Historical Evidence of the 19-Year Intercalation Cycle

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Part I

Introduction

Archaeological discoveries during the last century have uncovered more than 3700 BC years of calendar history. Clay tablets tell the story of the calendars that were used in the Ancient Near East from the dawn of civilization to the time of Nebuchadnezzar II of Babylon and the later kingdoms of Cyrus in Persia and the Parthians of Iran. Inscriptions that have been translated to date show that each of the early city-states and kingdoms applied the same astronomical principles in calculating the months of the year. All used the lunar cycle as a basis for determining the months, and all used the principle of intercalation to keep their lunar calendars synchronized with the solar year. (The word "intercalation" simply means the addition of a day or a month to a calendar year.) They had calculated the length of the lunar year and the length of the solar year, and understood that they could reconcile the difference by adding an additional month in 7 years out of 19. Thus their calendars were composed of 12 years of twelve months and 7 years which were intercalated with a thirteenth month.

The records of history show that the principle of intercalation was used long before the Hebrew Calendar was delivered to Moses. Unquestionably, it was recognized as a mathematical principle which accurately reflects the 19-year cycle that God established in the heavens. This paper sets forth the evidence for such as preserved in the inscriptions of ancient civilizations from 3700 BC to the end of the Middle Babylonian Kingdom in 979 BC.

The Earth makes a complete circle of the Sun in approximately 365 days, thus creating a solar year. In each solar year, the Moon completes 12 orbits around the Earth, thus completing a lunar year. The lunar year, however, is completed in approximately 11 days less than the solar year.

This discrepancy between the length of the solar year and the length of the lunar year requires a periodic adjustment in a calendar that uses the lunar cycle to determine the months of the year. Without such adjustments, the months of the year will gradually shift out of their normal climatic seasons.

To illustrate this fact, consider the Islamic calendar of the Muslim nations. This calendar is solely a lunar calendar and makes no adjustment for the length of the solar year. When the Islamic calendar was instituted in 638 AD, the holy month of Ramadan was observed in the month of March. In the following years, this Islamic holy month gradually backed up through the seasons, falling about one month earlier every three years (3 x 11 days less than the solar year).

It takes approximately 33 years for the month of Ramadan to cycle through all 12 months of the year and return to its original season. Thus, during the vast majority of years since Islam was founded, their holy month of Ramadan has not been observed at the time it was originally instituted. In the year 2001, Ramadan was celebrated from November 17 through December 15. In the year 2002, the celebration of Ramadan will begin 11 days earlier on November 6. It will take 22 more years for the month of Ramadan to return to its original season in the spring of the year.

The deviation of this Islamic holy month from the season of its origin was inevitable because the Koran strictly forbids the practice of intercalation. The Koran views the 12 months of the year as fixed periods, determined only by the new moon. The practice of intercalating the year by adding an additional month is regarded as a great "evil," as the writings of the Koran clearly show.

The second chapter of the Koran, entitled "The Cow," expresses their belief that the months of the year are "appointed times" and are based solely on the new moon. Bracketed comments are inserted to clarify the text:

> [**2.189**] They ask you concerning the new moon. Say: They are times appointed [i.e., designating the months of the year] for (the benefit of) men, and (for) the pilgrimage….

The ninth chapter, entitled "The Immunity," sets forth the premise that no year may consist of more than 12 months because the months are rigidly fixed in time. To permit any interruption or fluctuation in the 12-month period would result in defiling time that has been sacred from the creation of the world:

> [**9.36**] Surely the number of months with Allah is twelve months in Allah's ordinance since the day when He created the heavens and the earth, of these four being sacred; that is the right reckoning; therefore be not unjust to yourselves regarding them, and fight the polytheists all together as they fight you all together; and know that Allah is with those who guard (against evil).

In contradiction to this teaching, we Christians have the testimony of Scripture that time has not been rigidly fixed from creation. The cycle of time that God established at the creation of the world was altered by God Himself on several occasions. Joshua's long day is the first example that we find in Scripture. God interrupted the flow of time by causing both the sun and moon to stand still in their respective orbits (Joshua 10:12-14). Later, in the days of King Hezekiah, God caused the shadow on the sundial to retrace its steps by going backward 10 degrees (II Kings 20:11 and Isaiah 38:8). These Scriptural examples make it very clear that God Himself altered His original calendar by interrupting the cycle that He had instituted in the heavens.

Many believe that the calendar God established at creation was composed of 12 months of 30 days each, composing a fixed 360-day year. Whether or not this was true in the past, it is not a reality today. No calendar can accurately depict time unless its calculations are based on the reality of the heavens as they exist today.

Since God Himself instituted the present astronomical cycles, it is evident that He also provided the necessary rules for determining His holy days, which must be observed in their seasons. Unlike the Islamic calendar, the calendar that God instituted is synchronized with the seasons from year to year continually. This accuracy is made possible by the rules of intercalation, which make provision for an additional month to be added as needed to compensate for the disparity between the lunar cycle and the solar

cycle. Those who reject the addition of a thirteenth month as a human institution have fallen prey to the same seductive reasoning that inspired the founders of Islam, who regard intercalation as heresy:

> [**9.37**] Postponing (of the sacred month) is only an addition in unbelief, wherewith those who disbelieve are led astray, violating it one year and keeping it sacred another, that they may agree in the number (of months) that Allah has made sacred, and thus violate what Allah has made sacred; the evil of their doings is made fairseeming to them; and Allah does not guide the unbelieving people.

