The Astronomical Dating of Ancient History Before 700 B.C.

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[1981/1988.]

[Author's Note: This is a working draft. The endnotes need verification and additions. The evidence and arguments need further evaluation.]

Introduction

Beginning students of ancient history are easily impressed by the beautiful chronological charts which they find in the books which introduce them to ancient history. Each king or pharaoh stands in his place with the years of his reign neatly printed behind his name. However, students soon learn that it is not so neat and simple after all, and that these lists are not at all like a list of the presidents of the United States whose years in office are well established. They find that there is not one established chronology for the ancient Near East, but several competing chronologies to be considered. There are high, medium, and low chronologies for both Egypt and Mesopotamia. Furthermore, for the most ancient times these must be compared with three different radio-carbon chronologies which are based on different uncorrected and corrected half-lives for carbon 14.

However, the divergence between all of these systems is relatively minor when we are speaking in terms of millennia. In itself the existence of high, middle, and low chronologies would seem to be an incentive to thorough scholarly research in order to resolve the debate, rather than a cause for grave misgivings about the basic framework of ancient chronology. The very debate about high, middle, and low chronologies implies that the basic framework is well established and that our main need today is to tie up a few loose ends.

However, the last half-century of development in the discipline of ancient history provokes the question of whether the "fixed dates" of ancient history are really quite as fixed as is often implied. In the course of development of Egyptology the dates assigned to certain pharaohs have been lowered by more than 2000 years. The date of Sargon of Akkad has been lowered from 3800 B.C. to 2500 B.C.[i] Hammurabi was once dated to about 2400 B.C., but the Mari records indicate that he was a contemporary of Shamshi-Adad, who is dated to about 1700 B.C.

Such drastic revisions of ancient chronology do not, of course, prove that the presently accepted chronology will be subject to the same drastic revisions as older chronologies. But they should encourage us to take a closer look at the foundations of presently accepted chronologies to try to determine if they are, in fact, much more soundly based than the efforts of the recent past.

One basic problem that confronts us is the interdisciplinary nature of the construction of a sound chronology. Knowledge of such varied fields as astronomy, Semitic languages, Egyptian hieroglyphics, ceramics, field archeology, and various methods of scientific and statistical analysis are all essential factors in the construction of a dependable chronology for ancient history. Unfortunately, it is impossible for anyone to become an expert in all of these fields. To a considerable degree, a person working on the problem of chronology must depend on secondary information from disciplines in which he has a very limited knowledge. This may require a person to place too much confidence in the findings of experts in other disciplines, simply because one does not feel qualified to analyze or question such information.

Most of the work currently being done on ancient chronology is based on the assumption that the presently accepted chronology is on solid foundations and that the only remaining questions concern upward or downward revisions of relatively few years. However, there is a surprising amount of uncertainty and conjecture in the data and interpretations which form the basis for the presently accepted chronology of the ancient Near East. We run a very real danger of debating about millimeters and centimeters when we should rather be rechecking our measurement of the meters --- that is, a great deal of effort is being spent to determine exact days, when the years, decades, and perhaps even the centuries are in doubt.

This paper will examine the foundations of the chronology of the ancient Near East to determine if the presently accepted chronology could be in error, not just by years, but by decades or even centuries. It is limited largely to one type of evidence which is crucial to ancient chronology, namely, the astronomical basis of ancient chronology for the period before 700 B.C.

I am approaching this study from the perspective of a historian with no formal background in mathematics or astronomy. Otto Neugebauer, one of the foremost experts on ancient astronomy has observed, "Historical chronology rests on an interplay of theoretical astronomy and historical conditions far more intricate than professional historians usually realize—to the great detriment of their insight into the very foundations of their field."[ii] A re-examination of these foundations is the goal of this paper. The aim of the paper is not to demolish, correct, or reconstruct ancient chronology. It is rather to examine the case for a thorough reconsideration of the chronological framework which presently serves as the basis for the study of the history of the 2nd millennium B.C. Does such a re-examination need to go beyond debating the relatively small differences between the high, middle, and low chronologies to a thorough re-evaluation of the very foundations of ancient chronology? Are there serious questions about the validity of the astronomical foundations of ancient chronology, and if so, what is the nature of these questions?

Since the absolute dating of almost all areas of the ancient Near East is heavily dependent on literary and cultural synchronisms with the supposedly well established chronology of Egypt, we will turn our attention first of all to the astronomical foundations of the chronology of Egypt.

Egypt, A Shakey Reed

Although it has been made the keystone of the absolute dating of ancient history, the chronology of ancient Egypt rests on a host of unproven assumptions. The whole structure is rendered even more shaky by the lateness and the fragmentary nature of most of the literary sources which are crucial for providing a skeleton for Egyptian chronology.

The basic organization of Egyptian history around 31 dynasties begins from the work of Manetho compiled in the 3rd century B.C. Manetho's records are supplemented and corrected by records recovered from the ancient monuments and archeological excavations of Egypt.

Manetho's work survives only in quotation. It is not clear how reliable these materials are. Nor is it clear how much his dynasties overlap with one another or how all of the royal names in Manetho match up with the different names recovered from ancient monuments and records. Manetho's general outline of dynasties is followed, but there are serious problems with his pharaohs' names and his sequence of pharaohs.

The Palermo Stone of the 5th Dynasty (from about 2400 B.C.) is the only major document which originates from the period preceding the 12th Dynasty, but it is only a fragment of a large slab. A fragmented papyrus of the 19th Dynasty (about 1300 B.C.), known as the Turin Royal Canon, gives a complete list of the kings of Dynasties I-VIII, which seem to cover a period of about 955 years.[iii] The important point is that none of these documents can by themselves provide any absolute dates for early Egyptian history since they are not linked to our modern era of dating or to any other system which can be connected to our system.

To form such connections with absolute calendar dates we are dependent on astronomy. For the period before 800 B.C. our primary tool is the study and analysis of the Egyptian Sirius/Sothis cycles. The ability to calculate dates for early Egyptian history depends on an understanding of this astronomical cycle and upon a consistency of the Egyptian calendar throughout the period in question.[iv] The use of astronomical calculations to decipher references to this Sothic cycle in ancient Egyptian records forms the foundation of all ancient chronology.

The dating of the seventh year of Pharaoh Sesostris III (Senusert III) to about 1872 B.C. by means of this Sothic cycle is the anchor point around which the absolute chronology of Egypt in the 2nd and 3rd millennia B.C. has been organized. Sesostris was a pharoah of the Twelfth Dynasty. Historians use the dating of his seventh year to 1872 B.C. as the starting point for assigning dates to Dynasties XII-XX in one direction and to the earlier dynasties of the Turin Royal Canon in the other direction. They do this on the basis of the recorded reign-lengths of some pharaohs and elapsed time estimates for some dynasties. With 1872 B.C. as a starting point historians use the list of Twelfth Dynasty pharaohs to calculate back to 1991 B.C. as the staring point for Dynasty XII. Dynasty XI and the contemporaneous Dynasty X are then traced back to 2134 B.C. in a similar way. Dynasty IX seems to last no more than 30 years, so this brings us to about 2164 B.C. The 955 year span of the Turin Canon, therefore, takes us back to about 3119 B.C. as the beginning of Dynasty 1.[v]

Since this date, 1872 B.C., is one of the keys of all ancient chronology, we will devote more careful attention to it as a test case for the validity of the astronomical dating of the second millennium B.C. How was this date determined?

The dating of the 7th year of Sesostris III to about 1872 B.C. is based on the alleged ability of historians and astronomers to derive an absolute calendar date from a reference like "Year 7: Sothis rose heliacally on month four of Coming Forth (or Winter), day 16." For such dating to be valid we must first make a number of assumptions: 1) The ancient record is accurate. 2) It has been correctly translated and interpreted by the modern linguist. 3) The astronomical event is uniquely identifiable so that we can actually pinpoint the astronomical event which the text is describing. 4) The ancient astronomical observations and records were sufficiently precise to be useful to modern astronomers for calculating precise dates. 5) The event is dated in an undisturbed and precisely known local calendar, or we have adequate knowledge of any calendar changes, so that we are able to make the transition from our modern calendar to the ancient calendar. Unfortunately, there are grounds for questioning the validity of every one of these assumptions in the case of the text underlying the 1872 B.C. date. We will now turn to an examination of the evidence for this date.

