3. Astronomical Data

"*One of our problems, as Assyriologists, is going to be knowing how to handle what is to us entirely strange statistical data rather than straightforward historical narrative such as we have been previously accustomed to use.*"
C.B.F. Walker (1983) 14

Sources, Textual Evidence for the 2nd millennium BC

General editions

– **EAE** (tablets which are essential for chronology, including the lunar eclipses of EAE 20 and 21 as well as the Venus cycles recorded in EAE 63; Venus Tablet [VT]): Reiner – Pingree (1975), Rochberg-Halton (1988)
– **Month-lengths: Huber *et al.*, OPNE**
– **MEC** (→ **Eponyms**): Birot (1985) 219–242
– **KUB 14, 4** (partial solar eclipse)

Mesopotamia	**Assyria**	**Anatolia**
EAE 20: Akkad **eclipses** (lunar)		
EAE 21: Ur III **eclipses** (lunar) linked to **Šulgi** and **Ibbi-Sîn**		
Ur III month-lengths linked to **Amar-Sîn**		
	MEC (solar eclipse) linked to **Šamšī-Adad I**	
VT = EAE 63 (Venus Tablet): visibility phenomena of Venus linked to **Ammiṣaduqa**		
Old Babylonian month-lengths		
Tell Muḫammad year-name: lunar eclipse		
		KUB 14, 4 (partial solar eclipse) linked to **Muršili II**

Further studies

Gurzadyan, *Dating* ... 71–76, (2000), 177–186, (2000a) 40–45 and (2003) 13–17; Huber (1987a) 3–13, *High* ... 1, 5–17 and (1999–2000) 50–79, 287–290; Hunger (2000) 155–158; Koch (1998) 126–129; Michel – Rocher (1997–2000) 111–126; Michel (2002) 17–18; Mitchell (1989/90) 7–26; Reade (2001) 1–26; Rochberg-Halton (1995) 1925–1940; Seal (2001) 163–173; Walker (1983) 10–26; Warburton (2002) 108–114 and (2004) 583–598; Weir (1994/1995) 70–78.

General

3.1. *Enūma Anu Enlil* tablets (EAE)

Enūma Anu Enlil (lit. "When (the gods) Anu, Enlil [and Ea established in council the plans of Sky and Earth]") is a manual of celestial omens and consists of ca. 70 tablets comprising ca. 7000 omens and corresponding predictions. The tablets of the astrological omen series EAE were found in the royal archives in Nineveh and date to the 7th cent. BC. It is assumed that they incorporate much older material, in some cases dating to the beginning of the 2nd millennium. The first 49 tablets of the EAE deal with lunar, solar and meteorological omens, and the last 20 with planets and stars.[251] Unfortunately, the information extracted for chronological purposes (EAE 20, 21 and 63) derives from corrupted copies referring to astronomical events which took place ca. 1000 years before. According to Huber some omens in **EAE 20** and **21**, plus the description of a lunar eclipse (→ below), refer to specific historical events and are therefore relevant for absolute dating:

1) presumably referring to Sargon, king of Akkad (Akkad eclipses);
2) presumably referring to the death of Šulgi and to the imprisonment of Ibbi-Sîn, king of Ur by the Elamites. These Ur III eclipses took place 41–44 years apart.

Among the texts in this corpus one can observe a collection of Venus risings and settings covering 21 years (**EAE 63**), which may be connected with

[251] See Reiner in collaboration with Pingree (1998) = BPO 3. See also BPO 1 on EAE 63. For a short description of the well preserved tablets of EAE see Baigent (1994) 59, Koch-Westenholz (1995) 74–92 and Hunger – Pingree (1999) 12–20.

Ammiṣaduqa's 8th year. Next to the AKL, the VT has been the major source for chronological calculations in the past, and has been especially central to the disputes concerning the "High, Middle or Low" chronologies.

Lit: Baigent (1994) 59–77; Gurzadyan, *Dating* ... 71–76 and (2000) 177–180; Huber (1987a) 3–13, *High* ... 1, 5–17 and (1999–2000) 50–79 and 287–290; Koch (1998) 126–129; Reiner – Pingree (1975); Rochberg-Halton (1988); Weidner (1941–1944) 172–195, 308–318, (1954–1956) 71–89 and (1968–1969) 65–75. See also www.caeno.org.

3.1.1. Venus Tablet (VT)

The Venus Tablet of Ammiṣaduqa is part of ***Enūma Anu Enlil*** (EAE 63 = K.160 [shown in Fig. 3][252] + fragments) and contains 59 omens that deal with phenomena of the planet Venus and with predictions corresponding with the observed phenomena. Most of the observed phenomena are pairs of last and first visibilities of Venus and most of the omens' apodoses refer to events of a turbulent period (floods, food supply, activities of kings, and wars).[253] Obviously the Babylonians linked these planetary movements to the political and economic affairs of their country. The VT contains the earliest known list of codified omens referring to planetary observations. The importance of the VT for Mesopotamian chronology is the possibly dated Venus observation of omen 10, which forms the basis for dating of the tablet's

Figure 3 Langdon, Fotheringham and Schoch (1928) plates I and II (K.160)

[252] Published by Langdon, Fotheringham and Schoch (1928) plates I and II.

[253] Reiner – Pingree (1975) 13–14 with a list of apodoses of EAE 63.

Venus cycles.[254] This omen records the disappearance of Venus on the 25th day of the 12th month (Addaru) of the "Year of the golden throne", which is usually identified as the year-name of the 8th year of Ammiṣaduqa.[255] This date formula appears in the place of the omen's apodosis. (Ammiṣaduqa – as we shall see below – is dated between 1922 and 1542, depending upon the adopted chronology.)

The text, then known in seven exemplars, was first published by Langdon, Fotheringham and Schoch in the late twenties as "The Tablets of Ammizaduga". They proposed 1920 for year 1 of Ammiṣaduqa (UHC). Later, due to the newly-discovered synchronism between Šamšī-Adad I and Hammu-rāpiʾ, three solutions to the tablet's data, using the 56/64-year **Venus cycle**, were calculated that would conform the Šamšī-Adad I/Hammu-rāpiʾ synchronism: –1701, –1645 and –1581 (HC, MC and LC respectively). In 1975 the VT, now known in eleven exemplars, was re-edited by Reiner and Pingree, who warned that, due to the long tradition of the text, its data are highly corrupted and therefore highly unreliable for chronological purposes. According to them, omens 1–10 are related to an eight-year cycle of Venus, its first and last evening and morning appearances as it approaches or leaves inferior and superior conjunction,[256] comprising five synodic periods[257] or cycles around the sun during the first eight years of Ammiṣaduqa, the penultimate ruler of the **Babylon I dynasty**. The rest remains unclear due to corruption of the text, which may imply that several omens listed in this tablet do not date to the time of Ammiṣaduqa at all (→ below). The original of EAE 63 is generally believed to have been written during the reign of Ammiṣaduqa since the end of the first eight-year cycle has the same **year-name** of the 8th year of Ammiṣaduqa. By the time its text had reached the Nineveh library (7th cent.) the VT must have undergone considerable expansion and corruption through extensive recopying in addition to any errors made by the original scribe. The main difficulty in the evaluation of the Venus observation is the number of inconsistencies of disappearance and (re)appearance dates, the duration of invisibility, and the discrepancies within duplicates.