The Koran teaches that there are twelve and only twelve months in a year. To add a thirteenth month would not agree with the "number (of months) that Allah has made sacred." In the Islamic calendar, the order of the months depicts the events that took place during the life of the prophet Mohammed. Each month therefore has a sacred place among the twelve and cannot be moved in relationship to the other months. This rigid view absolutely prohibits any use of intercalation. Thus there is no possible way to keep the lunar months of the Islamic calendar aligned with the climatic seasons of the solar year.

Conversely, by applying the rules of intercalation, the Hebrew Calendar is periodically adjusted to the solar year so that the annual holy days of God remain in their original seasons from year to year. The Scriptures require that the months of the Hebrew Calendar, which begin with each new moon, be synchronized with the seasons (Lev. 23:4). These months, and the holy days that fall within them, center around three major harvest seasons. To keep them in synchronization with their respective harvest seasons, an additional month must be added at set intervals of years to correct the difference between the solar and lunar years. Because the Hebrew Calendar uses both the lunar cycle and the solar cycle to determine the months of the year, it is known as a luni-solar calendar.

Every calendar that is synchronized with the climatic seasons of the solar year must use some form of intercalation. The Gregorian Calendar of today, which is strictly a solar calendar, intercalates every four years by adding an extra day to the month of February. This intercalary day compensates for the quarter of a day per year that the calendar falls short of the solar year (which is 365 ¼ days). Because the Gregorian Calendar does not use the lunar cycle to determine the months of the year, (but elongates all months to

either 30 or 31 days with February at 28—29 in a leap year), there is no other shortfall, and therefore no need to add an intercalary month.

The Hebrew Calendar requires intercalation on a much broader scale because the lunar cycle figures prominently in its calculations. To compensate for the shortfall of about 11 days less in the lunar year, the Hebrew Calendar intercalates every two to three years by adding a 13th month. In addition, one or two days are periodically added to keep the months of the year closely synchronized with the new moons. The intercalary months synchronize the Hebrew Calendar with the solar year so that the holy days of God are always observed in their appointed times, and the intercalary days synchronize the calendar with the monthly cycles of the moon so that the feasts on Nisan 15 and Tishri 15 are observed as closely as possible at the full moon.

The Hebrew Calendar has an ancient history that can be traced through Scripture to the time of Moses in the 15th century BC. Moses was given divine instructions for a luni-solar calendar that calculated the annual holy day seasons by both the new moons (lunar year) and the harvest seasons (solar year). The first month of the year began in the spring at the time of the barley harvest and was designated as the Abib (meaning "green ears"), as we read in Deuteronomy 16. Many centuries later, the original name of this month, Abib, was replaced by the Akkadian name Nisan. The Israelites of old adopted the name Nisan, and other Akkadian names for the months, during the Babylonian captivity. These Akkadian names had been earlier adopted by the Babylonians during the Middle Babylonian Period (1150-1000 BC), some six hundred years before Judah was taken captive. Whether or not we view these names as acceptable, in no way do they alter the calculations of the Hebrew Calendar, nor do they detract from its accuracy.

Although the Hebrew Calendar was given directly to Moses by the revelation of God, (i.e., the Israelites did not glean calendric cycles from other cultures) the astronomical cycles on which it is based were known to other peoples. These astronomical cycles were widely used by ancient city-states and empires, whose calendars determined the months by the lunar year and therefore followed the principle of periodically adding an intercalary month to remain synchronized with the solar year. Many centuries before Moses, Sumerian astronomers discovered that by adding an additional month to seven years out of nineteen, the number of days in the solar year

and the number of days in the lunar year could be synchronized within a small fraction. This astronomical principle is known as the 19-year cycle.*

Archaeological records indicate that the Sumerians were the earliest in the ancient Near East to make use of the 19-year cycle in their lunar calendars. The lunar calendars of ancient Sumeria can be traced as far back as the Ubaid culture of 3760 BC. This so-called prehistoric culture is named after an archaeological site at Tall al-'Ubayd in southeastern Iraq, which is very close to the ruins of ancient Ur (not the Ur from which Abraham came). Archaeological records dating from the two cultures that followed Ubaid—the Uruk culture (3500-3100 BC) and the Jemdet Nasr culture (3100-2900 BC)—show that the lunar calendar was being refined into a precise instrument for aligning lunar months with the seasons of the solar calendar.

* Historical evidence points to the fact that the Hebrew Calendar was first to incorporate the use of the 3,6,8,11,14,17 and 19 year pattern—a leap year system established well before the time of Christ.

Early Dynastic I-III
2900-2350 BC

The first evidence of this refinement appears during the rule of Early Dynastic I-III. Cuneiform tablets of c. 2800 BC record that the Sumerian astronomers of Nippur made use of the 19-year cycle to synchronize the lunar calendar with the seasons of the solar calendar. This suggests that they had mastered the intercalation cycle of seven years out of nineteen to a very high level.

Although Nippur was a religious and cultural center for all the city-states of southern Mesopotamia, not all city-states adopted this calendar. Ancient records reveal various intercalation schemes. These calendars, while they differed in certain respects, all used the principle of intercalation.