To begin with, the Kahun or Ilahum Papyrus, the text which is used to date the reign of Sesostris III does not even contain the name of Sesostris. The text, which was found in the temple of Sesostris II simply says "Year 7-you should know that the rising of Sothis occurs on the 16th day of the 4th month of Coming Forth." The name of the king is missing. Sesostris III is associated with the text on the basis of comparing the handwriting of this text and the handwriting of other texts found at the same place, which do contain the name of Sesostris III.[vi] If the text really belongs to some other king of the Twelfth Dynasty, the margin of error in dating the pharoahs could be as much as 200 years. Richard Parker defends the assigning the papyrus to Sesostris III on the basis of lengths of reign among the pharaohs of the Twelfth Dynasty and on an appropriate pattern for lunar dates for the reigns of various pharaohs of the Twelfth Dynasty, but there is an element of circular argument here, because Parker's analysis of these other lunar dates is based on the prior assumption that the Kahun Papyrus belongs to Sesostris III. Since such lunar cycles repeat every 25 years, this form of verification is only valid when one is already in the right ballpark. Parker gives no real basis for his assumption that the reign of Amenemet III, another candidate to be the pharaoh of the papyrus, must be limited to the narrow range of dates which he has selected.[vii] Although the connection of this text with Sesostris III is plausible, it is reasonable to maintain that the attribution of this crucial papyrus to Sesostris III is open to debate. It is also noteworthy that the crucial Kahun Papyrus had still not been published almost 80 years after its discovery so the opportunity to examine it has been limited to the inner circle of Egyptologists.

There are also archeological grounds which would lead us to take a closer look at this Sothic date. When this Sothic date was accepted, it became necessary to lower the date of Sesostris by over 100 years from the date that had already been established on the basis of literary texts. The discovery of Sothic dating also required considerable shortening of the time interval between the Twelfth and Eighteenth Dynasties which had previously been accepted. Borchardt also reports that archeological finds which have been associated with Sesostris were found together with the earliest types of Mycenaean Ware. This type of ware is dated to the 15th century, not the 19th century, the period to which Sesostris has been dated. Since Borchardt gave no further description of this ware, it is unclear exactly what he meant by "earliest Mycenaean ware."[viii] According to the description of the Aegean pottery at Kahun in Ehrich's *Chronologies* this pottery is very likely Minoan IIB (18th Century B.C.).[ix] Therefore, Borchardt is probably simply using a poorly defined term, but this matter should be investigated further in Petrie's report of the Kahun excavations. Doubts about the Sothic dating of the Twelfth Dynasty are compounded by the fact that it does not agree with radiocarbon dating.[x]

However, even if we accept the attribution of this papyrus to Sesostris III, we must ask other more serious questions about the very concept of astronomical dating on the basis of an alleged Sothic cycle. The basic idea behind Sothic dating is the theory that the Egyptians were aware of and used a calendric cycle based on the observation of the heliacal rising of the star Sothis.[xi] According to the standard form of this theory the heliacal rising of the star Sothis was chosen as the beginning of the Egyptian new year, because this occurred near the start of the annual Nile flood and the summer solstice. When the civil year of 365 days was first put into effect, the rising of Sothis coincided with Thoth 1, the first day of the first month of the year. However, because the Egyptian year of 365 days was shorter than the true solar year by about ¼ of a day, the heliacal rising of Sothis would keep moving away from the first day of the year at a rate of about one day every four years. In the fourth year it would occur on day 22 of Thoth; after 8 years it would occur on day 3, and so on. Only after about 1460 years would the heliacal rising of Sothis move all the way through the calendar and be back on day 1 of Thoth again. This period of 1460 years is called the Sothic cycle. If we know the length of the Sothic cycle, and if we know a date when the heliacal rising of Sothis fell on the first day of the year, then we should also be able to compute the calendar date of a reference like "Sothis rose heliacally on month four of Coming Forth (the 8th month of the year), day 16." This is the theory of Sothic dating, but we shall see that it is open to serious question, because it rests on a number of unproven assumptions.

The theory assumes that we have an accurate knowledge of the Egyptian use of the Sothic cycle. We have no Egyptian monumental or textual sources which mention the use of a Sothic dating cycle in the 2nd millennium B.C.[xii] Our information on the alleged Sothic cycle depends largely on the late classical writers Censorinus (ca. 238 A.D.) and Theon (379-395 A.D.). Censorinus says,

The moon is not relevant to the "great year" of the Egyptians which we call the "Year of the Dog" in Greek and the "Year of the Little-Dog" in Latin, because it begins when the constellation or star "Little-Dog" [allegedly the modern Canis Major or Sirius rises on the first day of the month which the Egyptians call "Thouth". For their civil year has only 365 days without any intercalation. Thus a quadrennium among them is about one day shorter than the natural quadrennium, thus it is 1461 years before this "year" returns to the same beginning point. This "year" is called "heliacal" by some and "the divine year" by others. (Censorinus, *De Die Natali,* ch. 18, My translation)

"Ad Aegyptiorum vero annum magnum luna non pertinet, quem Graece kunikon Latine canicularem vocamus, propterea quod initium illius, sumitur, cum primo die eius mensis, quem vocant Aegyptii Thouthi, Nam eorum annus civilis solos habet dies CCCLXV sine ullo intercalaris itaque quadrennium apud eos uno die minus est quam naturale quadrennium, eoque fit ut anno MCCCCLXI ad idem revolvatur principium. Hic annus etiam heliakos a quibusdam dicitur et ab alliis theou eviautos."

Censorinus' statement certainly is not exhaustive. It gives us little information about how this "great year" was used or when it came into use. It is certainly open to debate how applicable this description of the Egyptian

calendar and astronomy is to the 2nd and 3rd millennia B.C. It does not address the issue of changes in the nature of the Egyptian calendar which may have occurred over the millennia. We have no definite proof that the Egyptians were aware of dating long eras by the Sothic cycle in the 2nd millennium B.C.

Even if we grant that they did, we have no certain knowledge of the date when any Sothic cycle began. Most historians presently accept the claim that Censorinus places the beginning of a Sothic cycle in about 140 A.D. and by extension in 1320 B.C., 2780 B.C. and perhaps 4240 B.C. Censorinus says,

As among us so also among the Egyptians a number of "eras" are referred to in their literature, such as that which they call "of Nabonnasar" which began from the first year of his reign, which was 986 years ago. Another is called "of Philip" which is counted from the death of Alexander the Great which was 562 years ago. But the beginning of these is always from the first day of the month which the Egyptians call Thoth, which this year fell on the 7th day before the Calends of July [June 25], 100 years ago when Emperor Antoninus Pius was consul for the second time, and Bruttius Praesens was the other consul, the same day fell on the 12th [corrected to the 13th] day before the Calends of August [July 21, corrected to July 20] at which time the "Little-Dog" usually rises in Egypt. Therefore it is possible to know that of that great year, which as I wrote above is called "solar" or "of the Little-Dog" or the "divine year," now the hundredth year has passed. I have noted the beginnings of these years lest anyone think that they begin from January 1 or some other time, since the starting points chosen by the originators of these years are no less diverse than the opinions of philosophers. For that reason the natural year is said to begin by some at the new sun, that is the winter solstice, by others at the summer solstice, by others at the vernal equinox and by others at the autumnal equinox, by some at the rising of the Pleides and by some at their setting, by many at the rising of "the Dog." (Censorinus, Ch. 21, My translation).

Nam ut a nostris ita ab Aegyptiis quidam anni in litteras relati sunt, ut quos Nabonnazari nominant, quod a primo imperii eius anno consurgent, quorum hic nongentensimus octogensimus sextus est; item Phillippi, qui ab excessu Alexandri Magni numeratur et ad hunc usque perducti annos DLXII consummant. Sed horum initia semper a primo die mensis eius sumuntur cui apud Aegyptios nomen est Thouth, quique hoc anno fuit ante them VII Kai. Iul., cum abhinc annos centum imperatore Antonino Pio II et Brutio Praesente Romae Coss. idem dies fuerit ante them XIII (XII) Kai. Aug. quo tempore solet canicula in Aegypto facere exortum. Quare scire etiam licet anni illius magni, qui, ut supra dictum est, solaris or canicularis et dei annus vocatur, nunc agi vertentem annum centensimum. Initia autem istorum annorum propterea notavi tie quis eos aut ex. Kal !an. aut ex aliquo tempore simul putaret incipere, cum hinc Conditorum voluntates non minus diversae sint quam opiniores philosophorum Idcirco aliis a novo sole id est a bruma, aliis ab aestivo solstitio plerisque ab aequinoctio verno , partim ab autumnali aequiroctio, quibusdam ab ortu virgiliarum, nonnullis ab earum occasu, multis a canis exortu incipere annus naturalis videtur.

