therefore it is just possible that day 226 in the temple diary is mistakenly copied and the day ought to be 228. Taking these uncertainties of a Sothic date into account, the date for the Illahun Sothic date should lie between 1881 and 1826 BC.[29]

Absolute chronology: lunar and sothic dates

21 lunar dates equivalent to the observation of 21 old crescents observed at Illahun are recorded in the Illahun papyri, dating from year 9 of Sesostris III through to year 32 of Amenemhet III. If one supposes that year 7 of Sesostris III with the Illahun Sothic date lies in the period between 1881 and 1826 BC, or that Sesostris III and Amenemhat III belong somewhere between 1900 and 1700 BC (which allows more freedom), then there are in principle three possibilities for the complete set of their lunar dates.

If the set of Illahun lunar dates is calculated using year 1 of Sesostris III as 1863 BC, 15 of 21 crescents would have been observable above the visibility borderline. Two recorded crescents would have been just below the visibility borderline, three others would have been far below. This means that five physically impossible observations below the borderline would have been recorded.

If year 1 of Sesostris were 1836 BC, then two old crescents would have been missed. 19 of 21 crescents would have been observable above the visibility line and none below.

If year 1 of Sesostris III were 1811 BC, then sixteen crescents would have been visible. 3 old crescents would have been missed and 2 recorded old crescents would in fact have been unobservable, beneath the visibility borderline.

The astronomically correct set is evidently the one with no observations below the borderline of visibility, corresponding to 1836 BC as year 1 of Sesostris III. It follows from these conditions that the Illahun Sothic date of year 7 of Sesostris III fell in 1830 BC.[30]

This at least allows us to fix the absolute dates for the end of Dyn. XII. Calculating the absolute dates for the earlier reigns of Dyn. XII is tied up with another controversial issue, which cannot be unanimously resolved at this point. Among Egyptologists, there is a controversy over the question of whether or not the kings of Dyn. XII introduced their proposed successor as coregent towards the end of the reign. In the event that they did, it is assumed that the successor started counting his regnal years from the date of this accession to a co-regency, and did not wait until the death of his successor to commence an independent year count. If this proposition is accepted (and the principle is highly debated) it thus follows that there may have been an overlap in the dead-reckoning of regnal years, since other sources may be dated according to the reign of the elder king. In this case, years 33–35 of Amenemhat II would be identical to years 1-3 of Sesostris II; years 43–45 of Sesostris I would be identical to years 1–3 of Amenemhat II; and years 21–30 of Amenemhat I would be identical to years 1–10 of Sesostris I. Taking year 1 of Sesostris III as 1837/36 BC, year 1 of Dyn. 12 would be 1939 BC – if we assume coregencies. If not, then according to dead-reckoning, the start of Dyn. XII would be 3+3+10=16 years earlier, *i.e.* around 1955 BC.

With one possible exception, there are no lunar dates known from Dyn. XII before Sesostris III – and thus astronomical verification of the coregency hypothesis is excluded. The potential exception is recorded in a fragmentary inscription of year 10 of Sesostris I, reporting on a royal audience of the king and his counsellors on civil day 243. One can follow Gabolde in concluding that another text with similar passages refers to the same event, and that at this session the king and his advisors may have made the earliest known decision concerning

[29] Krauss 1985, 77.

[30] To be precise, the exact equivalence of the ancient Egyptian civil calendar year for the regnal year 7 of Sesostris III would be the period between 24 November (Jul.) 1831 BC = Day 1 (= Month I *Akhet* Day 1) and 23 November 1830 BC = Day 365 (=5th epagomenal day). Depending upon whether the Sothic date fell on Day 226 or Day 228, the Sothic date of regnal year 7 would be 7 or 9 July (Jul.) 1830 BC.

a construction at the temple of Karnak.[31] If the lunar day 1 was the day selected for the foundation of temples (as it was later), then the audience may have preceded the day of the foundation ceremonies.