> While each city-state had its own calendar, the basis was common: from the end of the fourth millennium [3000 BC], a 12-month, 360-day year was used, a rationalization of natural lunistellar divisions (Englund 1988:122-123). The 360-day(u_4) calendar was then a bureaucratic systemization…of the year (mu) into 12 synodical months (iti), each consisting of 29.53 days. The resulting year of approximately 345¼ days consequently fell short of the 365¼ days of the tropical year (equinox to corresponding equinox), so that an intercalation of the so-called diri-month was necessary, on average, every three years [Englund 1988:123] (*Early Civilizations of the Old World*, s.v., "Exact and predictive sciences: arithmetic, geometry, astronomy and a calendar" p. 181).

An incomplete reconstruction of the ancient calendar of Sumerian Nippur is presented at the end of this section on page ten. The names of the month are listed in the cuneiform tablets, but not the lengths of the months. Thus, although we know that ^{iti}bára-zà-ğar is the first month and that it equates to the general season of March and April, we do not know whether it had 29 or 30 days. The same holds true for the rest of the months. We have therefore assigned to it a theoretical length of 29 days, and to subsequent months, alternating lengths of 29 or 30 days, which is typical of lunar months.

In addition, archaeological records of this calendar show that it was intercalated in seven of the years in a nineteen-year cycle. However, the records that have been translated to date do not reveal which years were intercalated, nor do they reveal which months in these years were intercalated. Based on the subsequent history of the calendar, intercalation

years may have been randomly chosen within certain parameters. The most likely month or months of intercalation would have been the sixth month, named ^{iti}kíĝ-^{d}Inanna, and the twelfth month, named ^{iti}še-saĝ$_{11}$-ku$_{5.}$

One further point must be made at this time. There is no record to date of when the 19-year cycles began. It is possible that the Nippurians matched or came close to matching the cycles of the later Babylonian calendar of Nebuchadnezzar II of the Bible. This opinion is based on an interesting 19-year cyclic connection between the solar calendar of Nabonassar and the luni-solar calendar of Babylonia. Any year of a Babylonian 19-year cycle can be obtained by dividing the year of the calendar of Nabonassar by 19. The remainder is the year of the Babylonian cycle.

Luni-Solar
Calendar of Ancient Nippur

During Early Dynastic I-III Period
2900-2350 BC

Nippur 19-Year Cycle	Nippur Month of Year	Number Days in Month	Julian Calendar Date (January-December)
1	iti bára-zà-ĝar:	29	March-April
2	iti gud-si-su:	30	April-May
3	iti sig_4-ga:	29	May-June
4	iti šu-numun:	30	June-July
5	iti NE-izi-ĝar:	29	July-August
6	iti kíĝ-^{d}Inanna:	30	August-September
7	iti du_6-kù:	29	September-October
8	iti apin-dug-a:	30	October-November
9	iti gan-gan-è:	29	November-December
10	iti ab(-ba)-è:	30	December-January
11	iti zíz-a:	29	January-February
12	iti še-sa$ĝ_{11}$-ku_5:	30	February-March

Halloran, John A. Home page. 29 October 2001
http://www.sumerian.org/sumerian.htm

The Akkadian Empire
2350-2100 BC

The calendric wisdom of Nippur was not lost on Sargon when he came to power. Sargon, a Semite servant to the city-state of Kish, rebelled against his master about the year 2350 BC, usurping the throne. He wasted no time in building a new capital, the city of Akkad, and from there he quickly conquered southern Mesopotamia by defeating Lugalzaggisi of the ancient Sumerian city of Erech (also know as Uruk). Once he had secured his southern boundary to the Persian Gulf, Sargon set his sights on territory to his north. The kingdoms of Mari, Tuttul and Ebla soon fell to his power. Now stretching from the Mediterranean coast of present-day Syria to the Persian Gulf of present-day Kuwait, his empire straddled the entire Fertile Crescent of Mesopotamia. Sargon controlled all the trade routes at the crossroads of world commerce. His seaports included those of the Mediterranean to those of the Persian Gulf.

To administer this vast empire, Sargon centralized the government to Akkad, thus forming one of the earliest centralized governments in the world. He also built a standing army of at least 5400 men. To administer this realm, he placed his sons and daughters and other members of his family in key positions, both politically and religiously.

Although Old Akkadian was the native tongue of the Akkadians of Sargon's time, few tablets reflect this fact. Most tablets of the period reflect the use of Sumerian as the scribal language of the realm. (It is the scribes who preserved and maintained the calendar.) Few tablets remain that were written solely in Old Akkadian. Sargon retained the scribal class of the Sumerians, and thus preserved their language and their cultural history in the form of clay tablets written in the Sumerian dialect. In so doing, he also preserved the Nippurian calendar.

Archaeological records reveal that this calendar, like the calendar of Nippur, was intercalated in seven of the years in a nineteen-year cycle. However, there is no record as to which years were intercalated, nor do we know which months in these years were intercalated. The most likely month or months of intercalation would have been the sixth month, named ^{iti}kíĝ-^{d}Inanna, and the twelfth month, named ^{iti}še-saĝ$_{11}$-ku$_{5.}$

Sargon ruled until 2330 BC, at which time his sons Man-ištušu and Rimuš succeeded him. These two may have been twins, as they ruled together. During their rule they gained hegemony over 32 cities of the Elamites in what is today southern Iran. Naräm-Sîn, son of one of these kings, and grandson of Sargon, was a king of great accomplishment and fame. His title was *šar kibrät arba'im*, 'king of the four quarters,' a term for the entire civilized world. This great leader soon found himself under attack from quarters in the north of Akkad, especially those of a mountain people known from the records as the Guti or Quti. These semi-nomadic peoples began to move against Naräm-Sîn from what is present-day Iran. Naräm-Sîn ruled until about 2225 BC. Following the great Naräm-Sîn to the throne was his son Shar-kali-shari, who ruled over a crumbling empire for the next 25 years until his death in 2200 BC.

