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CULTURAL CONTEXT FROM THE ARCHAEOASTRONOMICAL DATA AND THE ECHOES OF COSMIC CATASTROPHIC EVENTS

A New Chronology of the Old Babylonian Kingdom and Ur I-III Based on Identification of Solar and Lunar Eclipses

Göran Henriksson

Abstract. A new absolute chronology of the Old Babylonian Kingdom and Ur I-III is presented. The chronology is based on the identification of two total solar eclipses and three lunar eclipses, using a new computer program. According to this chronology, the Amorite dynasty ruled the Old Babylonian Kingdom between 1855-1555 BC. Babylon was temporarily conquered by the Hittite king Mursilis I in 1557 BC. This is considered as the fall of Babylon because the statue of the citygod Marduk was taken as booty. The resurrection of Babylon took place in 1533 BC, when this statue was brought back to the city by the second king of the Kassite dynasty. The third dynasty in Ur can be dated to 2084-1976 BC by identification of two lunar eclipses. A well-defined total lunar eclipse dates the dynasty of Akkad, which means that the First and Second dynasty in Ur can be dated to 2518-2341 and 2340-2224 BC respectively. The first king of Ur I, Messannipadda, ruled 2518-2478 BC.

Introduction

The absolute chronology of the civilizations of the Ancient Near East depends on the well-documented solar eclipse in the city of Assur on June 15th, 763 BC. Before the identification of this solar eclipse (Smith 1878) there was only a relative chronology. The so-called Khorsabad list of Assyrian kings (Poebel 1942; 1943) is complete back to Enlil-nasir II, 1430-1425 BC. The length of rule for the two kings preceding him is unknown because the text is damaged. This means that no absolute dates can be calculated for the earlier kings.

The dating of the Old Babylonian Kingdom is essential for the chronology of the early civilizations of the Ancient Near East. Since the discovery (Kugler 1912) that the year formula for Year 8 of Ammisaduqa, tenth king of the first dynasty of Babylon, was mentioned in the Venus Tablet (Reiner and Pingree 1975), which contain systematic observations of Venus during the 21 years of the king's reign, this Tablet has been of central importance for all attempts to fix the absolute chronology. However, the suggested solutions by Kugler for Year 1 of Ammisaduqa are no longer of chronological interest. Several alternative chronologies have been proposed, but all of these are in conflict with other known facts.

During the second half of the last century, the chronological discussions have mainly included the following three possibilities for the date of Year 1 of Ammisaduqa's reign: 1702, 1646 and 1582 BC. These are usually referred to as the High (Sidersky 1941), Middle (Smith 1940), and Low (Albright 1942; Cornelius 1943) Chronologies, respectively. An Ultra Low Chronology has also been recently proposed (Gasche *et al.* 1998) with 1550 BC as Year 1 of Ammisaduqa.

In the new chronology, proposed in this paper, Year 1 of Ammisaduqa is 1606 BC. It is not in conflict with any facts known to the author.

A New Computer Program for Solar Eclipses

In the present paper two total solar eclipses mentioned in the texts, but not earlier identified, date the first dynasty of the Old Babylonian Kingdom. The circumstances during the two eclipses agree well with the calculations and even with the time-interval of 300 years between them.

The calculations have been performed using a new computer program developed by the author of this paper. In this program a formula by Carl Schoch (1931: B2-5) is used to correct for the so-called secular acceleration of the moon, -29.68 (arcseconds/century²). All others who have calculated solar eclipses have used formulas by Simon Newcomb, who has been considered as the great authority in this field. However, the followers of Newcomb have not been successful in calculating ancient solar eclipses and some of them are so frustrated that they believe that it is impossible.