From the Illahun lunar dates, it follows that year 1 of Sesostris III lay in 1837/36 BC. Thus 1911/10 BC would correspond to year 10 of Sesostris I if there were coregencies, or 1918/1917/1916 if there were not. In 1910 BC, civil day 244 – as the day following the audience – coincides with a lunar day 1, whereas in 1917/16, it does not. Before 1917/1916 BC, civil day 243 was lunar day 1 in 1921 BC, and thus the day of the audience. However, it could be argued that adding a few hypothetical regnal years for Sesostris II and Amenemhat II would render 1921 BC for year 10 of Sesostris I possible, dispensing with coregencies. Thus this does not really resolve the issue, as either day can be argued, depending upon one's point of view.

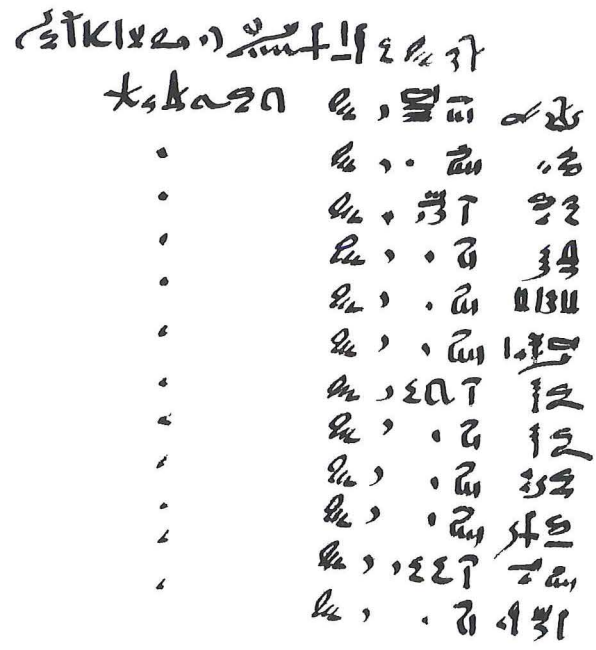

Fig. 1. The calendar of P. Ebers.

Back to late Dyn. XVIII

To make further use of the Illahun Sothic date for chronological purposes, we can relate it to another Sothic date, namely the date in the calendar of P. Ebers (Fig. 1). According to the standard reading, the calendar informs us that in regnal year 9 of Amenhotep I, Sothis rose on civil day 309. Thus, in terms of the civil calendar, the phenomenon has moved 83 days or so since day 226 or day 228 in year 7 of the reign of Sesostris III. Since each additional day means a difference of 4 years, the total number of years elapsed between the two dates is achieved by multiplying the number of days by 4. Thus at most 332 years separated the two Sothic dates – or 324 years, if the Illahun Sothic date has to be understood as day 228. It follows that regnal 9 of the Ebers calendar corresponds to a year between 1506 and 1498 BC.

P. Ebers also preserves a lunar date which fits within the interval 1506 to 1498 BC, but only in the year 1506 BC. If year 1 of Thutmose III is to be shifted from 1479 BC to 1468 BC, 1506 BC can only be maintained as year 9 Amenhotep I if the combined lengths of the reigns of Thutmose I and Thutmose II totaled 25 years altogether. As, however, only year 1 is attested for Thutmose II, and the year 3 (but perhaps also years 8 and 9) for Thutmose I, it would be bold to propose that together they reigned for 25 years. Under the circumstances, it is advisable to conclude that year 9 of Amenhotep I lay well after 1506 BC.

One solution to the problem could be that the name to be read on the P. Ebers calendar should not be read as *Djeser-ka-Re* (the throne name of Amenhotep I), which would allow us to assign the calendar to another king. It is well-known that the *djeser* of this text is not palaeographically certain. Doubts about the reading were expressed by the great Egyptologist Erman, virtually as soon as it was announced (see Fig. 2). This has since generally been forgotten, but Erman's doubts remain valid when the writing is viewed objectively. If the reading is not *djeser* (*cf.* Fig. 1) then the calendar could be assigned to the last Hyksos king. The last Hyksos king is named as Khamudi on a fragment of the Turin Royal Canon, which also includes the final total for the reigns of the kings of the Hyksos

[31] Gabolde 1998, 40–41; *cf.* Belmonte in Hornung *et al.* 2006, 384.

