

THE VENUS TABLES OF

*AMMIZADUGA*

A SOLUTION OF BABYLONIAN  
CHRONOLOGY BY MEANS OF  
THE VENUS OBSERVATIONS  
OF THE FIRST DYNASTY

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## PREFACE

AS will be seen from Chapter V, the authors have had this work in hand for several years. The greater part was in the hands of the printers in 1926, and, though other parts progressed more slowly, Dr. Fotheringham has thought it undesirable otherwise than in exceptional cases to refer to matter published after the beginning of 1927 or communicated to him privately after that date. None of this matter affects the conclusions at which he arrives.

Although Dr. Fotheringham acknowledges considerable assistance from Herr Schoch, neither is responsible for the views of the other. In order to secure full liberty of expression to Herr Schoch he has been permitted to cover in his chapter on Astronomical and Calendrical Tables some of the matter included in Dr. Fotheringham's chapters and on certain details he has expressed different opinions. Dr. Fotheringham has at Herr Schoch's request supplied the precepts for the use of Tables M and N and has given a purely verbal revision to the rest of the chapter.

Acknowledgements to Professor Schnabel and Dr. Thureau-Dangin for valuable material and suggestions are made in their proper places.

The Tables have been printed by the Isle of Wight County Press and the rest of the work by the Oxford University Press.

Professor Langdon wishes to thank the Trustees of the British Museum and the Keeper of the Department of Egyptian and Assyrian Antiquities for their permission to copy the astronomical texts of that collection which are published in this volume.

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LIST OF ABBREVIATIONS

- AB. *Allorientalische Bibliothek*, ed. EBELING, MEISSNER, and WEIDNER.  
 AJSL. *American Journal of Semitic Languages*.  
 BE. *Babylonian Expedition of the University of Pennsylvania*.  
 BH. *Babylonian Historical Texts*, by SIDNEY SMITH.  
 BIN. *Babylonian Inscriptions in the Collection of James B. Nies*.  
 BM. British Museum.  
 BRM. *Babylonian Records in the Library of J. Pierpont Morgan*.  
 CT. *Cuneiform Texts from Tablets in the British Museum*.  
 EG. ELIHU GRANT, *Babylonian Business Documents of the Classical Period*.  
 F. TH. FRIEDRICH, *Allbabylonische Urkunden aus Sippar, Beiträge zur Assyriologie*, v 4.  
 Ga. J. E. GAUTIER, *Archives d'une famille de Dilbat au temps de la première dynastie de Babylone*.  
 G. E. M. GRICE, *Records from Ur and Larsa, Yale Oriental Series V*.  
 HG. *Hammurabi's Gesets*, by KOHLER, UNGNAD, and KOSCHAKER.  
 JAOS. *Journal of the American Oriental Society*.  
 JRAS. *Journal of the Royal Asiatic Society*.  
 KAH. *Keilschrifttexte aus Assur historischen Inhalts*; vol. i by L. MESSERSCHMIDT; ii by O. SCHROEDER.  
 KAV. *Keilschrifttexte aus Assur verschiedenen Inhalts*, by O. SCHROEDER.  
 KB. *Keilschriftliche Bibliothek*.  
 M. B. MEISSNER, *Beiträge zum altbabylonischen Privatrecht*.  
 MN. *Monthly Notices of the Royal Astronomical Society*.  
 MVAG. *Mitteilungen der Vorderasiatischen Gesellschaft*.  
 OBL. *Old Babylonian Inscriptions*, by H. V. HILPRECHT.  
 OECT. *Oxford Editions of Cuneiform Texts*, ed. S. LANGDON.  
 OLZ. *Orientalistische Literaturzeitung*.  
 P. A. POEBEL, *Babylonian Legal and Business Documents*, BE. vi 2.  
 PBS. *Publications of the Babylonian Section of the University Museum, Philadelphia*.  
 PSBA. *Proceedings of the Society of Biblical Archaeology*.  
 Raw. RAWLINSON, *Cuneiform Inscriptions of Western Asia*.  
 RA. *Revue d'Assyriologie*.  
 Ranke. H. RANKE, *Babylonian Legal and Business Documents*, BE. vi 1.  
 RFH. R. F. HARPER Collection in AJSL. xxxiii, 206 ff.  
 TD. F. THUREAU-DANGIN, *Lettres et Contrats de l'époque de la première dynastie babylonienne*.  
 TSBA. *Transactions of the Society of Biblical Archaeology*.  
 VAB. *Vorderasiatische Bibliothek*.  
 VS. *Vorderasiatische Schriftdenkmäler der staatlichen Museen zu Berlin*.  
 W. LEROY WATERMAN, *Business Documents of the Hammurabi Period*. Also abbreviation for the Weld Collection in the Ashmolean Museum.  
 Warka. J. N. STRASSMAIER, *Die altbabylonischen Verträge aus Warka, Verhandlungen des Fünften Orientalisten-Congresses*.  
 YBC. *Yale Babylonian Collection*.  
 ZA. *Zeitschrift zur Assyriologie*.  
 ZDMG. *Zeitschrift der Deutschen Morgenländischen Gesellschaft*.

CHAPTER I

ANALYSIS OF THE CUNEIFORM TEXTS

THE large tablet K. 160 was first published in III Raw. 63, and was reproduced with transcription and translation by PROFESSOR SAYCE, TSBA. 1874, 316-39. Obverse 1-14 is a duplicate of K. 2321+3032 (a neo-Babylonian text published by JAMES A. CRAIG, *Astrological-Astronomical Texts* Pl. 46) Obv. 16-27. These lines contain 6 observations of the heliacal settings of Venus in the east and west for the 7th-11th years of Ammizaduga.<sup>1</sup> K. 160, begins with the heliacal eastern setting of Venus on the 21st of the 5th month in the 7th year of this king. The text of K. 160, 1-30, which contains 14 observations of the same backward and forward movements of Venus across her periods of darkness for the years 7-17 of Ammizaduga, was combined with K. 2321, Obv. 16-27, and the whole was published in this form by VIROLLEAUD, *Ishtar*, No. XII. In this composite text lines 1-15 constitute a new copy of K. 2321, Obv. 1-15; lines 16-27 are made up by combining K. 160, 1-14 with K. 2321, Obv. 16-27. The remaining observations for the years 19-21 of Ammizaduga are continued on K. 160, Rev. 34-46; the observation for the 18th year was suppressed or lost when the long insertion, Obv. 31-Rev. 33, was made in K. 160. This continuation of the original text in Obv. 34-46 was unfortunately detached from the main text and put under a separate number in VIROLLEAUD, *Ishtar* XIV.

By combining K. 2321 Obv. with K. 160, Obv. 1-30+Rev. 34-46, a complete set of these movements of Venus for the 21 years of Ammizaduga is obtained, with the exception of the data for the year 18. It is obvious even to one possessed of only popular knowledge of astronomy that the text is often corrupt and the various scribes of Nineveh, Babylon, and Kish, whose copies in the 8th and 7th centuries we possess, were extremely careless about their figures. Numerous examples of dittography are indicated in my notes.

Undoubtedly K. 2321, a neo-Babylonian copy, and its duplicate, W. 1924, 802, excavated at Kish, and dated in the reign of Sargon of Assyria, represent the original tablet of the astronomers of Ammizaduga. This original text was made at Babylon, as the colophon of the *Kish tablet* proves, and was incorporated into the series *Enuma Anu Enlil* as the 62nd or 63rd tablet of that astronomical work. Rm. II 531 is a small Assyrian fragment of a duplicate of K. 160 and contains fragmentary lines of the groups for the years 13-17.

The reverse of K. 2321 contains the same observations as those of the 21 years of Ammizaduga on the obverse and on K. 160, but these are arranged according to the settings of Venus in either east or west in order of the months from *Nisan* to *Adar*. This discovery was first published by Dr. PAUL SCHNABEL, ZA. 36, 114-17, and the fact became clear to me,

<sup>1</sup> K. 160 is broken across the upper part and at least 20 lines are lost here. These contained seven observations partially restored from K. 2321. A photograph of K. 160 will be found on the frontispiece of VIROLLEAUD, *L'Astrologie Chaldéenne, Sin*. A small join which restores the beginnings of lines 34-9 of the obverse has been made since this photograph was taken. K. 2321 is also a long thin tablet like K. 160; it is written in neo-Babylonian

script and is broken across the middle. Between the end of the obverse and the beginning of the reverse at least 50 lines are lost. I have collated both tablets in the British Museum, and have detected a large number of errors in previous copies. For permission to collate these important texts we are most grateful to Dr. HALL, Keeper of the Department of Egyptian and Assyrian Antiquities.

when I discovered the *Kish tablet*, with its peculiar arrangement of groups (*kisru*) of these same observations. It was obvious that the scribe was grouping the observations by months here. I was requested by SCHNABEL and FOTHERINGHAM to collate all the tablets which contain the name *Ninsianna* for Venus. This was the name of Venus current in the late Sumerian period and in the time of the First Dynasty.<sup>1</sup> I also copied S. 174 and observed its similarity to K. 160 and 2321; the eastern and western settings do not occur in their natural order here, but are arranged on some other principle. In collating Rm. 134 and K. 7072 = VIROLLEAUD, *Suppl.* p. 48, it became evident, at once, that the scribe had arranged the settings of Venus, both eastern and western, beginning with *Nisan* and proceeding to *Ayar*.<sup>2</sup> By reconstructing the Reverse of K. 2321 with the aid of Rm. 134, K. 7072, S. 174 and W. 802 (which completed all the first lines of the original document), I was able to obtain duplicates and restorations of a great number of the observations on the obverse and on K. 160.

The scribe, who compiled the document K. 160, probably did not copy for the series *Enuma Anu Entil*. For some reason he copied the original observations of the 21 years from the obverse of the Babylonian tablet and then inserted a long reconstruction, taken from some other Babylonian tablet, on the periods of visibility in the east and west. The compilers of the Babylonian and *Kish* tablets had arranged the observations of the 21 years of Ammizaduga in the order of the monthly settings, and we know from Rm. 134, K. 7072 and S. 174, that this text also existed at Nineveh. The omens depend upon the months of the *risings* and consequently this scribe, having more interest in astrology than in astronomy, has made an artificial set of Venus risings in consecutive monthly order throughout the year, assuming a regular period of visibility in east and west of 8 months and 5 days, a regular interval of invisibility between eastern setting and western rising of 3 months, and a regular period of invisibility between western setting and eastern rising of 7 days. He begins with an eastern rising in *Nisan*, but there is no *Nisan* rising, either eastern or western, in the Ammizaduga observations; moreover, in this scheme of monthly risings no allowance is made for intercalary months, and consequently the composition has no relation at all to the Ammizaduga observations. The scribe assumes a constant value of 30 days for the month. The scribe's scheme has scientific value only for reckoning the average periods of the various appearances of Venus, whose regular period is 584 days. The scribe assumes a period of 19 months 17 days for the period of Venus (8 months 5 days in east + 3 months' invisibility + 8 months 5 days in west + 7 days' invisibility = 19 months 17 days = 587 days). By assuming 360 days for the year he must add 5 or 6 days to the date of any appearance and then add 19 months 17 days to obtain the next corresponding appearance. Thus, in the first group the eastern rising is I 2 and the next eastern rising will be VIII 19+6 = VIII 25, as given in Group 12. But the risings exhibited in this scheme have no historical relation to each other and must have been selected from a large number of Venus observations in the records of previous centuries.

More interesting is a comparison of the omens on this document with those of the original document. The scribe indicates clearly enough that the omens are taken from the *risings* only. 'The heart of the land will be happy' occurs here with *Ulul* and *Tebit*, but with *Ulul* and *Adar* on the Ammizaduga documents. 'The harvest of the land will be successful' occurs with *Tebit*,

<sup>1</sup> See Langdon, *Tammuz and Ishtar*, 175.

<sup>2</sup> SCHIAPARELLI had already made this discovery in 1912, on the basis of K. 2321, and it is doubtful whether I should

have seen the importance of Rm. 134 and K. 7072 if SCHNABEL and FOTHERINGHAM had not requested me to collate them.

*Tammuz, Ulul, Tešrit, Arašsamna* and *Šabat = Ayar, Tešrit, Tebit*, and *Adar* of the Ammizaduga texts. 'King shall send greetings to king' in *Šabat* and *Adar* of the old source does not occur at all in his text! 'King shall send challenge of war to king' occurs in *Adar*, only, = *Adar*, only, in the Ammizaduga texts.

'Destruction shall be (in the land)' or 'calamity shall be, in the land' occurs in *Nisan, Ab, Arašsamna*, = *Ab, Arašsamna, Kislev*, of the old source, which uses only 'destruction shall be wrought'. But a *Nisan* rising did not occur in the Ammizaduga observations; consequently we have no indication of the character of that month there. Omens of rains and floods are entirely omitted in this text. *Kislev* is associated with 'dearth of grain and straw', as in the Ammizaduga texts. A rising in *Sivan* means calamity to the army of the Babylonians as in the omen for the years 8-9 on the old source. 'There will be hostilities in the land' occurs with *Ayar, Tammuz, Tešrit = Ayar, Tešrit*, in the Ammizaduga sources.

It is obvious that the omens of this inserted artificial text of K. 160 agree almost completely with those of the old source. *Ab, Sivan, Arašsamna* and *Kislev* are clearly months of evil omen for Venus risings. Definitely propitious for Venus risings are *Ulul, Tebit, Šabat*, and *Adar*.

## OMENS OF THE ORIGINAL SOURCE.

Setting.	Rising.	Omen.
Nisan—East	Ulul—West	<i>libbi māti iđđ.</i> Year 12.
Nisan—West	Ayar—East	<i>nukurāti ina māti ibaššá ebur māti iššir.</i> Year 21.
Ayar—West	Ayar—East	<i>sunne u mlé ibaššá ebur māti iššir.</i> Year 5.
Ayar—West	Ayar—East	<i>ebur māti iššir.</i> Year 13.
Sivan—East	Ulul—West	<i>libbi māti iđđ.</i> Year 20.
Tammuz—East	Ulul—West	<i>libbi māti iđđ.</i> Year 4.
Tammuz—West	Tammuz—East	<i>sunne ina šamé mlé ina nakbe ibaššá.</i> Year 16.
Ab—East	Ab—East	<i>sunne ina māti ibaššá arbātu iššakan.</i> Year 8.
Ab—East	Arašsamna—West	<i>sunne ina māti ibaššá arbātu iššakan.</i> Year 15.
Ulul—West	Arašsamna—West	<i>sunne ina māti ibaššá arbātu iššakan.</i> Year 7.
Ulul—West	Tešrit—East	<i>nukuratum ina māti ibaššá ebur māti iššir.</i> Year 3.
Ulul—West	Ulul <sup>2</sup> —East	<i>libbi māti iđđ.</i> Year 11.
Tešrit—West	Arašsamna—East	<i>sunne ina māti ibaššá arbātu iššakan.</i> Year 14.
Arašsamna—West	Kislev—East	<i>hušahhi š'im u tibni ina māti ibaššá arbātu iššakan.</i> Year 6.
Arašsamna—East	Tebit—West	<i>ebur māti iššir.</i> Year 2.
Arašsamna—East	Tebit—West	<i>ebur māti iššir.</i> Year 10.
Kislev—East	Šabat—West	<i>ebur māti iššir.</i> Year 13.
Kislev—East	Šabat—West	<i>ebur māti iššir.</i> Year 5.
Tebit—East	Adar—West	<i>šarru ana šarri šalla iššappar.</i> Year 21.
Šabat—West	Šabat—East	<i>lapde šarrāni</i> <sup>4</sup> <i>Adad sunne šu</i> <sup>4</sup> <i>Ea nakbe šu ubbalam šarru ana šarri šulma iššappar.</i> Year 1.
Adar—East	Sivan—West	<i>šumkūt umman māti.</i> Years 8-9.
Adar <sup>2</sup> —West	Adar—East	<i>šarru ana šarri šulmā iššappar.</i> Year 9. Variant <i>šalla iššappar.</i>
Adar—West	Adar—East	<i>ebur (māti) iššir šarru libbi māti iđđ.</i> Year 17.
Adar—East	Sivan—West	<i>šumkūtum umman-manda eli naphari</i> -(šunu šarru iđđ). Years 16-17
Ulul <sup>2</sup> —West	Ulul <sup>2</sup> —East	<i>lapde ina māti rukti ibaššá: ina ekalli amtu.</i> . . Year 19.

It will be noted that 'the heart of the land will be happy' occurs only with risings in *Ulul, Adar*, and intercalary *Ulul*. 'The harvest of the land will prosper' occurs with risings in *Ayar*,

<sup>4</sup> Text Sivan.

THE MONTHS OF VENUS RISINGS GOVERN OMENS

*Tešrit, Tebit, and Šabat.* 'King shall send greetings to king' occurs with risings in *Šabat* and *Adar*, and 'King shall send challenge of war to king' is found also with an *Adar* rising.<sup>1</sup> 'Destruction shall be wrought' occurs with risings in *Ab, Araḥsamna, Kislev.* 'Rains and floods' occur with risings in *Ayar, Tammuz, Ab, Araḥsamna, Šabat*; this omen occurs in months both propitious and nefast. A rising in *Kislev* is regarded as particularly nefast:— 'Dearth of grain and straw will be in the land *but the harvest will prosper.*' The nature of the omen seems to depend almost entirely on the month of *rising.* *Ayar, Ulul, Tebit, Šabat* and *Adar* are clearly propitious months, especially for harvests. *Ab, Araḥsamna, and Kislev* are clearly nefast. Two risings in *Sivan* occur, one denoting the destruction of the Babylonian army, and the other the destruction of the *Umman-manda*, hence the month was either indeterminate, or (and this is more probable) we have here references to historical events as in the Sargon liver omens and many others.

OMENS OF THE RISINGS ON THE K. 160 INSERTION.

Rising.	Omen.
1. Nisan—East	<i>urubatum ina māti ibaššá.</i>
Adar—West	<i>šarru ana šarri nukurta išappar.</i>
2. Ayar—West	<i>nukurāti ina māti ibaššá.</i>
Tebit—East	<i>ebur māti iššir libbi māti iḫḫ.</i>
3. Sivan—East	<i>miḫilli umman matti.</i>
Ayar—West	<i>nukurāti ina māti ibaššá.</i>
4. Tammuz—West	<i>nukurāti ina māti ibaššá.</i>
Adar—East	<i>šarru ana šarri nukurta išappar.</i>
5. Ab—East	<i>arbatu ibašši.</i>
Tammuz—West	<i>nukurāti ina māti ibaššá ebur māti iššir.</i>
6. Ulul—West	<i>ebur māti iššir libbi māti iḫḫ.</i>
Ayar—East	<i>nukurāti ina māti ibaššá.</i>
7. Tešrit—East	<i>nukurāti ina māti ibaššá ebur māti iššir.</i>
Ulul—West	<i>ebur māti iššir libbi māti iḫḫ.</i>
8. Araḥsamna—West	<i>mata dannatu išabbat.</i>
Tammuz—East	<i>nukurāti ina māti ibaššá ebur māti iššir.</i>
9. Kislev—East	<i>fušahḫi šé im u libni ina māti ibašši.</i>
Araḥsamna—West	<i>ebur māti iššir</i>
10. Tebit—West	<i>ebur māti iššir.</i>
Ulul—East	<i>ebur māti iššir libbi māti iḫḫ.</i>
11. Šabat—East	<i>ebur māti iššir.</i>
Tebit—West	[ <i>ebur māti iššir.</i> ]
12. Adar—West	<i>šarru [ana šarri nukurta išappar].</i> Cf. Groups 1 and 4.
Araḥsamna—East	<i>mata dannatu išabbat.</i>

<sup>1</sup> Also on Var. for ninth year.

TABLE OF THE RISINGS, SETTINGS, AND PERIODS OF VISIBILITY AND INVISIBILITY.

Sources.	Year.	WS.	Interval.	ER.	K. 2321, Rev.	WS.	Interval.	ER.	Variants.	
									WS.	ER.
K. 2321, 1-3	1	XI 15	3 days	XI 18	22-23	XI 25	3 days	XI 28	K. 7072	II 2
6-7	3	VI 23	20 days	VII 13	7-8	VI 23	20 days	VII 13	W. 802	VIII 28?
10-11	5	II 2	15 days	IX 1	Rm. 134, 7-9	II 2	[15 days]	IX 3		IX 1
14-15	6	VIII 28	3 days	V 2	K. 2321, 13-17	VIII 28	5 days	[IX 3]		
K. 160, Obv. 4-6	8	IV 25	7 days	V 2						
+ K. 2321, 18-19										
K. 160, 9-10 +	9	XII 11	4 days	XII 15	26-27	[XII 11]	4 days	[XII 15]		
2321, 22-3										
K. 160, 13-14 +	11	VI 26	11 days	VI 27	9-10	VI 26	12 days	VI 28		
2321, 26-7										
K. 160, 17-18	13	II 5	7 days	[II 12]						
K. 160, 17-18	14	VII 10	1 month 16 days	VIII 26 <sup>1</sup>	10-12 W. 802, R. 12-13	VII 11	1 month 17 days	VIII 28	Rm. II 531	II 12
K. 160, 20-21									Rm. II 531	VIII 26
K. 160, 24-5	16	IV 5	15 days	IV 20						
K. 160, 28-9	17	XII 11	4 days	XII 15	26-27	[XII 11]	4 days	[XII 15]		
K. 160, R. 34-6	19	VI 21	15 days	VI 27						
K. 160, R. 40-2	21	I 27	7 days	II 3	Rm. 134; K. 7072	I 26	6 days	II 3		

  

Sources.	Year.	ES.	Interval.	WR.	K. 2321, Rev.	ES.	Interval.	WR.	Variants.	
									ES.	WR.
K. 2321, Obv. 4-5	2	VIII 11	2 months 7 days	X 19	15	[VIII 11]	2 months 8 days	X 19		
W. 802										
8-9 W. 802	4	IV 2	2 months 1 day	VI 3						
12-13	5	IX 12	2 months 4 days	XI 16	19	[IX 24]	2 months 4 days	XI 28	W. 802	IX 29
K. 160, 1-3, K. 2321, Obv. 16-17	7	V 21	2 months 11 days	VIII 2	5-6				W. 802 16-17	
K. 160, 7-8, K. 2321, 20-1	8-9	XII 25	[2 months 7 days]	[III 2]	24-5	[XII 25]	2 months 7 days	[III 2]		
K. 160, 11-12, K. 2321, 24-5	10	VIII 10	2 months 6 days	X 16	16	[VIII 8]	2 months 8 days	X 16		
K. 160, 15-16	12	I 9	5 months 16 days	VI 25	Rm. 134, 1-3, K. 7072, 2-3	I 8	5 months 17 days	VI 25		
K. 160, 18-19	13	[IX] 20	2 months	XII 11						
22-3	15	V 20	2 months 15 days	VIII 5						
26-7	16-17	XII 25	3 months 9 days	III 2[4]	K. 2321, R. 17-18	[IX] 21	2 months	[XII 21]	Rm. II 531	X 21
Lost on K. 160, K. 160, R. 37-9	18	III 25	2 months 6 days	VI 24 +					Rm. II 531	V 21
43-5	20	X 28	2 months 6 days	XII 28					Rm. II 531	IX 15
	21		[2 months]		20-21	[X 28]	2 months	[XII 28]		[III 24]

WS. = Western setting. WR. = Western rising. ES. = Eastern setting. ER. = Eastern rising.

<sup>1</sup> See notes on K. 2321, R. 12. + Read VI 1.

Rising.	Period of Visibility.	Setting.	Interval.	Rising.
1. I 2 East	8 months 4 days	IX 7 East	3 months	XII 8 West
2. II 3 West	8 months 3 days	X 7 West	7 days	X 15 East
3. III 4 East	8 months 4 days	XI 8 East	3 months	II 9 West
4. IV 5 West	8 months 4 days	XII 10 West	7 days	XII 17 East
5. V 6 East	8 months 4 days	I 11 East	3 months	IV 11 West
6. VI 7 West	8 months 4 days	II 12 West	7 days	II 19 East
7. VII 8 East	8 months 4 days	III 13 East	3 months	VI 13 West
8. VIII 9 West	8 months 4 days	IV 14 West	7 days	IV 21 East
9. IX 10 East	8 months 4 days	V 15 East	3 months	VIII 15 West
10. X 11 West	8 months 4 days	VI 16 West	7 days	VI 23 East
11. XI 12 East	8 months 4 days	VII 17 East	3 months	X 17 West
12. XII 13 West	8 months 3 days	VIII 17 West	7 days	VIII 25 East

## CHAPTER II

## TRANSCRIPTION AND TRANSLATION

## K. 160, Obverse

1. [*šumma ina araḥ Abi ūm 21-kam* <sup>4</sup>*Nin-si-an-na ina šit šamši*]<sup>1</sup> *bal-it*
2. [*2 arḥē ūmī 11-kam ina šamē ih-ḥa-ram-ma*]<sup>1</sup> *ina araḥ Araḥsamna ūm 2-kam* <sup>4</sup>*Nin-si-an-na*
3. [*ina erib šamši innamir*] *zunnē ina māti ibaššū ar-bu-tu iššakan*

If on the 21st of Ab Venus disappeared in the east, remaining absent in the sky for two months and 11 days, and in the month Araḥsamna on the 2nd day Venus was seen in the west, there will be rains in the land; desolation will be wrought. [7th year]

4. *šumma ina araḥ Du'uzi ūm 25-kam* <sup>4</sup>*Nin-si-an-na ina erib šamši it-bal*
5. *ūmī 7-kam ina šamē ih-ḥa-ram-ma ina araḥ Ab ūm 2-kam* <sup>4</sup>*Nin-si-an-na*
6. *ina šit šamši innamir zunnē ina māti ibaššū ar-bu-tu iššakan*

If on the 25th of Tammuz Venus disappeared in the west, for 7 days remaining absent in the sky, and on the 2nd of Ab Venus was seen in the east, there will be rains in the land; desolation will be wrought. [8th year]

7. *šumma ina araḥ Adar ūm 25-kam* <sup>4</sup>*Nin-si-an-na ina šit šamši it-bal*. [8th + 9th years]

If in the month Adar on the 25th day, Venus disappeared in the east,<sup>2</sup> . . . . .

8. *mu* <sup>6</sup>*dūr-gar kug-gi-ga*<sup>3</sup>-*kam*

Year of the golden throne. For restoration, v. K. 2321, R. 24-5.

9. *šumma ina araḥ Sivan* <sup>4</sup>*ūm 11-kam* <sup>4</sup>*Nin-si-an-na ina erib šamši it-bal* 9 *arḥē ūmī 4-kam* *ina šamē ih-ḥa-ram-ma*
10. *ina araḥ Adar ūm 15-kam ina šit šamši innamir šarru ana šarri šulma išapp-ār*

If on the 11th of Sivan<sup>4</sup> Venus disappeared in the west, remaining absent in the sky for 9 months and 4 days, and on the 15th of Adar she was seen in the east, king shall send greetings<sup>5</sup> to king. [9th year]

11. *šumma ina araḥ Araḥsamna ūm 10-kam* <sup>4</sup>*Nin-si-an-na ina šit šamši it-bal* 2-*arḥē ūmī 6-kam*<sup>7</sup> *ina šamē ih-ḥa-ram-ma*<sup>8</sup>
12. *ina araḥ Tebet ūm 16-kam ina erib šamši innamir ebūr māti iššir*.

<sup>1</sup> Restored from K. 2321, Obv. 16.

<sup>2</sup> The period of absence and the date of the western rising were omitted or suppressed to insert the date formula.

<sup>3</sup> The ideogram for 'gold' is usually read *guškin* = *ḥurāsu*, but in all the variants for this passage the phonetic complement *ga* indicates a Sumerian word ending in *g*. See also PBS. X 20, 12 = AJSL. 39, 180, 12. This is the date formula of the eighth year of Ammizaduga; for the more complete forms see POEBEL, BE. VI p. 100. In the preceding year, when this event actually occurred, this king placed a golden throne and his statue in Enamtila, which usually refers to the chapel of Enlil in Ekur at Nippur, see

Langdon, *Babylonian Liturgies*, p. 134. But there was a

chapel of Gula-Bau in Babylon, probably in Esagila, and this date formula undoubtedly refers to that chapel. See also Langdon, *Babylonian Wisdom*, 64, 7.

<sup>4</sup> So the text clearly on K. 2321, Obv. 22.

<sup>5</sup> *Sivan*, the 3rd month, must be changed to *Adar*, the 12th month, and the 9 months which follow are to be struck out. In other words, the scribe was operating with *figures*, not names of months, and 9 months were inserted in the wrong place. See note on K. 2321, Rev. 25, and Obv. 22.

<sup>6</sup> Var. K. 2321, Obv. 23 has *šalla išapp-ār*, shall send declaration of war.

<sup>7</sup> K. 2321, R. 16 as 8 here.

<sup>8</sup> Written *NI-ma*, but Var. K. 2321, Obv. 24, *ih-ḥa-ram-ma*.

If on the 10th of Arašsamna Venus disappeared in the east, remaining absent 2 months and 6 days in the sky, and was seen on the 16th of Tebit in the west, the harvest of the land will be successful. [10th year]

13. *šumma ina araš Ululī ūm 26-kam<sup>4</sup> Nin-sī-an-na ina erib šamši it-bal ūmī 11-kam ina šamē ihharam-ma*  
 14. *ina araš Ululī šani ūm 7-kam ina erib šamši<sup>1</sup> innamir libbi māti iṭa-ab*

If on the 26th of Ulul Venus disappeared in the west, remaining absent in the sky 11 days, and was seen on the 7th of intercalary<sup>2</sup> Ulul in the east, the heart of the land will be happy. [11th year]

15. *šumma ina araš Nisani ūm 9-kam<sup>4</sup> Nin-sī-an-na [ina šit šamši] it-bal 5-arḫē ūmī 16-kam ina šamē [ihharam-ma]*  
 16. *ina araš Ululī ūm 25-kam ina erib šamši innamir libbi māti [iṭa-ab]<sup>3</sup>*

If on the 9th of Nisan Venus disappeared in the east, remaining absent in the sky 5 months and 16 days, and was seen on the 25th of Ulul in the west, the heart of the land will be happy. [12th year]

17. *šumma ina araš Aṣari ūm 5-kam<sup>4</sup> Nin-sī-an-na ina erib šamši it-bal 7(?) ū-mi ina šamē ihharam-ma [ina araš Aṣari ūm 12(?) -kam<sup>4</sup>*  
 18. *ina šit šamši innamir ebur māti iššir: [šumma ina araš Tebeti]<sup>5</sup> ūm 20<sup>6</sup>-kam ina šit šamši it-bal [1 arḫam ina šamē ihharamma]<sup>7</sup>*  
 19. *[ina šit šamši it-bal ūmī 16-kam ina šamē ihharam-ma]<sup>8</sup> ina araš Šabaṭi ūm 21-kam ina erib šamši [innamir . . . . .]<sup>9</sup>*

If on the 5th of Aṣar Venus disappeared in the west, remaining absent in the sky 7(?) days, and she appeared in the east on the 12th(?) of Aṣar, the harvest of the land will be successful. If on the 20th of Tebit(?) she disappeared in the east, remaining absent in the sky one month, and on the 21st<sup>10</sup> of Šabat she appeared in the west. [13th year]

20. *šumma ina araš Tešrit ūm 10-kam<sup>4</sup> Nin-sī-an-na ina šit šamši it-bal araš ūmī 16-kam [ina šamē ihharamma]*  
 21. *ina araš Arašsamna ūm 26-kam ina erib šamši innamir zunnē ina māti ibaššū [ār-bu-lu iššakan]*

If on the 10th of Tešrit Venus disappeared in the west, remaining absent in the sky 1 month

NI=*uḫḫuru*, to loiter, with *ur-lal*, 'to bind the legs', = *uḫḫuru*, II R. 47, Rev. 57. The Sumerian value is *zal*. to loiter, hence *gū-zal* = *guzallu*, *gūḫappu*, *nū'u*, *aḫurū*, loiterer, indolent person, imbecile, RA. I, 124, R. 1 = BM. 38372, Rev. 10-14.

<sup>1</sup> So the text. Obviously an error for *šit šamši*, sunrise.

<sup>2</sup> Hence the 11th year of Ammizaduga was an intercalary year, and so was the 10th year. See KUGLER, *Sternkunde*, II 250.

<sup>3</sup> Rm. 134, 1-3 has *Nisan* 8 and an interval of 5 months, 17 days. Both have *Ulul* 25 (collated).

<sup>4</sup> Figures apparently assured by Rm. II 531, 1-2.

<sup>5</sup> Traces on K. 160 may be *KAN* or *AB*, but Rm. II 531, 3 favours *AB*. This line is repeated on K. 2321, Rev. 17-18, where the interval is 2 months and no space for the days, and the month names are lost.

<sup>6</sup> Rm. II 531, 3 has 21 here.

<sup>7</sup> At the end of line 18 there is a long break.

<sup>8</sup> The text enclosed in parentheses has been displaced from line 20.

<sup>9</sup> Restore *ebur māti iššir*, from K. 2321, R. 18.

<sup>10</sup> I read 21 on the tablet clearly. Rm. II 531, 4 has 11 plainly.

and 16 days, and appeared in the east on the 26th of Arašsamna, there will be rains in the land;<sup>1</sup> desolation will be wrought. [Year 14]

22. *šumma ina araš Abi ūm 20-kam<sup>4</sup> Nin-sī-an-na ina šit šamši it-bal 2 arḫē ūmī 15-kam<sup>2</sup> [ina šamē ihharam-ma]*  
 23. *ina araš Arašsamna ūm 5-kam<sup>2</sup> ina erib šamši innamir zunnē ina māti ibaššū a[r-bu-lu iššakan]*

If on the 20th of Ab Venus disappeared in the east, [remaining absent in the sky] 2 months and 15 days, and appeared in the west on the 5th of Arašsamna, there will be rains in the land; desolation will be wrought. [15th year]

24. *šumma ina araš [Du'uzu] ūm 5-kam<sup>2</sup> Nin-sī-an-na ina erib šamši it-bal ūmī 15-kam [ina šamē ihharam-ma]*  
 25. *ina araš [Du'uzu]<sup>4</sup> ūm 20-kam ina erib šamši<sup>5</sup> innamir zunnē ina šamē mlē ina naḫbē ibaššū*

If on the 5th of [Tammuz] Venus disappeared in the west, [remaining absent in the sky] 15 days, and on the 20th of [Tammuz] appeared in the east, there will be rains in heaven and floods in the springs.<sup>6</sup> [16th year]

26. *šumma ina araš Adari ūm 25-kam<sup>4</sup> Nin-sī-an-na ina šit šamši it-bal 3 arḫē ūmī 9-kam [ina šamē ihharam-ma]*  
 27. *ina araš Simāni ūm 20(?) -kam ina erib šamši innamir šumḫu-tim ummān-man-da<sup>7</sup> eli<sup>8</sup> naḫḫari-<sup>9</sup> [šu-nu šarru iḫe-el]*

If on the 25th of Adar Venus disappeared in the east, [remaining absent in the sky] 3 months and 9 days, and appeared in the west on the 20th(?) of Sivan,<sup>9</sup> disaster of the Manda hordes; *over all of them the king shall rule.* [16th and 17th years]

<sup>1</sup> If *Arašsamna* in line 21 be correct then *Tešrit* must be read in line 20, and the traces of this blurred sign seem to indicate *DUL*, as written in Rev. 9, i. e. *Tešrit*. The entire text in lines 20-21 is suspect; for the western setting and eastern rising should appear here. Note that the corrupt text at the beginning of line 19 has also 16 days, which is probably an insertion there, from line 20. The prototype of lines 18-21 has been incurably confused in transmission. *ina šit šamši it-bal ūmī 16-kam ina šamē ihharam-ma* of line 19 has been taken from line 20, where *erib šamši* stood originally. *erib šamši* was changed to *šit šamši* by dittography with line 18, and the insertion in line 19 with *šit šamši* caused the original<sup>10</sup> of line 20 to be corrupted to *šit šamši* also. Lines 20-21 must surely be corrected to western setting on the 10th of Tešrit, eastern rising on 26th of *Arašsamna*. See the same errors in Rm. II 531, 5-6! Correct text on K. 2321, R. 11-12?

<sup>2</sup> Text clearly 15 and 5. See also photograph. Rm. II 531 has 21 in line 22, and *Kislev* for *Arašsamna* in line 23.

<sup>3</sup> Rm. II 531, 10, has 4 here.

<sup>4</sup> *Du'uzu* is clear on Rm. II 531, 11.

<sup>5</sup> Sic! Read *šit šamši*.

<sup>6</sup> The figure 5 is fairly certain in line 24. Traces of *ŠU* for the month-name remain in both lines.

<sup>7</sup> The Ummān-Manda are the Cimmerians, CT. 34, 10, 16. According to FORRER, ZDMG. vol. 76, they were an Aryan people; WEIDNER, *Rivista degli Studi Or.*, IX 292, describes them as Indo-Germanic. See also STRECK, *Assurb.* p. ccclxxv. They are mentioned in the *Hittite Law Code*, ZIMMERN, *Der Alte Orient*, 23 Heft 2, p. 14, § 55. But in the royal inscriptions of the neo-Babylonian Empire, the Ummān-Manda are certainly identical with the *Madaī*, Medes; v. THUREAU-DANGIN, RA. 22, 28, 11, and GADD, *Fall of Nineveh*, 35, 59. The term is, therefore, applied to peoples who were nomads, and does not always indicate the same race. Cf. VIROLLEAUD, *Adad*, X 11, *libūt ummān dadme*, uprising of people of fixed abode, and *libūt Ummān-man-da*, *Sin*, III 7; XXXIII 30; *Ištār*, XXI 42, 95, &c. <sup>8</sup> *ŠU*.

<sup>9</sup> If *Adar* 25 in line 26 and the interval 3 months and 9 days be correct, then Venus would have risen on the 4th of *Tammuz*. But Rm. II 531, line 12, has *Adar* 15th for *Adar* 25th. If this be correct then *Sivan* 24 should stand in line 27.



28. *šumma ina araḥ Adari ūm 11-kam*<sup>1</sup> *⁴Nin-si-an-na ina [riḥ šamši] it-bal ūm 4-kam ina šamē [iḥḥaram-ma]*

29. *GAB-BE (?) . . . . ūm [15-kam innamir] ebūru (KI-A)*<sup>2</sup> *iššir libbi māti iṭa-ab*

If on the 11th of Adar Venus disappeared in the west, remaining absent 4 days in the sky and appeared [again in the east] on the [15th] day, the harvest will be successful; the heart of the land will be happy. [17th year]

30. *GAB . . . . . dīn ša-ru zunnu šal-gu*<sup>3</sup> . . . . .

31. *šumma ina araḥ Nisanni ūm 2-kam*<sup>4</sup> *⁴Nin-si-an-na ina šit šamši innamir ū-ru-ba-tum ina māti ibaššā*

32. *adi ūm 6-kam ša araḥ Kislimi ina šit šamši izza-az ūm 7-kam ša araḥ Kislimi i-tab-bal-ma 3 arḥē ina šamē*

33. *iḥ-ḥa-ram-ma ūm 8-kam*<sup>4</sup> *⁴ša araḥ Adari*<sup>4</sup> *⁴Nin-si-an-na ina erib šamši inappaḥ-ma šarru ana šarri nukurta išappa-ār*

If on the 2nd of Nisan Venus appeared in the east, distress will be in the land. Until the 6th of Kislev she will stand in the east; on the 7th of Kislev she will disappear, and, having remained absent 3 months in the sky, on the 8th of Adar Venus will shine forth in the west; king will declare hostility against king.

34. *šumma ina araḥ Aḡari ūm 3-kam*<sup>5</sup> *⁴Nin-si-an-na ina erib šamši innamir nukrāti ina māti ibaššā*

35. *adi ūm 6-kam ša araḥ Tebiti ina erib šamši izza-az ūm 7-kam ša araḥ Tebiti i-tab-bal-ma*

36. *ūm 7-kam ina šamē iḥ-ḥa-ram-ma ūm 15-kam ša araḥ Tebiti*<sup>4</sup> *⁴Nin-si-an-na*

37. *ina šit šamši inappaḥ-ma ebūr māti iššir libbi māti iṭa-ab*

If on the 3rd of Ayar Venus appeared in the west, there will be hostilities in the land; she will stand in the west until the 6th of Tebit; on the 7th of Tebit she will disappear, and, having remained absent 7 days in the sky, on the 15th of Tebit Venus will shine forth in the east; the harvest of the land will be successful; the heart of the land will be happy.

38. [*šumma ina araḥ*] *Simāni ūm [4-kam]*<sup>4</sup> *⁴Nin-si-an-na ina šit šamši innamir miḫitti*<sup>6</sup> *ummān ma-at-ti*

39. [*adi*] *ūm 8-kam*<sup>7</sup> [*ša araḥ šabati*] *ina šit šamši izza-az ūm 8-kam*<sup>7</sup> *⁴ša araḥ šabati i-tab-bal-ma*

40. [*3*] *arḥē ina šamē iḥ-ḥa-ram-ma ūm 9-kam ša araḥ Aḡari*<sup>4</sup> *⁴Nin-si-an-na*

41. [*ina*] *erib šamši inappaḥ-ma nukrāti ina māti ibaššā*

If on the [4th] of Sivan Venus appeared in the east, there will be a catastrophe of the army of the (home)-land. Until the 8th of Šabat she will stand in the east; on the 8th of Šabat she will disappear,<sup>8</sup> and, having remained absent [3] months in the sky, on the 9th of Ayar Venus will shine forth in the west; there will be hostilities in the land.

<sup>1</sup> Only the figure 10 is certain here. The stroke for the unit 1 is very doubtful. Only 10 or 11 is possible.

<sup>2</sup> WEIDNER, *Handbuch*, 174, suggested that *KI-A* = *eburu*; he compared *KI-A iššir*, THOMPSON, *Reports*, 253 A 2, with *eburu iššir* in 253, 2, &c. See K. 2321, R. 27.

<sup>3</sup> These signs are all uncertain.

<sup>4</sup> KUGLER corrects this figure to 7.

<sup>5</sup> This figure is on a new join or flake, now added to the tablet.

<sup>6</sup> *RI-RI-GA*. Cf. VIROLLEAUD, *Ištar*, XX 85, with THURBAU-DANGIN, URUK. 30, 9.

<sup>7</sup> The figure 8 is certain in both places in line 39.

<sup>8</sup> 'Be taken away'.

42. [*šumma ina araḥ*] *Du'uzi ūm 5-kam*<sup>4</sup> *⁴Nin-si-an-na ina erib šamši innamir nukrāti ina māti ibaššā ebūr māti iššir*

43. *adi ūm 9-kam ša araḥ Adari ina erib šamši izza-az ūm 10-kam ša araḥ Adari ittabbal-ma*

44. *ūm 7(?) -kam ina šamē iḥ-ḥa-ram-ma ūm 17-kam ša araḥ Adari*<sup>4</sup> *⁴Nin-si-an-na*

45. *ina šit šamši inappaḥ-ma šarru ana šarri nukurta išappa-ār*

If on the 5th of Tammuz Venus appeared in the west, there will be hostilities in the land; the harvest of the land will be successful. Until the 9th of Adar she will stand in the west and on the 10th of Adar she will disappear, and, having remained absent in the sky 7 days, on the 17th of Adar Venus will shine forth in the east; king will declare hostility against king.

K. 160, Reverse.<sup>1</sup>

1. *šumma ina araḥ Abi ūm 6-kam*<sup>4</sup> *⁴Nin-si-an-na ina šit šamši innamir zunnē ina šamē ibbaššā ār-bu-tu ibašši*

2. *adi ūm 10-kam ša araḥ Nisanni ina šit šamši izza-az ūm 11-kam ša araḥ Nisanni i-tab-bal-ma*

3. *3 arḥē ina šamē iḥḥaram-ma ūm 11-kam ša araḥ Du'uzi*<sup>4</sup> *⁴Nin-si-an-na ina erib šamši inappaḥ-ma*

4. *nukrāti ina māti ibaššā ebūr māti iššir*

If on the 6th of Ab Venus appeared in the east, there will be rains in heaven; there will be disaster. Until the 10th of Nisan she will stand in the east; on the 11th of Nisan she will disappear, and, having remained absent 3 months in the sky, on the 11th of Tammuz Venus will shine forth in the west; hostilities will be in the land; the harvest of the land will be successful.

5. *šumma ina araḥ Ululi ūm 7-kam*<sup>4</sup> *⁴Nin-si-an-na ina erib šamši innamir*<sup>2</sup> *ebūr māti iššir libbi māti iṭa-ab*

6. *adi ūm 11-kam ša araḥ Aḡari ina erib šamši izza-az ūm 12-kam ša araḥ Aḡari i-tab-bal-ma*

7. *7 ū-mi ina šamē iḥ-ḥa-ram-ma ūm 19-kam ša araḥ Aḡari*<sup>4</sup> *⁴Nin-si-an-na*

8. *ina šit šamši inappaḥ-ma nukrāti ina māti ibaššā*

If on the 7th of Ulul Venus appeared in the west, the harvest of the land will be successful; the heart of the land will be happy. Until the 11th of Ayar she will stand in the west and on the 12th of Ayar she will disappear, and, having remained absent 7 days in the sky, Venus will shine forth in the east on the 19th of Ayar; hostilities will be in the land.

9. *šumma ina araḥ Tešriti ūm 8-kam*<sup>4</sup> *⁴Nin-si-an-na ina šit šamši innamir nukrāti ina māti ibaššā ebūr māti iššir*

10. *adi ūm 12-kam ša araḥ Simāni ina šit šamši izza-az ūm 13-kam ša araḥ Simāni i-tab-bal-ma*

11. *3 arḥē ina šamē iḥ-ḥa-ram-ma ūm 13-kam ša araḥ Ululi*<sup>4</sup> *⁴Nin-si-an-na*

12. *ina erib šamši inappaḥ-ma ebūr māti iššir libbi māti iṭa-ab*

If on the 8th of Tešrit Venus appeared in the east, hostilities will be in the land; the harvest of the land will be successful. Until the 12th of Sivan she will stand in the east and on the 13th of Sivan she will disappear, and, having remained absent 3 months in the sky, Venus will shine forth in the west on the 13th of Ulul: the harvest of the land will be successful; the heart of the land will be happy.

<sup>1</sup> III Raw. 63 Rev. 1 = VIROLLEAUD, *Ištar*, XIII 16. <sup>2</sup> Written *IGI*; *GAB* omitted. Also in lines 13, 17, 21, 25, 29.

13. *šumma ina araḥ Araḥsamna ūm 9-kam* <sup>4</sup>*Nin-si-an-na ina erīb šamši innamir māta*<sup>1</sup> *dannatu iṣabbat*  
 14. *adi* [ūm 13-*kam ša araḥ Du'uzi ina erīb šamši izza-az ūm 14-kam ša araḥ Du'uzi i-tab-bal-ma*  
 15. *ūmi 7-kam ina šamē iḥ-ḥa-ram-ma ūm 21-kam ša araḥ Du'uzi* <sup>4</sup>*Nin-si-an-na*  
 16. *ina šit šamši inappaḥ-ma nukrāti ina māti ibaššā ebūr māti iššir*

If on the 9th of Araḥsamna Venus appeared in the west, disaster will seize the land. Until the 13th of Tammuz she will stand in the west; on the 14th of Tammuz she will disappear, and, having remained absent 7 days in the sky, Venus will shine forth on the 21st of Tammuz (in the east); hostilities will be in the land; the harvest of the land will be successful.

17. *šumma ina araḥ Kislimi ūm 10-kam* <sup>4</sup>*Nin-si-an-na ina šit šamši innamir ḥušaḥḥi še'im u tibni ina māti ibaššā*  
 18. *adi ūm 14-kam ša araḥ Abi ina šit šamši izza-az ūm 15-kam ša araḥ Abi i-tab-bal-ma*  
 19. *arḥē 3 ina šamē iḥ-ḥa-ram-ma ūm 15-kam ša araḥ Araḥsamna* <sup>4</sup>*Nin-si-an-na*  
 20. *ina erīb šamši inappaḥ-ma ebūr māti iššir*

If on the 10th of Kislev Venus appeared in the east there will be hunger for grain and straw in the land. Until the 14th of Ab she will stand in the east; on the 15th of Ab she will disappear, and, having remained absent 3 months in the sky, Venus will shine forth in the west on the 15th of Araḥsamna; the harvest of the land will be successful.

