THE VENUS TABLETS OF AMMIZADUGA

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I. THE DATING OF THE HAMMURABI DYNASTY

1. *Introduction.* One of the treasured possessions of the British Museum is the Assyrian library of cuneiform clay tablets which once belonged to King Assurbanipal. This library, which was founded in the 7th century B.C., represented the learning of that age. Among its many branches was a section dealing with astrology. This section had at least 70 tablets, each with the title, "When the gods Anu and Enlil", forming an astrological series. Within that group, the 63rd tablet dealt with the planet Venus.

This 63rd tablet gives a sequence of setting and rising dates of Venus as observed over a period of 21-years, with the appropriate astrological omens added. Since no undamaged tablet containing that important document has so far been excavated, the text has had to be reconstructed from the various portions of different tablets which have been found. These fragments are known collectively as the Venus tablets.

2. *Father Kugler's Discovery of the Year Name.* Now, this Venus tablet astronomical record would have had no greater significance for dating purposes than the other astrological information in the series, had it not been itself dated by the Babylonian scribes. This fact was not immediately realised, however, because of the initial difficulties experienced by scholars in translating the newly discovered cuneiform symbols [1].

In 1912, Father Francis X. Kugler, who was a German professor of astronomy, correctly translated the phrase, "Year of the golden throne", which had been inserted between the data of the 8th and 9th years on the tablet. He pointed out that this is a year name belonging to the First Babylonian, or Hammurabi dynasty; being, in fact, the date-formula for the 8th year of King Ammizaduga [2].

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[1] Langdon-Fotheringham-Schoch, *The Venus Tablets of Ammizaduga*, Oxford University Press, London 1928. Chapter V: J. K. Fotheringham, *Past Studies on the Subject*. Dr. Fotheringham deals with the early investigators in this chapter.

[2] F. X. Kugler, *Sternkunde und Sternendienst in Babel*, Teil II, Heft I of the second book, Pages 257-311. (1912). Dr. Fotheringham summarises the contents of this portion of Kugler's book in Chapter V of *The Venus Tablets of Ammizaduga*.

Year names were in use by the Babylonians throughout the 300 years of the Hammurabi dynasty, but the custom dates from much earlier times. Each year was designated by some important event which had taken place, sometimes in the previous year, sometimes during the year itself. Thus the year name would record the occurence for posterity. When set out in their correct sequence, these year names provide a condensed history of the dynasty.

The story begins with an initial period of military expansion and consolidation, followed by 50-years of peaceful development. Then came the campaigns of Hammurabi, which gave the Babylonians temporary control of all Mesopotania. Six years after his death, however, a Kassite invasion paved the way for a successful revolt in the South. As a result, the Babylonians remained in control of only a very small area round their capital city. In due course, a Hittite incursion ended the dynasty, and in the resulting confusion the Kassites moved in and gained control of Babylonia.

The exact length of the Kassite period is very much more difficult to determine than that of the Hammurabi dynasty. Not only did they abolish the use of year names, but even the inscriptions which they left are less numerous than might be expected. Thus, when Dr. Kugler made his great discovery, the relationship of the rulers within the dynasty to each other was known, but not the relationship of the Hammurabi dynasty itself to the present day. The latter relationship was very uncertain.

However, Dr. Kugler's discovery meant that the choice of possible dates for the dynasty could be limited. Previously, only archeological evidence was available for this purpose. Now the astronomical conditions recorded by the Venus tablets had to be complied with. Thus, any date assigned to Ammizaduga must allow for a particular relationship between the planet Venus and the moon.

3. *The Early Chronologies.* Assyriologists of the period before the First World War were in general agreement that Hammurabi lived some time around 2,000 B.C. Thus, when Dr. Kugler in 1912, announced his discovery of the date-formula and proposed on astronomical grounds that Hammurabi should be dated 2123 B.C. to 2081 B.C., his arguments met with general acceptance. He based his chronology upon a solution of the Venus tablets which assiged the years 1977 B.C. to 1956 B.C. to Ammizaduga. The evidence must have seemed very convincing at first, till it began to be realised that other solutions to the astronomical problem were possible. Then doubts were expressed by some authorities.