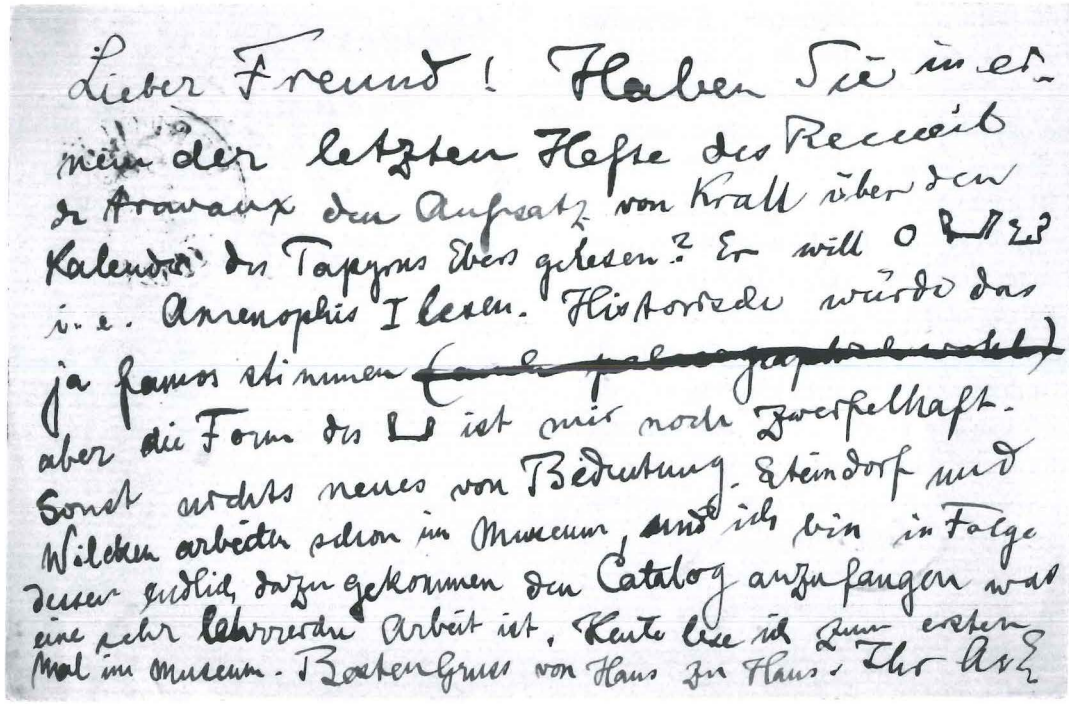
Lieber Freund! Haben Sie in ei-
nem der letzten Hefte des Recueil
de travaux den Aufsatz von Krall über den
Kalender des Papyrus Ebers gelesen? Er will o
i.e. Amenophis I lesen. Historisch würde das
ja ganz stimmen ~~(and also probably palaeographically)~~,
aber die Form des [illegible] ist mir noch zweifelhaft.
Sonst existirt neues von Bedeutung. Steindorff und
Wilcken arbeiten schon im Museum, und ich bin in Folge
dessen endlich dazu gekommen den Catalog anzufangen, was
eine sehr lehrreiche Arbeit ist. Heute bin ich zum ersten
Mal im Museum. Bestens Gruss von Haus zu Haus. Ihr Erm

Fig. 2. Erman's doubts about the reading of Djeser-ka-Re in Papyrus Ebers (Fig. 1).
On May 1, 1885, Adolf Erman wrote a postcard with the following text to the historian Eduard Meyer:
My dear friend! Have you seen the article by Krall about the calendar of Papyrus Ebers in one of the recent fascicles of the Recueil de travaux? He wants to read Djeser-ka-Re, i.e. Amenhotep I. Historically this would fit quite well ~~(and also probably palaeographically)~~, but the form of the [djeser] still appears doubtful to me. Otherwise, there is nothing new of importance. Steindorf[f] and Wilcken are already working in the museum, and as a result, I have finally managed to begin with the catalogue, which is a very instructive activity. Today is the first day that I am reading in the museum. Warmest greetings from house to house. Yours, Ad[olph] Er[man] (Translated by the editor).

Initially, Erman accepted Krall's suggestion, but then changed his mind, crossed out his support, and indicated his doubt.

Erman is referring to an article: J. Krall, 'Der Kalender des Papyrus Ebers', *Recueil de travaux relatifs à la philologie et à l'archéologie égyptiennes et assyriennes* 6 (1885), 57-63.