The century that followed his death was the dark age of the empire. Although the central government had collapsed (the empire was now divided among the Guti and two city states of the south—Lagash and Uruk), the city of Akkad remained intact, and was ruled until 2100 BC by two succeeding kings.

One of the most famous kings of this period of collapse was Gudea of Lagash. Gudea reigned for 20 years shortly before the Ur-III period began in 2100 BC. The rule of Gudea over Ur, Uruk and Nippur saw a renaissance in Sumerian literature. These clay cylinders devoted to the accomplishments of Gudea are the most complete literary compositions we have in Sumerian and are the major source of our understanding of the Sumerian language.

Presented on page thirteen is an incomplete reconstruction of the ancient calendar of Nippur preserved through the Akkadian Period. Once again, the names of the months are listed in the cuneiform tablets, but not the lengths of the months. Like the earlier calendar of Nippur, ^{iti}bára-zà-ĝar is listed as the first month, but its length is not recorded. The same holds true for the rest of the months. We have assigned theoretical lengths of 29 or 30 days, as is typical of the months in lunar calendars.

Luni-Solar Calendar Preserved by the Ancient Akkadians

2350-2100 BC

Akkadian 19-Year Cycle	Akkadian Month of Year	Number Days in Month	Julian Calendar Date (January-December)
1	^{iti}bára-zà-ğar:	29	March-April
3	^{iti}gud-si-su:	30	April-May
3	^{iti}sig$_4$-ga:	29	May-June
4	^{iti}šu-numun:	30	June-July
5	^{iti}NE-izi-ğar:	29	July-August
6	^{iti}kíğ-^{d}Inanna:	30	August-September
7	^{iti}du$_6$-kù:	29	September-October
8	^{iti}apin-dug-a:	30	October-November
9	^{iti}gan-gan-è:	29	November-December
10	^{iti}ab(-ba)-è:	30	December-January
12	^{iti}zíz-a:	29	January-February
12	^{iti}še-sağ$_{11}$-ku$_5$:	30	February-March

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The Empire of Ur III

2100-2000 BC

With the complete collapse of the Akkadian Empire the base of power returned to southern Mesopotamia. The period of Ur III saw a revival of Sumerian culture in the form of building and literature. Although Akkadian was the spoken language of the period, Sumerian was the written language, as was Latin for centuries after the fall of the Roman Empire.

Ur III is transitional in every sense of the word. It witnessed the last consolidation of Sumer and Akkad as an Empire. The central government was transferred from Akkad to Ur in extreme southern Mesopotamia. On the demise of Ur III, the power base shifted to the Chaldean city of Babylon and the Assyrian city of Assur.

Five kings composed the dynasty of this empire, two of which are notable. The founder and first king of Ur III was a general named Urnammu, who consolidated the regions of Sumer and Akkad. The four ziggurats that he built bear record to the importance of calendrical calculations to his empire. Šulgi, son of Urnammu, succeeded his father. As king of Ur III, he initiated a Neo-Sumerian Renaissance of Sumerian literature and culture that lasted for 48 years. Although no new literature was produced during his rule, his great accomplishment, like the Medicis' revival of Greek and Hebrew studies in the 1400's AD, was the collection and canonization of Sumerian literature, history and science. Largely due to his patronage, more than 100,000 clay tablets were issued, preserving for posterity the story of ancient Sumer. To date, only a few of these tablets have been translated.

A term for calendric intercalation began to appear in the clay tablets of Sumeria sometime during the rule of Ur III. The name of the term is "iti dirig." As had been done for centuries, seven additional months, now called "iti dirig," were added to selected years in a 19-year cycle. The fact that Sumerian astronomers utilized a 19-year cycle shows that they knew the lengths of both the solar year and the lunar year. They had calculated the

number of days in 19 solar years and knew that there was a total of 6,939 days in a normal cycle. (The cycle can vary in length from 6,939 to 6,942 days.) They also knew the length of the lunar year, and that in each period of 19 years the shortfall between the solar and lunar years would add up to 213 days. It was therefore evident that 7 additional months were needed in each 19-year period in order to keep their calendar synchronized with the solar year. Unfortunately, intercalation was haphazard in many areas and each city of the realm inserted months as it chose. Sometimes 11 months in a 19-year cycle were intercalated; at other times, two months were intercalated during a single year.

It was during the dominion of Ur III that the month names of the Sumerian Nippur calendar became standard in Babylon. This process began sometime in 2100 BC and continued on through the Old Babylonian period of 2000-1600 BC.

In 2004 BC, Ur III was overrun by the Elamites thus ending the hegemony of Ur III over a great part of the Mesopotamian region. This marked the end of the Sumerian culture and its literature, which had existed for nearly 1700 years. The overthrow of Ibbisin was lamented by his countrymen.