First the Austrian archeologist, Professor E. F. Weidner, wrote in 1914, that in

his opinion Dr. Kugler's restoration of the chronology was extremely problematical [3]. He himself thought, in 1917, that this chronology should be based on a solution dated 1809 B.C. to 1788 B.C. [4]

Dr. Kugler, while disagreeing with Professor Weidner's proposed dating, nevertheless began to accept the argument put forward for a late chronology. So in 1923, he abandoned his own earlier solution in favour of another dated 1801 B.C. to 1780 B.C. [5]

Meanwhile, Professor S. Langdon of Oxford university had requested the British astronomer, Dr. J. K. Fotheringham to analyse the Venus tablet data on astronomical grounds. This analysis revealed a solution dated 1921 B.C. to 1900 B.C. Professor Langdon put that solution forward in 1923 [6].

Finally, in 1927, Monsieur F. Thureau-Dangin, Chief Conservateur of Oriental Antiquities at the Louvre Museum, adopted the only remaining possible chronology within the accepted limits. His solution of the Venus tablets gave as Ammizaduga's reign, the dates 1857 B.C. to 1836 B.C. [7]

Thus there were now five rival solutions of the Venus tablets. The problem was to determine which was the correct one.

4. *The Langdon-Fotheringham-Schoch Investigation.* This task was undertaken by Professor Langdon and Dr. Fotheringham. They employed the German astronomer and mathematician, Herr Carl Schoch, to construct up-to-date astronomical tables. These tables yielded for each solution seemingly accurate setting and rising dates of Venus which were compared with the ancient record. The comparison disclosed that Ammizaduga could not have lived in either 1809 B.C. or 1801 B.C.; but the other three dates remained theoretically possible.

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[3] According to Dr. Fotheringham in Chapter V of *The Venus Tablets of Ammizaduga.*

[4] Berichte der Mathematisch-Physischen Klasse der Sachsischen Akademie der Wissenschaften zu Leipzig, 94. Band, Leipzig, 1943. Pages 23-56: B.L. van der Waerden, *Die Berechnung der Ersten und Letzen Sichtbarkeit von Mond und Planeten und die Venustafeln des Ammisaduqa.* On page 24 is the following list of Venus Tablet solutions: Kugler 1912, -1976 to -1956; Fotheringham 1923, -1920 to -1900; Thureau-Dangin 1927, -1856 to -1836; Weidner 1917, -1808 to -1788; Kugler 1923, -1800 to -1780.

[5] See note 4.

[6] S. Langdon, Oxford Edition of Cuneiform Text (1923), Vol. II. Professor Langdon's conclusion is in the Preface to volume II. Dr. Fotheringham summarises his argument in Chapter V of *The Venus Tablets of Ammizaduga.*

[7] See note 4.

To narrow down the choice, the legal documents of the period were examined. Among them were found written agreements between landlord and tenent for the division of the date-harvest. The practice was for the unripe dates to be counted some time before the harvest, and a contract signed, by which the tenant undertook to supply to his Superior a given quantity of ripe dates by a given day in the month TESRIT, or by the first day of the next month, ARAHSAMNA. Judging by similar Neo-Babylonian documents, which can be related to the Gregorian calendar with certainty, and also on the basis of present-day harvest conditions, this Final Delivery Date would not normally come before October 14th. (Gregorian).

Now, the respective Contract and Delivery dates computed for the five solutions vary within a limit of two months. For the two solutions, 1977 B.C. and 1921 B.C., the landlord named in each contract would have duly received his quota after 14th October. According to the other three solutions, however, his share in the harvest would appear to have been delivered too early in the month. Thus, provided the crops ripened no earlier than at present, which seemed a reasonable assumption, the choice appeared to lie between the first two solutions. Other documents, connected with the wheat and barley harvests, confirmed this conclusion.