21. *šumma ina araḥ Tebiti ūm 11-kam* <sup>4</sup>*Nin-si-an-na ina erīb šamši innamir ebūr māti iššir*  
 22. *adi ūm 15-kam ša araḥ Ululi ina erīb šamši izza-az ūm 16-kam ša araḥ Ululi i-tab-bal-ma*  
 23. *ūmi 7-kam ina šamē iḥ-ḥa-ram-ma ūm 23-kam ša araḥ Ululi* <sup>4</sup>*Nin-si-an-na*  
 24. *ina šit šamši inappaḥ-ma ebūr māti iššir libbi māti itāb*

If on the 11th of Tebit Venus appeared in the west, the harvest of the land will be successful. Until the 15th of Ulul she will stand in the west; on the 16th of Ulul she will disappear, and, having remained absent 7 days in the sky, Venus will shine forth in the east on the 23rd of Ulul; the harvest of the land will be successful; the heart of the land will be happy.

25. *šumma ina araḥ Šabati ūm 12-kam* <sup>4</sup>*Nin-si-an-na ina šit šamši innamir ebūr māti iššir*  
 26. *adi ūm 16-kam ša araḥ Tešriti ina šit šamši izza-az ūm 17-kam ša araḥ Tešriti* [i-tab-bal-ma]  
 27. *3 arḥē ina šamē iḥ-ḥa-ram-ma ūm 17-kam ša araḥ Tebiti* <sup>4</sup>*Nin-si-an-na*  
 28. *ina erīb šamši inappaḥ-ma* [ebur mati iššir]

If on the 12th of Šabat Venus appeared in the east, the harvest of the land will be successful. Until the 16th of Tešrit she will stand in the east; on the 17th of Tešrit she will disappear, and, having remained absent 3 months in the sky, Venus will shine forth in the west on the 17th of Tebit; [the harvest of the land will be successful].

29. *šumma ina araḥ Adari ūm 13-kam* <sup>4</sup>*Nin-si-an-na ina erīb šamši innamir šarru* [ana sarri nukurta iṣappa-ār]  
 30. *adi ūm 16-kam* <sup>4</sup> *ša araḥ Araḥsamna ina erīb šamši izza-az ūm 17-kam ša araḥ Araḥsamna i-tab-bal-ma*  
 31. *ūmi 7-kam ina šamē iḥ-ḥa-ram-ma ūm 25-kam ša araḥ Araḥsamna* <sup>4</sup>*Nin-si-an-na*  
 32. *ina šit šamši inappaḥ-ma māta dannatu iṣabbat*

<sup>1</sup> Cf. KING, *Magic*, 31, 6.

<sup>2</sup> VIROLLEAUD has 11 here, but III R. 63 correctly 21.

<sup>3</sup> Sign KUR.

<sup>4</sup> This figure is clearly written and may be seen on the photograph.

If on the 13th of Adar Venus appeared in the west, king shall send challenge of war to king. Until the 16th of Araḥsamna she will stand in the west; on the 17th of Araḥsamna she will disappear, and, having remained absent 7 days in the sky, Venus will shine forth in the east on the 25th of Araḥsamna; calamity will seize the land.

33. 12 *ki-iṣ-ru-ta MU-ra-tum*<sup>1</sup> *šā* <sup>4</sup>*Nin-si-an-na gab-ri Bāb-ili-(ki)*

Twelve corresponding groups (of the motions) of Venus. A copy from Babylon.

34. *šumma ina araḥ Ululi šanī-kam ūm 1-kam* <sup>4</sup>*Nin-si-an-na ina erīb šamši it-bal*  
 35. *ūm 15-kam ina šamē iḥḥaram-ma ina araḥ Ululi šanī-kam ūm 17-kam* <sup>4</sup>*Nin-si-an-na*  
 36. *ina šit šamši innamir*<sup>2</sup> *tapdū*<sup>2</sup> *ina māti ruḥ-ti ibašši : ina ekalli amtu* . . . . .

If on the 1st of intercalary Ulul Venus disappeared in the west, remaining absent 15 days in the sky, and on the 17th of intercalary Ulul Venus appeared in the east, there will be a defeat in a distant land; in the palace a female servant will . . . [19th year]

37. *šumma ina araḥ Simāni ūm 25-kam* <sup>4</sup>*Nin-si-an-na ina šit šamši it-bal*  
 38. *2 arḥē ūmi 6-kam ina šamē iḥḥaram-ma ina araḥ Ululi ūm 24-kam*<sup>3</sup>  
 39. <sup>4</sup>*Nin-si-an-na ina erīb šamši innamir libbi māti ita-ab*

If on the 25th of Sivan Venus disappeared in the east, remaining absent 2 months and 6 days in the sky, and on the 24th of Ulul Venus appeared in the west, the heart of the land will be happy. [20th year]

40. *šumma ina araḥ Nisanni ūm 27-kam*<sup>4</sup> <sup>4</sup>*Nin-si-an-na ina erīb šamši it-bal*  
 41. *ūmi 7-kam ina šamē iḥ-ḥa-ram-ma ina araḥ Ažari ūm 3-kam* <sup>4</sup>*Nin-si-an-na*  
 42. *ina šit šamši innamir nukrāti ina māti ibaššā ebūr māti iššir*

If on the 27th of Nisan Venus disappeared in the west, remaining absent in the sky 7 days, and on the 3rd of Ayar Venus appeared in the east, there will be hostilities in the land; the harvest of the land will be successful. [21st year]

43. [*šumma ina araḥ Tebiti ūm 28-kam*]<sup>4</sup> <sup>4</sup>*Nin-si-an-na ina šit šamši it-bal*  
 44. [*2 arḥē ina šamē iḥḥaram-ma ina*] *araḥ Adari ūm 28-kam* <sup>4</sup>*Nin-si-an-na*  
 45. [*ina erīb šamši innamir*] *šarru ana sarri šalta iṣappa-ar*

If on the 28th of Tebit Venus disappeared in the east, remaining absent 2 months in the sky, and on the 28th of Adar Venus appeared in the west, king will send a challenge of war to king. [Restored from K. 2321, R. 20-1.] [21st year]

46. [ . . . . . ] *gab-ri (?) . . . . . ] ki (?) ki-i pš labiri-šu*<sup>5</sup>

<sup>1</sup> *Kiṣrātu* is clearly a singular fem. as the adjective *MU-ra-tum* proves. KUGLER, *Sternkunde*, 262, reads *gabratum*, but there is no adjective *gabru*. Apparently only *māḥiratum* or *paṣratum* are possible, and no adjective *paṣru* or *paṣiru*, *paṣiratum*, exists. VIROLLEAUD also transcribes *gab-ra-tum*. KUGLER rendered the phrase by '12 corresponding groups', which makes good sense. If *kiṣrātu* means 'problem', and *paṣratum* be assumed as the correct reading, the sense may be '12 problems solved'. But I cannot see the sign *GAB* on the tablet. See also the photograph. Read *šajratum*?

<sup>2</sup> This source, Obv. 1-30 + Rev. 34-46, employs *IGI-GAB* for *namāru* in Obv. 1-30, but *IGI* only in Rev. 34-46,

unless line 36 be an exception, as is supposed by my rendering. I take *ŠI* for *tapdū*, and cf. RA. 12, 7 n. 1. VIROLLEAUD transcribed *gab-lim*, by which he probably means *kablu*. I cannot see *GAB* on the tablet; *MU* seems to be clearly written. What then is *MU-ši*? *GAB* would be the better reading. <sup>3</sup> Sic: read 1 for 24.

<sup>4</sup> K. 7072 + Rm. 134, 4, has 26 here. Rm. 134 has 6-day interval.

<sup>5</sup> Text has *ki-i KA Ū-RA-šu*, like the original (it has been written and collated). Space for about 20 lines is broken away here. The colophon occupied a few lines, and the remainder was probably uninscribed.

CHAPTER III  
TRANSCRIPTION AND TRANSLATION

K. 2321 + K. 3032, Obverse.

1. [šumma ina araḥ šabati ūm 15-kam<sup>4</sup> Nin-si-an-na ina erīb šamši it-bal ūmī 3-kam ina šamē iḥ-ḥa-ram-ma  
iḥ-ḥa-ram-ma
2. [ina araḥ Šabati ūm 18-kam<sup>4</sup> Nin-si-an-na ina šit šamši innamir taḫdē šarrāni
3. [<sup>4</sup>Adad zunnē-šu<sup>4</sup> Ea nakḫē-šu] ub-ba-la šarru ana šarri šulma išappar  
[If on the 15th day of the month Šabat] Venus disappeared in the west, remaining absent in the sky 3 days, and [on the 18th day of the month Šabat] Venus appeared in the east, catastrophes of kings; [Adad] will bring [rains, Ea subterranean waters]; king will send greetings to king. See K. 2321, R. 22-3. [Year 1]
4. [šumma ina araḥ Araḥsamni ūm 11-kam<sup>4</sup> Nin-si-an-na ina šit šamši it-bal 2 arḥē ūmī 7-kam ina šamē iḥ-ḥa-ram-ma
5. [ina araḥ Tebeti ūm 19-kam<sup>4</sup> Nin-si-an-na] ina erīb šamši innamir ebūr māti iššir  
[If on the 11th day of the month Araḥsamna Venus] disappeared in the east, remaining absent in the sky 2 months and 7 days, and [on the 19th day of the month Tebit Venus] appeared in the west, the harvest of the land will be successful. See K. 2321, R. 17. [Year 2]
6. [šumma ina araḥ Ululi ūm 23-kam<sup>4</sup> Nin-si-an-na] ina erīb šamši it-bal ūmī 20-kam ina šamē iḥ-ḥa-ram-ma
7. [ina araḥ Tešriti ūm 13-kam<sup>4</sup> Nin-si-an-na] ina šit šamši innamir nukrāti ina māti ibaššā ebūr māti iššir  
[If on the 23rd day of the month Ulul Venus] disappeared in the west, remaining absent 20 days in the sky, and [on the 13th day of the month Tešrit Venus] appeared in the east, there will be hostilities in the land; the harvest of the land will be successful. [3rd year]
8. [šumma ina araḥ Du'zi<sup>1</sup> ūm 2-kam<sup>4</sup> Nin-si-an-na ina] šit šamši it-bal 2 arḥē ūm 1-kam ina šamē iḥ-ḥa-ram-ma
9. [ina araḥ Ululi ūm 3-kam<sup>4</sup> Nin-si-an-na] ina erīb šamši innamir libbi māti iḥ-ab  
[If on the 2nd day of the month Tammuz Venus] disappeared in the east, remaining absent in the sky 2 months and 1 day, and [on the 3rd day of the month Ulul Venus] appeared in the west, the heart of the land will be happy. [4th year]
10. [šumma ina araḥ Aḫari ūm 2-kam<sup>4</sup> Nin-si-an-na ina] erīb šamši it-bal ūmī 15-kam<sup>2</sup> ina šamē iḥ-ḥa-ram-ma
11. [ina araḥ Aḫari ūm 18-kam<sup>4</sup> Nin-si-an-na] ina šit šamši innamir zunnē u mīlē ibaššā ebūr māti iššir  
[If on the 2nd day of the month Ayar Venus] disappeared in the west, remaining absent in

<sup>1</sup> Text of W. 802 has *KU*, error from line 7.

<sup>2</sup> Var. W. 802 has 18 here and 18 in line 11, which is clearly a case of dittography.

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the sky 15 days, and [on the 18th day of the month Ayar Venus] appeared in the east, there will be rains and floods; the harvest of the land will be successful. [5th year]

12. šumma ina araḥ Kislimi ūm 10 + [2-kam<sup>4</sup> Nin-si-an-na ina] šit šamši it-bal 2 arḥē ūmī 4-kam ina šamē iḥ-ḥa-ram-ma

13. ina araḥ Šabati ūm 16-kam<sup>1</sup> 4. Nin-si-an-na ina] erīb šamši innamir ebūr māti iššir

If on the 12th of Kislev Venus disappeared in the east, remaining absent in the sky 2 months and 4 days, and on the 16th of Šabat Venus appeared in the west, the harvest of the land will be successful. See K. 2321, R. 19. [5th year]

14. šumma ina araḥ Araḥsamna ūm 20 + [8]<sup>2</sup> 4. Nin-si-an-na [ina erīb šamši] it-bal ūmī 3-kam ina šamē iḥ-ḥa-ram-ma

15. ina araḥ Kislimi<sup>3</sup> ūm 1-kam<sup>4</sup> Nin-si-an-na ina [šit šamši innamir] ḥušaḫḫi še'im u tibni ina māti ibaššā<sup>4</sup> ar-bu-tu iššakan.

If on the 28th of Araḥsamna Venus disappeared [in the west], remaining absent in the sky 3 days, and on the 1st of Kislev Venus appeared [in the east], hunger for grain and straw will be in the land; desolation will be wrought. [6th year]

16-17 = K. 160, Obv. I 1-3.

Venus disappeared in the east, Ab 21st; period of absence 2 months and 11 days; rose in the west, Araḥsamna 2nd. [7th year]

18-19 = K. 160, Obv. I 4-6.

Venus disappeared in the west, Tammuz 25th; period of absence 7 days; rose in the east, Ab 2nd. [8th year]

20-1 = K. 160, Obv. I 7-8.

Venus disappeared in the east, Adar 25th, in the 8th year of Ammizaduga. [8th and 9th years]

22-3 = K. 160, Obv. I 9-10.

Venus disappeared in the west, Adar 11th;<sup>5</sup> period of absence 4 days; rose in the east, Adar 15th. [9th year]

24-5 = K. 160, Obv. II 11-12.

Venus disappeared in the east, Araḥsamna 10th; period of absence 2 months and 6 days; rose in the west, Tebit 16th.<sup>6</sup> [10th year]

26-7 = K. 160, Obv. I 13-14.

Venus disappeared in the west, Ulul 26th; period of absence 11 days; rose in the east, intercalary Ulul 7th. [11th year]

<sup>1</sup> Var. W. 802 has 29 here, and in line 12 *Kislimu* 26.

<sup>2</sup> *ḫi-pi eš-šu*, scribal note, 'a recent defacement of the text'.

The units of this figure were lost on the original from which Ašurbanipal's scribe made his copy. Var. W. 802 has 18, clearly an error for 28.

<sup>3</sup> The text has *Kislimu* clearly. See K. 2321, R. 12-13.

<sup>4</sup> Here Var. inserts *KI-MiN*, which probably refers to line 13, *ebur māti iššir*.

<sup>5</sup> The text has *Sivan* for *Adar*, and the interval is 9 months and 4 days!

<sup>6</sup> Text of K. 2321 has 16 clearly.

Reverse<sup>1</sup>

1. *šumma ina araḥ Nisanni* <sup>d</sup>*Nin-si-an-na ūm 8-kam ina šit šamši it-bal 5 arḥē ūmī 17-kam ina šami-e iḥ-ḥi-ram-ma*
2. *ina araḥ Ululī ūm 25-kam* <sup>d</sup>*Nin-si-an-na ina erīb šamši innamir lib-bi māti iḏāb*<sup>2</sup> [Year 12]
3. *šumma ina araḥ Nisanni* <sup>d</sup>*Nin-si-an-na ūm 26-kam ina erīb šamši it-bal ūmī 6-kam ina šami-e iḥ-ḥi-ram-ma*
4. *ina araḥ Aḫari ūm 3-kam ina šit šamši innami-ir nu-ku-ra-tu ina māti ibaššū ebūr māti iššir*<sup>3</sup> [Year 21]
5. *šumma ina araḥ Aḫari* <sup>d</sup>*Nin-si-an-na ūm 2-kam ina erīb šami-e it-bal ūmī 15-kam ina šami-e iḥ-ḥi-ram-ma*
6. *ina araḥ Aḫari ūm 18-kam* <sup>d</sup>*Nin-si-an-na ina šit šamši innami-ir zunnē u milē ibaššū ebūr māti iššir*<sup>4</sup> [Year 5]
7. Set in west, Ayar 5th, interval 7 days; rose in east,
8. Ayar 12th. [Year 13] Restored from K. 160, 17-18.
9. Set in east, Sivan 25th, interval 2 months 6 days; rose
10. in west, Ulul 1st. Restored from K. 160, R. 37-9. [Year 20]
11. Set in east, Tammuz 2nd, interval 2 months and 1 day; rose in
12. west, Ulul 3rd. Restored from K. 2321, Obv. 8-9. [Year 4]
13. Set in west, Tammuz 5th, interval 15 days; rose in east,
14. Tammuz 20th. K. 160, Obv. 24-5. [Year 16]
15. Set in west, Tammuz 25th, interval 7 days; rose in east, Ab 2nd.
16. Restore from K. 160, 4-6, and K. 2321, Obv. 18-19. [Year 8]<sup>5</sup>
17. 18 = 3, 4, on fragment.  
[*šumma ina araḥ Abi ūm 20-kam* <sup>d</sup>*Nin-si-an-na ina šit šamši it-bal 2 arḥē ūmī 15-kam ina šami-e iḥ-ḥi-ram-ma*  
*[ina araḥ Araḥsamna ūm 5-kam ina erīb šamši innami-ir zunnē ina māti ibaššū] ar-bu-tu iššakan*  
Restored from K. 160, Obv. 22-3; and Sm. 174, 4-5. [Year 15]<sup>6</sup>
- 19, 20 = 5, 6, on fragment.  
[*šumma ina araḥ Abi ūm 21-kam* <sup>d</sup>*Nin-si-an-na ina šit šamši it-bal 2 arḥē ūmī 11-kam ina*  
*šami-e iḥ-ḥi-ram-ma*  
*[ina araḥ Araḥsamna ūm 2-kam]* <sup>d</sup>*Nin-si-an-na ina erīb šamši innamir zunnē ina māti*  
*ibaššū ar-bu-tu iššakan*  
Restored from K. 160, 1-3, and K. 2321, Obv. 16-17; Sm. 174, 6-7. [Year 7]<sup>6</sup>

<sup>1</sup> Text in VIROLLEAUD, *Ištār*, XV.<sup>2</sup> 12th year. Restored from Rm. 134 and K. 7072 = K. 160, 15-16. K. 7072 has 25th of Ulul clearly.<sup>3</sup> 21st year. Restored from Rm. 134 and K. 7072 = K. 160, R. 40-2. Rm. 134 has interval of 6 days, and 26th of Nisan; K. 160 has 7 days and 27th of Nisan. K. 7072 has Ayar 3.<sup>4</sup> 5th year. K. 7072 and Rm. 134 = K. 2321, Obv. 10-11.<sup>5</sup> This should correspond to K. 2321, rev., first line on the fragment, which has *ebūr māti iššir*, but the corresponding omen on the obverse has *arbutu iššakan*! Since the omen for lines 13-4 has *ina šamē milē ina naḫḫē ibaššū*, and this may agree with Sm. 174, 3, *zunnē ina šamē* (?), FOTHERINGHAM would invert 13 + 14 and 15 + 16.<sup>6</sup> FOTHERINGHAM would invert these two paragraphs as here restored; he argues that the observations are usually in order

7. *šumma ina araḥ Ululī* <sup>d</sup>*Nin-si-an-na ūm 23-kam ina erīb šamši it-bal ūmī 20-kam ina šamē iḥ-ḥi-ram-ma*
8. *ina araḥ Tešrit*<sup>1</sup> *ūm 13-kam ina šit šamši innami-ir nu-ku-ra-tum ina māti ibaššū ebūr māti iššir*  
If on the 23rd of Ulul Venus disappeared in the west, remaining absent 20 days in the sky, and appeared in the east on the 13th of Tešrit, there will be hostility in the land; the harvest of the land will be successful. [Year 3]
9. *šumma ina araḥ Ululī* <sup>d</sup>*Nin-si-an-na ūm 26-kam ina erīb šamši it-bal ūmī 12-kam*<sup>2</sup> *ina šamē iḥ-ḥi-ram-ma*
10. *ina araḥ Ululī šanē ūm 8-kam*<sup>3</sup> *ina šit šamši innamir libbi māti iḫa-ab*  
If on the 26th of Ulul Venus disappeared in the west, remaining absent 12 days in the sky, and appeared in the east on the 8th of intercalary Ulul, the heart of the land will be happy. K. 160, Obv. 13-14. [11th year]
11. *šumma ina araḥ Tešrit* <sup>d</sup>*Nin-si-an-na ūm 11-kam ina erīb šamši it-bal 1 araḥ ūmī 17-kam ina šamē iḥ-ḥi-ram-ma*
12. *ina araḥ Araḥsamna ūm 28-kam* <sup>d</sup>*Nin-si-an-na ina šit šamši innamir zunnē ina māti ibaššū ar-bu-tu iššaka-an*<sup>4</sup>  
If on the 11th of Tešrit Venus disappeared in the west, remaining absent 1 month and 17 days in the sky, and on the 28th of Araḥsamna Venus appeared in the east, there will be rains in the land; destruction will be wrought. K. 160, Obv. 20-1. [Year 14]
13. *šumma ina Araḥsamna* <sup>d</sup>*Nin-si-an-na ūm 28-kam ina erīb šamši it-bal ūmī 5-kam ina šamē iḥḥiram-ma*
14. *ina araḥ Kisilimi* [*ūm 3-kam ina*] *šit šamši innami-ir ḥusaḥḥi še'im u tibni ina māti ibaššū*  
If on the 28th of Araḥsamna Venus disappeared in the west, remaining absent 5 days in the sky, and [on the 3rd] of Kislev she appeared in the east, there will be hunger for grain and straw in the land. K. 2321, Obv. 14-15. [6th year]
15. [*šumma ina araḥ Araḥsamna* <sup>d</sup>*Nin-si-an-na ūm 11-kam ina*] *šit šamši it-bal 2 arḥē ūmī 8-kam ina šamē iḥḥiram-ma ina araḥ Tebiti ūm 19-kam ina erīb šamši innami-ir ebūr māti iššir*  
If on the 11th of Araḥsamna Venus disappeared in the east, remaining absent in the sky 2 months and 8 days, and on the 19th of Tebit she appeared in the west, the harvest of the land will be successful. K. 2321, Obv. 4-5. [Year 2]
16. [*šumma ina araḥ Araḥsamna* <sup>d</sup>*Nin-si-an-na ūm 8-kam ina šit šamši*] *it-bal 2 arḥē ūmī 8-kam ina šami-e iḥ-ḥi-ram-ma ina araḥ Tebiti ūm 16-kam ina erīb šamši innami-ir ebūr māti iššir*  
K. 2321, Obv. 24-5; K. 160, Obv. 11-12. [Year 10]

of years (*Nisan* 12, 21, *Ayar* 5, 13, *Tammuz* 4, 8, 16, *Ulul* 3, 11, *Adar* 8, 9).<sup>1</sup> Text *KU*. So already CRAIG.<sup>2</sup> K. 160, Obv. 13 has 11.<sup>3</sup> K. 160, Obv. 14 has 7.<sup>4</sup> This impossible astronomical statement agrees with the major text K. 160, Obv. 20-1, where the figures are *Tešrit* 10, interval 1 month and 16 days, and *Araḥsamna* 26. TheKish duplicate, Rev. 12, has *Araḥsamna* 27, which FOTHERINGHAM identifies as the only correct date, astronomically, in this observation. *Tešrit* in line 11 is clearly an error for *Araḥsamna*, but the figure 11, or 10, on all three texts is erroneous. The interval according to FOTHERINGHAM should be about 3 days, consequently *Araḥsamna* 24 should stand in line 11.

17. [šumma ina araḥ Kislīmi<sup>4</sup> Nin-si-an-na ūm 2]1-kam ina šit šamši it-bal 2 arḥē ina šami-e iḥ-ḥi-ram-ma
18. [ina araḥ Šabati ūm 21-kam ina erīb šamši] innami-ir ebūr māti iššir  
K. 160, Obv. 18-19. [Year 13]
19. [šumma ina araḥ Kislīmi<sup>4</sup> Nin-si-an-na ūm 24-kam ina] šit šamši<sup>1</sup> it-bal (2) arḥē<sup>2</sup> ūmī 4-kam ina šami-e iḥḥiram-ma ina araḥ Šabati ūm 28-kam ina erīb šamši<sup>3</sup> innamir ebūr māti iššir<sup>4</sup>  
K. 2321, Obv. 12-13, and Kish tablet. [Year 5]

20. [šumma ina araḥ Tebiti<sup>4</sup> Nin-si-an-na ina ūm 28-]kam ina šit šamši it-bal 2 arḥē ina šami-e iḥ-ḥi-ram-ma
21. [ina araḥ Adari ūm 28-kam ina erīb šamši innami-]ir šarru ana šarri šalta išappa-ar.

An eastern setting in Tebit is expected here, and the only observation possible is the broken text of K. 160, R. 43-5, for the 21st year, where the western rising is on the 28th of Adar. The omens also agree, and there seems to be no alternative. [Year 21]

22. [šumma ina araḥ Šabati<sup>4</sup> Nin-si-an-na ūm 25-]kam ina erīb šamši it-bal ūmī 3-kam ina šami-e iḥḥiram-ma ina araḥ Šabati ūm 28-kam
23. ina šit šamši innami-ir tapdē šarrāni<sup>4</sup> Adad zunnē-šu<sup>4</sup> E-a naḫḫē-šu ub-ba-lam šarru ana šarri šulma(ma) išappa-ār

This is obviously identical with K. 2321, Obv. 1-3, and Kish tablet, Obv. 1-3, but the figures there are 15-18, being raised by 10 on K. 2321, Rev. 22; the omission or insertion of the unit 10 is a common error. [Year 1]

24. [šumma ina araḥ Adari<sup>4</sup> Nin-si-an-na ūm 25-]kam ina šit šamši it-bal 2 arḥē ūm 7-kam ina šami-e iḥ-ḥi-ram-ma
25. [ina araḥ Simani<sup>5</sup> ūm 2-kam] ina erīb šamši innami-ir šumkut ummān ma-at-ti. [Year 8]  
This is probably the fragmentary observation in K. 160, Obv. 7, and K. 2321, Obv. 20, and has been entered before the setting on Adar 11th in line 26.<sup>6</sup>

26. [šumma ina araḥ Adari ūm 11-kam<sup>4</sup> Nin-si-an-na ina erīb šamši it-bal ūmī 4-kam ina šami-e iḥ-ḥi-ram-ma
27. [ina araḥ Adari ūm 15-kam ina] šit šamši innami-ir : (ina šamē innamir) šarru ana šarri šulma(ma) išappa-ār ebūru<sup>7</sup> iššir libbi māti ita-ab. [Year 17]

This entry apparently combines K. 160, Obv. 9-10 = K. 2321, Obv. 22-3 (9th year), and

<sup>1</sup> The text has erīb šamši.

<sup>2</sup> The text has no figure before arḥē.

<sup>3</sup> The text has šit šamši.

<sup>4</sup> The scribe has interchanged the eastern setting with the western rising in his copy. Obviously the month *Kislev* stood in line 19, and if a western setting be assumed as in the text then the interval cannot be so long as a month, to the eastern rising in *Šabat*; the scribe's text imposes the restoration of *Šabat* in line 19, which would make the successive order of month-names wrong. The interval has no number before 'month'; the scribe's copy had a figure here,

but he observed that, if the text be correct, the interval must be less than a month, and he consequently omitted the figure.

<sup>5</sup> So, since the 8th year had no intercalary *Adar*. Note that the next observation on K. 160, Obv. 9, has *Simanu* erroneously for *Adar*, a corruption taken from *Simanu* which had been suppressed.

<sup>6</sup> This is due to a secondary principle introduced into the method here. When settings occur in the same month the scribe follows the order of the years. This was discovered by FOTHERINGHAM.

<sup>7</sup> *KI-A*.

K. 160, Obv. 28-9 (17th year). Note that the omen here combines the omens of these two years, and that *KI-A*, ideogram for *ebūru*, or *ebūr māti*, has been erroneously inserted into K. 160, Obv. 29.<sup>1</sup>

28. [24? ki-iš-ru-ti] ša<sup>4</sup> Nin-si-an-na a-ḥu-tum

This restoration 'Twenty-four groups (of the motions) of Venus, *aḥūtum*', is suggested by K. 160, Rev. 33. The Rev. of K. 2321 does not include two observations: (1) the eastern setting on the 15th of *Adar*, year 16, and (2) the western setting of intercalary *Ulul* 1st, year 19.<sup>2</sup> There should be 13 eastern settings and 13 western settings in the 21 years of Ammizaduga, or a total of 26 settings on the reverse of K. 2321. *aḥūtu* is probably the classical plural of the adjective *aḥu*, 'strange', 'rare', 'unusual', that is 'groups arranged in a different order from those on the obverse'. *aḥūtum* may possibly be a variant of *aḥītum*, as *šakūtum* of *šakītum*. Cf. also *nēkūtum* for *nēkatum*, 'adulteress', *Assyrian Code of Laws*, §§ 23, 33. On this supposition *Ninsianna a-ḥu-ḫum* means the 'hostile Venus', for which see the title of *Ishtar mul-bar*, the hostile star, *CHIERA, Sumerian Religious Texts*, No. 1, Col. III 16; IV 22, and my edition of this text in *JRAS*. 1926, pp. 15-72. Cf. *kaḫḫab a-ḥu-u*, title of Nergal, Mars, K. 7646; WEIDNER, *Handbuch*, p. 9, line 11. But Venus is not, by any means, always a hostile star.

[The technical term corresponding to *kišru* in modern astronomy is 'conjunction'.—J.K.F.]

29. Summa<sup>3</sup> sag-me-gar ina še-ir-ti ik-[tu-]un šarrāni nakrūti ultallamu tuppū 63-kam enuma Anu<sup>4</sup> Enlil

If Jupiter, in the morning (of his heliacal rising), was brilliant, hostile kings will make peace. 63rd tablet of 'When Anu, Enlil'.

This catch-line occurs at the end of K. 3601 = VIROLLEAUD, *Ishtar* IV, a tablet of entirely different Venus observations, and is partially preserved on the duplicate, K. 11840, *Babyloniaca*, VI 253. The Kish tablet has the same catch-line, but numbers the tablet 62 in the series. An extract of the 64th (63rd?) tablet begins with this line, DT. 77 = VIROLLEAUD, *Suppl.* XLIV, and is cited by THOMPSON, *Reports*, 185, 1; 186, 1; 196, 11; 271, edge. *Ishtar* IV 35 apparently explains the obscure verb *iktun* by *šarrura išši*, 'he bore brilliance'. JASTROW, *Religion* 639, supposed *iktun* to stand for *iktum*, and rendered 'is covered', but even were the verb *katāmu*, 'to cover', assumed, it cannot be passive or neuter. THOMPSON, *Rep. Index*, placed the form under *kānu*, for which there is, so far as the form goes, justification in *liktunnu*, *Epic of Creation*, IV 35; VI 12 b; this would mean 'he was firm, certain'. Undoubtedly we have here a new verb, *kānu* or *kat(š)ānu*.

K. 2321, a neo-Babylonian copy, was written by the hand of Nergaluballit, and the Kish duplicate has a long colophon, '37 lines (observations), a copy from Babylon, written according to its original and collated, by the hand of Nergal-epuš, son of . . . . ., Kish, in the year . . . . . of Sargon, king of [the land of Assyria]'. The Kish tablet was therefore copied in the period 721-705, and is the oldest copy which we now possess.

The reverse of the Kish tablet (12-13) ends with the western setting in *Tesrit*, and the

<sup>1</sup> A conflate text is also suggested by the colon after the sign *ŠI* and the insertion *AŠ-AN-ŠI*, probably a remnant of a second *ina šit šamši innamir*.

<sup>2</sup> Also the group for the year 18, suppressed on K. 160, after

line 29, by the long insertion, does not appear on K. 2321, Rev. This eastern setting should have occurred in *Araḥ-samna*.

eastern rising on the 27th of *Araḥsamna* (26th and 28th on the other texts), year 14 = K. 2321, Rev. 11-12. It is followed by 2 *kišru ša* <sup>4</sup>*Ninsianna*, but there is only one observation or group above it; *kišrutum* in K. 160, Rev. 33, is employed for a single group. Line 11 begins *ta-bar-ri*?, 'thou shalt see (?)', and line 10 has 4 *ki-iš-ru-ti*, and in fact the ends of 4 groups remain on the tablet above it, hence a group must be missing between lines 11-12, and this is undoubtedly the group, K. 160, Rev. 34-6, western setting on intercalary *Ulul* 1st, also omitted on K. 2321. The four groups on the Kish tablet, Rev. 2-9, do not entirely agree with the text of K. 2321, Rev. 3-10. Lines 6-7 do correspond to the proper group, K. 2321, Rev. 7-8, but the remaining three do not, and consequently the Kish tablet arranged the 26 observations on some other principle. K. 2321, Rev., clearly adheres to the scheme of arranging the groups in the monthly order of Venus settings, whether eastern or western. It is not possible to discover what principle the scribes of Kish followed on the reverse of this tablet.

## CHAPTER IV

## TRANSCRIPTION AND TRANSLATION

Rm. II 531

1. [Summa ina araḥ Aḫari ūm 5-kam <sup>4</sup>[*Nin-si-an-na ina erib šamši it-bal 7 ū-mi ina šami-e iḥḥaram-ma*]
2. [ina araḥ Aḫari ūm 12-kam ina [šit šamši innamir ebūr māti iššir] [Year 13]
3. Summa ina Tebiti(!) ūm 21-kam <sup>1</sup> <sup>4</sup>[*Nin-si-an-na ina šit šamši it-bal . . . . . ina šami-e iḥḥaram-ma*]
4. ina araḥ Šabati ūm 11-kam <sup>4</sup>[*Nin-si-an-na ina erib šamši innamir* ] [Year 13]
5. Summa ina araḥ Tešriti ūm 10-kam <sup>4</sup>*Nin-si-an-na* [ina erib šamši it-bal 1 araḥ ūmi 16-kam ina šami-e iḥḥaram-ma]
6. ina araḥ Araḥsamna ūm 26-kam ina šit šamši <sup>2</sup> innamir zunnē [ina māti ibaššu ] [Year 14]
7. Summa ina araḥ Abi ūm 21-kam <sup>4</sup>*Nin-si-an-na ina šit šamši* [it-bal 2 arḥē ūmē 16(?) -kam ina šami-e]
8. iḥḥaram-ma ina araḥ Araḥsamna <sup>3</sup> ūm 5-kam ina erib šamši [innamir zunnē ina māti ibaššu]
9. ar-bu-tu [iššakan] [Year 15]
10. Summa ina araḥ Du'uzi <sup>4</sup> ūm 4-kam <sup>4</sup>*Nin-si-an-na ina erib šamši* [it-bal ūmē 16-kam ina šami-e iḥḥaram-ma]
11. ina araḥ Du'uzi ūm 20-kam ina šit šamši innamir zunnē u [mīlē ibaššu] [Year 16]
12. [Summa ina araḥ] Adari ūm 15-kam <sup>4</sup>*Nin-si-an-na ina šit šamši it-bal* [ . . . arḥē . . . ūmē -kam ina šami-e iḥḥaram-ma]
13. [ina araḥ . . . ūm . . . ]kam ina erib šamši innamir . . . . . <sup>5</sup> [Years 16+17]
13. [Summa ina araḥ Adari ūm 11-kam] <sup>4</sup>*Nin-si-an-na* [ina erib šamši it-bal, &c.] <sup>6</sup>

S. 174

This small fragment probably belongs to the same tablet as Rm. 134 or K. 7072, that is, to an Assyrian copy of the reverse of K. 2321, and partially restores lines 14-20 of these two tablets as reconstructed in my edition of Rm. 134 + K. 7072; see the restoration of K. 2321, Rev. 1-5. Line 8 of S. 174 corresponds to K. 2321, Rev. 7, and line 9 to K. 2321, Rev. 8.

<sup>1</sup> K. 160, Obv. 18, has 20 here and 21 in line 19, which is probably correct.

<sup>2</sup> Text *erib šamši* as on K. 160, Obv. 21, where line 20 has also a false text, *šit šamši* for *erib šamši*.

<sup>3</sup> Text has *Kislev*, which is corrected after K. 160, Obv. 23.

The scribe should have *Araḥsamna* here, which he falsely entered in line 10!

<sup>4</sup> Text *Araḥsamna*!

<sup>5</sup> The traces are certainly not *RU-TIM* as on K. 160, Obv. 27.

<sup>6</sup> See K. 160, Obv. 28.

1	...	...
4	...	...
11	...	...
15	...	...
17	...	...
20	...	...
22	...	...
24	...	...
26	...	...
28	...	...
30	...	...
31	...	...
34	...	...
38	...	...
42	...	...

1	...	...
5	...	...
9	...	...
15	...	...
17	...	...
21	...	...
25	...	...
29	...	...
33	...	...
37	...	...
40	...	...
43	...	...

PLATE III

W 1924, 802 Obverse

1	...	1
4	...	4
6	...	6
8	...	8
10	...	10
12	...	10
14	...	13

Em. II 551

3	...	18
5	...	20
7	...	22
10	...	
12	...	

PLATE IV

K. 612

...

W 1924, 802 Reverse

10	...	10
11	...	11
12	...	12
14	...	14
15	...	15

3152

E



K 2321 + 3032 Obverse

2  
4  
6  
8  
10  
12  
14  
16  
18  
20  
22  
24  
26  
28

Handwritten Chinese characters in vertical columns, numbered 2 through 28. The text is arranged in a grid-like fashion with some irregularities in line lengths.

K 2321 + 3032 Reverse

7  
9  
11  
13  
15  
17  
19  
20  
22  
24  
26

Handwritten Chinese characters in vertical columns, numbered 7 through 26. The text is arranged in a grid-like fashion with some irregularities in line lengths. There are some annotations and markings on the page, including a circular stamp and a note at the bottom left.

Annotations:  
 - K 2321 R2  
 - K 2321 R7  
 - R. 2321  
 - Here text has a gloss as a gloss

## CHAPTER V

## PAST STUDIES OF THE SUBJECT

AMONG the tablets discovered by SIR HENRY LAYARD in his excavation of the library of Ashurbanipal at Kuyunjik, the ancient Nineveh, in 1850 and following years, and deposited in the British Museum, is a document in the Assyrian language (K. 160), the cuneiform text of which was published by SIR HENRY RAWLINSON and GEORGE SMITH, *Cuneiform Inscriptions of Western Asia*, vol. iii (1870), pl. 63, under the title of 'Table of the Movements of the Planet Venus and their influences'. This text, which as we know contained serious errors, was reprinted with interlinear transcription and translation by SAYCE, *The Astronomy and Astrology of the Babylonians, with Translations of the Tablets relating to these Subjects*, TSBA. iii (1874), pp. 316-39. The translation is fairly successful as a rendering of the astronomical contents, but it expresses the different phenomena categorically, instead of hypothetically, and the duration of invisibility of Venus is in each case given as the date of reappearance measured from the date of disappearance. This latter error is of purely grammatical importance. It is not surprising that the eighth line, which contains the year-formula of the eighth year of the reign of Ammi-zaduga, expressed as usual in the Sumerian language, should have been wrongly read and, in consequence, not recognized as a date. The system of dating by year-formulae was first made known by GEORGE SMITH in his paper *Early History of Babylonia*, TSBA. i (1872), pp. 45 ff. SMITH's paper gave translations of many such formulae, but no cuneiform texts. There was, therefore, nothing to suggest that the words in the eighth line were such a formula. In SAYCE's paper the text and translation are not accompanied by any commentary or other attempt at the explanation of the tablet, which is briefly described<sup>1</sup> as a long table of the phases of Venus. How completely it could be misconceived is shown by a reference made by LENORMANT, *La Divination* (1875), p. 21, note, who refers to SAYCE's paper and describes the document as a complete table of the movements of the planet and of auguries from its positions during one year.

A translation of the text with an astronomical discussion was contributed by BOSANQUET and SAYCE under the title of *The Babylonian Astronomy*, No. 3. *The Venus Tablet* to MN. 40 (1880), pp. 565-78. The translation differs very little from that which SAYCE had published six years earlier, and contains substantially the same false interpretation of the line which is now known to contain the year-formula. In this paper BOSANQUET and SAYCE went far in the way of interpreting the tablet. They realized that it consisted of three parts, the first of which contained a series of observations of Venus including last appearance in the east, first appearance in the west, last appearance in the west, first appearance in the east, continued through at least six synodic periods, the day of the month of each phenomenon and the duration of invisibility being recorded. The rest of this part they considered too imperfect for analysis. The second part they found to be different in style and grammar from the rest; and, though it contained phenomena of Venus similar to those contained in the first part, they noticed that these were made to recur at uniform intervals; by a not unnatural misunderstanding they concluded that it gave Venus a synodic period six months too long, and decided that it was a fabrication by some person wholly

<sup>1</sup> p. 196.

unacquainted with the phenomena. The third part was found to be analogous to the first and to consist of a continuous series of observations. BOSANQUET and SAYCE were in doubt whether the calendar to which the observations were referred was a lunar calendar or one where each month contained 30 days. They realized that the date of a conjunction of Venus and the Sun with its attendant disappearance and reappearance of the planet recurred at periods of just under eight years, and computed that Venus would return to the same phase at the same date in the sidereal year at the close of a period of 235.182 sidereal years. They went on to say:

'It would be quite possible in this way to calculate the dates at which the observations of this tablet could have been made; but a conjectural element enters into the reconstruction of the calendar of the observations. And as there is nothing to associate these observations with historical dates, there is no possibility of a real contribution to ancient history in this case.'

The astrological influences of the phases were not discussed in this paper.

Though unable to date the observations astronomically, they observed that the antique style and the fact of their belonging to the collection supposed to have been made by Sargon of Agade tended to refer them to a period older than 1700 B. C.

BOSANQUET and SAYCE's analysis of the observations may be made clearer to those who are not astronomers by a little explanation of the successive phenomena of the planet Venus. Venus, moving in an orbit smaller than the Earth's, must always appear to be much in the same direction as the Sun. She may sometimes be to the left of the Sun, sometimes to the right of him, but she is never more than 48° distant from him, and at her greatest distance crosses the meridian between three and four hours before or after him. The result is that she can only be seen in the morning before sunrise or in the evening after sunset, and if she is very near the Sun she cannot be seen at all, except that very clear-sighted people may sometimes see her near the Sun in broad daylight. We have no mention of any such observation at Babylon. Venus is therefore in succession:

- (1) the evening star, Greek Hesperos and Latin Vesper;
- (2) invisible;
- (3) the morning star, Greek Phosphoros, Latin Lucifer;
- (4) invisible;

and then the evening star again.

The synodic period or mean duration of the four phases is 584 days, while the length of the individual phases is variable. Five of these periods will last 2,920 or, more exactly, 2,919½ days; eight solar years are 2,922 days; 99 lunar months are 2,923½ days. The result is that a particular phase of Venus recurs at the same season of the year and month at intervals of eight years; only the return is not absolutely exact, for it falls about 2½ days earlier in the solar year and 4 days earlier in the lunar month. From this it follows that if a conjunction of Venus with the Sun falls two days after new moon, it may be expected to fall two days before new moon eight years later, but will not fall near new moon again till 64 years after the first date, when eight intervals of four days will have amounted to a complete month. At this recurrence the conjunction will fall 17 days earlier in the solar year, so that if the exact position of the calendar months in the solar year is not fixed, a phase of Venus may recur in the same month and on or near the same day of the month at intervals of 8, 56, 64, and even 112 or 120 years. When Venus at conjunction is between the Earth and the Sun, she is said to be at inferior conjunction; when the Sun at conjunction with Venus is between her and the Earth, Venus is said to be at superior conjunction.

The notice of the tablet by BEZOLD, *Catalogue of the Cuneiform Tablets in the Kouyunjik Collection of the British Museum*, vol. i (1889), p. 42, recorded the fact that it is in neat Assyrian characters, but added nothing further to our knowledge. It is there described as 'Astrological forecasts'. The second volume of this catalogue, also by BEZOLD (1891), contains notices of two other tablets which, as we now know, contain some of the same appearances and disappearances of Venus as K. 160. These are K. 2321 + K. 3032 and K. 7072. The first of these is described as 'Babylonian Astrological forecasts, which form, according to the colophon, the 63rd tablet of the Series "When Anu and Enlil"'.<sup>1</sup> The obverse begins "...na disappeared in the west, remaining absent in the sky 3 days, and".<sup>2</sup> K. 7072 is thus described, 'Fragment out of the middle, 2½ in. by 1½ in. 7 + ... lines. Fragment of a text containing astrological forecasts for the various months, taken from observations of the Star Nin-si-an-na'.<sup>3</sup>

In the fourth volume of the catalogue (1896) BEZOLD deals with three more tablets which are now known to preserve parts of our text. One of these, S. 174, is described as 'Fragment out of the middle 1⅞ in. by ⅞ in.; 9 + ... lines. Part of a text containing astrological forecasts taken from observations of the Sun', a somewhat misleading description of a text which gave little indication of its character. Another, Rm. 134, is described as 'Left half, upper portion, 2⅞ in. by 2½ in.; 10 + ... lines. Part of a text containing astrological forecasts similar to those of K. 7072'. Then follow the words in cuneiform with which each paragraph begins. The remaining text, Rm. II 531 is described as 'Fragment of the left half, 2½ in. by 1½ in.; 15 + ... lines; partly vitrified. Part of a text containing astrological forecasts for the various months, taken from observations of the "Nin-si-an-na," and other stars'. As will be seen from LANGDON'S study, the document is not arranged by months, and is not taken from observations of any star except Ninsianna, i.e. Venus.

In 1898 JASTROW dealt briefly with K. 160 in his *Religion of Babylonia and Assyria*, pp. 371, 372, and translated select passages from the first and second part of the document. His translation differs in detail from SAYCE'S and in particular he correctly translates the intervals of disappearance as such; he recognized the hypothetical form of some of the appearances in the second part of the tablet, but still treats the statements in the first part as categorical; but his suggestions for the translation of the eighth line were equally unhappy with his predecessor's. He also made the suggestion that the document belonged to the series 'Illumination of Bel', i.e. to the series 'When Anu and Enlil', a conjecture that was destined to be confirmed by SCHIAPARELLI'S identification of this document with that represented by K. 2321 + K. 3032. On the whole JASTROW, unlike BOSANQUET and SAYCE, showed more interest in the astrological than in the astronomical significance of the documents.

In 1899 J. A. CRAIG published in *Assyriologische Bibliothek*, xiv, cuneiform texts of the documents belonging to the series known as the 'Illumination (?) of Bel', so far as he was able to recover them. No. 46 in this volume contains the text of K. 2321 + K. 3032 and of K. 3129, which professes to be the 63rd of that series. It is no discredit to CRAIG that his text should have been found to contain errors which are corrected by LANGDON in this volume.

So far attention had nowhere been drawn to the partial identity of any of these different texts dealing with Venus phenomena. This was reserved for the Italian astronomer SCHIAPARELLI, whose 'Venusbeobachtungen und Berechnungen der Babylonier', *Das Weltall*, 6. Jahrg.,

<sup>1</sup> BEZOLD gives the cuneiform text of this phrase. I owe this translation to LANGDON.

<sup>2</sup> LANGDON'S translation.

<sup>3</sup> Printed in cuneiform.

Heft 23, 7. Jahrg., Heft 2 (1906), constitutes a most important study of the character and interpretation of these texts. He recognized that K. 2321 + K. 3032 contains fragments of two documents, one of which, on the obverse, is the same as the main document of K. 160, though, since both tablets are imperfect, the greater part of each lies outside the range of the other. This document, which he called C, he recognized as containing a continuous series of observations of appearances and disappearances of Venus, preserved for 21 consecutive years. He conceived that in its complete state it would have contained three Venus periods or 24 years. The document on the reverse of K. 2321 + K. 3032 which he called B was, he found, a series of actual observations of disappearances and appearances of Venus arranged according to the months in which they occurred, without any mention of the years to which they belonged. Relying unduly on the accuracy of the numbers in the published texts, he held that these observations were entirely distinct from those in Document C. The insertion which forms the second part of K. 160, which SCHIAPARELLI called Document A, was found by him to be a table by means of which, given the time of any reappearance of Venus, the time of the next disappearance and reappearance could be computed, assuming mean intervals between the different phenomena. With a mean lunation of 29.5 days, he found that the intervals used implied a synodic period of 577.5 days, about 6.4 days less than the true period of 583.9 days. He noticed the close similarity of all these texts in form and character and in terminology, and laid stress on their all using exclusively what he regarded as the rare name *Nin-si-an-na*, or, as he wrote it, *Nin-dar-an-na*, for Venus, from which he inferred that the three documents had their origin in the same astrological school, and therefore, since Document A professes to be copied from a Babylonian original, he inferred that all three documents must be of Babylonian origin. BEZOLD had already recognized that, while K. 160 is in Assyrian script, K. 2321 + K. 3032 is in Babylonian script. SCHIAPARELLI, while exhibiting in full the recorded dates of disappearance and reappearance with the recorded intervals of invisibility, as he found them in the printed cuneiform texts, and in the case of Document C assigning them to their proper year in the series of 21 years, did not attempt a translation of any of the documents, but illustrated their character with a few examples. Like SAYCE, he treated the expressions as categorical, but like JASTROW, to whom he does not refer, he translated the references to intervals of invisibility correctly. While realizing that the real value of the record for the Babylonians lay in the astrological omens, he neither collected these nor dealt with them in detail.

