ÖSTERREICHISCHE AKADEMIE DER W1SSENSCHAFTEN PHILOSOPHISCH-HISTORISCHE KLASSE
DENKSCHRIFTEN, 195. BAND

ASTRONOMICAL DIARIES AND RELATED TEXTS FROM BABYLONIA

BY THE LATE

ABRAHAM J. SACHS

COMPLETED AND EDITED BY

HERMANN HUNGER

Volume I
Diaries from 652 B.C. to 262 B.C.

Volume II
Diaries from 261 B.C. to 165 B.C.

Volume III
Diaries from 164 B.C. to 60 B.C.

VERLAG DER OSTERREICHISCHEN AKADEMIE DER WISSENSCHAFTEN

WIEN 1988

PREFACE

When Abe Sachs in April of 1983 made known to me his wish that I should complete the edition of the diaries and related texts which he could no longer expect to finish, I felt honored to have been chosen by him for this task. It was already too late for my affirmative answer to be given to Abe himself. When the papers left by Abe (as far as they concern this edition) reached me, I set to work on them at once. This turned out to be not as easy as one might have expected. Although Abe had worked on the diaries over a period of more than thirty years, nothing was available that could have been used unchanged as a manuscript for a printer. Among the materials are transliterations for almost all dated diaries and for many as yet undated ones; computations of planetary and lunar positions and phenomena, mostly using the tables of B. Tuckerman or of P. V. Neugebauer, but also others; finally, translations of some (better preserved) diaries. I therefore had to complete unfinished transliterations, occasionally do more computations, and (in most cases) produce a translation. Since almost all diary tablets are damaged, passages with uncertain readings abound; although Abe had collated many of them, I had to undertake more collations of the tablets in the British Museum. Abe had found numerous joins among fragmentary diaries; I was able to add a few more, but there are certainly still more fragments in the British Museum which belong together.

Since Abe's work on the diaries extended over such a long time, details of the presentation varied from one text to another; different transliterations and translations for the same words and phrases were found in many places. For a printed edition, the tedious work of going through each text and producing a consistent format was unavoidable.

From all that I realized that I would have to write the whole manuscript on my own. While this meant that the edition would appear later than I had first hoped, it at least gave me the opportunity to prepare the manuscript with the help of a computer which made proofreading, corrections, and especially the final production easier.

Whereas Abe had intended not only to edit the diaries, but also to restore "a huge archive .... to its full usefulness .... in all its aspects, philologically, historically, and astronomically" (O. Neugebauer, in B. Tuckerman: Planetary, Lunar, and Solar Positions 601 B.C. - A.D.I, p.V), I had to restrict myself primarily to the philological part of this task. I may (or may not) be able to evaluate the historical and astronomical information contained in the diaries, but it certainly would take a long time to do so. I feel obliged, however, to publish Abe's work as soon as possible; completion and striving for consistency have already delayed me long enough. It is clear that I am responsible (at least in a negative sense) for whatever is printed in this book.

While I have done my best to make this edition a fitting memorial for Abe, I am still aware that he could have done most of it better. Readers will therefore usually be right if they follow the judgment which a colleague anticipated when he heard that I was to edit the diaries: "People will attribute all the good ideas to Sachs and all the mistakes to you". I nevertheless hope that this edition will be useful.

It remains to thank O. Neugebauer and G. Toomer, who went through the materials left by Abe, sorted them, and handed over to me what was relevant to this edition of non-mathematical astronomical texts. I am indebted to the Osterreichische Akademie der Wissenschaften which at the recommendation of O. Neugebauer and M. Mayrhofer undertook the publication of this work. Their printer, E. Becvar, helped to remove technical problems from the task of preparing the manuscript. From an earlier time thanks are due to the Rockefeller Foundation which supported Abe's coming to Brown 'University, and then his travels to the British Museum and to J. Schaumberger. Thanks are also due to G. R. Meyer, former director of the Staatliche Museen in Berlin (GDR), who kindly permitted publication of photographs of tablets in Berlin.

I thank the Trustees of the British Museum who gave permission to publish these tablets. Both Abe and I enjoyed the generous help of the staff of the Department of Western Asiatic Antiquities over an extended time and on innumerable occasions. I especially want to thank C. B. F. Walker, who is now in charge of the tablets concerned, and I. L. Finkel.

Finally, I wish once more to thank O. Neugebauer who is to me an example of a scholar, and who has always encouraged me to proceed with this work.

Hermann Hunger

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INTRODUCTION

OVERVIEW

A. Sachs had planned to edit all non-mathematical astronomical texts in the order in which he had arranged them in LBAT (and defined in his article "A Classification of the Babylonian Astronomical Tablets of the Seleucid Period" in JCS 2 271ff.). The four main groups within this material are:

Diaries
Normal-Star Almanacs
Almanacs
Goal-Year Texts

In each group, datable texts will be edited first, arranged in chronological order; undated texts will then follow and are arranged by museum number. Since the diaries are the largest group (ca.1200 pieces), and are also most likely the source for much of what is contained in the other groups, they will be presented first.

The present introduction, written before the text edition was complete, is necessarily preliminary. Discussions of terminology etc. will be contained in the glossary, which will appear after the texts are published. Similarly, indices will have to wait until the end of the whole work.

DIARIES [1]

The texts edited here are usually called "diaries" or "astronomical diaries" by modern authors. The Akkadian term for them is *naṣāru ša ginê* "regular watching" which is written at the end and on the edges of the tablets. That a regular watch was kept by observers specifically trained and employed for this purpose is shown by two documents dealing with such employment by the assembly of the temple Esangila in Babylon [2].

In these documents the term *naṣāru naṣāru* is used for one of the duties of the employees, and it seems very likely that this can be translated "to make regular observations". They also have to "give" to their employer yearly *tersêtu* and *meš.hi*^{mes}. *tersī tu* occurs in the colophons of astronomical tablets (cf. ACT p.22f.) where it seems to refer to the tablets themselves or their contents; *meš.hi* is the word for the texts called "almanacs" by A. Sachs in JCS 2 277ff. It is therefore likely that the same people who had to make observations also prepared almanacs and astronomical tables.

Diaries were filled with entries day by day as the observations were made. This can be seen from the "short diaries" which cover from a few days to a little over a month. In several cases the last lines on these short diaries have rather shallow wedges which are scratched into the clay (e.g., Nos. -200 and -191). This is probably because the tablet was already too dry to allow impressing the wedges in the normal way. While tablets can be kept humid (e.g., by wrapping them in wet cloths) and remain inscribable for a time, some obviously dried too fast in the course of the observation period for which they were used.

Some observations were first written down on writing boards [3], as is indicated by a note in No. -384 r.6, referring to such a board.

From these short diaries, longer diaries covering usually half a year were compiled. It is evident from several points that the longer diaries were not the immediate observational notes: they are more carefully written (usually in smaller script) than the short diaries, and they show no signs of successive adding of material. Occasionally a remark by the scribe that they were checked (i.e., compared to an original) can be found (e.g., No. -384 rev. 5). In one case a diary for a half-year period was compiled although material for part of the time to be covered was not available (No. -384 rev. 6).

Scribes are only infrequently mentioned on the diary tablets. It is not clear why the scribe in most ceases did not put his name on the tablet. One guess could be that the tablets were kept in an archive belonging not to a single astronomer but to the community of them or even to the temple Esangila. The latter possibility is given more weight by the documents

mentioned above (p. l 1) in which the "assembly of Esangila" agrees to pay certain astronomers who will make observations and prepare tablets. One should keep in mind, however, that these two documents are of comparatively late date (SE 185 and 193), and that the situation may have been different earlier. Also, nothing is known about the locations of discovery of the tablets and their original arrangement, whether they were all found in one building or come from different places within Babylon.

The earliest diary found so far concerns the year -651. We know however that observation of the sky with the intention to control the observed phenomena is older than this date. Eclipse reports preserved on tablets go back to the second half of the 8th century B.C.[4] , thus confirming the well-known claim of Ptolemy (Almagest III, 7) that he had at his disposal more or less continuous eclipse records from the time of Nabonassar (747-734 B.C.) onwards.

Eclipse records and observations of the moon are also among the scholarly correspondence in the royal archives of Nineveh[5]. Fragments of texts derived from observations of Mercury have also been found in Nineveh, thus dating to the 7th or 8th century [6]. Planetary observations, some of them from the 6th century, are also found in the LBAT material [7]. A text containing observations of Saturn from the reign of Kandalanu (7th cent.) was discovered by C.B.F.Walker [8].

Since the Babylonian day began with sunset (see below p. 15), the diaries record first the events of the nighttime, and then of the daytime segment of a day. Nighttime is identified as such by the word GE_6 "night" before the day number; daytime has no specification. For a given night, the weather situation is usually reported first; then follow lunar and finally planetary observations. During daytime, weather phenomena naturally dominate.

CONTENTS OF DIARIES

A typical diary contains information on the following topics:

1. Moon
2. Planets
3. Solstices and equinoxes, Sirius phenomena
4. Meteors, comets, etc.
5. Weather
6. Prices of commodities
7. River level
8. Historical events

These topics will be taken up in detail below. Before that, some general concepts and preliminary information have to be presented.

THE BABYLONIAN CALENDAR

The Babylonian calendar uses days, months, and years. No weeks or units longer than a year are attested.

The month begins after sunset on the evening when the lunar crescent becomes visible for the first time after conjunction. Each month contains either 29 or 30 days.

Babylonian month names are represented in this edition by Roman numerals; intercalary months (see below) are identified by a subscript $_2$, i.e. VI_2 or XII_2. The names of the months are:

I	Nisannu (BAR)
II	Ajjaru (GU_4)
III	Simānu (SIG)
IV	Du'ūzu (ŠU)
V	Abu (IZI)
VI	Ulūlu (KIN)
VII	Tešrītu (DU_6)
VIII	Arahsamnu (APIN)
IX	Kislīmu (CAN)
X	Tebētu (AB)
XI	Šabātu (ZÍZ)
XII	Addaru (ŠE)

The year is not defined by some independent observation of natural phenomena. It is intended to have the same seasonal events occur at approximately the same point in the year; on the other hand, the year has to contain a whole number of months. The number of days in a year is of no interest in the Babylonian calendar. Since twelve months are about 11 days too short to make up a full solar year, an additional month has to be added to about every third year to keep the seasonal events at the same place in the year. This custom of adding a month to a year can be found in the oldest documents which give any calendaric information (from the third millennium) and continues to the end of the attested use of cuneiform writing. In the first millennium B.C., there are two points in the year where an intercalary month can be added: either after the sixth or after the twelfth month. Until about the middle of the first millennium B.C., this intercalation was done when one felt that it was needed. We know this from royal letters commanding intercalation as late as the reign of Nabonidus and from other official letters on the same topic from the time of Cyrus or even Cambyses. From -380 onwards, a fixed pattern of intercalation was followed which had seven intercalary years in a 19-year period. Even before this time, one had evidently tried to establish such a pattern, as can be seen from the ahnost but not quite regular distribution of intercalary months during the preceding centuries [9].

In the astronomical compendium ^{mul}APIN (Tablet II, see my forthcoming edition of this text) several rules for deriving intercalation from the observation of stars or the moon can be found. It is uncertain to what extent these rules were utilized; there is no reference to them in the scholarly letters of the 7th century royal correspondence from Nineveh (edited by S. Parpola in LAS).

The Babylonian year begins in spring, around the vernal equinox; obviously, true lunar months do not permit the beginning of the year to remain at a fixed distance from the equinox. The relation between the beginning of the year and the equinox can be followed with the help of the tables in PD; computations were done by F. X. Kugler, SSB II 435ff. and Erg. 227ff.

The Babylonian day begins with sunset.

In the diaries, the night is divided into three parts which correspond to the three watches of the night, as can be seen from the abbreviated terminology. These technical terms are:

USAN	"first part of the night"
MURUB$_4$	"middle part of the night"
ZALÁG	"last part of the night"

A fourth designation, SAG GE$_6$ "beginning of the night", is listed before USAN if both are used on the same night. The duration of this interval is unclear. Either "beginning of the night" or "first part of the night" may be used in connection with any meteorological phenomenon. Their use with lunar and planetary data, however, is usually differentiated. Observations of the moon with stars or planets during the first half of the month always take place (with rare exceptions) in the "beginning of the night", and even this temporal designation is omitted when the lunar phenomenon occurs in the first few days of the month. On the other hand, observations of planets in relation to stars or other planets before midnight are always timed in the "first part of the night", never in the "beginning of the night". No similar temporal differentiation occurs with corresponding lunar observations in the second half of the month and with planetary observations in the east; they are always labeled "in the last part of the night".

Daytime, too, has a tripartite division:

ina še-ri	"in the morning"
AN-BAR$_7$	"(around) noon"
ina KIN-SIG	"in the afternoon"

A relatively shorter period at the end of the last part of the day is called KI ŠÚ *šamáš* "with sunset". The precise definitions of the beginning of night, presumably the end of sunset, and of the beginning of daytime, presumably the beginning of sunrise, are uncertain.

The relation between the Babylonian and the Julian calendar as far as covered by each diary is given in this book in tabular form. To facilitate computations, I give the equivalent not of the 1st day of a Babylonian month, but of the preceding day 0. I list the two consecutive days in the Julian calendar on which this zero day of the Babylonian month fell. This deviates from PD who give the Julian date of the day which contains the daylight part of the first day of the Babylonian month. Their Julian date for the beginning of a Babylonian month is therefore one day later than the *second* part of my date.

I also indicate if the calendar resulting from the diary and presented here does not agree with the tables in PD. If no remark is added, PD's tables are not contradicted by the diary. "Day 0" of a month is the same as "last day of the preceding month"; in the calendar tables, both designations for this day are given. This makes it possible to see at a glance the lengths of the months as attested by the diary; II 0 = 1 29 shows that month I had 29 days.