For a transcription of the postcard: <http://ag.geschichte.hu-berlin.de/site/lang__de/4280/Default.aspx>

Der Briefwechsel zwischen Eduard Meyer und Adolf Erman (1881-1930). Unter Mitwirkung von Yasser Sabek und Sascha Winkelmann bearbeitet von G. Audring. © Berlin-Brandenburgische Akademie der Wissenschaften. Akademiearchiv. Nachlass Eduard Meyer; Signatur : 575.

dynasty; all of the other names are lost. "Khamudi" is clearly the personal name of the last Hyksos king, and not his throne name – which is unknown. It could thus be that the name which is usually read as *Djeser-ka-Re* in P. Ebers is actually the throne name of "Khamudi". In terms of relative chronology, assigning the year 9 of the P. Ebers calendar to "Khamudi" is possible, as the regnal year 11 in the notes on the verso of P. Rhind is usually (but not without objections) assigned to Khamudi.

If a single year is proposed for Thutmose II and at least 3 years (with a maximum of 9) for Thutmose I, then it is probable that year 9 of Khamudi (as 1506 BC) would fall in years 15–20 of Ahmose (Table 1).[32] Since Avaris must have fallen in year 11 of Khamudi (following the notes in P. Rhind), and other hints have been used to propose that the conquest of Avaris took place around year 18/19

[32] We provisionally assume that the 25 years + 4 months which Manetho assigns to the King who defeated the Hyksos refer to the reign of Ahmose.

Last Hyksos King	Early Dyn. XVIII	
Khamudi 1515 – 1504 BC	Ahmose	*c.* 1524 – 1499 (or 1-3 years later)
	Amenhotep I	*c.* 1498 – 1477 (or 1-3 years later)
	Thutmose I	*c.* 1476 – 1470 (or 1-3 years later)
	Thutmose II	*c.* 1469 – 1468
	Thutmose III	April/May 1468 – Nov 1415 BC

Table 1.

of Ahmose, it follows that this would have taken place around 1504 BC. These assumptions allow the following reconstruction of the chronology of early Dyn. XVIII, and the end of the Hyksos, Dyn XV(Table 1).

Conclusions

Dead-reckoning, supplemented by the synchronisms, the kinglists, the archaeological data, and lunar dates allows us to conclude that the conquest of Avaris and the defeat of the Hyksos by the first king of Dyn. XVIII took place around the end of the 16th century BC. The end of Dyn. XII can be estimated as having been at least two centuries earlier.

The Sothic date from Illahun allowed us to estimate that year 7 of the reign of Sesostris III fell between 1881 and 1826 BC. The lunar dates from the Illahun papyri mean that year 1 of Sesostris was 1837/36 BC. Thus the year 7 Sothic date of Sesostris III can be pinpointed at 1830 BC. Dyn. XII would have ended around 1760 BC.

The relationship between the Illahun Sothic date and the Sothic date in the calendar of P. Ebers allows the regnal year 9 of that papyrus to be placed in the years 1506 to 1498 BC. Taking account of the lunar date, this regnal year 9 must be 1506 BC. If year 1 of Thutmose III was 1468 BC, then dead reckoning means that this year 9 cannot be that of Amenhotep I, as this cannot have fallen before 1490 BC. It follows that we revive the doubts about the reading of the royal name (as that of Amenhotep I), and instead read this as the throne name of the last Hyksos king.

The end of Dyn. XIII and the beginning of the Hyksos Dyn. XV would have been around 1650 BC. The elimination of the Hyksos would have taken place roughly 1504 BC. The year 1613 BC would lie towards the beginning of the Hyksos period.

Chronology, stratigraphy, typology & Tell el-Dabᶜa

Postscript by *David A. Warburton*

There remains one essential point concerning the chronology of ancient Egypt which is relevant in this context. Ultimately, virtually all of the archaeological arguments against the ^{14}C date of 1600-1627 for the Minoan eruption of Santorini are based on the stratigraphy and finds at Tell el-Dabᶜa or personal communications by the director of those excavations. This case is thus worth discussing in detail.