Among the most interesting parts of SCHIAPARELLI'S paper are his astronomical examination of Documents B and C and his attempt to determine the date of the observations contained in the latter document. He assumed that the dates exhibited on the tablets were not all observations in the modern sense, but that in a minority of instances observation had been impossible, and the recorded dates had been deduced by computation from other observations. Neglecting what appeared to be doubtful dates, he found that the intervals of invisibility at inferior conjunction yielded an *arcus visionis* of 5.42°, and with this value he proceeded to determine the series of years which would best agree with the recorded dates of the Venus phenomena. Since the tablets were found at Nineveh, he assumed that the observations must be older than the destruction of that city, which was then placed in 606 B.C., while an upper limit seemed to be provided by the reference in Document A to a disaster of the *ummān-man-da* or Manda hordes, with which he identified the *ummān-matti* (properly 'army of the land'), which suffers disaster in Documents B and C. Believing that the *ummān-man-da* made their first appearance in

history in the eighth century before Christ, and being impressed by their complete absence from the extensive records of Ashurnasirpal II, Shalmaneser III, and Shamshi-Adad V, whose reigns extend from 882 to 810 B. C., he concluded that his inquiry could be limited to the seventh and eighth centuries before Christ. He found that the solution depended on the assumed position of the Babylonian months in the solar year. With a mean date for the 1st of Nisan 16 days after the spring equinox, he found 657 B. C. as the first of the series of 21 years; with mean 1st of Nisan 18 days after the equinox he found 665 B. C.; with mean 1st of Nisan 11 days before the equinox he found 812 B. C., in which case the 17th year, with which the defeat of the *ummān-man-da* was connected, fell in the year 796 B. C. and would, so he thought, be the earliest well-attested reference to that people. Finally he found that with the mean 1st of Nisan five or seven days later than the equinox, the data would be satisfied by a series of years beginning in 868 or 876 B. C. respectively. He left it to orientalists to determine whether so early a reference to *ummān-man-da* was possible. He felt, however, that the dates 657, 665, and 812 B. C. were more probable, but that new discoveries and investigations would be necessary to decide the question. As an example of method this work is excellent. Unfortunately for these conclusions, the Manda are now known to have been mentioned as far back as the Hittite laws of the seventeenth century B. C. A clue to the date had yet to be discovered.

In 1908 appeared the two parts *Sin* and *Ishtar* of VIROLLEAUD'S *L'Astrologie Chaldéenne, Texte Cuneiforme*, the former of which contained those documents believed to belong to the book entitled *enuma* (Anu) <sup>in</sup> *Bel* (now read *enuma Anu in En-lil*) which dealt with the Moon and the latter those which dealt with the fixed stars. The frontispiece to *Sin* is a photograph of K. 160. No. XII in *Ishtar* is a composite text, in which lines 1-15 are lines 1-15 of the obverse of K. 2321 + K. 3032, lines 16-27 are a conflate text based on lines 16-27 of K. 2321 + K. 3032 and lines 1-14 of the obverse of K. 160, and lines 28-43 are lines 15-30 of K. 160, ending where the series of observations is interrupted at the conclusion of the first part of that document. No. XIII is the second part of K. 160. No. XIV is the third and concluding part of K. 160. No. XV is the reverse of K. 2321 + K. 3032. A transcription of these texts was published by VIROLLEAUD in 1909 in *L'Astrologie Chaldéenne, Transcription, Ishtar*. The same editor published in 1910 a *Supplément* to his *L'Astrologie Chaldéenne*, in which he included as No. XLI the cuneiform text and transcription of Rm. 134, and as No. XLII the cuneiform text and transcription of K. 7072. He also included the cuneiform text of S. 174 in his 'Fragments astrologiques', published in the same year in *Babyloniaca*, iii. 285.

1910 is also the date of FATHER KUGLER'S *Im Bannkreis Babels*. In a note on pp. 147-8, he showed that, reckoning the month at a conventional length of 30 days and the year at a conventional length of 360 days, the insertion in K. 160—SCHIAPARELLI'S Document A—implies a synodic period of 587 days.

Next in order of time comes JASTROW'S German treatise, *Die Religion Babyloniens und Assyriens*, II. Band, II. Hälfte, pp. 617-25, which bears on its title-page the date 1912, though the earlier part of the half-volume was in the hands of scholars in time to be used by them in works which appeared in 1911 and 1912. In this treatise JASTROW makes use of VIROLLEAUD'S work, but appears to have been ignorant of SCHIAPARELLI'S. He gives a translation of the texts of the two documents which SCHIAPARELLI had called B and C, beginning with the 12th line of the obverse of K. 2321 + K. 3032. He regards the two documents as a single text broken by a gap of unknown length. Though he recognizes that the dates on the tablets are

derived from observation, he attempts no astronomical control, and his emendations of dates are in consequence unfortunate. The references to the appearances are recognized as hypothetical throughout. The mysterious phrase in the eighth line of the obverse of K. 160, the twenty-first of the obverse of K. 2321 + K. 3032, once more has a false meaning found for it, but JASTROW'S interest was mainly in the omens and in their relation to the phenomena. He imagined that he had discovered that a medium interval of invisibility was accompanied by a favourable omen, while an interval which was short or long for its particular phase was accompanied by an unfavourable omen, a somewhat curious result since in the same work he translates in full Sm. 781, col. ii (VIROLLEAUD, *Supplément*, No. XXXVII), which gives omens in good general agreement with those of K. 2321 + K. 3032, but makes them depend entirely on the month in which Venus disappears, giving different omens according as the disappearance is in the morning or in the evening, and taking no notice of the duration of invisibility. JASTROW also translates the insertion (SCHIAPARELLI'S A) but in view of the schematism of its intervals of visibility and invisibility, and, as he thinks, of its omens in relation to the season of the year for the different phases, he suspects that it is merely a school exercise.

In 1911 WEIDNER contributed to *Memnon*, v 29-39, a paper entitled 'Die astronomische Grundlage des Venusjahres', in which he included a transcription and translation of this insertion, deduced from it the knowledge of a synodic period of Venus amounting to 584 days, and by a somewhat bold argument tried to show that the document in its original form dates from the end of the fifth millennium before Christ.

In 1912 KUGLER produced Teil II, Heft I, of the second book of his *Sternkunde und Sternendienst in Babel*. Pp. 257-311 of this publication are concerned with the two Venus tablets which had engaged the attention of SCHIAPARELLI and with discussions arising out of them. He writes with full knowledge of the work of his predecessors, but gives neither full text nor full translation of the documents, nor even a full *résumé* of SCHIAPARELLI'S criticism on which he builds. In order, therefore, to follow KUGLER in detail it is necessary to refer to the older studies of the documents. He has, also, chosen to rename the documents and in so doing has used SCHIAPARELLI'S names in a new sense. Thus SCHIAPARELLI'S A is KUGLER'S B. The text of SCHIAPARELLI'S B, found on K. 160, is KUGLER'S A, and the two texts, B and C in SCHIAPARELLI'S notation, found in K. 2321 + K. 3032, are called by KUGLER, A'. I prefer, with SCHIAPARELLI, to use the letters of the alphabet as names for documents, in preference to KUGLER'S system, in which the nomenclature is partly by documents and partly by tablets, but in order to avoid the confusion of using a symbol in a different sense from that in which it has been used by KUGLER I will in the present study use the terms L, M, and N, which have not hitherto been used in this connexion.

L is the document in which the phenomena are arranged in chronological order, and is equivalent to SCHIAPARELLI'S B. It is found on K. 160, Obv. 1-29, Rev. 34-45; K. 2321, Obv.; Rm. II, 531; W. 1924, 802, Obv.

M is the document in which the phenomena are arranged in calendrical order, and is equivalent to SCHIAPARELLI'S C. It is found on K. 2321, Rev.; K. 7072; Rm. 134; S. 174.

N is the document containing an artificial series of phenomena, inserted in K. 160, and is equivalent to SCHIAPARELLI'S A. It is found on K. 160, Obv. 31-Rev. 33.

KUGLER devotes some space to a more detailed demonstration of the conclusion, which he had drawn from Document N, that its compiler regarded 19 months 17 days or 587 days as the con-

ventional length of the synodic period of Venus, and replies to SCHIAPARELLI's deduction of a period of  $577\frac{1}{2}$  days and WEIDNER's deduction of one of 584 days. KUGLER is undoubtedly right, so long as we recognize that the conventional month is not an exact period independent of the calendar month, but is merely the calendar month reckoned inexactly. The writer would not expect the synodic phenomena to recur at a mean interval of 587 days precisely, but at an interval of 19 months 17 days which might be treated for purposes of computation as 587 days, but would not be so treated for purposes of observation. The observer would look for a repetition of the phenomena after 19 calendar months 17 days, ignoring intercalary months. It seems impossible to convert this into an exact number of days, and we must not suppose that the writer imagined that he knew the exact number of days in the synodic period.

After a few explanatory remarks KUGLER proceeds to give a transcription and translation of K. 160, obv. lines 1-14, as a specimen of the character of the text. Like the earlier translators he treats the references to phenomena as categorical. Then follows a tabular presentation of the phenomena contained in Document L, so far as it is represented by K. 160. This is followed by a discussion of some length in which very little use is made of K. 2321 + K. 3032, and the impression is created that the discussion was written before KUGLER was aware that the two tablets represented the same document, and was only imperfectly revised afterwards. The discussion begins with a presentation of late Babylonian material illustrating the length of the synodic period of Venus and the intervals between the different appearances and disappearances. He then proceeds to deduce the intercalary years from the intervals separating the phenomena recorded in K. 160. Here he fails to show his usual arithmetical skill. Using \* for a year with second Adar and \*\* for a year with second Ulul, he gives the following as intercalary years. [For convenience I number the years from the beginning of Document L, adding 6 to the number given by KUGLER.] (9)\* or (10)\*\*, (11)\*\*, (14)\*\*, (17)\*, (19)\*\*, of which (11)\*\* and (19)\*\* are directly attested. If he had reckoned the intervals accurately he would have found (9)\* or (10)\*\*, (11)\*\*, (13)\*\*, (19)\*\*, (20)\*\* or (20)\*.<sup>1</sup> Or, accepting his conjectural emendation of the western rising in the 13th year, he should have had (9)\* or (10)\*\*, (11)\*\*, (13)\* or (14)\*\*, (19)\*\*, (20)\*\* or (20)\*. These will be discussed later along with the other intercalary years.<sup>2</sup>

Then follows a critical and in large measure successful investigation of errors made by copyists, followed by a very unconvincing attempt to detect and explain errors which appear to go back to the parent document. There remains a residuum of dates which KUGLER regards as trustworthy and which are reserved for an astronomical test when a clue shall have been found to the age of the tablet. The dates so selected have at least the merit of not being prima facie incoherent. One group among them is affected by textual uncertainty. The others are probably among the best in the series.

KUGLER next endeavours to prove that the constant values used for intervals in Document N are derived from the figures contained in Document L, or in that part of it which is represented by K. 160. The whole argument appears to be a piece of arithmetical jugglery. It is based upon arbitrary assumptions as to the length of mean lunation used by the author of N, now 30 days, now  $29\frac{1}{2}$  days, as suits KUGLER's convenience. It is based on arbitrary assumptions

<sup>1</sup> The dates of observations at inferior conjunction in Adar of the 17th year and at superior conjunction (Sivan-Ulul) in the 20th year show that there was only one intercalation between these conjunctions.

<sup>2</sup> KUGLER is in fact merely repeating an error made by SCHIAPARELLI, who found that Years 9, 11, 14, 17, and 19 were intercalary.

as to his use of intercalary months, and it is based on arbitrary assumptions as to the extent to which the corruptions, existing in K. 160, were in the text used by the author of N. It also assumes what seems very doubtful, that the first five years of the text of L were already missing in the older text from which N is derived, while the sixth year, which is also missing from K. 160, is supposed to have been present.

Then KUGLER announces his great discovery, that the misunderstood words in line 8 of the obverse of K. 160, line 21 of the obverse of K. 2321 + K. 3032, are the year-formula of the eighth year of Ammizaduga, and this announcement is followed by a table giving the complete series of dates recorded in Document L as obtained from a combination of K. 160 with the obverse of K. 2321 + K. 3032, such a table as SCHIAPARELLI had previously compiled. Here it is shown that the year-formula in question belongs to the eighth year of the twenty-one years of the document, which, as KUGLER rightly concludes, contains the twenty-one years of the reign of Ammizaduga.

Then comes an exposé of the dates on the reverse of K. 2321 + K. 3032 (Document M). KUGLER ignores SCHIAPARELLI's recognition of these as a single series of observations arranged according to the months in which they fell, and breaks them up into three series. First he finds a series of four pairs of observations near inferior conjunction arranged in calendrical order, then five pairs near superior conjunction the order of which he does not explain, and finally three pairs of observations consisting of one at inferior, one at superior, and another at inferior conjunction. He supposes that the two first of these three are in chronological order, but infers from the duration of invisibility in the last that it cannot follow chronologically its predecessor on the tablet. On the whole he realizes that these observations are not chronologically continuous with those in Document L, and pays no further attention to them. He also ignores the astrological omens.

Then he resumes his comparison of the dates of Document L with those of the reign of Ammizaduga and points out that the leap-years in the reign of Ammizaduga known to us through contracts are 4\*, 10\*\*, and 11\*\*, where, as before, \* indicates a year with second Adar and \*\* a year with second Ulul. This, as he points out, is the only example known to us of a second Ulul being intercalated in two successive years,<sup>1</sup> and this is supported by the intercalations in Document L, where, as has been seen, a second Ulul is directly attested in the eleventh year, while the tablets imply either a second Adar in the ninth year or a second Ulul in the tenth year and are therefore consistent with a second Ulul in the tenth year.

Having established that the observations belong to the reign of Ammizaduga, KUGLER next seeks an astronomical verification. He points out that each observation of an appearance or disappearance of Venus, being dated by the lunar month, involves a more or less definite relation between the Sun, Venus, and the Moon. The reference to Ammizaduga limits the inquiry to a few centuries, and he assumes that he need only examine dates falling between 2080 and 1740 B.C. He does not regard the position of the Babylonian months in relation to the Julian calendar as absolutely fixed, but thinks it safe on a superficial examination of contracts relating to harvest to suppose that Nisan began not earlier than the middle of the Julian March nor later than the middle of the Julian June. In order to avoid elaborate computations he examines in the first instance one pair only of the dates which he had previously found to be

<sup>1</sup> We now know that second Ulul was intercalated in the 39th and 40th years of Hammurabi, and in the 8th and 9th and again in the 16th and 17th years of Samsuiluna.

trustworthy, the western setting of Venus in the 6th year on Arahšamna 28, followed by her eastern rising on Kislev 1, an interval of three days only, from which he concludes that the inferior conjunction must in that year have been within two or three days of the new moon of Kislev. He then seeks between 2080 and 1740 B.C. for inferior conjunctions between the middle of November and middle of February of the Julian calendar falling within two or three days of new moon. He finds nine such phenomena, but he has for some reason overlooked the conjunction of -1759 February 1. He then proceeds to narrow the selection further by the assumption, which, even if the computed dates of conjunction and new moon were beyond doubt, would not be astronomically justifiable, that the interval between new moon and conjunction must not exceed a day. In this way he has only three solutions left. These would make the first year of Ammizaduga begin in 2041, 1977, and 1857 B.C. respectively. After noticing that of these three dates 1977 B.C. agrees best with the conclusions hitherto attained by Assyriologists and historians, KUGLER proceeds to test it by an astronomical computation of the angular depression of the Sun below the horizon at the time of rising or setting of Venus on a series of dates of first or last visibility of that planet, as given in Document L. The test is made almost entirely by means of observations near inferior conjunction, only two pairs of observations near superior conjunction being subjected to the test. Altogether KUGLER finds two instances where both the dates of evening setting and morning rising are confirmed by computation, four instances where one of the two is confirmed, two instances where both dates would hold good for observations separated by eight or sixteen years from the years implied in the document, and three instances where one observation in each pair would hold good if transferred eight or sixteen years backwards or forwards. He also finds two instances where the date given for evening setting would hold good for morning rising. In the last of these instances, belonging to the 13th year of Ammizaduga, he has exhibited no computation, and it would appear that his statement that Venus should be visible on Ayar 5 of that year is even on his own data erroneous, and should be changed to Ayar 7, which is inconsistent with his proposed correction of the reading in the text. From the frequency with which he has succeeded in explaining apparently false dates by transferences of genuine dates by eight or sixteen years KUGLER infers that the compiler of our Document L had before him a list of observations in chronological order in which several of the dates were missing or illegible and that these have been restored from a document similar to Document M in which the observations were arranged in calendrical order without any indication of the year to which they belonged. To this it may be replied that, so long as the recorded dates are in the neighbourhood of the computed dates, any conceivable discrepancy could be explained by KUGLER's method. If a recorded last visibility falls a few days before, or a recorded first visibility a few days after, the computed date, we merely assume that Venus was missed for a few days. If the difference between observed and computed dates is in the opposite direction or is too long to be explained by this method, we merely transfer the observation eight or sixteen years backwards or forwards, for since the phenomena always recur four days earlier in the lunar month at the end of each eight-years period any discrepancy not exceeding eight days can be explained in this way. The combination of these devices gives a far better result on the assumption that the pair of observations in the 6th year really belongs to that year than on the assumption that it has been transferred eight years. The date 1977 B.C. for the first year of Ammizaduga is therefore supposed to be established as against 1985 B.C.

It remains to compare it with a possible 2041 or 1857 B.C. This time the test is no longer strictly astronomical. As has been remarked in our discussion of BOSANQUET and SAYCE, after the lapse of an eight-years period, a conjunction of Venus falls about  $2\frac{1}{2}$  days earlier in the solar year than it had done at the beginning of that period. In 64 years the date of the phenomenon in the solar year is shifted by 19 days, and in 120 years it is shifted by 35 days. KUGLER doubted whether an astronomical verification would yield a decisively different result so far as the comparison of computed appearances and disappearances of Venus with the lunar calendar is concerned, but he considered it possible to discover by means of literary evidence at what season the months named on our documents fell, and thus to choose between theories which placed those months at perceptibly different seasons of the natural year. With this end in view he began by computing the date of equinox for each year from the 7th to the 21st of Ammizaduga on the assumption that his first year began in 1977 B.C., and the date of the new moon of Nisan for each of these years on the assumption that the months in which the phenomena were recorded had been correctly identified in his astronomical study. This of course included the assumption that his inferences as to the position of intercalary months were correct. As has been seen, he places the beginnings of the 18th, 19th, and 20th years one month too late. When, therefore, he deduces that on the theory in question the mean interval between the equinox and the 1st of Nisan was 35.15 days, we must correct this figure by deducting  $29.53 \times \frac{3}{15}$  days, i. e. 5.91 days, so that the mean interval becomes 29.24 days. In view, however, of the fact that the first and last years of this series both began later than the mean date, KUGLER thought it wise to include the 6th year, which he assumed to be a leap-year with second Ulul. He overlooked the fact that this assumption would place eleven lunar months approximately between inferior conjunction in the 6th year and superior conjunction in the 8th year, an interval too long by one month. It will be seen, therefore, that he places the beginning of the 6th year one month too early, so that his mean interval between equinox and the new moon of Nisan as determined from the 16 years requires to be reduced by  $29.53 \times \frac{1}{16}$  days, i. e. by 3.69 days, or from 34.59 to 30.90 days. Adding 1.50 days for the mean interval between new moon and the beginning of Nisan, he obtains a mean interval of 36 days between equinox and Nisan 1, and fixes the mean position of the latter at April 26 of the Gregorian calendar. Adopting the above revision of the position of his intercalations, we find that April 22 would have been more correct. He notes that the earliest new moon of Nisan in these 16 years fell 23 days before the mean date, and the latest 16 days after the mean date. Making the corrections mentioned above, the extremes should be 29 days earlier and 26 days later than the mean date. KUGLER contrasts this mean date for Nisan 1 with that which he found for the period 358 to 339 B.C., when it was April 4 Gregorian. It will be seen from the table which he published on p. 285 of the study under discussion that if he had chosen to shift his whole chronology by seven Venus periods, or 56 years, all the lunar dates would have fallen 18 days earlier in the solar year, and we should have had April 4 for the mean date of Nisan 1 in the years 6-21 of Ammizaduga as well as in the years 358-339 B.C.

KUGLER then proceeds to demonstrate to his satisfaction that such a transference of the calendar months by 18 days backwards or forwards is inconsistent with the information supplied by those dated contracts which can be connected with agricultural operations. He cites from modern writers the opinion that the Babylonian harvest season begins about May 10 and closes about the end of that month. These dates probably relate to wheat-harvest, and it will be seen

later that they are far too late for barley-harvest, which was the principal harvest in the time of the first dynasty of Babylon, and that the correct date is from about April 10 to May 15, so that KUGLER's error in the date of harvest exactly coincides with the difference between a year beginning in the mean on April 4 and one beginning in the mean on April 26. If, therefore, the evidence which KUGLER has collected supports his chronology on the assumption that his date for harvest is correct, it would support a chronology falling 56 years later, when the correction just mentioned is applied.

KUGLER then produces a series of contracts from KOHLER and UNGNAD's *Hammurabi's Gesetz*. He deals first with contracts to make payments in silver or barley 'at the time of harvest' and finds that these generally imply that the harvest was later than the eleventh month, while six contracts imply that it fell in the twelfth month at the earliest, and two contracts of the reigns of Sinmuballit and Hammurabi would place it at the earliest in the first month. Then he cites from the same source a series of contracts hiring labourers for the coming harvest. The latest dated of these is on the 30th day of second Adar in the 4th year of Ammizaduga, which KUGLER equates with April 30 Gregorian. This he considers fatal to any attempt to throw the chronology 56 or 64 years farther back, which would bring it to May 18 or May 16. Of course, if we threw back the date of harvest 22 days, this contract would tell with equal force against KUGLER's own solution.

KUGLER then proceeds to deal with contracts for letting fields. He gives examples from KOHLER and UNGNAD of such contracts for every month from Arahsamna to Ayar, citing altogether 19 from Ayar, 9 from Nisan, 2 from Adar, 1 from Šabat, 1 from Tebit, 1 from Kislev, and 9 from Arahsamna. A reference to KOHLER and UNGNAD will, however, show that two of the last-named really belong to Tešrit, and KUGLER himself treats one of them as belonging to Tešrit in his discussion. He supposes that contracts dated in Nisan and Ayar were made after harvest, while those dated in other months were made before harvest, and infers that Nisan was the proper harvest month. This argument appears to be very precarious. The agricultural operations of the year would not be concluded until the corn was threshed and divided between landlord and tenant. It may be presumed that a contract for the new year was generally made before these operations were concluded, but it seems unsafe to suppose that such contracts were regularly made after harvest. KUGLER, however, uses it as a means to prove that the chronology cannot be reduced by 56 years, in which case he remarks that Ayar, not Nisan, would be the harvest month, and the Ayar contracts could not be made to fall after harvest. He also supposes that the Arahsamna and Tešrit contracts were made immediately before seed-time, which, according to him, would be in November and December. This he thinks is consistent with the solution which he favours, but inconsistent with one 64 years earlier, which would place these contracts at the end of December. This again appears to be a precarious argument. It should be noted that contracts for letting fields are to be found in KOHLER and UNGNAD in every month of the Babylonian year. KUGLER's selection is far more exhaustive in Nisan, Ayar, and Arahsamna than in the other months, and must not be taken as evidence of the actual distribution of lettings throughout the year. KUGLER's final conclusion is that the contracts by which Babylonian months can be correlated with definite seasons of the year exclude all solutions separated by 56 years or more from that which makes the first year of Ammizaduga begin in 1977 B.C., while solutions differing by less than 56 years from this solution are astronomically inadmissible.

The whole discussion must be regarded as a masterly piece of work, and while it is open to

criticism in detail, the method is excellent. It is to be regretted that KUGLER did not attempt a more complete astronomical computation of the recorded phenomena both on his own and on alternative theories, and also that he adopted a questionable date for harvest, and thus weakened the effect of the contracts as a means of deciding between rival astronomical theories.

The discussion is followed by a chapter on the relative positions of the First, Second, and Third Babylonian Dynasties, which lies outside the scope of my share in the present work.

KUGLER's conclusions met with general acceptance, but doubt was expressed in 1913 by EDUARD MEYER, *Geschichte des Altertums*, 3<sup>e</sup> Aufl. i. 2, pp. 369-72, who, while provisionally accepting KUGLER's chronology, expressed himself unable to check his astronomy or to judge of the correctness of his conjectural emendations of the text. He found the chronology in good agreement with that current in later times in Babylon, but in disagreement with that current in Assyria, and pointed out that it requires us to assume that more than five hundred years (1925 to 1380 B.C.) elapsed without any private documents and with hardly any inscriptions. He therefore regarded it as not excluded that these dates might hereafter be found untenable.<sup>1</sup>

In the following year WEIDNER expressed the opinion that KUGLER's restoration of the chronology of the First Dynasty of Babylon was extremely problematical. See his *Alter und Bedeutung der babylonischen Astronomie*, p. 69, where, founding on a neo-Babylonian tablet published by KING in *Cuneiform Texts*, xxxiii, and on an unpublished duplicate of the same, according to which the vernal equinox appears to be placed on Nisan 15, he drew the inference that at least since the time of Hammurabi Nisan 15 coincided in the mean with the vernal equinox, a conclusion inconsistent with KUGLER's, which appeared to place it 50 days in the mean after the equinox.

In 1915 KING expounded and discussed the new chronology in his *History of Babylon*, pp. 106-18. He mentions KUGLER's three astronomical solutions, and decides with KUGLER for 1977 B.C. as the date of the first year of Ammizaduga on the ground that this agrees with the duration of 368 years which the kings' list assigns to the Second Dynasty, and he finds it supported by both Babylonian and Assyrian statements of a later age.

In 1917 there appeared in MVAG. xx, 1915, 4, a long article by WEIDNER entitled *Studien zur assyrisch-babylonischen Chronologie und Geschichte auf Grund neuer Funde*. On p. 24 of this article WEIDNER announced that an astronomical examination of the Venus tablets would shortly appear, from which it would be seen that the most probable date for the First Dynasty of Babylon lay 168 years later than KUGLER's. This new chronology was brought into connexion with the chronology of Assyria, and WEIDNER maintained that it agreed with all the statements of a later age except those of Nabuna'id.

We learn from a later paper by WEIDNER<sup>2</sup> that the new examination of the Venus tablets was the joint work of himself and NEUGEBAUER and that it involved some corrections of the text. In 1925 SCHNABEL<sup>3</sup> published the fact that the manuscript of this study was lost in the German revolution of 1918.

In 1920 HOMMEL, in an appendix to *Assyr. Bibl.* xxv, Nies, 'Ur Dynasty Tablets', pp. 197-9, expressed the view that the year-formula of Ammizaduga's 8th year was inserted into the Venus tablets by a scribe in the reign of Ashurbanipal, who adopted a system of chronology current

<sup>1</sup> The same criticisms had been expressed by MEYER in *Sitzungsberichte d. k. preuss. Akad. d. Wissenschaften*, 1912, pp. 1063, 1064, except that he did not on that occasion suggest that KUGLER's dates might hereafter be found untenable.  
<sup>2</sup> MVAG. xxvi (1921), 2, p. 41.  
<sup>3</sup> ZA. xxxvi, p. 113.

from the eighth century B.C. onwards, which placed all early dates about 170 years too high. HOMMEL was thus able to accept KUGLER's identification of the recorded phenomena while accepting a historical chronology falling seven years later than WEIDNER'S. This curious suggestion implies that the scribe who inserted the year-formula knew the true interval of time that had elapsed since the Venus observations, but was in error to the extent of 170 years in his historical chronology, a most improbable supposition. It also ignores the agreement between the intercalations implied on the tablets and those supplied by the contracts of the reign of Ammizaduga. As will be seen, this agreement can be checked throughout the whole reign of Ammizaduga. In 1920 UNGNAD, in ZDMG. 74, p. 425, expressed doubt about the reliability of KUGLER's chronology on the ground that it placed the delivery of dates too late in the year. In support of this view UNGNAD cited VS. xiii 18, which has since appeared as No. 1724 in the sixth volume of his *Hammurabi's Gesetz* (1923). He states that in this document the delivery of dates was fixed for Kislev 1, or, as he thinks, at the same time of year as in late Babylonian times when Nisan 1 fell approximately between the middle of March and the middle of April of the Gregorian calendar. The document selected by UNGNAD was certainly unfortunately chosen. It asks for payment not on Kislev 1, but merely in Kislev, thus permitting the tenant to postpone payment to the last day of Kislev. The document belongs to the 23rd year of Hammurabi, in which year the last day of Kislev would fall on or about December 25 Gregorian according to KUGLER's chronology. This is certainly late for a delivery of dates, but, as LANGDON has pointed out to me, the contract requires the delivery not only of dates, but of planks of wood, and even of 10 talents of palm branches blown down by the wind, which would hardly be available until the winter storms had begun. It may also be noted that even in the Persian period Kislev was an unusually late season for requiring delivery of dates. In 1921 UNGNAD repeated in OLZ. 24, 17, his doubt of the trustworthiness of KUGLER's conclusion, adducing the difficulty of reconciling it with the Assyrian king list as well as its failure to place the date-harvest at the proper season, and expressed a desire to see the rival examination of the Venus tablets which WEIDNER had adumbrated.

So far the strictly astronomical part of KUGLER's reconstruction of the chronology had remained unanswered, and his calendrical study had been questioned on very unconvincing evidence, WEIDNER's argument assuming (1) that the astronomical statements of a neo-Babylonian document represented the state of the calendar under the First Babylonian Dynasty, and (2) that the fixed Nisan of that document was identical with the mean Nisan of the lunar calendar, while UNGNAD's argument rested on a single date-contract, whose relevancy to the calendrical question was at least doubtful. It may, therefore, seem strange that in 1922 KUGLER, in his *Von Moses bis Paulus*, pp. 497-501, announced his conversion to the late date for this dynasty, mainly because of the arguments which WEIDNER and UNGNAD had adduced. The first objection which he brings against his former conclusion is the well-known one that it is inconsistent with the Assyrian chronological tradition<sup>1</sup>, but he regards this as inconclusive in view of the support which it receives from the Babylonian chronological tradition. The second objection is based on the dates of autumn lettings. Seed-time according to his information was in November and December, from which he infers that the latter half of October would be the most likely time for autumn lettings. He finds that the contracts of Arahšamna 20 in the 10th year of Ammizaduga and of Tešrit 28 in the 14th

<sup>1</sup> It will be seen from LANGDON's reconstruction of the Assyrian and Babylonian chronology that there is no such inconsistency.

year of Ammizaduga fall on December 14 and December 8 Gregorian respectively, according to the solution which he had propounded, and he regards these as suspiciously late dates. But, as has been seen, such contracts are distributed throughout the whole year and prove little or nothing. His third objection to his original solution is based on the date-harvest. He argues that the date-harvest must have been in Tešrit, because the division of the crop between landlord and tenants is repeatedly mentioned as due in Arahšamna. He cites one contract for delivery in Arahšamna and one for delivery on Arahšamna 1. He also cites II Raw. 15, 40 c.d., for delivery on Arahšamna 30. He had apparently overlooked LANGDON's paper, RA. xiv (1917), pp. 16-19, in which this date is shown to belong to a grammatical exercise and to have no bearing on the delivery of dates. KUGLER computes that on his original solution the mean Arahšamna 1 would be November 19 of the Gregorian calendar, which he regards as too late for delivery of dates, since according to him the date-harvest falls in September and October. By reducing his chronology 120 years he thought he would transfer this date to October 15, and by reducing it 176 years he would transfer it to September 28. The argument does not appear to be conclusive, though it suggests that some reduction in the chronology would improve the agreement with date-harvest.

On these grounds KUGLER rejected his original solution and imagined that with it the late Babylonian chronological tradition must also be abandoned. If so, he felt that the Assyrian tradition must be adopted, which he thought inconsistent with a reduction by 120 years only, and he therefore decided on a reduction by 176 years. This had in his eyes, as in WEIDNER'S, the further merit of bringing the vernal equinox into an approximate coincidence with the mean Nisan 1. He did not review the arguments by which he had previously applied the contracts for payments at the time of harvest nor the contracts for hiring labourers. Thus while the rejection of his original theory was based on the contracts bearing on the seasons of the year, his new solution was only preferred to an intermediate solution on the evidence of a supposed Assyrian chronological tradition and on a very doubtful interpretation of a late astronomical text. It was not supported by a single computation of an appearance or disappearance of Venus, but it was naively assumed that these phenomena would be separated by the same intervals of time from the conjunction of 1796 B.C. December 1 by which those computed for the original solution were separated from the conjunction of 1971 B.C. January 23.

In 1923 LANGDON published the second volume of the *Oxford Editions of Cuneiform Texts*, including the chronological prism, W. 444. In order to obtain a basis for the reduction of the dates on this prism he requested me to examine the astronomical data on which KUGLER had based his two systems of chronology. The time available before the publication of his work was not sufficient to permit a recomputation of all the observations contained on the tablets, much less to permit a discussion of the motion of Venus in the light of all the ancient observations. But it was clear to me that the table in KUGLER'S *Sternkunde und Sterndienst*, ii 285, on which both his earlier and his later determination of the date of the 6th year of Ammizaduga depended, suffered from two defects: (1) the dates given for conjunction and new moon depended on tables which did not take account of the latest values for the motion of the Sun and Moon, nor of such corrections to the motions of Venus as seemed to be implied in the acceleration of the Sun which I had evaluated from ancient observations; (2) the table took no notice of the duration of invisibility of Venus, but only of the date of conjunction. The duration of invisibility was, as has been seen, computed by KUGLER for his earlier solution, but for no other solution. Since the duration of invisibility at a given place is dependent on the geocentric latitude of the planet,



which in its turn is mainly dependent on the heliocentric latitude of the planet, which is dependent on the distance of the planet from its node, and since at inferior conjunction the longitude of the planet is always exactly  $180^\circ$  different from the longitude of the Sun, the duration of invisibility will depend on the distance of the Sun from the planet's node, but since the node changes its longitude very slowly the duration of invisibility may be said within a range of a few hundred years to depend entirely on the longitude of the Sun, or in other words on the season of the year. It was therefore to be expected that since KUGLER's different solutions placed the conjunction in question at different seasons of the year, they would be accompanied by different geocentric longitudes of Venus and different durations of invisibility. In this way I found that the solutions lying 112 or more years later than KUGLER's earlier solution were inconsistent with an invisibility of three days only. I found that a solution 56 years later than KUGLER's earlier solution would stand the test of the observations in question, and I found that if the apparent acceleration of the Sun's motion were explained by a change in the length of the day and if a corresponding apparent acceleration were assumed in the motion of Venus, Venus would not be visible on the day which KUGLER had originally regarded as the 28th of Arahšamna, the day of her last visibility in the 6th year of Ammizaduga. I therefore inferred that, if this explanation of the solar acceleration was correct, the 6th year of Ammizaduga must have been 1916-1915 B.C. and the 1st year of Ammizaduga, 1921-1920 B.C. This conclusion was published by LANGDON in the preface to the second volume of *Oxford Editions of Cuneiform Texts* (1923).

At that time I was employing HERR CARL SCHOCH of Berlin on the reduction of certain ancient eclipses, and when he had finished this task I thought the most useful work that I could give him would be the reduction of ancient planetary observations, in order to see whether they afforded evidence of an apparent acceleration. SCHOCH computed for me the angular distance of the Sun below the horizon at all late Babylonian observations of first or last visibility of Venus, but as soon as I had introduced him to the Venus tablets his mind began to run on a possible restoration of ancient Babylonian chronology and even on a continuous restoration of the Babylonian calendar by means of the recorded intercalary months. He also formed the idea of using references on contracts to the 30th day of a month as a test for the computed interval between two successive first appearances of the lunar crescent, thus providing a new astronomical criterion for deciding between rival restorations of the Babylonian calendar. In the hope of obtaining more information than was given in KUGLER's *Sternkunde und Sterndienst* about contracts containing intercalary months he entered into a private correspondence with KUGLER, and thus provided that scholar with material which he partly misunderstood and which he used in his *Sternkunde und Sterndienst in Babel*, Buch II, Teil II, Heft 2 (1924), pp. 622-7. This Heft is a valuable contribution to the chronology of the last nine centuries before Christ, but also contains, on pp. 563-71, a discussion of early Babylonian chronology, which reproduced with small verbal changes the discussion which had already appeared in *Von Moses bis Paulus*. The earlier parts of the Heft would appear to have been printed off before KUGLER had arrived at his new conclusions, and it is only in the concluding pages that notice is taken of my work. The computations, but not the conclusions, contained in those pages are due to SCHOCH, who had compiled, in 1922, tables for the rapid computation of the phases of the Sun, Moon, and planets, and who had also compiled tables for computing the first visibility of the moon, based on late Babylonian data. He also constructed, in 1924, tables for the rapid conversion of Babylonian dates into dates of the Julian calendar, in which the inequalities in the Moon's

motion and the irregularity of Babylonian intercalation are disregarded, but which will in about 80% of cases place the beginning of a Babylonian month on the right day, though there is room for an error of one day, and though it may sometimes be necessary to re-identify the months according to the theory that is adopted of their position in the natural year and of Babylonian intercalation.<sup>1</sup> KUGLER's study will be noticed in its proper place so far as is necessary for the purposes of the present work. In June 1924 I engaged SCHOCH to come to Oxford to assist me in a study of the whole problem. Before leaving Germany he had on his own account contributed a brief note on the bearing of astronomy on the subject to *Astronomische Nachrichten*, Band 222 (1924), pp. 27, 28, in which he stated that according to his tables a last visibility of Venus on the evening of Arahšamna 28 followed by a reappearance on Kislev 1 was possible only in 1971 and 1915 B.C. within the 3,000 years following 3000 B.C. He himself regarded 1915 B.C. as the correct date.

The present study is largely the result of SCHOCH's co-operation with me. Almost all the astronomical computations were made by SCHOCH with the aid of his own tables; the restoration of the calendar is my own work, and supersedes a restoration which SCHOCH had attempted with less complete material. The references to 30-day months were collected by SCHOCH and have been verified and revised by me with LANGDON's assistance. The subject was a matter of daily discussion between SCHOCH and myself while he resided with me from June to December 1924. In October 1924 we learned from DR., now PROFESSOR, SCHNABEL that he had discovered that K. 7072 and Rm. 134 were fragments of Document M, and he afterwards drew our attention to the value of the fragments contained in Rm. II, 531, and S. 174.<sup>2</sup> With the aid of the two first-named of these tablets together with the omens, which SCHIAPARELLI and KUGLER had ignored, he drew the conclusion that M contains the same observations as L, but that, whereas they are arranged in chronological order in L, they are arranged in calendrical order in M. He also emphasized the importance of the omens for the reconstruction of the text. In December 1924 M. THUREAU-DANGIN communicated to SCHOCH at the joint request of SCHOCH and LANGDON for use in our work a number of unpublished contracts for division of date-crops belonging to the later years of Hammurabi. We also had the benefit of a revised collation and translation of K. 160 and K. 2321 + K. 3032 by LANGDON, and of his translation of K. 7072, Rm. 134, and Rm. II, 531. After returning to Germany SCHOCH published on his own responsibility a condensed study of the whole chronological question and concluded in favour of a chronology falling 64 years later than that which I had proposed. This work appeared under the title of *Ammizaduga*, von C. SCHOCH, Selbstverlag, Berlin-Steglitz, Kuhlignkshof 5, 1925. A review of the literature of the subject with a brief announcement of his own views and contributions was published by SCHNABEL in ZA. xxxvi (1925), pp. 109-22, in which he concluded in favour of the chronology which I had proposed. SCHOCH came to the same conclusion in a paper entitled 'Die erste Dynastie von Babylon', *Klio* xx (1925), pp. 107-9.

Since SCHOCH's papers consist mainly of work which he had done for me as my assistant and since SCHNABEL's paper apart from the history of the subject consists mainly of work privately communicated to me which became inseparably united with my own studies, their work will be incorporated in the present study without separate discussion here.

<sup>1</sup> These tables appear in a revised form as an appendix to S. 174 must be a fragment of one of these texts and the present volume. SCHNABEL had identified it as a fragment of Document M.

<sup>2</sup> WEIDNER had informed him that he had recognized that

MEYER published in 1925 a 'Nachtrag' to the first volume of his *Geschichte des Altertums* under the title *Die ältere Chronologie Babyloniens, Assyriens und Ägyptens*. He acknowledges the force of the arguments in favour of the solution which I had proposed, but in view of the errors which appear to exist in the Venus tablets and of the doubt attaching to any restoration of the chronology where the series of intercalations is not known for certain, and in view of his preference on historical grounds for a shorter system of chronology, he leaves the question undecided between KUGLER's solution published in 1922 and mine published in 1923.

In *The Illustrated London News*, Oct. 10, 1925, p. 666, LANGDON announced that in 1924 a fragment of a clay tablet had been excavated at Kish, completing the text contained on K. 2321. Photographs of the obverse of both tablets were included in his article.

## THE VISIBILITY OF THE LUNAR CRESCENT

THAT the late Babylonians began their months at the actual or supposed date of the first appearance of the lunar crescent in the evening sky is well known. Elaborate computations of the date of this appearance have come down to us, and we are able to check Babylonian lunar dates for predicted phenomena with sufficient frequency to know the high accuracy with which the late Babylonians were able to predict this phenomenon. The late Babylonian ephemerides must in the nature of the case have been regulated by predicted appearances. But it is not so easy to determine whether observations were dated from the actual or from the predicted appearance of the Moon.

In 274 B. C. November 1 Julian we have<sup>1</sup> on an observation-tablet an example of a new month being made to begin after two successive months of 29 days on an evening on which it is recorded that the sky was cloudy and the Moon was not seen. Now in any calendar governed by observations of the Moon, there must have been some rule to govern the length of the month when observation was impossible, but it may be regarded as certain that two months in succession would not be given 29 days only unless the Moon was actually seen at the end of the latter month or unless computation had shown that the Moon ought to be visible. There would appear to be three possible explanations of a month beginning on that evening: (1) that the Moon was seen by other observers; (2) that the calendar was governed regularly by the predicted appearance of the crescent; (3) that the predicted date of appearance of the crescent was adopted when it was too cloudy to observe the Moon on the particular evening.<sup>2</sup> LANGDON has drawn my attention to JOHNS, *Assyrian Deeds and Documents*, iv (1923) 333, under *kabhadu* (4), and to KOHLER and UNGNAD, *Assyrische Rechtsurkunden* (1913), 258, 3; 263, 5; 649, 5, for references to the appearance of the crescent, apparently referring to the first day of the month. These documents belong to the seventh and sixth centuries before Christ, when accurate methods of prediction were certainly beyond the reach of Babylonian science, but they do not by themselves prove that the beginning of the month was determined by observation instead of by such methods of computation as were available at that time. A stronger proof that the beginning of the month was fixed by observation is to be found in the success with which SCHOCH has represented the attested dates of the beginning of the month by an astronomical formula. If this formula had applied only after the discovery of the anomalistic motion of the Moon<sup>3</sup>, it would have been possible to maintain that SCHOCH's formula was equivalent to the formula used by neo-Babylonian astronomers in making predictions, and afforded no proof that the beginning of the month was fixed by observation.

But, as SCHOCH's tables appear to satisfy the attested first days of the month at all epochs,

<sup>1</sup> ZA. VII (1892), 229.

<sup>2</sup> According to SCHOCH's tables the Moon should not have been visible that evening, but he informs me that between 400 B. C. and 100 B. C. in August, September, and October the beginning of the month on observation-tablets sometimes falls earlier than the date given in his tables, if the Moon's argu-

ment of latitude, as in this case, falls between 40° and 140°.

<sup>3</sup> Callippus (about 330 B. C.) is supposed to have been the earliest Greek astronomer who could give a mathematical representation of the anomalistic motion of the Moon. But it was known at Babylon in the sixth century B. C.

the inference is that the attested beginnings of the month must have been determined originally by actual observation of the crescent.

We have not the same wealth of observations for early times, but a month beginning with the actual appearance of the crescent is the simplest and most primitive of all forms of month, and it is therefore reasonable to expect that both in astronomy and in civil life the month was in early times reckoned from the first visibility of the crescent.

The term *ud-ná-a*, 'day of passing (of the Moon) into darkness', usually rendered by *ám bubbulim*, 'day of the ravishing or taking away (of the Moon)' is used from a very early date for the day when the Moon was last visible in the early morning. We generally find this day identified with the 28th day of the month, but examples exist of the 24th,<sup>1</sup> 25th, 27th, 29th, and 30th days of the month being called by this name. The term is sometimes given an extended meaning so as to apply to any night during the period of the Moon's darkness and also to the day of the Moon's reappearance. For the old moon to be seen last on the morning of the 28th day is in excellent agreement with a month beginning at the appearance of the crescent. Early dates such as the 24th or 25th might be supposed to indicate that the month did not regularly begin with the appearance of the crescent, but might begin a few days later. On the other hand, an occasional last visibility so early may be simply due to weather conditions. It may be doubted whether in practice the calendar was governed by actual observation or by a rough computation of the date of appearance, but, as will be seen later, such evidence as we possess points to a calendar regulated by observation.

In order, therefore, to reduce Babylonian lunar dates to the Julian or to the Gregorian calendar it is necessary to have some knowledge of the conditions of visibility of the lunar crescent. There are three causes which affect the visibility of the crescent: (1) the phase of the Moon, i. e. the degree to which it is illuminated by the Sun; (2) the extent to which its light is absorbed in passing through the Earth's atmosphere; (3) the brilliance of the part of the sky in which it is situated, that is, of the background against which it is seen. The first of these depends, theoretically, partly on the distance of the Moon from the observer, which is in inverse ratio to its parallax, and partly on the angle subtended at the Moon by a line joining the Sun and the Earth. The effect of variations in the lunar parallax is for our present purpose negligible, as also is the angle subtended at the Sun by a line joining Earth and Moon. The angle at the Moon may therefore be regarded as equal to  $180^\circ$  less the angular distance between Sun and Moon as seen from the Earth, and the phase of the Moon may in consequence be regarded as dependent on this angular distance. Such evidence as we have would tend to show that the brilliance of the lunar crescent is roughly proportional to the cube of the angular distance. This angular distance may be regarded as a function of the altitude of the Moon above the horizon and of the difference in azimuth of Sun and Moon at time of sunset or at the time when the Sun is at some given distance below the horizon. The extent to which the Moon's light is absorbed by the atmosphere depends partly on the absorbing power of the atmosphere at the particular place and on the particular day and partly on the amount of atmosphere which its rays have to traverse. The latter depends wholly on the altitude of the Moon above the horizon, but, owing to the difference between the absorptive power of the atmosphere at different places and seasons, any study of the effect of altitude on the brilliance of a heavenly body should,

<sup>1</sup> THOMPSON, *Reports*, 85, Obv. 2-4, K. 752. In this case the phenomenon is described by the phrase, 'When the Moon disappears out of its reckoning'.

if possible, take into account the atmospheric conditions, which were, probably, as favourable at Babylon as at any place where observation has been made. The brilliance of any part of the sky during daylight or twilight, given constant weather conditions, is dependent on its position in altitude and azimuth as compared with the Sun. It would, therefore, appear that, apart from variations in weather beyond the reach of astronomical computation, all the causes affecting the visibility of the Moon may be reduced to difference in azimuth and altitude of Sun and Moon. In a paper on the smallest visible phase of the Moon, published in *MN.* 70 (1910), pp. 527-31, I analysed a series of 48 successful observations of first sight of new moon made with the naked eye by JULIUS SCHMIDT at Athens in 1859-79, one such observation made by him at Corinth in 1862, one such made by AUGUST MOMMSEN at Athens in 1879, 18 unsuccessful attempts at observation of new moon made by JULIUS SCHMIDT at Athens in 1860-76, one such made by him at Troy in 1864, one such made by MOMMSEN at Athens in 1879, two successful observations of last visibility of old moon made by JULIUS SCHMIDT at Athens in 1870 and 1872, one such by FRIEDRICH SCHMIDT at Athens in 1871, two such by MOMMSEN at Athens in 1879 and 1880, and one unsuccessful observation of the old moon by MOMMSEN at Athens in 1879, 76 observations in all. I found in the case of each observation the altitude of the Moon at sunset for evening and at sunrise for morning observations, ignoring the effect of parallax and refraction on both bodies, and I also found the difference between the azimuths of the two bodies at the same moment. I found that the following table would satisfy all the observations with the exception of FRIEDRICH SCHMIDT's successful observation in the morning and one of JULIUS SCHMIDT's successful observations in the evening.<sup>1</sup>

Difference in azimuth at sunset or sunrise.	Minimum altitude of Moon at sunset or sunrise to be visible same evening or morning.
0°	12.0°
5	11.9
10	11.4
15	11.0
20	10.0
23	7.7

The two exceptions fall respectively  $3.1^\circ$  below the tabular minimum altitude with  $2.8^\circ$  difference in azimuth, and about  $3.6^\circ$  below the tabular minimum altitude with  $20.5^\circ$  difference in azimuth. In *The Journal of Theological Studies*, xii (1910), p. 121, I dealt with a rule given by Maimonides for making the same computation for Jerusalem, and reduced his rule to a form similar to my own, as follows:

Difference in azimuth at sunset.	Minimum altitude of Moon at sunset to be visible same evening.
0°	11.8°
5	11.3
10	9.7
15	9.7
20	9.7
23	7.3

<sup>1</sup> The precepts given in NEUGEBAUER'S *Tafeln zur astronomischen Chronologie* iii (1922), xxviii-xxxI, for computation with my figures are based on the setting of the Sun's upper limb as affected by refraction. The figures given by me were for the setting of the centre of the Sun's disk, disregarding refraction. To compensate for this the figures headed  $h_2$  in his 'Tafel 14' should be diminished by about  $0.8^\circ$ .