Again it is noteworthy how little Censorinus actually says and how much is deduced from his statement. Censorinus is writing not to establish a system of chronology, but to discuss various dates for New Years Day in different cultures. He gives no specific date as the starting point for a Sothic Cycle as he does for the other eras which he mentions. All he does is give the date of the Julian calendar on which the first of Thoth fell in the year of his writing, which is well established as 238 or 239 A.D., and one hundred years earlier in 139 A.D. In 238 A.D. the first of Thoth fell on about June 25 Julian. One hundred years earlier it fell on about July 20, which is the date The Little-Dog (supposedly Sothis) usually rises in Egypt. He seems to be referring to a conventional method of dating more than to an actual observation of the rising of Sothis on that date. As noted in the translation above, a textual correction of one day is necessary to get the rising of Sirius onto the correct calculated date. Censorinus, makes no direct statement that a new Sothic cycle began then, but his statement about the passage of one hundred years of the great year and his indirect reference to the rising of Sothis are interpreted as indications that a new Sothic cycle began in about 139 A.D. It is argued that some coins of 139 A.D. also suggest that a new Sothic cycle began then.[xiii]

Theon, another late classical writer, explicitly states that a Sothic cycle began in 26 B.C.

Now this period of 1460 years, commenced from a certain time, terminated in the 5th year of the reign of Augustus so, from the last epoch, the Egyptians begin all over again to find themselves every year one quarter of a day in advance.[xiv]

Al Biruni an Arab chronologist (973-1048), supports Theon.

It was Augustus who caused the people of Alexandria to give up their system of reckoning by non-intercalated Egyptian years, and to adopt the system of the Chaldeans, which in our time is used in Egypt. He did this in the sixth year of his reign; therefore, they took this year as the epoch of this era... Augustus wanted the Egyptians to intercalate the years, that they might always agree with the Greeks and the people of Alexandria. Into this subject, however, it would be necessary to inquire more closely. At that time precisely five years were wanting till the end of the great intercalation period. Therefore, he waited till five years of his rule had elapsed, and then he ordered people to intercalate one day in the months in every fourth year, in the same

way as the Greeks do. Thereupon they dropped the use of the names of the single days, because, as people say, those who used and knew them would have been required to invent a name for the intercalary day.[xv]
If Theon rather than Censorinus is correct, the chronology of early Egypt is off by 165 years.

Among recent astronomers the same divergencies exist. Lockyer rejected the Censorinus date and placed the beginning of Sothic cycles in 270 B.C., 1728 B.C. and 3192 B.C. He bases his conclusions on the premise that
Censorinus was in error because he failed to take into account. calendric reforms which Lockyer believed *might* have occurred about 600 B.C. If Lockyer's theory were correct Egyptian history would be misdated by over 400 years. Other pioneers of the field, such as Boit, had still different dates.[xvi]

Lockyer's theory does not seem to be acceptable, because he calculates the move of Sothis through the fixed year in the opposite direction from all other authorities. However, Lockyer does introduce an additional Sothic date which has a bearing on the Censorinus/Theon controversy. According to an inscription found at Philae, which can be dated to about 122 B.C., the rising of Sirius was 37 days away from Thoth 1. Since Sirius moves one day every four years, it would take about 148 years for the rising of Sirius to arrive on Thoth 1. Lockyer counts in the wrong direction (122+148 = 270 B.C.). However, if we go in the standard direction (148-122= 26 A.D.), we get the same date specified by Theon, and thus we have support for Theon versus Censorinus.[xvii]

Besides lack of agreement of the time when a Sothic cycle began, this theory also faces other uncertainties. It is not certain how long a Sothic cycle lasts since there are other astronomic variables involved besides the precise length of the solar year. Calculations of the Sothic cycle have ranged from 1423 to 1506 years.[xviii] Parker has suggested that the length of the Sothic cycle may be different for each Sothic period.[xix]

We do not know for sure with which star or constellation Sothis should be identified for all periods of Egyptian history. It is generally accepted that Sothis is the star which we call Sirius, although none of the sources gave any evidence for this from before classical times. Porphry in De Antro Nym harum 24 says, "Near Cancer is Sothis which the Greeks call the Dog." Solinus Eolyhistor 32:12-13) says that this star rises between July 19-21. In Chapter 21 of his work, goncerning Isis and Osiris, Plutarch says, "The soul of Isis is called 'Dog' by the Greeks and the soul of Horus is called Orion." Since Sothis is identified with Isis in other Egyptian texts, and Sirius is called the Dog in Greek, we conclude that Sothis is the star which we-call Sirius. However there are a number of difficulties. At least the second half of Plutarch's statement appears to be in error, because Orion is usually associated with Osiris not Horus. According to some Egyptologists Egyptian astronomical
names did not always remain attached to the same celestial object. Osiris was first associated with Venus; later Osiris was associated with Jupiter. The planet Venus, which was first identified with Osiris, was later identified with Isis. Sometimes "right eye" is a title of Isis-Hathor, sometimes it is a title of the sun. Plutarch also identifies Osiris with the constellation which the Greeks call Argo. The hieroglyphic triangle which represents Sothis also appears to represent the zodiacal light, and the Egyptians apparently knew both an Isis-Sothis and a Horus-Sothis.[xx] The term *wp rnpt* which refers to the rising of Sothis, also refers to the beginning of the civil year and the birthday of the king.[xxi] Even the Greek word "Sirius" is not always attached to the same celestial object.[xxii] Similar shifts and uncertainties apply to the identification of ancient astronomical names in general, for example, the constellations in Job.

According to the English astronomer Poole, Sirius was not on the horizon co-incident with the rising of the sun on the Egyptian New Year's Day in 140 B.C., the date specified by Censorinus and those who follow him.[xxiii] Macnaughton set up a chronology based on the supposition that Sothis was Spica, not Sirius, as a way around this difficulty.[xxiv] Canopus and Venus are other candidates that have been suggested, perhaps less plausibly.[xxv]

Kenneth Brecher has revived the doubts about identifying the bright star referred to in records as Sothis/the Dog/Sirius with the star we call Sirius today. Babylonian and Roman sources as late as Ptolemy

All call "Sirius" a red star. Seneca says it is redder than Mars. In his star catalog Ptolemy refers to the bright red star in the face of the Dog. He links Sirius with red stars like Aldebaran and Arcturus. The star which we presently call Sirius is not a red star. No theory of stellar evolution offers any explanation for how a red star could become white in 2000 years, although much speculation has centered around possible changes in the companion star which is part of Sirius. There is a flaw either in our identification of Sothis as our Sirius, in the ancients' observations, in our translation of their texts, or in present theories of stellar evolution, which must be based more on computer analysis than on observation.[xxvi] One explanation which has been offered is that the red color refers to the star only as observed in heliacal rising near the horizon. Perhaps "red" simply means "bright" or "beautiful" as it does in Akkadian or Russian. At any rate, we can say that there is at least some question about the identification of Sothis as our star Sirius, and a thorough restudy of the pertinent Egyptian and Greek astronomical terms would be valuable.