The stratigraphic and chronological sequence of Tell el-Dabᶜa is organized in terms of uniting the layers and structures of the entire tell into a single coherent chronology and stratigraphic system. The pottery in any given part of an excavation, in any

part of the site, is meticulously excavated and is assigned to layers which are then dated relatively according to the overall stratigraphy of the site and also relatively according to other sites, and absolutely according to the Egyptian chronology. In this fashion, pottery forms and import articles can be dated relatively and absolutely.

However, there are three problems with this procedure. The first is that pointed out a decade ago: that the stratigraphic methods employed in the excavations at Tell el-Dabᶜa do not appear to be entirely coherent, and there are not very many sections published, especially in view of the importance of the stratigraphy and the size of the excavations.[33] The situation has not changed remarkably since the earlier review, as another section published since then still has a layer e/2=D/2 which both abuts a wall marked as e/2=D/2 and also goes under that same wall and then is cut by another unit likewise marked e/2=D/2.[34] Thus, sherds from the foundation trench and occupational layers and collapse would all presumably be mixed in the publication – even if the layers have been recognized and separated during excavation. Yet obviously sherds in the walls and in the foundation trench will belong to the earlier units (and not necessarily merely the preceding unit) while the sherds in the floors could be contemporary.[35] On the mentioned section, one also has difficulties recognizing how the excavators distinguished between f/2=D/2 and e/2=D/2. It is also impossible to understand how b/2=B was identified in squares o/18 and p/18.

The second difficulty for outside observers is the remarkable fact that of the very few sections which have been published, many of the actual layers are not assigned to any of the various stratigraphic systems used at Tell el-Dab ᶜa. Instead, usually it is only the walls which are assigned to the various stratigraphic systems and the layers are usually only designated in terms of excavation units, or not at all.[36] Thus the reader is at a loss when endeavouring to understand how the pottery is all published by layers yet the layers are not even identified in the few published sections.

In effect therefore, it is impossible for an outside observer to understand how all of the pottery at Tell el-Dab ᶜa is carefully distinguished and published according to layers if the sections are not published. It is also impossible for any outside observer to understand how the pottery is so distinctive for the various strata when virtually none of the published strata (visible in the sections) appears to be intact. Furthermore, it is not entirely clear how much pottery actually came originally from occupational levels. And, as noted long ago, it is difficult to understand why it is that the pottery is so distinctive for each level and yet fragments of the easily dated Minoan frescos are scattered over several layers. Is the pottery being sorted in a fashion which is effectively the opposite of the treatment of the Minoan frescos?

This seemingly rhetorical question is quite real. The sequences of artefacts from Tell el-Dabᶜa are generally characterized by a clear and regular evolution in form. Yet, in contrast to this evolution, all of the fragments of Minoan frescos – regardless of the layers in which they are found – are all assigned the same date. Thus clearly, two different chronological methods are being applied. Seemingly, specific pottery forms are selected as being typical of the various layers and the remaining pottery discarded. At the same time, however, it is recognized that all of the fragments of Minoan frescos belong to the same group although they are found in different layers.

Methodologically this would pose a serious problem for outside observers unable to follow the methods and process. Above all, one could legitimately enquire how the layers at Tell el-Dabᶜa are dated. Are they dated via pottery and artefacts – and if so, how is the decision made to discard or maintain specific artefacts which then become characteristic of a given layer. And how is that layer dated?

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[33] Warburton 2000a; this was repeated and amplified in Warburton 2008, 2103–4.

[34] Visible, reading from right to left in o/18 (marked between metres 5 and 6) and p/18 (again marked in wall between metres 5 and 6, but recognizable to the right of the wall, and finally cut at extreme left), Fuscaldo 2000, Plan VII.

[35] For a discussion of the value of distinguishing these various types of unit, *cf.* Warburton 2003.

[36] *E.g.*, Bietak, Marinatos & Palivou 2007, 32-7.