This rule gives a somewhat discontinuous result, but on the whole implies a smaller minimum altitude for a given difference in azimuth than I had deduced from the Athens series.

In *The Observatory*, xliv (1921), pp. 308-11, I dealt with a number of early observations of the evening crescent, partly collected from the *Journal of the British Astronomical Association*, partly supplied from his own observations by SCHOCH, and partly obtained by an appeal for observations issued by SCHOCH and myself with the aid of PROFESSOR H. H. TURNER of Oxford. In none of these observations did the difference in azimuth exceed  $16.1^\circ$ , and only in one instance did it exceed  $7.1^\circ$ . These observations are, therefore, of little value for the minimum altitude which should be associated with large differences in azimuth. In the series were two observations made at different places in England on 1916 May 2 where with a difference of azimuth of  $0.6^\circ$  and  $0.7^\circ$  respectively the Moon was seen  $3.7^\circ$  below my tabular minimum altitude. Otherwise there was no instance of her being found with the naked eye more than  $1.2^\circ$  below my tabular minimum altitude.

A slightly better result might have been obtained by taking the differences in altitude and azimuth of the two luminaries for the time when the Sun was  $4^\circ$  below the horizon instead of for the time when the Sun was on the horizon. But in view of variable atmospheric conditions, the gain in accuracy would have been more apparent than real.

SCHOCH has investigated about 400 beginnings of months in the neo-Babylonian period, which can be fixed by astronomical observations or predictions referred to the days of the month. 250 of these are months in which observations are recorded, while 150 are taken from ephemerides. He has been able to construct tables for computing the minimum age at which the crescent should be visible, taking into consideration the longitude of the Sun or season of the year, the Moon's elliptical orbit and her latitude. He has in this way been able to satisfy 380 out of the 400 dates of first visibility assumed in the Babylonian observations and ephemerides. Of the 20 discrepancies he attributes 10 to a delay in the appearance of the crescent due to bad weather, while 10 remain enigmatical. On the other hand he finds 55 cases where the crescent computed by the formula which I had deduced from the Athens observations would appear one day later than the date used for the beginning of the month in Babylonian observations. For the sake of comparison he has made a computation in which his formula is reduced to a form analogous to mine, as follows:

Difference in azimuth at sunset.	Minimum altitude of Moon at sunset to be visible same evening.
$0^\circ$	$10.7^\circ$
5	$10.3$
10	$9.4$
15	$7.6$
19	$6.3$

This formula implies a greater transparency of the air at all altitudes than I had deduced from the Athens observations. It also implies that the transparency diminishes less rapidly at Babylon than at Athens as the horizon is approached, so that the difference between the two formulae is most marked for the low altitudes which accompany great differences in azimuth. I have no hesitation in adopting SCHOCH's figures for use in computations for Babylon.

## THE VISIBILITY OF VENUS

THE visibility of Venus like that of the Moon is affected by the atmospheric absorption of her light, which depends on the altitude of the planet above the horizon, and by the degree of illumination of the sky, which depends on the angular distance of the Sun below the horizon. It is not, however, appreciably affected, so far as first and last visibility are concerned, by the phase of the planet, for we find that there is little difference in the stellar magnitude of the planet at different first or last appearances. Difference in azimuth, in so far as it affects the illumination of the part of the sky where the planet is situated, might be regarded, but it is unimportant compared with difference in altitude. Since the time of Ptolemy, it has been customary to regard the visibility of a star as dependent on the angular distance of the Sun below the horizon at the time of the rising or setting of the star. We shall call this angular distance  $\gamma$ . The minimum value of  $\gamma$  which will render a star visible is known as the *arcus visionis*. Ptolemy found that the *arcus visionis* (in Greek *καθόλου διάστασις*) of Venus was  $5^\circ$  (*Math. Syn.*, ed. HEIBERG, ii [1903], p. 597). It appeared to me desirable to determine the *arcus visionis* for Babylon by an analysis of neo-Babylonian observations. At my request SCHOCH computed the value of  $\gamma$  for eighteen such observations, which we found published in Assyriological works. We adopted NEWCOMB's mean places and mean motions of Venus and the Sun for the epoch A. D. 1800 Jan. 0.0, but applied to NEWCOMB's acceleration for 1800 the correction of  $+1.521''$  per century for the Sun and  $+2.472''$  for Venus. The correction to the Sun's acceleration is that which I deduced in my paper, *A Solution of Ancient Eclipses of the Sun*, MN. 81 (1920), p. 126. The correction to the acceleration of Venus is obtained on the assumption that the correction to the Sun's acceleration bears the same ratio to the correction to the acceleration of Venus that the mean motion of the Sun bears to the mean motion of Venus. This would be the case if the apparent acceleration of the Sun were due either to a retardation of the Earth's rotation or to an increase in the Sun's mass. All other terms are taken from NEWCOMB, except the obliquity of the ecliptic, which is taken from my paper in MN. 78 (1918), p. 411. The observations of the year 419-418 B. C. were communicated by SCHNABEL and reduced by me on the same assumptions.

The result of our reduction of the neo-Babylonian observations is given below:

Reference.	Last visibility in evening, 'Western setting'.		Julian date, days reckoned from noon.	$\gamma$ .
	Babylonian date.			
KUGLER, <i>Sternkunde</i> , i 70	Cambyses 7	Sivan 10	523 B. C. June 12	$7.68^\circ$
VAT. 4924	Ochus 5	Ayar 22	419 B. C. May 16	$5.94$
EPPING and STRASSMAIER, ZA. vii 229	S. A. 38	Arahsamna 1	274 B. C. November 4	$6.35$
" " ZA. vi 91	S. A. 110	Tešrit 19	302 B. C. October 9	$4.80$
" " ZA. vi 221	(A. A. 153) (S. A. 217)	Arahsamna 23	95 B. C. November 28	$5.1$
" " ZA. v 357	(A. A. 164) (S. A. 228)	Šabat 10	83 B. C. February 10	$3.89$

To these I may add a western setting observed by LANGDON at Kish, A. D. 1926 January 31 Gregorian, where the value of  $\gamma$  was  $12.55^\circ$ .

## THE VISIBILITY OF VENUS

First visibility in morning, 'Eastern rising'.<sup>1</sup>

Reference.	Babylonian date.	Julian date, days reckoned from noon.	$\gamma$ .
KUGLER, <i>Sternkunde</i> , i 71	Cambyses 7 Sivan 27	523 B.C. June 29	8.44°
VAT. 4924	Ochus 5 Sivan 3	419 B.C. May 26	5.71
EPPING and STRASSMAIER, ZA. vii 230	S. A. 38 Arahsamna 11	274 B.C. November 14	2.6
" " ZA. vi 91	S. A. 110 Arahsamna 4 <sup>2</sup>	202 B.C. October 24 <sup>2</sup>	4.92
KUGLER, <i>Sternkunde</i> , i 84	S. A. 132 Šabat 29	179 B.C. March 12	7.49
EPPING and STRASSMAIER, ZA. vi 221	[A. A. 153] Arahsamna 27	95 B.C. December 2	2.3
" " ZA. v 357	[S. A. 217] Šabat 12	83 B.C. February 12	8.08

Last visibility in morning, 'Eastern setting'.

KUGLER, <i>Sternkunde</i> , i 70	Cambyses 7 Adar 7	522 B.C. March 3	4.93
" " Erg. 233 <sup>4</sup>	" " Ulul 26	425 B.C. September 21	5.4
" " i 84	S. A. 132 Nisan 15	180 B.C. April 8	5.55

First visibility in evening, 'Western rising'.

KUGLER, <i>Sternkunde</i> , i 70	Cambyses 8 Nisan 13 <sup>5</sup>	522 B.C. May 6	6.20
" " Erg. 234 <sup>4</sup>	" " Arahsamna 26	425 B.C. November 19	6.3
VAT. 4924	Ochus 5 Adar II 21	418 B.C. April 5	5.91
KUGLER, <i>Sternkunde</i> , i 84	S. A. 132 Ab I	180 B.C. July 20	11.21
EPPING and STRASSMAIER, ZA. v 355	[A. A. 164] Ayar 11	84 B.C. May 21	6.38
	[S. A. 228]		

<sup>1</sup> Sometimes a later date is given for eastern rising with a note that Venus was already seen on an earlier specified date. In such cases I have adopted the earlier date.

<sup>2</sup> 14 in text. But the date clearly falls before Arahsamna 7, and 4 would appear to be the correct reading.

<sup>3</sup> EPPING makes Arahsamna being one day earlier than we do, but this involves too early an appearance of the crescent. <sup>4</sup> The year to which this tablet belongs is not preserved. WEIDNER who published it in *Aller und Bedeutung der babylonischen Astronomie und Astrallehre* (1914) recognized it as an observation-tablet, but failed to date it. KUGLER, loc. cit., dated it correctly, but mistook it for an ephemeris. SCHÖCH gives six reasons for regarding it as an observation-tablet:

(1) The appearance of the crescent agrees regularly with his computation. This, as he remarks, is not conclusive, because the ephemerides as well as the observations generally agree with his computations.

(2) The appearances and disappearances of Sirius, Jupiter, Saturn, and Venus are in full agreement with computation. The difference nowhere exceeds two days. But here again the Babylonian ephemerides are generally in good agreement with his computations.

(3) The western setting and morning rising of Mars vary from his computation by three and four days respectively. The dates given on Babylonian ephemerides habitually deviate from computation by ten or twelve days. Therefore the dates given here must be the result of observation.

(4) The Mercury phases are as follows:

WR. 2 days before computation.

WS. 2 days before computation.

ER. 4 days after computation (perhaps delayed by weather conditions). ES. 1 day before computation.

WS. Day of computation. MR. 1 day after computation. The concluding interval between WS. and MR. is correctly given as 14 days. 13 days is the minimum duration at inferior conjunction, and 41 days the maximum. The Babylonians had not the requisite knowledge to predict the phases of Mercury with such accuracy.

(5) The time given for the lunar eclipse is only seven minutes earlier than that found by computation for the beginning of the eclipse. Babylonian ephemerides do not give the exact time of an eclipse, and no Babylonian astronomer of the fifth century B.C. could predict it with such accuracy.

(6) The lunar eclipse is described by the words *Sin atala škun*, which refer regularly to an observed eclipse. It is true that the solar eclipse, which is misdated, and which was not visible at Babylon, is described as *Samaš atala*, but that is clearly an error. The observation-tablet of 568-567 B.C. includes a predicted eclipse of the Moon which was not visible at Babylon, using the words *atala Sin ša LU*. See NEUGEBAUER and WEIDNER in *Berichte der k. sächsischen Gesellschaft*, 67 (1915), phil. hist. Klasse, pp. 31, 35, 50. The scribe of our text was right in inserting the solar eclipse, but ought to have stated that it was not observed.

The last four of these reasons are conclusive.

<sup>5</sup> So the text. KUGLER proposes to read 'Ayar'.

## OBSERVATIONS OF VENUS

With these I compare some naked-eye observations made in England in the years 1923-6. I give the most successful observation at each observed appearance and disappearance:

## Western setting.

Place.	Observer.	Gregorian date, days reckoned from noon.	$\gamma$ .
Oxford	J. K. F. and Miss Dalton	1924 June 20	6.11°
Bicester	S. W. Hayes and Miss Hayes	1926 February 8	3.21

## Eastern rising.

Dedham	H. G. Tomkins	1924 July 13	6.42
Charing	Rev. D. R. Fotheringham	1926 February 13	11.56

With these we may compare a western setting observed by HERR STILLHART at St. Gall, Switzerland, 1926 February 6, where the value of  $\gamma$  was 6.2°, and an eastern rising observed by HERR WIDMER at Bertiswil, Switzerland, 1926 February 4, where the value of  $\gamma$  was 5.4°.

## Western rising.

Place.	Observer.	Gregorian date, days reckoned from noon.	$\gamma$ .
Oxford	J. H. Jeffree	1923 November 7	5.20°
Bicester	S. W. Hayes	1925 May 30	6.06

To appreciate the Babylonian observations properly it is necessary to arrange them according to the season of the year. I have therefore classified them according to the months of the Gregorian calendar in which they fall, reckoning the day according to civil usage from midnight. For this purpose we must deduct five days from eastern and six from western observations before 501 B.C., four days from eastern and five from western observations between 501 and 301 B.C., three days from eastern and four from western observations between 301 and 201 B.C., two days from eastern and three from western observations between 201 and 101 B.C., and one day from eastern and two from western observations after 101 B.C. The values of  $\gamma$  then group themselves as follows:

WS. = western setting; ER. = eastern rising; ES. = eastern setting; WR. = western rising.

January	12.55° (WS.)		
February	3.9 (WS.), 8.1° (ER.), 4.9° (ES.)		
March	7.5 (ER.), 5.9 (WR.)		
April	5.55 (ES.), 6.2 (WR.)		
May	5.9 (WS.), 6.4 (WR.), 5.7 (ER.)		
June	7.7 (WS.), 8.4 (ER.)		
July	11.2 (WR.),		
August	None		
September	5.4 (ES.)		
October	4.8 (WS.), 4.9 (ER.), 6.35 (WS.)		
November	2.6 (ER.), 6.3 (WR.), 5.1 (WS.)		
December	2.3 (ER.)		

It will be observed that the value of  $\gamma$  is markedly lower in the autumn and winter months September-February than in the spring and summer months March-July, the lowest values being found in November and December, while the value steadily rises till July. But the high value of  $\gamma$  at LANGDON'S observation in January shows that unfavourable weather may occur in the winter as well as in the summer. It will be noticed that, while six out of twelve  $\gamma$ 's in

September–February are less than  $5^\circ$ , the ten  $\gamma$ 's in March–July all exceed  $5^\circ$ , and six of them exceed  $6^\circ$ . It will also be observed that while in June and July the English observations are more successful than the Babylonian observations in the same months, the reverse is the case on an average in February, May, and November. It may also be noted that the twenty-one ancient observations contain nine pairs of 'settings' followed by 'risings', and three isolated observations. In six of the nine pairs the setting shows a lower value of  $\gamma$  than the rising. This is what we should expect, for the observer of a setting ought to know from the previous day's observation where to look, while the observer of a rising has no such guidance.

The effect of the empirical correction to the accelerations is to diminish the value of  $\gamma$  at western settings and to increase it at eastern risings. As the two lowest values ( $2.3^\circ$  and  $2.6^\circ$ ) are both found at eastern rising, while the lowest for western setting is  $3.9^\circ$ , it is clear that the rejection of this correction would increase any difficulty that there may be in accepting the data supplied by the neo-Babylonian observations.

Since this chapter was written I have found from the Greenwich meridian observations of the Sun, 1750–78 and 1839–1925 an empirical acceleration of  $+1.4''$  per century for the Sun, in good agreement with that deduced from the ancient observations. See MN. 87 (1926), pp. 142–167; 87 (1927), pp. 182–5. DE SITTER has since obtained from the transits of Mercury (1677–1924) an empirical acceleration of Mercury which on the assumption that the accelerations are in proportion to the mean motions would correspond to an acceleration of  $+1.55''$  per century for the Sun. See *Bulletin of the Astronomical Institutes of the Netherlands*, 4 (1927), pp. 21–38. The acceleration assumed in this chapter for Venus would appear, therefore, to be well supported by such modern observations as are available.

## REDUCTION OF THE OBSERVATIONS ON THE VENUS TABLES

FOR accurate work on the lunar dates of disappearance and reappearance of Venus it is necessary to compute the beginning of the lunar month by SCHOCH's crescent tables and to compare the value of  $\gamma$  for one or more days about the date when the first or last visibility of Venus might be expected. But for a preliminary test cruder methods will suffice. SCHOCH printed in a paper entitled *The 'Arcus Visionis' in the Babylonian Observations*,<sup>1</sup> and again in *Ammizaduga*,<sup>2</sup> handy tables for converting Babylonian into Julian dates and vice versa. In the former publication he assumed for purposes of computation the accuracy of WEIDNER's restoration of the chronology of the First Dynasty, while in the latter he assumed the accuracy of the chronology which he had himself proposed, falling 64 years later than that which I had favoured.<sup>3</sup> It must also be remembered that until the year 528 B.C.<sup>4</sup> intercalation at Babylon was irregular, so that any table for converting Babylonian dates must necessarily be subject to occasional errors of one lunar month. A student who does not accept the system of chronology to which SCHOCH's table is adapted must be prepared for the possibility of an error of a second lunar month, and it seems best, therefore, to identify the months independently of SCHOCH's tables and to confine those tables to the problem of identifying the days of an identified lunar month with days in the Julian calendar. In the case of the Venus observations the computed dates of disappearance and reappearance define the position of the months, and the handy tables are of use for identifying the days.

Any lunar date may be converted at a glance with the handy tables, and in eighty per cent. of the cases the day so found will agree with that given by the crescent tables. When, therefore, dates are found with the handy tables, we must allow for the possibility of an error of one day. Where such an error is not permissible, recourse should be had to the crescent tables.

SCHOCH has also constructed tables for the rapid computation of the disappearance and reappearance of Venus at Babylon. Here he has adopted  $5.2^\circ$  as the minimum value of  $\gamma$  at western setting,  $5.7^\circ$  at eastern rising, and  $6.0^\circ$  at eastern setting and western rising. These values are considerably higher than those which result from the autumn and winter observations, and one of the neo-Babylonian April eastern settings gives a lower value than SCHOCH assumes. But the values would appear to be too small for spring and summer observations. The daily change in the value of  $\gamma$  ranges from  $0.4^\circ$  to  $2.0^\circ$  near inferior conjunction (i. e. at western setting and eastern rising) and from  $0.1^\circ$  to  $0.4^\circ$  near superior conjunction (i. e. at eastern setting and western rising).

When we allow for the possibility of an error of one day in the computed day of the lunar month and for one day or more in the computed date of the first or last phase of Venus near inferior conjunction, we must be prepared for frequent errors of one day in the computed lunar dates of the phenomena and for a certain number of errors of two days, occasionally more. Larger errors are possible near superior conjunction. On the whole, autumn and winter settings

<sup>1</sup> University Observatory, Oxford (1924), pp. 7–11.

generally with the chronology proposed by me.

<sup>2</sup> Pp. 7–12.

<sup>3</sup> See KUGLER, *Sternkunde und Sterndienst*, ii, T. 2, H. 2

<sup>4</sup> SCHOCH's tables M and N in the present volume are computed on the same principle, but are made to agree (1924), 428.

and spring and summer risings should fall later than the computed dates, autumn and winter risings and spring and summer settings earlier than the computed dates.

Table I contains a comparison between the dates of western setting and eastern rising recorded on the tablets and the dates computed by SCHUCH for each of five hypothetical dates of the reign of Ammizaduga, 1977-1956 B.C., 1921-1900 B.C., 1857-1836 B.C., 1809-1788 B.C., and 1801-1780 B.C. The headings WS., Int., ER. indicate respectively the date of western setting, the interval between western setting and eastern rising, and the date of eastern rising. The observations are arranged in groups, so that those belonging to the same season of the year are thrown together. Throughout the table Roman numerals indicate Babylonian months. In computed dates the numerals are assigned on the assumption that the intercalations are to occupy the places attested by contracts or implied in the intervals between recorded dates of phenomena. Dates not recorded, but supplied arithmetically, are placed in brackets. As a rule the date which is best attested on the tablets is given in each case under the heading 'Tablets'. Where the evidence seems equally divided, alternative dates are given. The computed dates are reduced to the Gregorian calendar, and the day is reckoned from noon. This is essential. The Babylonians, reckoning the day from sunset, made observations at the beginning and end of the night belong to the same day. If we reckon the day from midnight, we have the inconvenience of having different Gregorian days to correspond to the same Babylonian day according as the observation is in the morning or in the evening. The Gregorian calendar permits ready comparison with observations made at the same season in other ages, and shows at a glance at what season of the year each of the five hypotheses would place the different Babylonian calendar months. The computed dates for the second and third hypotheses are based on computation of the actual crescent; for the other hypotheses they are computed with SCHUCH's handy tables.  $5.6^\circ$  has been taken as the minimum value of  $\gamma$  for an observation of Venus.

One of the most striking facts disclosed by the table is that observations separated by eight years rarely recur four days earlier in the Babylonian calendar month, as they ought to do on the astronomical theory. This failure is, no doubt, due in part to variations in the weather, but this is not a complete explanation, because there is not even an approximation to a four-days difference.

On the other hand, except in the corrupt date VII 11 for western setting in the fourteenth year, the total variation in the day of rising or setting in each group never exceeds fifteen days. We should have expected a maximum variation of eight or nine days. It might be tempting to explain this irregularity by supposing that our conclusion from other evidence that the Babylonian month was reckoned from actual appearance of the crescent was erroneous. If the beginning of the month was fixed arbitrarily in the neighbourhood of that appearance, it would explain a variation of a few days backwards and forwards as opposed to a regular four-days difference in eight years, but it would imply the same variation in eastern risings as in western settings, and there is no such consistency. We are therefore driven to the conclusion that quite apart from their consistency or inconsistency with any of the proposed solutions, the recorded dates are proved by their mutual inconsistency to contain numerous errors. How far the errors are copyists' mistakes and how far they are erroneous conjectures made to supply missing observations it is difficult to say. The repetition of 7-day and 15-day intervals in different groups looks suspicious, and it may be observed that seven days is the standard interval in the artificial system of Document N.

We can presumably place most reliance on those dates which show a difference of three, four, or five days in a recurrence after eight years, that is on the two first eastern risings of the third group, the two eastern risings of the fourth group, and the first two pairs of western setting and eastern rising in the fifth group. Of these the two first eastern risings of the third group appear to be best satisfied by the first and third solutions, of which the first satisfies one of the corresponding western settings and the third the other western setting. The two eastern risings of the fourth group are best satisfied by the second and third solutions, of which the second satisfies also the western setting corresponding to the first eastern rising. The two pairs of western settings and eastern risings in the fifth group are excellently satisfied by the first, second, and third solutions. If we treat an exact agreement or a difference of one day as an agreement with the recorded dates and examine all the dates by this criterion it will be found that the first solution shows 10 agreements, the second and third 11 each, the fourth 5 agreements, and the fifth 3 agreements. It is clear, therefore, that these observations are satisfied far better by the first three solutions than by the two last.

Table II exhibits the eastern settings and western risings treated in the same manner. The headings ES. and WR. indicate the dates of eastern setting and western rising respectively. The computation has been made with SCHUCH's handy tables,  $6.0^\circ$  being taken as the minimum value of  $\gamma$  for an observation. That this is approximately correct is evidenced by the good agreement between the computed and observed intervals of invisibility, the former varying between  $1^m 25^d$  and  $2^m 17^d$ , and the latter, ignoring two exceptionally long intervals, varying between  $2^m 0^d$  and  $2^m 15^d$ . Whether the computed or the observed interval is the longer appears to depend mainly on the season of the year. As the relative positions of the Sun, Venus, and the horizon near eastern setting and western rising vary but slowly from day to day, we cannot expect to compute the exact date of rising or setting with any accuracy, and, therefore, the four-day rule will hardly apply, though it is possible to find it in the third group. The difficulty in applying these observations to a chronological purpose is not, as in Table I, that there is any general discordance between observation and computation, but that all the solutions show a very fair agreement. But there are certain groups which are satisfied by some solutions better than by others. In the first group it will be observed that Venus reappears six days before the computed date in Year 4 according to the first and second solutions, but the third, fourth, and fifth solutions make her disappear nine, ten, or eleven days after the computed date both in Year 4 and in Year 20. It would seem, therefore, that this group favours the first and second solutions. In the second group the computed interval of invisibility falls according to each solution within the observed interval, so that it is impossible to base any preference on this group alone. In the third group the second pair gives a reappearance three days before the computed date according to the third solution, but this is of small importance. In the fourth group the first two disappearances are later than the computed dates in the earlier solutions and the reappearances earlier than the computed dates in the later solutions, the discrepancies being particularly noticeable in the fourth and fifth solutions. In the Year 13 in this group XI 21 in the texts is probably a mistake for XII 21, but it must be an ancient error for the omen is appropriate for Sabat. The intercalations can, as will be seen, be fixed with certainty with the aid of the contract-tablets. The observations of the 21st year seem to fall too late on all except the two last solutions. If the observations of the 8-9th year are rightly restored the date of disappearance is satisfied by all solutions, while the reappearance is rather early for all. The observations of

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the 16-17th year are satisfied by all. There would seem on the whole to be a marked superiority on the side of the first three solutions over the last two in this table as in Table I, and in the first group of observations a superiority of the first and second solutions over the third. But the evidence of these tablets does not appear to be decisive as between the first three solutions.

I shall endeavour to show later that the second solution alone satisfies certain other tests, and I have therefore thought it advisable to obtain from SCHUCH more detailed computations of the value of  $\gamma$  for each observation on that solution. This has involved a computation not only of the phases of Venus, but of the date of appearance of the lunar crescent.

Year of Ammisaduga.	Class of observation.	Babylonian date.	Gregorian date.	Value of $\gamma$ .
1	WS.	XI 15	Feb. 27	6.6°
1	ER.	XI 18	March 2	5.6
2	ES.	VIII 11	Nov. 16	8.5
2	WR.	X 19	Jan. 22	6.6
3	WS.	VI 23	Sept. 19	9.2
3	ER.	VII 13	Oct. 9	4.0
4	ES.	IV 2	June 20	6.2
4	WR.	VI 3	Aug. 20	5.4
5	WS.	II 2	May 10	1.7
5	ER.	II 18	May 26	10.7
5	ES.	IX 25	Jan. 24	6.4
5	WR.	XI 29	March 28	6.0
6	WS.	VIII 28	Dec. 18	6.1
6	ER.	IX 1	Dec. 21	6.0
7	ES.	V 21	Sept. 3	7.3
7	WR.	VIII 2	Nov. 12	6.3
8	WS.	IV 25	July 28	-12.0
8	ER.	V 2	Aug. 4	14.2
8	ES.	XII 25	March 22	6.2
9	WR.	(III 2)	May 25	3.9
9	WS.	XII 11	Feb. 25	6.5
9	ER.	XII 15	March 1	7.0
10	ES.	VIII 10	Nov. 16	7.7
10	WR.	X 16	Jan. 20	6.8
11	WS.	VI 26	Sept. 23	4.7
11	ER.	VI b 8	Oct. 5	0.8
12	ES.	I 9	April 30	11.5
12	WR.	VI 25	Oct. 12	12.0
13	WS.	II 5	May 15	-10.0
13	ER.	(II 12)	May 22	9.5
13	ES.	X 20	Jan. 21	6.5
13	WR.	(XII) 21	March 22	5.0
14	WS.	VII 11	Nov. 3	33.0
14	ER.	VIII 27	Dec. 19	6.6
15	ES.	V 20	Sept. 4	6.9
15	WR.	VIII 5	Nov. 17	7.0
16	WS.	IV 5	July 10	5.2
16	ER.	IV 20	July 25	4.6

<sup>1</sup> III in text.

SETTINGS AND RISINGS

Year of Ammisaduga.	Class of observation.	Babylonian date.	Gregorian date.	Value of $\gamma$ .
16	ES.	XII 15	March 12	7.8
17	WR.	(III 24)	June 18	8.9
17	WS.	XII 11	Feb. 26	1.25
17	ER.	XII 15	March 2	10.0
19	WS.	VI b 1	Aug. 31	15.2
19	ER.	VI b 17	Sept. 16	-23.6
20	ES.	III 25	June 17	6.0
20	WR.	(VI 1)	Aug. 21	5.9
21	WS.	I 26	May 8	-1.1
21	ER.	II 3	May 15	5.8
21	ES.	(X 28)	Jan. 31	4.0
21	WR.	XII 28	March 31	7.2

It will be seen from the figures in the last column that some of these dates are impossible and some others highly improbable, but on the whole the values of  $\gamma$  are in good accord with the values found above in the neo-Babylonian observations. It will be observed that in a large majority of instances the settings show a larger value of  $\gamma$  than the risings. This is contrary to what we discovered in the case of the neo-Babylonian observations and to what we should naturally expect, and it is found both at inferior (WS. and ER.) and at superior (ES. and WR.) conjunction. Had no empirical acceleration been introduced into the computation, the excess of the value at settings over that at risings would be markedly greater, and to that extent these observations are evidence of the existence of an acceleration of the motion of Venus. The explanation of the greater success of the observers in picking up the reappearing Venus than in retaining the disappearing Venus in view is perhaps that greater pains were taken to watch the rising than the setting. It is possible that in some instances the date of eastern rising has been taken erroneously for the date of western setting. If in the 8th year we take IV 25 as the date of eastern rising, we find  $\gamma = 5.0^\circ$ ; if in the 13th year we take II 5 as the date of eastern rising, we find  $\gamma = 4.7^\circ$ , and, if in the 17th year we take XII 11 as the date of eastern rising, we find  $\gamma = 6.3^\circ$ .



WESTERN SETTING AND EASTERN RISING OF VENUS

TABLE I

Year of Ammi-saduga.	Tablets.			1977-1956 B.C.			1921-1900 B.C.		
	WS.	Int.	ER.	WS.	Int.	ER.	WS.	Int.	ER.
5	II 2	15	II 18	May 23 I 27	14	June 6 II 11	May 7 I 29	12	May 19 II 11
13	II 5	7	(II 12)	May 20 I 23	14	June 3 II 7	May 5 I 25	12	May 17 II 7
21	I 27/26	7/6	II 3	May 18 I 18	14	June 1 II 3	May 4 I 22	11	May 15 II 3
8	IV 25	7	V 2	July 27 IV 5	18	Aug. 14 IV 23	July 12 IV 9	17	July 29 IV 26
16	IV 5	15	IV 20	July 25 IV 1	18	Aug. 12 IV 19	July 10 IV 5	16	July 26 IV 21
3	VI 23	20	VII 13	Oct. 16 VI 30	12	Oct. 28 VII 12	Sept. 25 VI 29	16	Oct. 11 VII 15
11	VI 26	11/12	VI b 7/8	Oct. 13 VI 26	12	Oct. 25 VI b 9	Sept. 22 VI 25	16	Oct. 8 VI b 11
19	VI b 1	15	VI b 17	Oct. 11 VI b 22	13	Oct. 24 VII 5	Sept. 19 VI b 20	17	Oct. 6 VII 8
6	VIII 28	3	IX 1	Jan. 4 VIII 27	2	Jan. 6 VIII 29	Dec. 18 VIII 28	3	Dec. 21 IX 1
14	VII 11	1 <sup>m</sup> 17 <sup>d</sup>	VIII 27	Jan. 2 VIII 23	2	Jan. 4 VIII 25	Dec. 16 VIII 24	3	Dec. 19 VIII 27
1	XI 15	3	XI 18	March 17 XI 15	4	March 21 XI 19	Feb. 27 XI 15	3	March 2 XI 18
9	(III) 11	(9 <sup>m</sup> ) 4 <sup>d</sup>	XII 15	March 14 XII 11	4	March 18 XII 15	Feb. 26 XII 12	2	Feb. 28 XII 14
17	XII 11	4	XII 15	March 12 XII 7	4	March 16 XII 11	Feb. 23 XII 8	3	Feb. 26 XII 11

EASTERN SETTING AND WESTERN RISING OF VENUS

TABLE II

Year of Ammi-saduga.	Tablets.			1977-1956 B.C.			1921-1900 B.C.		
	ES.	Int.	WR.	ES.	Int.	WR.	ES.	Int.	WR.
4	IV 2	m. d. 2 1	VI 3	July 12 IV 5	m. d. 2 4	Sept. 13 VI 9	June 21 IV 3	m. d. 2 6	Aug. 26 VI 9
12	I 9/8	5 16/17	VI 25	July 10 III 1	2 4	Sept. 11 V 5	June 19 II 29	2 6	Aug. 23 V 5
20	III 25	2 6	VI 24	July 8 III 27	2 4	Sept. 8 VI 1	June 17 III 25	2 6	Aug. 21 VI 1
7	V 21	2 11	VIII 2	Sept. 28 V 27	1 29	Nov. 25 VII 26	Sept. 12 V 30	2 0	Nov. 10 VII 30
15	V 20	2 15	VIII 5	Sept. 26 V 23	1 29	Nov. 22 VII 22	Sept. 10 V 26	2 0	Nov. 8 VII 26
2	VIII 11	2 7	X 19	Dec. 12 VIII 19	1 26	Feb. 5 X 15	Nov. 26 VIII 21	1 25	Jan. 19 X 16
10	VIII 10/(8)	2 6/8	X 16	Dec. 10 VIII 15	1 26	Feb. 3 X 11	Nov. 23 VIII 17	1 25	Jan. 16 X 12
18	...	...	...	Dec. 8 VIII 11	1 26	Feb. 1 X 7	Nov. 21 VIII 13	1 25	Jan. 14 X 8
5	IX 25	2 4	XI 29	Feb. 7 IX 20	2 7	Apr. 14 XI 27	Jan. 26 IX 27	2 3	March 29 XI 30
13	X 20	2 0	XI 21	Feb. 4 X 16	2 7	Apr. 12 XII 23	Jan. 24 X 23	2 3	March 27 XII 26
21	(X 28)	2 0?	XII 28	Feb. 3 X 13	2 6	Apr. 9 XII 19	Jan. 22 X 19	2 3	March 25 XII 22
8-9	XII 25	2 7	(III 2)	Apr. 9 XII 25	2 17	June 23 III 12	March 23 XII 27	2 16	June 6 III 13
16-17	XII 15	3 9	III 24?	Apr. 6 XII 21	2 17	June 21 III 8	March 20 XII 24	2 15	June 3 III 9

TABLE I

WESTERN SETTING AND EASTERN RISING OF VENUS

Year of Ammi-saduga.	1857-1836 B.C.			1809-1788 B.C.			1801-1780 B.C.		
	WS.	Int.	ER.	WS.	Int.	ER.	WS.	Int.	ER.
5	Apr. 21 I 29	8	Apr. 29 II 7	Apr. 7 II 5	7	Apr. 14 II 12	Apr. 6 II 2	6	Apr. 12 II 8
13	Apr. 18 I 25	8	Apr. 26 II 3	Apr. 6 II 2	6	Apr. 12 II 8	Apr. 3 I 27	6	Apr. 9 II 4
21	Apr. 16 I 21	8	Apr. 24 I 29	Apr. 3 I 27	6	Apr. 9 II 4	Apr. 1 I 24	6	Apr. 7 I 30
8	June 26 IV 8	15	July 11 IV 23	June 13 IV 16	15	June 28 V 1	June 12 IV 12	15	June 27 IV 27
16	June 23 IV 5	15	July 8 IV 20	June 12 IV 12	15	June 27 IV 27	June 10 IV 8	14	June 24 IV 22
3	Sept. 4 VI 24	18	Sept. 22 VII 13	Aug. 20 VI 29	19	Sept. 8 VII 25	Aug. 19 VI 25	18	Sept. 6 VII 14
11	Sept. 2 VI 20	18	Sept. 19 VI b 8	Aug. 19 VI 25	18	Sept. 6 VI 21	Aug. 16 VI 21	19	Sept. 4 VI b 11
19	Aug. 30 VI b 16	18	Sept. 17 VII 4	Aug. 16 VI b 21	19	Sept. 4 VII 11	Aug. 13 VI b 18	18	Aug. 31 VII 6
6	Nov. 29 VIII 24	6	Dec. 5 VIII 30	Nov. 12 VIII 29	8	Nov. 20 IX 7	Nov. 11 VIII 25	8	Nov. 19 IX 4
14	Nov. 26 VIII 21	5	Dec. 1 VIII 26	Nov. 11 VIII 25	8	Nov. 19 IX 4	Nov. 8 VIII 21	8	Nov. 16 VIII 29
1	Feb. 11 XI 15	3	Feb. 14 XI 18	Jan. 28 XI 23	2	Jan. 30 XII 25	Jan. 27 XII 18	2	Jan. 29 XII 20
9	Feb. 8 XII 11	3	Feb. 11 XII 14	Jan. 27 XII 18	2	Jan. 29 XII 20	Jan. 25 XII 15	2	Jan. 26 XII 17
17	Feb. 6 XII 7	3	Feb. 9 XII 10	Jan. 24 XII 15	2	Jan. 26 XII 17	Jan. 22 XII 11	2	Jan. 24 XII 13

TABLE II

EASTERN SETTING AND WESTERN RISING OF VENUS

Year of Ammi-saduga.	1857-1836 B.C.			1809-1788 B.C.			1801-1780 B.C.		
	ES.	Int.	WR.	ES.	Int.	WR.	ES.	Int.	WR.
4	May 25 III 22	m. d. 2 12	Aug. 4 VI 4	May 6 III 23	m. d. 2 16	July 19 VI 9	May 5 III 20	m. d. 2 15	July 18 VI 5
12	May 23 II 18	2 12	Aug. 2 IV 30	May 5 II 20	2 15	July 18 V 5	May 2 II 15	2 17	July 16 V 2
20	May 21 III 14	2 12	July 30 V 26	May 2 III 15	2 17	July 16 VI 2	Apr. 30 III 11	2 17	July 16 V 28
7	Aug. 20 V 24	2 2	Oct. 20 VII 26	Aug. 6 V 29	2 3	Oct. 6 VIII 2	Aug. 5 V 25	2 3	Oct. 5 VII 28
15	Aug. 18 V 20	2 2	Oct. 18 VII 22	Aug. 5 V 25	2 3	Oct. 5 VII 28	Aug. 2 V 21	2 3	Oct. 3 VII 24
2	Nov. 7 VIII 19	1 28	Jan. 3 X 17	Oct. 25 VIII 25	1 27	Dec. 19 X 22	Oct. 23 VIII 21	1 28	Dec. 18 X 19
10	Nov. 5 VIII 15	1 28	Jan. 1 X 13	Oct. 23 VIII 21	1 28	Dec. 18 X 19	Oct. 20 VIII 17	1 28	Dec. 15 X 15
18	Nov. 3 VIII 12	1 27	Dec. 29 X 9	Oct. 20 VIII 17	1 28	Dec. 15 X 15	Oct. 18 VIII 13	1 28	Dec. 15 X 11
5	Jan. 13 IX 30	2 0	March 13 XI 30	Dec. 31 X 9	1 26	Feb. 26 XII 5	Dec. 30 X 4	1 28	Feb. 24 XII 2
13	Jan. 10 X 26	2 0	March 10 XII 26	Dec. 30 XI 4	1 28	Feb. 24 X 30	Dec. 27 X 30	1 28	Feb. 22 XII 28
21	Jan. 8 X 22	2 0	March 8 XII 22	Dec. 27 X 30	1 28	Feb. 22 XII 28	Dec. 26 X 26	1 28	Feb. 21 XII 24
8-9	March 6 XII 27	2 14	May 18 III 14	Feb. 27 I 9	2 9	May 6 III 18	Feb. 25 I 5	2 9	May 4 III 14
16-17	March 5 XII 24	2 13	May 16 III 7	Feb. 25 I 5	2 9	May 4 III 14	Feb. 22 I 1	2 9	May 2 III 10

## CHAPTER IX

RESTORATION OF THE BABYLONIAN CALENDAR BY MEANS OF  
ATTESTED INTERCALATIONS

WHEN once we have fixed the position of the Babylonian months in the solar year, expressed for us in terms of the Gregorian calendar, for the reign of Ammizaduga, we may attempt to do the same right back to the beginning of the dynasty, and in fact for the Dynasty of Ellasar that coincided with the first part of it. The clue to this is provided by the numerous contract-tablets, dated in intercalary months, by means of which we are able to place a large number of Babylonian leap years. Twelve lunar months contain rather more than 354 days, just about 11 days less than a solar year. It follows that a Babylonian calendar year following an ordinary year begins 11 days earlier than its predecessor, while a year following a leap year begins 19 days later than its predecessor. If the intercalation were guided purely by astronomical considerations the beginning of the calendar year would fluctuate by about 30 days, while the beginning of the calendar leap year would fluctuate by about 11 days in the solar year. Now, if we can fix the date of Ammizaduga, then, since the lengths of all the reigns in the First Dynasty of Babylon and in the Dynasty of Ellasar are known, we can identify each year, and since every month began shortly after the true new moon, we can select by conjecture the date of beginning of each month. But we can do more than this. If we find that the attested leap years are all years when new moons fall within a comparatively narrow range of days in the solar year, it is unlikely that two different groups of such days separated by a month were beginnings of leap years. We must assume that one group only represents leap years, and that that group does not suddenly change its position in the solar year. For instance, if we find that all Babylonian leap years begin in the first half of the month in the Gregorian calendar, that half may be the first half of March or the first half of April, but we are not to expect some leap years to begin in the first half of March and others in the first half of April, if there are none in the second half of March. Now the earliest new year's days must necessarily be those of leap years and the latest must necessarily be those of years succeeding leap years. The total range of new year's days in any reign or group of reigns will therefore be from the beginning of the earliest leap year to 19 days later than the beginning of the latest leap year. If in any solar year there is only one new moon in this interval, that gives us the Babylonian new year's day with certainty, but if there are two, some uncertainty attaches to the determination of the Babylonian date, unless the particular year or one in its immediate vicinity is known to have been a leap year.

Intercalation was made by inserting a second Ulul or a second Adar. Ammizaduga shows a distinct preference for second Ulul; one second Ulul, one second Adar, and one second Nisan are found under Abeshu'; Samsuiluna is known to have inserted a second Ulul five times and a second Adar seven times, and second Ulul would appear to have been inserted three times under Hammurabi. But except in the reign of Ammizaduga there is a presumption in favour of intercalation having been made by inserting a second Adar. Second Nisan is very rare, being found once under Abeshu' and once under Samsuditana.<sup>1</sup>

<sup>1</sup> The principal authority for intercalary months is UNGNAD'S JOHNS, PSBA. xxxiv (1912). I have received valuable paper *Zur Schaltungs-Praxis in der Hammurabi-Zeit*, OLZ. additions and comments from SCHNABEL and others. 13 (1910), 66, 67. Some additional dates are given by

Every intercalary month in the reign of Ammizaduga has been found on some contract or other. The list is as follows. In accordance with KUGLER'S practice I use \* for a year with second Adar, and \*\* for a year with second Ulul.

- 4\* VS. vii 76 (VAT. 6238) = HG. 557.  
 5\*\* Two examples from unpublished contracts, communicated to me by SCHNABEL.  
 10\*\* Ranke 106 (CBM. 437) = HG. [120; VAT. 633 (UNGNAD, *Beitr. zur Assyriol.* vi, 3 [1907], p. 32).  
 11\*\* CT. viii 3<sup>a</sup> (88-5-12, 12) = HG. 74.  
 14\*\* An unpublished contract, communicated to me by SCHNABEL.  
 19\*\* In an unpublished contract of Ammizaduga belonging to the year which UNGNAD styles '17+a', twelve months are reckoned from the second Ulul of the previous year to Ab of the year *mu urudu ki-lugal-gub-ba-a ib-dirig-ga*. From this it follows that the year preceding '17+a' contained a second Ulul, and since we know from HG. 164 and other contracts that '17+a' contained a second Adar, these two years must be Ammizaduga 19 and 20, for the Venus tablets show that Ammizaduga 19 contained a second Ulul and that Ammizaduga 20 contained either a second Ulul or a second Adar. They also show that there was no intercalation between the 14th and the 19th year. I owe this reference and the identification of the year '17+a' to SCHNABEL.  
 20\* M. 9 (88-5-12, 454) = HG. 164; VAT. 5895, 5898, 5907, 5928, 5931, 5949, 5978 (UNGNAD, *ubi supra*, p. 35).

If in the 13th year of Ammizaduga we place the eastern setting in Tebit with Rm. II 531, and the western rising in Adar against the readings of K. 160 and Rm. II 531, all the dates on the Venus tablets are consistent with the intercalations attested by the contracts. If, however, with K. 160 and Rm. II 531 we retain Šabat as the month of western rising in the 13th year, and supply Kislef for the month of eastern setting, against the reading of Rm. II 531, we shall be compelled to make the 13th year intercalary with second Ulul instead of the 14th, thus leaving an interval of six years between two successive intercalations and producing a discord between the contracts and the Venus observations. I have no hesitation, therefore, in reading Tebit and Adar in the Venus texts for this year. The intercalations as thus restored give us twice over an interval of five years, viz. between second Ulul in the 5th year and second Ulul in the 10th year, and between second Ulul in the 14th year and second Ulul in the 19th year. On three occasions Ammizaduga intercalated in two consecutive years, the intercalary months being separated by half a year, a complete year, and a year and a half on the different occasions. In fact the 14th year was the only leap year in his reign which did not form one of a pair.

With these data it is easy to reconstruct a detailed calendar of the reign of Ammizaduga. In the following table I give the Gregorian date of Nisan 1 and Tešrit 1 for each year on the assumption that the second solution is correct. The Gregorian date is that which agrees with the Babylonian date during the daytime. The computation is made with SCHOCH'S handy tables.

Year of Ammizaduga.	B.C.	Nisan 1.	Tešrit 1.
1	1921	April 24	Oct. 19
2	1920	April 14	Oct. 8
3	1919	April 3	Sept. 28
4*	1918	March 24	Sept. 17

<i>Year of Ammizaduga.</i>	<i>B.C.</i>	<i>Nisan 1.</i>	<i>Tešrit 1.</i>
5**	1917	April 10	Nov. 3
6	1916	April 29	Oct. 24
7	1915	April 19	Oct. 13
8	1914	April 8	Oct. 3
9	1913	March 27	Sept. 21
10**	1912	March 17	Oct. 10
11**	1911	April 5	Oct. 29
12	1910	April 24	Oct. 18
13	1909	April 12	Oct. 6
14**	1908	April 1	Oct. 25
15	1907	April 20	Oct. 15
16	1906	April 10	Oct. 4
17	1905	March 29	Sept. 22
18	1904	March 18	Sept. 12
19**	1903	March 8	Sept. 30
20*	1902	March 27	Sept. 20
21	1901	April 15	Oct. 9

On the first solution each year should begin 19 days later, on the third solution 16 or 17 days earlier, on the fourth solution 36 days earlier, and on the fifth solution 34 days earlier than on the second solution, on which this table is constructed.

It will be observed that the beginning of the year varies from March 8 to April 29, 52 days, while the beginning of Tešrit varies by the same amount between September 12 and November 3. The beginnings of leap years vary from March 8 to April 10, 33 days.

In the thirty-seven years of Ammiditana we have eight attested intercalary months as compared with the seven of Ammizaduga. These are as follows:

4* Ranke 91 (CBM. 723) = HG. 110.	33* P. 112.
11* Unpublished.	36* CHIERA, PBS. viii 2, no. 202, erroneously identified by CHIERA with Ammiditana 32.
22* JOHNS, PSBA. xxxiv (1912), 24.	37* Unpublished.
26* CT. vi 39* (91-5-9, 734) = HG. 1249.	
27* P. 109.	

In six of these years there is only one new moon falling within the range of leap year dates of the reign of Ammizaduga. The exceptions are the 26th and 37th years. The 26th is the earlier of two consecutive years, both leap years, and we are bound to accept the earlier new moon falling within the range, if the beginning of the next year is also to fall within the range. The 37th is the second of two similarly placed leap years. In this case the relation of the calendar to the solar year is determined by the Venus tablets, which begin in the following year, and the determination of the beginning of this year carries with it the determination of the beginnings of the 33rd and 36th years, for it is inconceivable that either the 34th or 35th year can have been a leap year.