Furthermore, the whole concept of dating by reference to the Sothic cycle is only tenable if we assume that there were no revisions of the Egyptian calendar between the Hellenistic age and the time of the Twelfth Dynasty, or that we have an accurate knowledge of any such changes that did occur. Such changes are especially possible in the Hyksos period when foreigners controlled Egypt. Two notes in Manetho's king lists say that two different Hyksos kings introduced changes from 360 day calendars to 365 day calendars in the time following the Twelfth Dynasty. Since there is evidence that a 365 year calendar was in use already in the 5th Dynasty, it is possible that the Hyksos introduced their own calendar when they took control of Egypt, but then returned to the superior Egyptian calendar.[xxvii] Lockyer and Courville list the evidence for calendar changes between the time of Ramses and Ptolemy and for the change in meaning of astronomical and calendric terms in the course of Egyptian history.[xxviii] It is, however, true that we know of no definite attempt to change the calendar before the Canopus Decree of 238 B.C. Breastad maintains that there are enough Sothic dates to disprove correction of the calendar, because the moving of Sirius through the months of the Egyptian year is always in the right direction and of an appropriate magnitude for the time interval between the pharaohs in question, but this is circular argument since those pharaohs were dated by Sothic dating in the first place. In fact, these Sothic readings were assigned to these pharaohs without the pharaohs being named in the texts in question.[xxix] There are, moreover, dates for Sothic risings which seem to contradict the theory that the calendar was never corrected. Sothic dates from the Ebers Papyrus and from the time of Seti I can be interpreted as supporting a fixed or corrected calendar.[xxx] Parker solves such difficulties by assigning those dates which cannot be reconciled to the Sothic dating theory to some other form of calendar besides the wandering civil year. This points out a problem which crops up in other places, namely that it is often not possible to tell to which of several calendars an Egyptian date belongs. However, it leaves the door open for a lot of juggling if the researcher can solve problems by shifting dates to another type Of calendar without more compelling evidence for doing so than the mere fact that the date messes up his theory if it is assigned to the wandering solar year. The statement of P. Nigilius Figulus that the Pharaohs swore never to change the 365 day calendar is cited as proof that the Egyptians never corrected the drift of the calendar.[xxxi] The Canopus Decree from the time of Ptolemy III (238 B.C.) also is cited as proof that Egyptians never corrected the calendar, but both of these statements are late and only involve rejection of regular intercalation or change to a leap-year system. Rejection of the regular addition of an extra day every four years does not prove that the Egyptians never adjusted their calendar to get the festivals back in line with the seasons. Adjustment of a calendar and changing the length of the year are two different types of calendar reform. The Canopus Decree does, in fact, seem to indicate that the Egyptians were disturbed by the drift of the seasonal festivals.

The theory that the calendar was never corrected throughout the long sweep of Egyptian history asks us to believe that the Egyptians were content with a calendar which was in step with its main feature, the heliacal rising of Sirius on Moth 11, only once in every 1460 years, and that they were satisfied with a calendar in which the seasons could get so far out of line with the calendar, even though the original names of the parts of their year and the names of some of the months had seasonal, agricultural significance. The three seasons were called Flood, Growth or Seed, and Harvest.[xxxii] If the civil year was the basis of taxation, the drift of the year would make constant adjustments necessary since taxation was largely in kind. There is some evidence in late texts for a fiscal year which began at the start of the fifth month, but I know of no evidence that this was anything but an artificial departure from the civil year like our fiscal year.[xxxiii] If the year were allowed to drift, it also would have made it necessary to constantly readjust the decans (groups of stars used to tell time at night). The Egyptians would even have had to divide and rearrange their star groupings to keep their system of telling time operative.[xxxiv] The time-telling tables in the tombs of the New Kingdom pharaohs Seti I (1300 B.C.) and Ramses IV (1155 B.C.) illustrate the problem. If there was no correction of the months of the Sothic year, these time tables were over 500 years out of date and totally useless when they were inscribed in the tombs of these pharaohs.[xxxv] All of this seems very inconvenient and unlikely to be tolerated, although it must be admitted that we do some strange things-with our calendar today with our ninth month being called September (7th month), our shifting Easter, and our variable IRS tax dates.

It is often claimed that the Egyptians were too conservative to allow a correction of the calendar. But it is hard to see much justice in this claim if we concede (as defenders of the Sothic cycle do) that the Egyptians changed to the 365 day solar calendar from an earlier 354 day lunar calendar. If they made this great change, it is hard to imagine why they would be adverse to a relatively small adjustment a few years later when it became apparent that 365 days was not the true length of the solar year.[xxxvi]

Breastad argues that the drifting of the seasons through the year was not that serious, since it would only amount to about 20 days in a lifetime and this wouldn't be too disturbing.[xxxvii] The irregularity of the Nile flooding meant it would take quite awhile for the drift of seasons to be noticed. This however, ignores the names of the seasons. Regardless of how long it took to happen, it certainly would seem to be an odd thing to be calling the season of the low Nile "Flood" and vice versa. This would certainly make the drift conspicuous.

In *Calendars of Egypt* Parker tries to solve the problem with his theory of three distinct calendars, an original lunar calendar which was tied to tile rising of Sothis, a 365 day civil year which was not tied to Sothis at first so that its drift was not immediately noticed, and finally, a schematic lunar calendar which, was attached to the wandering civil year. According to this view the seasonal festivals were transferred from the original Sothic lunar calendar to the 365 day calendar at a time when it was in agreement with the original 365 day lunar calendar. Later when these two calendars began to drift apart, the festivals were transferred back to the original lunar calendar and the schematic lunar calendar was invented to be a companion to the drifting civil year. All three of these calendars continued in simultaneous use until the end of pagan times. There may have been two dates for each festival—one fixed to the civil year and the other determined by the original lunar year. These would naturally fall on different dates in the civil calendar. Parker states that the Egyptians probably resorted to such a complicated solution to the calendric problem because they had such a horror of correcting the calendar by intercalation.[xxxviii] The complexity of Parker's arguments and the many contrary theories illustrate the uncertainty concerning Egyptian calendars, calendric change, and the correct seasonal positioning of festivals throughout the long span of Egyptian history. If we can trust the remark of Herodotus, who says that the Egyptians discovered the solar year on the basis of their observations of the stars (*Persian Wars* II 4), this would cast doubt on Parker's theory that the civil year was not tied to Sothis from the very start.

There is no definite proof of any calendar correction in the course of Egyptian history which was intended to get the seasons back in line. However, there is a great deal of confusing evidence and many counterclaims about the exact nature and history of Egyptian calendars. Gardiner proposed that Mesore was once the first month of the year, but around 1300 B.C. all the month names were moved forward one. Such a change could throw off the Sothic reckoning by 120 years, unless the proper adjustments were made. Parker rejects Gardiner's theory.[xxxix] But if a single such calendar adjustment, unknown to us, was made at any time in Egyptian history, the continuity of the Sothic cycle was broken and the concept of Sothic dating is untenable.

The concept of Sothic dating assumes a certain amount of precision in the observations and measurements of Egyptian astronomy. Throughout three-millennia of Egyptian history there is no evidence of careful systematic observation. Neugebauer observes, "We cannot expect astronomy to derive highly accurate results from observations, whose inaccuracy has never been disputed."[xl] Even if we would assume accurate observations, there are astronomical variables which complicate chronological work. Often we do not know where an observation was made, although it is assumed that Memphis was the standard site. The time for the heliacal rising of a star could vary by almost a week from Memphis to Thebes. Since Sothis moves one day every four years, this factor alone could produce a 28 year variation depending on the place of observation. This factor must be taken into consideration, since some of the astronomical references used in Sothic dating, including the crucial Ilahun reference, are not reports of actual sightings of the heliacal rising observed at the site where the document was found, but rather predictions telling priests what day they should expect the rising. These prediction texts may have been made at a site other than the site where the text was found. Furthermore, as we have seen there are many ambiguities in interpreting the precise astronomical significance of many of the hieroglyphic signs in the astronomical texts and problems with the hieretic script. Even the identification of many constellations is doubtful.[xli]

Otto Negebauer, who is generally considered to be one of the foremost authorities on ancient astronomy, rejected the possibility of dating the Twelfth Dynasty on astronomical grounds. It is invalid to try to go back from 700 B.C. to 1800 B.C., trying to determine highly accurate results from inaccurate observations and vague records. There is no sound basis for the astronomical dating of the Twelfth Dynasty, which must be dated from archeology and the kings lists alone.[xlii]

At the very least, all of these considerations should convince a historian that the earliest fixed date of Egyptian history is not nearly as certain as is often believed. There is considerable evidence to support the analysis of R.D. Long:

Unfortunately, probationary conclusions have gained unqualified acceptance gradually, while the controversial evidence on which the conclusions are based have been relegated to total obscurity... Little by little, archeologists and historians from other fields of Near Eastern, European, and Mediterranean studies subscribed to the dating placing their trust and confidence on those knowledgeable in Egyptian languages and affairs. Through the years the unresolved difficulties and the provisional nature of the astronomical data has been buried and hidden under a mass of literature which originated in unreserved acceptance of the chronology. It should be recognized that the conclusions arrived at years ago by the teachers of our teachers have a tendency to become more “factual” in our minds and less subject to criticism.[xliii]

A careful re-examination of the validity of the Sothic dating of early Egypt, based on a restudy of the original evidence which formed the foundation of this theory, is very much needed because of the dependence of all Near Eastern chronology on this dating system. Although the dating based on this system has not been proven wrong, there are enough questions so that historians should be alerted to the doubts about the validity of the system, and it should be seriously re-examined by those equipped with the skills to do so. Two points which deserve special attention because they would be especially devastating to Sothic dating are the possibility of breaks in the calendaric continuity of Egypt and the possibility that Sothis is not our Sirius. If either of these was true, Sothic dating would be impossible unless we were able to make a new identification of Sothis and we knew the nature of such a calendaric break. At any rate, such corrections would result in an entirely revised set of dates for Egyptian history.