Example (from No. -302):

SE 9	I 0			-302 Apr 2/3
	II 0	=	I 29	May 1/2
SE 10				
	III 0	=	II 29	May 30/31(PD: May 31/Jun 1)
	IV 0	=	III 30	Jun 29/30
	V 0	=	IV 29	Jul 28/29
	VI 0	=	V 30	Aug 27/28
	VII 0	=	VI 30	Sep 26/27
	VIII 0	=	VII 30	Oct 26/27
	IX 0	=	VIII 30	Nov 25/26
	X 0	=	IX 30	Dec 25/26 (PD: Dec 24/25)
	XI 0	=	X 29	-301 Jan 23/24
	XII 0	=	XI 29	Feb 21/22
	XII2 0	=	XII 30	Mar 23/24
	I 0	=	XII2 29	Apr 21/22
	II 0	=	I 29	May 20/21
	III 0	=	II 29	Jun 18/19 (PD: Jun 19/20)

TIME MEASUREMENT

Time intervals shorter than a day are measured in the diaries by the unit UŠ, which corresponds to 4 of our minutes. An appropriate translation for UŠ is "time degree" because the celestial sphere moves 1° in right ascension in the time of 1 UŠ. 1/60 of an UŠ is called 1 NINDA. These units are well known from other astronomical texts, see ACT pp. 39f.

From the diaries it is not apparent how time intervals were measured. The general assumption is that waterclocks were used[10]. These instruments are attested in texts (see the dictionaries s.v. *dibdibbu*, *maltaktu*) but little is known about their construction [11].

Another candidate for time measurement is the sundial. In the astronomical compendium ^{mul}APIN we find tables for shadow lengths which show that the Babylonians were interested in the variations of the shadow in the course of the day. The tables in ^{mul}APIN are very crude and in addition contain a basic error[12]. In any case sundials, which work only during daytime, would have been of very linfited usefulness for the purposes of the diaries.

It is of course also possible to measure time at night by means of fixed stars. Lists of *ziqpu* stars which give the time in UŠ between successive culminations of stars could be used for exactly this purpose. Unfortunately most time intervals recorded in the diaries, especially those concerning the moon, fall around sunrise or sunset when only few stars are visible. On the other hand, the inaccuracy of time measurement seems to have been of little importance for the development of Babylonian astronomy.[13]

NORMAL STARS

In order to give the position of the moon and the planets a number of stars close to the ecliptic are used for reference. These have been called "Normalsterne" by Epping [14], and the term has remained in use ever since [15]. The Akkadian word for them is MUL ŠID ^{meš} (attested in a diary for SE 175 XII_2, and in a procedure text concerning planetary periods [16]), probably to be read *kakkabū minâti*, which seems to mean something like "stars of counting, predictable stars" (see CAD s.v. *minītu*). Note that Mars had the epithet *kakkab lā minâti* (see CAD loc.cit.), which has been taken to refer to the difficulties in predicting its motion [17].

The following table lists the Babylonian names, their translation, the modern names, and the ecliptic coordinates for the years -600, -300, and 0, of the usual Normal Stars:

MÚL KUR *šá* DUR nu-nu	The bright star of the Ribbon of the Fishes		
η Piscium	350.73/5.23	354.87/5.24	359.02/5.26
MÚL IGI *šá* SAG HUN	The front star of the head of the Hired Man		
β Arietis	357.88/8.39	2.02/8.40	6.17/8.41

MÚL *ár šá* SAG HUN	The rear star of the head of the Hired Man		
α Arietis	1.52/9.90	5.67/9.90	9.82/9.91
MÚL MÚL	The Bristle		
η Tauri	23.90/3.78	28.04/3.81	32.19/3.84
is le_{10}	The Jaw of the Bull		
α Tauri	33.65/-5.65	37.80/-5.63	41.95/-5.61
ŠUR GIGIR *šá* SI	The Northern (Variable Star) [18] of the Chariot		
β Tauri	46.47/5.17	50.61/6.19	54.76/5.22
ŠUR GIGIR *šá* ULÚ	The Southern (Variable Star) of the Chariot		
ζ Tauri	48.68/-2.53	52.83/-2.49	56.98/-2.45
MÚL IGI *šá še-pít* MAŠ-MAŠ	The front star of the Twins' feet		
η Geminorum	57.38/-1.23	61.52/-1.18	65.67/-1.14
MÚL IGI *ár šá še-pít* MAŠ-MAŠ	The rear star of the Twins' feet		
μ Geminorum	59.16/- 1.09	63.31/- 1.06	67.46/- 1.02
MAŠ-MAŠ *šá* SIPA	The Twins' star near the Shepherd		
γ Geminorum	62.98/-7.06	67.13/-7.02	71.28/-6.98
MAŠ-MAŠ IGI	The front Twin star		
α Geminorum	74.23/9.86	78.37/9.89	82.50/9.92
MAŠ-MAŠ *ár*	The rear Twin star		
β Geminorum	77.54/6.48	81.64/6.50	85.74/6.53
MÚL IGI *šá* ALLA *šá* SI	The front star of the Crab to the north		
η Cancri	89.32/1.33	93.46/1.36	97.61/1.39
MÚL IGI *šá* ALLA *šá* ULÚ	The front star of the Crab to the south		
ϑ Cancri	89.66/-1.00	93.80/-0.97	97.96/-0.94
MÚL *ár šá* ALLA *šá* SI	The rear star of the Crab to the north		
γ Cancri	91.49/2.96	95.63/2.99	99.77/3.02
MÚL *ár šá* ALLA *šá* ULÚ	The rear star of the Crab to the south		
δ Cancri	92.59/-0.03	96.74/-0.01	100.89/0.00
SAG A	The Head of the Lion		
ϵ Leonis	104.59/9.51	108.73/9.54	112.88/9.57
LUGAL	The King		
α Leonis	113.90/0.35	118.02/0.37	122.15/0.38
MÚL TUR *šá* 4 KÚŠ *ár* LUGAL	The small star which is 4 cubits behind the king		
ρ Leonis	120.29/0.02	124.44/0.03	128.59/0.05
GIŠ.KUN A	The Rump of the Lion		
ϑ Leonis	127.28/9.65	131.43/9.65	135.59/9.66

GÌR *ár šá* A	The rear foot of the Lion		
β Virginis	140.49/0.64	144.70/0.65	148.92/0.66
DELE *šá* IGI ABSIN	The Single star in front of the Furrow		
γ Virginis	154.40/3.01	158.51/2.99	162.61/2.96
SA_4 *šá* ABSIN	The bright star of the Furrow		
α Virginis	167.77/-1.88	171.91/-1.90	176.06/-1.92
RÍN *šá* ULU	The southern part of the Scales		
α Librae	189.04/0.65	193.18/0.62	197.32/0.58
RÍN *šá* SI	The northern part of the Scales		
β Librae	193.30/8.80	197.44/8.76	201.59/8.73
MÚL $MURUB_4$ *šá* SAG GÍR-TAB	The middle star of the Head of the Scorpion		
δ Scorpii	206.48/-1.66	210.62/-1.69	214.77/-1.73
MÚL *e šá* SAG GÍRTAB	The upper star of the Head of the Scorpion		
β Scorpii	207.09/1.34	211.23/1.30	215.38/1.26
SI_4	(the god) Lisi		
α Scorpii	213.68/-4.23	217.82/-4.27	221.96/-4.31
MÚL KUR *šá* KIR_4 *šil* PA	The bright star on the tip of Pabilsag's arrow		
ϑ Ophiuchi	225.30/-1.48	229.44/-1.53	233.59/-1.57
SI MÁŠ	The Horn of the Goat-fish		
β Capricorni	267.94/4.88	272.08/4.85	276.23/4.81
MÚL IGI sa SUHUR MÁŠ	The front star of the Goat-fish		
γ Capricorni	285.56/-2.28	289.72/-2.32	293.88/-2.35
MÚL *ár šá* SUHUR MÁŠ	The rear star of the Goat-fish		
δ Capricorni	287.33/-2.13	291.48/-2.19	295.64/-2.24

It has to be noted that this selection of stars is not distributed evenly along the ecliptic, as one would expect a system of reference points to be. There is a gap between about 230° and 265°, and another one between 290° and 350°. It is not clear why these gaps occur; there are stars available in these areas which are at least as bright (or faint) as some of the other Normal-Stars. So far, no convincing explanation has been found [19].

While the stars contained in the above list are by far the most common Normal stars, occasionally others are used for the purpose of indicating the position of moon or planets as well. These are however exceptions which prove the rule.

DATING THE DIARIES

Very few diaries have been preserved intact. When the statement of date is broken away, how does one proceed in an effort to establish the date?

A dense network of positions for the planets, sun, and moon during the last six centuries B.C. is available in Tuckerman. Using the tables of C. Schoch [20] and P.V. Neugebauer [21], A. Sachs computed for the period from -450 to -10 the planetary phenomena which the Babylonians considered significant: last appearance, first appearance, stationary points and (for outer planets) acronychal rising. Tables for lunar and solar eclipses exist; I mention P. V. Neugebauer, Spezieller Kanon der Mondfinsternisse ...., Astronomische Abhandlungen 9/2 (1934) and Spezieller Kanon der Sonnenfinsternisse...., Astronomische Abhandlungen 8/4 (1931), and the recent work by H. Mucke and J. Meeus, Canon of Solar Eclipses, and Canon of Lunar Eclipses (Vienna 1983). For the last several centuries B.C., the Babylonian scheme for the dates of solstices,

equinoxes, and Sirius phenomena is known[22] and can help to determine the date of a diary.

It is, of course, trivial that the mention of a king Arsaces means that there is no need to look for a date before SE170. The occurrence of the city Seleucia makes only dates beginning with the 3rd century B.C. possible. Less trivial criteria, like changes in orthographic conventions, emerge after one arranges the already dated texts in their chronological sequence.

Whenever the date of a diary is not immediately obvious, I give a justification for the date chosen.

CONTENTS OF DIARIES

1. LUNAR PHENOMENA

a) Lunar Six

This term was coined by A. Sachs[23] to refer to the following group of six time intervals:

(1) On the first day of the month, the time between sunset and the setting of the moon after it had become visible for the first time after conjunction. This interval is called *na*.

Around the middle of the month, four intervals relating to full moon are given under the date at which they occur:

(2) the time between moonset and sunrise when the moon set for the last time before sunrise;called ŠÚ.

(3) the time between sunrise and moonset when the moon set for the first time after sunrise; called *na*.

(4) the time between moonrise and sunset when the moon rose for the last time before sunset; called ME.

(5) the time between sunset and moonrise when the moon rose for the first time after sunset; called GE_6.

(6) At the end of the month, the date and the time between moonrise and sunrise when the moon was visible for the last time; called KUR.

These intervals are measured in time degrees (UŠ see above p. 16). In the translations, the unit degree (°) is retained.

Since the syzygies cannot be observed directly (except in the case of eclipses), the Babylonians observed the time difference between the crossings of the horizon by sun and moon as close as possible to the syzygy in question. For conjunctions, items numbered (1) and (6) above could be used. By definition the first visibility of the new moon always takes place on the first day of the month; for the preceding last appearance a date will be noted. In order to know the number of days between last and first appearance, however, one needs to know the length of the month, which can be 29 or 30 days. For this reason, at the beginning of each monthly section of a diary the length of the preceding month is given by adding after the month name either 30 (if the preceding month had 29 days) or I (if the preceding month had 30 days) (see above p. 13).

In the case of oppositions (full moons) the four time intervals numbered (2) to (5) above can be measured. The sequence of these intervals depends on whether the moment of opposition falls into daytime or nighttime; the sequence can also vary because of the variation of the angle between ecliptic and horizon in different seasons and because of the variation in lunar latitude.

The Lunar Six are the object of the predictions contained in the mathematical-astronomical texts which were edited by O. Neugebauer in ACT (especially No. 201) and discussed by him again in HAMA 535ff.

When weather conditions prevented the observation of any of the Lunar Six, a predicted time interval is nevertheless recorded, followed by an explicit statement that the observer could not carry out the measurement (NU PAP, to be read *ul attasar*"I did not watch"). Although such predicted time intervals are frequent in the diaries for the Lunar Six, it is still not clear how they were found. Comparison with the procedures of the mathematical-astronomical texts is hampered by the bad state of preservation of the relevant passages there. An analysis of the Lunar Six material in the diaries may lead to interesting results; I did not feel able to do the necessary statistical investigations.

The readings and literal meanings of the terms for the Lunar Six are not as clear as one would wish.

(1) *na* can occur alone or followed by -su, i.e. na-su. It is furthermore found not only at first appearance and

opposition of the moon, but with first and last appearances of planets as well.

For *na-su* F.X.Kugler as early as 1912 proposed a reading "wohl namurat-su oder ähnlich" [24]; i.e.; he interpreted *na* as an abbreviation of some Akkadian word beginning with this syllable, followed by the possessive suffix in the form *-su* which is required after a noun ending in a dental or sibilant. Unfortunately, there are grammatical difficulties in this proposal: *nanmurtu*, attested as a word for "visibility, rising", would require the form -gu of the possessive suffix, not *-su*; "its visibility" being *nanmurtašu*. Apart from this, Kugler's proposal remains attractive. The only alternative reading that has come to my mind is to take NA as a logogram for *manzāzu* "position". While *manzāzu* is frequent in astronomical texts, it is almost always written syllabically or KI-GUB. The logogram NA for *manzāzu* is in general restricted to extispicy texts, but it probably does occur in the second tablet of the astronomical work ^{mul}APIN (IIi 8, see my forthcoming edition of this text). Reading *manzāzu* for NA would have the advantage that *manzāzu* takes the form *-su* of the possessive suffix, in agreement with the writing *na-su*. On the other hand, it is not easy to see why "position" should have been used to describe an interval of time or an angle. As far as I know, no unabbreviated writing of the word *na* has been found so far in astronomical texts. It therefore remains uncertain whether we have to understand it as *nanmurtu* and accept an irregularity in grammar, or read it differently.