> The destruction of the great old city of Ur in Mesopotamia by the Elamites in about 2000 B.C. left a deep impression on the contemporary Mesopotamians. Two Sumerian lamentations on clay tablets reflect the memory of this event: the lament over the destruction of Ur and the lament over the fate of Ibbisin, the last king of Ur, who was led away into captivity. A few lines of the latter lament describing the fate decreed by the great gods Anu and Enlil follow in translation: ' . . . hostile Su people and Elamites will attain the inhabitants [of UR], the king [of Sumer] will have to leave the palace, Ibbisin will have [to go] to the country of Elam, [go] from the Sabu mountain, the "breast" of the mountain range, to the end of Anshan; like a bird which left its abode, like a stranger [he will not return] to his city.' [1]

Porada, Edith. The Art of Ancient Iran, Pre-Islamic Cultures.
New York, 1962.
Crown Publishers, Inc. Art of the World.
With the collaboration of R. H. Dyson
and contributions by C.K. Wilkinson
http://www.noteaccess.com/Texts/Porada/5.htm+Ibbisin+&hl=en
http://www.noteaccess.com/Texts/Porada/5.htm

Luni-Solar
Calendar of Ancient Ur III

2100-2000 BC

Ur III 19-Year Cycle		Ur III Month of Year	Number Days in Month	Julian Calendar Date (January-December)
	1	^{iti}bára-zà-ğar:	29	March-April
	4	^{iti}gud-si-su:	30	April-May
	3	^{iti}sig$_4$-ga:	29	May-June
	4	^{iti}šu-numun:	30	June-July
	5	^{iti}NE-izi-ğar:	29	July-August
	6	^{iti}kíğ-^{d}Inanna:	30	August-September
	7	^{iti}du$_6$-kù:	29	September-October
	8	^{iti}apin-dug-a:	30	October-November
	9	^{iti}gan-gan-è:	29	November-December
	10	^{iti}ab(-ba)-è:	30	December-January
	13	^{iti}zíz-a:	29	January-February
	12	^{iti}še-sağ$_{11}$-ku$_5$:	30	February-March

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The Isin-Larsa Period

2000-1800 BC

In the waning years of Ur III, an Amorite sheikh of Larsa by the name of Naplanum (2025-2005 BC) revolted against Ibbi-Sin and declared independence from Ur—the year was 2025 BC. Larsa was situated on the Euphrates River about 40 to 50 miles north-northwest of the city of Ur, which was located in what is now the extreme southern tip of Iraq.

Eight years later, in 2017 BC, Ibbi-Sin of Ur placed an Akkadian servant of his from Mari in charge of the cities of Nippur and Isin—his name was Ishbi-Erra. Nippur and Isin were 30 to 40 miles north-northwest of Larsa. Ishbi-Erra wasted no time in extending his influence from the Persian Gulf in the south to the Elamite State of Hamazi, about 225 miles upriver in the north. The result was that King Naplanum of Larsa became a vassal of Ishbi-Erra. After the fall of Ur III in 2004 BC, Ishbi-Erra invaded the city, driving out the Elamite overlords.

Ishbi-Erra ruled the city-state of Isin to 1985 BC, after which his son Shu-Ilishu (1985-1975 BC) took the reins of power. Isin became the most powerful city-state for the next two centuries until its conquest in 1787 BC by Hammurabi of Babylon. The city of Larsa fell to the Babylonians 24 years later in 1763 BC, thus ending the Isin-Larsa Period.

Archaeological records of the kings who ruled during the Isin-Larsa Period show an advanced knowledge of astronomical cycles. The reigns of the kings, which are recorded on clay tablets, are listed not by years but by *saroi*. This measurement of time is based on the cycles of the moon:

> These numbers are those of the cycle of the eclipses and of the anomalistic cycle of the moon. In point of fact, solar and lunar eclipses recur at the same moment after each 54 years, or 669 synodic months (approximation 0.15%). By synodic rotation of the moon is understood the interval between two full moons or two new moons. The period of 54 years is attested in a tablet from Uruk (cf. F. Thureau-Dangin, "Tablettes d'Uruk," *Textes Cunéiformes du Louvre*, 6, Paris, 1922, and Bartel van der Waerden, *Science Awakening II: the Birth of Astronomy*, 1965; English rev. ed., Leyden, Noordhoff, 1974, p. 103).

One-third of this period of 54 years, called *saros* by the Greeks, i.e. 18 years and 11.3 days, is the classic cycle of solar and lunar eclipses, and includes 29 lunar eclipses and 41 solar eclipses. The **Saros cycle** is the period of return of the Sun and Moon to their initial positions relative to the Earth: this return is possible because of synchronization between the synodic and anomalistic revolutions of the Moon….This relation between synodic months and anomalistic months of the Moon was known to Babylonian astronomers, who used it to predict the return of lunar and solar eclipses….

The second number (27.5658) is that of the **anomalistic lunar cycle** (in reality 27.555, or an approximation of 0.04%). Hence these two numbers relate to extremely precise data concerning knowledge of lunar motion, and take on even more significant shape if one keeps in mind that it was Ishbi-Erra (2017-1985 B.C.), the founder of the Isin Dynasty, who imposed on the greater part of southern Mesopotamia the **lunar calendar of Nippur**, to the detriment of numerous local competing calendars (cf. Mark Cohen, *The Cultic Calendars of the Ancient Near East*, Bethesda (Md.), CDL Press, 1993).