Other Egyptian Dates

We have devoted most of our attention to the Ilahun/Kahun date because it is the key to the dating of the longest period of Egyptian history. The same general principles apply to the other key Sothic dates for early Egyptian history. I will make just a few brief observations on these other key dates.

Ebers/Smith

The second most important Sothic date is the Ebers Papyrus date, which has been associated with the ninth year of Amenhotep I (supposedly 1540 B.C.). This date is a key to the dating of the Egyptian New

Kingdom and the Late Bronze Age in neighboring countries. Concerning this text too there has been a great deal of dispute about the date and the name of the pharaoh. For 20 years the Egyptologists who first worked with the text argued about the identity of the pharaoh because of the unclarity of the script. Identifications of the pharaoh ranged from the Pyramid Age to the Hellenistic period. Whether the text referred to the 3rd, 6th, or 9th year of his reign and the day of the month in the citation were also the subject of argument. It is this debate which is Long's basis for questioning the validity of this Sothic date.[xliv] Parker defends the date by citing more recent authorities, Erman and Moller, who feel quite confident that the text refers to the 9th day of the 11th month of the 9th year of Amenhotep I.[xlv]

Elephantine

A third Sothic date is derived from an Elephantine inscription which has been assigned to the time of Thutmose III. This text says, "Epiphi, day 28, the day of the festival of the rising of Sothis." This text includes neither the name of the pharaoh in question nor the year of his reign in which the text was written. It is noteworthy that *none* of the three principal Sothic texts includes undisputed evidence of the name of the pharaoh in question, but all three are connected with a particular pharaoh by means of association with other finds.

Medinet Habu

A fourth Sothic date is from a calendar found in Ramses III's temple at Medinet Habu, which has been associated with either Ramses II or Ramses III (1316 or 1196 B.C.) It gives only a month, not a day of the month, in its citation. Therefore at best the date can be narrowed down only to a range of about a century since it takes about 120 years for the rising of Sothis to move through a month of the Egyptian year. It is, therefore, impossible to assign this date to a specific pharaoh. It seems to fit with Ramses III according to the present system of Sothic dating. If it belongs to Ramses II, present Sothic dating is incorrect.

Menophres

Another controversial item of Sothic dating is the so-called "era of Menophres." This discussion is based on a statement in the late classical writer, Theon, who has been mentioned earlier in this paper. Theon says:

> On the 100th year of the era of Diocletian, concerning the rising of the Dog, because of the pattern we received from the era of Menophres to the end of the age of Augustus the total of the elapsed years was 1605. (My translation).[xlvi]
>
> Ἐπὶ τοῦ ρ ἔτους Διοκλητιανοῦ περὶ τῆς τοῦ κυνὸς ἐπιτολῆς ὑποδείγματος ἕνεκεν λαμβάνομεν τὰ ἀπὸ Μενόφρεως ἕως τῆς λήξεως Αὐγούστον. Ὁμοῦ τὰ ἐπισυναγόμενα ἔτη αχε.

Theon makes no mention of Sothic dating, but it has been supposed that Theon is referring to the start of the same Sothic cycle which Censorinus tells us began around 1321 B.C. (From the Age of Diocletian in 284 A.D. subtract 1605 years which leads to 1321 B.C.) Remember that Theon has elsewhere expressly stated that a Sothic cycle began in 26 B.C. so if we accept the above interpretation of his Menophres comment, Theon is contradicting himself, or else he did not realize the implications of his remark about Menophres. Many attempts have been made to identify Theon's Menophres. Menophres has been identified as the city Memphis or one of a number of pharaohs. Merneptah, Seti I, Harmhab, and Ramses I are among the candidates that have been suggested. There is simply not enough evidence to draw any firm conclusions about the meaning of this text.[xlvii]

Canopus

The previously mentioned Canopus Decree contains a Sothic reference placing the rising of Sothis on the first day of the 10th month. This means that it would take about 380 years from the time of the Canopus decree for the Sothic cycle to come to an end (the 95 remaining days of the year times 4). Since the Canopus Decree is dated to about 238 B.C., this would place the end of the Sothic cycle in 142 A.D. within four years of the point indicated by Censorinus.

Lunar

One other form of astronomical dating used for Egyptian chronology is lunar dating, which is used in an attempt to pinpoint events in given pharaohs' reigns to a specific day.[xlviii] Since this is based on a 25 year lunar cycle of the Egyptian calendar, this method is valid only if the date has been narrowed down to a 25 year span by other means. It is doubtful whether the dates can be narrowed down to the 25 year span necessary for the lunar dating to be effective. If the Sothic dating is invalid, then we do not have a firm starting point for lunar dating.

Summary

It seems valid to conclude that all of these Sothic dates suffer from the same uncertainties which raise serious doubts about the Ilahun date with which we began our discussion. Although Sothic dating has a degree of plausibility and cannot be proved wrong at present, there are serious doubts that it is backed by adequate evidence at a number of points. This evidence is very difficult for non-Egyptologists and non-astronomers to assess, so most historians are dependent on the testimony of authorities for the foundations of Egyptian chronology. There is room for doubt about a lot of this testimony. We will now turn to Mesopotamia to see if we can find a firmer foundation there.

Mesopotamia

Key sources for the chronology of Mesopotamia are the Assyrian eponym lists and the king lists which are apparently derived from them. These lists are complete back to the 11th century B.C. The earliest king who can be clearly placed in these lists as a holder of the eponym office dates to the 14th century.[xlix] Besides these lists we have many other lists of one sort or another, particularly synchronistic king lists from Babylon and the Sumerian king lists. The chief problem is not a lack of lists, but more fundamental questions concerning the purpose and reliability of these lists and the problem of finding fixed dates around which these lists can be organized.

Concerning the Assyrian king list for the mid centuries of the 2nd millennium Rowton states that we have no means of verifying their reliability, but no reason to doubt their accuracy. He further acknowledges that the Babylonian lists are not free from error and that some figures of the Sumerian king list give the impression of being entirely artificial. Sequence of events, rather than the interval between them, seems to have been the primary concern of many records of this type right down to the end of Babylonian history.[l]

Sorting out truth from error depends heavily on the subjective interpretation of the historian. Under such circumstances there is certainly an ever-present temptation to find the "errors" particularly at those points in which the sources are in conflict with the interpreter's theory.

Recent research into the nature of geneological and succession lists in the ancient Near East raises questions about whether they are intended to be accurate chronologies at all.[li] Political motives relating to the legitimacy and antiquity of the ruling house were perhaps more important than chronological, historical, and biological accuracy.

There are also uncertainties about the calendar, since we do not know what method of intercalation the Assyrians used in the 2nd millennium B.C. However, the greatest discrepancy, 11 days per year, would create a variation of only about 3 years per century.[lii]

The Assyrian king list of the 1st millennium can be connected to the well established dating of classical times, but the king list of Assyria for the 2nd millennium B.C. is separated from it by breaks in continuity. The only literary means which we have for dating the second millennium are elapsed time intervals such as those referred to by Sennacherib, who states that 418 years passed between Tiglath Pileser I and himself and that 600 years had elapsed between Tikulti Ninurta I and himself. We have already mentioned that we must be very cautious in interpreting such expressions as true measures of elapsed time, unless they can otherwise be confirmed. The same caution applies to efforts to reach back to Shamshi-Adad I and beyond on the basis of other elapsed time references and the Khorsabad king list. Despite Rowton's confidence in its accuracy, we should be suspicious of the alleged 701 year interval between Tiglath Pileser I and Shamshi-Adad I because it is based on building inscriptions. It is clear that these figures are often rough estimates based on approximations using centuries and periods of 60 years as round numbers.[liii] Many of these elapsed time figures are obviously wrong.[liv]

Since our main concern is astronomical dating, we will do no more in this paper than merely to note these difficulties concerning the lists, the calendar, and elapsed time dating. We will turn our attention to the astronomical dates which form the necessary starting point for assigning absolute dates to all of the lists mentioned above.