Some errors in Schoch's theory have been corrected, and the program has been successfully tested since 1985 against all known welldocumented ancient solar eclipses. These include Copernicus' notations on five solar eclipses in his copy of *Calendarium Romanum Magnum* (Stöffler 1518) - now in the library of the Astronomical Observatory in Uppsala, medieval monastery

chronicles, Classical Greek texts, cuneiform tablets from Babylon and the Hittite Kingdom, and Chinese oracle bone texts and chronicles. The most exact information can be found on two separate cuneiform tablets (Sachs 1974), in the British Museum, which tell us about a total solar eclipse in Babylon, April 15th (Julian Calendar) in 136 BC, with the time given for the different phases of the eclipse. The difference between the time recorded in the cuneiform texts and the author's computed time is 0 ± 2 minutes. Stephenson and Morrison (1984) give a general review of the problems involved in the computation of ancient eclipses. The errors depend on the square of the timeinterval before 1900 AD. The value -26.0 $(arcseconds/century^2)$, used as the lunar secular acceleration in the Atlas of historical eclipse maps, East Asia 1550 B.C.-A.D. 1900 (Stephenson and Houlden 1986), has unfortunately not been successful, as no reliable identifications with solar eclipses in the Chinese texts have been possible.

The new program can correctly describe the socalled double-dawn solar eclipse in Zheng, April

11th 899 BC, mentioned in the Old Version of the Chinese Bamboo Annals (Liu 1944: 30). Because of the demonstrated great problems that the established authorities have had in computing ancient solar eclipses, the details from the computations of this solar eclipse were given as an Appendix in an earlier paper by the author (Henriksson 2005). The Old Testament mentions three miraculous situations that can be explained as the partial solar eclipse in 700 BC, the total solar eclipse in 1131 BC and the annular solar eclipse in 1207 BC. Another important eclipse occurred in the Hittite capital Hattushash in 1335 BC, during the 10th year of king Mursilis II, see below. These independent written sources overlap in time with the total solar eclipses in 1666, 1596, 1460, 1411, 1366, 1230, 1185, 1169 and 858 BC, identified by the author on the Swedish rock carvings from the Bronze Age (Henriksson 1992). А newly

interpreted cuneiform text, LBAT 1456, describes a total solar eclipse in Babylon, 30 June 10 BC, Julian Calendar. It proved to be total in the author's table from 1985, but was only partial according to the calculation by Steele (Steele 2000).

Identification of the Total Solar Eclipse that Predicted the End of the Old Babylonian Kingdom

From the translation of *Solar Omens of Enuma Anu Enlil*, it became clear that the calculated circumstances during the total solar eclipse in 1558 BC, on August 27th, Gregorian Calendar, at 10.57 local mean solar time, could be identified with the omen on Tablet 24 (van Soldt 1995: 42): "If the sun weeps because of the decision of the Annunaki, (and when) you observe the sky there is darkness, (and) Libra is surrounded by a green halo - on the 28th of Abu, an eclipse of the sun will take place, it will be surrounded by a green halo. (Green radiance means: the sun's glow is dark.)"

In the year 1558 BC, August 27th corresponded to Abu 28th and Libra was visible below the totally eclipsed sun, see Figure 1.

The same eclipse is mentioned in another text



Figure 1. The total solar eclipse on August 27th 1558 BC, at 10.57.23 local mean solar time in Babylon. (Stellar magnitudes <4.5.)

with an indirect prediction of the conquest of Babylon by the Hittite king Mursilis I: "If the sun weeps because of the decision of the Annunaki, (and when) you observe the sky there is darkness, (and) Libra is surrounded by a green halo: ... a period of hostilities will come and one king will defeat another king [...], the king of a faraway barbarous country, an enemy who does not know the country, will rise ..." (van Soldt 1995: 36).

According to P. van der Meer (1955: 22): "The cause of this time of conflict was the capture of Babylon by Mursilis I, concerning which the Babylonian chronicle states the following 'in the time of Samsuditana the Hittite came against the land Akkad. ...'. The plundering raid of Mursilis was of a transitory nature, for he at once marched away again and did not hold Babylon under his sway."