The 8th year of Ammiṣaduqa was originally dated 2041, 1977 or 1857 (using 64-years Venus cycles).[258] Mari texts excavated in the 1930s then demonstrated that Šamšī-Adad I of Aššur and Hammu-rāpiʾ of Babylon were contemporaries, dated roughly to 1800 (MC).[259] This new fact forced the calculatuion of a new data-set: **1702 (HC),**[260] **1646 (MC)**[261] and **1582 (LC)**[262] for Ammiṣaduqa's first year. The fall of Babylon, which marks the onset of the Dark Age, thus would be 1651 (HC), 1595 or 1587 (MC, two different dates dependant on the 56/64-year cycle; → below sub **3.6.**) and 1539 or 1531 (LC).[263] Using the data of Late Babylo-

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[254] Since it lacks an apodosis it is not technically an omen: Reiner – Pingree (1975) 9.

[255] The relation between the observations and this year-name was first observed by Kugler in 1912. (Note that the 21 years VT observation corresponds to the 21 years of Ammiṣaduqa's reign according to the BKL B. For an attempt to identify this year-name with one of Samsuditana (?) see Sassmannshausen, MDAR 65. He rejected the high, middle or low chronology scheme and stressed, as did most of the other authors of MDAR, that the VT cannot be used as primary evidence for the absolute chronology of the early 2nd millennium For a review of MDAR and the lines of argument of its contributors see George, *BSOAS* 68 (2005) 105–107.

[256] See Aaboe (1977) 1–4 on BM 37151, which reports on Venus for eight years.

[257] A synodic period is "the time it takes two celestial bodies to reach the same relative position in relation to a third..." (Koch-Westenholz [1995] 31). Five synodic periods of Venus last eight years minus 2.5 days, or 99 Babylonian months minus 4 days.

[258] The first attempt to evaluate the Venus data chronologically was performed by Kugler in 1912, who favored –1976 for the 8th year of Ammiṣaduqa. But already the reliability of VT data for chronological purposes was viewed suspiciously (see Kugler [1912] 38 of his study). Thureau-Dangin (1927) 181–198, based on calculations by Fotheringham, placed the beginning of the Babylon I dynasty at 2015.

[259] Thureau-Dangin, *RA* 34 (1937) 135–139, Weir (1972).

[260] For instance Sidersky, *RA* 37 (1940) 45–54; the fall of Babylon would then have been in 1651/1650.

[261] E.g. Smith (1940), Ungnad (1940) and Weir (1972).

[262] Poebel (1942–1943), Cornelius (1942) and (1954–1956) 296–297, and van der Waerden (1945–1948).

[263] Cryer (1995) 656–659 stated that no great faith should be put in the Venus Tablet for the reconstruction of the chronology of the 2nd millennium because of false and misleading data and unreliable and unlikely observations. Note also de Martino (1993) 219–221 in connection with Muršili I and his overview on Hittite chronology. For further solutions (UHC, ULC and NC) → **General** sub **1.6.** James *et al.* (1991) working with a Babylonian chronology mainly based on the VT, date the fall of Babylon in 1466. This solution has been widely ignored due to its conflict with historical facts, such as the Amarna period. For another impossibly low chronology, giving the accession year of Ammiṣaduqa as 1419, see Mitchell (1989/90) 7–26, who used a computer program capable of accommodating various theories on long term deceleration of the earth's rate of rotation and based his work on a 30-day month analysis and revised (unpublished!) lunar tables from other astronomical records. A critical reply to his study by Weir can be found in *JACF* 7 (1994/1995) 70–78.

nian sources concerning Venus observations,[264] Huber produced new statistics on the first and last visibilities of the planet as viewed from Babylon. These demonstrated that the dating of the Babylon I dynasty according to the MC is unsatisfactory in conjunction with the lunar eclipse data from EAE 20 and 21. According to Huber, there is only a 5% chance that the data fits the widely used MC chronology, whereas a 95% chance exists for the HC.[265]

Overview of proposed dates (in chronological order of publication) for Ammiṣaduqa year 1 according to the VT[266]

Kugler (1912)	between –2060 and –1800: –1976/75
Weidner (1914)	–2000
Weidner (1917)	–1808/1807
Fotheringham – Langdon (1923)	–1920/1919
Kugler (1924)	–1800/1799
Schnabel (1925)	–1920/1919
Langdon – Fotheringham – Schoch (1928)	–1920/1919
Neugebauer (1929)	rejected the use of the VT for dating the fall of the Babylon I dynasty
Sewell – Smith (1940)	–1645/1644 + –1920/1919
Sidersky (1940)	–1701/1700
Ungnad (1940)	–1659/1658
Neugebauer (1941)	rejected the use of the VT for dating the fall of the Babylon I dynasty
Cornelius (1942)	–1581/1580
van der Waerden (1943–1965)[267]	–1581/1580
Weir (1972)[268]	–1645/1644
Pingree – Reiner (1975)	only 8-year cycle can be determined based on omens 1–10; the VT is insufficient to establish dates
Huber (1982)[269]	–1701/1700 (in combination with attested 30-day months and attested intercalations, statistical analyses)
Gurzadyan, *Dating* ...	–1551/1550 (8-year cycle)

Table 22

3.2. Month-lengths

The general mistrust in the Venus Tablet data led to cross-checks of it with the month-length data in the texts. After initial attempts by Langdon – Fotheringham – Schoch (1928) and Weir (1972), Huber *et al.*, OPNE attempted to combine a study of contemporary month-lengths (in order to calculate the lunar crescent visibility) with other ancient astronomical data.[270] Intercalary and 30-day months were sampled from various documents with the idea of finding which chronology best fit the distribution of 29- and 30-day months.[271] Checking the Venus chronologies against the month-length data might also help determine whether calculated month-lengths are sufficiently accurate to be used for dating purposes. The Babylonian day started at sunset, the Babylonian month with the first visibility of the lunar crescent after the new moon. Under ideal conditions month-lengths vary irregularly between 29 and 30 days, with an occasional 31-day month. According to the textual evidence, one month was usually 30 days. The terms used when the appearance of the moon on the evening of the 29th day cut short a 30-day month were *šullumum* "complete" or *turrum* "turn back". Day 30 would almost always be followed by day 1. The Babylonian year started near the spring equinox. From irregular intercalations it is evident that the beginning of the year must have fluctuated a great deal. Unfortunately no complete list of intercalations exists.

The OPNE method was:

1) The choices were narrowed down to those compatible with the Venus data.
2) Then the Venus chronology was checked against the month-length data from Ammiṣaduqa's reign.
3) Then this was checked against month-lengths from segments of consecutive years with complete intercalations (Ammiditana – Hammu-rāpiʾ).
4) The Ur III chronology was fixed with month-lengths within about 10 years relative to the Babylon I dynasty.
5) Finally, the eclipse material was compared.

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264 Huber (1999–2000) 288–289.

265 Huber's calculations are hardly ever taken by Assyriologists as a decisive argument for the HC (Huber [1999–2000] 68). Only a few Assyriologists use the HC: → **General** sub **1.3.**

266 The following is based on Hunger – Pingree (1999) 37–38. The pairs of dates are according to the astronomical and Julian calendars respectively, since the Babylonian year started in spring. For details of bibliography, see Hunger – Pingree.