(2) ŠÚ is the logogram for *rabū* "to set". Here it must be the abbreviation of an expression referring to moonset, since this interval is defined as "moonset to sunrise".

(3) For *na* see already above under 1.

(4) ME is a special logogram for "daylight" used in astronomical texts. Here it may be an abbreviation of the phrase ME *ana* ŠÚ *šamáš* "daylight (remaining) to sunset" which identifies a point of time during the afternoon [25].

(5) GE_6, the usual logogram for "night", could in a similar way be derived from GE_6 GIN, lit. "the night went away", the phrase for describing a point of time during the first half of the night [26].

(6) KUR can be explained as an abbreviation of *ana* KUR *šamáš* "until sunrise" which also occurs among the terms for the epochs of the day discussed by Neugebauer and Sachs[25]. This explanation fits the meaning "moonrise to sunrise" established for KUR.

At the beginning of a month, additional remarks are sometimes found describing the new moon. It can be qualified as KUR_4 (Akk. *ba 'lu*) "bright" or SIG (Akk. *da 'mu*) "faint". The moon may be said to have been comparatively high or low with respect to the sun (*ana šamáš* NIM/SIG). Sometimes the crescent is bright enough to be seen while (part of) the sun is still above the horizon; this is expressed by the remark ina *ana šamáš* GUB IGI "(the moon) became visible while the sun stood there". AGA *apir* (abbreviated to *apir*), literally "(the moon) wore a crown", refers to earthshine.

b) Passing by Normal Stars

Whenever the moon passed one of the Normal Stars (see above p. 17) its distance from that star is recorded. The moon may be "above" or "below" a star, or "in front of" (i.e., to the west of) or "behind" (i.e., to the east of) the star. The expressions "in front of" and "behind" are meant in relation to the daily rotation of the celestial sphere, not to the movement of the moon. If the moon seemed to be not exactly "above" or "below" a certain star, the observer added a remark about the amount by which the moon was still "in front of" or "behind" the star. The distance between moon and star is expressed in "cubits" (KÙŠ, Akk. *aramatu*) and "fingers" (SI or U, Akk. *ubanu*), the "finger" being 1/ 24th of the cubit. In the Neo-Babylonian period, 1 cubit corresponds to 2° [27]. For example, the moon will be reported to have been "1 cubit below α Leonis, the moon being back to the west 1/2 cubit". In a similar way, the moon can be observed "in front of"' or "behind", but in addition at the same time "high to the north" or "low to the south".

These formulations give the impression that the distances between the moon and the Normal Stars were measured in the direction of the cardinal points. It has also been argued, however, that they were equivalent to our longitude and latitude. O. Neugebauer[28] considers the latter assumption impossible according to his investigations of conjunctions between Normal Stars and planets. It remains to be seen whether this question can be solved in some way; for reasons already stated above (p. 7), I did not think it appropriate to embark on such an investigation.

Normal Stars are used with different frequency in these statements. Brighter stars are more likely to be observed close to the moon. Where two or more Normal Stars lie close to each other, only one of them will be chosen as point of reference for the movement of the moon.

Not all possible combinations of numbers occur with the measures "cubit" and "finger". The greater the distance, the less precise will be the measurement. Between 4 and 5 cubits, the only intermediate points will be 4 1/3, 4 1/2 and 4 2/3. At shorter distances, sixths and fourths of a cubit (mostly expressed as 4 or 6 fingers) will be given. Only distances less than 1/2 cubit will be measured to the finger. 1/3 cubit almost never occurs; it is replaced by 8 fingers, probably to avoid

misreadings of the very similar signs for 1/3 and 2/3. The small distance of 2 fingers is usually accompanied by the word DIM_4 (Akkadian equivalent *sanāqu* "to come near"), the smallest observed distance of 1 finger by the remark TE (Akk. equivalent *tehû* "to come close").

Finally, a star (or planet) may disappear behind the moon; the Akkadian phrase is, it "entered" the moon. Sometimes the point of entrance or exit is specified by expressions like "one third of the disk to the north". When at the time of observation a Normal star or planet is so close to the moon that an occultation can be expected (but will not be observable because the moon will set before it takes place), the star is said to be ana *libbišu kunnu* "set towards its (viz. the moon's) inside".

While the distances between moon and stars at the passings are observed with some precision, the times of the passings are indicated only by parts of the night. In general, during the first half of a month, the time indication will be "beginning of the night "; for the first few days of the month, even this is deemed superfluous, as the moon is above the horizon for a relatively short time only. During the second half of the month, we regularly have "in the-last part of the night" (i.e., the third watch). The reason may be that the observers went to-sleep after they had done their work at the beginning of the night, and got up only at the end of the night in order to carry out whatever observations were required at that time. In fact most phenomena which interested the Babylonians do occur at the beginning and end of the night. Eclipses, of course, can happen at any time of day or night, but only on certain dates which could be established in advance. In view of the rough time indication used with the passings of the moon by Normal Stars, it seems doubtful that they could be used in the construction of lunar ephemerides. Certainly eclipse observations could produce far more useful data.

Because of the precision that can be obtained from the observation of occultations, they are occasionally fixed in time more precisely by means of stars culminating at the same time. For close encounters between stars and planets, see below p. 25.

c) Eclipses

Eclipse reports are among the earliest astronomical cuneiform texts available [29]. Omens derived from eclipses are preserved from the Old Babylonjan period on and make up an important section of the celestial omen work Enuma Anu Enlil [30]. The diaries include eclipses, predicted and observed. A predicted eclipse is denoted by $AN\text{-}KU_{10}$ *sin/šamáš* , an observed eclipse by the opposite order *sin/šamáš* $AN\text{-}KU_{10}$. In the course of time, the reports become more and more detailed. The following items can be listed in eclipse reports [31]:

(1) Date
(2) Time between moonrise and sunset (ME)
(3) Time of beginning of eclipse in terms of a culminating star (*ziqpu*; e.g. -162 XII2 14: 3 UŠ *ár* ^{múl}*na-ad-dul ár ziq-pi* (the point) 3° behind ν Bootis culminated")
(4) Entrance direction of shadow (*e.g.* sin $AN\text{-}KU_{10}$ Á KUR *u* SI *ki-i* TAB-*ú* "lunar eclipse, (obscured) on the northeast side when it began")
(5) Time to maximal phase.
(6) Magnitude of maximal phase (e.g., *šal-šú* HAB-*rat* "one-third of the disk"; *ina* 10 GE_6 4 SI GAR-*an* "in 10° of night, it made (an eclipse of) 4 fingers"; 2 SI *ana* TIL-*ti* TAG_4 "2 fingers remained to totality")
(7) Duration of maximal phase (e.g. 6 GE_6 ÍR *ana* ZALÁG *ki-i* TAB-*ú* "6° of night "weeping" (i.e., totality) when it began to clear")
(8) Time from the end of the maximal phase to the end of the eclipse
(9) Direction in which the shadow crossed the disk (e.g. *ina* 16 UŠ GE_6 TA ULÙ *u* KUR *ana* SI u MAR ZALÁG-*ir* "in 16° of night it cleared from the southeast to the northwest")
(10) Duration of eclipse (sum of items 5,7,and 8; e.g. 44 GAR ÍR *u* ZALÁG-*ru* "44° onset, "weeping"(totality), and clearing")
(11) Meteorological remarks (especially wind)
(12) Presence and absence of planets and Sirius (e.g. *ina* $AN\text{-}KU_{10}$ *šú dele-bat u* GENNA GUB-*ú* ÍB-TAG ^{d}UDU-IDIM^{meš} NU GUB^{meš} "during its eclipse, Venus and Saturn stood there, the remainder of the planets did not stand there")
(13) Position of the moon relative to a Normal Star (for terminology see above, section b)
(14) Time of the beginning of the eclipse relative to sunset or sunrise [32]
(15) Time between sunrise and moonset (*na*).

In this edition, eclipses will be identified by their date in the Julian Calendar; details can then be found, e.g., in the tables of P. V. Neugebauer or of H. Mucke and J. Meeus, see above p. 19.

2. PLANETARY PHENOMENA

a) Planetary phases

Inner planets show the following phases:

first appearance in the east	Γ
stationary point in the east	Φ
last appearance in the east	Σ
first appearance in the west	Ξ
stationary point in the west	ψ
last appearance in the west	Ω

Phases of the outer planets:

first appearance	Γ
first stationary point	Φ
"opposition" (acronychal rising)	Θ
second stationary point	ψ
last appearance	Ω

The Greek letters at the right end of each line have been used in the literature[33] to conveniently refer to the planetary phases ("Greek-Letter phenomena").

For all planets, last and first appearances (Γ, Ξ, Σ, Ω) are noted in the diaries together with the zodiacal sign in which they occurred. The time for which a planet remained visible on this occasion (called *na*, as with the moon) is given in UŠ. If this time interval appears to the observer to be too long for a first appearance and thereby shows that the planet could have been sighted earlier, the ideal date of first appearance is also mentioned (in x IGI "it could have been seen on the xth" or the like; translated here as "(ideal) first appearance" to convey the appropriate meaning). If for any reason the appearances of the planets could not be observed, a date is nevertheless given, accompanied by the remark NU PAP (Akk. *ul attasar*) "I did not watch ". Such dates were obviously computed in some way, but it remains uncertain how this was done. Theoretically, the ephemerides were capable of predicting these dates. I compared several dozen dates mentioned in diaries with those predicted in preserved ephemerides. While the dates agree within a few days, no complete agreement can be found. One also has to keep in mind that several systems of computation of ephemerides are attested for the planets which can produce slightly different results. Computed data in the diaries are found already at a time for which we have no examples of ephemerides; so far, all ephemerides are later than the middle of the 4th century B.C. Unless much additional material is found, the source of predictions contained in the diaries will remain uncertain.

1) Inner planets:

As stated above, appearances and disappearances are recorded, but not stationary points. In the case of Mercury, a first appearance (and the subsequent last appearance) if not observable because of unfavorable visibility conditions[34] is given, obviously as a prediction, and marked by DIB, lit. "it will pass by", to indicate that the phenomenon will not occur.

2) Outer planets:

All five phases of outer planets are recorded in the diaries. For Γ and Ω, and Φ and ψ the date and the sign of the zodiac are noted. Only the date is found with Θ.

b) Passing by Normal Stars

As with the moon, the passings of a planet by a Normal Star are collected in the diaries. Although the terminology is slightly different, the measurements are again made in cubits and fingers. Particularly close approaches between planets and stars are given special attention. They can be classified as "near" (DIM_4, Akk. *sanāqu*) or "close" (TE, Akk..*tehû*). On rare occasions, a planet and a fixed star may even "turn into one star". Passings of planets by other planets are recorded in the same manner as those of Normal Stars.

c) Planetary summaries

At the end of each monthly paragraph we find a summary of the positions and phenomena of the planets. If a planet moved from one zodiacal sign into another in the course of the month, this is expressed by: "planet X was in sign A, at the end of

the month in sign B". Later in the Seleucid period, this is replaced by "on day n, planet X reached(KUR-*ád*) sign B".

The order of the planets in these summaries follows a strict rule which applies to most astronomical texts of the Seleucid period [35]: Jupiter, Venus, Mercury, Saturn, and Mars. If two planets are in the same zodiacal sign, both are listed at that point in the sequence where the first of the two ought to be mentioned. The planets are listed in two groups: visible and invisible. The order just described is applied within each group. If, e.g., in some month Venus and Mars were invisible, the sequence would be: Jupiter, Mercury, Saturn; Venus, Mars. - There are occasional deviations from the practice of grouping visible and invisible planets together; in Nos. -277 and -273 the planets are listed in the customary order; if one of them was invisible, this is remarked, but the planet following it may again be a visible one.

3. SOLSTICES AND EQUINOXES, SIRIUS PHENOMENA

a) Solstices and Equinoxes

The diaries regularly give the dates of solstices (*šamáš* GUB, probably read *šamáš izziz (a)*) and equinoxes (LÁL-*tim*, Akk. *šitqultu*). As has been shown by O. Neugebauer [36], these dates are not the result of observations, but follow a scheme connected with the 19-year intercalation cycle (see above p.14). This is already evident from the remark "I did not watch" (NU PAP) after many of these dates; if they were not observed, they must have been found by some kind of computation. And indeed, from the year -322 on almost all dates agree with the scheme discovered by Neugebauer. There is a violation in -278 IX 26 (scheme: 28). -324 VI 27, -322 XII 25 and -321 VI 30 agree, whereas -322 VI 18 should be 19 (the remark NU PAP in the text shows that VI 18 is a computation, not an observation). The few earlier attestations do not fit the later scheme, but this may be partly due to the irregularities of intercalation. For a similar situation with the dates for Sirius phenomena see below.

Interest in the date of the equinox is attested for the 7th century by two letters to an Assyrian king reporting it [37]. Fixed dates for the place of the equinoxes and solstices in the lunar calendar are found in ^{mul}APIN (e.g., Tablet IIi 9ff.).