The final choice, however, had to depend upon a different type of evidence. Some of the documents were dated on the 30th day of the month. From this it was inferred that those particular months must have contained 30-days. Accordingly, these attested 30-day months were compared with the corresponding lunar months computed for each solution. The percentage agreement for the 1921 B.C. solution was 72; which was the highest percentage from all the solutions. By contrast, the 1977 B.C. solution had only 38 %. The logical conclusion seemed to be that Ammizaduga was king of Babylon from 1921 B.C. to 1900 B.C.

These findings were made public in 1928, when they appeared in book form, under the title, *The Venus Tablets of Ammizaduga*. In general, that proposed chronology was accepted up to the begining of the Second World War [8].

5. *Macnaughton's Chronology.* One other alternative system of dating did, however, appear in 1930. This was Mr. Macnaughton's book, *A Scheme of Babylonian Chronology*. Mr. Macnaughton, who is a member of the legal profession, had made a study of ancient astronomy. He discovered that certain year names of the Hammurabi period, which record the enthronement of Babylonian gods, fall on dates which are apparently related in some way to the synodic periods of the

[8] See p. 1, note 1.

planets. The inference was that an enthronement of one of the "planetary gods" occurred whenever the associated planet was at a certain position during the month of Nisan [9]. Unfortunately, there is no evidence among the surviving records to establish whether that was indeed the case; and, if so, what particular aspect of the planetary phenomena the Babylonians were interested in. However, if the theory was correct, it offered an avenue of approach which might lead to the date of the Hammurabi dynasty.

It is, perhaps, unfortunate that when this enquiry was carried out, solutions later than 1801 B.C. were not thought possible. Within the then historical limits, Mr. Macnaughton established that for a solution dated 2260 B.C. to 2239 B.C., the enthronement of the planetary gods was apparently being carried out when the heliacal rising of their respective planets took place during Nisan [9]. In fact, it was not the heliacal rising, but the maximum brightness which was the deciding factor [10]. However, that information could not have been deduced from a study confined to the early solutions. Thus, on the basis of the knowledge available at the time, Mr. Macnaughton decided quite logically, that Ammizaduga must have reigned from 2260 B.C. to 2239 B.C., and worked out his chronology accordingly.

Macnaughton's Chronology was the last to be based on a very early date. Fresh evidence was about to be published, which pointed in the opposite direction.

6. *Smith and Ungnad's Solution.* The palace archives of the Royal City of Mari had been discovered by the French archeological expedition led by Professor Parrot. Mari was looted and destroyed by the troops of Hammurabi, during the latter part of that monarch's reign. Accordingly, the archives contained interesting information about happenings around the early part of his reign. This information was now becoming available to Assyriologists as translation of the tablets progressed.

One of the contemporaries of Hammurabi, according to the archives, was almost certainly Yarim-Lim, king of Alalak. Alalak was then a town near the Mediterranean coast, strategically sited on the trade route from the upper part of the Euphrates valley. The ruins were still being excavated by the British expedition

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[9] Duncan Macnaughton, *A Scheme of Babylonian Chronology*. London, Luzac & Co. 1930. Pages 88-92. Note 28: *The Thrones of the Planetary Gods.*

[10] I have found, for Smith and Ungnad's solution only, a relationship between the religious events recorded by the year-names of the Hammurabi period and the planets visible, usually at their maximum brilliance, in the months Nisan, Tammuz, Tesrit and Tebit.

under Sir Leonard Wooley, but cuneiform tablets from Yarim-Lim's own archives had by now been found. Thus his Period could be safely assigned to a particular level of the excavation.

Apart from these tablets, objects of Egyptian origin had been unearthed at various levels of the site. These discoveries made it possible to synchronise the development of the town of Alalak with the main periods of Egyptian history. So Egyptian chronology could now be used as a guide to Babylonian dating. The result of this link-up was a provisional date of ± 1600 for the end of the First Babylonian dynasty.