267 His results were used in Röllig's unpublished 1965 study.

268 Reviewed by Oelsner, *OLZ* 72 (1977) 477–480.

269 Reviewed by Oelsner, *OLZ* 83 (1988) 554–558.

270 See also Mitchell (1989/90) 7–26.

271 For details see Huber (1999–2000) and (2000), who based his results on what is known in 1982 (Huber *et al.*, OPNE). → **Calendar** sub **6.3.**

It must be stressed that the month-length data is the only truly "contemporary" Babylonian astronomical data we have because the astronomical information on the Ur III and Old Babylonian period came from late texts. HUBER *et al.*, OPNE. used Neo- and Late Babylonian month-lengths and intercalations served as a control for the computation, since the chronology of the Neo- and Late Babylonian period is securely fixed.[272]

According to GURZADYAN (2000) 183–184, Huber *et al.*'s statistical approach concerning month-lengths cannot be used for any far-reaching chronological conclusions. He listed some astronomical observational effects not taken into account by Huber *et al.* He pointed out that the month-length data is not statistically sufficient to support Huber's chronological claims ("*statistical significance is not quite reached*"). TANRET (2004) claimed that there is no evidence for 29-day months during the Old Babylonian period, that during this period a fixed 30-day month was used independently of the lunar observations. Thus he regarded Huber's computations with the months of the Old Babylonian period as "useless" (p. 11). Tanret suspected that the same is true for the Ur III period and therefore the issue of the month-lengths should be ignored in chronology. A fixed month-length of 30 days would result in far fewer intercalations than a true lunar calendar: since only ca. 5 days are missing from 12 × 30 = 360 from the length of the solar year, it would suffice to intercalate about every 6 years. However, the frequency of attested intercalations (see OPNE) is much higher than that. HUBER (1999–2000) 53 maintained that month-lengths can serve as a useful complementary tool for data sets, and will help prove which of the Venus chronologies is correct. This technique was not used by GASCHE *et al.*, *Dating* ... whose calculations emphasized lunar eclipse data (→ below sub **3.3.**).[273] As was pointed out by SEAL (2001) 171 in her review of GASCHE *et al.*, *Dating* ...., further and more detailed investigation of this subject is possible because of new knowledge about Old Babylonian and 3rd millennium month-lengths available since the publication of OPNE.[274]

3.3. Lunar eclipses

The two lunar Ur III eclipse descriptions in EAE 20 and 21, frequently used for chronological purposes,[275] are described in considerable detail: day, month, direction of the eclipse and description of the watch period in which they began.[276] However, it is uncertain how much of the eclipse descriptions in EAE is based on a single, actually observed eclipse and how much is schematic composition and learned speculation. One of these eclipses is said to have taken place on the 14th day of Simānu, and is usually associated with the death of Šulgi, the second ruler of the Ur III dynasty. The other important eclipse is said to have taken place on the 14th day of Addaru and is connected with the destruction of Ur at the end of reign of Ibbi-Sîn, the last ruler of the Ur III dynasty. Based on the known reign lengths of the kings of the Ur III period the interval between the two eclipses is assumed to be in the range of 41 to 44 years, which are the maximum possible intervals between the penultimate and final years of the two kings (→ **Year**).[277]

Huber proposed the dates 25 July **2095** and 13 April **2053** BC (HC) for the two eclipses as the most probable; but KOCH (1998) 126–129 demonstrated that neither of Huber's proposed lunar eclipses matches the actual description in the omina. GURZADYAN, *Dat-*

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[272] For more details on month-lengths see HUBER (1999–2000) 53 and (2000) 166–167.

[273] Criticism by SEAL (2001) 171: "For Mesopotamia the (month-length) argument rests on the fact that in ancient Babylon new months were decided by observation, leading to an essentially random sequence of 29 and 30 day months which can be compared to the calculated sequence [Huber 1982, 1987b]. While this technique should be investigated in more detail before its accuracy can be fairly judged, it should have been mentioned by Gasche et al."

[274] See for instance SALLABERGER (1993) 12–14.

[275] See GURZADYAN in *Dating* ... 74–75 and 78–79 (the eclipses apparently took place in the penultimate year of Ibbi-Sîn and Šulgi respectively). The Ur III eclipses were discussed by Weidner, Rochberg-Halton (on texts) and Schaumberger (on astronomical issues) in detail. For a summary of HUBER *et al.*'s results in OPNE see HUBER (1987) 7–9.

[276] ROCHBERG-HALTON (1988) 20–21 (time, magnitude, direction and duration) and 36ff. (description of eclipse appearance, phenomena associated with eclipses, planets and stars visible during eclipses). See also TUMAN, *High* ... 3, 198–201, HUBER, *High* ... 3–7 and a critical review of GURZADYAN, *Dating* ... by KOCH (1998) 126–129.

[277] GURZADYAN, *Dating* ... 74^{299}. Additional assumptions must be made for retro-calculation (aside from the recent advancements in the measurement of planetary motion) because deceleration of the earth's rate of rotation, which is dependant on tidal friction and numerous non-tidal mechanisms (changes in the moment of inertia of the earth, electromagnetic coupling between core and mantle, solar-induced atmospheric pressure variations), occurs at an irregular rate. These mechanics have an impact on the motion of the moon and consequently for calculation of past eclipses. See for instance HUBER *et al.*, OPNE on the difficulty of "secular terms".

ing ... on the basis of a new calculation found 27 July **1954** and 16 March **1912** BC (NC) as the pair which best matched the text's information throughout a period of 300 years. KOCH (1998) 126–129 criticized GURZADYAN's treatment of the "Finsternisverlauf" (*Dating* ... 79) of the second eclipse.[278] A reply was published by HUBER (1999–2000) 58 concerning the interpretation of the terms KI.TA (*šapliš)* and AN.TA *(eliš)* as referring to the leading and trailing edge of the lunar disk (for details see ROCHBERG-HALTON [1995] 1925ff.). KOCH (1998) 128 criticized the timing by means of night-watches, which depend on seasons, and might have changed throughout the year, and concluded: "Ob Ur III-Mondeklipsen für eine Entscheidung in der babylonischen Chronologie hilfreich sein können, sei nach allem dahingestellt." (→ below sub **3.5.**).

The Akkadian eclipses, which are both reported to have taken place in the month Nisannu, are documented in EAE 20: the first one, apparently presaging the death of a king of Akkad, begins in the last watch in the south and then the moon sets eclipsed. Furthermore an occultation [*šurinnu*]? of Venus is mentioned in this omen in connection with the succession of the king's son. Using SOLLBERGER's (*AfO* 17 [1954–1956]) relative dates, HUBER (1987a) 9–11 calculated backwards and found 15 possibilities between 2400–2150 for the Akkad eclipses (see table 1 on p. 11).[279] Three transitions of reigns are preceded by eclipses matching the description of the omen: Maništušu to Narām-Sîn, Narām-Sîn to Šarkali-šarri, and the accession of Dudu I. But, Huber was unable to find any occultation of Venus within the given period for the month Nisannu, but pointed out that Venus occurs as morning or evening star near the eclipses of March –2301, –2264 and –2236. For the dynasty of Akkad seven changes of reign are reported in an interval of 120 years, among which there are four father-son successions: –2324, –2300, –2263 and –2214 BC. But this time span contains numerous eclipses matching the description of the Nisannu eclipse.[280] HUNGER (2000) 157–158 pointed out the difficulties in assigning any of the Akkad eclipses to specific historical events and recommended to forget about their chronological relevance.