We thus get for Nisan 1:

Ammiditana 4 March 12	Ammiditana 27 March 28
11 March 25	33 March 22
22 March 23	36 March 19
26 March 9	37 April 7

It will be observed that the total range of the beginnings of these leap years is only 29 days, March 9 to April 7, and with one exception they fall within the narrower range, March 9 to March 28, showing a distinct preference for the earlier part of the range which Ammizaduga permitted himself. It will also be observed that all leap years from the 22nd year of Ammiditana to the end of the reign of Ammizaduga are known with the exception of one falling between the 27th and 33rd years of Ammiditana.

There are no intercalary months in the reign of Abeshu' which we can assign to particular regnal years.

In the reign of Samsuiluna there are twelve such:

2* Unpublished.	17** Unpublished.
5** TD. 114 = HG. 1103.	20* P. 53.
8** Warka 69 = HG. 334.	23* CT. viii 32* (91-5-9, 2503) = HG. 365.
9** Unpublished.	27* JOHNS, PSBA. xxxiv 24.
10* Unpublished.	28* Unpublished.
16** Unpublished.	37* JOHNS, PSBA. xxxiv 24.

In Years 5, 16, and 27 there are two new moons within the range permitted by Ammizaduga. But to accept the later date for 5 would involve placing the beginning of 10 thirty-four days later than the last day within the range, while to accept the earlier date for 5 involves nothing worse than placing the beginning of 8 one day earlier than the first day within the range and the beginning of 10 four days later than the last day within the range. Similarly, if we accept the later dates for 16 and 27, we must place the beginning of 17 sixteen days and the beginning of 28 fourteen days after the end of the range. We therefore adopt the earlier date in each of these cases, and reconstruct the beginnings of leap years as follows:

Samsuiluna 2 March 14	Samsuiluna 17 March 28
5 March 11	20 March 24
8 March 7	23 March 22
9 March 26	27 March 8
10 April 14	28 March 26
16 March 9	37 March 17

The total range is 38 days, March 7 to April 14, five days longer than under Ammizaduga. But with one exception all dates fall within the narrower range, March 7 to March 28, practically the same range as that found for the reign of Ammiditana. Our reconstruction also implies that all the leap years of the first 28 years of Samsuiluna are known.

In the reign of Hammurabi we have the following leap years:

3 VS. vii 96 (VAT. 943) = HG. 881. Intercalary month, name not given.
10* Unpublished.
15* VS. viii 131-3 (VAT. 1028, 922) = HG. 858, 859; also in unpublished tablets of which SCHNABEL has informed me, from which we learn that this year contained a second Adar.
16* P. 70 = HG. 989.

- 17\* M. 71, VS. ix 6 (VAT. 974/75) = HG. 505.  
 23\* Unpublished: communicated by SCHNABEL.  
 24\* Unpublished.  
 25\* Unpublished. See also JOHNS, PSBA. xxxiv 24, whose Year 42 is really 25.  
 30\* Unpublished.  
 33\* Bu. 88-5-12, 739. See KING, *Letters*, iii, p. 13, note 1.  
 36\*\* Unpublished: *mu e-me-te-ur-sag*, i. e. Year 36, not 41.  
 39\*\* Unpublished: *mu kur su-bir*<sup>41</sup>.  
 40\*\* 32 in JOHNS, PSBA. xxxiv 24, identified by SCHNABEL, perhaps from the same tablet.

From the Year 10 to the end of the reign we have here a complete series of leap years continuous with those which we have just found for the reign of Samsuiluna. We may date the beginnings of these leap years as follows:

Hammurabi 3 March 27	Hammurabi 25 April 23
10 April 10	30 March 30
15 March 15	33 March 26
16 April 3	36 March 23
17 April 22	39 March 20
23 March 17	40 April 8
24 April 5	

The total range is 39 days, March 15 to April 23, rather more than the widest range known to us in any other reign. It will be observed that the earliest date falls eight days later and the latest nine days later than under Samsuiluna.

In dealing with the reign of Rim-Sin I follow LANGDON and UNGNAD and equate his 32nd year with the 1st year of Hammurabi. This date does not affect the identification of his leap years with years before Christ, but only the place which they are to occupy in relation to the date of his accession. The regnal years given by MISS GRICE are in consequence diminished by one.

The known leap years are as follows. In each instance the intercalary month is second Adar.

- 7 G. 176 (YBC. 8761), G. 210 (YBC. 4413), G. 212 (YBC. 7476).  
 16 VS. xiii 59 (VAT. 3977) = HG. 1536.  
 18 Communicated by SCHOCH: I have failed to find this.  
 32 EG. 61 = HG. 1505.  
 49 PSBA. xxxiv, Pl. X, No. VII (Ash. 1911-279) = HG. 1824.

In each of these years there is only one new moon within the range in which leap years began under Ammizaduga. We can therefore fix the beginnings of these years as follows:

Rim-Sin 7 March 26	Rim-Sin 32 March 20
16 March 17	49 March 13
18 March 24	

These give a total range of 13 days only, and agree excellently with the dates adopted in this discussion for the reigns of Samsuiluna and Ammiditana. It may be noted that the 18th year of Hammurabi, which corresponds to the 49th of Rim-Sin, was not a leap year at Babylon. On the other hand, the 18th year of Rim-Sin, which coincided with the 7th year of Sinmuballit, was a leap year both at Ellasar and at Babylon.

In the reign of Sinmuballit of Babylon we have three recorded leap years.

- 7 VS. viii 26 (VAT. 700) = HG. 806. Intercalary month not named.  
 9\* VS. viii 30 (VAT. 1489) = HG. 875.  
 19 TD. 72 = HG. 1224. Intercalary month not named.

If we suppose that these years began within the same limits as the leap years of Ammizaduga we obtain the following new year's days.

Sinmuballit 7 (= Rim-Sin 18) March 24
9 April 2
19 March 12 or April 10

The selection of April 10 for the 19th year gives a narrower range of dates than the selection of March 12 and agrees better with the run of the calendar under Hammurabi.

The only recorded intercalation under the First Dynasty of Babylon before Sinmuballit is that in the 5th year of Sumulailum, RFH. 39 (= AJSL. 33, 243), HG. 1776, which contained a second Adar and which ought to have begun on March 18, well within the normal range of beginnings of leap years.

In Ellasar before Rim-Sin the following leap years are known:

- Abisaré 1\* RA. xiv (1897), p. 153.  
 Siniribam 1\* G. 133 (YBC. 8755), G. 157 (YBC. 5093).  
 Sinikisham 1\* G. 62 (YBC. 4851).  
 Warad-Sin 9\* G. 119 (YBC. 5686).

Adopting the chronology shown in the List of Kings in this volume, we get the following dates:

King.	Regnal Year.	Interval to Rim-Sin 1.	Gregorian date of Nisan 1.
Abisaré	1	83	March 19
Siniribam	1	21	March 24
Sinikisham	1	19	March 31
Warad-Sin	9	4	March 16

Three of these are within the range which was found applicable to Rim-Sin, so that the nine identifiable leap years of Ellasar range from March 13 to March 31 only, and the calendar therefore approximates to strict regularity, for in any lunisolar calendar the beginning of leap year must range by at least 10 or 11 days.

It is now possible to make a conjectural table, showing the beginning of each year on the hypothesis that what is here called the second solution is correct. The narrow range of intercalations under Rim-Sin and the abundance of known leap years from the 10th year of Hammurabi to the end of the reign of Samsuiluna leave little doubt as to the correct new moons to assume for Nisan during those periods. Recorded leap years are indicated by B, assumed leap years by *B*. BB indicates a year known to have contained a second Ulul.

## RESTORATION OF THE BABYLONIAN CALENDAR

		B. C.		
Rim-Sin	1	April 2	2098	
	2	March 21	B 2097	
	3	April 9	2096	
	4	March 30	2095	
	5	March 19	B 2094	
	6	April 6	2093	
	7	March 26	B 2092	
	8	April 14	2091	
	9	April 4	2090	
	10	March 23	B 2089	
	11	April 11	2088	
	12	March 31	2087	Sinmuballit 1 March 31 B
	13	March 21	B 2086	2 April 19
	14	April 7	2085	3 April 7
	15	March 28	2084	4 March 28 B
	16	March 17	B 2083	5 April 16
	17	April 5	2082	6 April 5
	18	March 24	B 2081	7 March 24 B
	19	April 12	2080	8 April 12
	20	April 2	2079	9 April 2 B
	21	March 22	B 2078	10 April 20
	22	April 9	2077	11 April 9
	23	March 29	2076	12 March 29 B
	24	March 19	B 2075	13 April 17
	25	April 7	2074	14 April 7 B
	26	March 26	2073	15 April 24
	27	March 15	B 2072	16 April 14
	28	April 3	2071	17 April 3 B
	29	March 24	B 2070	18 April 22
	30	April 10	2069	19 April 10 B
	31	March 31	2068	20 April 29
	32	March 20	B 2067	Hammurabi 1 April 19
	33	April 8	2066	2 April 8
	34	March 27	2065	3 March 27 B
	35	March 17	B 2064	4 April 15
	36	April 5	2063	5 April 5 B
	37	March 25	B 2062	6 April 24
	38	April 12	2061	7 April 12
	39	April 1	2060	8 April 1 B
	40	March 22	B 2059	9 April 20
	41	April 10	2058	10 April 10 B
	42	March 29	2057	11 April 27
	43	March 18	B 2056	12 April 17
	44	April 6	2055	13 April 6
	45	March 27	2054	14 March 27
	46	March 15	B 2053	15 March 15 B
	47	April 3	2052	16 April 3 B
	48	March 23	2051	17 April 22 B
	49	March 13	B 2050	18 May 11
	50	March 30	2049	19 April 29
	51	March 20	B 2048	20 April 19

## REDUCTION OF DATES

		B. C.							
Rim-Sin	52	April 8	2047	Hammurabi 21 April 8					
	53	March 28	2046	22 March 28					
	54	March 17	B 2045	23 March 17 B					
	55	April 5	2044	24 April 5 B					
	56	March 25	B 2043	25 April 23 B					
	57	April 13	2042	26 May 12					
	58	April 1	2041	27 May 1					
	59	March 22	B 2040	28 April 20					
	60	April 10	2039	29 April 10					
<hr/>									
B. C.				B. C.					
2038	Hammurabi	30	March 30	B	1998	Samsuiluna	27	March 8	B
2037		31	April 17		1997		28	March 26	B
2036		32	April 6		1996		29	April 14	
2035		33	March 26	B	1995		30	April 3	
2034		34	April 13		1994		31	March 24	
2033		35	April 3		1993		32	March 12	B
2032		36	March 23	BB	1992		33	March 31	
2031		37	April 11		1991		34	March 20	B
2030		38	March 31		1990		35	April 8	
2029		39	March 20	BB	1989		36	March 27	
2028		40	April 8	BB	1988		37	March 17	B
2027		41	April 27		1987		38	April 5	
2026		42	April 16		1986	Abeshu'	1	March 25	
2025		43	April 4		1985	(No attested intercalations)	2	March 13	B
2024	Samsuiluna	1	March 25		1984	(All leap years conjectural)	3	April 1	
2023		2	March 14	B	1983		4	March 22	B
2022		3	April 2		1982		5	April 10	
2021		4	March 21		1981		6	March 29	
2020		5	March 11	BB	1980		7	March 18	B
2019		6	March 30		1979		8	April 6	
2018		7	March 19		1978		9	March 27	
2017		8	March 7	BB	1977		10	March 15	B
2016		9	March 26	BB	1976		11	April 3	
2015		10	April 14	B	1975		12	March 23	
2014		11	May 3		1974		13	March 13	B
2013		12	April 21		1973		14	March 30	B
2012		13	April 11		1972		15	March 20	B
2011		14	March 31		1971		16	April 8	
2010		15	March 21		1970		17	March 28	
2009		16	March 9	BB	1969		18	March 17	B
2008		17	March 28	BB	1968		19	April 5	
2007		18	April 16		1967		20	March 25	
2006		19	April 5		1966		21	March 14	B
2005		20	March 24	B	1965		22	April 1	
2004		21	April 12		1964		23	March 22	B
2003		22	April 2		1963		24	April 10	
2002		23	March 22	B	1962		25	March 30	
2001		24	April 9		1961		26	March 18	B
2000		25	March 29						
1999		26	March 19						

## RESTORATION OF THE BABYLONIAN CALENDAR

B. C.			
1960	Abeshu'	27	April 6
1959		28	March 26
1958	Ammiditana	1	March 16 B
1957		2	April 3
1956		3	March 23
1955		4	March 12 B
1954		5	March 31
1953		6	March 20 B
1952		7	April 8
1951		8	March 28
1950		9	March 17 B
1949		10	April 4
1948		11	March 25 B
1947		12	April 13
1946		13	April 2
1945		14	March 21 B
1944		15	April 9
1943		16	March 30
1942		17	March 19 B
1941		18	April 6
1940		19	March 26
1939		20	March 16 B
1938		21	April 4
1937		22	March 23 B
1936		23	April 11
1935		24	March 31
1934		25	March 21
1933		26	March 9 B
1932		27	March 28 B
1931		28	April 16

B. C.			
1930	Ammiditana	29	April 5
1929		30	March 24
1928		31	March 14 B
1927		32	April 2
1926		33	March 22 B
1925		34	April 9
1924		35	March 29
1923		36	March 19 B
1922		37	April 7 B
1921	Ammizaduga	1	April 24
1920		2	April 14
1919		3	April 3
1918		4	March 24 B
1917		5	April 10 BB
1916		6	April 29
1915		7	April 19
1914		8	April 8
1913		9	March 27
1912		10	March 17 BB
1911		11	April 5 BB
1910		12	April 24
1909		13	April 12
1908		14	April 1 BB
1907		15	April 20
1906		16	April 10
1905		17	March 29
1904		18	March 18
1903		19	March 8 BB
1902		20	March 27 B
1901		21	April 15

## CHAPTER X

## COMPARISON OF THE RESTORED BABYLONIAN CALENDAR WITH CONTRACTS BEARING ON AGRICULTURAL OPERATIONS

THE Babylonian calendar as restored for each year in the last chapter is approximately correct for our second solution of the Venus observations. The first solution, as has been remarked, requires an addition of 19 days to each date, the third a subtraction of 16 or 17 days, the fourth a subtraction of 36 days, and the fifth a subtraction of 34 days approximately. As was seen in the first chapter, KUGLER, with the material at his disposal, attempted to decide between certain solutions by the seasons of the year at which they would place dated contracts bearing on agricultural operations. The criterion is sound and there is sufficient evidence to enable us to apply it.

The most crucial test appears to be supplied by the contracts for division of dates between landlord and tenant. The practice was for the unripe dates to be counted some time before date-harvest and for a contract to be signed by which the tenant undertook to supply by a given day, generally the last day of Tešrit, or first day of Arahsamna, a given quantity of ripe dates determined by the estimated number of unripe dates. From this we may infer that the dates would be expected to be harvested before the day named on the contract, and that any solution of the calendar which makes that day fall before the completion of date-harvest could be expected, must necessarily be false. On the other hand, a solution which interposes an unnecessary interval between date-harvest and the division is improbable.

In answer to an inquiry from LANGDON, MR. J. F. WEBSTER of the Agricultural Directorate, Baghdad, wrote on 1924 November 16 as follows:

'Since the date-export to America started the demand has been for *early* maturing types, and date-picking began this year in the Basrah gardens in the last week in August.

'The bulk of the crop was picked in September, and late varieties which are valued locally, as they are table delicacies, extended well into October, and there is one variety which is not picked until November.

'It is probable that for your purpose mid-September to mid-October should be taken as the month of date-harvest, since I doubt if the very early varieties existed in any great quantity before the specialized demand for them arose.'

In response to a further inquiry from me, MR. WEBSTER wrote again on 1925 January 15:

'My statement that date-harvest extends from mid-September to mid-October was intended to cover the bulk of the crop.

'I should certainly change this to the month of October were the inquiry confined to Hillah District.'

Even more important for our purpose are the neo-Babylonian contracts relating to date-harvest. Thanks to KUGLER's industry and ingenuity we have in his *Sternkunde und Sternendienst*, ii, T. 2, H. 2 (1924), 435-8, 461-3, a restoration of the Babylonian calendar from 573 B. C. to 1 B. C., and we can with great confidence convert any Babylonian date into the corresponding Gregorian date within those limits. There are also other contracts for payments in dates, for

payments in kind were quite common both in early and in late Babylonian times, but although these are often required to be made at the time of date-harvest, they are also found scattered over the rest of the year and are therefore of less weight than contracts for division of the harvest.

In BE. viii 39, p. 32, in the accession year of Nabuna'id, in a contract signed on Ayar 15 (May 18 Gregorian), a debtor promises to pay 3 kors of dates, the equivalent of 2 shekels of silver, on Tešrit 7 (October 5). It looks as if this date was selected because it was expected that new dates would be available at that time. The quantity is small and it is conceivable that payment was to be made before the end of date-harvest. This may also explain the selection of the 7th rather than the usual last day of the month. On the other hand, the date may have been selected for some reason which had no connexion with harvest.

An interesting contract is KB. iv (1896), p. 229 = BM, S + 76, 11-17, 261, also in STRASSMAIER, ZA. iv 128, 152. This is dated at Babylon in the first year of Barzta, the pseudo-Smerdis, 522 B.C., Tešrit 1, September 14 of our calendar. The owner gives the recipient an order to receive from his servant at the picking in Arašsamna a certain quantity of dates 'still on the tree'. Arašsamna began that year on October 13. So it would appear that on September 14 the picking was expected to take place on or after October 13.

KB. iv, pp. 309, 311 (VAT. 78), contains a similar order of the 36th year of Darius I (486 B.C.), signed on Ulul 13 (September 19), which gives the right to receive a specified quantity of dates 'still on the tree' at the picking in Tešrit, which in that year began on October 7. In this case we infer that on September 19 the picking was expected to take place on or after October 7.

A document, CT. iv 34d, of the 10th year of Xerxes (476 B.C.), signed on Arašsamna 24 (November 7), demanding a payment of dates in Kislev (ending December 12), may be disregarded, since it was made after harvest. The same probably applies to BE. x 68, signed at Nippur on Tešrit 2 (October 8) in the 3rd year of Darius II (B.C. 421), requiring payment in Arašsamna, which in that year ended on December 4, except that this contract appears to have been signed during, rather than after, harvest. A contract, VS. iii 183, of the 16th year of Xerxes (470 B.C.), signed at Nippur on Ulul 5 (September 14), requires a delivery of dates in Arašsamna, which in that year ended on December 7. Otherwise the contracts regularly require payment in Tešrit. As the day of Tešrit is not stated, it would appear that payment might be made at any time up to the last day of that month. Examples of contracts for payments of dates to be made in Tešrit are the following. In each case the year given is the year in which payment was to be made.

BE. ix 9	Artaxerxes I 28
BE. ix 7	" 29
BE. ix 19, 22	" 31
BE. ix 31	" 33
BE. ix 36, 37, 38	" 34
BE. ix 62, 63	" 38
BE. ix 91, 92, 93, 95, 97, 103, 104, 105	" 41
BE. x 8, 16, 27, 38, 51	Darius II 1

We also have in BE. ix 48, signed on the 2nd of Tešrit of the 36th year of Artaxerxes I (429 B.C. October 6), a contract to pay rent in dates annually in the month of Tešrit for 60 years, and in BE. x 61, signed on Tebit 18 in the 2nd year of Darius II (421 B.C. January 2), a contract to pay rent in dates annually in the month of Tešrit for 3 years. Within the range of years

covered by these contracts, including the 60 years from 429 B.C., the last day of Tešrit would range from October 14 to November 15. As the system of intercalation had nothing to do with the lateness or earliness of date-harvest in the solar year, it may be inferred that the contractors considered it normally possible to deliver the landlord's supply of dates on October 14, though a period of grace may have been given when the harvest was late and Tešrit early. And we have no reference to any demand for a delivery of dates earlier than October 5, if so early. It would, however, be rash to suppose that if the calendar had been so arranged that the last day of Tešrit sometimes fell a few days earlier than October 14 or later than November 15, the contracts would have named some other month instead of Tešrit. Judging from the modern time of date-harvest and from the contracts for delivery of dates in neo-Babylonian times, we should look with suspicion on any restoration of the calendar which places any contract for delivery of dates to a landlord much before October 14, but we should expect the earliest day for delivery to be not far distant from October 14.

Till recently there were very few published contracts for the delivery of dates to landlords in or near the time of the First Dynasty of Babylon. We owe to the courtesy of M. THUREAUX-DANGIN a series of contracts for delivery of dates to landlords, belonging to the latter years of Hammurabi, which have now been published by JEAN.<sup>1</sup> Including those only where the year can be identified and the date of delivery is preserved, we have:

No.	Reference.	Year.	Date of Contract.	Contracted Date of Delivery.
1	VS. xiii 18 (=VAT. 6076) = HG. 1724	Hammurabi	23 Ulul 17	Kislev
2	Ao. 8397, J. 144	"	32	Tešrit
3	Ao. 8382, J. 147	"	33	Ab 18
4	Ao. 8386, J. 157	"	33 <sup>2</sup>	Ab 20
5	Ao. 8385, J. 150 (=RA. xxi, pp. 2, 3)	"	35	Ulul 21
6	Ao. 8400, J. 160	"	38	Tešrit
7	Ao. 8383, J. 170	"	39	Ulul
8	Ao. 8384, J. 169	"	39	Ulul
9	Ao. 8394, J. 175	"	40	Ulul 20
10	Ao. 8402, J. 186	"	42	Tešrit
11	Ao. 8399, J. 180	"	43	Ulul 8
12	Ao. 8395, J. 187	"	43	Ulul 9
13	Ao. 8392, J. 182	"	43	Ulul 10
14	TD. 138 = HG. 1187	Samsuiluna	19 Ulul 23	Arašsamna 1
15	TD. 143 = HG. 1189	"	24	Ab 22

In reducing these to Gregorian dates, I assume that a contract for delivery in a particular month is equivalent to a contract for delivery on the last day of that month. I show the Gregorian date of contract and delivery on each of the five solutions discussed for the Venus observations.

No.	Solution I.		Solution II.		Solution III.		Solution IV.		Solution V.	
	Date of Contract.	Date of Delivery.	Date of Contract.	Date of Delivery.	Date of Contract.	Date of Delivery.	Date of Contract.	Date of Delivery.	Date of Contract.	Date of Delivery.
1	Sept. 15	Dec. 25	Aug. 28	Dec. 7	Aug. 10	Nov. 19	July 21	Oct. 30	July 23	Nov. 1
2		Nov. 17		Oct. 29		Oct. 12		Sept. 22		Sept. 23
3	Aug. 28	Nov. 6	Aug. 9	Oct. 18	July 23	Oct. 1	July 2	Sept. 11	July 4	Sept. 13
4	Aug. 30	Nov. 6	Aug. 11	Oct. 18	July 25	Oct. 1	July 4	Sept. 11	July 6	Sept. 13

<sup>1</sup> *Textes Cuneiformes*, xi, Larsa 2 (1926).

<sup>2</sup> JEAN in error gives 36.

## COMPARISON OF THE RESTORED BABYLONIAN CALENDAR

No.	Solution I.		Solution II.		Solution III.		Solution IV.		Solution V.	
	Date of Contract.	Date of Delivery.	Date of Cont. act.	Date of Delivery.	Date of Contract.	Date of Delivery.	Date of Contract.	Date of Delivery.	Date of Contract.	Date of Delivery.
5	Oct. 6	Nov. 13	Sept. 18	Oct. 26	Sept. 1	Oct. 9	Aug. 11	Sept. 18	Aug. 13	Sept. 20
6		Nov. 11		Oct. 23		Oct. 6		Sept. 16		Sept. 18
7	Sept. 2- Oct. 1	Nov. 29	Aug. 15- Sept. 12	Nov. 10	July 28 Aug. 26	Oct. 24	July 8- Aug. 6	Oct. 4	July 10- Aug. 7	Oct. 5
8	Sept. 2- Oct. 1	Nov. 29	Aug. 15- Sept. 12	Nov. 10	July 28- Aug. 26	Oct. 24	July 8- Aug. 6	Oct. 4	July 10- Aug. 7	Oct. 5
9	Oct. 10	Dec. 18	Sept. 22	Nov. 29	Sept. 5	Nov. 12	Aug. 15	Oct. 23	Aug. 17	Oct. 24
10		Nov. 26		Nov. 8		Oct. 22		Oct. 2		Oct. 3
11	Sept. 25	Nov. 15	Sept. 6	Oct. 27	Aug. 20	Oct. 10	July 31	Sept. 20	Aug. 1	Sept. 21
12	Sept. 26	Nov. 15	Sept. 7	Oct. 27	Aug. 21	Oct. 10	Aug. 1	Sept. 20	Aug. 2	Sept. 21
13	Sept. 27	Nov. 15	Sept. 8	Oct. 27	Aug. 22	Oct. 10	Aug. 2	Sept. 20	Aug. 3	Sept. 21
14	Oct. 11	Nov. 17	Sept. 22	Oct. 29	Sept. 5	Oct. 12	Aug. 17	Sept. 22	Aug. 18	Sept. 23
15	Sept. 14	Nov. 20	Aug. 26	Nov. 2	Aug. 9	Oct. 16	July 20	Sept. 26	July 22	Sept. 27

It will be seen that No. 1 on which UNGNAD relied as showing that date-harvest would fall too late on the first solution, and which requires delivery not later than the last day of Kislev instead of on the last of Tešrit or first of Araḥsamna, gives a Gregorian date falling later than any of the others. But, as has been noticed earlier,<sup>1</sup> this contract requires the delivery not only of dates, but of planks of palm wood and even of 10 talents of palm branches blown down by the wind, an obligation which could not be fulfilled before the winter storms had begun. The date of signature is within the range given by other contracts. If we ignore this contract, the date of delivery varies from November 6 to December 18 according to the first solution, from October 18 to November 29 according to the second, from October 1 to November 12 according to the third, from September 11 to October 23 according to the fourth, and from September 13 to October 24 according to the fifth. The September deliveries found on the fourth and fifth solutions are quite inconsistent with the evidence of the Persian period and of modern times. In six out of ten years the third solution gives deliveries in the first twelve days of October contrary to the same evidence. The dates on the second solution fall entirely within the range given by contracts of the Persian period, except in the case of No. 9, where delivery is not required till November 29, but the custom of requiring delivery in Tešrit was obviously well established, and this would explain the naming of Tešrit in the contract even when a delivery in Ulul II was possible. The first solution would imply that the date of delivery was generally fixed a month later than was necessary. It may also be observed that on the first solution, contracts Nos. 9 and 14 in this table, where the dates are distinctly described as green, were not signed till October 10 and 11 respectively. This would imply great delay in signing the contracts, for the actual enumeration of the green dates must have taken place long before those dates. On the second solution the latest dated contracts belong to September 22, and the earliest to August 9. The third, fourth, and fifth solutions imply an enumeration of unripe dates as early as July.

It may be taken, therefore, that the evidence of date-harvests excludes all solutions except the second.

Next in importance to the date-harvest is the barley-harvest. Here we have a number of contracts dealing with the employment of labourers. On the present date of harvest MR. WEBSTER wrote to LANGDON as follows:

<sup>1</sup> p. 40.

## CONTRACTS WITH HARVESTERS

'Barley-harvest begins in the area specified [between Basrah and Baghdad] about the middle of April and ends about the middle of May. There are of course seasonal variations, but these may be taken as average dates. Wheat-harvest commences about the beginning of May and ends with the end of the month.

'Native varieties of barley exist having 2, 4, and 6 rows of seed.'

In his supplementary letter to me, MR. WEBSTER wrote:

'The harvest of all crops is certainly not at the same time from Basrah to Baghdad. It may be taken as a general rule that the harvests at Basrah are about fifteen days earlier than those of Baghdad.

'Hillah harvests are almost synchronous with those of Baghdad.

'My statement that barley-harvest begins about the middle of April and ends about the middle of May was intended to cover the chief barley-growing districts.

'If the area is confined to the Babylon-Nippur district it would remain unmodified, as these tracts are the chief barley-producing areas. As a matter of fact the latest date we have for barley-harvest in that region is May 15th, and the earliest April 10th.'

We have numerous examples of barley being regarded as the medium for payment of debt, but the date at which such debts were to be paid would be evidence of the customary season for settling accounts rather than of the date of harvest. I note, however, two late Babylonian contracts for payment of rent in barley. Both contracts run for three years and stipulate for payment in Ayar.

The contracts are BE. ix 45, belonging to Ab 20 in the 36th year of Artaxerxes I, and BE. ix 89, belonging to the 41st year of the same reign. The last day of Ayar in the three years following the first of these contracts should on KUGLER'S restoration of the calendar fall on May 28, June 16, June 6 respectively, and in the three years following the other contract on June 2, May 22, June 10 respectively. These dates accord well with the modern date of harvest varying from April 10 to May 15. Since the contracting parties could not foresee the weather, the date in the contracts would have to be consistent with a late as well as with an early harvest.

In the following contracts of the First Dynasty, labourers are engaged for the harvest. The dates are converted on the assumption that the second solution is correct.

VS. ix 3 (VAT. 1090), HG. 1003, Hammurabi 17, Kislev	Dec. 14-Jan. 12
VS. vii 60 (VAT. 6392), HG. 555, Ammiditana 34, Kislev 30	Dec. 30
CT. vi 44 <sup>a</sup> , HG. 541, Hammurabi 30, Šabat 10	Jan. 28
Ga. 59, HG. 1010, Hammurabi 38, Šabat 15	Feb. 4
VS. vii 58 (VAT. 6337), HG. 554, Ammiditana 30, Adar 4	Feb. 15
Ga. 60, HG. 1011, Hammurabi 38, Šabat	Jan. 21-Feb. 18
P. 115, HG. 1022, Ammiditana 37, Adar 5	Feb. 29
W. 47, HG. 1678, Ammiditana 2, Adar 14	March 6
P. 116, HG. 1023, Ammiditana 37, Adar 21	March 16
VS. ix 109, 110 (VAT. 641), HG. 1007, Hammurabi 35, Adar 30	March 22
(In this case the contract is for the harvest month.)	
P. 119, HG. 1024, Ammizaduga 2, Adar 18	March 22
M. 22 (VAT. 630), HG. 559, Ammizaduga 8, Adar 25	March 22
TD. 176, HG. 1171, Samsuiluna 5 (?), Adar	Feb. 28-March 29
(One woman engaged as harvester for one month.)	
VS. vii 76 (VAT. 6238), HG. 557, Ammizaduga 4, Adar II 30	April 10



Ranke 111 (CBM. 381), HG. 563, Samsuditana, Ayar 14

(If the position of Ayar in the solar year fluctuated between the same limits under Samsuditana as under Ammizaduga this contract cannot belong to a date earlier than April 19.)

Here then, we have fifteen contracts for hiring labourers for harvest, most probably for barley-harvest, for in the time of this dynasty we hear far more of barley than of all other kinds of grain. One of these contracts was made as early as December, but they become more numerous as the date of harvest draws near, and the latest are signed about or shortly after the earliest date of barley-harvest under modern conditions. If we were to adopt the first solution, all the dates would fall nineteen days later. The contracts computed for March 22 would have been dated April 10, the earliest date reported by MR. WEBSTER for barley-harvest, while the contract computed for April 10 would fall on April 30, and the contract dated Ayar 14 would hardly be older than May 8. That means that two of the contracts would have been made close to the time of a late harvest.

Another group of contracts seems to contain lists of labourers who have presented themselves for the harvest.

In TD. 123, 124, HG. 1373, Samsuiluna 8, Nisan 25 and Ayar 2, March 31 and April 7 of our calendar, we have the name of a single harvester.

In VS. vii 57, HG. 1380, Ammiditana 30, Nisan 13, April 5 of our calendar, we have a list of twenty-nine harvesters.

In CT. vi 23<sup>b</sup>, HG. 1382, Nisan 20 of an unknown year of Ammizaduga, not earlier than March 27 nor later than May 18 of our calendar, we have a similar list of sixteen harvesters.

These lists are of course quite inconsistent with the adoption of any solution except the first two of the present discussion, for on any other solution the first three of them would fall long before harvest. The second solution assumes that they assembled shortly before the earliest possible date for barley-harvest, the first solution that they arrived well within the range of harvest dates, though not necessarily after the beginning of harvest in the particular year.

Next we have a group of documents, which UNGNAD takes as acknowledgements of work done, which the workmen or their foremen received on the completion of their labour. Two of these belong to the first year of Rim-Sin. One of these, BRM. iii 18<sup>b</sup>, HG. 1787, is dated Nisan 11, our April 12; the other, BRM. iii 18<sup>a</sup>, HG. 1789, is dated Ayar 4, May 4 of our calendar. This seems a wide difference between harvest dates in the same district and suggests that the later acknowledgement is for a different kind of grain. It will be observed that it is for one day's work by one harvester; the earlier is for work by five harvesters.

VS. ix 25, HG. 1411, Hammurabi 27, Nisan 12, May 12 of our calendar, is a note of a harvester, who may have worked that day.

VS. xiii 19 (VAT. 6438), HG. 1979, Hammurabi 29, Nisan 27, May 6 of our calendar, is a note of ten harvesters, who appear to have come five times for the harvest, which must therefore have begun and which was probably completed.

From the reign of Samsuiluna we have:

BRM. iii 182, HG. 1864, Samsuiluna 4, Nisan, March 21-April 19.

PINCHES, *Berens Collection* 96 (19<sup>b</sup>), HG. 1868, Samsuiluna 6, Ayar 11, May 8.

In the former of these there are seven labourers, but the duration of work is not specified; in the latter there are eleven labourers, who have worked for 13 $\frac{2}{3}$  days. This agrees excellently with an acknowledgement signed about the end of the season of barley-harvest.

There remains an acknowledgement dated Ayar 5 in an unknown year of Ammiditana, a date which may fall anywhere from April 11 to May 19, and an acknowledgement dated Nisan 9 in an unknown year of an unknown king, BRM. iii 188, 185, HG. 1875, 1877.

Altogether these acknowledgements agree excellently with our second solution. On that solution they range from April 12 to May 12, almost precisely the range of harvest dates given by MR. WEBSTER. The first solution would make them range from May 1 to May 31, the third from March 26 to April 25, and in the case of HG. 1868 it would imply that 13 $\frac{2}{3}$  days' work had been done in the harvest-field ending on April 21.

The documents dealing with barley-harvest appear, therefore, to be conclusive in favour of the second solution, and to be in excellent accord with those dealing with date-harvest.

A caution may be inserted here about certain documents which are taken by UNGNAD to refer to fields standing in ear. In HG. 1700 such a field is mentioned on Ayar 16, and in HG. 1717 such a field is mentioned in Nisan, but in HG. 1720 we find it in Ab, and in HG. 1710 it is found in Ulul. The phrase is regularly contrasted with uncultivated land, and LANGDON assures me that it should be translated 'cultivated', not 'standing in ear'.

## CHAPTER XI

## CONTROL OF THE BABYLONIAN CALENDAR BY MEANS OF MONTHS OF THIRTY DAYS

AS has been seen, the beginning of each Babylonian month appears to have been based on astronomical observation. A record of the length of the month is, therefore, a record of the interval between two astronomical observations. Where a contract is dated on the 30th day of a Babylonian month, we know that 30 days elapsed between two successive appearances of the Moon. If the calendar is sufficiently restored to enable us to identify the months, we can determine by computation the length of the months in which such contracts are dated, and a comparison of the computed and recorded durations of the months is a good test of the accuracy of any restoration of the calendar. I owe the idea of this test to SCHOCH, who amplified KUGLER's collection of attested months of 30 days, and computed the lengths of these months astronomically. Since the mean length of a lunation is 29.53 days, it follows that 53 per cent. of lunar months should contain 30 days, and therefore a false restoration of the chronology may be expected to satisfy about 53 per cent. of months known to have contained 30 days. It has been seen in Chapter VI that SCHOCH's tables have been made to satisfy 95 per cent. of the dates accepted for the beginning of the month in neo-Babylonian times. It is reasonable to suppose that the first appearance of the Moon was less accurately timed in early ages, and in testing any theory we have to allow for the fact that as our series of leap years is imperfectly restored, the identification of the months is to a small extent conjectural. But, if we are right in supposing that the early Babylonians, like their descendants, determined the beginning of the month by the actual appearance of the crescent, we should, when every allowance has been made, find that the correct solution should satisfy a great deal more than 53 per cent. of the months known to have contained 30 days. In the following table I show the Gregorian date of beginning and end of each month in which a contract is dated on the 30th day. The identification of the month is based on Chapter IX of this work. I assume the correctness of the second solution. The day given is that which was current at sunset, when the Babylonian day began.

The length of each month is given for each of the five solutions. Nearly all computations were made by SCHOCH with his crescent tables, though a few were made by me with SCHOCH's tables. Wherever the year to which a contract belonged appeared to be in doubt, I consulted LANGDON. Where two lengths are given, the former is that which results from the tables, but the astronomical conditions are near the margin that separates 29-day months from 30-day months.

Reference.	Reign, Year, and Month.	Solution II.			Solution.			
		Beginning.	End.	No. of Days.	I. Days.	III. Days.	IV. Days.	V. Days.
G. 171	Rim-Sin 6 IV	July 3	Aug. 2	30	29	30	30	29
G. 194	" 10 II	April 21	May 20	29	30	30	30	29
G. 192	" 10 XII	Feb. 10	March 12	30	29	30	29	29
VS. xiii 64 a,	HG. 1646 " 30 XII	Feb. 28	March 30	30	29	29/30	30	29
EG. 35,	HG. 1652 " 32 X	Dec. 10	Jan. 9	30	29	29	30	30
G. 95	" 32 XII	Feb. 7	March 8	29	30	30	30	30
Warka 9,	HG. 709 " 35 XII	Feb. 4	March 6	30	30/29	29/30	30	29
Warka 13, 14,	HG. 277 " 42 VII	Sept. 22	Oct. 22	30	30	30	30	29
VS. xiii 82 a,	HG. 1657 " 44 XI	Jan. 26	Feb. 25	30	30/29	30/29	30	29
EG. 66,	HG. 1733 " 58 II	April 30	May 30	30	29	29/30	29	29
VS. xiii 92,	HG. 1676 " 59 V	July 17	Aug. 16	30	29	30	30	29
CT. viii 18 b,	HG. 286 Hammurabi 4 I	April 14	May 14	30	30	29	29	30
Ranke 25,	HG. 91 " 7 XII	March 2	April 1	30	30/29	30	29	30
TD. 87,	HG. 1099 " 26 V	Sept. 7	Oct. 6	29	29	29	29	30
VS. xiii 20,	HG. 1575 " 30 X	Dec. 20	Jan. 19	30	29	29	30	29
F. 13	" 32 VIII	Oct. 29	Nov. 28	30	30/29	29	30	29
*F. 12,	HG. 1374 " 32 XI	Jan. 26	Feb. 25	30/29	29	30/29	30	29
VS. ix 57,	HG. 1006 " 34 XII	March 3	April 2	30	30	29	30	29
VS. ix 148,	HG. 899 " 39 VIII	Nov. 11	Dec. 10	29	29	30	29	29
VS. ix 138,	HG. 964 " 41 XII	March 17	April 15	29	29	30	29	30
VS. ix 109, 110	HG. 1007 " 42 XII	March 5	April 4	30	29	30	29	29
Ranke 33,	HG. 520 " 43 XI	Jan. 23	Feb. 22	30	29	30	30	30
Warka 68, M. 66,	HG. 513 Samsuiluna 1 VIII	Oct. 17	Nov. 15	29	30	29/30	29	30
RA. xv 191,	HG. 1949 " 5 III	May 7	June 6	30	29	30/29	30	29
BIN. ii 75,	HG. 1425 " 7 IV	June 14	July 14	30	30	29/30	30	30
Warka 49,	HG. 333 " 7 IX	Nov. 9	Dec. 9	30	29	29	30	29
*F. 12,	HG. 1374 " 9 XI	Feb. 13	March 15	30	30	29	30	29/30
C. 91,	HG. 1628 " 28 IX	Nov. 16	Dec. 16	30	30	29/30	29	30
CT. vi 26 b,	HG. 1250 Ammiditana 1 XII	Feb. 3	March 3	29	29	30	29	30
CT. xxxiii 47 b,	HG. 1874 " 4 VIII	Oct. 4	Nov. 3	30	30	30	30	29
Ranke 91,	HG. 110 " 4 XII b	March 1	March 30	29	29	30	30	29
Ranke 82,	HG. 772 " 5 XII	Feb. 18	March 19	30	30	29/30	29	29
TD. 153,	HG. 1248 " 24 VII	Sept. 24	Oct. 23	29	29	30	30	29
VAT. 5912,	Ku. <sup>1</sup> 246 " 26 VI	Aug. 3	Sept. 2	30	29	29/30	30	30
VAT. 5806,	Ku. <sup>1</sup> 246 " 26 IX	Oct. 31	Nov. 29	29	29	29/30	29/30	29
Ranke 83,	HG. 650 " 31 II	April 11	May 11	30	29	30	29	29
Ranke 84,	HG. 9 " 31 XII	Jan. 31	March 2	30	29	29	30	29
VS. vii 60,	HG. 555 " 34 IX	Nov. 30	Dec. 30	30	29	30	30	29
VS. vii 68,	HG. 631 Ammizaduga 1 VIII	Nov. 16	Dec. 16	30	30/29	29	30	29
VS. vii 73,	HG. 115 " 3 VI	Aug. 28	Sept. 27	30	29	30	29	30
VS. vii 76,	HG. 557 " 4 XII b	March 10	April 9	30	29	30	30	30
VS. vii 139,	HG. 640 " 13 XII	March 1	March 31	30	29	30	30	29
CT. ii 18,	HG. 1308 " 15 XII	March 10	April 8	29	29	29	30	29
M. 107,	HG. 75 " 16 I	April 8	May 8	30	30	30	29	30
CT. ii 8,	HG. 639 " 16 V	Aug. 5	Sept. 4	30	29	30	30	29
VAT. 5925, 5938,	Ku. <sup>1</sup> 246 " 16 XI	Jan. 29	Feb. 27	29	30	29	29	30
VS. vii 121,	HG. 770 " 16 XII	Feb. 27	March 28	30	29	30	30	29
VS. vii 133,	HG. 1263 " 20 XI	Jan. 15	Feb. 13	29	29	30	29	29

\* It is uncertain whether this contract belongs to Hammurabi 32 or to Samsuiluna 9.

<sup>1</sup> KUGLER. *Sternkunde* ii.

The agreement between theory and practice is represented in the different solutions as follows :

Solution	No. of computed months of 30 days.	No. of actual months of 30 days.	Percentage of agreements.
I	17 or 18*	47	36 or 38*
II	34	47	72
III	27 or 26*	47	57 or 55*
IV	29	47	62
V	16	47	34

Combining the five solutions, we get agreement in 123 out of 235 instances, i.e. in 52 per cent. of the whole number ; while if we combine solutions I, III, IV, and V, we get agreements in 89 out of 188 instances, i.e. in 47 per cent. of the whole number. As has been seen above, 53 per cent. of all lunar months should contain 30 days each. When, therefore, we combine a number of solutions of which one only can be correct, the agreement between theory and practice is found to be no greater than it would be if the months were selected at haphazard. It will be noticed that the second solution, which has been found superior on other grounds, satisfies as large a proportion of the attested months of 30 days as we could expect. In this respect it is far more successful than any of the other theories. The preponderance of computed months of 30 days appears in this solution in each of the five reigns. No other solution shows so disproportionate a distribution of months in either direction.<sup>1</sup>

The final conclusion of this discussion is that the Venus tablets, date-harvest contracts, barley-harvest contracts, and attested 30th days of months unite in supporting our second solution, on which the detailed reduction of dates in Chapter IX is based.

\* According as we place F. 12 in Hammurabi 32 or Samsuiluna 9. second solution to satisfy the recorded 30-day months of the reign of Ammizaduga is based on a misunderstanding of a letter from Schoch.

<sup>1</sup> KUGLER's note in *Sternkunde*, ii 627, on the failure of the

CHAPTER XII

THE BABYLONIAN SOLAR AND STELLAR CALENDAR

BEFORE leaving the subject it may be well to discuss the attempts made by WEIDNER and KUGLER to establish a change in the position of the Babylonian months in the solar year by means of the tablets belonging to the astrological series Mul Apin. In these tablets the month names of the Babylonian calendar are used, but each month is given a fixed position in the solar year, so that a definite calendar date is given to each year-point and to the heliacal rising of each of the principal fixed stars. KUGLER, followed by WEIDNER, has assumed that this fixed position of the month is the mean position of the month in the civil calendar at the time when the astronomical data exhibited in the tablets were collected. Now this is merely an assumption. That the solar Nisan belonged roughly to the same season as the calendar Nisan may be taken as certain, but I see no reason for supposing that there was in the minds of the early Babylonians any conception of a mean position of Nisan. They had no fixed rule of intercalation, and, if they had, they might just as easily have had regard to the earliest possible position of Nisan as to the mean position of Nisan. The Nisan of the Christian paschal calendar is always defined not by its mean position, but by its earliest possible position, and the rule holds that Nisan must never be so placed as to make the vernal equinox fall later than its 14th day. In the tablets in question the four year-points are made to fall on the 15th day of Nisan, Tammuz, Tešrit, and Tebit respectively, and our study of the intercalations has shown that the vernal equinox or March 21 was the earliest possible date permitted for Nisan 15 under the First Dynasty of Babylon.<sup>1</sup> It appears that so early a date was not favoured in neo-Babylonian times, but the calendar Nisan 15 was permitted to fall before the equinox as late as 564 and 537 B.C. (See the table in KUGLER's *Sternkunde*, ii, 1924, p. 435.) I do not wish to press the suggestion that Nisan 15 was regarded as the latest possible calendar date of the equinox. It is just as easy to suppose that the calendar was arranged without reference to the year-points and that the placing of the year-points in the middle of their respective months is mere schematism.

It appears, moreover, to me that the astronomical data contained in the tablets in question are of far later date than the First Dynasty. If we treat the heliacal risings apart from the year-points, we may compare the intervals between those risings with the intervals computed for different epochs in Schoch's *Arcus Visionis*, p. 6 (published by the University Observatory, Oxford, 1924). Treating the months of the Babylonian document as of 30 days each, we have the following table :

Text.	Computation.			
	-3000	-2000	-1000	0
α Arietis-Capella	19 <sup>d</sup>	17 <sup>d</sup>	15 <sup>d</sup>	15 <sup>d</sup>
Capella-Pleiades	11	20	22	21
Pleiades-Aldebaran	19	17	15	14
Aldebaran-Bellatrix	30	29	27	25
Bellatrix-Sirius	25	33	30	28
Sirius-Regulus	20	7	12	17
Regulus-Arcturus	40	33	39	44
Arcturus-Spica	10	18	13	9
Spica-α Librae	20	24	24	24
α Librae-Vega	30	34	30	26
Vega-Altair	30	27	29	31

<sup>1</sup> According to our restoration March 21 is found for Samsuiluna 8 and March 22 for Samsuiluna 27 and Ammizaduga 19.

Now it is clear that the date given for the heliacal rising of the Pleiades is not in agreement with SCHUCH's computation, and it may therefore be best to treat the interval between the risings of Capella and Aldebaran as a single interval. Similarly the intervals seem to show a discordance from SCHUCH's computations in the date of the heliacal rising of  $\alpha$  Librae.

Perhaps the best way of treating these observations is by the mathematical principle of least squares. We compare each computed interval in turn with the recorded interval and square the difference. Then we sum the squares of the differences for each epoch separately, and find by interpolation the epoch which will give the smallest sum.

In this way I get the following sums of squares of differences:

	-3000	-2000	-1000	0	Resultant epoch.
Including all stars	477	278	227	378	-1250
Excluding Pleiades and $\alpha$ Librae	473	190	95	170	-940

Instead of taking individual intervals, we may, if we prefer, group the intervals. It will be observed that from  $\alpha$  Arietis to Sirius the interval diminishes with the time. From Sirius to Arcturus it increases. From Arcturus to Vega it diminishes again, and from Vega to Altair it increases. We thus have four natural groups of intervals as follows:

	Computation.				
	Text.	-3000	-2000	-1000	
$\alpha$ Arietis-Sirius	104	116	109	104	97
Sirius-Arcturus	60	40	51	61	69
Arcturus-Vega	60	76	67	59	52
Vega-Altair	30	27	29	31	34
Sum of squares of differences		809	156	3	210

This analysis gives us by interpolation -1075 as the epoch which will best satisfy the intervals between the different heliacal risings. The three analyses just made seem to indicate 1100 B.C. as the approximate epoch of the astronomical system contained in these tablets.

A more accurate result can be obtained by forming one equation of condition for the determination of two unknown quantities from each of the heliacal risings whose recorded dates have been used above.

For the two unknowns I take

$x$  = Interval in days from Nisan 1 of Mul Apin series to April 6 Julian.