The Last Years of the Rule of Samsuditana

According to the Low Chronology, Samsuditana became king in 1561 BC and ruled to 1531 BC. If this chronology is correct the total solar eclipse on August 27th 1558 BC occurred in the fourth year of Samsuditana's rule and seems to confirm the Low Chronology. However, from dated texts on cuneiform tablets from Samsuditana's rule, found between two floor layers in a house in the Merkes area in Babylon, we can conclude that nothing violent happened during the first 26-27 years of his rule (Klengel 1983). Above the layer with the tablets there was found clear evidence of a fire and destruction of the house. A catastrophic fire that by the excavator was correlated with the plundering of Babylon by the Hittite king Mursilis I, also destroyed other houses in the Merkes area (Reuther 1926: 13). The attack by Mursilis must therefore have happened during Samsuditana's last four years. If the total solar eclipse on August 27th 1558 BC is accepted as an omen for the attack by Mursilis, this attack must have happened only a few years later.

From Gurzadyan's statistical investigation (Gasche *et al.* 1998; 72-73) of the Venus Tablet of Ammisaduqa we are justified in shifting the chronologies by multiples of 8 years. If we shift the Low Chronology backwards by 24 years, the last year of the rule of Samsuditana was 1555 BC and the attack by Mursilis took place between 1558 and 1555 BC.

Dating the Fall and Resurrection of Babylon

Two tablets, with economic transactions for the months Nisannu and Abu, found at Tell Muhammad in south-eastern Baghdad, mention an eclipse of the moon during Year 38 after the resettlement of Babylon (Gasche et al. 1998: 83-87). Lunar eclipses occur more or less every year so there must have been something extraordinary with this eclipse or eclipses. From my calculations it appears that the year 1495 BC was very unusual in that there were two total lunar eclipses. If this identification is correct, we can date the fall of Babylon to 1557 BC and its resettlement to 1533 BC, because the return of the statue of Marduk, after 24 years in Hani, has been considered as the resurrection of the city of Babylon (Brinkman 1976: 97).

Identification of the Total Solar Eclipse that Predicted the Establishment of the Old Babylonian Kingdom

According to the Low Chronology, the Amorite Dynasty ascended the throne of Babylon in 1831/30 BC. If we shift this year backwards by 24 years, in accordance with the proposed chronology. we get 1855/54 BC as the first year for Sumuabum, the first Amorite king. In the beginning of Tablet 27 of the Enuma Anu Enlil, there is a prediction that fits the situation for the first Amorite king on the throne of the Old Babylonian Kingdom. According to the translation of van Soldt (1995: 85-86), we find in I 1^{1} , line B 10': "If the sun rises and its light is strong: one not of royal descent will be appointed king." and in line B 11': "If at sunset the light is very dark [...]". The omen can be interpreted as a normal sunrise with a total solar eclipse at sunset.

The total solar eclipse in 1859 BC, on April 27th, Gregorian Calendar, with the total phase at 17.10 local mean solar time, fulfils the criteria in the first version of this omen very well and it must in any case have been observed, because, according to Tablet 27, II 4¹ A: "[If the sun] becomes visible in the afternoon and is white, variant: its light is very dark: in the course of one double hour [... *before*] it sets at night, the moon is surrounded by a halo, and it breaks towards the east: during the day, at noon, an eclipse [of the sun will take place]" (van Soldt 1995: 87).



Ammisaduqa year 1, from the Venus Tablet

Figure 2. The variation of statistical parameters for different chronologies (dots) based on an analysis of the Venus Tablet of Ammisaduga by Gurzadyan (Gasche et al. 1998: 73), with spline-curves by the author of this paper. The Skewness and Kurtosis are most sensitive to systematic trends in the data. This analysis is an independent confirmation of the new chronology.

The important message here is the observation of a total solar eclipse a double hour before sunset, with the "white" light corresponding to the solar corona and the very "dark" light describing the effect of the total phase of the eclipse. The comment that the moon was surrounded by a halo is of course true if they understood that it was the moon that covered the solar disc. The partial phase began at 16.10 and ended 2 hours and 0 minutes later at 18.10, and the sunset took place 23 minutes later at 18.33 local mean solar time.

Independent Support for the Proposed Chronology

1) In the chronology proposed in this paper the first year of Ammisaduga was 1606 BC, which agrees very well with the minimum errors around 1600 BC for the statistical parameters in the investigation of the Venus Tablets of Ammisaduqa by Gurzadyan (Gasche et al. 1998: 73). The author of this paper has plotted these statistical parameters and computed the corresponding spline-curves, see Figure 2.