Professor Sydney Smith, who was at that time Keeper of the Department of Western Asiatic Antiquities at the British Museum, had realised the significance of the referance to Yarim-Lim in the Mari records. In 1940, he published a brochure entitled *Alalak and Chronology*, in which he set out the archeological and documentary arguments for a revision of the dating of the Hammurabi dynasty. The shortened chronology which he suggested was based on the Venus tablet solution, 1646 B.C. to 1625 B.C. That solution was computed by Brigadier-General J. W. Sewell [11].

Professor Sydney Smith was not, however, the only person trying to establish a new chronology. The German expert, Professor Arthur Ungnad had been working quite independant of the British investigation, and following a different method. Yet he reached the same conclusion as Professor Sydney Smith, and published his results in the same year [12].

7. *Sidersky's Solution*. Meanwhile, another investigator had been working on the problem. This was Monsieur David Sidersky. Monsieur Sidersky was by profession a Chemical Scientist, but his hobby was ancient Oriental astronomy, mathematics, and chronology. He had already written a number of books on these subjects, and was also a member of the "Société Asiatique".

In 1940, the same year in which Professor Sydney Smith's brochure apeared, Monsieur Sidersky published findings which were somewhat different. He based

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[11] Sidney Smith, *Alalakh and Chronology*, London, 1940. Brigadier-General J. W. S. Sewell, C.B., *The Observations of Venus*, on Page 27.

[12] Mitt. altorient. Ges. XIII, Heft 3, 1940. A. Ungnad, *Die Venustafeln und das Neunte Jahr Samsuilunas*.

his chronology on an earlier solution of the Venus tablets. Ammizaduga, according to that solution, reigned from 1702 B.C. to 1681 B.C. [13]

A Turkish scholar, Kemel Turfan, reached a similar conclusion independently in the following year. However, his date for Hammurabi was approximate, whereas Monsieur Sidersky based his chronology on a more precise astronomical date [14].

Monsieur Thureau-Dangin examined very closely the arguments for the two rival chronologies. He thought the link with Egyptian history was not yet definite enough to rule out either system of dating. Certainly, both seemed to be within the bounds of historical possibility [15].

However, Professor Sydney Smith's chronology had by now been adopted by the American archeologist, Professor W. F. Albright. It seemed likely to gain universal acceptance, but the situation was again altered by the publication of a new approach to the problem [16].

8. *The Cornelius Solution.* In 1942, Dr. F. Cornelius proposed an even later date for Hammurabi than had hitherto been thought possible [17]. Dr. Cornelius, who is a member of the Federation of German Historians, deduced the date of Hammurabi, not from archeological evidence, but from a historical source.

During the Seleucid Period, a history of Mesopotania had been written by Berossos, who was a priest from the Marduk temple at Babylon. It dealt with the period from the Deluge to Alexander the Great. The book itself, which was known as the "Babyloniaca", has unfortunately, not survived; but extracts are quoted by various Classical writers. Among those quotations is a list of kings from the Flood to Tiglath-Pileser III [18]. This list was regarded by scholars as being somewhat unrealistic, but Dr. Cornelius now showed that it could be interpreted to agree with Babylonian tradition. It runs as follows : –

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[13] Rev. Assyr. 37, 1940. Page 45. D. Sidersky, *Nouvelle étude sur la chronologie de la dynastie Hammurapienne.*

[14] Ex Oriente Lux. Jaarbericht N° 10. 1945-1948. Pages 481-490. C. Kern, *Primum Monumenta, Deinde Chronologia.* Alalakh (Thans Tell Atsjana), Hammurabi 1792-1750. Kemel Turfan is mentioned at the end of the middle paragraph on page 487.

[15] C. Kern, *Primum Monumenta, Deinde Chronologia.* (See footnote 10). Page 487.