$y$  = Interval in years from -1000 to epoch of the astronomy contained in the series of heliacal risings. Then, comparing the recorded dates with those tabulated by SCHUCH, we have

	Residual.	Residual, omitting Pleiades.
(1) $x+0.006 y = 0$ ;	+0.6	-0.0
(2) $x+0.007 y = +3$ ;	+3.8	+3.1
(3) $x+0.006 y = -7$ ;	-6.4	
(4) $x+0.005 y = -2$ ;	-1.5	-2.1
(5) $x+0.003 y = +3$ ;	+3.1	+2.7
(6) $x+0.001 y = 0$ ;	-0.2	-0.4
(7) $x+0.006 y = +3$ ;	+3.6	+3.0
(8) $x+0.010 y = -1$ ;	+0.3	-0.7

	Residual.	Residual, omitting Pleiades.
(9) $x+0.006 y = 0$ ;	+0.6	-0.0
(10) $x+0.006 y = -4$ ;	-3.4	-4.0
(11) $x+0.002 y = 0$ ;	-0.0	-0.3
(12) $x+0.004 y = -1$ ;	-0.7	-1.2

Solving in the usual way, I get  $x = +0.391 \pm 1.46$   
 $y = -172 \pm 258$

The residuals left after adopting these values are shown in the penultimate column above. The conclusion is that the epoch of the astronomy contained in these heliacal risings is -1172, subject to a probable error of  $\pm 258$  years. It will be observed, however, that the cluster of the Pleiades makes its appearance according to the tablets 6.4 days before it ought to be due according to this solution. This discordance greatly exceeds all others, and suggests that SCHUCH's tables do not correctly represent the date at which the Babylonians were able to gain their first sight of this cluster. If we omit the third equation and solve the remaining equations, we get

$$x = +0.505 \pm 1.11$$

$$y = -81 \pm 198$$

The residuals are shown in the last column above. We now have for the epoch of the heliacal risings -1081, subject to a probable error of  $\pm 198$  years. It seems probable, therefore, that the epoch of these heliacal risings falls within two or three centuries on one side or the other of 1100 B.C.

But this renders it impossible to bring the recorded dates of heliacal risings into agreement with the recorded dates of the year-points. It seems not unreasonable to suppose that the dates of heliacal risings were reduced on the assumption that the heliacal rising of  $\alpha$  Arietis, the star of Nisan, was to be taken as fixing the beginning of the stellar Nisan. But we have to go back to the neighbourhood of -2500 if we wish to have the heliacal rising of  $\alpha$  Arietis falling 14 days before the equinox, which these tablets place on Nisan 15. As this epoch is excluded by the analysis of the dates of heliacal risings, there would appear to be no alternative but to suppose that the dates of the year-points are determined independently of the dates of the heliacal risings in the Mul Apin series. The range of the calendar months found in the present work is such that from time to time the year-points would fall approximately on the days of the civil calendar bearing the same names as the days to which they are assigned in the Mul Apin series, and similarly the heliacal risings would from time to time fall approximately on the days of the civil calendar bearing the same names as the days to which they are assigned in that series, but these two series of coincidences would not be realized in the same year in the neighbourhood of 1100 B.C.

I conclude that we cannot use the dates of the Mul Apin series for the reconstruction of the calendar under the First Dynasty (1) because there is no indication of the relation of its stellar and solar months to the calendar months whose names they bear, and (2) because an analysis of the dates of the heliacal risings contained in that series shows that their epoch is approximately 1100 B.C., long after the time of the First Dynasty.

## CHAPTER XIII

## SOURCES FOR THE RECONSTRUCTION OF THE LIST OF KINGS

THE principal source for the reconstruction of the dynasties before the First Babylonian Dynasty is the *Weld-Blundell Prism* in the Ashmolean Museum, edited by LANGDON, *Oxford Editions of Cuneiform Texts*, Vol. II, Oxford University Press, 1923, where the various duplicates from Nippur and other chronological sources are given. For the dynasty of Ellasar, the two principal sources are (1) the Louvre Prism, 7025, originally containing a list of the year dates of the 14 kings of Ellasar; edited by F. THUREAU-DANGIN, *La Chronologie des Dynasties de Sumer et d'Accad*, Paris, 1918, and (2) a small tablet giving only the names of the 14 kings with lengths of their reigns; edited by A. T. CLAY, *Miscellaneous Inscriptions*, Yale, 1915, No. 32, pp. 30 ff. Since these lists join up with the names of the First Dynasty, the entire system depends upon the date of this dynasty and, as our succeeding records in both Assyria and Babylonia do not permit a dead reckoning, I am forced to depend upon FOTHERINGHAM'S astronomical reckoning, whose results are confirmed by SCHOCH and SCHNABEL. I have no longer any doubt concerning the correctness of my colleague's brilliant calculation; for it is confirmed by the Babylonian calendar, the historical sources (which can be adjusted to this date only, without violently discrediting their testimony) and by SCHOCH'S astronomical reckoning for the destruction of Ur and the end of the reign of Ibi-Sin, based upon the lunar eclipse of the 14th of Adar, CHAS. VIROLLEAUD, *L'Astrologie chaldéenne*, *Stn.*, xxxiii 79-82. This date is fixed by him in 2283 B.C.,<sup>1</sup> night of March 8/9 (Julian = Gregorian Feb. 17/18).

The omen preceded the year of the event and hence 2282 B.C. would be the year of the Fall of Isin, or 19 years later than the date in my list.<sup>2</sup> But contemporary documents all tend to prove that Ibi-Sin was a contemporary of Išbi-Girra of Isin; for dated tablets, in the kingdom of Ur, suddenly cease early in the reign of Ibi-Sin, everywhere except at Ur itself. This is a very decisive confirmation of FOTHERINGHAM'S reckoning. I have not deducted 19 years from all dates before 2301, but have retained the statement of the Weld-Blundell Prism. I have, however, no doubt but that Ibi-Sin reigned contemporaneously with Išbi-Girra of Isin and Naplanum of Ellasar for 19 years.

For the subsequent dynastic lists, the sources are: (1) King list A, *Cuneiform Texts in the British Museum*, Vol. xxxvi, 24-5; (2) King list B, HUGO WINCKLER, *Untersuchungen zur Altorientalischen Geschichte*, 145 (BM. 38122); (3) dynastic Assyrian lists in OTTO SCHROEDER, *Keilschrifttexte aus Assur verschiedenen Inhalts* (= KAV.), Nos. 10-11-12-13-182 (synchronistic Assyrian-Babylonian), 9-14 + 18-15 (Assyrian only); (4) the Assur tablet 4128 is the most important of all synchronistic lists. Ass. 4128 really refers to a photo of Ass. 14616 c, but I have retained the photo number, the museum number being unknown to me when my manuscript

<sup>1</sup> CARL SCHOCH, *Die Ur-Finsternis* (eine Hypothese!), privately printed at Berlin-Steglitz 31, December 1927.

<sup>2</sup> Ašurbanipal restored the statue of Nanā of Erech, which had been taken to Elam by Kudurnanundi 1635 years before Ašurbanipal's eighth campaign, and his second campaign against Elam. This occurred circa 642-639 B.C. (v. STRECK, *Ašurbanipal*, i, p. cccxxvi), giving a date circa 2277 for the Elamitic invasion of Sumer by Kudurnanundi.

Undoubtedly the Fall of Ur was due to the same invasion, when Ibi-Sin was taken captive to Elam, VIROLLEAUD, Supplement ii, p. 95, 13; LANGDON, BE. xxxi 7, 5. See also for 1635 as interval between Kudurnanundi and the sack of Susa by Ašurbanipal, ESSAD NASSOUHI, *Mitteilungen der Altorientalischen Gesellschaft*, iii 35. FOTHERINGHAM'S calculation alone agrees with SCHOCH'S calculation for the Fall of Isin.

was printed. The text is published by E. F. WEIDNER, *Mitteilungen der Vorderasiatischen-Aegyptischen Gesellschaft*, 1912, part 2, 67-70, with corrections in *Archiv für Orientforschung*, iii 70-1. (5) C. 8836 refers to the valuable Assur tablet in Constantinople, published by ESSAD NASSOUHI, *Archiv für Orientforschung*, iv 1-11; Assyrian list with regnal years. The *Synchronous History* (= *Syn. Hist.*) is published in CT. xxxiv 38-42 and edited by PEISER and WINCKLER, *Keilschriftliche Bibliothek*, ii 194-203. The *Babylonian Chronicle* is published in CT. xxxiv 43-50 and lastly edited by FRIEDRICH DELITZSCH, *Die Babylonische Chronik*, Leipzig, 1906. *Chronicle P(inches)*, first discovered by T. G. PINCHES and translated in *Records of the Past*, 2nd ed., 106 ff., is published by HUGO WINCKLER, *Altorientalische Forschungen*, Leipzig, 1897, *Erste Reihe*, 298-303, and lastly edited by DELITZSCH, *ibid.*, pp. 43-6; see also L. W. KING, *Records of the Reign of Tukulti-Ninib I*, London, 1904, p. 157 and pp. 96-100.

A few comments on the views of the writer of the dynastic list should be added, to avoid misunderstandings. The last year of Ibi-Sin is made contemporary with the first year of Išbi-Girra, and with this exception the list actually represents the statements of the Sumerian chroniclers themselves, back to the beginning of the Akšak dynasty. My own chronology for all reigns from Ibi-Sin upward is obtained by subtracting 19 from each date. In regard to SCHOCH'S astronomical reckoning for the Fall of Ur (2282), and the statement that this alone agrees with FOTHERINGHAM'S solution, it should be stated that there is astronomically an alternative date 94 years later, which would agree approximately with WEIDNER'S low dates. There is astronomically no alternative. But WEIDNER'S system is proved to be erroneous on astronomical and calendrical grounds and by the impossibility of making Ulamburiyaš (p. 88) the immediate successor of Ea-ga-mil. This not only violates the clear evidence of the Assur synchronous list, Ass. 4128, but it does not follow from the text adduced to prove it; for the chronicle, BM. 96152, published by L. W. KING, states that Ulamburiyaš became king 'after him', i. e. after Ea-ga-mil, which by no means necessarily implies an immediate event. This chronicle has long gaps between historical events entered in it, and even were the usual translation of *arki-su* 'after his death' adopted (KING'S translation 'in pursuit of him' was erroneous), there is no reason for violating the evidence of the mace-head inscription of *U-la-bu-ra-ri-ya-š mar Bur-na-bu-ra-ri-ya-š sarri*, published by WEISSBACH. Here his father, Burnaburiyaš, is distinctly described as 'king', and there was no king by this name until long after *Ea-ga-mil*.

CHAPTER XIV  
LIST OF THE KINGS AND DYNASTIES OF SUMER AND ACCAD,  
BABYLONIA AND ASSYRIA

TEN MYTHICAL KINGS BEFORE THE FLOOD.		
<i>Ellasar Tablet.</i>	<i>Weld-Blundell Prism.</i>	<i>Berosos.</i>
28800. Alulim. Eridu.	67200. Alulim. Ħabur.	36000. Alorus = Alulim. Babylon.
36000. Alagar. "	72000. Alagar. "	10800. Alaparos = Alagar. "
43200. Enmenluanna. Badtibira.	72000. . . . . kidunnu-šakinkin. Ell- asar.	46800. Amēlōn = Enmenluanna. Badtibira.
28800. Enmengalanna. "	21600. . . . . uk? ku? Ellasar.	43200. Ammenōn.
36000. Dumuzi-sib. "	28800. Dumuzi-sib. Badtibira.	64800. Megalaros = Enmengalanna. Badtibira.
28800. Ensibzianna. Larak.	21600. Enmenluanna. "	36000. Dađzos = Dumuzi. Badti- bira.
21000. Enmenduranna. Sippar.	36000. Ensibzianna. Larak.	64800. Euedorachos = Enmendur- anna. Badtibira.
18600. Ubardudu. Suruppak.	72000. Enmenduranna. Sippar.	36000. Amempsinos = Ensibzianna. Larak.
	28800. Aradgin. Suruppak.	28800. Opartes = Ubardudu. Larak.
	36000. Zišudra. "	64800. Xisuthros = Zišudra.
Total 241200.	Total 456000.	Total 432000.

THE FLOOD.			
NORTHERN KINGDOMS.	ERECH.	KISH. FIRST DYNASTY. <sup>1</sup>	UR.
		Ga-ur.	
		Gulla-Nidaba-anna.	
		.....	
		Baba.	
		Bu-Sin.	
		Galibum.	
		Kalumumu.	
		Duggagib.	
		Atab.	
		Atabba.	
		Arpium.	
		Etana.	
		Bališ.	
		Enmenunna.	
		Melam-Kiš.	
		Barsalnunna.	
	FIRST DYNASTY OF ERECH. <sup>2</sup> Circa 4500-3150.		
	Meskemgašer.		
	Enmerkar.		
	Lugalbanda.		
	Dumuzi.		
	Gilgamish.		
	Ur-Nungal.		

<sup>1</sup> OECT. II 9, I 42-II 45. The Weld-Blundell Prism assigns 24,510 years to this semi-mythical kingdom.  
<sup>2</sup> Ibid. II 11, II 46-III 36. This dynasty is also called *Eanna*, name of the temple at Erech. Cf. *kur E-an-na*, 'Land of Eanna', with Sutiium, Gutium, PBS. V 75, Rev. IV 11. The sources assign 2,310 years to this semi-mythical kingdom.

NORTHERN KINGDOMS.	ERECH.	KISH.	UR.
	FIRST DYNASTY (continued). Utukalamma. Labašer. Ennunnadanna. .....hede. Melamanna. Lugalkiaga.	FIRST DYNASTY (continued). Tupzaš. Tikkar. Iku. Itasadun. Enmenbaragigur. Agga. ( <i>Enbi-Ašdar</i> ) Circa 3170.	FIRST DYNASTY OF UR. <sup>3</sup> Circa 3150-3000. 80. Mesannipadda. <sup>4</sup> (A-an- ni-pad-da.) <sup>5</sup> 36. Meskem-Nannar. 25. Elulu. 36. Balulu.
DYNASTY OF AWAN. <sup>1</sup> ..... ..... Ku-ul..... Circa 3100.	SECOND DYNASTY OF ERECH. <sup>1</sup> Circa 3150-3090. Enugduanna = (Enšagku- šanna?) Lugalkigubnilaš. Lugalkisalsi.		
DYNASTY OF ĦAMASI. <sup>6</sup> Ħadaniš. <sup>7</sup> Circa 3090.	DYNASTY OF ADAB. <sup>2</sup> Lugalmundu. Mebasi.  Lugaldalu.	SECOND DYNASTY OF KISH. <sup>10</sup> Laš... Dadasig. Kalbum. Umuše. .....nunna. Ibiniš? Lugalmu.	SECOND DYNASTY OF UR. <sup>11</sup> Circa 3000-2900. Four names broken away on the Weld-Blundell Prism and Nippur tablets.
DYNASTY OF MAER. <sup>8</sup> 30. Anšir. 3087-3058. 25? [Lugaltar]zi. 3057- 3033. 30. ....lugal. 3032-3003. 20. ....lù-gal. 3002-2983. 30. ....bi-im. 2982-2953. 9. ....bi. 2952-2944.	DYNASTY OF AKŠAR. <sup>12</sup> 30. Unzi. 2943-2914. 6. Undalulu. 2913-2908. 6. Urur. 2907-2902. 20. Gimil-Šašan. 2901-2882. 24. Išu-il. 2881-2858. 7. Gimil-Sin. 2857-2851.	THIRD DYNASTY OF KISH.  Kug-Bau. <sup>13</sup> Ur-Nina at Lagash.	
		PATESIS OF LAGASH. Eannatum. Enannatum.  Entemena. Ennatum II.  Enetarzi. Lugalanda.	FOURTH DYNASTY OF KISH. 25. Gimil-Sin. 2850-2826. 63. Ur-Zamama. 2825- 2818. 30. Zimudar. 2817-2788. 7. Ušiwatar. 2787-2781. 11. Ašdarmuti. 2780-2770. 11. Išme-Šamaš. 2769- 2759.

<sup>1</sup> OECT. II 13, IV 6-16. Prism assigns 356 years to this kingdom.  
<sup>2</sup> Ibid. II 13, III 39-IV 4.  
<sup>3</sup> Mesannipad, ZA. 7, 29 IV 11; RA. 22, 116.  
<sup>4</sup> OECT. II 14, IV 43-8.  
<sup>5</sup> Son of Mesannipadda. *Ur Excavations*, I, Pl. XL, TO. 160; 287; U. 26; TO. 286. Written *Annani*, PBS. V 6, 10, and *Nanni*, PBS. XIII 48, II 2.  
<sup>6</sup> OECT. II 14, IV 36-42.  
<sup>7</sup> Sources assign 90 years to this kingdom.  
<sup>8</sup> OECT. II 15, V 23-32.

<sup>9</sup> OECT. II 15, V 16-22. Sources assign 90 years to this kingdom.  
<sup>10</sup> Ibid. II 13, IV 18-35. From this point upward I regard the various city kingdoms of Kish, Ur, and Erech as consecutive, and not to be divided by insertions of other city kingdoms as on the Weld-Blundell Prism and Nippur tablets. The sources assign a period of 3,195 years to the Second Dynasty of Kish, which is impossible.  
<sup>11</sup> Ibid. II 14, V 1-15. <sup>12</sup> Ibid. II 15, V 43-VI 5.  
<sup>13</sup> Mother of Gimil-Sin, first king of the Fourth Dynasty of Kish. She is said to have reigned 100 years.

DYNASTY OF AGADE. <sup>1</sup>	THIRD DYNASTY OF ERECH. <sup>2</sup>	FOURTH KISH DYNASTY (continued).
56. SARGON. 2751-2696. 9. Rimuš. 2695-2687. 15. Maništuš. 2686-2672. 38? Narām-Sin. 2671-2634. 24? Šargališarri. 2633-2610. Period of anarchy. 3. { Igigi. Imi. 2606-2604. Nani. Elulu. 21. Dudu. 2603-2583. 15. Gimil-durul. 2582-2568.	25. Lugalzaggisi. 2776-2752.	7. Nanniyah. 2758-2752.
FOURTH DYNASTY OF ERECH. <sup>3</sup>	DYNASTY OF GUTIUM (continued).	
7. Urnigin. 2567-2561. 6. Urgigir. <sup>4</sup> 2560-2555. 6. Kudda. 2554-2549. 5. Gimil-ili. 2548-2544. 6. Ur-Babbar. 2543-2538.	3. ....nedin. 2445-2443. 2. ....ra-bu-um. 2442-2441. 2. Irarum. 2440-2439. 1. Ibranum. 2438. 2. Ḥablum. 2438-2437. 7. Gimil-Sin. 2436-2430. 7. Yarlaganda. 2429-2423. 7. .... <sup>5</sup> 2422-2416. Tirigan (forty days). 2415.	
DYNASTY OF GUTIUM. <sup>5</sup>	FIFTH DYNASTY OF ERECH. <sup>7</sup>	
34. Period of no king. 2538-2505. 3. Imtā. 2504-2502. 6. Inkišu. 2501-2496. 6. Nikillagab. 2495-2490. 6. Šulmē. 2489-2484. 6. Elulumeš. 2483-2478. 5. Inimabikeš. 2477-2473. 6. Igešauš. 2472-2467. 15. Yarlagab. 2466-2452. 3. Ibate. 2451-2449. 3. Yarlagas. 2448-2446. 1. Kurum. 2445.	7. Utuḫegal. 2415-2409.	
	THIRD DYNASTY OF UR. <sup>8</sup>	
	18. Ur-Nammu. 2408-2391. 46. Dungi. 2390-2345. 9. Bur-Sin. 2344-2336. 9. Gimil-Sin. 2335-2327. 26. Ibi-Sin. 2326-2301. <sup>9</sup> [2282, p. 82]	

ASSYRIA.	ISIN. <sup>10</sup>	ELLASAR. <sup>11</sup>
Ušpia. <sup>12</sup> Kikia. <sup>13</sup>	33. Išbi-Girra. 2301-2269. 10. Gimil-ili-šu. 2268-2259.	21. Naplanum. 2301-2281. 28. Emišum. 2280-2253.

<sup>1</sup> OECT. II 17, VI 31-VII 12.<sup>2</sup> For Lugalzaggisi contemporary of last three kings of the Fourth Dynasty of Kish, and of *Urakagina* of Lagash, v. LANGDON, *Excavations at Kish*, I, p. 2.<sup>3</sup> OECT. II 18, VII 15-23.<sup>4</sup> Cf. RA. 20, 5.<sup>5</sup> OECT. II 18, VII 24-51. On Weld-Blundell Prism 91 years is the actual total of 20 reigns given by the scribe. Total for the entire dynasty 125 or 124 years, *ibid.* 19 n. 5. Consequently 34 years are allowed for the 'period of no king'.<sup>6</sup> Possibly *I-ti-ti* son of Yakulaba, AB. 2 = KAH. II 1, whose inscription was found at Assur. LEGRAIN, PBS. XIII1, VIII 17, has a king .....*ti* near the end of this dynasty.<sup>7</sup> OECT. II 19, VIII 1-6; JRAS. 1926, 684-8.<sup>8</sup> OECT. II 19, VIII 9-20.<sup>9</sup> Text of Prism, 24 years. See *ibid.* 20 n. 5.<sup>10</sup> OECT. II 26.<sup>11</sup> CLAY, *Miscellaneous Inscriptions*, No. 32; Louvre Prism, 7025 in THUREAU-DANGIN, *Chronologie des Dynasties de Sumer et d'Accad*.<sup>12</sup> AB. 121, 33, mentioned by Šalmanasar I; KAH. I 51, II 13 (Asarhaddon). Probably a Gutean.<sup>13</sup> AB. 35, XIV 5, mentioned by Ašurrimnišēšu, and *ibid.* 36 n. 3, by Šalmanasar III.

ASSYRIA (continued).	BABYLONIA.	ISIN (continued).	ELLASAR (continued).
Ititi. Circa 2422. <sup>1</sup> ZARIKUM. <sup>2</sup> Circa 2346-2336. Puzur-Ašur I. <sup>3</sup> Šalim-aḫum. <sup>4</sup> Ilušuma. <sup>5</sup> Erišum I. <sup>6</sup> Ikunum. <sup>7</sup> Šarru-ki-en I. <sup>8</sup> Puzur-Ašur II. <sup>9</sup> Aḫi-Ašur. <sup>10</sup> Rfm-Sin. <sup>11</sup> Erišum II. <sup>12</sup> Bēliḫbi. <sup>13</sup>	14. Sumu-abum. <sup>5</sup> 2169-2156. 36. Sumu-la-ilum. 2155-2120. 14. Zabum. 2119-2106. 18. Apil-Sin. 2105-2088. 20. Sinmuballiḫ. 2087-2068. 43. Hammurabi. 2067-2025. 38. Samsu-iluna. 2024-1987. 28. Abi-ešub. 1986-1959. 37. Ammiditana. 1958-1922. 21. Ammizaduga. 1921-1901. 31. Samsuditana. 1900-1870. 11 kings of Babylon. 300 years.	21. Idin-Dagan. 2258-2238. 20. Išme-Dagan. 2237-2218. 11. Lipit-Ištar. 2217-2207. 28. Ur-Ninurta. 2206-2179. 21. Bur-Sin. 2178-2158. 5. Lipit-Enlil. 2157-2153. 8. Girra-imiti. 2152-2145. 24. Enlilbani. 2144-2121. 3. Zambiya. 2120-2118. 4. Iter-pi-ša. 2117-2114. 4. Urdukugga. 2113-2110. 11. Sinmagir. 2109-2099. 23. Damiḫilišu. 2098-2076. 15 kings of Isin. 226 years. End of dynasty in 12th year of Sinmuballiḫ. ŠEŠ-KUG or Sea Dynasty (at Isin?) 60. Iluma-ilu. <sup>14</sup> 2007-1948. 56. Itti-ili-nibi. <sup>15</sup> 1947-1892. 36. Damiḫ-ili-šu (II). 1891-1856.	35. Samūm. 2252-2218. 9. Zabāya. 2217-2209. 27. Gungunūm. 2208-2182. 11. Abisarē. 2181-2171. 29. Sumu-ilum. 2170-2142. 16. Nūr-Immer. <sup>16</sup> 2141-2126. 6. Sinidinnam. 2125-2120. 2. Siniribam. 2119-2118. 6. Sinikīšam. 2117-2112. 1. Šilli-Immer. 2111. 12. Warad-Sin. 2110-2099. 61. Rfm-Sin. 2098-2038. <sup>14</sup>
Šamši-Adad I. <sup>16</sup> Išme-Dagan I. <sup>14</sup> .....as-kur. <sup>17</sup> Rimu[š]. <sup>18</sup>			

<sup>1</sup> Probably one of the kings of the Gutium dynasty. See p. 86 n. 6.<sup>2</sup> Contemporary of Bur-Sin of Ur and also mentioned on unpublished tablet of the Rylands Library, in 46th year of Dungi.<sup>3</sup> KAV. 18 I 1; AB. 4, 4.<sup>4</sup> KAV. 18 I 2.<sup>5</sup> KING, *Chronicles*, II 14. KAV. 18 I 3, has Šamši-li-šu-ma ?]<sup>6</sup> Ass. 4128 IV 17-20. KAV. 18 I 4. Contemporary of Sumu-la-ilum.<sup>7</sup> KAV. 18 I 5.<sup>8</sup> Identical with *Immerum*, CT. 4, 50 A; PSBA. 1910, 281.<sup>9</sup> KAV. 18 I 6-7.<sup>10</sup> *Ibid.* 18 I 8; 14, 1; 15, 2; C. 8836 I 27.<sup>11</sup> KAV. 14, 2; 18 I 9; 15, 4. Probably not Rfm-Sin of Ellasar.<sup>12</sup> *Ibid.* 14, 3; C. 8836 I 29. Here, ll. 31-6, two kings,

between Erišum II and Šamši-Adad I. Text wholly uncertain and unusable.

<sup>13</sup> RANKE, BE. VI 18, 3-4, "*Be-el-DA-bi*", with Sinmuballiḫ in the oath formula. For *da* = *ḫabā*, v. *Sumerian Grammar*, 207. Var. "*Bēl-KA-bi*", father of Šamši-Adad, KAH. I 51, II 22. Omitted on KAV. 14. Here perhaps C. 8836 I 35.<sup>14</sup> Rfm-Sin conquered by Hammurabi in the 30th year of the latter's reign. Louvre Prism has 60 years for Rfm-Sin.<sup>15</sup> KAV. 14, 4. With Hammurabi in oath formula, VAB. V 284, 11, 10th year of Hammurabi. C. 8836 I 37-40. Son of I-ri-kapkapu. From photo of C. 8836, *Karduniāš* is hardly to be discovered on the tablet.<sup>16</sup> KAV. 14, 4; son of Šamši-Adad, AB. 32 XII 7-8.<sup>17</sup> KAV. 14, 5.<sup>18</sup> Contemporary of Samsu-iluna and Abi-ešub. KING, *Chronicles*, II 20-1; POEBEL, BE. VI, p. 119; CHIERA, PBS. VIII, p. 66; in King-list A. I 4; B. Rev. 1.<sup>19</sup> A. I 5; B. Rev. 2. <sup>20</sup> KAV. 14, 5.

ASSYRIA (continued).	BABYLONIA (continued).	ŠEŠ-KUG DYNASTY (continued).
A[da-si]. <sup>1</sup> Circa 1870-1856.	[Damik-ilīšu (II)] (14 years at Babylon).	
Bēl-ba-ni. <sup>2</sup>	15. Iškibal. <sup>3</sup> 1855-1841.	15. Iškibal. 1855-1841.
Lu(?)ba-aj.	24. Šuši. <sup>4</sup> 1840-1817.	24. Šuši. 1840-1817.
Šarma-Adad I.	55. Gulkišar. 1816-1772.	55. Gulkišar. 1816-1772.
21. Lilkud-Šamaš. <sup>5</sup>	.....en. <sup>4</sup>	
Bazāya. <sup>6</sup>		50. Pešgaldarames. <sup>6</sup> 1762-1713.
Lullāya. <sup>7</sup>		28. Adarakalmana. <sup>8</sup> 1712-1685.
Ši-Ninūa. <sup>9</sup>		26. Ekur-du-anna. <sup>10</sup> 1684-1659.
Šarma-Adad. <sup>11</sup>		7. Melamkurkurra. <sup>12</sup> 1658-1652.
		9. Ea-ga-mil. <sup>13</sup> 1651-1643.
Erišu III. <sup>14</sup> Circa 1651-1627.		11 kings (+ .....en Ass. 4128 I 5). 368 years <sup>15</sup> of ŠEŠ-KUG <sup>16</sup> dynasty.
		16. Ga-an-du-uš. <sup>17</sup> 1642-1627.
		22. Agum-maḥrū. <sup>18</sup> 1626-1605.
		22. Kaštilyaši I. <sup>19</sup> 1604-1583.
		Abirataš. <sup>20</sup>
		(Kaštilyaši). <sup>21</sup>
		Tazzigurumaš. <sup>22</sup>
		Ḫurbašipak. <sup>24</sup>
		Tiptakši. <sup>25</sup>
		Agūm II. <sup>26</sup>
		Burnaburiyaš I. <sup>28</sup> Circa 1545-1530.
		..... <sup>29</sup>
		Kaštilyaši II. <sup>31</sup> Circa 1510-1491.
Šamši-Adad II. <sup>27</sup> Circa 1626-1576.		
		<sup>34</sup> Ulamburiyaš. <sup>35</sup> Circa 1490-1456.
16. Išme-Dagan II. <sup>27</sup> Circa 1575-1560.		
15. Šamši-Adad III. <sup>29</sup> Circa 1559-1545.		
26. Ašurnirari I. <sup>30</sup> Circa 1544-1519.		
14. Puzur-Ašur III. <sup>31</sup>		
13. Enlilnašir I. <sup>32</sup>		
12. Nur-ili. <sup>34</sup>		
Ašur-šad-šabē. <sup>37</sup>		

<sup>1</sup> Ass. 4128 I 1. Restored from VS. I 78, Rev. 17, &c. See WEIDNER, MVAG. 1915, 4, p. 30. KAV. 14, after Rimuš, omits 7 names here, Adasi to Lullā. Above Adasi on Ass. 4128, break for 11-12 names.  
<sup>2</sup> Ass. 4128 I 2; King-list A. I 7; B. Rev. 4.  
<sup>3</sup> C. 8836 II 15-16; C. 8836 II 16, 21 years?  
<sup>4</sup> Ass. 4128 I 5. A. B. omit.  
<sup>5</sup> Ass. 4128 I 6; C. 8836 II 17-18.  
<sup>6</sup> Ass. 4128 I 6; King-list A. I 10; B. Rev. 7.  
<sup>7</sup> Ass. 4128 I 7; C. 8836 II 19-20.  
<sup>8</sup> Ass. 4128 I 7; A. I 11; B. Rev. 8.  
<sup>9</sup> Ass. 4128 I 8; KAV. 14, 6.  
<sup>10</sup> Ass. 4128 I 8; B. Rev. 9, *A-kur-dū-an-na*; A. I 12, *Ekurdū*.  
<sup>11</sup> Ass. 4128 I 9; KAV. 14, 6.  
<sup>12</sup> Ass. 4128 I 9; B. Rev. 10; *Me-lam-ē*, A. I 13.  
<sup>13</sup> Ass. 4128 I 10. *E-ga-mil*, B. Rev. 11; KING, *Chronicles*, II 22, 11. A. I 14, *BAD-ga-mil*; Ass. 4128 I 10, *Y-ga-mil*. KAV. 14, 7.  
<sup>14</sup> Ass. 4128 I 10; KAV. 14, 7. Omitted on C. 8836.  
<sup>15</sup> So A. I 15.

<sup>16</sup> So B. Rev. 12; but A. I 15, *ŠEŠ-ĦA*.  
<sup>17</sup> Ass. 4128 I 10; A. I 16, *Ga-an-diš*.  
<sup>18</sup> King-list A. I 17; Ass. 4128 I 11.  
<sup>19</sup> A. I 18; Ass. 4128 I 12. Here Ušši or Duši of A. is omitted.  
<sup>20</sup> Ass. 4128 I 13.  
<sup>21</sup> Ass. 4128 I 14. Omitted on A. and clearly a repetition here.  
<sup>22</sup> Ass. 4128 I 15. <sup>34</sup> Ass. 4128 I 16. <sup>35</sup> Ass. 4128 I 17.  
<sup>23</sup> Ass. 4128 I 18. Son of Taššigurumaš, VR. 33 I 2.  
<sup>24</sup> Ass. 4128 I 19; C. 8836 II 27; KAV. 14, 8.  
<sup>25</sup> Ass. 4128 I 19.  
<sup>26</sup> Ass. 4128 I 20; KAV. 14, 8; C. 8836 II 29-31.  
<sup>27</sup> Ass. 4128 I 21; C. 8836 II 32-3. Son of Išme-Dagan.  
<sup>28</sup> Ass. 4128 I 21. <sup>31</sup> KAV. 14, 9; C. 8836 II 34.  
<sup>29</sup> C. 8836 II 36. <sup>32</sup> Ass. 4128 I 22-5.  
<sup>30</sup> Son of Burnaburiyaš and called *šar mat tamim*, WEISSBACH, *Miscel.*, p. 7. Brother of Kaštilyaš, KING, *Chronicles*, II 23, 12. Apparently from KING, *ibid.*, 24, 14, an *Agum*, son of Kaštilyaš, succeeded Ulamburiyaš.  
<sup>31</sup> C. 8836 II 38; KAV. 14, 10. <sup>37</sup> C. 8836 II 40.

ASSYRIA (continued).	BABYLONIA (continued).
Ašur[nirari] II. <sup>1</sup> Circa 1470-1461.	[Agum III?]. Circa 1455-1443.
[Puzur-Ašur IV], <sup>1</sup> son of Ašurnirari II. <sup>2</sup> Circa 1460-1451.	
En[lil-našir II], <sup>1</sup> son of Puzur-Ašur IV. <sup>3</sup> Circa 1450-1436.	Enlil-š-maḥ? <sup>4</sup> Circa 1442-1435.
[Ašur-rabi I]. <sup>5</sup> Circa 1435-1426.	Kadašman-Enlil I. <sup>6</sup> Circa 1434-1415.
Ašur-[nirari III]. Circa 1425-1416.	[Burnabu]riyaš II. <sup>7</sup> Circa 1414-1410.
Ašurbēlnišēšu. <sup>7</sup> Circa 1415-1407.	Kara-indaš I. <sup>7</sup> Circa 1409-1391.
6. Ašur-rim-nišē-šu. <sup>8</sup> Circa 1406-1401.	
Ašurnādinahi. <sup>9</sup> Circa 1400-1396.	[Kurigalzu I]. <sup>10</sup> Circa 1390-1384.
Eriba-Adad. <sup>11</sup> Circa 1395-1384.	
Puzur-Ašur V. <sup>12</sup> Circa 1383-1377.	27. Burnaburiyaš III. <sup>12</sup> Circa 1383-1357.
Ašurballi. <sup>14</sup> Circa 1376-1336. (Son of Eriba-Adad.)	Kara-indaš II. <sup>15</sup>
Enlilnirari. <sup>16</sup> Circa 1335-1321.	Kadašmanḫurbe I. <sup>16</sup> } Circa 1356-1352.
Arikdīnili. <sup>18</sup> Circa 1320-1307.	24. <sup>17</sup> Kurigalzu ( <i>šihru</i> ) II. <sup>18</sup> Circa 1351-1328.
10+? Adadnirari I. <sup>19</sup> Circa 1306-1290.	
20+? Salmanasar I. <sup>21</sup> Circa 1289-1261.	26. Nazimarattaš. <sup>20</sup> Circa 1327-1302.
	18. Kadašmanturgu. <sup>23</sup> Circa 1301-1284.
	7? Kadašman-Enlil II. <sup>20</sup> Circa 1283-1275
	8. Kudur-Enlil. <sup>24</sup> Circa 1274-1267.
	13. Šagaraktišuriyaš. <sup>25</sup> Circa 1266-1254.
30+? Tukulti-Ninurta I. <sup>28</sup> Circa 1260-1225.	8. Kaštilyaš III. <sup>27</sup> Circa 1253-1246.
	1 $\frac{1}{2}$ . Enlilnādin( <i>akīr</i> ?)šumi. <sup>28</sup>
4. Ašurnādinapi. <sup>29</sup> Circa 1224-1221.	1 $\frac{1}{2}$ . Kadašmanḫurbe II.

<sup>1</sup> KAV. 14, 11-12. <sup>2</sup> AB., pp. 30-2.  
<sup>3</sup> AB. 32 XII; KAV. 11, 1.  
<sup>4</sup> PBS. VIII 160 (seventh year).  
<sup>5</sup> KAV. 14, 13. Father of Ašurnirari III, AB. 34 XIV 4.  
<sup>6</sup> Placed here provisionally. Inscription in BE. I 68, I 6-15, Burnaburiyaš son of Kadašman-Enlil.  
<sup>7</sup> KAV. 11, 2; *Syn. History*, I 1-4; C. 8836 III 9-10.  
<sup>8</sup> KAV. 11, 3; C. 8836 11-12.  
<sup>9</sup> KAV. 11, 4; C. 8836 III 13-14.  
<sup>10</sup> KNUDTON, *Amarna Letters*, 9, 19, a Kurigalzu was father (*abu*) of Burnaburiyaš and in correspondence with Amenophis III, but in 10, 8-9, Kara-indaš is father (*abbu*) of Burnaburiyaš. It is probable that *abbu* means 'grandfather' here. In this case Kadašman-Enlil I, Kara-indaš I, and Kurigalzu I were all correspondents of Amenophis III. Kurigalzu *šihru* is then grandson of Burnaburiyaš III, and this is the meaning of *Kurigalzu mar Burnaburiyaš* in NRES and KNISER, *Historical Texts*, No. 15; HILPRECHT, OBI. 35-36-39-40. <sup>11</sup> KAV. 11, 4; C. 8836 III 15-16.  
<sup>12</sup> *Syn. Hist.* I 5-7; PBS. II 2, p. 64. C. 8836 III omits Puzur-Ašur. 700 years after Hammurabi, VAB. IV 239, 21; 245, 4-5. <sup>13</sup> *Syn. Hist.* I 8, grandson of Ašurballi.  
<sup>14</sup> *Syn. Hist.* I 8-17; *Chronicle P.* Col. I; C. 8836 III 17-18.  
<sup>15</sup> *Chron. P.* I 5, son of Kara-indaš and grandson of Ašurballi. But v. note 13; the two accounts not reconcilable. No dated documents from Kara-indaš and Kadašmanḫurbe.

<sup>16</sup> KAV. 11, 5; but *Chronicle P.* III 20 has Adadnirari I. C. 8836 III 19-20; *Syn. Hist.* I 18-23; *Chronicle P.* II-III.  
<sup>17</sup> (Grand)son of Burnaburiyaš III, *Syn. Hist.* I 16, and son of Kara-indaš. Highest date 24th year, BE. XIV, p. 3; PBS. II 2, p. 63; A. II 1.  
<sup>18</sup> KAV. 11, 7; C. 8836 III 21-2.  
<sup>19</sup> C. 8836 III 23-4; *Syn. Hist.* I 24-31.  
<sup>20</sup> A. II 2; PBS. II 2, p. 64; *Syn. Hist.* I 24-31; *Chronicle P.* III 23.  
<sup>21</sup> C. 8836 III 23-6. 586 years before Asarhaddon, KAH. II 125, 24, 580 on KAH. II 126, III 12. According to KAH. II 126, III 6 and KAH. I 51, II 24 only 434 years after Šamši-Adad I, which is impossible on any system of chronology. <sup>22</sup> A. II 3; PBS. II 2, p. 64.  
<sup>23</sup> A. II 4 has 11 years. Latest known date 7, PBS. II 2, p. 64. <sup>24</sup> A. II 5; PBS. XIII, p. 100; II 2, p. 64.  
<sup>25</sup> A. II 6; PBS. II 2, p. 64. 800 years before 552! (*sic*): read 700, VAB. 229, 27.  
<sup>26</sup> Ass. 4128 II 1; C. 8836 III 27-8; *Chron. P.* Col. IV, *Syn. Hist.*, CT. 34, 42, Sm. 2106, 9-10. 600 years before Senecherib, KING, *Tukulti-Ninib*, 108.  
<sup>27</sup> A. II 7; *Chron. P.* IV 1.  
<sup>28</sup> A. II 8. *Chron. P.* IV 14, and in l. 9, a predecessor, *Ramman-šum-ušur*!  
<sup>29</sup> Ass. 4128 II 3; C. 8836 III 30-1; *Chron. P.* IV 10 has *Ašur-na-šir-apli*!



ASSYRIA (continued).	BABYLONIA (continued).
6. Ašurnirari IV. <sup>1</sup> } <i>Circa</i> 1220-1215. 5. Enlilkuduruşur. <sup>1</sup> } <i>Circa</i> 1214-1210.	6. Rammanšumnašir. <sup>2</sup> <i>Circa</i> 1243-1238.
13. Ninurta-apil-ekur. <sup>4</sup> Son of Nabu-dân. <i>Circa</i> 1209-1197.	30. Ramman-šum-iddina. <sup>3</sup> <i>Circa</i> 1237-1208. 15. Melišipak. <sup>5</sup> <i>Circa</i> 1207-1193. 13. Mardukapiliddin I. <sup>6</sup> <i>Circa</i> 1192-1180. 1. Zamamašumiddin. <sup>7</sup> 3. Bēlnādinšumi. <sup>9</sup> } <i>Circa</i> 1179-1176.
36. Ašurdân. <sup>8</sup> <i>Circa</i> 1196-1161.	36 kings of Cassite dynasty. 576 years <sup>10</sup> on A. II 16.
Ninurta-tukulti-Ašur. <sup>11</sup> } <i>Circa</i> 1160-1154. Mutakkil-Nusku. }	17. Marduk-šapik-zēri. <sup>12</sup> 1175-1159.
Ašur-rēš-iši. <sup>14</sup> <i>Circa</i> 1153-1134.	6. Ninurta-[nadin-šumi]. <sup>13</sup> 1158-1153. Nabukudur-ušur. <sup>15</sup> 1152-1139. Enlil-nadin-apli. <sup>17</sup> <i>Circa</i> 1138-1124. Marduknadinahi. <sup>18</sup> <i>Circa</i> 1123-1113. 11 Itti-Marduk-balaṭi. <sup>19</sup> <i>Circa</i> 1112-1105. Marduk-šapik-zēr-māti. <sup>20</sup> 1102. 22. Ramman-apil-iddin-na. <sup>21</sup> 1101-1080. 12. Marduk-aḫē-eriba. <sup>23</sup> 1080. 12. Marduk-zer-[šumi]. <sup>24</sup> 1079-1068. 8. Nabu-šum-libur. <sup>25</sup> <i>Circa</i> 1067-1060.
27? Tukulti-apil-ešarra I. <sup>17</sup> <i>Circa</i> 1133-1107. 3. Ninurta-apil-ekur. <sup>18</sup> <i>Circa</i> 1106-1104.	11 kings of PA-ŠE <sup>m</sup> dynasty. 132½ years.
38. Ašur-bēl-kala. <sup>22</sup> <i>Circa</i> 1103-1066. Eriba-Adad II. <sup>25</sup> <i>Circa</i> 1065-1058.	18. Šimmaš-šipak. <sup>29</sup> <i>Circa</i> 1059-42? Ea-mukin-zēri. <sup>30</sup> ? 3. Kaššû-nādin-aḫi. <sup>31</sup> 1025-1023.
Šamši-Adad IV. <sup>28</sup> <i>Circa</i> 1057-1042.	
19. Ašur-našir-apli I. <sup>31</sup> <i>Circa</i> 1041-1023.	

<sup>1</sup> Ass. 4128 II 5-6; KAV. 15, Rev. 1-4 = C. 8836 III 32-5; *Syn. Hist.* II 3-5.

<sup>2</sup> A. II 10; but Ass. 4128 must be in error in making Ašurnirari contemporary with Rammanšumnašir.

<sup>3</sup> *Chron. P.* IV 17; Ass. 4128 III 7; *Syn. Hist.* II 3-5.

<sup>4</sup> Ass. 4128 II 7-9; KAV. 10 I 1; *Syn. Hist.* II 5-8; C. 8836 III 36-8 = KAV. 15 R. 5.

<sup>5</sup> A. II 12; Ass. 4128 II 8. <sup>6</sup> A. II 13; Ass. 4128 II 9.

<sup>7</sup> Ass. 4128 II 10; *Syn. Hist.* II 9-12; A. II 14.

<sup>8</sup> Ass. 4128 II 10; KAV. 10 I 2; *Syn. Hist.* II 9-12; C. 8836 III 41-2.

<sup>9</sup> Ass. 4128 II 11; A. II 15.

<sup>10</sup> This figure is clearly too high by at least 100 years. On A. I 16-II 15, the total for 19 names is only 165 years. It is impossible to assign 411 years to the remaining Cassite kings. The period, 466 years, allowed for this dynasty in my list presumes that the figures in A. II 16 are 9 x 50 + 16, not 9 x 60 + 36.

<sup>11</sup> Ass. 4128 II 12-13; KAV. 10 I 3-4; *Chron. P.* IV 12; C. 8836 III 44-6 + IV 1-3.

<sup>12</sup> Ass. 4128 II 12. <sup>13</sup> *Clay, Miscel.* 45, 30.

<sup>14</sup> Ass. 4128 II 14-16; KAV. 10 I 5.

<sup>15</sup> *Syn. Hist.* II 1-13. But KAV. 12, Nebuchadnezzar contemporary of Ninurta-tukulti-Ašur, Mutakkil-Nusku, Ašur-rēš-iši. This surely correct. See MVAG. 1921, 2, p. 38.

<sup>17</sup> KAV. 10 I 6; 12 II 5; Ass. 4128 II 17; *Syn. Hist.* II 14-23; C. 8836 IV 6-7.

<sup>18</sup> Ass. 4128 II 18; KAV. 12, 6; 10 I 7; C. 8836 IV 8-9; KAV. 21 III 13-15.

<sup>19</sup> *King, Chronicles*, II 59, 8. <sup>20</sup> Ass. 4128 II 20.

<sup>21</sup> Ass. 4128 II 21; A. III 1; *King, Chronicles*, II 59; GADD, in *Tallquist, Studia Orientalia*, 27.

<sup>22</sup> C. 8836 IV 10-11; Ass. 4128 II 20-4; KAV. 10 I 8.

<sup>23</sup> Ass. 4128 II 22; A. III 2.

<sup>24</sup> Ass. 4128 II 23; A. III 3.

<sup>25</sup> Ass. 4128 III 1; C. 8836 IV 12-13.

<sup>26</sup> Ass. 4128 II 24; A. III 4. <sup>27</sup> Certainly for *Isin*.

<sup>28</sup> Ass. 4128 III 3; C. 8836 IV 14-18.

<sup>29</sup> Ass. 4128 III 1; A. III 6.

<sup>30</sup> Ass. 4128 III 3; A. III 7; *King, Chronicles*, II 52, 5.

<sup>31</sup> C. 8836 IV 19-20; KAV. 21, IV 4.

<sup>32</sup> Ass. 4128 III 4; A. III 8; *King, Chronicles*, II 53, 7.

ASSYRIA (continued).	BABYLONIA (continued).
12. Šalmanasar II. <sup>3</sup> <i>Circa</i> 1022-1011. 6. Ašurnirari V. <sup>4</sup> <i>Circa</i> 1010-1005. [28?] Ašur-rabi II. <sup>6</sup> <i>Circa</i> 1004-977.	21 years and 5 months. 3 kings of the Sea Country. <sup>1</sup>
[13?] Ašur-reš-iši II. <sup>9</sup> <i>Circa</i> 976-964.	17. Ulmaš-šakin-šumi. <sup>3</sup> <i>Circa</i> 1022-1006. 2. Ninurta-kudur-ušur. <sup>5</sup> <i>Circa</i> 1005-1004. 2. Širiktu-Šukamuna. <sup>7</sup> <i>Circa</i> 1004.
	3 kings of dynasty of the sons of Bazi. 20 years. <sup>4</sup>
	[?] Mar-bitu-apil-ušur. <sup>10</sup> <i>Circa</i> 1003-970.
	1 king, descendant of Ši..... of Elam. <i>King, Chronicles</i> , II 55, 13.
33 Tukulti-apil-ešarra II. <i>Circa</i> 963-931. <sup>12</sup>	Nabu-mukin-apli. <sup>11</sup> 955-?
Ašurdân II. <sup>16</sup> } <i>Circa</i> 930-890. Adadnirari II. <sup>17</sup> } Adadnirari II. <sup>18</sup> }	Ninurta-kudur-ušur. <sup>14</sup> Mar-bitu-aḫi-iddin. <sup>15</sup> Šamši-mudammik. <sup>16</sup> <i>Circa</i> 910-896.
7. Tukulti-Ninurta II. <sup>20</sup> 889-883. 24. Ašurnāširapli II. <sup>21</sup> 882-859. 35. Šalmanasar III. <sup>22</sup> 858-824.	Nabu-šum-ukfn ( <i>ikun</i> ). <sup>19</sup> <i>Circa</i> 895-880. Nabu-apil-iddin. <sup>22</sup> <i>Circa</i> 879-855. [11+] Marduk-zākīr-šumi. <sup>24</sup> ( <i>Mardukbēlūsūti</i> , brother). <sup>25</sup> <i>Circa</i> 854-840.