The authors of *Dating* ... attempted to see in a lunar eclipse mentioned in two **year-names** of the yet unpublished texts from **Tell Muḥammad** support for the NC.[281] These year-names mention a lunar eclipse 38 years after the resettlement of Babylon, which according to the NC fell to the Hittites in 1499 BC. Assuming that the eclipse was conspicuous ("*we presume that it was total*") and was preceded by a period without eclipses, from the eclipses between –1442 and –1470 (following the discussion of the other astronomical evidence from Mesopotamia) Gurzadyan favored the one of –1458 (1459 BC), 40 years after the NC date for the fall of Babylon. Combining this lunar eclipse with the resettlement of Babylon mentioned in a year-name and the archaeological evidence from Tell Muḥammad (compared to that from Tell ed-Dēr), Gasche *et al.* concluded that the city was taken over by the Kassites only three years after the fall of Babylon, in 1496.[282] HUBER (1999–2000) 289 remarked that nothing specific is known on the nature of the eclipse (which is also true for the solar eclipse treated below sub 3.4.), and therefore considered it to be chronologically useless, since lunar eclipses take place every year. He labeled the proposed date "possible", in contrast to Gasche *et al.*'s "probable". More doubts arose on the dating system naming the time span of the resettlement of a new central authority within a period of three years only. No other options were discussed by Gasche *et al.*, who aimed at keeping the gap between Babylonian and Kassite power as small as possible and therefore the chronology as low as possible,

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[278] Subsequently GURZADYAN – COLE (1999) 1–5 questioned the possibility of precision as had been suggested by KOCH (on the beginning of the evening-watch) by questioning the accuracy of eclipse predictions in general: "Particularly, a glance at the perturbation theory is enough to realize how naïve it is to speak, as Koch does, of the accuracy on the order of several minutes when predicting eclipses for an epoch as distant as the Ur III period." (p. 3). The authors stressed that the statistical data of the VT is too "noisy" to extract reliable direct information on chronology. They continue to rely on the interdisciplinary approach for a solution to the problem of 2nd millennium chronology. WARBURTON (2004) 594–595, defending Gasche's NC, stated, "... Huber had selected two eclipses which did not match the records while neglecting the two selected by Gurzadyan, which came closer to matching records.", and, in reference to the second criticized lunar eclipse, "In reality, the only discrepancy is the time of exit, and this is clearly a scribal error since the eclipse would have lasted longer than possible ... it is important to note that this scribal error concerns only the duration of the eclipse." Warburton doubts that this "one discrepancy" can vitiate all the other evidence adduced by Gasche and his team.

[279] On the absolute chronology of the Akkadian period based on absolute dates for the 2nd millennium see BOESE (1982a) 33–55. For the chronology of the Akkadian period see SALLABERGER (2004) 27–29, where a summary of the most important issues is provided.

[280] HUBER (1999–2000) 50–79 arrived at the same results.

[281] *Dating* ... 86–88. On these year-names note also RICHARDSON (2002) 9 and SASSMANNSHAUSEN, MDAR 64.

[282] See SEAL (2001) 169.

which they considered necessary in the light of the pottery sequences of the period.

3.4. Solar eclipses

The solar eclipse reported in the **MEC** (→ **Eponyms**) is associated with the year following the birth of Šamšī-Adad I. The badly broken beginning of the MEC tablet can now be restored with the help of the **KEL**.[283] The MEC starts with the enthronement of Amīnum, son of Ilu-kabkabi, and ends with the death of Šamšī-Adad I, son of Ilu-kabkabi. A collation by Durand and Guichard in FM 3 (1997) 42–43 revealed the reference to a solar eclipse (*na'dur* ^{d}UTU[284]), observed in the year of Amīnum's death, during the eponym Puzur-Ištar:

na'dur ^{d}UTU in MEC, A.1288 I, 22–25:[285]
23 [*i-na*] ⌜*Da*⌝*-dí-ia* LUGAL ^{d}UTU-*ši*-^{d}IM *wa-li-id*
In (the eponym) Dadia King Šamšī-Adad was born
24 [*i-na Puzur*$_2$*-Ištar n*] *a-aḫ-du-ur* ^{d}UTU
In (the eponym) Puzur-Ištar the solar eclipse
25 [*ib-ba-ši-ma m*] *u-ut A-mi-nim*
took place and Amīnum died.

Thus, this solar eclipse of the MEC can be connected with an historical event.[286]

On the nature of the eclipse, its visibility, its appearance somewhere between Aššur and Baghdad (region of Akkad), and its possible date see Michel – Rocher (1997–2000) 113–117.[287] They immediately eliminated the NC,[288] and calculated three possible dates for the eclipse between –1850 (MC) and –1740 (NC): **1833, 1795** and **1743 BC**.[289] However, there were a large number of partial and total eclipses during the period in question (see map in Michel – Rocher p. 126), and the MEC provides no specific information about the eclipse's nature.[290] Furthermore, we have no other evidence that might corroborate any computed date for this eclipse (such as another solar eclipse and the time span between them). Consequently the MEC eclipse is ignored in discussions on chronology.[291]

Michel – Rocher (1997–2000) 116 checked their three possible dates for the MEC eclipse and the birth of Šamšī-Adad I, which are 89 years apart, against the 1996 ("older") **dendrochronological** dates from Acem-Höyük, where seal impressions of Šamšī-Adad I and his officials have been found.[292] The first one is 13 years lower than the MC; the second one is somewhere between the LC and MC, and the third one is 14 years lower than the NC proposed by Gasche *et al.* They concluded (p. 124) that the total eclipse dates of 1795 and 1744 were the most likely with preference for the first date. Shortly after the publication of Michel and Rocher, a revision of the dendrochronological dates was proposed by Manning *et al.* (2001) 2532–2535, who concluded that the MC/LC is the most plausible chronology.[293] Their result was based on the assumption that only an 8-year cycle (→ sub **3.6.**) can be extrapolated from the VT, which allows more possibilities than the 56/64-year cycle applied by Huber based on the link with the lunar calendar. Because of the new dendrochronological results,[294] Michel revised and

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[283] See Günbatti (2008) 123ff. with a complete list of eponyms filling the gaps of the MEC.

[284] In the Old Babylonian period the terms *antallûm* or *namtallûm* usually designated an eclipse.

[285] Restored following Durand – Guichard, FM 3 (1997) 43.

[286] Note Veenhof (2007) 60–61^{3}.

[287] Warburton (2002) 109–110 warns against the perils of subjectivity in interpreting this sort of text: "This means that subjective assumptions excluding certain eclipses or preferring a certain time range because of a preferred chronology are not best points of departure" (p. 109) and: "Since these variables (visibility: total, partial and path) are unknown, that search for an eclipse becomes subjective, and can only be modified by seeking an alternative means of checking." (p. 110).

[288] However, they refrained from mentioning that the MC is generally understood as a chronology of compromise only.

[289] Different results were proposed by Huber [priv. comm.], who also included the HC in his calculations, therefore screening for results between –1950 and –1700 in Aššur. He concluded that the solar eclipse in the MEC can be used to support any chronology, except the ULC or "Supershort" Venus Chronology (Ammiṣaduqa 1 = –1517). In accordance with his earlier calculations linking astronomical dates and the VT data to the lunar eclipse data of the EAE, he favors the HC. See also his "high" result for the solar eclipse in KUB 14, 4 below.

[290] Gurzadyan (2003) 15–16 concluded that the solar eclipse without description and without links to any other chronologically anchored astronomical events (by which he means the lunar eclipses of EAE) can hardly serve as good evidence for a specific chronology.