[16] *Loc. cit.*

[17] KLIO 35, 1942, Page 1. F. Cornelius, *Berossus und die Altorientalische Chronologie.*

[18] Ex Oriente Lux. Jaarbericht N° 10. 1945-1948. Pages 414-424. B. L. van der Waerden, *On Babylonian Astronomy I., The Venus Tablets of Ammizaduga.* VI. Berossos' List of Kings. (Pages 419-420).

BEROSSOS' LIST OF KINGS

1st dynasty	86 kings,		reigning 34,090	years.
2nd "	8 or 21 Marians		" 224	"
3rd "	11 kings		" 48	"
4th "	49 Chaldaeans		" 458	"
5th "	9 Arabs		" 245	"
6th "	1 Assyrian and 45 kings		" 526	"

Berossos' list as it stands, is incomplete. Since his history stopped at Alexander the Great, his list presumably continued in its original form to that historical landmark. Accordingly, Dr. Cornelius added a further 409 years to fill the gap from Tiglath-Pileser III to Alexander. This gave a total of 36,000 years for the period covered by the list. Since the starting date of the 1st dynasty is, obviously, conjectural, the over-all total must be an approximation. Thus the assumed figure of 36,000 years is very probably correct. Accordingly, it should not be affected by any copyists' errors.

The identification of the six dynasties is a necessary preliminary to establishing the year of Ammizaduga. The first one, of course, is largely made up of mythical kings; but it agrees well with Babylonian tradition. The second must comprise 21 kings of Gutium in Media. So the word "Marian" should be altered to read "Median".

Three Sumerian dynasties are grouped together to form the 3rd dynasty. They are the 4th and 5th dynasties of Urak and the 3rd dynasty of Ur, which together total 11 reigns covering a period of 148 years. The list, of course, only gives 48 years, but the time allowed for the previous dynasty is much too long. The Medes only reigned for 124 years. So 100 years can be deducted from the 2nd dynasty total and added to that of the 3rd dynasty. This adjustment leaves the over-all total unaltered.

The Hammurabi dynasty is included in Berossos' 4th dynasty. It is grouped with the dynasties of Larsa, Isan, and the Sea Country. The Kassite rulers are represented by the 9 Arabs of the 5th dynasty, though, presumably, the figure 9 is corrupt. Finally, the 1 Assyrian is Tukulti-Ninurta I, who conquered Southern Mesopotamia and destroyed Babylon.

The dating of Ammizaduga follows logically once these identifications have been made. Alexander the Great died in 323 B.C. Adding 409 years to this date gives 732 B.C. for Tiglath-Pileser III. Moving back from there a further 1229 years,

which is the total of the last three dynasties, leads to 1961 B.C. for the founding of the Larsa dynasty. Then, working down through each reign, and knowing the relationship between the Larsa and the Hammurabi dynasties, the year 1582 B.C. for Ammizaduga's accession to the throne, is finally arrived at. This date might vary within narrow limits, since in a few cases, the exact length of a reign may be in doubt.

However, whether by coincidence or otherwise, a possible solution of the Venus tablets happens to be 1582 B.C. to 1561 B.C. Since this could so easily not have been the case, that fact seemed to be a very strong argument in favour of acceptance of this new Chronology. Moreover, the Cornelius chronology appeared at a very opportune time.

During the season 1932/33, when excavations were being conducted by the Oriental Institute of the University of Chicago, an Assyrian Kinglist- was found at Khorsobad [19]. This list covered the period from Shamsi-Adad I to Ashur-Nirari V.

The name of the Assyrian king Shamsi-Adad I had been found on letters from the archives of Mari. He wrote to his son, Yashmakh-Adad, who was king of Mari. Shamsi-Adad had, in fact, conquered that city and put his son on the throne. Since some of the letters refer to Hammurabi, it follows that Hammurabi and Shamsi-Adad I must have been contemporaries.

Previously, it had been thought that Hammurabi lived two generations before Shamsi-Adad. Then, some time before 1930, a recorded oath was discovered, dated the 10th year of Hammurabi. It had been sworn "by the god Marduk, and the kings Hammurabi and Shamsi-Adad". The Mari letters now confirmed the evidence of the oath. Since Shamsi-Adad lived certainly later than 1900 B.C., all the early chronologies were ruled out by this discovery, apart from any other reason.