In his study of the last phase of Knossos, Hallager noted that "The main part of the sherds collected from an undisturbed destruction level are datable to periods earlier than the destruction."[37] If this is true of stone architecture at Knossos, it will be even more true of mudbrick architecture in the Nile Delta. Thus, it follows that in any ordinary stratigraphic sequence, a series of layers with earlier material lying above later material will be part of a pattern, constantly repeated after each destruction level. Thus in each case, the material contemporary with the occupation will be sandwiched between the destruction debris and the foundation trench – both of which will contain earlier material.[38] In fact, the greater part of this material will be earlier than the occupation in date. Thus, to date a level one must carefully distinguish the occupation layers, and separate the layers and the material they contain during the excavation. The publication of the pottery should be based exclusively on the pottery from occupational layers. And obviously a great deal of the earlier pottery will have to be discarded without being recorded: this is absolutely normal and legitimate, aside from being necessary. The question is simply: what are the criteria used to distinguish the relevant typological forms characterizing a given layer, and how are the occupational layers from that layer distinguished from the rest?

This is extremely significant since the impression conveyed by the few published sections is that very few of the occupational layers are intact, and thus one would expect substantial mixing in any of the layers of collapse and fill which characterize the site. And this difficulty increases when it is appreciated that few of the few published sections allow the student to understand the logic upon which any of the stratigraphic distinctions were made. Furthermore, as noted, it is impossible to understand how a method which mixes deposits from collapse, floors and foundation trenches (meaning that the pottery in them would each belong to different periods) can possibly be used to create a pottery sequence, in which the pottery is so distinctive for each layer.[39]

There are three important reservations. Firstly, there is not one single published section from Tell el-Dabᶜa that can be used coherently to support the arguments which are routinely made about the value of this data for dating the Minoan eruption of Santorini in print. Secondly, most of the sections have never been published. Thirdly, the interpretation of the stratigraphy and chronology have been repeatedly disputed by other authorities (from Dever to Merrillees). It follows that merely because the excavators of Tell el-Dabᶜa propose a series of dates for their strata does not mean that these must be accepted by others, as the stratigraphic basis of these chronological claims is far from clear. Thus, until the stratigraphy and the chronology of Tell el-Dabᶜa have been adequately published, it is difficult to argue on the basis of the stratigraphy of Tell el-Dabᶜa for any archaeological or chronological argument.

The real problem is, however, of far greater import. It has been argued that all of the ^{14}C dates for Tell el-Dabᶜa are off by more than a century, and that the chronology of the excavators used to interpret the stratigraphy of Tell el-Dabᶜa should be used to correct the ^{14}C dates. However, this effectively means denying the statistically significant series of ^{14}C dates from Tell el-Dabᶜa. It is not a matter of dates which are vague enough to account for differences of centuries, but of dates which are clearly not in accord with the dates proposed by the excavators. Under ordinary circumstances, it would not be suggested that all of the ^{14}C dates are anomalous, but rather that one reconsider the issue. Furthermore, the same laboratories in Vienna and Oxford that have provided the radiocarbon dates for the samples from Tell el-Dabᶜa have also done experiments with other samples from well-dated contexts in Egypt and the dates for the well-dated contexts are entirely in accord with the chronology established by historical methods for the second millennium BC.[40] Thus, it would follow that the

[37] Hallager 1977, 67.

[38] Warburton 2003, 19 Fig. 11.

[39] It is possible that the excavators do distinguish the foundation trenches from the occupational levels, but it is incomprehensible that the material from the collapse of structures is then assigned to a period later than the occupation – which is nevertheless the logic of the publications.

[40] Pers. comm. from W. Kutschera; Marcus *et al.* n.d.

radiocarbon control samples from secure contexts should be used to date the radiocarbon samples from the layers at Tell el-Dabᶜa. This in itself would mean dating the strata of Tell el-Dabᶜa roughly a bit more than a century earlier than has been generally claimed by the excavators.[41]

Yet the tendency is instead to use the data from Tell el-Dabᶜa to throw doubt on all ^{14}C dates. Hassler and Höflmayer cite the case of a tomb assemblage dated by Petrie to the "Second Intermediate Period and Pan-Graves",[42] but then date it themselves to early Dyn. XVIII and suggest that the ^{14}C date pointing to the 17th century BC is erroneous.[43] In fact, however, the ^{14}C date which also includes a hump for the 16th century would certainly include Petrie's Dyn. XVII – but admittedly not their Dyn. XVIII date. Yet, they themselves concede that dating the collection "is not easy",[44] and thus obviously, the dating of the archaeological material is up for discussion. Furthermore, Bennet's suggestion that Dyn. XVII overlapped with Dyn. XIII[45] would allow the date of the archaeological material to be placed even earlier, rather than later. Thus, the purpose of the exercise carried out by Hassler & Höflmayer is clearly to throw doubt on the ^{14}C dates rather than to use the archaeological material itself as a means of dating.