[291] For example Eder (2004) 193.

[292] Dates were taken from Kuniholm *et al.* (1996) 780–783. On their chronological value see Collon (2000) 7–8.

[293] For an adaptation to the new dendrochronological results by Manning *et al.* (2001) 2532–2535 see Michel (2002) 17–18. Note p. 17: "Les nouvelles données dendrochronologiques impliquent naturellement une révision de ces (*from the article published in 1997–2000*) conclusions". The new dates were shifted by ca. 22 years upwards.

[294] According to this new results with a shift of ca. 22 years upward, Sarıkaya palace in Acem-Höyük would have been constructed in 1774 (+4/–7) BC (synchronizes with Kültepe-Kaniš Ib). This new date has been used as an argument for the MC or MC/LC (p. 2354 and 2355, fn. 10), and Manning *et al.* exclude all other chronologies.

adapted her conclusions in 2002, proposing 1833 as the most probable solar eclipse. This implies a MC lowered by 16 years (according to the assumption that Šamšī-Adad died during the 17th year of Hammu-rāpi[3]).[295] Different approaches using different values resulted in the usual difficulties in fitting the solar eclipse into any of the chronology systems.

Banjevic (2005) tried to find a solution with statistical methods, using the lunar eclipses found in EAE, in a letter from Mari, and in the texts from Tell Muḥammad. He concluded 1547 BC to be the most likely year for the end of the Babylon I dynasty.[296] Sassmannshausen (2006) 160 thought the solar eclipse of 1795 BC better fits the dendrochronological data.[297] A critical review on methods used when combining astronomical data with historical and chronological issues was published by Warburton in 2002, who stressed "the necessity of abandoning the entire foundations of the system upon which both it (*MC*) and the Low Chronology are based."[298]

Eder (2004) 193 warned against using any of the existing dendrochronological dates within the current discussion as well, since according to him "die bislang gewonnenen Werte noch nicht als endgültig zu betrachten sind". Furthermore, as has been pointed out by Collon and others, the link between the wooden beams found at Acem-Höyük and the Assyrian king is not as firmly established as one could wish: "Die im Zusammenhang mit dem Palast aufgedeckten Tonbullen ... aus der Zeit der Könige Yaḫdun-Lim von Mari, Šamšī-Adad I. von Assyrien und Aplaḫanda von Karkemiš gehören ganz offensichtlich zu einem länger geführten Archiv, dessen Zusammenhang mit dem um 1774 v. Chr. errichteten Palasttrakt nicht zu klären ist." (Eder, p. 204). Eder, whose approach is based on historical evidence only, especially the **AKL**, **eponyms** and **Distanzangaben**, argued that this and the fact that the archaeological contexts have not yet been published, does not permit a choice from among the chronological systems. This view is certainly justified, since the dendrochronological data is floating. However, most of the proposals made during the past years persist in incorporating these dendrochronological (and astronomical) dates in their arguments, at least as "supporting" evidence for the LC or lowered MC.

From Hittite records (the prayer CTH 70) we have a report on a (partial) solar eclipse during the 10th year of Muršili II, while he was at war with Azzi-Ḫaiaša (KUB 14, 4, IV, 24'–25'). Forrer proposed March 1335 for this eclipse and Boese – Wilhelm June 1312 or April 1308.[299] Only Huber (2001) 640–644, based on a different interpretation of the passage in KUB 14, 4 proposed "higher" dates for it: –1339 (January 8) or –1334 (March 13). But as this solar eclipse is referred to in connection with Muršili's campaign against Azzi, only a date during the months April to June (spring) seems likely. Moreover, Wilhelm and Boese point out that the early date of 1335 is not possible due to the shortened Egyptian chronology (this astronomical event would fall into Šuppiluliuma's reign). Therefore they prefer 1308. But whether a solar eclipse is really meant by the text's passage "the sun gave an omen" is still under discussion. Röllig (1965) 355 referring to Cornelius (1954–1956) 306f. and Rowton (1970) ("(sinister) omen of sun"), pointed out that "Diese sehr allgemeine Bedeutung (*to give an omen*) erlaubt nicht, die in dem zitierten Text erwähnte Erscheinung speziell auf eine Sonnenfinsternis zu deuten ...".

The absolute dates of the rulers of the 1st millennium BC are secured by an astronomical date, the solar eclipse of 15 July 763 BC, which is mentioned in the Eponym Chronicle Cb (Ungnad [1938] 430, rs. 7).[300] This eclipse is believed to have been total and was observed in Nineveh during the eponymate of Būr-Saggile in the 9th year of Aššur-dān III. This date is confirmed by the Ptolemaic Canon, which dates the first year of Sargon II to 709. The eponym of that year was Mannu-kī-Aššur-lē'i, who, according to the eponym canon, was preceded by Būr-Saggile by 54 years. A lunar eclipse of 714 BC, observed during the

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295 See Pruzsinszky (2006) 73–79 on the possible compatibility of these new dates with the Assyrian Distanzangaben.

296 Banjevic (2005) 189.

297 We still have to await another publication by another astronomer (preferably Huber) to explicitly explain his view on this subject.

298 He (p. 111) also criticized Michel's ([1997–2000] 121–122 and [2002] 18) political reconstruction (synchronism of Anum-Ḫirbi & Waršama & Zimri-Līm year 7), which is dependent upon the chronology. See Michel (2002) 18 with critical remarks on Miller, *AOF* 28 (2001) 65–101 (esp. pp. 66–67 and 98; MC). Warburton believed the year 1764 for the solar eclipse of the MEC would be the most compatible with the chronology of Egypt and the Levant (see Warburton [2004] 583 who generally favors the NC proposed by Gasche *et al.*).

299 See de Martino (1993) 219 and Beckman (2000) 22 for other important events crucial to Hittite chronology (including the raid against Babylon by Muršili I and the battle of Qadeš in the 5th year of Ramses II, whose astronomically-based accession date is either 1279, 1290, or 1304).

300 Millard (1994) 2; on solar eclipses in 1st millennium in Assyria see Maul (2000) 1–12.

8th campaign of Sargon II to Urartu also confirms the date of 763.[301] Unfortunately we do not have any such comparative astronomical data to help date the solar eclipse mentioned in the MEC as occurring during Šamšī-Adad's lifetime.[302]

Value for Absolute Chronology and Historical Relevance

Absolute chronology could not be established without knowledge of the calendars in use and astronomical events observed. Egyptian chronology is based on Sothis dates and several lunar dates, and 1st millennium BC Mesopotamian absolute chronology is firmly established on the basis of the solar eclipse date of 763 BC.

Within the past few years the amount of chronologically-useful astronomical data from Mesopotamia has not increased substantially, but the discussion on the known data has not diminished. A focus of the debate is how the astronomical data fits together with the historical and archaeological data. It seems that there has been and always will be a discrepancy in the results; but as long as we lack a sufficient number of astronomical dates which can be linked to archaeological or historical facts, the debate cannot be resolved. As has been mentioned, astronomical data, specifically the 56/64-year Venus cycles, form the basis of the Mesopotamian chronological systems, the HC, MC and the LC.[303] Any reference to one of those chronologies therefore touches on issues connected with astronomical observations.