The scheme mentioned above seems to have impressed Babylonjan astronomers as sufficiently accurate to dispense with observations. Otherwise one would expect to find occasional remarks about deviations between observation and scheme, as is the case with Sirius (see below).

b) Sirius phenomena

The dates ofheliacal rising (Γ), heliacal setting (Ω) and acronychal rising (Θ) of Sirius are regularly mentioned in the diaries. These dates, like those of solstices and equinoxes, are the result of a scheme connected with the 19-year cycle [38]. At least occasionally, however, the dates predicted by the scheme were compared to observations: in no. -289 r. 7, a heliacal rising of Sirius is reported for the 13th of month IV; then the time interval between rising of Sirius and sunrise is given, and (as a consequence of this time interval) the "ideal" date IV 12. This "ideal" date agrees with the scheme for Sirius. Earlier, in no. -324 IV 18 a heliacal rising of Sirius is reported; again an "ideal" date is given as IV 16. This time, however, the date derived from the scheme does not agree: it would be IV 15. Still earlier dates for Sirius phenomena (-384 X I for Θ , -418 ii 23 for Ω) also deviate from the scheme and suggest that it was introduced at the end of the 4th century [39]. This more or less agrees with the evidence from the dates for solstices and equinoxes in the diaries, and also coincides roughly with the implementation of the 19-year cycle of intercalation. Schematic predictions of solstices, equinoxes, and Sirius can be traced back to the end of the 7th century, but intercalation was not regulated yet at that time.

4. METEORS, COMETS, ETC.

Meteors are called *kakkabu rabú* "big star" in the diaries. It seems that only exemplars of remarkable brightness were recorded. We find that sometimes a meteor was so bright that its light "could be seen on the ground"; also, noise connected with it is noted. Usually the direction in which the meteor crossed the sky is given, either in terms of the wind directions or with reference to constellations.

In a similar way, comets are reported. The word for comet is *sallammû* or *sallummû*. The meaning of this word is beyond doubt since in diaries for SE 148 and SE 225 a *sallammû* is recorded which can be definitely identified with Halley's comet [40] . Several other comets occur in the diaries, but since no other can be traced back as far as Halley's, there is no way to combine the information of the diaries with later observations.

5. WEATHER

The diaries contain a wealth of information on weather and climate. It seems that weather had to be recorded just like celestial phenomena. No mention is ever made of clear skies; this was probably considered the normal situation, not requiring special attention since it did not inhibit astronomical observation. There are texts which contain nothing but weather (and which cannot, therefore, be dated if no date is preserved). It is probable that the weather data were intended to provide material for the prediction of weather. Within the Babylonian view of the cosmos there was reason to assume that it might one day be possible to find periods for recurrent weather phenomena, just as it was possible to identify such periods for celestial events and to use them for predictions of future occurrences. Weather and planets could even be combined, as has been done in some omens[41]. In any case, the diaries are an important source for the climate of Mesopotamia in antiquity.

Use of the abundant information about Mesopotamian climate spread throughout the diaries is hampered by the particular terminology applied to weather phenomena in these texts. While some of the signs or sign groups can be recognized as words well-known from other texts, others seem to be peculiar abbreviations or logograms not attested elsewhere. Variations of writing permit in some cases conclusions about the Akkadian words hidden behind these signs, but some of them remain obscure.

Under the auspices of the Akademie der Wissenschaften und der Literatur in Mainz, a comprehensive project on "palaeoclimatology" is being carried out. In its context, the ancient Near Eastern sources will be treated under the direction of Prof. Hecker of the University of Münster. I made available the diaries to him at the end of 1983, and results from these investigations are to be expected soon. I have been able to discuss the problems of weather terminology with Prof. Hccker and his collaborator Dr. J. Kamminga in order to provide the best possible translations in the present edition. Further progress may be made while the palaeoclimatological project is continued, and its results will be included in the glossary at the end of the diaries edition.

In spite of these combined efforts several of the weather expressions remain uncertain or entirely obscure[42]. While their meaning may be reasonably well understood from context, no Akkadian reading can be offered. In such cases I have refrained from translating the signs in question. In other cases, when a reading and understanding can be proposed but not proved, I do give a translation so as to make the English text as readable as possible. Any user should keep this in mind and consult the following preliminary list (and later, the glossary) with discussions of weather words before trying to build any conclusions on my translations of them. References for the Akkadian terms can be found in the dictionaries AHw. and CAD.

The more common weather words are discussed here in alphabetical order:

akamu "mist"

This word is written *a-kám* in the diaries, occasionally abbreviated to *a*. Its meaning was determined by Kugler, SSB I 78 ad 4.

AN "rain"

The writing AN is an abbreviation of A.AN (= ŠÈG); the latter logogram is still used in the oldest diaries. While it is probably to be read *zunnu* in most cases, there are contexts where it may be something like a determinative which was not pronounced. If, e.g., UTAH, is to be read tYktu, then AN in the combination AN UTAH, seems to be superfluous. Similar observations can be made in other cases as well, see DUL, *nalšu*, PISAN, and *rādu*.

butuqtu see TIR-AN-NA

DIB see DIR and PISAN.

DIR "clouds"

Abbreviation of IM.DIR (Akk. *erpetu*). Simple DIR without specification occurs only to excuse a missing observation (DIR NU PAP "clouds, (therefore) I did not watch") or to qualify an observation as having been carried out in spite of adverse conditions (DIR mug "measured (despite) clouds").

DIR AN ZA, "clouds were in the sky"

This phenomenon generally does not prevent an observation involving the moon or planets coming in conjunction with Normal Stars or planets. It is frequently accompanied by a wind from the north. Haloes of the sun and the moon may

be associated with it. There is also the possibility of rain from it. The combination of these data leads to a light cloud cover or to clouds with wide spaces between them.

The philological analysis of DIR AN ZA is difficult. The most natural approach is to take DIR ("clouds") as the subject, with AN ("the sky") as the direct, object of a verb that is hidden behind ZA. This last element is apparently not a sumerogram, but the only word that would fit an Akkadian abbreviation *za* or *sa* seems to be *sabātu*. *sabātu* is attested once with the sky as object. Unfortunately, this very same verb could also be proposed as the reading of the logogram DIB in another frequent phrase describing clouds, DIR AN DIB. In order to provide consistent translations, I translate DIR AN ZA as "clouds were in the sky", literally, "clouds took their position in the sky". While my assumption that ZA is an abbreviation of *sabit* or the like may be wrong, it seems certain that DIR AN ZA is a type of cloud distribution that frequently allows astronomical observation.

DIR SAL AN ZA, "thin clouds were in the sky"

The reading of SAL as *raqqatu* "thin" when said of clouds is proved by a passage from an unpublished commentary to Enuma Anu Enlil, BM 47447 rev.4: *ina* AN-KU$_{10}$ IM-DIR *sa-lim-tu$_4$ raq-qa-tu$_4$* GUB-*ma* "during the eclipse, a thin dark cloud stood there".

DIR AN DIB, "clouds crossed the sky"

This cloud condition normally inhibits an observation of the moon or a planet with a Normal Star or a planet; thus we are obviously dealing with a heavy cloud cover of some sort. It is often associated with winds from the south or from the south and the east. It is possible that the literal translation is "clouds took possession of the sky", with DIB read as *sabātu* D, a view which is based on the unique passage from Sargon's 8th Campaign[43] quoted in CAD I/J 108a s.v. *imbaru*: "I set fire to their handsome houses and made the smoke from them billow up and *pān šamě kīma imbari ušabit* cover the sky like a fog". In other passages, however, *katāmu* is used with *pān šamě*, see CAD K 300 mng.le; see also below s.v. ŠÚ. The meteorological interpretation was first proposed by Kugler[44].

If, on the other hand, DIR AN ZA is considered as containing the verb *sabātu*, then DIB in DIR AN DIB must be a different verb. A possible candidate is *etēqu*, "to pass, go along". I therefore translate DIR AN DIB as "clouds crossed the sky", although *etēqu* is not so far attested with clouds as a subject. The reader should keep in mind that this is a provisional translation intended to maintain the difference between DIR AN DIB and DIR AN ZA. While the translation may be wrong philologically, it is meant to indicate that there were too many clouds to permit observations. Additional material may one day provide the clue to these logograms.

DUGUD "heavy" is said of fog and clouds.

DUH. see TU.H

DUL

is one of the most problematic weather words. It occurs exclusively with rain of different kinds (and hail). It is written either alone or followed by PA; during part of the 3rd century B.C., it may also be followed by H.A. PA or H.A never occur alone, i.e., without DUL before them; so they do not stand for independent words, but are complcments to DUL. This is confirmed by the occurrence of DUL-PA in TCL 6 20 rev. 7. If both PA and H.A are meant to indicate the same reading of DUL, a common initial consonant *-h* can be found by reading PA as *hat* and H.A as *ha*. Unfortunately, no fitting reading for DUL can be suggested. DUL is a well known logogram for , *katāmu*, but this cannot be reconciled with a complement *h*. To assume a word *dulhu* or *duluhtu* which would have the literal meaning "confusion" does not seem to fit the syntax; DUL must contain a verb, as is shown by the passage AN *kab-bar u* NA$_4$ GAL DUL "thick rain and large hail DUL" in *LBAT* 665 rev. 4'. In view of this situation, I do not translate DUL.

$^{(kuš)}$E-SÍR see TUH.

GIB see TIR-AN-NA

GÍR "lightning"

This is an abbreviation of NIM-GÍR, Akk. *birqu* (the longer form is also attested occasionally in diaries). Since *birqu* is frequently used with the cognate verb *barāqu*, GÍR GÍR is to be understood as *birqu ibriq* "lightning flashed". GÍR

GÍR-GÍR is probably to be read *birqu ittanabriq* "lightning flashed repeatedly, continuously"; for syllabic writings cf. CAD B 104 *barāqu* mng.3.

GIŠ.HUR see TÙR

GÙ U "thunder"

This pair of signs is to be read *rigim Adad* "cry of (the weather god) Adad'. This cry of Adad can be called *sarhu* "wailing"; see *AHw*. s.v.. *sarhu* II. Another expression is ^{d}IM GÙ-*šú* ŠUB-*di*, *Adad rigimšu iddi* "Adad gave his cry". This is used to indicate a single clap of thunder, and is counted (up to three) in the diaries. I translate GÙ U by "thunder", the other phrase by "it thundered".

hillu "haze"

hillu occurs with the same phrases AN ZA and AN DIB as does DIR "clouds"; for a discussion of these, see above s.v. DIR. In addition, *hillu* is also said to "cover the sky", written AN ŠÚ-*im*. The reading is not entirely certain, but is likely to be *šamê katim*. *katāmu* is said of the sky, and ŠÚ is a common logogram for *katāmu*.

IM. UGUD "fog"

Akk. *imbaru*. It occurs alone or together with clouds and "mist" (*akamu*); sometimes it "covers the sky" (AN ŠÚ-*im*).

IM-GÚ "mud"

Akk. *qaduūtu*.

kab-bar "thick" .

Often abbreviated to *kab*, once written *ka-bar*. It is said of rain, probably in regard to raindrops.

NA_4 "hail"

NA_4, Akk. *abnu*, means "stone", but the phrase "it rained stones" is used to describe hail. Occasionally the size of hail stones is indicated in the diaries.

nalšu "dew"

The meaning "dew" of this word is established from other texts. Strangely enough, it is usually preceded by AN "rain". The syntactic relation between the two words remains uncertain, but cf. the possibly analogous situation with UTAH, DUL and PISAN.

PISAN

The reading PISAN for this sign was chosen by A.Sachs probably because of the occurrence of a rain-connected phenomenon written *pi-sa-an-nu* in TCL 6 20 r. 8. The same *pisannu* may be attested in Ebeling Handerhebung 18:6: *kīma tīk šamê ana ašrišu lā iturru kīma mê pi-sa-ni ana arkišunu lā iturru* "just as a (rain) shower from the sky does not return to its place, as water of a *pisannu* does not turn back". Admittedly, this passage can also be understood as referring to water poured from a container called pisannu.

In the diaries, PISAN always follows rain of some kind; it never occurs alone. This does not mean that it needs to be connected with the word "rain" syntactically. PISAN can in turn be followed by MAH' "much" or *isa* "a little"; in two cases, PISAN is followed by *rad* which otherwise occurs as a specification of rain and is considered as *radu* "cloudburst". The phrase containing PISAN always ends with the sign DIB which therefore most likely represents a verb construed with PISAN. Either the rain is the subject of the sentence, PISAN the object, and DIB the verb; or "rain" is standing alone, and PISAN is the subject of a sentence with DIB as its verb. The latter possibility is supported by passages where "rain" is followed by a verb of its own, separating it from PISAN, like AN ŠUR-*nun* PISAN DIB "it rained, PISAN DIB". There are three passages where rad seems to take the place of PISAN; I do not understand them either. Because of the problems connected with PISAN DIB, I do not translate it. For a detailed presentation of the combinations occurring with it, see the glossary.

rādu "cloudburst"

almost always is preceded by AN "rain"; other words like kabbar or MAH. may come between them. AN *rādu* is similar to some other combinations with "rain" where AN seems to have the force of a determinative because the word following it is not an adjective but a substantive. Only once (-384 IX 13) this word is written *ra-a-du*; all other occurrences use the sign *rad*. Were it not for the one syllabic passage, one would expect *rad* to be a logogram for some adjective describing rain; but it does occur alone in BM 65170, a fragment containing weather observations only, where we twice find DIR AN ZA *rad*. This also suggests that *rad* represents a substantive. In most cases it precedes PISAN DIB (see PISAN); the relation between the two is unclear. Three passages have *rad* apparently instead of PISAN; it is not clear to me what this implies for the understanding of *rad* or PISAN.

sarhu see GÙ U

ŠÁR

frequently follows the name of a wind. It is in turn sometimes (but not always) followed by GIN, which said of a wind means "it blew" (Akk. *illik* "it went"). ŠÁR is therefore likely to be an adjective. Since winds which are ŠÁR are in addition often described as strong or stormy, a reading DÙG and meaning "sweet" seems unlikely. In some places in his translations, A.Sachs rendered it by "gusty". While this would fit, I have been unable to find an appropriate Sumerian or Akkadian equivalent. Once ŠÁR is followed by *ah* which may be a phonetic complement. In A.Aaboe's article in *Centaurus* 24 (1980) 17ff., Sachs leaves the word untranslated. I translate "gusty", but this is very uncertain.