Significantly, in a recent contribution, Thomas Schneider proposes that the difficulties with the astronomical and ^{14}C dates can only be overcome by using the stratigraphy at Tell el-Dabᶜa as the basis for an absolute chronology.[46] This argument has two aspects. The first is that of confusion about the debate over the observation points of the Heliacal rise of Sothis and the relationship between the lunar dates and the civil calendar on the one hand. And, on the other is the concept that the stratigraphy of Tell el-Dabᶜa is sufficiently reliable to establish an absolute chronology.

In fact, there is an enormous difference between confirming the existence of a scholarly debate over the methods of exploiting the astronomical observations in the ancient sources to recognize actual absolute dates, and the concept of throwing doubt onto the very principal itself. It is true that Hunger and Koch both dispute the idea that one can use the alleged observations of eclipses to support chronological arguments in Mesopotamia.[47] However, this merely confirms the fact that there is no unity on the dates which are proposed by different scholars: it does not mean that the data cannot be exploited. Despite Schneider's assertion, it can be argued that the same is true of Egypt. Obviously it is possible that the details of astronomical observations in antiquity have not been fully mastered. However, the lack of a consensus does not mean that one of the systems on offer today is not in fact in accord with the facts. Thus, it is possible that the system requires improvement, or it requires further examination until the correct solution is identified. The lack of harmony does not mean that the technique is erroneous or that it cannot be improved.

As noted, I stress that the essentials of the Egyptological historical reconstructions mean that if one can master the details of the astronomical observations and exploit them fruitfully, then the difference will merely amount to the few decades separating Luft and Krauss. The two approaches differ depending upon whether the heliacal rise of Sirius was observed from Memphis or Elephantine (which leads to the difference in the dates of the observation and thus in the disparity in the chronologies, amounting to a couple of decades).

The key issue is that the letter recording a heliacal rise of Sirius during the reign if Sesostris III in the Illahun archives was a prediction (rather than an

[41] Under the circumstances, my observations about the stratigraphy would thus simply mean that the deposits cannot be excavated in the way they are, or the deposits simply cannot be used for chronological arguments. It is clear that there is far too much mixing of material for any chronological argument.

[42] Hassler & Höflmayer 2008, 146, citing Petrie.

[43] Hassler & Höflmayer 2008, 145–9. In the case of their other example (Hassler & Höflmayer 2008, 153), an error of some kind is quite obvious. The date they propose based on the archaeological material is reasonable – yet the ^{14}C date is not compatible with this, being off by two centuries. Whatever the explanation, their dating of the archaeological material is indisputable. And, in any case, in this volume Höflmayer confirms that there is little doubt about ^{14}C dates for the late second millennium.

[44] Hassler & Höflmayer 2008, 146.

[45] Bennett 2006.

[46] Schneider 2008.

[47] Koch 1998; Hunger 2000.

observation). Since it was found at Illahun, which is not far from Memphis, it was largely assumed that the observation was related to Memphis. However, the fact that it is a prediction renders the proximity of Memphis irrelevant. Thus, the observation could have been made anywhere, and the chronological value of the date is thrown into confusion.

Yet the fact that it was a letter might in fact be quite interesting and relevant. It has been proposed that such calculations were based on tables or charts. Yet Schneider proposes that rather than tables, it would have sufficed to have taken a look in the archives, and located the date of the recent observations.[48] This point is entirely valid, and reasonable. The only problem is that the date is contained in a letter, and the existence of the letter demonstrates that someone outside of the immediate region was relied on to predict the date.

Obviously, it is easier to imagine that the records and observations were maintained at Elephantine as this would have demanded that letters be dispatched (since the observations in Memphis will have been irrelevant). And in this sense, the existence of the letter would of itself support the argument in favour of Elephantine. Obviously if – following Schneider – the prediction could have been made by anyone checking in the archives, sending a letter would be quite pointless as this could have been done in every temple in the country. The existence of the letter itself speaks against Schneider's proposition.