- Cornelius (1958) 101–104: "Die kurze Chronologie beruht auf astronomischen Daten und mit Jahreszahlen versehenen Königslisten, die längere Chronologie beruht auf unsicheren Generationenabschätzungen in ebenso unsicheren Chronologien."
- Gurzadyan (2000) 184: "Huber (1999/2000b) himself concedes that the High Chronology is not supported by other alternative data. He nevertheless continues to claim that his astronomical arguments remain valid ..."
- But note Huber in van der Waerden (1966) 42, where he suggested the suggested the LC for Mesopotamia: "Achtet man auf die Grösse der Differenzen 'Text minus Rechnung', so ergibt sich, dass die kurze Chronologie am besten stimmt und die lange am schlechtesten. Achtet man auf die Differenzen, so zeigt sich, dass die mittlere Chronologie ganz auszuschliessen ist. Möglich bleiben die lange und die kurze Chronologie; die kurze passt viel besser zum Text als die lange."
- Warburton (2000) 62[12] stated: "It is evidently impossible for non-astronomers to judge these matters before they have been resolved by recognized authorities reaching a consensus or declaring the specific character of their disagreement in terms which are comprehensible and not merely dismissing the projected data as inaccurate."

Discussion will certainly continue about the **solar eclipse** of the **MEC** and its use for absolute chronology.[304] Though the 763 BC solar eclipse helped to establish the chronology of the eponyms of the 1st and the latter part of the 2nd millennia, major difficulties are still present in the evaluation of the astronomical data for the early 2nd and later 3rd millennia.

Next to the latest astronomical computations by Gurzadyan in *Dating* ... (NC), the statistical approach of Huber and his colleagues (HC) has dominated the chronological discussion during the past few years. The analysis of Huber for the period –1362 to –1976 using the VT and statistical methods, and including the lunar eclipse and contemporary month-length data, resulted in following dates for Ammiṣaduqa. Huber divided into good, median and bad matches with the data:[305]

Ammiṣaduqa year 1 = –1701 (= 1702 BC; **HC**), best fit
Ammiṣaduqa year 1 = –1645 (= 1646 BC; **MC**), poorest match
Ammiṣaduqa year 1 = –1581 (= 1582 BC; **LC**), median match, between HC and MC
Ammiṣaduqa year 1 = –1517 (= 1518 BC; **ULC** or **"Super-short"**), mild agreement

Gurzadyan, *Dating* ... 72 criticized Huber's assumption that one of these three (four) chronologies has to be correct assuming that a 21-year Venus period corresponded with Ammiṣaduqa's reign can be extracted from the VT. As mentioned above, according to Gurzadyan and others the 8-year cycle

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301 Oppenheim, *JNES* 19 (1960) 137.
302 See also Gasche (2003) 210.
303 Goetze was the last one to combine the LC based on astronomical data with the historical and archaeological evidence (Huber [1999–2000] 288).
304 See the comments by Warburton (2002) 108–114 on the result by Michel (2002) 17–18, which essentially was an adaptation of the dates for the solar eclipse mentioned in the MEC to Manning *et al.*'s (2001) new results.
305 See Huber (1999–2000) 67–68 for an overview on his evaluation of these dates and their fit with the eclipse data of the Akkadian and Ur III periods.

(= five synodic periods) is the only reliable data which can be extracted from the VT and therefore the 56/64-year cycle upon which the MC and HC scheme is based does not derive directly from the textual evidence (see also GURZADYAN [2000] 184). He concluded: "... the statistical analysis does not indicate any preference for the High Chronology, thus demonstrating that we are dealing with absolutely noisy data, from which we cannot reach any reliable conclusions."[306]

Unfortunately, the historical evidence and the dendrochronological results do not agree with the HC. Moreover, the archaeological evidence (pottery and glyptic), according to the scholars working on the material (GASCHE *et al.*, *Dating* ..., STIEHLER-ALEGRIA [1999] 95–97 or GUALANDI [1998] 133–134) is also contrary to the HC. Nevertheless HUBER (1999–2000) 68 sticks to his solution awaiting other "hard" evidence (such as new astronomical data).[307]

Irregularities in observed astronomical data could have been caused by volcanic eruptions, such as that of Thera saturating the atmosphere with volcanic dust, which would have particularly interfered with observations near the horizon and thus affected the dates of Venus' first and last visibility.[308] The date of the Thera eruption is still uncertain, 1645, 1628 or 1520 BC,[309] but perhaps may eventually be determined by **dendrochronological data**, the **ice cores of Greenland**, and dated archaeological strata with traces of ash and pumice deriving from this eruption.[310]

Despite all the studies of recent years, which have tended towards a chronology somewhere between the classical MC and the NC,[311] HUBER (1999–2000) 53 still argues contra Gurzadyan's computations. On the other hand KOCH (1998) 127 stated that Gurzadyan's calculations could match the eclipse. However since it started below the horizon, its beginning would not have been visible (see Koch's endnote no. 18 for details). In 2000 Gurzadyan also demonstrated that Huber's selection of calendars did not correspond to the full range of choices (pp. 180–181). Obviously their approach differs in several respects, the computation programs producing one of the major discrepancies (HUBER [1999–2000] 57 and GURZADYAN [2000] 183[312] and [2000a] 40–45).

3.5. Historical Omens and the Historicity of Eclipse Data

The lower chronologies generally are opposed only by those who rely on the astronomical data for chronology. But HUNGER (2000) 155–158 pointed out, that the connection between eclipses of EAE and historical events is not secured at all,[313] and presented a quite pessimistic view of the chronological usefulness of the omens EAE 20 and 21. The apodoses of those omens alluding to specific historical events may have been altered, thus making it "impossible for us to identify their historical basis" (p. 158).

The problems with the omens are:[314]

- No ruler is mentioned by name in them.
- The ascription of specific omens to Ibbi-Sîn or Šulgi is a modern leap of faith.
- The destruction of Ur is predicted by an eclipse in two different months: month XII (EAE 21) and II (EAE 20)
- Concerning the king of Ur whom a son will "wrong" (i.e. "kill"), no evidence exists that any king of Ur was mistreated or killed by his son.
- The death of a king of Akkade is no specific event.

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306 GURZADYAN, *Dating* ... 74. For an explanation of "*noisy data*" see GURZADYAN (2000a) 40–45. See the response to GURZADYAN (2000) by HUBER (1999–2000) 51–52. His view has remained unchanged since HUBER *et al.*, OPNE. Note that HUBER initially argued for a LC in VAN DER WAERDEN (1966) 42 and 47: "Die einzige Chronologie die zu allen Daten gut passt, ist die kurze. Danach regierte die Hammurapi-Dynastie von –1829 bis –1530, Hammurapi von –1727 bis –1685 and Ammizaduga von –1581 bis –1561." As to the historical sources for absolute chronology Huber referred to ROWTON's study in *JNES* 17 (1958) 97; for the archaeological results he referred to ALBRIGHT, *BASOR* 69 (1942) 18.

307 Note his criticism of dendrochronological results from a "single" site: but the data were samples from a large area in order to achieve results for this site: see lately NEWTON – KUNIHOLM (2004) 165–176.

308 WEIR (1972).

309 See e.g. MANNING (1999), MANNING – RAMSEY (2003) 120–122 and BIETAK (2003) 23–33 and see fn. 14.

310 To collect and analyze these traces is the task of one of the projects of SCIEM 2000 under the direction of M. Bichler: see in ed. BIETAK (2000) 30ff. Some results by M. Bichler and his team can be found in CChEM 9 (2007) 49ff. Note id. in CICHOCKI *et al.* (2004) 87–93.