$ŠED_7$ "cold"

Akk. *kussu*. Frequently the sign group IG-TE-ŠIR, sometimes abbreviated to ŠIR, follows $ŠED_7$. This looks like a 3rd ps. sing. perf. of a verb *gešēru* etc. There are some problems with this form, though: if it came from *gašāru* "to be strong", one would expect *igdašir* or *igdešir*; *kešēru*, which would yield the form attested here, means "to succeed" and does not fit the context; *qašaru* does not exist. With some hesitation, I translate *ig-te-šir* as "(the cold) became severe".

$ŠED_7$ can also be used for an adjective *kasu* "cold" to describe a cold wind.

sēnu see TUH

ŠIR see ŠED7

ŠÚ "overcast"

This translation was used by A.Sachs *apud* A.Aaboe, *Centaurus* 24 19. From the writing ŠÚ-*up* in Nos. -651 and -567 one would assume a reading *īrup* "(the weather) became cloudy", cf. AHw. s.v. *erēpu*; correspondingly, ŠÚ ŠÚ "very overcast" would have the reading *urrup* or *urrip*. Unfortunately, ŠÚ is once (No. -112 XII2 8) followed by the phonetic complement *im*, which implies a reading *katim* or *arim* "covered". Some confusion may well have arisen from the several different uses of the sign ŠÚ in the diaries.

TIR-AN-NA "rainbow"

also written ^{d}TIR(-RA)-AN(-NA), Akk. *manzât*. The well-known meaning "rainbow" fits the passages in the diaries. Rainbows are always said to "stretch" (GIB, Akk. *parāku*) in some direction. If a rainbow is not a complete arch, it is called *butuqtu* or *butqu* "section ".

TUH

occurs in the phrase AN *sēnu* TUH. Its meaning was discovered by A.Sachs [45]. He realized that the writings $^{(kuš)}$E-SĪR and *še-ni* both represent *šēnu* "sandal", and that TUH is the logogram for *patāru* "to loosen, to remove". Confirmation for this he found in an Old-Babylonian proverb [46] *"u_4-mu i-ru-up-ma šá-mu-ú u*[*l iz-nu-un*] *šá-mu-ú iz-nunma še-na ul i*[*p-tur*] "the weather became cloudy, but rain did not fall; rain fell, but it did not loosen the sandal ". In this proverb the idiom *šéna patāru* seems to imply that it is the rain which removes the sandal, presumably from the feet of people. In fact the ground in southern Iraq becomes muddy and rather sticky after a rain so that one is better off to carry one's sandals and walk barefoot than having to pull the sandal from the mud with every step. *patār šéni* also occurs in TCL 6 20 rev. 7 [47] among terms for types of rain. I translate AN *šéni* TUH "rain (so that) the sandal was removed". This translation is deliberately ambiguous (as is the cuneiform): one can either understand that people removed their sandals during rain (as they do in Iraq today), or that the rain removed the sandals by making the ground sticky.

TÙR "halo"

Akk. *tarbasu* "pen, fold". Haloes are frequently described as "billowing" (*iqtur*, lit. "it smoked"). If a halo is not closed it is said to have a "gate" in a certain direction. The larger type of halo called *supūru* is not so far attested in diaries. Sometimes a GIŠ.HUR "drawing" around the moon is reported; this refers to the corona phenomenon, as was seen already by F. X. Kugler [48].

UTAH,

This word occurs almost exclusively after AN "rain". UTAH, probably represents some form of the verb nataku "to drip". Occurrences where an adjective qualifying "rain" separates AN from UTAH, (like AN *kab-bar* UTAH,) support this interpretation. Following A.Sachs, I translate AN UTAH, as "rain shower". One should not associate the idea of a heavy shower with this translation; J. Kamminga informs me that UTAH, is the lightest form of rain occurring in the diaries.

ZI IR The reading and meaning of this expression are unknown to me, and I leave it untranslated.

6. PRICES

In Babylonia, the relation between money and goods is expressed by the amount of goods that can be bought for a unit of money. For this reason, the word "price" which means the amount of money corresponding to a unit of merchandise is slightly misleading in this context. As an example, the tariff regulating "prices" in the Laws of E~nunna lists the amounts of goods that are to be sold for 1 shekel of silver. The statements about "prices" at the end of each monthly section of the diaries are introduced by the word KI.LAM (Akk. *mahīru*) which in this context is best rendered by "equivalent". Here too the unit of money is 1 shekel of silver. Sometimes the diaries explicitly say *ana* 1 *šiqil kaspi qalû* "for 1 shekel of refined silver". In later diaries (from about SE 60 on) we find the additional remark *ša ina māti innadnu* "which was given in the land" after the statement of the equivalents for the commodities mentioned.

The "equivalent" of the following basic commodities is considered in the diaries: *še 'u* "barley", *suluppu* "dates", *kasû* "mustard", *sahlû* "cress", ŠE.GIŠ.Ì "sesame", and SÍG "wool" [49]. Wool is weighed, i.e. measured in minas; 1 mina is approximately one pound. The other commodities are measured in capacity units: 1 kur = 5 pān; 1 pān = 6 sūt; 1 sūt = 6 qa. 1 qa is about one liter; so 1 kur corresponds to ca.180 liters. When no further remarks are made, the equivalents given can be assumed to have been valid for the whole month. Sometimes changes in the prices occurred in the course of a month, and these are recorded in the diaries. In general, prices changed more often at times when they were high, i.e. when the amount of commodities available was small. If some goods were not for sale at all, this is also noted in the diaries: *mahīru paris* "sales were cut off"; this could occur as a consequence of war or similar disturbances.

There are also texts which contain prices only. These were apparently excerpted from diaries.

7. RIVER LEVEL

At the end of each monthly section (in earlier diaries also among the day-to-day observations), changes in the height of the water in the river Euphrates are listed. Whenever the water switched from rising to falling or vice versa, the preceding period is summarized and the amount of change over this period noted. This is best explained by an example:

TA x EN y ILLU m SI LAL TA y EN z ILLU n SI GIN "from day x until day y, the river level receded m fingers; from day y until day z, the river level rose (lit. went) n fingers".

ILLU (Akk. *mīlu*) is the word for the high water in the rivers in spring and early summer, frequently translated by "flood". In the diaries, it simply means "river level", regardless of season or height. Therefore another term had to be used to designate the highest water; this is *mīl kiššati* "peak flood". - LAL is sometimes written LAL-*is* which shows that it is to be read as a form of *nah*āsu "to recede". GIN (Akk. *alāku*) "to go" is used for "to rise", a usage well attested in other texts.

If the water remained at the same level for several days, this is expressed by GUB-*uz*, to be read *ušuz*, "it was standing".

The changes in the river level are measured in fingers and cubits which seem to be the otherwise known measures of length; 1 cubit = 24 fingers. In earlier diaries, all river level statements are relative, as described above. Towards the end of the 4th century, a method to indicate the absolute height of the water is introduced. After the statement of how much the water level changed (see above) follows: PAP x *na*. PAP in this phrase is optional; it probably is to be read *napharu* "total". *na* was assumed by A. Sachs [50] to refer to a kind of gauge on which the level was read; alternatively, *na* could

represent a measure. The reading and literal meaning ofna in this context are unknown to me; it may be an abbreviation or a logogram used only in these river level statements. The amount on the gauge is measured from some fixed point downwards because the number x before na increases when the water recedes, and decreases when it rises. This fixed point was probably some high part of a sluice gate in Babylon where the measurements could be taken. There also was a point to which one expected the peak flood to reach; once (SE 155 month I) it is reported that the water "rose above the peak flood by 2 fingers". When the water fell again by 2 fingers the text says that "there was no *na*". From this one can conclude that the na measured from the assumed peak flood level downwards. The units which are used in connection with na are equivalent to 1/6 cubit or 4 fingers, as can be seen from comparison between consecutive na values; A. Sachs [51] suggested that this unit corresponds to the height of a layer of bricks. If, as suggested above, na happens to be a measure, it should equal 1/6 cubit.

In earlier diaries, reference is made to something called *bābtu*, occasionally abbreviated *bāb*. *bābtu* means "remainder" (or, less likely in this context, "city quarter"). It is inserted in the river level statements as follows:
ILLU n SI *bābtu* m SI GIN "the river level - n fingers babtu - rose m fingers".

The first number is to be connected with *bābtu*, and the second number with the verb at the end; this is shown by one passage (No. -203 r. 7) where the numbers can be compared to measurements on the *na* gauge (see above). The numbers preceding *bābtu* are always smaller than those following it; otherwise, I cannot detect any arithmetical relation between them. In general, *bābtu* occurs in earlier texts, before the middle of the 3rd century (the passage from -203 just quoted is a late exception); the *na* measurements, on the other hand, appear only towards the end of the 4th century. The sign PAP, which is frequent in front of the *na* measurements, cannot be read *bab* and understood as the same as *bābtu* because its syntax is different from the latter.

In some cases of very high water the level is said to be *elēnu apāti* "above the apertures"; these apertures too are probably some part of a sluice.

8. HISTORICAL EVENTS

The so-called historical sections of the diaries are of remarkable unevenness: sometimes they record events of ephemeral bnportance from the city of Babylon, in other cases events of political significance.

The reason for this is that the compilers of the diaries lived in Babylon and depended for their historical remarks on whatever they happened to hear. This is frequently expressed by the word *alteme* "I heard". So it is understandable that sacrifices in the temple of Marduk provided by royal officials are often mentioned because the observers were connected with the temple. Similarly, they would know about fires in some city quarter or about the spread of diseases. For events in other parts of the empire they had to rely on hearsay.

Even if we had the diaries complete, historical information from them would be very Babylon-centered. But of course every bit of news is welcome for a period where so little is available.

FORMAT OF PRESENTATION

The diaries for each year will be presented in the following format: Transliteration and translation appear on opposite pages. At the beginning of each section, bibliographical information will be given. If several diaries are preserved for one year, they will be differentiated by capital letters A, B, etc. The year in the Julian Calendar is identified by the number of each section. On the right side of the heading, the year is named according to the Babylonian convention valid at the time, e.g., Artaxerxes III year 10, or, SE 25. Next to this, I list the months of the year in question for which information is preserved in the extant diaries.

Conventions of transliteration

The transliterations follow R. Borger, ABZ, with the addition of *šamáš* = MAN (following the usage of O. Neugebauer in ACT) and MUL_x = ÁB.

Since in many cases the Akkadian equivalents of logograms used in the diaries are unknown, and also in order to save space, I have transliterated logograms with Sumerian or conventional readings. To alleviate the burden thus placed on the Assyriological reader, the glossary provides Akkadian readings for all logograms (where known), and cross references from Akkadian to logograms. In addition, uncertain cases are explained in the commentary to the passage where they occur. It should be noted, however, that the highly formulaic style of the diaries, which gave rise to peculiar logograms and graphic abbreviations, leads to some doubt as to what extent these texts were actually read in Akkadian. Still, while the grammar

may be peculiar, we ought to assume that Akkadian words were used. I have tried to find an Akkadian reading for all the phrases occurring. In this I was not always successful; in fact, I could identify only a few readings beyond those established by A. Sachs. He may have had more ideas on some of the unread signs but he did not put them down in writing.

I am aware of the criticism raised by R. Borger[52] against the kind of transliteration described above, and I agree with him for most types of texts. The diaries, however, use so many exceptional logograms that a consistent application of the transliteration favored by Borger would result in a very cumbersome print, and also in a large number of additions to his list of Akkadian readings which would be valid only for diaries and similar astronomical texts, being useless (or even confusing) for Akkadian texts in general. For example, the diaries use the sign AN for *Salbatānu* "Mars" and for *zunnu* "rain", A for "Leo" (abbreviation of UR-A), and KUR (instead of KUR_4) for *ba ʿālu* "to be bright".

A. Sachs had used square brackets, half brackets, dots and their combinations to indicate the state of preservation of each sign. I did not consider it possible to consistently implement such a system or to use it in print, and decided to employ a simplified version of it which corresponds to the usage of the Chicago Assyrian Dictionary: If the right or left part of a sign is missing, this will be indicated by square brackets: [a]b or a[b]; signs damaged in some other way will be enclosed in half brackets: rabl, regardless of what part is damaged. No dots will be used. Where I have doubts about the reading of a sign a question mark is added after the transliterated sign. In some cases, when a sign or a passage could not be read or restored, I add a drawing of it. In the transliteration, I try to guess the size of gaps by putting as many x within square brackets as signs could be restored; .... indicate an indefinite number of missing signs; in the translation ..... mean an indefinite number of missing words. [nn] means that a number is missing, [mm] a missing measure.

A. Sachs collated almost all diaries in the British Museum as far as one can tell from numerous collation results entered in his copy of LBAT and in his transliterations. These results are incorporated here. I did not collate these passages again except where I had doubts about a reading or hoped to be able to find out more. It ought to be said, however, that I could only rarely improve on his collations.

This edition contains photographs instead of copies; the attempt to provide copies of new texts would have delayed publication far beyond any acceptable date. Many copies of diaries by Th.G.Pinches or J.N.Strassmaier are available in LBAT. A few copies by Pinches which were not included in LBAT are published here.

In accordance with the example of A. Sachs, diaries will be numbered in this edition by means of the year (in the Julian calendar) to which they refer: No. -300 means a diary for year 11 of the Seleucid era which falls for the greater part in the year -300 of our era. If several tablets exist for the same year, they will be differentiated by capital letters (A, B, etc.). In most cases, it will be sufficient to refer to a text passage by "diary for -292 X 12", thus using the date of a phenomenon as a means of reference. When questions of reading etc. are addressed, texts can be quoted as "no.-292 A rev. 10", indicating a line on a specific tablet. This way of quoting keeps to a minimum the disadvantages of yet another numbering (besides museum numbers and LBAT numbers); if new texts are found, they can be incorporated without upsetting the sequence of numbers.