Unfortunately, the Khorsobad king list cannot give an exact date for Shamsi-Adad. The tablet on which it was written was preserved in almost perfect condition till the moment of its discovery. It is thought that the spade of the excavator must have damaged the surface before its presence could be detected. As a result of this mishap, the length of five reigns has been lost. So Shamsi-Adad can only

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[19] JNES 1, 1942, pages 247-306 and 460-492. JNES 2, 1943, pages 56-90. A. Poebel, *The Assyrian King-list from Khorsabad.*

be dated to within ten years before, or after 1734 B.C. It follows that Hammurabi also must have lived about that year.

Hammurabi, according to Dr. Cornelius, reigned from 1728 B.C. to 1686 B.C. This period is certainly within the historical limits required by the Khorsobad king-list. The list itself was being prepared for publication by Professor Arno Phoebel of the University of Chicago, when Dr. Cornelius' findings were published. He seemed to confirm those findings by announcing that, according to the list, Shamsi-Adad's reign was from 1726 B.C. to 1694 B.C. Professor Albright then revised his chronology so as to conform to the Cornelius dating of the Hammurabi dynasty [20].

9. *Professor van der Waerden's Investigation.* Support for the Cornelius dating came next from Professor van der Waerden of Leipzig. In December 1942, he presented a mathematical treatise at a Sitting of the Leipzig Academy [21]. In this he included a comparison of Venus data computed for the three latest solutions.

The astronomical tables which he used were not those of Herr Schoch. They were, in fact, earlier tables compiled by the German astronomer Professor Paul V. Neugebauer, and first published in 1914 [22]. Schoch's planetary tables were becoming obsolete, whereas those of Neugebauer yielded more accurate results.

Exact agreement between record and computation was not, of course, to be expected. It was well known that when the Scribes copied from earlier documents they sometimes made mistakes. Also, the weather conditions under which the observations were taken are not recorded. Apart from that, slight variations occur in the results from different mathematical tables. Accordingly, a reasonable margin of error should be permitted when comparing those computed results with the recorded astronomical dates. Professor van der Waerden allowed two or three days difference at Inferior conjunctions, where the apparent brightness of the planet changes rapidly; and eight days at Superior conjunctions, where the change is more gradual. Within those limits he classified agreement as "good".

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[20] C. Kern, *Primum Monumenta, Deinde Chronologia.* (See footnote 14.) Page 488.

[21] B. L. van der Waerden, *Die Berechnung der Ersten und Letzten Sichtbarkeit von Mond und Planeten und die Venustafeln des Ammisaduqa.* (See footnote 4.)

[22] P. V. Neugebauer, *Tafeln zur Astronomischen Chronologie,* Leipzig, 1914.

The results of his comparison he listed as follows : -

SOLUTION	DATE (JULIAN)	"GOOD" EXAMPLES	GOOD AGREEMENT
Sideresky	-1701 to -1681	26 out of 50	that is 52 %
Ungnad	-1645 to -1625	27 out of 50	that is 54 %
Cornelius	-1581 to -1561	29 out of 50	that is 58 %

So the Cornelius data was found to be giving the best agreement. Naturally, this helped the argument in favour of accepting that solution.

Not everyone, however, was convinced of the merits of the Cornelius chronology. Professor van der Meer of the University of Amsterdam had examined the evidence, and his findings were published in 1944 [23]. His date for Hammurabi was almost identical with that of Smith and Ungnad.

In the following year Professor Sydney Smith himself was dating Hammurabi's reign as from 1792 B.C. to 1750 B.C.; whereas Professor Albright was pointing out links between the histories of Egypt and Mesopotania which he considered strengthened the case for the Cornelius chronology.