Hence the list of antediluvian kings of the Isin Dynasty is an encoding of astronomical data concerning the various lunar periods (The Lists of Antediluvian Kings: A Coded Document by Dr. Patrice Guinard--translation Matyas Becvarov).

Guinard, Dr. Patrice. "The Lists of Antediluvian Kings:
A Coded Document." Translated by Matyas Becvarov.

Primeras Jornadas Internacionales de Historia de la Astrología en la Antiguedad (2001):

http://cura.free.fr/11kings.html

Ancient Assyria

1900-1800 BC

While the kings of the Isin-Larsa confederation prospered in the south of Mesopotamia, an Assyrian trading colony by the name of Assur prospered in the north. The kings of the Isin-Larsa confederation maintained trade routes from the Persian Gulf north through Nippur, Kish, Babylon, Sippar and finally up the Tigris to the Assyrian trading colony of Assur. The Assyrians forged treaties and founded 12 trading centers westward to the great trading center of Kanesh. Kanesh, about 500 miles west of Assur, was situated on Kültepe hill, on the vast Anatolian Plateau that rose just north of the Taurus Mountains of Eastern Turkey. Caravans of 200 donkeys continuously wound their way back and forth along this trade route from trading center to trading center, covering a distance of about 15 miles a day.

The Assyrians, like all capitalists, traded for profit. The merchants of Assur formed trading companies, sold shares, contracted for transport, shipped merchandise to Kanesh and returned with donkeys laden with silver and gold. The monetary basis of this capitalism was silver and gold converted into paper notes. The following quote is an amazing example of capitalism at work in the ancient world.

> It is the most ancient example of a capitalistic structure with private enterprise in an open society. Earned silver was used for new investments and to buy the daily necessities of life. The Assyrian merchants must have been rich, but one doesn't know about it, because A□ur has not yet been excavated.
>
> To set up a caravan a merchant in A□ur buys his merchandise with silver. He chooses a carrier (often family) and entrusts the caravan by means of a contract for transportation. He pays export taxes and gives money for expenses and duties in transit. The journey lasts for approx. 6 weeks (25 km/day).
>
> After 6 weeks the agent in Kanesh accepts the merchandise. He announces by letter which goods are already sold and adds taxes and expenses….The local agents, who get credit against an interest rate of 33%, leave for other parts of the country to sell the goods.
>
> Investment is done in gold through so called z*ak*-contracts (the Akkadian name). A partnership consists of 14 persons, who collect together 30 mine gold (a mine is

about 500 grams)….If someone takes a share in a *zak*-contract he pays half of it in silver which is booked as the equivalent in gold. Silver is a medium of exchange. The contractual term is 12 years and one guarantees a profit of 100% (normal loans have an interests of 30%, so the profit is large). Dividend is paid during the term of the contract. Special rates apply at half-term withdrawal.

Heise, John. Home page. 17 Feb 1996
http://www.sron.nl/~jheise/jheise.html

The foregoing account of ancient Assyrian economic activity demonstrates the need of a calendar that was calculated well in advance. Contracts, interest rates and dividends all depended on fixed periods of time and exact numbers of days. In the 1900's BC trade extended from the western Mediterranean eastward into China, as well as from the great northern regions of Scandinavia southward to Africa. The peoples of Mesopotamia had an advantage in that they all used the same basic calendar. The Assyrians, Sumerians and Babylonians eventually all adopted similar versions of the calendar of ancient Nippur.

The First Dynasty of Babylon

1894-1596 BC

In 1894 BC, in the first year of the rule of Shu-Ilishu of Isin, an Amorite sheikh seized the town of Bab-ilim and declared its independence from Isin. Sheikh Sumu-Abum ruled Bab-ilim for the next 13 years until 1881 BC. Thus began one of the most interesting sagas of a city of the ancient world, one that would last for the next 1300 years until the fall of Babylon to the Persians in 539 BC. Bab-ilim, as the Akkadians called the town, is first mentioned during the reign of Shar-Kali-Sharri of Agade (Akkad) some 323 years earlier (2217-2193 BC). The Akkadian capital Agade was less than 30 miles up the Euphrates from Bab-ilim. The first Dynasty of Babylon ruled for the next 300 years until overthrown by the Hittites under Mursilis I.

The next three kings to follow Suma-Abum expanded their territory southward, making war on the ancient city of Kish (a stone's throw from Bab-ilim) and the kings of Larsa, including the famous King Rim-Sin, who defeated Sin-Muballit of Bab-ilim (1813-1792) in battle. Sin-Muballit was forced to retreat, ending his rule with little to show for his expansionist efforts. When Hammurapi, popularly known as Hammurabi, came to power (1792-1750), he inherited a realm controlling very little except the immediate area around Babylon and the important trading city of Sippar a few miles to the north. Hammurapi soon changed these boundaries in a very dramatic way. The locus of power since the fall of the Akkadian Empire in 2100 BC had been the powerful city-states of the vast alluvial plains of Sumer. By 1750 BC, Hammurapi had expanded his territory 300 miles southward along the rivers Euphrates and Tigris to the waters of the Persian Gulf, and nearly 250 miles north to the great trading city of Mari, which became a vassal state. The ancient cities of Kish, Nippur, Isin, Adab, Uruk, Larsa, Lagash, Eridu and Ur all fell under his control. Babylon became the new locus of power and remained so for the next 1200 years.