Obverse and reverse of a tablet are identified if possible; otherwise a fragment is called a flake. The following convention is used to indicate what part of the tablet is preserved:
Obv. = beginning and end (of obverse) preserved
'Obv. = beginning broken, end preserved
Obv.' = beginning preserved, end broken
'Obv.' = beginning and end broken.
Sometimes the number of lines missing to beginning or end is estimated.
It is evident from broken passages whether the left, middle, or right part of a text is preserved.

Remarks on Translation

The terminology used in the diaries is rigid and very condensed. The order of items recorded is also to a large extent fixed. Because of the repetitive character of these texts, the scribes apparently tried to reduce as much as possible the number of words they had to write.

In translating I have tried to imitate this style by using a similarly rigid terminology. Unfortunately, the almost exclusively logographic writing of the diaries frequently makes it impossible to determine whether the Akkadian text consisted of sentences or asyndetic sequences of nouns. Where this can be decided with the help of one of the rare syllable writings, I have of course translated accordingly. But more often I had to choose some fixed translation which may not be syntactically equivalent to the Akkadian hidden by the logograms. In addition, several statements which are very short in cuneiform had to be translated by longer expressions to convey the meaning without creating a new artificial terminology. The way in which the diaries indicate the length of a month can serve as an example. This length can be 29 or 30 days. The

diaries are arranged in sections each of which deals with a single month. Each section begins with the name of the month; after the name, a "1" indicates that the preceding month had 30 days; a "30", that it had only 29. The idea behind this terminology seems to be that a "regular" month ought to have 30 days[53], in which case the next month begins with a "lst" day; if a month has only 29 days, its successor begins, so to speak, already on the "30th" day which would have been theoretically possible for the preceding month. In order to make this visible in the translation, I have formulated sentences which contain the words "the lst" or "the 30th" (which are all that is written in the text), and at the same time clearly state the situation: Month X, the 1st (of which followed the 30th of the preceding month), or: Month X, (the 1st of which was identical with) the 30th (of the preceding month).

Notes

1 Much of the matter discussed here can be found, albeit in shorter form, in two articles by A. Sachs (*JCS* 2 271ff. and *Phil. Trans. R. Soc.* Lond. 276 (1974) 43ff.). Although the first of these articles was based on very limited material, its classification of the astronomical texts of the Seleucid period remained valid even after hundreds of tablets more had become available. A preliminary translation of a diary by A. Sachs is included in an article by A. Aaboe (Observation and Theory in Babylonian Astronomy, *Centaurus* 24 17ff.) where one can also find a short description of the diaries' content. The diaries and related texts are treated by P. Huber in B. L. van der Waerden, *AA*.

2 *BOR* 4 132, see B.Landsberger, *ZA* 41 298f., and *CT* 49 144, see G. McEwan, *FAOS* 4 18ft.; *cf.* the additional remarks on these texts, and on others referring to astronomers, by R.J.van der Spek, *Bi0r* 42 548ff.

3 For these wax-covered boards see D. J. Wiseman, *Iraq* 17 3ft.; S. Parpola, *LAS II* p. 333; idem, *JNES* 42 lff.

4 *Cf. LBAT* 1413ff.

5 *ABL* 882,909, 1408, and 1444, see Parpola *LAS* Nos. 80, 84, and 105. and his commentary to No. 105.

6 D. Pingree and E. Reiner, *RA* 69 175ft.

7 Nos. 1368ff.

8 *Bulletin of the Society for Mesopotamian Studies* 8 20f.

9 This development is discussed in *PI)* p. I ft. where references can be found. Additional material has become available since, but the general picture has not changed. See especially S. Parpola, *LAS* 1I p. 381 ft.: J. A. Brinkman and D. A. Kennedy, *JCS* 35 1 ft.; i). A. Kennedy, *JCS* 38 172ff. The mathematical properties of the 19 year cycle are discussed in *HAMA* 354ff and by K. P. Moesgaard. (*Centaurus* 24 51 ff. For the schematic dates of solstices and equinoxes, and of Sirius from the 19-year cycle, see below section 3.

10 A. Aaboe, *Centaurus* 24 24.

11 O. Neugebauer, *Isis* 37 37ff.

12 O. Neugebauer, *HAMA* 544f.

13 O. Neugebauer, *HAMA* 545.

14 *AB* p.115.

15 O. Neugebauer, *HAMA* p. 545f.

16 O. Neugebauer and A. Sachs, *JCS* 21 201 rev. lff.

17 Schaumberger, *SSB* Erg. 307.

18 I do not know of a part of the chariot called ŠUR. Is ŠUR to be taken as logogram of *sarāhu* "to twinkle' ?

19 0. Neugebauer, *HAMA* p. 545f.

20 *Planeten-Tafeln fur jedermann* (Berlin 1927); S. Langdon - J. K. Fotheringham - C. Schoch, *The Venus tablets of Ammizaduga* (Oxford 1928).

21 *Astronomische Chronologie*, 2 vols.(Berlin 1929); *Tafeln zur astronomischen Chronologie*, 3 vols. (Leipzig 1912-22)

22 O. Neugebauer, *JCS* 2 209ff.; A. Sachs, JCS 6 105ft.

23 *JCS* 2 281.

24 *SSB* II 540.

25 O. Neugebauer and A. Sachs, *JCS* 21 212f.

26 Neugebauer and Sachs, *ibid.*

27 F. X. Kugler, *SSB II* 547ff.; O. Neugebauer and A. Sachs, *JCS 21* 204f. ss *HAMA* 546f.

28 *HAMA* 546f.

29 *LBAT* 1413ff., going back to the second half of the 8th century.

30 See the forthcoming edition of these eclipse omens by F. Rochberg-Halton.

31 See already P. Huber in B. L. van der Waerden, *AA* p. 101 f., for a summary.
32 For the terminology used, see Neugebauer and Sachs, *JCS* 21 212f.
33 A. Sachs, *JCS* 2 274; O. Neugebauer, *ACT*.
34 0. Neugebauer, *ACT* p. 288.
35 A. Sachs, *JCS* 2 278f.
36 *HAMA* 357ff.
37 *ABL* 1428f., see S. Parpola, *LAS* No. 344f., and his commentary in *LAS II*, in which he suggests that a gnomon was used to determine the date.
38 Discovered by A. Sachs, *JCS* 6 105ft.
39 See already *HAMA* 364f.
40 See "Halley's Comet in History", ed. by F.R.Stephenson and C.B.F.Walker, London 1985.
41 See my article "Astrologische Wettervorhersagen" in *ZA* 66 234ff.
42 Cf. A.Sachs, *Phil. Trans. R. Soc*. Lond. A.276 p. 46.
43 TCL 3 261
44 *SSB* I 78f. and 269a under DIR.AN.LU.
45 *Phil. Trans. R. Soc*. Lond. A. 276 p.46.
46 *BWL* 263 BM 38283 rev. 11 f.
47 Misunderstood in *ZA* 66 239.
48 *SSB II* 124f.
49 The translations for *kasû* and *sahlû* are uncertain, see *CAD* and AHw. s.vv.
50 *Phil. Trans. R. Soc. Lond*. A 276 p.47.
51 *Op.cit.*
52 *ABZ* p. 301f.
53 This idea is attested already in celestial omens, see S.Parpola, *LAS II* p.88, referring to texts from the 7th century.

LIST OF ABBREVIATIONS

AA	B.L.van der Waerden, *Anfänge der Astronomie*. Groningen 1966.
AB	J. Epping, *Astronomisehes aus Babylon*. Freiburg 1889.
ABL	R.F.Harper, *Assyrian and Babylonian Letters*. London/Chicago 1892-1914.
ABZ	R. BorgeL *Assyrisch-babylonisehe Zeiehenliste*. Kevelaer/Neukirehen-Vluyn 1978.
ACh	C. Virolleaud, *L'Astrologie Chaldéenne*. Paris 1908-11.
ACT	O. Neugebauer, *Astronomical Cuneiform Texts*. London 1955.
Afo	*Archiv für Orientforsehung*. Berlin/Graz/Horn.
AHw	W. von Soden, *Akkadisches Handwörterbuch*. Wiesbaden 1959-81.
BHT	S. Smith. *Babylonian Historical Texts Relating to the Capture and Downfall of Babylon*. London 1924.
BiOr	*Bibliotheca Orientalis*. Leiden.
BM	Tablet numbers in the British Museum.
BOR	*The Babylonian and Oriental Record*. London.
BWL	W.G.Lambert, *Babylonian Wisdom Literature*. Oxford 1960.
CAD	*The Assyrian Dictionary of the Oriental Institute of the University of Chicago*. Chicago 1956ff.
CT	Cuneiform Texts from Babylonian Tablets etc. in the British Museum. London.
FAOS	*Freiburger Altorientalische Studien*. Wiesbaden.
Grayson Chronicles	A. K. Grayson, *Assyrian and Babylonian Chronicles*. Locust Valley 1975.
HAMA	O. Neugebauer, *A History of Ancient Mathematical Astronomy*. Berlin - Heidelberg - New

York 1975.

JCS — *Journal of Cuneiform Studies*. Cambridge, Mass./Philadelphia. Journal of Near Eastern Studies. Chicago.

LAS — S. Parpola, *Letters from Assyrian Scholars to the kings Esarhaddon and Assurbanipal*. Kevelaer / Neukirehen-Vluyn 1970/83.

LBAT — T.G.Pinches - J.X.Strassmaier - A.J.Saehs, *Late Babylonian Astronomical and Related Texts*. Providence 1955.

MSL — B.Landsberger et al., *Materialien zum Sumerischen Lexikon*. Rome 1937ff.

Or — *Orientalia*, Nova Series. Rome.

PD — R. A. Parker - W.H.Dubberstein, *Babylonian Chronology 626 B. C. - A. D. 75*. Providence 1956.

PVN — P. V. Neugebauer, *Astronomische Chronologie*. Berlin/Leipzig 1929.

RA — *Revue d'Assyriologie*. Paris.

Racc. — F. Thureau-Dangin, *Rituels accadiens*. Paris 1921.

SE — Seleucid Era.

SSB — F.X.Kugler, *Sternkunde und Sterndienst in Babel*. Miinster 1907 -24.

SSB Erg. — F.X.Kugler and J.Schaumberger, *Sternkunde und Sterndienst in Babel, Ergänzungshefte*. Miinster 1913 -35.

TCL — *Textes cunéiformes du Louvre*. Paris.

Tuckerman — B. Tuckerman, *Planetary, Lunar, and Solar Positions 601 B. C. to A. D. 1*. Philadelphia, 1962.

ZA — *Zeitschrift für Assyriologie*. Leipzig / Berlin.

THE DIARIES, CONCEPTS, AND NORMAL STARS

1.1 The Astronomical Diaries and Related Texts

Published in 1988, *Astronomical Diaries and Related Texts from Babylonia* by Abraham J. Sachs and Hermann Hunger represents the fruits of much labour embracing the collection, collation, transcription, translation, and not least of all the synchronization of precise dates with astronomical events recorded in the diaries from Babylonia. The following summary by Fatoohi *et al* (*The Babylonian First Visibility of the Lunar Crescent: Data and Criterion*, 1999:53-54) provides a helpful introduction:

> These diaries represent records of daily astronomical observations made in the Neo-Babylonian period by professionals who, according to excavated late documents, were employed and paid specifically to make these observations. Their job also included recording their observations in the diaries and preparing astronomical tables and yearly almanacs. A diary usually covered six months of observation. The entries for each month typically include information on the following: the length of the previous month; lunar and solar eclipses; lunar and planetary conjunctions with each other or with the normal stars; solstices and equinoxes; heliacal risings and settings of planets and Sirius; meteors; and comets. In the diaries, the Babylonians systematically recorded the six-time intervals termed by A. Sachs "Lunar Sixes." ... In addition to the astronomical data, the diaries also contain some non-astronomical information: on the weather, the prices of six basic commodities, the height of the river Euphrates, and certain historical events.
>
> It should be emphasized that although the major bulk of the celestial phenomena referred to in the diaries are actual observations, some of the recorded events are not observations but rather predictions based on certain mathematical calculations.
>
> Sometimes this is clearly stated whereas on other occasions it is implicit, as in the case when the sky is mentioned as having been overcast.
>
> Most of the available tablets containing diaries are damaged to varying degrees – often extensively. In some cases the date of the tablet is broken away. Such tablets can often be dated by using a unique combination of astronomical data that they record – for example, eclipses and lunar and planetary positions. This is how Sachs and Hunger determined many of the dates of the diaries, which they recently published in transliteration and translation in three volumes. These volumes, which form the exclusive source for the Babylonian data of the current study, cover diaries from -651 (652 B.C.) to -60 (61 B.C.).

Based on the 600-year interval of the Diaries one might reasonably expect to gain further insight into the methods by which Babylonian astronomers of the Seleucid Era determined their luni-solar and planetary parameters and eventually their theoretical framework. This is especially so with respect to the derivation of such things as fundamental period relations, lines of apsides, mean velocities and varying velocity functions for the major planets. Intuitively, this might reasonably have followed from continued observations of successive planetary phenomena, *i.e.*, first and last appearances in the east and west, corresponding disappearances, stationary points, regions of retrograde motion and achronical risings, etc. Such phenomena might seem somewhat archaic to us today, but they are natural enough and they could also eventually lead to both the Babylonian planetary period relationships, mean values, and varying velocity functions. But while the latter indisputably exist in the material from the Seleucid Era, any such final realization would nevertheless have required continuity. Yet disappointingly and perhaps surprisingly, this is not generally present in the Diaries. In short, though the current state of preservation may be a mitigating factor, the Diaries in general do not run continuously throughout the year. In fact VAT 4956, for example, only concerns events that occur in two widely separated four-month intervals. Thus, using modern dates the Diary largely concerns the second quarter of 568 BCE and the first quarter of 567 BCE, *i.e.*, from late April into July 568 BCE in the first instance and mid January into May 567 BCE in the second. Or, as recorded in the Diary itself, months I, II, III [ ] followed by months X, XI and XII belonging to Nebukadnezar II, Year 37 onward.