Since the literary means for establishing absolute dates for the 2nd millennium are of doubtful dependability and carbon 14 dating is not precise enough to be very helpful, the astronomical dates which provide a starting point for dating the individual kings of these lists are crucial. There are two main types of astronomical phenomena used for dating 2nd millennium Mesopotamia, eclipse observations and Venus observations. We will turn our attention first to the Venus observations which are used to date the 2nd millennium kings of Babylon. Kings from other areas are then dated by synchronisms with Babylon.

The date at which the Hittites brought the First Dynasty of Babylon to an end is one of the focal points of the chronological study of the 2nd millennium, because it allows easy cross reference to several other kingdoms. It is generally accepted that we can date the reign of Ammizaduga, one of the kings of the First Dynasty of Babylon, by references to Venus in texts belonging to his reign. If we can date Ammizaduga, we can date the other kings of the First Dynasty, the end of the First Dynasty, and then kings in other kingdoms by means of synchronisms. Because of its importance and wide-spread acceptance, we will take a closer look at the basis of this dating.

The texts in question are from Asshurbanipal's library at Nineveh and from a file of Sargon at Kish (7th and 8th centuries B.C.). They are copies of texts which apparently originated over 1000 years before the time of Asshurbanipal. Our extant copies were perhaps made in the 8th or 9th Centuries B.C. There is no complete version of the text extant. The text must be reconstructed from at least three different tablets which contain parts of the text. These partial texts have gaps and illegible sections in the portions of the text which they preserve. Different translations of the same portion of the text disagree about some of the numbers and month names because the texts are defaced and hard to decipher.[lv]

These texts were first interpreted by Kugler in 1911. One part of the texts consists of many I ines describing the movements of a heavenly body called Nin-dar~anna (mistress of the heavens). The sequence of tenses in the texts is peculiar (past tense, then future). This seems to indicate that the phenomena were observed in the past, and now are being used to make astronomical predictions for the future. Examples follow:

If on the 15th day of Shabatu Nin-dar-anna disappeared in the west, remaining absent from the sky 3 days, and on the 18th day of the month Shabatu Nin-dar-anna appeared in the east, catastrophes of kings. Adad will bring rains Ea subterranean waters; king will send greetings to king...

In the month of Abu on the sixth day Nin-dar-anna appeared in the east; there will be rains in the heavens, there will be devastations. Until the tenth day of Nissanu she stood in the east, at the eleventh day she disappeared. Three months she stayed away from the heavens. On the eleventh day of Duzu Nin-dar-anna flared up in the west. Hostility will be in the land; crops will prosper.[lvi]

The intervals between eastern appearance and disappearance are 8 months and 5 days; then 3 months elapse before the western reappearance; again 8 months and 3 days until disappearance; then 7 days till appearance in the east. The total is 19 months and 17 days, close to the correct period for Venus. These predicted intervals in the astrological part of the text must have been deduced from the observational data which is contained in the table in the last part of the text, but this data includes many obvious errors, which modern interpreters correct on the basis of their knowledge of the Venus cycle. A fault of copying in the observational data changed one of the long periods of invisibility, which are normally about 2 months, into 5 months and produced the false average value of 3 months, which appears in the predictive section of the text.

As has been mentioned, the texts are quite damaged. Reading them is sometimes like reading badly eroded brick. They do not contain the name of the king in whose reign they were written. However, the phrase "in the year of the golden throne" appears among the misplaced Venus phenomena in the texts of the 8th year. This same phrase occurs in the civil contracts of the 8th year of King Ammizaduga, the next to last king of the First dynasty, so historians conclude that the 21 years of this king exactly correspond to the 21 years of the Venus texts. The intercalary years in the Venus texts also seem to match the intercalary years of the civil contracts. However, it is possible that the key phrase is a late addition to the text which was not part of the original texts in the 2nd millennium.[lvii] The research of Reiner and Pingree has presented strong evidence for the composite nature of the extant texts.

The basis of Kugler's interpretation of the texts was the statement that in the 6th year, on the 26th of the month Arachsamma, Venus had disappeared in the west and on the 3rd day of the next month, Kislimu, it had reappeared in the east. Therefore, since the Babylonian months were based on new moons, Venus' conjunction with the sun nearly corresponds with the conjunction of the moon with the sun in a season roughly corresponding with our December or January. Kugler found that these conditions were best met on January 23, 11971 B.C.. This would produce dates for the First Dynasty of Babylon from 2225 BC. to 1926 BC. and for Hammurabi from 2123 B.C. to 2081 B.C.. However, very similar alignments occur every 56 to 64 years.[lviii] Langdon and Fotheringham found solutions which would date the first year of Ammizaduga to 1977 B.C., 1921 B.C., 1837 B.C., 1809 B.C., or 1801 B.C. They preferred 1921 B.C., because they felt that this date best keeps the lunar calendar in proper relationship to the solar year to account for harvest operations mentioned in some of the texts. ' Since the relationship of the phases of Venus and the position of the moon are the key factor here, Langdon and Fotheringham took the alleged accelerations of the moon and earth into consideration in their calculations. They used Fotheringham's acceleration calculations which apply for an epoch around the year 0. Fotheringham's values for the year 0 seem to contain errors, and it is also questionable how applicable these acceleration values would be to the time around 2000 B.C. since the accelerations must be considered time-dependent. Since the uncertainties are even greater than Fotheringham assumed, we may expect that there are more possible solutions than they found.[lix] There are at least four different sets of astronomical tables that have been used in performing the Venus calculations, so anyone attempting new calculations must begin by determining which set of tables he believes are most dependable or else developing his own.[lx]

In more recent major work on the tablets Weir acknowledges the severe problems involved in dealing with these texts. He discusses at least 10 additional solutions for the first year of Ammizaduga including 2260, 1710, 1702, 1646, and 1582 B.C. He prefers 1646, but recognizes that this date too has its problems.[lxi] Weir admits the lack of really close agreement between the astronomical data of the texts and any of the computed solutions. He says, "If the scribes had set out to deliberately confuse posterity they could hardly have chosen a better distribution of copyists' mistakes."[lxii] He recognizes copyist's errors, poor observations, and problems with the modern astronomical tables as three sources of the problems, but it is certainly disturbing when he studies three suggested solutions to the problem and finds that they produce a good agreement between the data in the documents and the computed solutions for only 53%, 54% and 58% of the total Venus sightings. He cites this as favoring the third solution, but in fact the difference of agreement between the three solutions is hardly enough to bear much weight, and it shows that *none* of the solutions provides very good agreement between the recorded data and the computed solutions.[lxiii] To escape the maze of difficulties Weir suggests that the observations were made at a latitude north of Babylon. He explains the discrepancies between the lunar movements required by the Venus tablets and the calculations based on modern lunar theory by suggesting a change in the eccentricity of Venus' orbit. Since Weir assumes that the astronomical data recorded in the Venus texts is basically correct, and that we are trying to locate the reign of Ammizaduga in the right time period (as he must if his work is to have any meaning), he is forced to the conclusion that the relationship of Venus to the earth has changed since Old Babylonian times, because no solutions can be found which give really good agreement between the ancient data and modern calculated solutions. He even mentions the possibility of another heavenly body passing near the orbit of Venus and changing it.[lxiv] In his closing remarks Weir shows how much the desire to solve the problem can lead to wishful thinking. He says that since the Venus tables used for the calculations are the best available, the calculations ought to be dependable: *if* the elements on which the tables are based are correct, the computed data *must* be reasonably correct. Although Weir admits that the unsolved textual discrepancies which are involved with his preferred solution certainly present an astronomical problem, he does not grant that they are in themselves a valid reason for not accepting his solution for dating purposes. He even alludes to continental drift, which might have moved the place of observation, as a possible solution.[lxv] We would certainly like to have a chronological solution be based on a much better foundation than this.

We have seen that the most basic problem with this type of dating is that so many solutions are possible. The dating has no validity unless the historian has already determined the century by other means, and it is doubtful if there is a reliable objective means of doing this. For example, a key site for archeological synchronism with Egypt is Alalakh, and the quality of the stratigraphic work there has long been suspect.[lxvi]

Even if we assume that the historians have determined the century of a given king; it is still questionable if the Venus dating is a valid means to pinpoint the year, month, or day, because such precise dating depends on a reasonably accurate values for the accelerations of the motion of the earth and moon since ancient times, and these can be determined only an the basis of circular argument. Scientists have to assume a value for the accelerations in order to determine a date for the texts. They cannot then use the date of the text to determine a value for the accelerations, because this will only confirm the acceleration values which have already been chosen. To make matters worse the poor preservation of the texts and the many copying errors make their use suspect.