2) The total lengths of rule for the kings Nos. 65 and 66 in the Assyrian King List is unknown because the text is damaged. In the Middle Chronology, the missing number of years is 72 and in the Low Chronology it is 8. According to Astour (1989: §10-12): "Two consecutive reigns could, in principle, have lasted 72 years, but in the sector in question of the Assvrian King List the average length of a documented reign is 13.4 years." If we calculate the sum of these two reigns according to the Ultra Low Chronology, it becomes -24 years, which certainly is impossible! In the new chronology proposed here, the corresponding sum of the regnal periods is 32 years, which is close to the average length, 26.8 years, for the reigns of two kings in the Khorsabad Assyrian King List.

3) The new chronology dates the rule of the most famous Old Babylonian king, Hammurabi, to 1752-1710 BC and the famous Code of Hammurabi to 1714 BC. Albright (1942) found that the Assyrian king Shamsi-Adad I was still reigning in the 10th year of Hammurabi and that Mari was conquered by Hammurabi in his 32nd year. The king of Mari was Zimri-Lim who reigned some 30 years and was preceded by Yasmah-Adad, son and viceroy of Shamsi-Adad, by at least 16 years. Veenhof (2000) has recently identified the eponym Asqudum for the year when Yasmah-Adad died and that year corresponds to Hammurabi year 11-12 or 1742-1741 BC in the proposed chronology.

Durand et al. (1997) interpreted a text from Mari in which a lunar eclipse was mentioned for the year when Yasmah-Adad or his father Shamsi-Adad I died. In 1742 BC there was only one partial eclipse of the moon with magnitude 0.66. However, 1741 BC was a very unusual year with three lunar eclipses: on January 1st a total eclipse after moon rise. June 25th a total eclipse after moon rise and, finally, on December 20th a partial eclipse with magnitude 0.42 after midnight. This means that Shamsi-Adad I may have died the same year as his son, most probably in 1741 BC. Yasmah-Adad ruled Mari at least from 1756 to his death in 1741. After him Zimri-Lim was the king of Mari 1740-1721 BC, when Hammurabi conquered Mari. According to Durand et al. (1997) Shamsi-Adad I was born the year before a solar eclipse in Mari. The author proposes that this eclipse is identical with the solar eclipse in 1833 BC, which was total in Mari. This means that Shamsi-Adad I lived between 1834 and 1741 BC and died at the age of 92-93 years.

4) The Anatolian dendrochronological sequence by Kuniholm et al. (1996) dates timbers of buildings, which are related to Shamsi-Adad I. They write: "For example, the Sankava Palace at Acemhöyük has wall footings of juniper and cedar that were cut (bark present) in 1752 BC, and the Warsama Palace at Kültepe was built in 1810 BC. Because documents preserved on clay in these buildings provide links with rulers from Assyria and Syria (Özgüc 1980), the new fixed dendro-chronology provides important evidence towards the resolution of a century of debate over Assyrian and Mesopotamian chronology. In particular, it renders the so-called High Chronology very unlikely, and supports either a Low or lower-Middle Chronology (or a new independent chronology in this range)." In the present paper such a new independent chronology is proposed: 40 years later than the Middle and 24 years earlier than the Low Chronology.

In the Sankaya Palace, clay bullae that were impressed with the seal of Shamsi-Adad I have been found. According to Veenhof (2000): "The presence of Shamsi-Adad's seal implies that this king must have lived after 1752 BC, when this 'palace' was built, which excludes his death in 1776 BC, as postulated by the Middle Chronology. An arrival of these bullae during the first years of the palace's existence and the last years of the king's reign, would still require a thirty years lowering of the Middle Chronology and one might easily add many years." The Warsama Palace was repaired in 1749 BC.

These independent circumstances are in very good agreement with the above proposed year, 1741 BC, for the death of this important Assyrian king.