<sup>1</sup> If the synchronisms of Ass. 4128 III 1-3 are correct, it is impossible to assign less than 19 years to *Eamukin-zēri* and *Kaššû-nādin-aḫi*, although the figures 1½ and 3 are supported by KING, *Chronicles*. Ass. 4128 is invariably supported by the *Synchronous History*; the evidence is against Ass. 4128, and the texts cannot be reconciled. On KAV. 21 III 15, end of *limu* of Ninurta-apil-ekur, to IV 4, end of Ašurnāšir-apli, fall all the *limu* names of Ašur-bēl-kala, Eriba-Adad, Šamši-Adad, and at end of Col. III, 16 names for Ašurnāširapli I. The space permits of no more than 40 years for Ašurbēl-kala, Eriba-Adad, Šamši-Adad, and Ašurnāširapli. It is, therefore, impossible to allow more than 24 years for Ašurbēl-kala, Eriba-Adad, and Šamši-Adad! It is clear that Ass. 4128 makes Ašurbēl-kala contemporary with 5 kings who must have reigned more than 18 years, and the *limu* list cannot be depended upon here. KING, *Chronicles*, II 53, 8, has 23 years for the fifth dynasty.

<sup>2</sup> Ass. 4128 III 5; KAV. 21 IV 5-17.

<sup>3</sup> KING, *Chronicles*, II 54, 9 has 15 years; A. III 10, 17 years. See also KING, *ibid.* 61, 14. Var. E-ulmaš-šakin-šumi.

<sup>4</sup> Ass. 4128 III 6; C. 8836 IV 21-2; KAV. 21 IV 18-22.

<sup>5</sup> KING, *Chronicles*, II 54, 10, 2 years; A. III 11, 3 years.

<sup>6</sup> Ass. 4128 III 7; C. 8836 IV 23-4; KAV. 21 IV 23 + 22 Col. IV.

<sup>7</sup> A. III 12; Ass. 4128 III 7.

<sup>8</sup> A. III 13; KING, *Chronicles*, II 55, 13.

<sup>9</sup> Ass. 4128 III 8; KAV. 182 III 5; 10 II 1; C. 8836

IV 25-6. In the break on KAV. 21 IV 23-V 1, were the reigns of Ašur-rabi II and Ašur-rēš-iši II, *circa* 41 years.

<sup>10</sup> Ass. 4128 III 8; A. III 14 has only 6 years, which is impossible if Ass. 4128 is correct. KAV. 10 II 2.

<sup>11</sup> A. III 15, 20? + 8? years. KAV. 182 III 6; KING, *Chronicles*, II 62, 17.

<sup>12</sup> Ass. 4128 III 9-11; KAV. 22 V 24; C. 8836 IV 27-8.

<sup>13</sup> KAV. III 182 7. A. III 16 has 8 months and 12 days.

<sup>14</sup> KAV. 182 III 8; 10 II 5.

<sup>15</sup> Ass. 4128 III 14. *Limu* list, KAV. 22 V 25 to 21 VI *circa* line 22 including Adadnirari.

<sup>16</sup> Ass. 4128 III 14-15; *Syn. Hist.* III 1-9; KAV. 10 II 6; 182 III 9.

<sup>17</sup> Ass. 4128 III 15; *Syn. Hist.* III 1-7.

<sup>18</sup> *Syn. Hist.* III 10-21.

<sup>19</sup> KAV. 10 II 7; Ass. 4128 III 16; *Syn. Hist.* III 10-21; KING, *Chronicles*, II 64, 2.

<sup>20</sup> Ass. 4128 III 16. *Limu* list. KING, *Chronicles*, II 64, 2. <sup>21</sup> Ass. 4128 III 18; KAV. 22 VI 13.

<sup>22</sup> Ass. 4128 III 18; KAV. 182 III 11; 10 II 8. KING, *Chronicles*, II 64, 3.

<sup>23</sup> Ass. 4128 III 20. Contemporary of Nabu-apla-iddin and Marduk-zākīr-šumi, *Syn. Hist.* III 22-35. *Limu* list.

<sup>24</sup> KAV. 10 II 9; 182 III 12; year-date 11, VS. I 35.

<sup>25</sup> Rebel who controlled part of Babylonia for a time, *Syn. Hist.* III 28-30; KING, *Chronicles*, II 65, 4-5, reading: *Marduk-bēl-ā-se*.....

ASSYRIA ( <i>continued</i> ).	BABYLONIA ( <i>continued</i> ).
14. Šamši-Adad V. <sup>1</sup> 823-810. (Semiramis.)	Marduk-balatsu-iḫbi. <sup>1</sup> <i>Circa</i> 839-820. Bau-aḫi-iddin. <sup>2</sup> <i>Circa</i> 819-816. (Interregnum.) <sup>3</sup>
28. Adadnirari III. <sup>4</sup> 809-782.	..... 4. Mar-bitī?..... <sup>5</sup>
10. Šalmanasar IV. <sup>7</sup> 781-772.	Marduk-bēl-zēri. <sup>8</sup> Marduk-apla-ušur. <sup>9</sup> Eriḫa-Marduk. <sup>11</sup> (Interregnum.) <sup>12</sup>
18. Ašurdān III. <sup>10</sup> 771-754.	Nabu-šum-iškun. <sup>14</sup> 760-746.
8. Ašurnirari VI. <sup>15</sup> 753-746.	14. Nabunašir. <sup>16</sup> 747-734
19. Tukulti-apil-ešarra III. <sup>15</sup> 745-727. (Pūlu.) <sup>17</sup>	2. Nadinu. <sup>18</sup> 733-732. 12. Nabušumukin. <sup>19</sup> 732.
	22 reigns <sup>20</sup> from <i>Nabu-mukin-apli</i> to Nabušumukin. 955-732.
5. Šalmanasar V. <sup>23</sup> 726-722.	3. Mukin-zēri. 731-729. <sup>21</sup>
17. Sargon. 721-705.	2. Pūlu. 728-727. <sup>22</sup>
	5. Ululāi = Šalmanasar V. <sup>23</sup> 726-722.
24. Sin-aḫē-eriba. 704-681. <sup>24</sup>	12. Marduk-apil-iddin II. <sup>24</sup> 721-710. 5. Sargon. <sup>25</sup> 709-705. 2. Sin-aḫē-eriba. <sup>27</sup> 704-703. 1 month. Marduk-zakir-šumi. <sup>28</sup> 8 months. Marduk-apil-iddin. <sup>29</sup> 3. Bēl-ibni. <sup>30</sup> 702-700.

<sup>1</sup> Son of Mardukzākīrsumi, RA. 16, 130; KAV. 182 III 13; *Syn. Hist.* CT. 34, 43, Sm. 2106, Rev. 6-9; KING, *Chronicles*, II 65, 6.

<sup>2</sup> RA. 16, 120; *Limu* list; *Syn. Hist.* CT. 34, 43, Sm. 2106, Rev. 6-9.

<sup>3</sup> *Syn. Hist.* IV 1-14; KAV. 182 III 14.

<sup>4</sup> KING, *Chronicles*, II 66, 7; for the remainder of Šamši-Adad's reign the king, Bau-aḫi-iddin, was not in the land, i.e. was captive in Assyria.

<sup>5</sup> *Syn. Hist.* IV 15-22; *Limu* list.

<sup>6</sup> CT. 34, 41, 15 = KAV. 13, 1? WEIDNER's collation of KAV. 13, 1, confirms SCHROEDER's copy, and seems to have AN-PA . . . . ., i.e. *Nabu*. . . . . <sup>7</sup> *Limu* list.

<sup>8</sup> KAV. 13, 2; JOHNS, *Assyrian Deeds*, 881, 1?; CLAY, JAOS. XLI (1921), 413.

<sup>9</sup> KAV. 13, 3; JOHNS, *ibid.* 3. <sup>10</sup> *Limu* list.

<sup>11</sup> KAV. 13, 4; CLAY, *Miscel.* 40, 13; KING, *Chronicles*, II 66-8.

<sup>12</sup> A. IV 1, 10-year interregnum?, when an Assyrian king ruled Babylonia, KING, *Chronicles*, II 69, 18.

<sup>13</sup> *Limu* list. KAV. 23 VIII 9, ten years!

<sup>14</sup> A. IV 2; KAV. 13, 5; highest known date, 13th year, CLAY, *Morgan Collection*, I 3.

<sup>15</sup> *Limu* list; KAV. 23 VIII 10-21 VIII 16.

<sup>16</sup> Ptolemaic Canon, 1; A. IV 3; *Babylonian Chronicle*, I 1-12. <sup>17</sup> As king of Babylonia.

<sup>18</sup> So *Bab. Chron.* I 12-13, and Ptolemaic Canon, 2. But A. IV 4, *Nabū-nādin-zēri*.

<sup>19</sup> *Bab. Chron.* I 16-17; here called *Šum-ukin* (2 months); A. IV 5.

<sup>20</sup> A. IV 5. No records of the period were available for this period of anarchy, and the compiler of King-list A gives only 22 *bal* or families who were temporarily in power. Some are called *Kaldu*, and some are said to be from the Sea Land, JOHNS, *Assyrian Deeds*, 888.

<sup>21</sup> A. IV 7; *Bab. Chron.* I 19-23; Ptolemaic Canon, 3, Chinzēr. Called *Nabū-mukin-zēri*, CLAY, *Morgan Collection*, I 22 (fourth year).

<sup>22</sup> A. IV 8; *Bab. Chron.* I 24-6.

<sup>23</sup> *Bab. Chron.* I 27-30; A. IV 9.

<sup>24</sup> Merodachbaladan; A. IV 10; *Bab. Chron.* I 32-II 4.

<sup>25</sup> A. IV 11; *Bab. Chron.* II 5-10.

<sup>26</sup> *Limu* list; Ass. 4128 IV 1-10.

<sup>27</sup> A. IV 12.

<sup>28</sup> A. IV 13; *Bab. Chron.* II 17.

<sup>29</sup> *Bab. Chron.* II 20. Ass. 4128 IV 1-5, 'three dynasties of *Bit*. . . .'. For the 2 years + 9 months from Sargon to Belibni, the Ptolemaic Canon has 2 'kingless' years.

<sup>30</sup> A. IV 15; *Bab. Chron.* II 23-9.

ASSYRIA ( <i>continued</i> ).	BABYLONIA ( <i>continued</i> ).
12. Ašur-aḫi-iddin. <sup>5</sup> 680-669.	6. Ašur-nādin-šumi. <sup>1</sup> 699-694.
43. Ašur-bāni-apli. <sup>6</sup> 668-626.	1. Nergal-usēzib. <sup>2</sup> 693-692.
4? Ašur-eṭil-ilāni. <sup>9</sup> 625-622?	4. Mušēzib-Marduk. 691-688. <sup>3</sup>
1? Sin-šum-īfšir. <sup>11</sup> 622?	7. Sin-aḫē-eriba. <sup>4</sup> 687-681.
10? Sin-šarra-ukin. <sup>13</sup> 621?-612.	12. Ašur-aḫi-iddin. 680-669. <sup>5</sup>
Ašur-uballit. <sup>13</sup> 611-?	20.7 Šamaš-šum-ukin. <sup>6</sup> 668-649.
(End of Assyrian Empire.)	23. Kandalānu. <sup>8</sup> 648-626.
	21. Nabu-apla-ušur. <sup>10</sup> 626-604.
	(Fall of Nineveh.)
	43. Nabu-kudur-ušur. 604-562.
	2. Amel-Marduk. 561-560.
	4. Nergal-šarra-ušur. 559-556.
	3? months. Labaši-Marduk.
	17. Nabu-na'id. 555-538. <sup>14</sup>

<sup>1</sup> A. IV 16. Son of Senecherib, *Bab. Chron.* II 30; Ass. 4128 IV 6, called *ašurāja*, Assyrian.

<sup>2</sup> A. IV 17. 1 year and 6 months, *Bab. Chron.* III 5. Ass. 4128 IV 7. An Elamite.

<sup>3</sup> A. IV 18; Ass. 4128 IV 8; *Bab. Chron.* III 12-27.

<sup>4</sup> A. IV 19; Ass. 4128 IV 10. Ptolemaic Canon describes the reign of Senecherib as eight 'kingless' years. Also S. SMITH, BH. 13, Rev. 8, eight years.

<sup>5</sup> A. IV 20; Ass. 4128 IV 12; *Bab. Chron.* III 39-IV 32; S. SMITH, BH. 13, Rev. 7; 23, 2. Ptolemaic Canon, 13 years. For astronomical reckoning of his first year, 680/679 (Gregorian), v. ZA. 37, 311.

<sup>6</sup> A. IV 21; Ass. 4128 IV 14; *Bab. Chron.* IV 33-8.

<sup>7</sup> Ptolemaic Canon, 20 years; also S. SMITH BH. 24, 3. Highest-dated tablet, year 20, CLAY, *Morgan Collection*, I 38.

<sup>8</sup> A. IV 22; Ass. 4128 IV 15. Ptolemaic Canon, 22 years. Highest-known date, 19, on Dilbat tablet (Oxford), but tablet from same group has date, Ašurbanipal, year 23. Hence Ašurbanipal and Kandalānu are the same persons, and the tablet of year 23 is the year 626/5. Clearly Ašurbanipal lived as late as 626.

<sup>9</sup> Highest-known date, year 4, at Nippur, CLAY, BE. VIII 5. At Dilbat, LANGDON, OECT. I 37; at Bit-Dakuri, CLAY, *Miscel.* 43.

<sup>10</sup> S. SMITH, BH. 24, Rev. 4; succeeds Kandalānu. Ptolemaic Canon, 21 years. A Chaldean, RA. 11, 142.

<sup>11</sup> Accessional year, BE. VIII 141; cf. CLAY, *Morgan Collection*, I 42, 19, and IV 50, 1-2, son of Ašurbanipal?

<sup>12</sup> GADD, *Fall of Nineveh*, l. 44. Latest-dated Babylonian tablets, 7th year, 10th month, ZA. 9, 398, *circa* 615, and JRAS. 1921, 387, 5th month, both dated at Erech. Hence Nabupalassar lost control of southern Babylonia until 615. But an Erech tablet dated in 5th year of Nabupalassar, RT. 36, 15, i.e. 621!

<sup>13</sup> Gadd, *ibid.* 49-75.

<sup>14</sup> Ass. 4128 IV 19-20 reckons 98 Accadian kings from *Sumu-la-īlu* to *Kandalānu*. In the above list there are 100 kings in this period, omitting the Assyrian kings who ruled in Babylonia, i.e. Pulu, Ululai, Sargon, Senecherib, Asarhaddon, and Kandalānu. But the suggestion for introducing *Mar-bitī*. . . . ., contemporary of Adadnirari in the 8th dynasty raises the number to 101. In any case it is impossible to account for as many as 22 kings in the 8th dynasty. This would raise the number of names to 105, from *Sumu-la-īlu* to *Kandalānu*. From *Erišum*, son of Ilušuma, to Ašurbanipal, Ass. 4128 gives 82 Assyrian kings, which exactly corresponds to the list above. It is probable that Kadašmanḫurbe of the Cassite dynasty was not mentioned; his existence rests upon doubtful authority.

CHAPTER XV

ASTRONOMICAL AND CALENDARIAL TABLES

INTRODUCTION AND ELEMENTS

THESE tables treat the heliacal risings and settings of the Moon and the five planets known to the ancients, the former from -3500 to +1300 and the latter from -2100 to the year 0, computed in each case for the horizon of Babylon ( $\lambda = 44.40^\circ$ ,  $\phi = 32.50^\circ$ ). But the figures hold approximately for any terrestrial latitude between  $31.5^\circ$  and  $33.5^\circ$  (e.g. Jerusalem, Borsippa, Sippara, Dilbat, Kish, Nippur, Isin, and less exactly for Erech, Ellasar, and Alexandria), because in the lower latitudes the figures are not greatly changed by a difference of one degree in latitude. Particular attention is given to the most important phenomenon, the appearance of the crescent (i.e. the heliacal rising of the Moon in the evening), namely, the first moment after new moon, when the fine, small lunar crescent becomes visible in the evening to a sharp-sighted man. This moment was the beginning of a new month to most ancient oriental peoples, especially the Babylonians. To determine the evening when this phenomenon takes place very accurate tables of new moon are required, because the visibility of the crescent depends on the age of the Moon, i.e. on the time expressed in tenths of an hour which has elapsed from the moment of true new moon to 6<sup>h</sup> the following evening. But there are no tables in existence which give the time of new moon with the necessary accuracy (error =  $\pm \frac{1}{4}$  hour).<sup>1</sup> I have, therefore, constructed new-moon tables on the model of SCHRAM'S *Tafeln zur Berechnung der näheren Umstände der Sonnenfinsternisse* (1885), where, however, the Period Table contains those new moons only, which are connected with a solar eclipse, about two in the mean for each year. I have adopted as the basis of my tables OPPOLZER'S monumental *Syzygien-Tafeln für den Mond* (1881), introducing modern elements of the Moon and Sun. With my tables it is the work of a few minutes to receive the time of true new moon with an error of  $\pm 3^m$  between -2000 and +2000. Before -2000 the error can reach 5<sup>m</sup>. Furthermore, the computation is far simpler than with NEUGEBAUER'S tables, because in Tables A and B the intervals of Argument II are so small that they are practically tables of single, not of double, entry. I have, of course, avoided the use of the cumbersome Julian day, which compels any one who works with OPPOLZER'S tables to perform the entire computation with a ten-figure quantity, T. I give the day of the month in a small Table C, p. [VIII]. No knowledge of astronomy is required for the use of any of my tables; any one can work with them who is able to interpolate between given table values.

I use the following elements:

For the Moon, epoch 1800 Jan. 0, Greenwich noon:

L =	335°	43'	24.37"	+	1732	564	394.50" s	+	12.200" s <sup>2</sup>	+	0.0066" s <sup>3</sup>
Ω =	33	16	22.57	-	6	962	920.90 s	+	7.489 s <sup>2</sup>	+	0.0075 s <sup>3</sup>
π =	225	23	50.37	+	14	648	593.70 s	-	37.033 s <sup>2</sup>	-	0.0440 s <sup>3</sup>
D =	55	48	34.74	+	1602	961	629.95 s	+	9.572 s <sup>2</sup>	+	0.0066 s <sup>3</sup>

<sup>1</sup> GRATTAN GUINNESS, *Creation Centred in Christ*, ii (1896), gives new moons back to -1621 with an error of  $\pm 4$  hours. The new moons computed with SCHRAM'S *Hilfs-Tafeln zur astronomischen Chronologie*, ii (1914), also an error of  $\pm 1$  hour.

For the Sun, Mercury, Venus, Mars, epoch 1900 Jan. 0, Greenwich noon:

L' =	279°	41'	48.48"	+	129	602	769.81" s	+	2.628" s <sup>2</sup>
π' =	281	13	14.32	+	6	183.62	s	+	1.680 s <sup>2</sup> + 0.010" s <sup>3</sup>
L =	178	10	45.7	+	538	106	660.8 s	+	7.30 s <sup>2</sup> Mercury
								+	3.55 s <sup>2</sup> Venus
								+	1.92 s <sup>2</sup> Mars

where  $s$  denotes the Julian centuries elapsed since the epoch and the longitudes are reckoned from the real equinox. All other elements of Mercury, Venus, and Mars are taken from NEWCOMB'S tables, and the elements of Jupiter and Saturn are taken wholly from GAILLOT'S tables.

The most important term for my purpose, the  $s^2$  term in  $L - L' = D$ , affecting T (the time of conjunction), and amounting to 9.6" approximately, I have derived (as well as  $\Omega$ ) from ancient eclipses.

The  $s^2$  term in the Moon's L, 12.20", which implies a term of 11.09"  $s^2$  in the Moon's motion compared with the fixed stars, I have derived from the only useful observation in all antiquity, the observation made by Timocharis at Alexandria -282 Nov. 9, when Spica in the morning touched the north cusp of the Moon after the Moon had risen over the horizon. Since 1919 I have made similar observations with Spica, Regulus, and Aldebaran (which are near the ecliptic and are all of magnitude +1.2 approximately) at Heidelberg and Berlin and have found that Spica could not on that morning have been visible earlier than 22<sup>m</sup> after moonrise, having regard to extinction of light by proximity to the horizon and invisibility through the diffusion of moonlight. That is the lower limit. The upper limit is 38<sup>m</sup> after moonrise, because a later moment could not be described by the phrase 'after the Moon had risen over the horizon'. For the mean, 30<sup>m</sup> after moonrise or 2<sup>h</sup> 56<sup>m</sup> a.m. Alexandria time, I have computed the apparent longitude of the Moon with the  $s$  term above and have found for the  $s^2$  term a value of 12.20", the most important result for the sidereal motion of the Moon within 2,300 years, because the error of time is only  $\pm 8^m$ . All other occultations in the *Almagest* were useless for my purpose because the time is given in seasonal hours measured with water-clocks, which could be in error by more than one hour.

The visibility of the crescent is given by my small Table K, in which  $\Delta$  denotes the difference

TABLE K

Δ	h	Δ	h
0	0	0	0
0	10.7	10	9.4
1	10.7	11	9.1
2	10.6	12	8.8
3	10.5	13	8.4
4	10.4	14	8.0
5	10.3	15	7.6
6	10.1	16	7.3
7	10.0	17	7.0
8	9.8	18	6.7
9	9.6	19	6.3

in azimuth of the Sun and Moon at the moment when the centre of the Sun sets, and  $h$  the altitude of the Moon over the horizon at the same moment, both terms being computed without regard to refraction and parallax. The crescent should be visible if  $h$  is equal to, or greater than, the figure shown in the column headed  $h$  in Table K. This problem is treated at large with historical examples in my *Planeten-Tafeln für Federmann*, Linser-Verlag, Berlin-Pankow, 1927. I have derived Table K from more than 400 Babylonian observations from -500 to the year 0 confirmed by observations from -2095 to -1900. I have also made more than 100 observations of the crescent myself during 34 years. How well Table K agrees with modern observations can be seen by comparing it with the computations given by FOTHERINGHAM in *The Observatory*, 1921, pp. 308-11.

For the planets I have twice differentiated the difference in the equations of the centre (Planet minus Sun) and have thus obtained the transition from mean to

true conjunction or opposition. Because from  $-2100$  to  $0$  the mean anomaly,  $g'$ , of the Sun differs by a constant from that of the planet,  $g$ , at the moment of mean conjunction or opposition, it was possible to tabulate one mean anomaly only, called I. The eccentricity of the Sun and planets is taken for  $-700$ , secular variations being neglected except in the case of the inferior conjunction of Venus. For the *arcus visionis* which I have used for the planets reference should be made to my *Planeten-Tafeln*, where they are deduced from ancient and modern observations.

I cannot accept NEUGEBAUER'S statement<sup>1</sup> that the heliacal phenomena of the planets and fixed stars are uncertain by several days. I have found an uncertainty of one day only, corresponding to a change of  $0.8^\circ$  in  $\gamma$ , as well for Mercury, Venus, Jupiter, and Saturn, as for Procyon, Aldebaran, and Betelgeuse. Mars alone can differ by about six days, because at times his  $\gamma$  changes very slowly. If the observed  $\gamma$  is greater than mine, the sky was not clear, or the observer had not sharp eyes or was not skilful. For Venus at Babylon the stellar magnitude is taken as  $m = -3.3$  for heliacal phenomena and the corresponding  $\gamma$  as  $5.3^\circ$ . But for northern latitudes the  $m$  for  $e$  last can reach  $-4.2$ , as on 1927 August 21, when HERR STILLHART at St. Gall saw  $e$  last with  $\gamma = 3.8^\circ$ . In these latitudes, therefore,  $\gamma$  can be much less than  $5.3^\circ$ . Allowing for cloudiness, it is to be expected that the sky should be clearer on winter and spring nights than on summer nights with their heat mist. Only in the most favourable circumstances can  $\gamma$  have a smaller value than I have adopted. The Egyptian observations are not relevant, because the Egyptian sky is far worse than the Babylonian.<sup>2</sup>

PRECEPTS FOR USE.

The Julian calendar is used throughout these tables, except for modern times (1904 onwards), where the Gregorian is used. Years are enumerated in the astronomical method in which the year 1 B. C. is styled 0, and other years B. C. are expressed by a minus sign followed by the number of the year diminished by one. Hence 2067 B. C. (first year of Hammurabi) is styled  $-2066$ . The time is always Babylon mean time (Bb), except for modern times, where Greenwich mean time (Gr) is used. Times from midnight to noon are indicated by a (*ante meridiem*) and from noon to midnight by p (*post meridiem*). Each set of tables includes a Cycle Table, in which the left-hand column contains the astronomical year with its fraction. To convert the day of the month into a fraction of the year use the first table on p. [I], where the fraction of the year is given in the second column for positive years and in the third column for negative years. Thus we have  $-2168$  April 22<sup>3</sup> =  $-2168.70$ ;  $-522$  (Cambyses 7) Oct. 23 =  $-522.19$ ; but 1928 Oct. 13 = 1928.78.

(a) *Computation of New Moon.* Pages [I] and [II] contain the Cycle and Period Tables for new moon. For this purpose the quantities I, II, and T are required. I and II are expressed in units of 0.001 of a circle. Hence when the sum of I or II exceeds 1,000, subtract 1,000. T is the number of days with three decimals of a day. Thus to find the time of new moon in  $-2168$  April. The fraction table gives for the middle of April  $-2168.71$ . Take in the Cycle Table the last preceding cycle,  $-2183.66$ . Take the period nearest to the difference, here 14.96. Write out the values of I, II, T corresponding to the cycle, and write below them the values of I, II, T

<sup>1</sup> *Tafeln zur astronomischen Chronologie*, iii (1922), xxxvii. <sup>2</sup> At 6<sup>h</sup> p on this day began the first of Nisan of the first year of the First Dynasty of Babylon.  
<sup>3</sup> See my article in *Sirius* (1926), Heft 10, and my *Planeten-Tafeln*, *passim*.

corresponding to the period 14.96. Add each of the two columns I and II, diminishing the sum,

Example 1.				
	I.	II.	T.	
Cycle	-2183.66	645	487	492.838
Period	14.96	267	957	1080.159
Year	-2168.70	912	444	
Table A, Arg. I, II			623	
Table B, Arg. II and Year			261	
			1573.881	

Table C gives April 21, Table D gives 9<sup>h</sup> 9<sup>m</sup> p Bb.  
 The next evening, April 22, at sunset was the beginning of the first Nisan of the First Dynasty.

decimal stands over the other columns. If the first two decimals are in the first column, the time is in the morning, a, if in the second, the time is in the afternoon, p. The table values are hours and minutes. For modern times apply to T the small correction d T, which stands in the last column of the Period Table (here =  $-1$ ). Hence period T = 34.106.

Example 2. New Moon 1928 October.				
	I.	II.	T.	
Cycle	1904.69	10	687	253.413
Period	24.09	370	93	34.106
	1928.78	380	780	
Table A			120	
Table B			24	
			287.663	

October 13<sup>d</sup> 3<sup>h</sup> 55<sup>m</sup> p Gr.  
*Nautical Almanac* gives 3<sup>h</sup> 56<sup>m</sup> p.  
 The agreement is very good.

*Mean New Moon.* If the mean new moon only is required, take from the Cycle and Period Tables T only, and add 0.610. Arguments I and II and Tables A and B are not required. Thus in Example I we have

T.	492.838
	1080.159
	0.610
	1573.607 = April 21 <sup>d</sup> 2 <sup>h</sup> 34 <sup>m</sup> p Bb.

(b) *Computation of Crescent. General Considerations.*

These tables are not to be used for this computation except for places whose latitude differs little from that of Babylon ( $32.5^\circ$ ). The tables are applicable from  $-3507$  to  $+1289$  and from 1904 onwards. A comparison of Babylon with a place in latitude  $51^\circ$  is interesting and instructive.

Column *a* shows that if at a new moon in March the Moon is in perigee and her latitude ( $\beta$ ) =  $+5^\circ$ , the minimum or necessary age at which the crescent can be visible is 16.5<sup>h</sup>. For latitude  $51^\circ$  the necessary age is 20.0<sup>h</sup>, the difference being only 3.5 hours. An instance of this will occur in 1937 March 13. Column *b*, on the other hand, shows that if at a new moon in September the Moon is in apogee and  $\beta = -5^\circ$ , the necessary age at Babylon is about 42.0<sup>h</sup>, while for latitude  $51^\circ$  it is 63.0<sup>h</sup>, a difference of 21 hours. In spring the mean anomaly of the Moon is of the same importance as her latitude, but in autumn her latitude is far more important.<sup>1</sup> I can say of the Babylonians, who were persistent observers of the crescent during 3,000 years, that not only their observations but their computations for ephemerides are

	a	b
	.h.	.h.
Babylon	16.5	42.0
51°	20.0	63.0

<sup>1</sup> See my detailed article in *Biblica*, Rome, 1928 January.

admirable. I have found only one large error in these, viz. the crescent of  $-273$  Nov. 4, on which evening Arahšamna 1 was made to begin. This is in contradiction to my own observations and computations of the crescent, according to which it was not visible that evening. These give as the necessary age of the Moon  $22.4^h$ , and as the time elapsed since new moon  $16^h$  only. KUGLER assumes that the time of appearance of the crescent was found by comparison with a year 18 years earlier. But this is impossible, because if we go back by the lunar cycle of 18 years, the Moon is about 8 hours older each evening. The only period which yields a good comparison is that of 19 years, after which the age, mean anomaly, and lunar latitude recur approximately with their former values. Both the Babylonians and the ancient Jews in determining the beginning of the month were interested only in observations made in the evening which closed the 29th day of the month. If the crescent was not seen, the day beginning at sunset was regarded as the 30th of the old month; if it was seen, that day was the 1st of the new month. The observation at the close of the 30th day had astronomical interest only, and had no bearing on the calendar. Since the synodic month contains  $29.53$  days (a little more than  $29\frac{1}{2}$  days), the calendar months were generally of 29 and 30 days alternately, and at an average interval of sixteen months there should have been two 30-day months in succession. But since the length of the month depended on the crescent, not on the mean new moon, the variation in length was not so regular. Two successive months of 29 days were possible, especially in the season from Sabat to Ayar. Three successive months of 29 days were impossible, but two or even three successive months of 30 days could occur. The rule governing the last is: If in three successive months in the season from Ayar to Kislev, the Moon when new is near her apogee, and her latitude ( $\beta$ ) is less at each new moon than at the preceding new moon, three successive months of 30 days are possible. This occurs about once in 10 years, was familiar to the Babylonians by observation, and is found in their ephemerides for  $-163$ ,  $-75$ , and  $-10$ . The computation of the crescent is very complicated and is the most difficult exercise in ancient astronomy, because for a given place the necessary age of the Moon for the visibility of the crescent depends upon three variables, the longitude of the Sun, the mean anomaly of the Moon, and her latitude ( $\beta$ ). KEPLER regarded the computation of the crescent as impossible. I have given in Tables G and H the transition from new moon to crescent. It will be noted that interpolation in Table H is more complicated than in Table G. But a larger and more convenient Table H would have involved a great expenditure of space.

The most valuable observations for my purpose are the most ancient, belonging to a time when the Babylonians were unable to compute the appearance of the crescent, i. e. the time from Rim-Sin to Ammizaduga and from Nebuchadnezzar to Xerxes. Within these two ranges I have collected about 80 months, which are known from contracts to have contained 30 days, including some which I have taken from KUGLER and UNGNAD. I find that these agree with the months which have 30 days according to my tables in about 80 per cent. of the cases. The remaining 20 per cent. must be explained by bad weather on the evening of the 29th day of the month or perhaps by a want of accuracy in my Tables G and H, which can easily be corrected in the future. The most important result historically is that these 30-day months confirm FOTHERINGHAM'S chronology for the First Dynasty, observation and computation agreeing in 80 per cent. of the instances, while for KUGLER'S original solution, in which the first year of Ammizaduga is  $-1976$ , agreement occurs in 40 per cent. only. From this it follows either that the last-named chronology is false or that the Babylonians of that age did not regulate the beginning of the month by the appearance of the crescent. From the reign of Xerxes to the year  $-7$  I have computed

about 400 crescents and find that the recorded dates agree throughout with my tables in 80 per cent. of the instances.

*Example 3.* I select the oldest 30-day month known to me, Rim-Sin 2, Ab (Contract LX. 20). The year is  $-2096/5$ . Enter Tables M and N, pp. [XV], [XVI], and find there  $-2096$  Ab 1 = August 4 Julian,  $-2096$  Ulul 1 = September 2 Julian, the day beginning with midnight. (Precepts for the use of Tables M and N are given later.) We have to compute the crescents at the beginning and end of Ab.

	I.	II.	T.	L.	$\theta$ .
Cycle $-2107.74$	982	404	463.073	357.67°	2.5°
Period $11.32$	40	319	1212.275	114.94	218.9
Year $-2096.42$	22	723	0.385	0.39	221.4
			0.012	113.00	111.0°
			1675.745	-2.04	332.4''
				110.96	

New Moon Aug. 1<sup>d</sup> 5<sup>h</sup> 53<sup>m</sup> p = 5.9<sup>h</sup> p Bb.

To Aug. 2<sup>d</sup> 6<sup>h</sup> p there elapsed 24.1<sup>h</sup>.

Table G gives with Arg.  $\odot = 111$ , and Arg.  $u = 332.4$

Table H gives with Arg.  $\odot, u, I$  the correction:

Visible Aug. 2, evening.

Necessary hours

Interpolation in Table H.

Correction with

Arg. I = 22

Arg.  $u = 332^\circ$

For  $\odot = 111^\circ$

$\odot = 60^\circ$  120'

-2.5 -3.1

-3.0<sup>h</sup>

	I.	II.	T.	L.	$\theta$ .
Cycle $-2107.74$	982	404	463.073	357.67°	2.5°
Period $11.40$	111	400	1241.816	144.05	220.5
Year $-2096.34$	93	804	0.226	0.23	223.0
			0.017	141.95	140.0°
			1705.132	-1.98	3.0''
				139.97	

New moon Aug. 31<sup>d</sup> 3<sup>h</sup> 10<sup>m</sup> a = 3.2<sup>h</sup> a Bb.

To Sept. 1<sup>d</sup> 6<sup>h</sup> p there elapsed 38.8<sup>h</sup>. The Moon was certainly visible on Sept. 1.

The Babylonian days counted from midnight (contract-day) must have been as follows: {Ab 1 = Aug. 3}. Therefore  
Ab had 30 days. {Ulul 1 = Sept. 2}.

For the first crescent take from Cycle and Period Tables the quantities I, II, T, L,  $\theta$ . Form by summation I, II,  $\theta$ . (See *Example 1*.) With Arg. I = 22 and II = 723 enter Table A and take out the quantities T = 385, L = 39. Sum L and with Arg. II = 723 and the year  $-2100$  enter Table B and take out the quantities T = 12, L =  $-2.04^\circ$ . Write the latter under the sum of L and add algebraically. The result is the true longitude  $\odot$  of the Sun at the moment of new moon. It is also the true longitude of the Moon at that moment. Write  $\odot = 111.0^\circ$  under  $\theta = 221.4^\circ$  and add. The result is the Moon's argument of latitude,  $u$ . Now sum the column T as in *Example 1*, obtaining 1675.745. With this value enter Tables C and D, p. [VIII], and obtain, new moon Aug. 1<sup>d</sup> 5<sup>h</sup> 53<sup>m</sup> p = 5.9<sup>h</sup> p Bb. If the place of observation were Jerusalem, the Babylon time of new moon would have to be corrected by  $-37^m$  as in Table E, p. [VIII]. To 6<sup>h</sup> p of the next day, Aug. 2, at Babylon there elapsed 24.1<sup>h</sup>. Enter Table G, p. [IX], with Arg.  $\odot = 111.0^\circ, u = 332.4^\circ$ , and find by interpolation the necessary hours, 26.2<sup>h</sup>. With the three Arguments  $\odot, u, I$ , enter Table H, p. [IX], which has four sections, headed with the Argument  $\odot$ . Enter the two sections between which lies the given value of  $\odot$ , here  $111^\circ$ , in this case those headed  $\odot = 60^\circ$  and  $\odot = 120^\circ$ . Find in these two sections with vertical Argument I = 22 and horizontal Argument  $u = 332^\circ$  the two values  $-2.5^h$  (for  $\odot = 60^\circ$ ) and

$-3.1^h$  (for  $\odot = 120^\circ$ ). Then by interpolation for  $\odot = 111^\circ$ , take out the value  $-3.0^h$ . This correction, found from Table H, when added to the value given in Table G (26.2<sup>h</sup>) gives the necessary number of hours which must have elapsed from new moon to 6<sup>h</sup> p for the crescent to become visible. If the number of hours which have actually elapsed is equal to, or greater than, the necessary number of hours, the crescent should have been visible that evening. In this example we have: hours elapsed 24.1<sup>h</sup>, necessary hours 23.2<sup>h</sup>. Therefore the crescent should have been visible on the evening of Aug. 2. Hence the first day of Ab began at that moment (at sunset), or, as we express it, Aug. 3 = Ab 1, reckoning both days by modern civil usage from midnight. For the second crescent the computation proceeds in the same way and gives: crescent visible on Sept. 1 evening, hence Sept. 2 = Ulul 1. The month Ab had, therefore, 30 days, in agreement with the evidence of the contract.

As the longitude  $\odot$  of the Sun and the longitude  $\lambda$  of the Moon are equal at the moment of new moon, we have for both  $110.96^\circ$ . The latitude  $\beta$  of the Moon at the moment of new moon is found from Table F, p. [VIII], which gives with Argument  $u = 332.4^\circ$  the value  $\beta = -2.31^\circ$ . If, as in this case, Argument  $u$  is on the right hand,  $\beta$  is negative. The error of  $\lambda$  and  $\beta$  is  $\pm 0.01^\circ$  only. We can compare these values with the Babylonian computations, which often give  $\lambda$  and  $\beta$  of the Moon for the moment of new moon.<sup>1</sup>

In the two following examples, one crescent has been selected with a small age (March) and one with a great age (September). It is generally sufficient to take T in each table to two decimal places and L to one decimal place only, as in these two examples:

Example 4. Crescent  $-74$  March 3, Bb.

	I.	II.	T.	L.	$\theta$ .
$-75.00$	972	89	733.37	278.8°	80.9°
$0.16$	143	162	59.07	58.2	3.1
$-74.84$	115	251	Tab. A 16	5	84.0
			Tab. B 38	+2.0	339.5°
			<u>792.98</u>	<u>339.5°</u>	<u>64 "</u>

New moon March 2<sup>d</sup> 11.5<sup>h</sup> p Bb.

To March 3<sup>d</sup> 6<sup>h</sup> p there elapsed 18.5<sup>h</sup>.

Visible on March 3 evening.

March 4 = Adar 1.

Necessary hours:  
Table G 19.6<sup>h</sup>  
" H -1.4  
Necessary 18.2

Example 5. Cambyses 7,  $-522$  Sept. 29, Bb.

	I.	II.	T.	L.	$\theta$ .
$-545.22$	892	876	1381.43	194.1°	345.7°
$22.96$	366	961	1081.70	346.3	84.1
$-522.26$	258	837	Tab. A 2	0	69.8
			Tab. B 4	-1.7	178.7°
			<u>2463.19</u>	<u>178.7°</u>	<u>249 "</u>

New moon Sept. 28<sup>d</sup> 4.6<sup>h</sup> a Bb.

To Sept. 29<sup>d</sup> 6<sup>h</sup> p there elapsed 37.4<sup>h</sup>.

Not visible on Sept. 29 evening.

October 1 = Tešrit 1.

Necessary hours:  
Table G 36.9<sup>h</sup>  
" H +0.9  
Necessary 37.8

In this example, by taking a third decimal place in T, we should have obtained for the sum of T 2463.180, giving 4.3<sup>h</sup> a Bb as the time of new moon, from which 37.7<sup>h</sup> elapsed to Sept.

<sup>1</sup> See, for example, KUGLER, *Sternkunde*, Buch ii, Teil 2 (1924), p. 602.

29<sup>d</sup> 6<sup>h</sup> p. The contracted computation is, therefore, confirmed, but the difference between the actual and necessary intervals is reduced from 0.4<sup>h</sup> to 0.1<sup>h</sup>. Where the difference between the two intervals amounts to 0.4<sup>h</sup> or less, it is desirable to repeat the computation with the full number of places given in the tables.

These two examples illustrate the great difference between spring and autumn crescents.

*Note.* The enumeration of years in the Cycle and Period Tables is mathematically accurate except in one respect. There is a leap of one year in the enumeration between  $-1.00$ , the close of the year  $-1$ , and  $+0.00$ , the beginning of the year 0. In consequence for the 23 new moons, which fall in the years 0 and  $+1$  before  $+1.92$ , which appears in the Cycle Table, it is necessary to substitute  $-16.11$  for  $-17.11$  as the year in the Cycle Table, in order to obtain the Period Year and corresponding values correctly.

(c) *Use of Tables M and N (Babylonian Calendar).* These tables are constructed on the same principle as those published in the *Arcus Visionis in the Babylonian Observations*, University Observatory, Oxford, 1924, in *Ammizaduga* (1925), and in *Planeten-Tafeln für Jedermann* (1927), and are accommodated to the system of Babylonian chronology adopted in this work, which was also adopted in *Planeten-Tafeln*, but not in the two earlier publications. The tables attempt to give as accurately as their size permits the beginning of each Babylonian month, having regard to inequalities in the date of that beginning so far as it depends on the season of the year. The first day of the month computed with these tables is in about 75 per cent. of cases identical with the first day astronomically computed. The identity of the calendar month is not so easily represented. From  $-382$  onwards a 19-years cycle was in use and from this date the identity of the months is given with strict accuracy. Before that date intercalation was less systematic, but an attempt has been made to assign to each month its most probable position consistent with the use of tabular form. If in any particular year Nisan is known to have begun earlier or later than the date given in these tables the whole calendar should be shifted by one or two calendar months so as to bring it into its correct position, regard being had to the intercalation of a second Ulul where that is known to have taken place.

*Conversion of Babylonian into Julian Dates.* For this purpose it is necessary to know the Julian year to which the Babylonian year corresponds. A Babylonian year belongs partly to each of two successive Julian years. The first of these should be used. Take the Cycle Year standing next before the given year, and make a mental note of the table value standing opposite to it. The difference between the Cycle Year and the given year is the 'period'. With the period as vertical argument and the name of the Babylonian month as horizontal argument take out the value given in Table M. Sum the values given in the two tables, and add the day of the Babylonian month. Enter Table N with the value thus obtained. The name of the Julian month stands over the next preceding number and the difference between that number and the given value gives the number of the day in the Julian calendar. Thus for Nisan 1 in the first year of Sumuabum =  $-2168/7$ , we have Cycle Year  $-2203$  with Day Number 9, Period 35 with Day Number under Nis. 0,  $105 +$  Day of Month 1. Sum of Day Numbers 115, for which we get from Table N April 24. For the Julian date of Hammurabi 6, Sabat  $28 - 2061/0$ , we have Cycle Year  $-2067$ , Period 6, with Day Numbers  $5 + 26 + 28 = 59 = -2060$  Feb. 28. It will be observed, however, that the tables give for Nisan 1 in the year  $-2061$ , April 11 = March 25 Gregorian, falling 30 days earlier than the date given by conjecture on p. 66. If we wish to adopt the beginning of the year as given on that page, we shall have to take Adar 28 instead of Sabat 28 from the table. We then have  $5 + 55 + 28 = 88 = -2060$  March 28.

Before - 382 Table M is constructed on the hypothesis that the intercalary month is always a second Adar. From that date onwards it was fixed by rule which years should have second Adar and which second Ulul. An asterisk is accordingly placed against each of the last five Cycle Years and an asterisk is also inserted in the column headed Adar b o in those years in which there was a second Ulul. Wherever an asterisk is found against the Cycle Year and also in this column, the name of the Babylonian months from Ulul b to Adar must be taken from the foot, not from the head of the column. Thus for - 274 Ulul b 25 we have Cycle Year - 295\*, Day Number 4, Period 21\*, Ulul b o (at foot), Day Number 988, Day of Month 25, sum 1017 = Oct. 13.

In the Period column the number 17 is printed in heavy type, because, if the intercalations are rightly restored, the Day Numbers to which this period serves as argument will when combined with the Day Numbers standing against the Cycle Year give the mean position of the Babylonian months in the Julian calendar, so long as the Day Number in the Cycle Table holds good. Thus, if it is desired to know the mean position of Nisan 1 from -995 to -928, we add the Day Numbers 3 + 824 + 1 and the sum 828 = April 7 is the mean date of Nisan 1 within that range of years.

*Conversion of Julian into Babylonian Dates.* The Cycle Year and Period are found as before. Find from Table N the Day Number corresponding to the Julian date. Deduct the Day Number corresponding to the Cycle Year. Seek the remainder in the period line. The vertical argument corresponding to the next smaller number gives the name of the month. Deduct this number, and the remainder is the day of the month. Thus for - 1477 June 1, we have Cycle - 1503, Period 26, Day Number 1248. Deduct the Cycle Number 9, and the remainder 1239 is Ayar 29 or Sivan o. The Day Number should always be selected so that when diminished by the Cycle Number it will be found against the period. If the date falls between December 31 Julian and the following Nisan 1, the Period Number will not be that corresponding to the actual Julian year, but to the preceding year in which the Babylonian year begins. Sometimes the Day Number of Table N is too small. In these cases add 1461 days.

*Conversion of Julian into Gregorian Dates and vice versa.* In accordance with astronomical usage the Julian calendar is used throughout these tables except for modern times. But for the benefit

Year.	d.	Year.	d.	Year.	d.
-3700	-29	-1900	-16	-200	-3
3500	28	1800	15	-100	2
3400	27	1700	14	+100	-1
3300	26	1500	13	200	0
3100	25	1400	12	300	+1
3000	24	1300	11	500	2
2900	23	1100	10	600	3
2700	22	1000	9	700	4
2600	21	900	8	900	5
2500	20	700	7	1000	6
2300	19	600	6	1100	7
2200	18	500	5		
2100	17	300	4		

of readers who desire to connect each month with a fixed season of the year the Gregorian calendar has generally been used in the work itself. The difference between the two calendars remains constant for 100 or 200 years at a time. The accompanying table shows the correction in days to be applied to a Julian date to obtain the corresponding Gregorian date. This table indicates that from - 3700 March 1 to - 3500 February 29, a correction of - 29 days must be applied to a Julian date to obtain the Gregorian date. Similarly, from - 2700 March 1 to - 2600 February 29, a correction of - 22 days must be applied. To convert any Julian date in a year not shown in the table into a Gregorian date it is necessary to take the number of days standing in the table against the year coming next before the given date. Thus for 324 B.C. (= - 323) June 9 the next preceding year in the table is - 500, and the correction is - 5.

Therefore - 323 June 9 Julian = - 323 June 9 - 5 Gregorian = June 4 Gregorian. The correction changes on March 1 in years which are leap years in the Julian, but not in the Gregorian, calendar. In these years February 29 should not be included in the number of days added or subtracted. Thus - 1700 March 10 Julian, falling on or after March 1, requires a correction of - 14 days to reduce to the Gregorian calendar. The Gregorian date will be February 28 + 10 - 14 = February 24.

In order to convert from the Gregorian to the Julian calendar apply the given correction in the opposite direction. Thus - 323 June 9 Gregorian = - 323 June 9 + 5 Julian = June 14.

*The Syzygy-Tables for the Planets*

pp. [X]-[XIV]. These give from - 2100 (- 3000 for Venus) to the year 0 and for modern times the following general phenomena: conjunction, opposition, stationary points, greatest elongation, greatest brilliance of Venus, &c. They also give, but only for latitudes + 31.5° to + 33.5°, the heliacal risings and settings and the acronychal risings of the planets. The following nomenclature is used for heliacal phenomena:

e first = first	} visibility in evening.	m first = first	} visibility in morning.
e last = last		m last = last	

These phenomena are computed approximately with an *arcus visionis*  $\gamma$ , shown in the following small table, based on ancient observations and my own observations.