1.2. Luni-solar and Planetary Phenomena; Angular Units of Measure

In spite of information in the Introduction to *Astronomical Diaries and Related Texts from Babylonia* by Sachs and Hunger detailed examination of the various phenomena in the Diaries might still require some groundwork for those unfamiliar with the astronomical side of the matter, not to mention the unusual notation and terminology applied in the Diaries themselves.

Luni-solar Phenomena

The evening of the first visibility of the lunar crescent defines the beginning of the month both here and in other Middle-Eastern contexts and as such it is among the most easily understood of the six lunar phenomena. This said, luni-solar motion itself is far from simple, but the following accurate mean Babylonian periods are attested by at least the time of the Seleucid Era:

The mean *synodic* month: 29;31,50,8,20 days (29.53059413)
The mean *sidereal* month 27;19,18 days (27.3216667),
The *anomalistic* month 27;33,16,19,20 days (27.5545370)
The *draconic* month: 27;12,43,40 days (27.21212963)
The *SAROS* of some 223 mean synodic months (5685.322... days)
The 18.6 Year/230 mean synodic month *Eclipse* cycle (SAROS + 7 months + k)
The 346-day *Eclipse* Cycle: (346.604554 days)
The 411-day *Anomalistic* Cycle: (411.779846 days)
The Lunar *Apsidal* cycle: (8.8509147 Years.) [Implicit]

A surprising variety of year lengths are also present in Babylonian astronomy, ranging from 365;14,44,51 days (365.2457916...) based on an 18-year cycle to the slightly too large value of 365.260637 days – a convenient approximation expressed in months, specifically 12;22,8 mean synodic months of 29;31,50,8,20 days as applied in impressive manner in planetary contexts. Other lengths for the years may be obtained from Babylonian parameters, and in passing it may be remarked here that it is impossible to ignore the pairing of the synodic and sidereal months in the Babylonian context (or indeed in any context) since the relationship between the two types of month *defines the motion of Earth* and *the sidereal year* (365.256469 days with the above constants), just as the synodic and draconic months define the 346-day eclipse cycle; the synodic and anomalistic months the 411-day anomalistic cycle, and the anomalistic-sidereal months the lunar apsidal period. But even so, to discus Babylonian luni-solar parameters in terms of mean values alone is an oversimplification given that a large part of Babylonian methodology concerns the determination of the limits of *varying* velocity in both planetary *and* luni-solar contexts. As for the latter, the Babylonian determination of varying velocities for both the Earth and the Moon still requires the understanding of the various inter-related cycles and the awareness that the lunar line of apsides is also moving throughout the month. All these cycles are implicit in the Babylonian mean periods, and many are in fact attested,

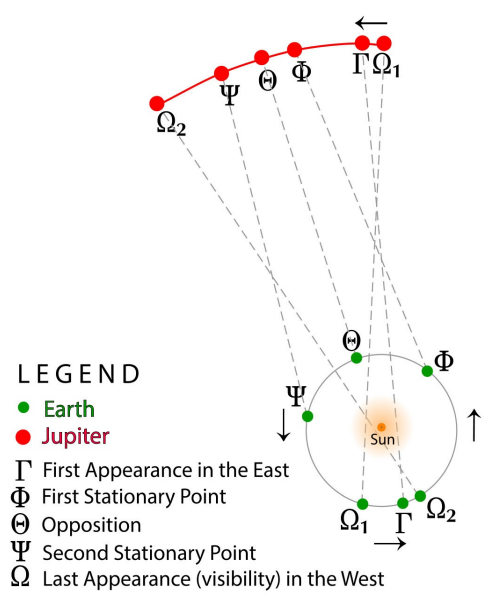
Planetary Phenomena

For the five visible planets known in Antiquity entries in the Diaries include what have become known as the characteristic "Greek-Letter phenomena" in the literature. For this reason they are presented below so associated and also as shown for the superior planet Jupiter in Figure 1:

TABLE 1 AND FIGURE 1 THE BABYLONIAN SYNODIC PHENOMENA

INFERIOR PLANETS		SUPERIOR PLANETS	
First Appearance in the East	Γ	First Appearance (in the East)	Γ
Stationary point in the East	Φ	First Stationary point	Φ
Last appearance in the East	Σ	Opposition	Θ
First appearance in the West	Ξ	Second Stationary point	Ψ
Stationary point in the West	Ψ	Last appearance (in West)	Ω
Last appearance in the West	Ω		

FIGURE 1.



The unfamiliar terminology in concert with sexagesimal notation and zodiacal signs is perhaps partly responsible for the limited understanding and lack of interest in Babylonian astronomy today. However, *historically correct or otherwise*, Babylonian characteristic synodic phenomena are *best understood in fictive, heliocentric terms incorporating the dual west-to-east motions of Earth, i.e.*, annual orbital *revolution* about the centre of the Solar system and diurnal *rotation* of Earth about its own axis.

The "Greek-Letter" synodic phenomena–with Earth the moving point of observation to provide dynamic substance to the terminology–are separated into two distinct groups depending on the relative positions of the planetary orbits with respect

to that of Earth. Thus Mercury and Venus, with orbits lying between Earth and the Sun belong to the Inner (Inferior) planets, while Mars, Jupiter and Saturn with orbits outside that of Earth are correspondingly the Outer (Superior) planets. The reason for two sets of first and last appearances for the Inferior planets and only one set for the Superior planets is best explained in fictive, heliocentric terms. In short, viewed from Earth, the superior planets only become obscured when passing around the far side of the Sun, whereas the Inferior planets become obscured twice, firstly when they too pass behind the Sun, and secondly, since their orbits lie between Earth and the latter, when they also routinely pass in front of the Sun. This necessarily includes occasional transits, but by and large (apart from the major influence of the diurnal rotation of Earth itself) their "settings" and "risings" are functions of their swifter motions and also their proximity to the Sun, hence their well known association as Evening and Morning "stars." As a natural consequence, evening observations towards the Sun and/or sunset are predominantly to the west, while morning observations towards the Sun and/or sunrise are correspondingly towards the east.

In terms of knowing what to look for, where and when, of the three Babylonian observational watches (shifts in modern parlance) for the Inferior planets (Mercury and Venus) the evening phenomena takes place during the "first part of the night" and the corresponding morning phenomena during the "last part of the night" as stated in the Diaries.

No doubt further explanation is required with respect to all of the above, although planetary entries in the Diaries are far from confined to these particular phenomena alone in any case, and many simply concern apparent planetary positions near specially designated stars distributed around the ecliptic (the “Normal” stars; see below). Rather than impose a lengthy introduction concerning such occurrences and the other astronomical terms treated in the Diaries, the following analysis assumes some degree of familiarity with the discipline.

Angular Units of Measure

Without invoking historical certitude, to render the material more understandable it seems best that it be treated in modern terms. This presents little difficulty where the phenomena recorded in the Diaries are understandable for what they are, *i.e.*, Sunrise and Sunset, Moonrise and Moonset, planetary risings and settings, etc, though even here attendant complications surface, for risings and settings naturally take place with respect to the horizon, but what actually constitutes the local horizon (with or without refraction) or precisely when such events took place in this particular context remains largely unknown. Also (and in general), a large part of initial difficulties with the material might arise from lack of familiarity with the units of measure and fundamental frames of reference against which the primary objects of interest are observed. The former are familiar enough since they are expressed in degrees, thus essentially sexagesimal notation in its original context. However, the larger cubit and lower subdivision the "finger" used for recording angular separation and relative positions in the Diaries cause problems since there appears to be no consensus among scholars concerning the precise value of the cubit itself. For present purposes and the time period under consideration the value given by Sachs and Hunger (1988:22) of 2 degrees per cubit and 1/24th of the latter for the finger (0; 5' or $1/12^{th}$ of a degree) may be retained in the present context (Neugebauer, *Astronomical Cuneiform Texts*,1955:39):

> The “degree (uš) is the fundamental unit for the measurement not only of arcs, especially for the longtiude, but also for the measurement of time, corresponding to ur use of right ascension. Therefore 1 degree = 4 minutes of time.
>
> The unit of 1 “finger” (šu-si) is 1/12th of a degree; 30 fingers make 1 “cubit“ (*ammatu*) and consequently
>
> (1) $$30^f = 1^a = 2;30°.$$
>
> It must be remarked that the relation $30^f = 1^a$ is actually Old Babylonian, whereas the Neo Babylonian relation is $24^f = 1^a$ which is also frequently used in Greek astronomy. It was Kugler, however, who showed that both norms $30^f = 1^a$ and $1^a = 24^f$ are in common use from Persian times into the Seleucid period. He found, moreover, that in the case of $1^a = 24^f$ the cubit corresponds only to 2 degrees instead of 2½ degrees in (1). In other words, regardless of whether we assume the cubit of 2 degrees or of 2½ degrees, the “finger” is always 1/12 of the degree.

Lastly, "time-degrees" are also applied with respect to the diurnal rotation of Earth for such intervals as the "moonset lagtime", *i.e.*, the time between sunset and moonset on the evening of the first lunar crescent. Such units are again familiar since we ourselves still utilize the 24-hour day, thus an hourly rotation of 15 degrees, etc., and as applied in the Diaries, 4 minutes of time per degree of angular rotation also confirmed by Fatoohi *et al* (1998:55).

2.1 The Babylonian Normal Stars

The two major frames of reference against which the main astronomical phenomena take place are the local horizon and a fixed celestial reference frame provided by some 33 bright stars distributed around the ecliptic, *i.e.*, roughly within a few degrees or so of the paths of the planets. For this group of stellar reference points (known as the "Normal Stars") Sachs and Hunger (1988:17–19) provide ecliptic coordinates covering the 600-year interval of the Diaries, specifically for the years –600, –300 and 0:

MODERN	BABYLONIAN NAME	STELLAR ECLIPTIC COORDINATES		
		-600	-300	0
η **Piscium**	The bright star of the Ribbon of the Fishes	350.73/5.23	354.87/5.24	359.02/5.26
β **Arietis**	The front star of the head of the Hired Man	357.88/8.39	2.02/8.40	6.17/8.41
α **Arietis**	The rear star of the head of the Hired Man	1.52/9.90	5.67/9.90	9.82/9.91
η **Tauri**	The Bristle	23.90/3.78	28.04/3.81	32.19/3.84
α **Tauri**	The Jaw of the Bull	33.65/-5.65	37.80/-5.63	41.95/-5.61
β **Tauri**	The Northern (Variable Star)[18] of the Chariot	46.47/5.17	50.61/6.19	54.76/5.22
ζ **Tauri**	The Southern (Variable Star) of the Chariot	48.68/-2.53	52.83/-2.49	56.98/-2.45
η **Geminorum**	The front star of the Twins' feet	57.38/-1.23	61.52/-1.18	65.67/-1.14
μ **Geminorum**	The rear star of the Twins' feet	59.16/- 1.09	63.31/- 1.06	67.46/- 1.02
γ **Geminorum**	The Twins' star near the Shepherd	62.98/-7.06	67.13/-7.02	71.28/-6.98
α **Geminorum**	The front Twin star	74.23/9.86	78.37/9.89	82.50/9.92
β **Geminorum**	The rear Twin star	77.54/6.48	81.64/6.50	85.74/6.53
η **Cancri**	The front star of the Crab to the north	89.32/1.33	93.46/1.36	97.61/1.39
ϑ **Cancri**	The front star of the Crab to the south	89.66/-1.00	93.80/-0.97	97.96/-0.94
γ **Cancri**	The rear star of the Crab to the north	91.49/2.96	95.63/2.99	99.77/3.02
δ **Cancri**	The rear star of the Crab to the south	92.59/-0.03	96.74/-0.01	100.89/0.00
ε **Leonis**	The Head of the Lion	104.59/9.51	108.73/9.54	112.88/9.57
α **Leonis**	The King	113.90/0.35	118.02/0.37	122.15/0.38
ρ **Leonis**	The small star which is 4 cubits behind the king	120.29/0.02	124.44/0.03	128.59/0.05
ϑ **Leonis**	The Rump of the Lion	127.28/9.65	131.43/9.65	135.59/9.66
β **Virginis**	The rear foot of the Lion	140.49/0.64	144.70/0.65	148.92/0.66
γ **Virginis**	The Single star in front of the Furrow	154.40/3.01	158.51/2.99	162.61/2.96
α **Virginis**	The bright star of the Furrow	67.77/-1.88	171.91/-1.90	176.06/-1.92
α **Librae**	The southern part of the Scales	189.04/0.65	193.18/0.62	197.32/0.58
β **Librae**	The northern part of the Scales	193.30/8.80	197.44/8.76	201.59/8.73
δ **Scorpii**	The middle star of the Head of the Scorpion	206.48/-1.66	210.62/-1.69	214.77/-1.73
β **Scorpii**	The upper star of the Head of the Scorpion	207.09/1.34	211.23/1.30	215.38/1.26
α **Scorpii**	Lisi	213.68/-4.23	217.82/-4.27	221.96/-4.31
ϑ **Ophiuchi**	The bright star on the tip of Pabilsag's arrow	225.30/-1.48	229.44/-1.53	233.59/-1.57
β **Capricorni**	The Horn of the Goat-fish	267.94/4.88	272.08/4.85	276.23/4.81
γ **Capricorni**	The front star of the Goat-fish	285.56/-2.28	289.72/-2.32	293.88/-2.35
δ **Capricorni**	The rear star of the Goat-fish	287.33/-2.13	291.48/-2.19	295.64/-2.24

TABLE 2. THE BABYLONIAN NORMAL STARS

2.2 The Babylonian Normal Stars and the Ecliptic

There are, however, difficulties with the disposition of the Normal Stars including unexpected gaps:

> It has to be noted that this selection of stars is not distributed evenly along the ecliptic, as one would expect a system of reference points to be. There is a gap between about 230° and 265°, and another one between 290° and 350°. It is not clear why these gaps occur; there are stars available in these areas which are at least as bright (or faint) as some of the other Normal-Stars. So far, no convincing explanation has been found. While the stars contained in the above list are by far the most common Normal Stars, occasionally others are used for the purpose of indicating the position of moon or planets as well. (Sachs and Hunger 1988:19)

Although not immediately obvious it is apparent from Table 2 that the distribution of the Babylonian Normal Stars exhibits certain oddities. Firstly, instead of an expected longitudinal spacing between adjacent stars, in regions approximately one third of the ecliptic apart, two pairs of Normal Stars are in fact quite close to each other, namely δ, γ Canci and δ, β Scorpii. However, the paired latitudes in these two instances extend slightly above and slightly below the ecliptic, thus basically bracketing this invisible reference line. Why these particular pairs? Although uncertain, it can be suggested that from one pair to the next provides a guideline for one third of the ecliptic and the entire ecliptic if a similar 120° pairing in Pisces is added. In which case the choice is limited to this constellation and also readily defined; *i.e.*, where the constellation line crosses the ecliptic and the nearest pair of brighter stars that bracket the same. Thus the choice is ζ Piscium and ϵ Piscium, albeit with a longitudinal separation of some three degrees, but so situated that the entire ecliptic is trisected with this addition. The latter set and the regions mentioned by Sachs and Hunger are best shown in a polar plot (Figure 2) with straight-line connections between the ecliptic longitudes of adjacent Normal Stars. Apparent with this representation are less pronounced gaps between Libra and Virgo and one more in Ares.