Triple Synchronism: Mesopotamia-Hittite Kingdom-Egypt

The oldest solar eclipse, which Schoch included in his formula for the secular acceleration of the moon, used in my computer program, was the partial solar eclipse in the Hittite capital Hattushash, on March 13th 1335 BC, in the Julian Calendar. A correct identification of this solar eclipse is therefore essential for the validity of my computer program. According to Astour (1989: §10-12): "A record from the reign of Shuppiluliumash's son and second successor, Murshilish II, tells us that at the beginning of his tenth regnal year, the young king led an expedition against the country of Havasha (in north-western Armenia). Right at the outset there occurred an omen of the sun so sinister that the dowager queen, Tawananna, interpreted it as portending the imminent destruction of the entire royal house. Murshilish, however, disregarded the omen, went on with his campaign, and was victorious." Forrer (1926-29) identified in the dreaded solar omen the partial eclipse of the sun that was visible in Hattushash and Bohazkoi on March 13th 1335 BC. Schoch's calculations made this identification possible: "Nachdem ich vor einem halben Jahr die Mursilis-Sonnenfinsternis, 13. März 1335 v. Chr. in Boghazkoi, festgestellt hatte (siehe meine Skizze in Forrers Abhandlung), die älteste Finsternis, die wir kennen, ..." (Schoch 1931: B 16). However, A. Goetze and other authorities denied the identification on the ground that the word *eclipse* is not explicitly mentioned in the text. This is technically correct, but it is obvious that only an eclipse was a sufficiently frightening and rare sight to warrant such a dire prediction.

The authors who favour the Low Chronology for Egypt have tried to identify Mursilis' eclipse with other partial solar eclipses, but none occurs in the correct season except possibly the partial solar eclipse of April 13th 1308 (Wilhelm and Boese 1987: 107). This means 27 years later than the chronology by Forrer. In a table at the end of their paper Wilhelm and Boese (1987: 117) reconstruct the reign of all the Hittite kings back to the conquest of Babylon by Mursilis I, dated to 1531 BC. If we add 27 years to their date we get 1558 BC as the year of Mursilis I's attack on Babylon, in very good agreement with the date 1557 BC proposed here.

From lunar observations, the first year of Ramesses II can be determined as 1304, 1290 or 1279 BC, according to the High, Middle and Low Egyptian Chronologies respectively. The battle at Qades, between the Hittite king Muwatalli II and Ramesses II, took place in 1300/1299, 1286/5 or 1275/4 BC according to the three different chronologies. This year may have been the last year of Muwatalli II and was the fifth year of Ramesses II. The total period of the reigns of Mursilis II and Muwatalli II can be estimated at between 43-47 years (Wilhelm and Boese 1987: 107). If 1344 BC was the first year of Mursilis II, the last year of Muwatalli II occurred between 1301-1297 BC, but if the first year of Mursilis II was 1317 BC the corresponding last year of Muwatalli II occurred between 1274-1270 BC.

The correlation with a chronology based on the solar eclipse in 1335 BC is excellent, while the correlation with the solar eclipse in 1308 BC is only marginally acceptable.

Triple Synchronism: Mesopotamia-Egypt-Byblos

Kitchen (1987) compares the chronologies in Egypt, Byblos and Mesopotamia during the time of Hammurabi in the following words: "Many years ago, Albright suggested that the synchronisms of Neferhotep I of Egypt (13th Dynasty) with Yantin of Byblos and of Yantin-'Ammu of Byblos with Zimri-lim of Mari (contemporary of Hammurabi of Babylon) could be linked by the identification of Yantin and Yantin-'Ammu as one and the same ruler of Byblos; this writer then set out the options then possible (Kitchen 1967, with references)." Kitchen (1987) presents three options for this synchronism (assuming it to be valid). The new chronology proposed in this paper fits perfectly with Kitchen's second alternative with High date for Neferhotep I and if we add 24 years to the Low Chronology for Mesopotamia and the new synchronized chronology of Mari:

Neferhotep I of Egypt: 1738-1727 Yantin('Ammu) of Byblos: 1730-1705 Zimri-lim of Mari: 1740-1721 Hammurabi of Babylon: 1752-1710.