This is, however, pure speculation. However, it is quite obvious that Schneider's observation – that the date could have been projected merely by taking a look at the earlier journals – is not supported by the existence of the letter. In fact, the existence of the letter is a tantalizing hint of an entirely different geographical location of the institution responsible for observations and predictions.

In reality, Schneider merely makes the suggestion to oppose Krauss, rather than as a result of having considered what he had written in terms of a larger argument. It is unfortunately the case that we are all the victims of our own projects, and tend to see the weaknesses of others' arguments more clearly than our own. As noted, Schneider throws doubt on all astronomical systems of dating. In passing, however, Schneider assures us that Krauss's astronomical approach is inadequate, and that Luft's may possibly be correct. Yet Schneider quotes another source to the effect that Luft's calculations of both the lunar and Sothic dates are off.[49] And, ultimately Schneider must concede that the real obstacle to Krauss's calculations is that they are "too good to be true".[50] And the veracity of this escapes Schneider when he makes his suggestion that the beginning of Dyn. XII lay "ca. 1980/60" BC,[51] which just happens to almost coincide with my own proposition – based on Krauss's calculations – that without coregencies Dyn. XII began around 1955 BC. Yet this leads Schneider to advocate abandoning all astronomical systems.[52]

This is the basis for Schneider's second claim: that the stratigraphy of Tell el-Dabᶜa itself can alone serve as the basis for a chronological argument. Yet, firstly, there is no single section from Tell el-Dabᶜa which shows the superpositioning of all of the levels from the site, as this is impossible due to the history of settlement at the site, and also due to the lack of access to the relevant sections because of the water table. Secondly, the mere depth of deposits cannot be used for any kind of chronological argument. Such arguments belong to the 19th century, not the 21st. Thirdly, the difficulties of the relationship between the stratigraphy and the typology and the chronological conclusions which the excavators at Tell el-Dabᶜa draw from their typological and stratigraphic analysis have been mentioned in the preceding paragraphs. It follows by definition that on a scientific basis – in terms of publication of material and statistical proof and controlled experiments – that the stratigraphy of Tell el-Dabᶜa cannot serve the purpose for which it is used: denying the validity of ^{14}C dates and seemingly, *pace* Schneider, also the astronomical dates.

It has apparently been forgotten that more than a century ago, typology somehow took precedence over stratigraphy in dating. The result is that typological parallels are given far more weight in

[48] Schneider 2008, 284.
[49] Rose quoted by Schneider 2008, 290.
[50] Bennett 2008, quoted by Schneider 2008, 292.
[51] Schneider 2008, 2983.
[52] Schneider 2008, 293-4.

comparisons than are the stratigraphic contexts from which samples are drawn. Arguments based upon scarabs or other objects bearing royal names found in the strata at Tell el-Dabᶜa take us back to the approach of the early 20th century.

Today, it is essential to have the exact context of such elements if they are to serve as chronological arguments. And the typological sequences of objects must be linked to the publication of the stratigraphy in a fashion which allows outsiders to follow the argument. This demands that archaeologists pay far more attention to stratigraphic excavation, not merely in terms of sequences, but also on identifying contexts. When typological methods began to take precedence over stratigraphy, stratigraphy was reduced to mere sequences. Now, however, it is clear that collapse and fill mean that sequences alone are far from sufficient – deposits themselves must be recognized, carefully excavated and classified, if their contents are to serve in overarching chronological arguments.

Archaeological layers should be dated by the material in those layers, and verified by controlled experiments using ^{14}C material from securely dated contexts. If the ^{14}C dates seem to correspond to the historical dates – and this is the case for the second half of the second millennium – then evidently, ^{14}C dates must be viewed as more important than alleged associations with Egyptian kings since the stylistic changes must be understood in terms of stratigraphy and not as reflecting kinglists.

In this volume, Wiener notes that the ^{14}C dates from Tell el-Dabᶜa differ radically from the dates of the various layers proposed by the excavators, and remarks that "the cause of the anomaly remains unknown". Yet, in fact, the situation is exactly the opposite. The excavators at Tell el-Dabᶜa insist that all of the dates for all of the levels at Tell el-Dabᶜa are off by a century and more. It is no longer possible to speak of an anomaly: the anomaly is the archaeological dating.