Each planet is treated on a separate page. For all planets there are given a Cycle Table,

<i>Superior Conjunction</i>	m last	e first
Mercury	9.5°	10.5°
Venus	6.0	6.0
<i>Inferior Conjunction</i>	e last	m first
Mercury	11.0	13.0
Venus	5.2	5.7
<i>Conjunction</i>	e last	m first
Mars	13.2	14.5
Jupiter	7.5	9.0
Saturn	10.0	13.0

a Period Table, and Table A. The Cycle and Period Tables, which give mean conjunction and mean opposition, are to be used in the same manner as the corresponding tables for new moon (pp. [I], [II]). Table A gives the transition from mean to true conjunction or opposition. The Babylonians gave also the zodiacal sign of the ecliptic in which such a phenomenon occurred. Accordingly the tables provide the means of computing the longitudes,  $\lambda$ , of Mars, Jupiter, and Saturn, but it should be noted that according to KUGLER the Babylonians from about - 300 to 0 placed the beginning of each sign

about 4° earlier than the established usage would sanction, so that Aries extended along the ecliptic from 356° to 26°, Taurus from 26° to 56°, &c. The time used in these tables is Babylon mean time (Bb) in antiquity, Greenwich mean time (Gr) from + 1904 onwards.

**MERCURY**, p. [X]. Since the synodic period is 115.88 days, about three or four superior conjunctions and three or four inferior conjunctions occur in each year. The interval between superior and inferior conjunction is in the mean 58 days. At Babylon Mercury was visible to the naked eye between superior and inferior conjunction (i.e. from e first to e last) in the evening for an interval varying from about 42 days in spring (Adar to Ayar) to 15 days in autumn (Ulul to Arahsamna). The possibility of the latter is denied by Ptolemy.<sup>1</sup> Between inferior and superior conjunction (i.e. from m first to m last) it was visible in the morning for an interval varying from about 36 days in autumn to 15 days in spring. Here the possibility of the spring visibility is denied by Ptolemy. In more northerly latitudes, e.g. with  $\phi = 51^\circ$ , it is difficult to see Mercury in the evening except in spring, and in the morning except in autumn

<sup>1</sup> *Math. Syn.*, ed. HEIBERG, ii. 602.

(1927 Nov. 28 it was visible about 70<sup>m</sup>). The interval of invisibility at inferior conjunction at Babylon varies between 13 and 41 days.

*Rough Computation.* In -567 Ayar 10 e first is recorded. This falls near superior conjunction. Tables M, N, pp. [XV], [XVI], make Ayar agree roughly with May. Hence we have -567 May = -567.63 (fraction table, p. [I]). Take the next preceding Cycle, -577.44. The difference, 9.81, is the period. In the Period Table for superior conjunction the year 9.84 appears as a period for a superior conjunction. Hence the observation is correct. On -424 Kislev 25 m first is recorded. This falls near inferior conjunction. Tables M, N make Kislev agree roughly with December. For -424.05 we have Cycle -424.36, period 10.31 for inferior conjunction. Hence the observation is correct.

*Accurate Computation.* I select the year -424, fixed by KUGLER as the date of an ephemeris, by myself as that of an observation-tablet, full of heliacal events, of which we should have 24, were not 6 months' observations lost. Mercury is observed 6 times, and we may test by computation whether e last = Kislev 11, m first = Kislev 25 is correct. Both phenomena are near inferior conjunction. Take out from Cycle -424.36 and Period 10.31 for inferior conjunction the quantities I, T, L, and sum I. In all tables for the planets, if I exceeds 400, subtract 400. With I = 42 find in Table A

Example 6.	I.	T.	L.
Cycle -424.36	118	957.2	134.6°
Period 10.31	324	844.0	112.0
Year -424.05	42	Tab. A 5.2	7.7
Dec. 10 <sup>d</sup> 10 <sup>h</sup> a Bb. Inferior conj.	1806.4		254 ⊙
Table C, Arg. ⊙		-8	
		+6	
Dec. 2, e last	1798	= Kislev 9	
Dec. 16, m first	1812	= Kislev 23	

under heading 'Inferior Conjunction' the values 5.2 for T, 7.7° for L and write them under the others. Then sum T and L (circumference 360°). On p. [XIV] Table N gives for T = 1806 the Julian date Dec. 10 for inferior conjunction, time 10<sup>h</sup> a. The longitude ⊙ of the Sun at this moment is 254° (which is also the longitude λ of Mercury). With ⊙ = 254° enter Table C and find there for e last 8<sup>d</sup> to subtract from the T of inferior conjunction (approximately 1806) and 6<sup>d</sup> to add for m first. The result is 1798 = Dec. 2 for e last, 1812 = Dec. 16 for m first, according to Table N, p. [XIV]. We can directly convert the figures 1798 and 1812 into Babylonian dates by means of Table M, pp. [XV], [XVI], diminishing them by 1461, so that we have 337 for e last, 351 for m first. Table M gives the Cycle -447, Day Number 4, and the Period 23. The figures 337, 351, diminished by the Day Number 4, become 333, 347, and give in Period line 23 the Babylonian dates, Kislev 9 for e last<sup>1</sup>, Kislev 23 for m first, one and two days respectively earlier than the observed date. m last and e first are computed in the same manner with the aid of Table B, using the first section of the Period Table headed 'Superior Conjunction'. For m last and e first the days shown in Table B with Arg. ⊙ must be applied to the T of superior conjunction. To show the use of Table D which gives the dates of greatest elongation and stationary points, both connected with inferior conjunction, I select the inferior conjunction

Example 7.	I.	T.
Cycle 1924.20	307	65.9
Period 3.97	186	1448.5
Year 1928.17	93	Tab. A 2.4
Inf. conj. Feb. 24, 7 <sup>h</sup> p Gr		1516.8
Table D, gr. elongation		-16 ev.
		+27 mor.
Gr. elong., east, Feb. 9		1501
" " west, March 23		1544
Inf. conj.		1517
Table D, station.		-10 ev.
		+12 mor.
Stationary points (Feb. 15)		1507
(March 8)		1529

with the aid of Table B, using the first section of the Period Table headed 'Superior Conjunction'. For m last and e first the days shown in Table B with Arg. ⊙ must be applied to the T of superior conjunction. To show the use of Table D which gives the dates of greatest elongation and stationary points, both connected with inferior conjunction, I select the inferior conjunction

<sup>1</sup> Kislev 10 in Babylonian phraseology, because the Babylonian day begins in the evening.

of 1928 Feb. 24, 3<sup>h</sup> p Gr (*Nautical Almanac*). While in antiquity the error is only 2 hours, here in modern times it is 4 hours. The values from Table D are all taken with the Argument I = 93. The agreement with the *Nautical Almanac* is very good in each case. Finally I note that in the Cycle Table the well-known cycle of 13 years is used throughout. The luminosity of Mercury is very variable. It is at its greatest at superior conjunction. See *Planeten-Tafeln*, p. 12, from which the stellar magnitudes of all the planets are easily computed.

**VENUS**, p. [XI]. The synodic period of Venus is 583.921 days. Hence from superior to inferior conjunction the mean interval is 292 days, so that in each year there are usually one superior and one inferior conjunction. The 8-year period of Venus is well known. We have 8 Julian years = 2922<sup>d</sup>, 5 synodic periods = 2919.6<sup>d</sup>, or 2.4<sup>d</sup> less. But 8 Babylonian lunisolar years, including 3 intercalary months, are 2923.5<sup>d</sup>, i. e. 4 days more than 5 synodic periods. From this it follows that in the Julian calendar the date of inferior conjunction recedes by 2.4 days in 8 years, while in the Babylonian calendar (with normal intercalation) it recedes 4 days in 8 years. For example, if in any year inferior conjunction is on May 31, 8 years later it will be on May 29 Julian. If in the former year it is on Ayar 21, it will in the latter be on Ayar 17. There are also the periods of 56, 64, and 120 years. If the last named has expired, the day of the Babylonian month is exactly the same, but the date has receded one month, as from Ayar 21 to Nisan 21.

Alternating cycles of 56 and 64 years have been selected in forming the Cycle Table, to show the similarity in the circumstances affecting heliacal phenomena as well as in those affecting the Babylonian month and day. The actual cycles shown in the Cycle Table have been selected so as to include the dates assigned on four solutions to the first year of Ammizaduga, viz. -1976, 1920, 1856, 1800.

The computation of the two phenomena connected with superior conjunction, viz. m last and e first, is very simple, Venus being invisible in the mean for 60 days at Babylon. For these computations it is sufficient to use one decimal place in T, and to take the sum of T in whole numbers, because in these cases the daily mean change in γ is 0.25° only. For inferior conjunction, i. e. for e last and m first, the conditions are quite different. Here the greatest accuracy is necessary. T must be taken to two decimal places, and the sum of T to one, so that the error in the time of inferior conjunction shall not exceed 3 hours. The interval of invisibility here depends only on the geocentric latitude β of Venus, which varies between +8.5° and -8.5°. The season (i. e. the Arg. ⊙) is of importance only for the distance of e last and m first from inferior conjunction. In the time of Ammizaduga (-1900) for the five different inferior conjunctions in each 8 years' period the intervals of invisibility at Babylon at the five different inferior conjunctions were: in Ayar about 11 days, in Tammuz 17 days, in Ulul 16 days, in Arahsamna 3 days, in Adar 2 days. But these figures change even in 56 and 64 years through the motion of the node of Venus. So I have found that the observation in the sixth year of Ammizaduga: VIII 28/3/IX 1, a reading now confirmed by two copies of the text, is within the 3,000 years from -3000 to 0 possible only in January -1970 and -1914. See *Astronomische Nachrichten* (1924), 5306. At Babylon the stellar magnitude m at the heliacal phenomena is always about -3.2.

*Computation at Superior Conjunction.* Here the daily change in γ is small, and therefore it is not easy to deduce from m last and e first values of the *arcus visionis*. I choose the observation of the twelfth year of Ammizaduga (-1909): I 9/VI 25, or, freed from scribal errors:



II 29/V 5. The compiler or copyist has in the numbers of the months taken for m last one unit too little (I instead of II), and has added this quantity to the number of the month of e first (VI instead of V). By a similar error he has taken two tens too little in the number of the day for m last, and has added these to e first. Afterwards he has found the difference between the false dates of the two phenomena, an interval of invisibility of 5 months 16 days instead of the correct difference, 2 months 6 days. The observation, thus restored, is excellent and with Ammizaduga 5 the best at superior conjunction. Since Ammizaduga 12 begins with Nisan 1 = May 10 Julian, the two Julian dates correspond to Ayar 30 and Ab 6. And since Table B is computed with  $\gamma = 6.0^\circ$ , it is an easy matter to find the Babylonian  $\gamma$  of observation, adding or subtracting for each day  $0.25^\circ$ .

<i>Example 8.</i>	I.	T.	L.
Cycle -1920-59	219	147.5	45.9°
Period 11.19	76	1165.5	68.8
Year -1909.40	295	Tab. A 0.6	0.6
Sup. conj., Aug. 5, 2 <sup>h</sup> p Bb		1313.6	115.3°
		Tab. B -30	
		Arg. ⊙ +35	
Table N, p. [xiv]	m last July 7	1284 = Ayar 30	
	e first Sept. 10	1349 = Ab 6	

*Computation at Inferior Conjunction.* Here the daily change in  $\gamma$  is great, sometimes as much as  $2^\circ$ , and the computation requires a corresponding degree of accuracy. If a tablet gives the interval of invisibility between e last and m first, the correct year can be quickly found. For example, in Ammizaduga 6, -1915/14 there is given the well-known interval of 3 days' invisibility. The season is about the end of December (end of Arahšamna). In the accompanying small table there are shown for all five solutions the year Ammizaduga 6, the Period of the Period Table (for inferior conjunction), ⊙, and the interval of invisibility in days. For No. 2 the computation proceeds as follows: Take out the Cycle -1920-59 and the corresponding value of L in degrees, increased by  $7^\circ$ , here  $53^\circ$ . Add the L of the period 5.60, here  $214^\circ$ . The sum is  $\odot = 267^\circ$ . The same procedure should be adopted with the other solutions. In Table C with Arg. ⊙ the first column shows approximately the necessary interval of invisibility in days. Only solutions 1 and 2 are possible, because in the other solutions the necessary interval is greater than the observed interval of 3 days. Hence only -1971 or -1915 can be Ammizaduga 6. The computation is not quite correct, because the secular variation of Table C has been neglected. As an example of accurate computation I select the inferior conjunction of Ammizaduga 16 = -1905, where the recorded dates are e last Tammuz 5, m first Tammuz 20. Tables M, N, pp. [XV], [XVI], give for Tammuz 1 in this year July 24. But the new moon occurred July 21, 8.4<sup>h</sup> p, whence Tammuz 1 = July 23 civil. See Crescent Tables. The computation gives e last July 26 = Tammuz 5 (not Tammuz 4, because in the evening Tammuz 5 had already begun); m first Aug. 13 = Tammuz 22. e last is in agreement with observation, but m first was observed two days earlier,  $\gamma$  being  $4.3^\circ$ , while my tables give the morning where  $\gamma = 5.7^\circ$ .  $\gamma = 4.3^\circ$  is an exceptionally successful observation. For an accurate computation of  $\gamma$  see *Planeten-Tafeln*, xxxiv. It should be noted that in Table A we must regard the secular variation of T, which is given for units of 1,500 years reckoned from -1500. Thus for the year 0 we should have with Arg. I = 34 the variation -5, and for the year +1930 about -11. Both these are expressed in units of 0.01 of T. After finding the time T

No.	Year.	Period.	⊙	Int.
1	-1971.0	5.60	283°	2 <sup>d</sup>
2	1915.0	5.60	267	3
3	1851.0	5.60	249	6
4	1803.0	53.56	236	7
5	1795.0	5.60	232	9

interval of invisibility in days. Only solutions 1 and 2 are possible, because in the other solutions the necessary interval is greater than the observed interval of 3 days. Hence only -1971 or -1915 can be Ammizaduga 6. The computation is not quite correct, because the secular variation of Table C has been neglected. As an example of accurate computation I select the inferior conjunction of Ammizaduga 16 = -1905, where the recorded dates are e last Tammuz 5, m first Tammuz 20. Tables M, N, pp. [XV], [XVI], give for Tammuz 1 in this year July 24. But the new moon occurred July 21, 8.4<sup>h</sup> p, whence Tammuz 1 = July 23 civil. See Crescent Tables. The computation gives e last July 26 = Tammuz 5 (not Tammuz 4, because in the evening Tammuz 5 had already begun); m first Aug. 13 = Tammuz 22. e last is in agreement with observation, but m first was observed two days earlier,  $\gamma$  being  $4.3^\circ$ , while my tables give the morning where  $\gamma = 5.7^\circ$ .  $\gamma = 4.3^\circ$  is an exceptionally successful observation. For an accurate computation of  $\gamma$  see *Planeten-Tafeln*, xxxiv. It should be noted that in Table A we must regard the secular variation of T, which is given for units of 1,500 years reckoned from -1500. Thus for the year 0 we should have with Arg. I = 34 the variation -5, and for the year +1930 about -11. Both these are expressed in units of 0.01 of T. After finding the time T

of inferior conjunction enter Table C with Arg. ⊙ =  $116.3^\circ$ . The table gives about 16.3 days as the interval of invisibility. This table also is constructed for the year -1500. Find by interpolation with Arg. ⊙ the values of T for e last and m first and add algebraically to them the small variation found in correction T under the headings -3000, -1500, 0. Write the sums under the T of inferior conjunction. The result is: e last (Table N, p. [XIV]) July 27<sup>d</sup> 2<sup>h</sup> p or July 26 evening; m first Aug. 12<sup>d</sup> 10<sup>h</sup> p or Aug. 13 morning. Observe that in Table C the T of m first is not always positive. If ⊙ is between  $300^\circ$  and  $350^\circ$ , it is negative, as also is e last, so that e last and m first both fall before inferior conjunction.

*Example 9.*

	I.	T.	L.
Cycle -1920-59	219	147.51	45.9°
Period 15.19	75	1164.26	67.6
Year -1905.40	294	Tab. A 2.81	2.8
Inf. conj., Aug. 6 <sup>d</sup> 2 <sup>h</sup> p Bb		1314.6	116.3°
		-10.0	
		+6.3	
Table C	-9.9	+6.3	e last 1304.6 = July 27
Correct.	-0.1	0.0	m first 1320.9 = Aug. 12
	-10.0	+6.3	

To illustrate the use of Table D, I select the inferior conjunction of +1934 Feb. 5, which is very interesting. With ⊙ =  $316^\circ$  I find from Table C that Venus is invisible at Babylon one day only, but at places in  $38^\circ$  terrestrial latitude she does not disappear. At latitude  $43^\circ$  she is both morning and evening star for one day, at  $48^\circ$  for two days, and at  $53^\circ$  for three days, the m first lying considerably before inferior conjunction. The greatest brilliance occurs on the evening of 1933, December 31, with stellar magnitude  $m = -4.4$  (*Planeten-Tafeln* give  $m = -4.44$ ), so that Venus on that day should be easily visible in the middle of the day to an observer who knows her approximate place in the sky.

*Example 10.*

	I.	T.	L.
Cycle 1920-50	199	180.18	93.9°
Period 13.59	235	580.33	212.1
Year 1934.09	34	6.90	10.0
		Var. -11	316.0°
Inf. conj., Feb. 5, 7 <sup>h</sup> a Gr		767.3	
Table D, Arg. I, gr. elong.		-72	Brill. Station.
		+70	767 767
Gr. elong. east, ev. Nov. 25		695	-36 -21
" " west, mor. Apr. 16		837	+35 +19
Greatest brilliance, Dec. 31			ev. 731 746 ev.
" " March 12			mor. 802 786 mor.
Stationary points {	Jan. 15		
	Feb. 24		

**MARS, p. [XII].** The cycles used in the Cycle Table are of 47 and 79 years, so as to keep the value of I in this table as close as possible to 0. The construction of Tables A and C was rendered extremely difficult by the great eccentricity of the planet's orbit and its proximity to the Earth at opposition. For these reasons and because of the length of the synodic period (779.94 days =  $2\frac{1}{2}$  years) it can be understood that the Babylonians took little notice of the heliacal phenomena of this planet and that the dates given for these phenomena in their ephemerides can be affected by large errors. As Table C shows in the column headed 'Interval', Mars can be invisible from e last to m first about 210 days at Babylon, while in our northern latitudes this interval can exceed 300 days. Now the  $\gamma$  of Mars changes sometimes by only  $0.05^\circ$  daily, so that Table C can give only a good approximation for e last and m first at Babylon. For all three outer planets the conjunction must be computed with Period Table and Table A if e last and m first are required, while the opposition must be computed with the same tables if the stationary points (Table B) are required. One of the stationary points (a) lies before opposition, the other (b) after opposition. Between a and b the planet is retrograde. At conjunction the Sun has the same longitude as the planet. Hence  $\lambda = \odot$ . At opposition  $\lambda = \odot \pm 180^\circ$ . To find in which sign of the zodiac e last or m first occurs apply to  $\lambda$  of conjunction the number of degrees shown

in Table C. For the longitude of the stationary points, Table B gives the correction to be applied to longitude of opposition, positive for point a and negative for point b.

Example 11.		I.	T.	L.
Cycle	-459.45	4	543.4	90.4
Period	35.23	293	1181.0	84.2
Year	-424.22	297	8.4	4.9
Conjunction, Sept. 27, 7 <sup>h</sup> p				
		1732.8	179.5	0, λ
Table C, Arg. 0		-66	-44	
		+49	+37	
Tammuz 25, e last		1667	136° = Leo	
Arahsamna 22, m first		1782	217° = Scorpius	

Cambyses 7, -522, e last observed on Ayar 28; computation gives Sivan 4.

In the Period Table for opposition there is a column which gives the stellar magnitude  $m$  for the moment of opposition, here -1.5. Mars reaches

Example 12. Mars opposition 1928 Dec. 21 <sup>d</sup> 2 <sup>h</sup> p Gr				
	I.	T.	L.	
Cycle	1924.64	395	209.2	126.2°
Period	4.27	108	98.9	97.5
Year	1928.91	103	48.3	45.3
356.4				
269.0 0				
Table B, Arg. I		-39	89.0 λ	
		+37	+2° β	
Stationary point a, 1928 Nov. 12		317	-1.5 $m$	
" " b, 1929 Jan. 27		393		
So also <i>Nautical Almanac</i> .				

Since the synodic period is 398.88 days all phenomena occur about 34 days later each year than in the preceding year of the Julian calendar, or in the absence of an intercalary month 45

Example 13. -386 opposition, stationary points.

	I.	T.	L.	
Cycle	-445.32	3	1337.5	152.4°
Period	58.97	389	1085.7	350.6
Year	-386.35	392	8.5	5.5
Opposition, Aug. 27, 5 <sup>h</sup> p Bb				
		2431.7	148.5 0	
Table B, stationary points		-59	328.5 λ	
		+59	+5.0	
Station a, June 29 = Sivan 30		2372	333.5° a	
" b, Oct. 25 = Tešrit 29		2490	323.5 b	
Acron. rising = 2429 = Aug. 25, Ab 27.				

is 328.5°, that of stationary point a = 333.5° (Pisces), that of stationary point b = 323.5° (Aquarius). Here the Babylonian dates are converted roughly (error one day) by Table M, p. [XV]. For the accurate date compute the crescent.

In the example of -424 the e last was observed on Kislev 7. The longitude λ of e last is about 257°, that of m first 263°, both in Sagittarius.

Artaxerxes 40, -424, e last observed on Tammuz 22, m first on Arahsamna 18. Computation gives Tammuz 25 and Arahsamna 22. The latter date is received as follows: The Day Number is 1782 - 1461 = 321. Table M, p. [XV], gives Cycle -447 with Day Number 4, and Period 23.

321 minus Day Number of Cycle is 317, which gives in period-line 23, Arahsamna 22.

Mars reaches  $m = -2.8$  at the oppositions of 1924 and 2003 only. The last column gives a very rough value of the geocentric latitude β at opposition.  $m$  in the Period Table for conjunction is the stellar magnitude at e last and m first for Babylon.

**JUPITER**, p. [XIII]. Cycles of 83 and 12 years are used so as to keep the value of I in the Cycle Table close to 0. To avoid errors of one day the great long-period inequality is included in the Cycle Tables of Jupiter and Saturn.

Since the synodic period is 398.88 days all phenomena occur about 34 days later each year than in the preceding year of the Babylonian calendar. Thus, if in any year e last falls on Nisan 1, it will fall in the next year about Ayar 17. The interval of invisibility at conjunction between e last and m first is for Babylon 28 to 34 days. See Table C. The acronychal rising lies about three days before opposition. In the example of -386 the Babylonians give the acronychal rising correctly, but, as might be expected, their stationary points are very inaccurate. The stellar magnitude at the moment of opposition is  $m = -2.4$ . The geocentric longitude λ at opposition

In the example of 1928 the *Nautical Almanac* gives the same dates. For modern times the heliacal phenomena also can be computed for Babylon, but the results, except in the case of

Example 14. -424 conjunction, e last, m first.

	I.	T.	L.	
Cycle	-445.32	3	1337.5	152.4°
Period	21.30	318	473.2	106.6
Year	-424.02	321	0.9	0.6
Conjunction, Dec. 15 <sup>d</sup> 2 <sup>h</sup> p				
		1811.6	259.6 0, λ	
Table C				
		-14	-3	
		+14	+3	
e last, Dec. 1 = Kislev 8		1797	257°	
m first, Dec. 30 = Tebet 7		1826	263°	

Modern time, 1928 opposition.

	I.	T.	
Cycle	1904.79	12	282.5
Period	24.03	10	9.4
Year	1928.82	22	11.0
Opposition, Oct. 28 <sup>d</sup> 10 <sup>h</sup> p Gr 302.9			
Stat. points, Aug. 30, Dec. 26.			

Venus, will not be accurate, because for these phenomena the Tables are only correct from -2000 to the year 0.

**SATURN**, p. [XIV]. Cycles of 59 and 58 years are used. Since the synodic period is 378.09 days all phenomena recur about 13 days later in the Julian and about 24 days later in the Babylonian calendar than in the previous year.

Example 15. -134 e last, m first.

	I.	T.	L.	
Cycle	-178.12	1	1042.5	224.6°
Period	43.99	197	1458.9	358.3
Year	-134.13	198	10.9	8.2
Conjunction, Nov. 16 <sup>d</sup> 7 <sup>h</sup> a				
		2512.3	231.1 0, λ	
		-17	-2	
		+15	+3	
e last, Tešrit 29		2495	229° e last	
m first, Kislev 3		2527	234° m first	

We have few Babylonian observations of Saturn, but more than of Mars. Invisibility at conjunction lasts at Babylon from 31 to 45 days. See Table C. The stellar magnitude at opposition varies greatly.

For -134 the Babylonians give e last Arahsamna 4, m first Kislev 4. They could see the planet 4 days longer in the evening than the tables imply. But the adopted value of  $\gamma =$

10.0° agrees well with other observations.

*Note.* Where the greatest accuracy is required, compute the crescent and determine the Babylonian day as beginning at sunset. Then, except for e last, m first of Venus, where these tables are sufficient, make the computation for the heliacal phenomena of the planets with the help of the *Planeten-Tafeln*, xxxiv, where several examples are given. These tables can be used without any knowledge of astronomy.

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## TABLES

CYCLE TABLE.

Table with columns: Day of Month, Fraction of Year, Year, I, II, T, L, S, MT. Contains data for years 1949-1958, including sub-sections for Dabylon, Midnight, and Greenwich Meridian.

PERIOD TABLE FOR NEW MOON.

Table with columns: Year, I, II, T, L, S, MT. Multiple columns for years 1949-1958. Contains data for various lunar cycles and periods.

Be the year and its fraction are in heavy type a solar eclipse visible at Babylon is possible.

NEW MOON. TABLE A.

VALUES OF T.

I	VALUES OF T.																													
	0	25	50	75	100	125	150	175	200	225	250	275	300	325	350	375	400	425	450	475	500	525	550	575	600	625	650	675	700	
0	425	423	421	419	416	414	413	413	413	413	413	414	414	415	415	415	415	416	416	417	417	418	418	419	419	420	420	421	421	422
10	402	400	398	396	394	393	391	390	389	389	389	390	390	391	391	392	392	393	393	394	394	395	395	397	397	398	398	399	399	400
20	378	376	374	372	371	369	368	367	366	366	366	367	367	368	368	369	369	370	370	371	371	372	372	373	373	374	374	375	375	376
30	355	353	351	349	347	346	344	343	343	343	344	344	345	345	346	346	347	347	348	348	349	349	350	350	351	351	352	352	353	353
40	332	330	328	326	323	322	321	320	319	319	319	320	320	321	321	322	322	323	323	324	324	325	325	327	327	328	328	329	329	330
50	309	307	305	304	302	300	299	298	297	297	296	296	297	297	298	298	299	299	300	300	301	301	302	302	303	303	304	304	305	305
60	287	285	283	281	280	278	277	276	275	274	274	274	275	275	276	277	277	278	278	279	280	280	281	281	282	282	283	283	284	284
70	265	263	261	260	258	256	255	254	253	252	252	252	253	253	254	254	255	255	256	256	257	257	258	258	259	259	260	260	261	261
80	243	242	240	238	237	235	234	233	232	231	231	231	231	232	232	233	233	234	234	235	235	236	237	237	238	238	239	239	240	240
90	222	221	219	217	216	214	213	212	211	210	210	210	211	211	212	212	213	213	214	214	215	215	216	216	217	217	218	218	219	219
100	202	201	199	197	196	194	193	192	191	190	190	190	191	191	192	192	193	193	194	194	195	195	196	196	197	197	198	198	199	199
110	183	181	180	178	177	175	174	173	172	171	171	171	171	172	172	173	173	174	174	175	175	176	176	177	177	178	178	179	179	180
120	164	162	161	159	158	156	155	154	153	152	152	152	153	153	154	154	155	155	156	156	157	157	158	158	159	159	160	160	161	161
130	146	145	143	142	140	139	138	137	136	135	135	135	136	136	137	137	138	138	139	139	140	140	141	141	142	142	143	143	144	144
140	129	128	126	125	124	122	121	120	119	119	118	118	118	118	119	119	120	120	121	121	122	122	123	123	124	124	125	125	126	126
150	113	112	110	109	108	107	106	105	104	103	103	102	102	102	103	103	104	104	105	105	106	106	107	107	108	108	109	109	110	110
160	98	97	96	94	93	92	91	90	89	88	88	88	88	88	88	89	89	89	89	90	90	91	91	92	92	93	93	94	94	95
170	84	83	82	81	80	79	77	77	76	75	75	75	75	75	76	76	76	77	77	78	78	79	79	80	80	81	81	82	82	83
180	71	70	68	67	67	66	65	64	63	63	63	62	62	62	63	63	64	64	65	65	66	66	67	67	68	68	69	69	70	70
190	60	59	58	57	56	56	55	54	53	53	53	52	52	52	52	53	53	54	54	55	55	56	56	57	57	58	58	59	59	60
200	50	49	48	47	46	46	45	44	43	43	43	42	42	42	43	43	44	44	45	45	46	46	47	47	48	48	49	49	50	50
210	41	41	40	39	38	38	37	36	36	35	35	34	34	34	34	34	35	35	36	36	37	37	38	38	39	39	40	40	41	42
220	34	33	33	32	31	31	30	29	28	28	27	27	27	27	27	28	28	29	29	30	30	31	31	32	32	33	33	34	34	35
230	28	27	27	26	25	25	24	23	23	23	22	22	22	22	22	23	23	24	24	25	25	26	26	27	27	28	28	29	30	31
240	24	23	23	22	22	21	21	20	19	19	18	18	18	18	18	18	19	19	19	20	20	21	21	21	21	21	22	22	23	24
250	21	21	20	20	19	19	18	18	18	17	17	17	17	17	17	18	18	18	19	19	20	20	20	20	20	20	21	21	22	23
260	19	19	19	19	19	18	18	18	17	17	17	17	17	17	17	17	18	18	18	19	19	19	19	19	19	19	20	20	21	22
270	20	20	20	20	20	20	20	19	19	19	19	19	19	18	18	18	18	19	19	19	20	20	20	20	20	20	20	21	21	22
280	22	22	22	22	22	22	22	22	22	21	21	21	21	21	21	21	21	22	22	22	23	23	23	23	23	23	24	24	25	26
290	25	25	25	25	25	25	25	24	24	24	24	24	24	24	24	24	24	25	25	25	26	26	26	26	26	26	26	27	27	28
300	31	31	32	32	32	32	32	32	32	32	32	32	32	31	31	31	31	31	31	31	32	32	32	32	32	32	33	33	34	35
310	37	37	38	39	40	40	40	40	40	40	40	39	39	38	38	37	37	37	37	37	38	38	38	38	38	38	38	39	39	40
320	46	47	48	48	49	49	49	50	50	50	50	49	49	48	48	47	46	45	44	43	42	41	40	40	40	39	39	39	39	40
330	56	57	58	59	60	60	61	61	61	61	60	60	60	60	60	60	60	60	60	60	61	61	61	61	61	61	61	61	62	63
340	68	69	70	71	72	73	73	73	73	73	73	72	72	71	70	69	68	67	66	65	64	63	62	61	60	60	60	60	60	61
350	82	83	84	85	86	87	87	88	88	88	87	87	86	85	84	83	82	81	80	78	77	76	75	74	73	73	73	73	74	75
360	97	98	99	100	101	102	103	103	104	104	103	103	103	102	101	100	99	97	96	95	94	92	91	90	89	88	87	87	87	
370	113	115	116	117	118	119	120	120	121	121	121	120	120	119	118	117	116	114	113	112	110	109	107	106	105	104	103	103	103	
380	131	133	134	135	136	137	138	139	139	140	139	139	139	138	137	136	134	133	131	130	128	127	125	124	123	122	121	120	120	
390	150	152	154	155	156	157	158	159	159	160	160	159	159	158	157	156	154	153	151	150	148	146	145	143	142	141	140	139	139	
400	171	173	174	176	177	178	179	180	181	181	181	181	181	180	179	178	177	175	174	172	170	169	167	165	164	162	161	160	159	
410	193	194	196	198	199	201	202	203	203	203	203	202	201	200	199	198	196	194	192	191	189	187	185	184	183	182	181	180	179	
420	216	218	219	221	223	224	225	226	227	227	227	226	225	224	223	221	219	218	216	214	212	210	208	207	205	204	203	202	201	
430	239	241	243	245	247	248	249	250	251	251	251	250	249	248	247	246	244	242	240	238	236	234	232	231	229	228	227	227	227	
440	264	266	268	270	272	273	274	275	276	276	276	276	275	274	272	271	269	267	265	263	261	259	257	255	254	253	252	251	250	
450	290	292	294	296	298	299	300	301	302	302	302	302	301	300	298	297	295	293	291	289	286	284	283	281	279	278	277	276	276	
460	316	318	320	322	324	326	327	328	329	329	329	328	328	328	327	327	326	325	323	321	319	317	315	313	311	309	307	306	304	
470	343	345	347	349	351	352	353	354	355	355	355	354	353	352	350	348	346	344	342	340	338	336	334	332	331	329	327	326	324	
480	370	372	374	376	378	380	381	382	383	383	383	382	381	379	378	376	374	372	370	367	365	363	361	359	357	355	353	351	349	
490	397	399	402	404	406	407	409	410	411	411	411	410	409	407	405	403	401	399	397	395	393									

NEW MOON. TABLE A—CONTINUED.

VALUES OF T.

Table with columns labeled I, 0, 25, 50, 75, 100, 125, 150, 175, 200, 225, 250, 275, 300, 325, 350, 375, 400, 425, 450, 475, 500, 525, 550, 575, 600, 625, 650, 675, 700. Rows contain numerical values for T.

Unit of T = 0.001.

P.P.

Small table with columns labeled 12, 13, 14, 15 and 16, 17, 18, 19, and 21, 22, 23, 24. Rows contain numerical values for P.P.

NEW MOON. TABLE A—CONTINUED.

VALUES OF L.

Table with columns labeled I, 725, 750, 775, 800, 825, 850, 875, 900, 925, 950, 975, 1000. Rows contain numerical values for L.

Unit of L = 0.01.

Small table with columns labeled 25, 26, 27, 28. Rows contain numerical values for L.

TABLE A (continued). Arg. 1-500 to 1000.

NEW MOON. TABLE B.

Table with columns for Year (1900-2000) and L (0-2000) for New Moon. Includes sub-tables for T and L.

Unit of T = 0.1001.

NEW MOON. TABLE B.

Table with columns for Year (1900-2000) and L (0-2000) for New Moon. Includes sub-tables for T and L.

Unit of T = 0.1001.

TABLE C.

Conversion of the days of T into Julian months and days.

Table with columns for months (Jan-Dec) and Julian months/days.

TABLE D.

Conversion of decimals of T into hours and minutes.

Table with columns for hours and minutes (0-60).

TABLE E.

Correction to the Babylonian time of new moon.

Table with columns for location (Greenwich, Rome, Athens, etc.) and time correction.

TABLE F.

Latitude beta of the moon at the moment of new moon.

Table with columns for location (Greenwich, Rome, Athens, etc.) and latitude beta.

If the Argument w is on the right hand the lower sign of beta is to be used.

TABLE G. Transition from New Moon to Crescent at Babylon.

Hours which must elapse from New Moon to 6 p.m. on day of appearance of Crescent.

0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	0
0	19	4	19	4	19	4	19	4	19	4	19	4	19	4	19	4	19	4	19	4	19	4	19	4	19	4
10	19	1	19	1	19	1	19	1	19	1	19	1	19	1	19	1	19	1	19	1	19	1	19	1	19	1
20	19	1	19	1	19	1	19	1	19	1	19	1	19	1	19	1	19	1	19	1	19	1	19	1	19	1
30	18	19	0	19	1	19	1	19	1	19	1	19	1	19	1	19	1	19	1	19	1	19	1	19	1	30
40	18	1	18	1	18	1	18	1	18	1	18	1	18	1	18	1	18	1	18	1	18	1	18	1	18	1
50	18	4	18	4	18	4	18	4	18	4	18	4	18	4	18	4	18	4	18	4	18	4	18	4	18	4
60	18	3	18	3	18	3	18	3	18	3	18	3	18	3	18	3	18	3	18	3	18	3	18	3	18	3
70	18	2	18	2	18	2	18	2	18	2	18	2	18	2	18	2	18	2	18	2	18	2	18	2	18	2
80	18	1	18	1	18	1	18	1	18	1	18	1	18	1	18	1	18	1	18	1	18	1	18	1	18	1
90	18	1	18	1	18	1	18	1	18	1	18	1	18	1	18	1	18	1	18	1	18	1	18	1	18	1
100	18	1	18	1	18	1	18	1	18	1	18	1	18	1	18	1	18	1	18	1	18	1	18	1	18	1
110	18	1	18	1	18	1	18	1	18	1	18	1	18	1	18	1	18	1	18	1	18	1	18	1	18	1
120	19	1	19	1	19	1	19	1	19	1	19	1	19	1	19	1	19	1	19	1	19	1	19	1	19	1
130	19	1	19	1	19	1	19	1	19	1	19	1	19	1	19	1	19	1	19	1	19	1	19	1	19	1
140	20	1	20	1	20	1	20	1	20	1	20	1	20	1	20	1	20	1	20	1	20	1	20	1	20	1
150	20	1	20	1	20	1	20	1	20	1	20	1	20	1	20	1	20	1	20	1	20	1	20	1	20	1
160	21	1	21	1	21	1	21	1	21	1	21	1	21	1	21	1	21	1	21	1	21	1	21	1	21	1
170	21	1	21	1	21	1	21	1	21	1	21	1	21	1	21	1	21	1	21	1	21	1	21	1	21	1
180	22	1	22	1	22	1	22	1	22	1	22	1	22	1	22	1	22	1	22	1	22	1	22	1	22	1
190	22	1	22	1	22	1	22	1	22	1	22	1	22	1	22	1	22	1	22	1	22	1	22	1	22	1
200	22	1	22	1	22	1	22	1	22	1	22	1	22	1	22	1	22	1	22	1	22	1	22	1	22	1
210	22	1	22	1	22	1	22	1	22	1	22	1	22	1	22	1	22	1	22	1	22	1	22	1	22	1
220	23	1	23	1	23	1	23	1	23	1	23	1	23	1	23	1	23	1	23	1	23	1	23	1	23	1
230	23	1	23	1	23	1	23	1	23	1	23	1	23	1	23	1	23	1	23	1	23	1	23	1	23	1
240	21	1	21	1	21	1	21	1	21	1	21	1	21	1	21	1	21	1	21	1	21	1	21	1	21	1
250	21	1	21	1	21	1	21	1	21	1	21	1	21	1	21	1	21	1	21	1	21	1	21	1	21	1
260	20	1	20	1	20	1	20	1	20	1	20	1	20	1	20	1	20	1	20	1	20	1	20	1	20	1
270	20	1	20	1	20	1	20	1	20	1	20	1	20	1	20	1	20	1	20	1	20	1	20	1	20	1
280	19	1	19	1	19	1	19	1	19	1	19	1	19	1	19	1	19	1	19	1	19	1	19	1	19	1
290	19	1	19	1	19	1	19	1	19	1	19	1	19	1	19	1	19	1	19	1	19	1	19	1	19	1
300	19	1	19	1	19	1	19	1	19	1	19	1	19	1	19	1	19	1	19	1	19	1	19	1	19	1
310	19	1	19	1	19	1	19	1	19	1	19	1	19	1	19	1	19	1	19	1	19	1	19	1	19	1
320	19	1	19	1	19	1	19	1	19	1	19	1	19	1	19	1	19	1	19	1	19	1	19	1	19	1
330	19	1	19	1	19	1	19	1	19	1	19	1	19	1	19	1	19	1	19	1	19	1	19	1	19	1
340	19	1	19	1	19	1	19	1	19	1	19	1	19	1	19	1	19	1	19	1	19	1	19	1	19	1
350	19	1	19	1	19	1	19	1	19	1	19	1	19	1	19	1	19	1	19	1	19	1	19	1	19	1
360	19	1	19	1	19	1	19	1	19	1	19	1	19	1	19	1	19	1	19	1	19	1	19	1	19	1
0	70	60	50	40	30	20	10	0	350	340	330	320	310	300	290	280	270	260	0	0	0	0	0	0	0	0

TABLE H. Correction in hours.

I	0°			60°			120°			180°			I
	90°	180°	270°	90°	180°	270°	90°	180°	270°	90°	180°	270°	
975	-2.2	-2.5	-2.5	-2.2	-2.6	-2.9	-2.3	-3.2	-3.8	-2.4	-3.5	-4.4	975
0	-2.2	-2.5	-2.5	-2.2	-2.6	-2.8	-2.3	-3.1	-3.7	-2.4	-3.4	-4.3	950
25	-2.1	-2.4	-2.4	-2.1	-2.5	-2.6	-2.2	-2.9	-3.5	-2.3	-3.2	-4.1	925
50	-1.9	-2.2	-2.2	-1.9	-2.3	-2.4	-2.1	-2.7	-3.3	-2.2	-2.9	-3.8	900
75	-1.7	-2.0	-2.0	-1.7	-2.1	-2.2	-1.9	-2.5	-3.0	-2.0	-2.6	-3.3	875
100	-1.5	-1.7	-1.7	-1.5	-1.8	-1.9	-1.6	-2.2	-2.6	-1.7	-2.3	-2.8	850
125	-1.2	-1.4	-1.4	-1.2	-1.5	-1.6	-1.3	-1.8	-2.2	-1.4	-1.9	-2.3	825
150	-0.9	-1.1	-1.1	-0.9	-1.2	-1.2	-1.0	-1.4	-1.8	-1.1	-1.5	-1.8	800
175	-0.6	-0.7	-0.7	-0.6	-0.8	-0.8	-0.7	-0.9	-1.2	-0.8	-1.0	-1.3	775
200	-0.3	-0.4	-0.4	-0.3	-0.4	-0.4	-0.4	-0.5	-0.6	-0.4	-0.5	-0.7	750
225	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	725
250	+0.4	+0.4	+0.5	+0.4	+0.5	+0.5	+0.4	+0.5	+0.6	+0.5	+0.6	+0.7	700
275	+0.8	+0.8	+0.9	+0.8	+0.9	+1.0	+0.8	+1.0	+1.2	+0.9	+1.1	+1.4	675
300	+1.2	+1.2	+1.3	+1.2	+1.3	+1.4	+1.2	+1.5	+1.7	+1.3	+1.7	+2.0	650
325	+1.5	+1.6	+1.7	+1.5	+1.7	+1.8	+1.6	+1.9	+2.2	+1.7	+2.2	+2.6	625
350	+1.8	+1.9	+2.0	+1.8	+2.1	+2.1	+1.9	+2.3	+2.7	+2.1	+2.6	+3.1	600
375	+2.1	+2.2	+2.3	+2.1	+2.4	+2.4	+2.2	+2.7	+3.2	+2.4	+3.0	+3.6	575
400	+2.3	+2.4	+2.5	+2.3	+2.6	+2.7	+2.4	+3.0	+3.6	+2.6	+3.4	+4.0	550
425	+2.5	+2.6	+2.7	+2.5	+2.8	+3.0	+2.6	+3.3	+4.0	+2.8	+3.7	+4.4	525
450	+2.7	+2.8	+2.9	+2.7	+3.0	+3.2	+2.8	+3.5	+4.2	+3.0	+3.9	+4.7	500
475	+2.8	+2.9	+3.0	+2.8	+3.1	+3.3	+2.9	+3.6	+4.3	+3.1	+4.0	+4.8	475
I	90	360	270	0	360	270	90	360	270	0	360	270	I

MERCURY.

CYCLE TABLE.

Year	I	T	L	Year	I	T	L
-2099	11	150	607	8	138	1	14
-2081	11	153	975	8	141	1	17
-2073	30	156	1343	7	144	1	20
-2060	49	159	1757	6	147	1	23
-2047	29	161	2187	5	150	1	26
-2034	28	164	2646	4	153	1	29
-2021	27	167	3134	3	156	1	32
-2008	27	170	3651	2	159	1	35
-1995	26	173	4197	1	162	1	38
-1982	25	176	4774	0	165	1	41
-1969	24	179	5382	9	168	1	44
-1956	24	182	6021	8	171	1	47
-1943	23	184	6691	7	174	1	50
-1930	22	187	7392	6	177	1	53
-1917	21	190	8124	5	180	1	56
-1904	21	193	8887	4	183	1	59
-1891	20	196	9682	3	186	1	62
-1878	19	199	10509	2	189	1	65
-1865	18	202	11368	1	192	1	68
-1852	18	205	12259	0	195	1	71
-1839	17	208	13182	9	198	1	74
-1826	16	211	14137	8	201	1	77
-1813	15	213	15124	7	204	1	80
-1800	15	216	16143	6	207	1	83
-1787	14	219	17194	5	210	1	86
-1774	13	222	18277	4	213	1	89
-1761	12	224	19392	3	216	1	92
-1748	12	227	20539	2	219	1	95
-1735	11	230	21718	1	222		



VENUS.

MARS.

CYCLE TABLE.

PERIOD TABLE.

TABLE A.

CYCLE TABLE.

PERIOD TABLE.

TABLE B.

Table with columns Year, I, T, L. Contains data for Venus cycles from 1909-70 to 1920-50.

Table with columns Year, I, T, L. Contains data for Venus conjunctions and oppositions from 1909-70 to 1920-50.

Table with columns Year, I, T, L. Contains data for Venus conjunctions and oppositions from 1909-70 to 1920-50.

Table with columns Year, I, T, L. Contains data for Venus conjunctions and oppositions from 1909-70 to 1920-50.

Table with columns Year, I, T, L. Contains data for Venus conjunctions and oppositions from 1909-70 to 1920-50.

Table with columns Year, I, T, L. Contains data for Venus conjunctions and oppositions from 1909-70 to 1920-50.

Table with columns Year, I, T, L. Contains data for Venus conjunctions and oppositions from 1920-50 to 1930-20.

Table with columns Year, I, T, L. Contains data for Venus conjunctions and oppositions from 1920-50 to 1930-20.

Table with columns Year, I, T, L. Contains data for Venus conjunctions and oppositions from 1920-50 to 1930-20.

Table with columns Year, I, T, L. Contains data for Venus conjunctions and oppositions from 1920-50 to 1930-20.

Table with columns Year, I, T, L. Contains data for Venus conjunctions and oppositions from 1920-50 to 1930-20.

Table with columns Year, I, T, L. Contains data for Venus conjunctions and oppositions from 1920-50 to 1930-20.

TABLE B.

TABLE C.

TABLE A.

TABLE C.

TABLE D.

Table with columns Gr. elong, T, m, m, T, m, m, T, m, m. Contains data for Venus conjunctions and oppositions.

Table with columns Superior Conjunction, Inferior Conjunction, Correction T. Contains data for Venus conjunctions and oppositions.

Table with columns Superior Conjunction, Inferior Conjunction, Correction T. Contains data for Venus conjunctions and oppositions.

Table with columns Superior Conjunction, Inferior Conjunction, Correction T. Contains data for Venus conjunctions and oppositions.

Table with columns Superior Conjunction, Inferior Conjunction, Correction T. Contains data for Venus conjunctions and oppositions.

Table with columns Superior Conjunction, Inferior Conjunction, Correction T. Contains data for Venus conjunctions and oppositions.

JUPITER.

CYCLE TABLE.

Table with columns Year, I, T, L. Contains astronomical data for Jupiter from 1894 to 1904.

PERIOD TABLE.

Table with columns Year, I, T, L, m. Contains astronomical data for Jupiter from 1894 to 1904.

TABLE B.

Table with columns Year, I, T, L. Stationary points. Contains astronomical data for Jupiter from 1894 to 1904.

SATURN.

CYCLE TABLE.

Table with columns Year, I, T, L. Contains astronomical data for Saturn from 1894 to 1904.

PERIOD TABLE.

Table with columns Year, I, T, L, m. Contains astronomical data for Saturn from 1894 to 1904.

TABLE B.

Table with columns Year, I, T, L. Stationary points. Contains astronomical data for Saturn from 1894 to 1904.

TABLE A.

Table with columns Year, I, T, L. Contains astronomical data for Jupiter from 1894 to 1904.

TABLE C.

Table with columns Year, I, T, L. Contains astronomical data for Jupiter from 1894 to 1904.

TABLE C.

Table with columns Year, I, T, L. Contains astronomical data for Saturn from 1894 to 1904.

TABLE A.

Table with columns Year, I, T, L. Contains astronomical data for Saturn from 1894 to 1904.

TABLE N.

To convert the days of T into Julian months and days.

Table with columns Year, I, T, L. Contains astronomical data for Saturn from 1894 to 1904.