311 Note that GURZADYAN (2000) 181 termed the NC as the ULC (the latter based on a 56/64-year Venus cycle).

312 A description of Gurzadyan's work can be found in GURZADYAN (2000a) 40–45.

313 See HUNGER (2002) 171–176. On p. 174 he repeated: "Bestimmte Finsternisse mit Ibbi-Sîn oder Šulgi zu verbinden, ist also moderne Interpretation."

314 See also SEAL (2001) 170–171.

- There are more apodoses in EAE with no possible historical counterpart, and which are apodoses repeated (EAE 21 II and VII).
- On days 20 and 21 there were no eclipses according to the Babylonian calendar (EAE 21).

TUMAN, *High* ... 3, 203 noted many cases of eclipses which the omens imply were followed by the death or disappearance of a king; but it is hard to judge how many of these omens derived from specific events. Thus the historical value of these astronomical omens is to be questioned, especially as the events described are unspecific and were sometimes obviously added later. But GASCHE (2003) 213 claimed that the historical events do fit the calculated eclipses, and therefore the identifications of the persons or events must be correct: "... toutes les charactéristiques mentionnées dans les textes sont vérifiées par l'astronomie avec une précision étonnante ..."

The solar eclipse reported in the **MEC** and linked to Šamšī-Adad I is, however, a different matter from the vague omen eclipses. Though different approaches based on different premises (→ **Eponyms** and **Dendrochronology**) have resulted in a variety of dates for Šamšī-Adad I,[315] nevertheless the eclipse of the MEC is something directly tied to this king and for that reason alone would merit the closest study. But also the MEC, in contrast to EAE, is a contemporary document, which has not been subject to repeated copying and editing. Moreover, the possibility of dating a solar eclipse is better than for lunar eclipses. Nevertheless this solar eclipse is not very clearly described and therefore subject to a variety of chronologies, depending on which other evidence the date is linked to (so far mainly the dendrochronological date from Acem-Höyük). Scholars working with this solar eclipse have not accepted the validity of attempting to apply the 56/64-year Venus cycle to the VT data (MICHEL – ROCHER [1997–2000], MICHEL [2002] and WARBURTON [2002]).

3.6. Venus Cycle

The **VT**, which deals with the risings and settings of Venus during the reign of Ammiṣaduqa (probably), is chronologically anchored within the Babylon I dynasty, but its date is so vague that it leaves us with three possible chronologies (if not more), the HC, MC and LC reflected in EAE 63. Studies on absolute chronology try to fit the VT data and all other known data into one of the major chronological schemes.[316] However, HUBER, *High* ... 1, 17 stated: "... It is no longer a question of picking one of several Venus chronologies on the basis of historical or other non-astronomical arguments, but a question of either accepting or refuting one single chronology. ..."

Omens listed in EAE 63 relate to Venus' synodic period, which lasts ca. 584 days or ca. 20 months.[317] Babylonian calendar dates of first and last visibilities of Venus repeat themselves after five synodic periods or ca. eight solar years – more precisely 99 synodic months[318] minus 4 days.[319] After seven or eight such 8-year periods the 4-day deficits accumulate to a full month, which means that after 56 or 64 years Venus phenomena are again more or less in step with the lunar calendar. Unfortunately the Old Babylonian observational data contains many errors. It is also difficult to find out according to which convention the astronomers would report on their observations (see HUBER *et al.*, OPNE 12–13). Despite all this, modern scholars have "aimed to squeeze objective negative information out of the Venus data by using statistical methods to fix the absolute chronology of the 2nd millennium BC." (HUBER, *High* ... 1, 6).

The VT contains information on the first and last visibility of Venus during a 21–year period assumed to correspond to the reign of Ammiṣaduqa. Its chronological value for 2nd millennium chronology has been widely discussed in the past: NEUGEBAUER (1929 and later) and REINER – PINGREE (1975) 25 believed that it is hard to extract reliable data from the later portions of the tablet (they even doubted

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[315] A summary on various approaches during the past few years was presented by WARBURTON in his insightful article of 2002, 108–114.

[316] LANDSBERGER commented in 1954, 48[68a]: "Wenn irgendeine vage Zahl in Sicht ist, wird sie sofort in die Zwangsjacke der Venusperioden gesteckt, die keinerlei Änderung mehr zulässt." He therefore focused on external links, their impact on the chronological setting of the Dark Age, and their relation to the Babylon I dynasty as well as to the known rulers in the 15th cent. This approach is in fact very valuable, but his study is based on outdated information. For an updated study on the Mesopotamian Dark Age see HUNGER – PRUZSINSZKY (eds.), MDAR.

[317] On the visibility and various positions of Venus see Pingree in REINER – PINGREE (1998) 3–20.

[318] A synodic month consists of 29 days, 12 hours, 44 minutes and 2.9 seconds. This results in an irregular series of 29- and 30-day months.

[319] See AABOE (1977) 1–4 (on BM 37151 from Babylon, which reports on Venus for eight years), HUBER *et al.*, OPNE 11 and HUBER (1999–2000) 288–289.

that the rest of the text belongs to Ammiṣaduqa). Huber performed statistical analysis combining the VT with Old Babylonian month-lengths in the effort to prove that the reports of the VT are to be attributed to the reign of Ammiṣaduqa.[320] In response to Reiner and Pingree's warning Huber (2003) 163 wrote: "I have made my career as a statistician by dealing with contaminated and otherwise corrupted data, and with data analysis... Those years 1–8 and 9–17 show an exactly parallel statistical behaviour across different chronologies, that is, they show the behaviour to be expected from consecutive data ...". In other words, Huber tried to prove both that the VT contains "a hard core of genuine, consecutive observations" for the years 1–17 and that the years 19–21 are to be attributed to observations during Ammiṣaduqa's reign.[321]

The reliability of the 56/64-year Venus cycle preserved in the VT was discussed by Gurzadyan (2000) 180 and Warburton (2002) 111 and (2004) 584. Referring to the latest statements by Huber (1999–2000) Gurzadyan remarked that even if certain Venus visibility data fit one given 8-year period, one cannot expect that "they would therefore necessarily fit the period of 56 or 64 years before/after with the same a) probability and b) accuracy."[322] Thus in *Dating* ... a basic 8-year cycle was applied by excluding other cycles, such as the 56/64-year Venus cycles, which generated the 20 possible chronologies of Huber *et al.*, OPNE. Gurzadyan argued that only the first ten omens belong to the reign of Ammiṣaduqa, whose 8th year is mentioned in the 10th omen, and that too little evidence is contained in EAE 63 to identify a 56- or 64-year Venus cycle.[323] Reiner and Pingree (1975) likewise accepted only an 8-year cycle for the VT. As was mentioned above sub 3.1.1., others disregard the VT for chronological purposes altogether.

Gurzadyan's sequence of inferior and superior conjunctions is therefore based on the 8-year Venus cycle, which according to him represents the only reliable cycle to extract from the VT.[324] Only the relative sequence of inferior and superior conjunctions, but no absolute lunar calendar reflected in the VT, form the basis of Gurzadyan's approach to the 8-year cycles of Venus. Gasche *et al.* paid more attention to the lunar eclipses of EAE 20 and 21 in order to narrow down the range of possibilities of 8-year cycles compatible with the VT data. However, Warburton (2002) 113 pointed out: "It is also remarkable that the only means of avoiding a substantial reduction from the 'Middle Chronology' requires the sacrifice of the very 56/64-year Venus cycle upon which the whole edifice of the three chronological systems was based...". This ultimately means that the concept of High, Middle or Low chronology in Mesopotamia might have to be given up, since potentially every eight years is a solution for the VT data.[325] It also suggests that we might have to give up on the VT – as indeed Neugebauer (1929 and later) and Reiner – Pingree (1975) had warned.