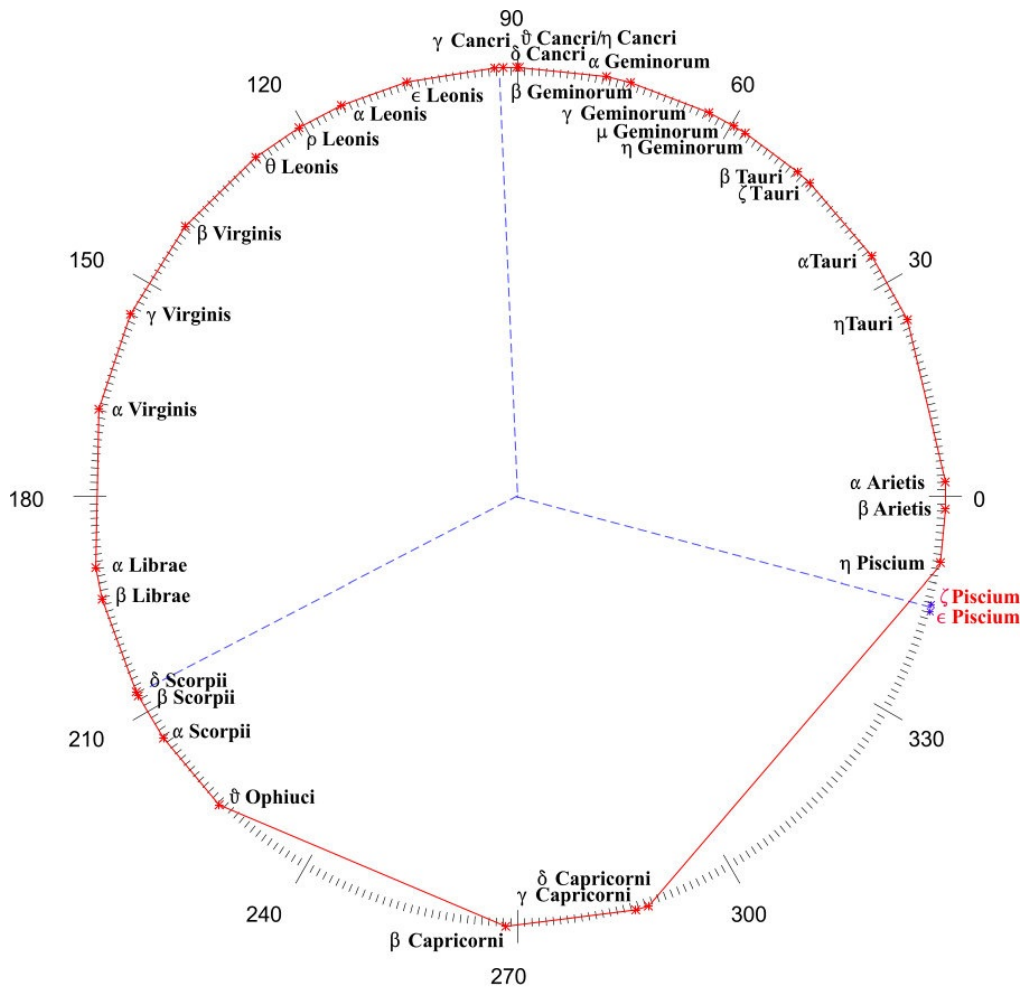


Fig. 2. Babylonian "Normal Stars" for the Year -567
Disposition of the three equi-spaced "latitudinal pairs"

The reason for this trisection might lie in practical complications arising from the tilt of Earth's axis and the resulting variations of constellation angles and the position of the ecliptic as viewed from Earth throughout the seasons of the year. In passing the pair in Cancer are of interest historically and also with respect to Diary No. –567where Mars is reported to have entered "Praesepe" (Obv.' 10: "The 3rd, Mars entered Praeseepe, the 5th it went out of it".) The track of Mars during the interval in question (Month II, Day 3 to Day 5 = May 24 to May 26,-567) passes north of the ecliptic between the two normal stars δ and γ Cancri (the Aselli). It seems possible that "Praesepe" mentioned in the Diary may also be a nebula in Cancer known in Antiquity, *i.e.*, Allen (1898:113) writes:

> the Almagest and astronomers generally of the 16th and 17th centuries referred to it as the *Nebula,* and *Nebula Nebulosa, in pectore Cancri,* for before the invention of the telescope this was the only universally recognized nebula, its components not being separately distinguished by ordinary vision.

In any event there are additional Normal Stars that could provide intermediate (60°) reference points between the three limits discussed above; namely α Tauri and perhaps the close pair δ and γ Capricorni (the latitudes of all three are *below* the ecliptic).

2.3 Further additions to the Babylonian Normal Stars

Intuitively, as many as 36 to 48 Normal Stars might be required to delineate the ecliptic with perhaps 3 normal stars distributed across the smaller constellations and as many as five across the larger. But why the list has remained with 33 such stars is somewhat puzzling since additional information may reasonably be gleaned from the Diaries, *e.g.*, from VAT 4956 (No.–567) as shown below in Figure 3:

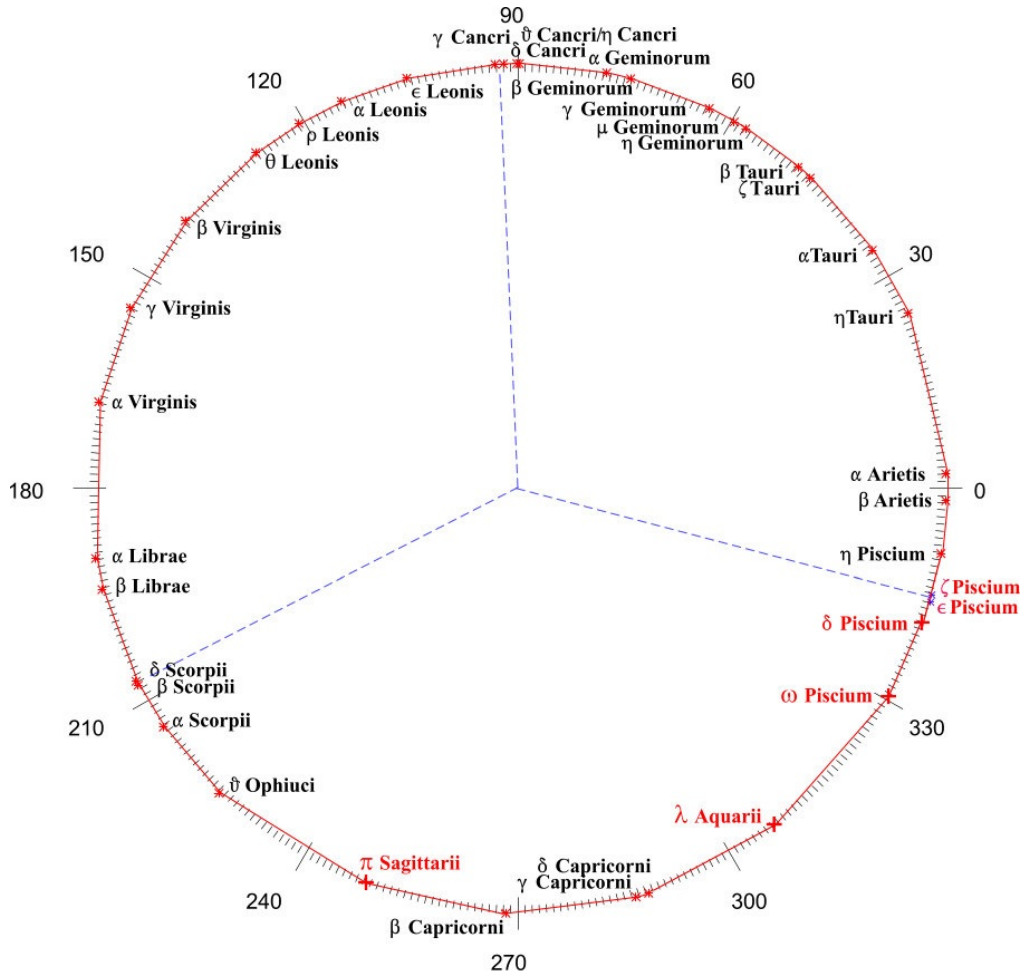


Fig. 3. Additions to the Babylonian "Normal Stars" (-567)

2.4 The Suggested Additions

A. THE "THIRD" LATITUDINAL PAIR

ϵ Piscium /ζ Piscium: Discussed earlier, the third (120°) latitudinal pair to complete the 360° delineation of the ecliptic ?

B. IN PISCES (THE "SWALLOW")

ω Piscium : The "Swallow" in Pisces, or the beginning of the "band" of the "Swallow" ?
δ Piscium : Anunitu, and/or the "band" of Anunitu?

Diary No. –567 (lines 9, 5', 16', 17', 19', 20')

9: [Month II] Saturn was in front of the Swallow, Mercury, which had set, was not visible. Night of the 1st gusty storm from east and south. The 1st, all day [.....]

5': Month XI (the 1st of which was identical with) the 30th (of the preceding month), the moon became visible in the Swallow; sunset to moonset:14° 30'; ...'; the north wind blew. At that time Jupiter was 1 cubit behind the elbow of Sagittarius [...]

16': [Month XII] Night of the 11th, overcast. The 11th, rain DUL. Night of the 12th, a little rain .... The 12th, one god was seen with the other, sunrise to moonset: 1°30..... [.....] Mercury]
17': was in front of the "band" of the Swallow, ½ cubit below Venus, Mercury having passed 8 fingers to the east; When it became visible it was bright and (already) high 1 ? [..... Saturn]
19': [Month XII] ....., ..., The 21st, overcast; the river level rose. Around the 20th, Venus and Mercury entered the "Band" of the Swallow. From [..... Jupiter,]
20': which had passed to the east became stationary. At the end of the month it went back to the west. Around the 26th, Mercury and Venus [came out] from the "band" of Anunitu (Sachs and Hunger, 1988:49)

C. IN AQUARIUS

λ Aquarii : Diary No. –567, March 27 through March 31 –566.
17' [.... Saturn]
18': was balanced 6 fingers above Mercury and 3 fingers below Venus, and Mars was balanced 2/3 cubits below the bright star of < .... > towards [...]
Name unassigned. Mercury, Venus and Saturn are in Pisces on these date(s); Mars is trailing behind in Aquarius.

D. IN SAGITTARIUS

π Sagitarrii : Previously identified in 1915. Sachs and Hunger (1988:53) state (comments, Line 5' above): The "elbow of Sagittarius" was identified as the cluster of stars around π Sagittarii by P.V. Neugebauer, op. cit., 50f."

* * *

RELATED MATERIAL

INTRODUCTION to the Diairies and VAT4956. The above Introduction plus a short astronomical diary for the year 567 BCE. (PDF: 285 kb)

A SELEUCID TABLE OF DAILY(?) SOLAR POSITIONS
Asger Aaboe, *Journal of Cuneiform Studies*, Volume 18, 1964:31-34. (Single-page PDF: 575 kb)

BABYLONIAN PLANETARY THEORY AND THE HELIOCENTRIC CONCEPT. Spirasolaris.ca (2000)

THE TRAPEZOID IN TWO ASTRONOMICAL CUNEIFORM TEXTS FOR JUPITER.
The unexplained trapezoid in two Babylonian astronomical cuneiform texts for JUPITER from the Seleucid Era (310 BCE-75 CE) Partial analysis by Otto Neugebauer (*Astronomical Cuneiform Texts*, 1955:405,430-31; one-page PDF, 34 kb).

JANUARY 2016. A modern, far-reaching analysis of the trapezoid in ACT 817, ACT 813 and additional Babylonian texts by Mathieu Ossendrijver (2016): "Ancient Babylonian astronomers calculated Jupiter's position from the area under a time-velocity graph."

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