It is now commonly accepted that the date of the coinciding conjunctions was December 25, 1641 B.C., that Hammurabi reigned from 1792 to 1750 B.C. and that the First Dynasty ruled from 1894 to 1595 B.C. An alternative view is to date all of these events 64 years later. But all of this is based on the assumption that synchronisms with the precise astronomical chronology of Egypt limit these events of Mesopotamian history to this rather limited time range.[lxvii] Since we have already seen that there are doubts about the astronomical chronology of Egypt, it is worth noting that even the astronomical dating of early Mesopotamian history is not independent, but depends at least in part on Egyptian chronology.

Historians who use these dates should be aware of evaluations such as those of Neugebauer, who says that the astronomical data used in these calculations are hardly more than estimates of mean values which can never reach reliability and usefulness for solving chronological problems. Much of the extensive modern literature is without practical value, since both the ancient and modern sources introduce strong schematization into their data. For example, Schoch's tables are too simple to serve their chronological purpose.[lxviii] Furthermore, the intercalations in the 2nd millennium Mesopotamian calendars were irregular and were probably done mainly to keep the harvest in the right month so debts could be paid. Because of irregularities of intercalations months of these Mesopotamian calendars may correspond with as many as four different months of our calendar.[lxix] The age of Hammurabi must be dated by historical means alone because the available astronomical data is not adequate to the task.[lxx]

The second major type of astronomical dating which is applied to Mesopotamian history is eclipse dating. The major problem concerning the 2nd millennium B.C. is the sketchiness of the sources. Because the eclipse terminology is often vague, there is room for a great deal of subjectivity in interpreting the texts. Many analysts interpret all such phrases as "darkness of day," "something awesome in the heavens," "the day became ashamed" and so on as total solar eclipses. Stephanson and Sawyer justify their interpretation of an eclipse allegedly occurring in Ugarit around 1300 B.C. by such methods. They interpret a vague Ugaritic phrase as a reference to a total eclipse by comparing it with an equally obscure Greek phrase in a poem of Pindar written almost a millennium later.[lxxi] F.R. Stephanson feels justified in regarding any allusion, no matter how obscure, as a total eclipse, because a total eclipse is so impressive.[lxxii] In dealing with many ancient eclipses scholars fail to ask whether these eclipse reports appear to be accurate scientific reports, or if they appear to be magic or literary eclipses assimilated to important events to give them special meaning. An example of such a literary eclipse is the eclipse associated by classical writers with Caesar's crossing of the Rubicon. Other factors, which make it possible to date this event quite closely, make it extremely unlikely that this event could have been associated with any eclipse. Many other texts which scholars have been using as observations of total eclipses are probably not actually intended to be such. The frequent use of vivid eschatological language in many Old Testament texts illustrates this principle. Some scholars have used these references to dramatic signs in the heavens as evidence that the author had witnessed a total solar eclipse and as a means of dating the writing of the book. But these are simply intended to be vivid pictures of impending divine judgment. There is no evidence that they are intended to be astronomical observations. It is apparent that other "dark days" which have been interpreted as astronomical eclipses cannot possibly be so, because they occur on the wrong day of the lunar month. They are very likely dust storms or some similar phenomenon.[lxxiii]

All of the eclipse references used for dating events of the 2nd millennium B.C. seem suspect on these and other grounds. The Ugaritic eclipse cited above gives an indication of some of the problems. Besides the assumption discussed above Stephanson and Sawyer must also assume that the Ugaritic calendar is the same as the Babylonian and that the history of Babylon and Egypt is dated precisely enough to limit the time range of the Ugaritic eclipse to a fairly narrow range. But this history has been dated by astronomical means as questionable as the method now being used to date the Ugaritic eclipse. Again it is the problem of one set of questionable data being used as the beginning point for establishing a new astronomical date which will then be cited as support of the first.

Another example is the only astronomical date of Hittite history. This too is based on a vague reference which *may* be a total eclipse.[lxxiv]

In summary, I have not been able to find any eclipse records from the 2nd millennium which seem to be precise enough to be very helpful in establishing the chronology of this period.

For the 1st millennium "The Great Eclipse of Bur Sagale" is alleged to provide such a dating basis. So we will now turn our attention to this very important basis of astronomical dating. This reference is found in the Assyrian eponym list. This is a list of the officials after whom the Assyrian years are named. They are listed consecutively so if we can date one year, we should be able to date them all if the list is complete. In this case Bur Sagale is the official who gave his name to one of the years of the reign of the Assyrian king Assur Dan. The citation in question simply says, "Bur-Sagale of Guzana, revolt in the city of Assur. In the month Simanu an eclipse of the sun took place." This eponym list overlaps the Canon of Ptolemy by about 100 years. Ptolemy's canon or king list begins with Nabonassar, a king of Babylon, whose reign began about 747 B.C. according to Ptolemy. Since we can identify some of the Assyrian kings in the last part of the eponym list as contemporaries of some of the Babylonian kings in the earliest part of Ptolemey's Canon, we have an approximate starting point for the Assyrian eponym list which leads us to look for the year of Bur—Sagale somewhere in the 8th century B.C. The eclipse of Bur—Sagale has been commonly identified with an eclipse which occurred on June 15, 763 B.C. If this is correct, we can accurately date the kings of Assyria who are named in this portion of the king list to the period from 891 to 648 B.C.

The first question, of course, is whether the Canon of Ptolemy is accurate enough to provide a starting point for the Assyrian eponym list. Because of the great reputation of Ptolemy, it has generally been assumed that his canon deserves the highest respect as a starting point for ancient chronological work. In fact all ancient astronomical dating has the data of Ptolemy as its starting point. The reason for this confidence is that the canon can be checked against astronomical observations recorded in Ptolemy's *Almagest.* However, R.R. Newton has brought extreme criticism against the usefulness of Ptolemy's data. He points out that there is disagreement between Ptolemy and the cuneiform records for the only eclipse which can be found in both sources.[lxxv] Newton
charges that the data in the *Almagest* is not based on genuine observational records which Ptolemy possessed but on calculations which he fabricated. For example, in Ch. 6.6 of the *Almagest* Ptolemy refers to a lunar eclipse which occurred in the night between the 18th and 19th of Thoth in the second year of Merodachbaladan. Newton believes that Ptolemy did not have an accurate observational record for this eclipse. He simply calculated how many years before his own time such an eclipse would have occurred, and he then looked up the proper king year in the canon which he had and assigned the eclipse to that year. The fact that modern astronomers can locate eclipses that correspond fairly well with Ptolemy's eclipses merely indicates that Ptolemy's eclipse calculations were quite accurate. These co-incidences do not confirm the accuracy of Ptolemy's canon since the connection between the eclipses and the kings listed in the canon is not based on ancient Babylonian observational records, but is merely an artificial creation of Ptolemy. In other words, all that can be established astronomically is that an eclipse actually occurred about 720 B.C. when Ptolemy said it did. This does not prove that 720 B.C. was actually the second year of Merodachbaladan. Since the accuracy of Ptolemy's canon of kings cannot be established, it cannot be used to provide an astronomically dependable starting point for the Assyrian eponym list, and the dating of the Bur-Sagale eclipse is less certain than is generally assumed.[lxxvi] Swerdlow strongly criticizes Newton's attack on Ptolemy, primarily on the grounds that his charges are based on a misuse of probability statistics and that he demands unreasonable accuracy of Ptolemy's observations. Swerdlow argues quite effectively that Newton cannot prove charges of deliberate fraud against Ptolemy, but he does acknowledge problems with the accuracy of Ptolemy's data. Although he defends Ptolemy against charges of deliberate fraud, he does not demonstrate that Ptolemy's data is accurate enough to be useful to us in chronological work.[lxxvii] For our purposes it does not really matter if Ptolemy's errors are due to deliberate fraud or honest mistakes. If they are of sufficient magnitude they will have the same negative effect on chronological work in either case. I will not evaluate the debate any further here since it is not that significant for our purposes here. All Ptolemy's canon does is provide a general starting point for the Assyrian eponymn list by placing Bur-Sagale somewhere in the 700's. He is assigned his precise date by a study of the eclipses occurring in the 700's not by Ptolemy's canon. If the charges against Ptolemy are true, they would have serious implications against using Ptolemy's data for precision dating of events from 600 B.C. to 200 A.D. to exact months or days, or for using it to calculate precise acceleration values. These questions are outside our main interest here.