Then in 1946, Professor van der Waerden republished his arguments in a more developed form [24]. He now focussed his attention on the alternative solutions proposed by Ungnad and by Cornelius. That of Sidersky would appear to be ruled out by his previous findings. He decided also not to use text data which gives information obviously incorrect. As a result, overall agreement based on the remainder of the text is much improved.

Now, the Cornelius solution gives slightly better agreement than its rival between text and calculation. Unfortunately, the difference is not enough to decide which of the two is the correct one.

However, one very significent factor was revealed by the new comparison. The Cornelius solution has a balanced distribution of positive and negative differences between the record and the computation. There are thirteen positive variations, eight negative and five zero. This is roughly what might be expected from a random distribution.

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[23] JEOL 9, 1944, pages 137-145 and page 192. P. van der Meer, *Chronologie des Assyrisch-Babylonischen Königne*. C. Kern, *Primum Monumenta, Deinde Chronologie*. (See footnote 14.) Page 488.

[24] See p. 7 note 18.

The alternative solution has nine positive differences, twenty-five negative, and two zero. On the theory of probability, the changes are 1/100 of finding such a preponderance of negative values.

Moreover, the chances are less than 1/2 that the Cornelius set of differences should be smaller than those of Ungnad for the setting and rising dates at Superior conjunction. Similarly, the chances of the same effect being found at the Inferior conjunction intervals is also less than 1/2.

Finally, there is the unlikely chance of agreement between the Berossos list and the Venus tablets. This could only occur four times in two hundred years, a probability of 1/50.

So combining these probabilities, it would appear that the chances of them all accidentally occuring together are less than : –

$1/50 \cdot 1/2 \cdot 1/2 \cdot 1/100 = 1/20{,}000.$

Faced with this probability fraction, who could doubt that Dr. Cornelius had found the correct solution? Yet there was one serious obstacle to be overcome before the Cornelius chronology could be accepted.

When the harvest contract documents compiled by Dr. Fotheringham are dated by this solution, the labourers coming to reap the harvest appear to be arriving from two to three weeks too early. If the documents are dated correctly, a change in climatic conditions must be inferred to allow barley and dates to ripen three weeks earlier in old-Babylonian times than during the Persian period and today. Could such a change of climate be possible?

Dr. Cornelius himself, writing two years earlier, considered that insufficient information was available about past climatic conditions. The correct procedure, he argued, should be to establish reliable calendar dates, and from them to determine the climatic conditions; not the other way round [25].

When Professor van der Waerden reviewed the evidence, he was unable to establish directly any change of climate affecting the Hammurabi period. Nevertheless, it seemed "highly probable, that before 1,000 B.C. the climate was warmer than

[25] Zeitschrift fur Assyriologie, N.F. XIV, pages 146 to 151. F. Cornelius, *Die Venusdaten des Ammisaduga*. See final paragraph, pages 150-151.

now, not only in Europe, where it is certain, but also in Near Asia". He concluded that there appeared to be nothing impossible in the assumption that during the period of the First Babylonian dynasty, barley and date crops were ripening three weeks earlier than at the present time.

Further investigation, however, has not confirmed this climatic change. It seems more likely that the climate has not changed significantly since the 5th millenium B.C. Thus, Professor M. A. Beek of the University of Amsterdam, in a book published in 1962, states that from 5,000 B.C. onwards "the inhabitants of Mesopotania lived in climatic conditions which probably differed little from those existing at present" [26].

So the anomaly remains unresolved. While the Cornelius chronology certainly links up with a Venus tablet solution, the seasons related to that solution appear to be incorrect.

10. *Other Solutions.* The reason why it has proved so difficult to establish a precise astronomical date from the Venus tablets is, of course, the lack of really close agreement between the astronomical record and the computed data of the various solutions. Had the scribes set out deliberately to confuse posterity, they could hardly have chosen a better distribution of copyists' mistakes. The unfortunate effect has been, that with each of the three solutions already considered there is another similar solution separated from it by an eight year interval.