In his response to Gurzadyan in *Dating* ..., Huber (1999–2000) 51–53 stressed that it is not possible to operate only with 8-year periods:[326] since there are five synodic periods within an 8-(solar) year cycle, there may be further solutions corresponding to one of the other four synodic periods within those eight years (causing the 56 and 64-year cycles to overlap) – which means that all the Venus phenomena for any particular chronology must be calculated and checked whether they are reasonably compatible with

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[320] For a criticism of Huber's approach see Gurzadyan (2000)183–184. Seal (2001) 171, in response to Gurzadyan, *Dating* ..., states that the approach to chronology through Old Babylonian month-lengths should be investigated in more detail before its accuracy is judged. Tanret (2004) postulated that 29- day months were not used during the Old Babylonian period. Such month-length discussions are well known from studies on Egyptian chronology. → above sub **3.2.**

[321] On difficulties with the statistical method see Gurzadyan, *Dating* ... 73 and Gurzadyan – Cole (1999) 5.

[322] Within the past few years more scholars have shown their preference for an 8-year Venus cycle: Gasche *et al.*, *Dating* ..., Zeeb (2001) 86, Michel (2002) 17–18 and Warburton (2002) 111–113. Apart from such problems we are confronted with "intrinsic noise" (Gurzadyan [2000] 181) in the VT: visibility aspects, potential scribal errors and unconscious restoration in antiquity. See Gurzadyan (2003) 13–17 on the role of refraction in observations near the horizon.

[323] See also Hunger – Pingree (1999) 33–34.

[324] Rowton (1970) 231–232 was in favor of an 8-year cycle as well.

[325] See Michel (2002) 17–18 who proposed a "reduced MC" (i.e. a reduction of 16 years) based on the MEC's solar eclipse combined with historical and dendrochronological data.

[326] Note also the review by Seal (2001) 169–172, where she stated that the analysis of the VT by Gasche *et al.* is far too simplistic with regards to their assumptions about the quality of the VT data and the links between the VT and astronomical theories of the first millennium BC. She also states that they misunderstood Huber's analysis.

the data or not. Furthermore (and this has a very strong impact on the discussion) Huber criticized Gurzadyan's computer program and his interpretation of the astronomical terms used in the protases of the omens.[327]

Gurzadyan in Gasche *et al.*, *Dating* ... achieved the reduction of half a Venus cycle (= 32 years), which resulted in 1550 for year 1 of Ammiṣaduqa and 1499 for the fall of Babylon. According to Seal (2001) 170–172, this solution still needs to be verified and discussed with respect to Huber's dates and methods. The 8-year cycle has won increasing support: but this means the VT data less is specific for absolute Mesopotamian chronology.

Concluding Remarks

Many scholars regard the astronomical data to be of questionable chronological value: Indeed, Unger and Neugebauer recommended the VT be disregarded; Gates, *High* ... 2, 77 suspicious of the quality of the VT data, hesitated to apply the Alalaḫ material to an "*artificially correct scheme*" and preferred "*a less satisfying series of rough absolute dates*".[328] Kühne (1999) 203 based his chronological arguments strictly on historical considerations. (He proposed 1550–1540 [between MC and LC] for the end of the Babylon I dynasty.)[329] This approach seems to be the one adopted by most scholars working primarily with relative chronology-systems. Eder (2004) 192–193, likewise put off by the difficulties with the astronomical information, disregarded it in deriving an UHC, slightly longer than the HC dating the fall of Babylon to 1665. Starke in Eder – Renger (2004) 59[1] also dismissed the VT's chronological value: "Inzwischen wird jedoch allg. anerkannt, daß es sich bei diesem Text um eine Fiktion bzw. gelehrte Konstruktion jenseits der Realität handelt."

The HC, MC and LC dates for the fall of Babylon are basing on astronomical data which derives from the VT using 56/64-year Venus cycles. Now, the VT is believed to be closely related to a certain year of Ammiṣaduqa's reign mentioned in the 10th omen instead of an apodosis: "Year of the golden throne" (= 8th year of Ammiṣaduqa: for a discussion of the identification of this year-name → above). But G. Wilhelm pointed out to me that the apodosis containing the year-name is not necessarily to be tied to the time when the observation was, but to the dating of the tablet on which the omen was originally written down.[330] This is another reason we must be cautious about using the Venus tablet for chronological purposes.

The lunar eclipses are also questionable for chronological purposes because they cannot be linked to specific historical events, and the protases of the omens mentioning some of them are ambiguous (note especially Huber [1999–2000] 61ff., who shows that some of the proposed dates do not match the omen-description of the eclipse). Even the lunar eclipse reported in the Tell Muḥammad texts (**year-name**[331]) is insufficiently clear for dating if not combined with other data.

The eclipse reported in Hittite sources, combined with other important synchronisms with Egypt and Babylonia, yields one absolute date for the reign of Muršili II: his 10th year can be dated to 1308 or 1312 respectively. This could help put other Syrian dynasties in chronological context. However, it is still debated whether this text really refers to an eclipse or is simply some solar omen.

The solar eclipse of 763 BC securely fixes absolute chronology of 1st millennium Mesopotamia and (→ **General**). We still lack a similar astronomical sign-post for the 2nd millennium.

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[327] Craig Crossen (priv. comm.) points out the problem of whether or not the Venus observations were made by the same observer. "There can be a great difference in visual activity between observers, particularly with notoriously hard-to-see twilight phenomena. Plus a trained and experienced observer will sight a planet in the twilight flow much earlier than an inexperienced observer."

[328] She worked with archaeological material of the MBA and with synchronisms (Egypt, Levant and Syria). See Thureau-Dangin (ed.) (1951) 43 (part of the discussion).

[329] Thus in BBVO 1 (1982) 203ff. Kühne proposed the dates of 1539 or 1531 for the fall of Babylon (LC, 8-year cycle) and stated in SCCNH 10 (1999) 203[1]: "I dispense with the long-cherished idea of obtaining reliable results from the evaluation of the relevant Babylonian dates."

[330] This was the convention for dating late Old Babylonian tablets, and the old date may have simply been left by the copyist. A different view was taken by Reiner – Pingree (1975) 9, who believed that "omen" 10 "was originally a report of an observation of the last visibility of Venus, followed by the date, as in the case of the reports of haruspices."

[331] The year-name merely reports that Babylon was resettled after the raid (Richardson [2002] 9): nothing further can be inferred from it.

Problems with late-3rd/early-2nd millennia Mesopotamian astronomical data

Lunar eclipses of the Akkad and Ur III period	Calculation, evaluation? Historical reliability?
VT (EAE 63)	8 year or 56/64 year Venus cycle? Reliable link of the observations with Ammi,aduqa?
Old Babylonian month-lengths	Sufficiently reliable data? New evaluation of existing data needed!
Solar eclipses during Šam¡²-Adad I (MEC) and Mur¡ili I (KUB 14, 4)	Both eclipses are insufficiently described!
Lunar eclipse linked to the fall of Babylon	Historical reliability? and too many options

Table 23

Links

Babylon I Dynasty, Calendar, Dendrochronology, Eponyms, Old Assyrian Period, Year-names