According to the new chronology these four kings ruled simultaneously for 3 years. In Kitchen's (1987) three proposed alternatives there is no period of simultaneous rule for all four kings.

Dating of the Third Dynasty of Ur

It has been proposed that a pair of lunar eclipses, separated by 42-43 years, can date the Ur III dynasty (Rochberg-Halton 1988). The author proposes a new pair of lunar eclipses: *The eclipse that predicted the death of king Sulgi took place in 2019 BC and the eclipse that predicted the fall of Ur III took place in 1976 BC*.

The eclipse in 2019 BC has also been mentioned by Huber as an alternative in combination with a marginal eclipse in 1977 BC (Huber 1987a: 5-17; 1987b: 3-13). The author prefers the eclipse in 1976 BC because it was much more impressive. Koch (1998: 126-129) proposed exactly the same pair of lunar eclipses. I had no knowledge of his important paper until recently. Our conclusions are therefore completely independent.

We have also independently rejected the pair of lunar eclipses proposed by Huber (1987a; 1987b) to support the High Chronology and another pair of eclipses proposed by Gurzadyan (Gasche *et al.* 1998: 72-83) to support their Ultra Low Chronology. The alternative by Gurzadyan is obviously not valid because the moon was below the horizon during the first half of the proposed lunar eclipse in 1954 BC, which means that the beginning of the eclipse, *described* in the omen text, was not visible at all.

Dating the Akkadian Dynasty and the First Dynasty of Ur

The death of the Akkadian king Naram-Sin is described in the lunar omens in Tablet 20 of *Enuma Anu Enlil* (Cornelius 1943). According to the calculations by the author we can safely identify this eclipse with the total lunar eclipse in 2164 BC, as the unique appearance of this eclipse fits very well with the omen text that tells us that the moon was still eclipsed during its setting, see Figure 3. The first year of the first king of Ur I, Messannipadda, can now be dated to 2518 BC.

Cornelius (1966) identified the death of the king mentioned in Enuma Anu Enlil, Tablet 20, with the death of the Akkadian king Naram-Sin. The following translation is made by Francesca Rochberg-Halton (1988: 179-180):

(1) If an eclipse occurs on the 14th day of Nisannu and

(2) the g[od, in his eclipse,] becomes dark on the side south ab[ove,] and clears on the side north below;

(3) the west wind blows while he is eclipsed, and

(4) [in the last watch (the eclipse) end]s;

(5) in his surinnu Venus [enters within him (the moon)] the son of the king will enter the throne of his father, variant: the house of his father.

(6) Observe his eclipse, (that of) [the god in whose surinnu Ven]us entered within him, and bear in mind the west wind.

(7) [The prediction is given] for Agade. [The king] of Agade will die, but his people will be well. The reign of Agade will fall into anarchy, (but) its future is propitious. (8) In Kislimu the 28th (or) 29th day, observe his last visibility (that of) the [god who in his eclipse] beg[an the last watch], delayed 1/3 of the watch, and set while eclipsed, and Venus entered within him the son of the king will enter the house of his father.

(9) Observe his last visibility [on the 28th variant: 29th of Kislimu], and you will predict an eclipse. The day of last visibility will show you the eclipse.

According to (8) the lunar eclipse started 1/3 of a watch after the beginning of the last watch, which means 03.20, and the moon set while still eclipsed. This is in very good agreement with the author's calculations of the circumstances during the total lunar eclipse on March 24, 2164 BC, because the calculated eclipse began at 03.17, local mean solar time, and was not finished above the horizon. The meaning of the word *surinnu* is unclear. Venus was rising when the moon was setting.

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Figure 3. The lunar eclipse mentioned on Tablet 20 started 1/3 of a watch after the beginning of the last watch, which means 03.20, and the moon set while still eclipsed. This is in very good agreement with the author's calculations of the circumstances during the total lunar eclipse on March 24, 2164 BC, because the calculated eclipse began at 03.17, local mean solar time, and was not finished before the moon had set.

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