However, the alternative dating of Sidersky's solution can be safely ignored. It would make his date sequence occur eight years earlier; whereas Sidersky's chronology is thought to be quite early enough. By contrast, the other two solutions have their alternative dates fixed by the succeeding 8-year Venus cycle. Thus all the arguments in favour of Smith and Ungnad's solution apply equally to a solution dated 1638 B.C. to 1617 B.C. Moreover, the alternative dates, 1574 B.C. to 1553 B.C., have been suggested for the Cornelius solution. The exact period of time between the begining of the Larsa dynasty and Ammizaduga's reign, which determines the choice of Venus tablet solution, was uncertain; but possibly not to the extent of eight years.

Perhaps because of this duality of the astronomical findings, Professor van der Meer, when he abandoned his earlier conclusions in favour of a solution designed

[26] M. A. Beek, *Atlas of Mesopotamia.* Translated by D.R. Welsh, M.A. Edited by H. H. Rowley, M.A., B. Litt., D.D., LL.D., F.B.A. Nelson, 1962. Page 9. *The Land and Climate of Mesopotamia.* See paragraph 5.

to fit in with the known sequence of events in the countries around Mesopotania, selected the date 1578 B.C. for the first year of Ammizaduga [27]. Placed half-way between the two possible solutions, it should only be four years out, assuming one of these solutions to be correct; whereas, an astronomical date might prove to be eight years out.

However, the tendancy seems now to have been to rely on archeological and historical, rather than astronomical evidence. A chronology with Hammurabi dated twenty-four years after the date given by Dr. Cornelius, was adopted by Professor E. F. Weidner [28]. On the basis of the Venus tablet evidence that system of dating would be impossible; though, apart from that, there were no doubt, good reasons for selecting it.

11. *The "Middle" Chronology.* The cause of these wide variations in the dates proposed by various experts is, of course, uncertainties in the interpretation of the available historical evidence. Thus dynasties which may have ruled simultaneously were listed sequentially by the Babylonians. Also, gaps in the sequences, due to damaged tablets, cause further uncertainty.

Then there was doubt, also, about when the Kassite period began. It might have followed immediately after the end of the Hammurabi dynasty; or the Kassites could have been already established in some other part of the country before that event took place.

It would now seem, on the evidence of one of the king lists, that the first king of the Kassite dynasty should be dated about 1740 B.C. On the assumption that the Kassites established themselves somewhere in Mesopotania on that date, they should have entered the country, according to Sidersky's chronology, in the reign of Ammiditana. That might well be possible; bearing in mind that the first Kassite king, at least, probably never reigned from Babylon. On the other hand, according to Smith and Ungnad's chronology, the Kassites should have appeared during the reign of Samsuiluna; and the year names of Samsuiluna certainly record a Kassite invasion. On the basis of the Cornelius chronology, however, the Kassites ought to have been already somewhere in the country before the reign of Hammurabi. Since there is no mention of them in the Mari archives.

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[27] M. A. Beek, *Atlas of Mesopotamia.* (See footnote 26). Professor van der Meer's Chronologie for the Hammurabi Dynasty is given on page 83.

[28] M. A. Beek, *Atlas of Mesopotamia.* (See footnote 26). Page 87. *Problems of Chronology.* Dating Hammurabi. Paragraph 2. "de Liagre Böhl 1704-1662 (and so Weidner)".

this is not very likely. So, on that evidence alone, the Cornelius chronology seems less likely to be correct than the other two.

The Sidersky chronology, however, requires a very high average for certain reigns in Assyria and Babylonia. While that fact suggests that the chronology may well be incorrect, it is not conclusive. The most that can be said on the evidence available, is that the "middle" chronology, based either on Smith and Ungnad's solution, or on the solution dated eight years later, is the most probable [29].

[29] The Cambridge Ancient History. Revised Edition of Volumes I & II. Cambridge University Press. 1964. M. B. Rowton, *Ancient Western Asia*. The Main Problem. (c) The date of the First Dynasty of Babylon (Babylon I). Pages 61-63. See last paragraph on page 63.