Before the death of his critically ill father, Samsu-Iluna (1750-1712), son of Hammurapi, assumed power. The empire went into an immediate tailspin; all territory but that immediate to Babylon was soon lost.

As the author of one website relates:

> To make up for the lost revenue from the lost provinces, merchants became bankers and loaned to the small shopkeepers and farmers. They in turn could not repay the loans, so they overworked their lands in order to try [to repay their debts]. In the process they ignored the rule of fallow and the land became increasingly salinized. Thus by c.1600, Babylon went from political dissent to economic disruption to ecological disaster.
>
> Gary. Home page. 14 Feb 02
> http://www.geocities.com/garyweb65/oldbaby.html

Of the four remaining kings of this dynasty, only one merits honorable mention. Ammi-Saduqa (1647-1626 BC) attempted economic reform by suspending some taxes and abolishing, through his "Edict of Justice," imprisonment for debt. This noble act, however, came too late. The dynasty continued to decline. The next and last king of this dynasty, Samsu-Ditana (1626-1595 BC), was overthrown by Mursilis I king of the distant Hittites of Turkey in 1595 BC. However, he overextended his military resources in the attack against Babylon and could not hold the city. He soon withdrew from Babylon and the Kassites of Iran came marching in.

This age of expansion and turmoil, and the transfer of regional power and prestige, was of paramount importance in the history of the calendar of ancient Nippur. Before the period of Dynasty I of Babylon, documents were dated by local calendars, as the names of the months varied within different parts of the empire:

> …Recent publication of Old Babylonian documents from Sippar yield important new data on the local month names, their place in the yearly calendar, and their equivalence with the standard, Sumerian Nippur series.
>
> American Oriental Society: Abstracts of Communications of the 208th Annual Meeting. U of Michigan. 1998
>
> Greengus, Samuel. "New Data on the Old Babylonian Calendar of Sippar"
>
> http://www.umich.edu/~aos/abstr98.html

During Dynasty I of Babylon, the use of local calendars was supplanted by the Sumerian calendar of Nippur, providing a single standard for business and commerce, and political and religious events, throughout the empire:

> In the 18th century BC, the Babylonian Empire standardized the year by adopting the lunar calendar of the Sumerian sacred city of Nippur. The power and the cultural prestige of Babylon assured the success of the lunar year….
>
> The International History Project: A Collection of World History Essays, Documents and Maps.
>
> Ragz-International. 23 August 2001
> http://ragz-international.com/mesopotamiancalander.htm

Calendar of Dynasty I
Babylon

1894-1595 BC

Dynasty I 19-Year Cycle	Dynasty I Month of Year	Number Days in Month	Julian Calendar Date (January-December)
1	iti bára-zà-ĝar:	29	March-April
5	iti gud-si-su:	30	April-May
3	iti sig_4-ga:	29	May-June
4	iti šu-numun:	30	June-July
5	iti NE-izi-ĝar:	29	July-August
6	iti kíĝ-^{d}Inanna:	30	August-September
7	iti du_6-kù:	29	September-October
8	iti apin-dug-a:	30	October-November
9	iti gan-gan-è:	29	November-December
10	iti ab(-ba)-è:	30	December-January
14	iti zíz-a:	29	January-February
12	iti še-saĝ$_{11}$-ku_5:	30	February-March

Halloran, John A. Home page. 29 October 2001
http://www.sumerian.org/sumerian.htm

The Kingdom of Kar-Duniash

The Kassite Period of Babylon
1595-1156 BC

When the Hittites abandoned the region, the Kassites, an Iranian tribe from the central Zagros region south of Hamadan, swept into Babylonia. Although their dynasty was the longest of all the dynasties of ancient Mesopotamia (nearly 450 years), very little is known of their rule and accomplishments. Historians divide this period in two: The period from 1595 to 1375 BC, dubbed The Dark Ages due to its lack of historical records, and the period from 1375 to 1156 BC, of which numerous records exist and regnal years are dated. Enlil-Nadin-Ahhe was the last king to rule Kingdom of Kar-Duniash.

Whereas the rulers of Dynasty 1 had destroyed the economy and ecology of Babylon, the Kassites restored both. Order and peace returned to the region because the Kassites were not expansionists, as were the rulers of Dynasty I. The Kassites also embraced Babylonian culture, thus preserving the calendar of Babylon as well.

Although the Kassites instituted their own method for counting regnal years, the lunar calendar of Babylon remained the standard calendar of the realm:

> The use of the date formulas was supplanted in Babylonia by the counting of regnal years in the 17th century BC.
>
> When, in the 17th century BC, the dating by regnal years became usual, the period between the accession day and the next Nisanu 1 was described as "the beginning of the kingship of PN," and the regnal years were counted from this Nisanu 1. It was necessary for the lunar year of about 354 days to be brought into line with the solar (agricultural) year of approximately 365 days. **This was accomplished by the use of an intercalated month**.
>
> The Babylonian month names were Nisanu, Ayaru, Simanu, Du'uzu, Abu, Ululu, Tashritu, Arakhsamna, Kislimu, Tebetu, Shabatu, and Adaru. **The month Adaru II was intercalated six times within the 19-year cycle but never in the year that was 17th of the cycle, when Ululu II was inserted**. Thus, the Babylonian

calendar until the end preserved a vestige of the original bipartition of the natural year into two seasons, just as the Babylonian months to the end remained truly lunar and began when **the New Moon was first visible in the evening. The day began at sunset. Sundials and water clocks served to count hours** [emphasis added throughout].