If we assume that Bur-Sagale must be dated some time around the 700's must we accept 763 B.C. as the only possible date? If we assume that the eclipse must be a total eclipse, 763 B.C. is the most likely date. However, we have ancient records that show that recorded eclipses were not necessarily total eclipses. If we accept that the eclipse could have been a partial eclipse, 791 and 751 B.C. are possible dates and perhaps even 803 or 723.[lxxviii]

It is quite probable that the eclipse date of 763 is correct although other possibilities should still be evaluated. Since the date is so important the original basis for this date which was established in the mid 1800's should be re-examined, rather than simply accepted uncritically. This identification was supposedly made by George Smith in 1867, but checking his *Assyrian Eponym Canon* yields only the information that this date was calculated by Mr. Hind using the table of Mr. Airy, the royal astronomer, without providing any evidence which adequately supports the accuracy of this date.[lxxix] An investigation into the basis for this important date would be worth while.

Summary

It appears that astronomical dating for the 1st millennium B.C. is reasonably accurate, especially for the second half, because for this period there are literary records of sufficient accuracy to give the astronomer a pretty good definition of the astronomical event which he is looking for and the time range in which he should look for it. However, the astronomical dating for the 2nd millennium B.C. is subject to serious doubts because the literary and astronomical information available to historians and astronomers is not clear and precise enough to put very great confidence in the results which are obtained from it. Some of the commonly accepted forms of dating, such as the Sothis dating of Egypt and the Venus dating of Babylon should be seriously re-examined since such great weight has been put on them in nearly all recent research and writing on the history of the 2nd millennium. Historians should be aware of the fact that the dates established by these methods are much less fixed than the standard reference sources for the period imply.

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[i] W.F. Albright, BASOR 88, p. 28
[ii] O. Neugebauer, History III, p. 1071
[iii] S. Fleming, Dating in Archaelogoy, p. 19
[iv] Neugebauer, History III, p. 1072
[v] Fleming, p. 19
[vi] L. Wood, BASOR 99, p. 8
Borchardt, ZAS 37, p. 101
[vii] R. Parker, SAOC 39, p. 177-183
[viii] L. Borchardt, ZAS 37, p. 102-103
[ix] Ehrich, *Chronologies*, p. 21-23
[x] For a survey of the relationship of carbon 14 and astronomical dating see Long, ZAS, Mellaart, and Olsson in the bibliography. Carbon 14 dates for Sesostris and Hammurabi are presented in W. Libby, *Radiocarbon Dating.*
[xi] The heliacal rising is the time when the star becomes visible again just before sunrise after it has been invisible for awhile because it was out during daylight hours.
[xii] Brugsch, *Thesaurus,* p. 215
[xiii] Borchardt, *Die Annalen,* p. 55-56
[xiv] Theon in *Commentaire sur les tablets manuelles astronomique de Ptolemee,* Abbe Hama, Paris, 1822, quoted in Long, *Orientalia,* p. 273

[xv] Al Biruni, *The Chronology of Ancient Nations,* London, 1879, p. 33, 58
[xvi] J. N. Lockyer, *Dawn of Astronomy,* p. 266-273
[xvii] Lockyer, p. 251, 261, 170
[xviii] E. Krupp, *In Search of Ancient Astronomies,* p. 208
[xix] Parker, SAOC 39, p. 182
[xx] Lockyer, p. 291
Brugsch, *Thesaurus I*, pg. 71, 82-83, 104
Gandz, p.219
[xxi] Parker, *Calendars,* p. 33, 49
[xxii] Pauly, IIIA1, c. 322-325
[xxiii] Poole, *Chronology of Ancient Egypt,* p. 30-31
[xxiv] Macnaughton, *Egyptian Chronology,* p. 30-31
[xxv] Further bibliography Parker-Neugebauer, *Egyptian Astronomical Texts I,* p. 24-25
[xxvi] Brecher, *Astronomy of the Ancients,* p. 96, 99, 114
Pauly, IIIA1, 325
Humboldt, *Cosmos III,* p. 131-135
[xxvii] Courville, *Exodus,* p. 55, 60-62
Manetho, p. 99 and 241
[xxviii] Lockyer, p. 269. Courville, p. 61
[xxix] Breastad, *History I,* p. 29
[xxx] Parker, *Calendars,* p. 37-40. Also *Egyptian Astronomical Texts,* p. 54-55. Van der Waerden, *Awakening,* pg. 10
[xxxi] From *De errore profanarum religionum* 27, cited by Long, p. 263
[xxxii] Parker, *Calendars,* p. 47, and Finegan, p. 21-29
Van der Waerden, *Awakening,* p. 10
[xxxiii] Finegan, p. 25
[xxxiv] Parker-Neugebauer, I, pg. 109
[xxxv] Van der Waerden, *Awakening,* p. 27, 28
[xxxvi] Neugebauer, *Bedeutunglosigkeit,* p. 175
[xxxvii] Breastad, I, pg. 25
[xxxviii] Parker, *Calendars,* p. 54-58
[xxxix] Parker, *Calendars,* p. 57
[xl] Neugebauer, JAOS 61, p. 59
[xli] Krupp, p. 204:208
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Brugsch #
[xlii] Neugebauer, JAOS 61, p. 58-61
[xliii] Long, p. 261-262
[xliv] Long, p. 267-268. For the arguments in detail cf. Also the ZAS articles of Brugsch, Eisenlohr, Lepsius, Goodwin, and Ebers listed in the bibliography.
[xlv] Parker, SAOC 39, p. 185. *Calendars,* p. 37:39
[xlvi] Theon re Menophres #
[xlvii] Rowton, *Iraq* 8, p. 94-110. Cerney, JEA 1961, p. 151-153
[xlviii] For examples: Parker, JNES 16, p. 39-40, and *Calendars* esp 63-69. Also Lello, JNES 7, p. 237
[xlix] CAH I:1, p. 194
[l] CAH I:1, p. 195, 200-202
[li] R.R. Wilson, Biblical Archaeology 42:4, p. 13-16
[lii] Macnaughton, *Babylonian Chronology,* p. 34. CAH I:2, p. 770-771
[liii] CAH I:1, p. 203
[liv] See P. Van der Meer, *The Chronology of Western Asia and Egypt,* Leiden, 1955, p. 25-73, David Oates, *The Ancient History of Northern Iraq,* London, 1968, p. 27, CAH I:2, p. 751 for more on this point.
[lv] Weir, *Ammizudaga Tablets,* p. 28-29, 32
[lvi] Van der Waerden, *Awakening,* p.50
[lvii] Reiner and Pinegree, p. 23 F. Hommel quoted in Velisovsky, *Worlds,* p. 206
[lviii] Pannekoek, *History,* p. 33-34. The best very brief summary of the problem.
[lix] Newton, *Planetary Observations,* p. 93-94. Weir, p.
[lx] Weir, p. 16-22
[lxi] Weir, p. 1-15, 47.
[lxii] Weir, p. 13
[lxiii] Weir, p. 11

[lxiv] Weir, p. 26, 62
[lxv] Weir, p. 43, 47. Emphasis mine.
[lxvi] *Alalakh* #
[lxvii] CAH I:1, p. 208, 231-233
[lxviii] Neugebauer, *History* III, p. 1091-1092
[lxix] Neugebauer, JAOS 61, p. 59, and Newton, *Moon Acceleration,* p. 51
[lxx] Neugebauer, JAOS 61, p. 61
[lxxi] Stephanson and Sawyer, *London Schools,* p. 468
[lxxii] F.R. Stephanson, PEQ 1975, p. 108
[lxxiii] Pannekoek, p. 44
Newton, *Moon Accelerations,* p. 191
[lxxiv] CAH I:1, p. 206, 215, 216
[lxxv] Newton, *Planetary Observations,* p. 118
[lxxvi] Newton, *Moon Accelerations,* p. 43-53, and *The Crime of Claudius Ptolemy*
[lxxvii] Swerdlow, *American Scholar,* p. 525-531
[lxxviii] Newton, *Moon Accelerations,* p. 51-53, and *Planetary Observations,* p. 60
[lxxix] Smith, *Assyrian Eponym Canon,* p. 82
Newton, *Moon Accelerations,* p. 50