The International History Project: A Collection of World History Essays, Documents and Maps.

Ragz-International. 23 August 2001
http://ragz-international.com/mesopotamiancalander.htm

The Calendar of the Kingdom of Kar-Duniash

1595-1156 BC

Old Babylonian Month of Year	Akkadian Names	Number Days in Month	Julian Calendar Date (January-December)
1^{iti}bára-zà-ğar:	Nisannu	29	March-April
2^{iti}gud-si-su:	Ayaru	30	April-May
3^{iti}sig$_4$-ga:	Simanu	29	May-June
4^{iti}šu-numun:	Du'uzu	30	June-July
5^{iti}NE-izi-ğar:	Abu	29	July-August
6^{iti}kíğ-^{d}Inanna:	Elulu/Ululu	30*	August-September
7^{iti}du$_6$-kù:	Tashritu	30	October-November
8^{iti}apin-dug-a:	Arahsamna	30	October-November
9^{iti}gan-gan-è:	Kissilimu	29	November-December
10^{iti}ab(-ba)-è:	Tebetu	30	December-January
11^{iti}zíz-a:	Shabatu	29	January-February
12^{iti}še-sağ$_{11}$-ku$_5$:	Addaru	30**	February-March

Halloran, John A. Home page. 29 October 2001
http://www.sumerian.org/sumerian.htm

American Oriental Society: Abstracts of Communications of the 208th Annual Meeting. U of Michigan. 1998

Greengus, Samuel. "New Data on the Old Babylonian Calendar of Sippar"

http://www.umich.edu/~aos/abstr98.html

* Month intercalated in seventeenth year only.
** Month intercalated in other years.

The Shang Dynasty of China

1554-1145 BC

Archaeological excavations in An Yang, China, have demonstrated that knowledge of the lunar year and the 19-year cycle in ancient times was not restricted to the Near East but also extended to the Far East. Like the clay tablets of Mesopotamia, carved oracle bones from the Shang Dynasty of China attest to a precise knowledge of both the lunar and solar cycles. The Shang Dynasty spanned the entire period of the Kassite rule of Babylon and the century that followed. The calendrical knowledge of the Shang Dynasty was later expanded to include not only the 19-year cycle but other complex astronomical cycles, which were used to predict both lunar and solar eclipses:

> About 26 BC, the Santong Li (Three Sequences Calendar) calculated…the period of 235 lunations, 19 years, called a Chang; 27 Chang, 513 years, called a Hui, for 47 Lunar eclipse periods; 3 Hui, 1,539 years, called a Thung, to get a round number of days; and finally 3 Thung, 4,617 years, to get a concording period of lunations, Solar tropical years, eclipse periods, and 60-year Stem-and Branch cycles.
>
> Going back prior to 26 BC, we get to the Sifen Li (Quarter-Remainder Calendar) of the Fifth Century BC, which was based on a Solar tropical year of 365 1/4 days and a Lunar synodic month of 29 499/940 days, so that there are 19x12 + 7 = 235 lunations in 19 years.
>
> Perhaps as long ago as the Shang oracle bones [1554-1045 BC], the Chinese knew that the Solar tropical year of about 365 1/4 days was incommensurable in terms of Earth days with the Lunar synodic month of about 29 1/2 days, and they may have known about the cycle of 235 lunations in 19 Solar years.
>
> The Chinese 13th century BC oracle bone value for the Lunar synodic month was 29.53 days. The Chinese Sifin Li 5th century BC value was 29 499/940 = 29.53085 days. The Chinese 237 AD value of Yang Wei was 29.530598 days. The 1996 space satellite value was 29.530588 days.The Torah-code Jewish calendar value is 29 + 12/24 + 793/(1080x24) = 29.530594 days.

Smith, Tony. Home page. 2002
http://www.innerx.net/personal/tsmith/StemBranch.html

Like the calendar of ancient Nippur, the Chinese calendar was based on the lunar year and acknowledged the astronomical fact of the 19-year cycle of lunations. Seven out of 19 years were intercalated to keep the lunar year synchronized with the solar year. Through the centuries, the ancient civilizations of both the Near East and the Far East applied the principle of intercalation by adding a 13th month to designated years.

Because the 19-year cycle has not changed, the Hebrew Calendar still follows this practice, adding a 13th month at set intervals of years to synchronize the lunar year with the solar year thus keeping the holy days of God in their seasons.

Middle Babylonian Period

1156-979 BC

Fourth Dynasty of Isin

The Middle Babylonian Period of central Mesopotamia began as the Shang Dynasty of China came to an end. In 1159 BC, King Shutruk-Nahhunte, of Kingdom of Elam marched northwestward into southern Mesopotamia, laying waste to the region as his armies advanced. The Elamites pivoted north and laid siege to the city Babylon. Babylon fell in 1157 BC, bringing the dynasty of the Kassites to an end. Kutir-Nahhunte, son of Shutruk-Nahhunte, was appointed governor of the region, and Shutruk returned to the Elamite capitol of Susa. Although Babylon had fallen, Enlin-Nadin-Ahhe fought on for two or three years more before succumbing to the armies of Kutir.

Elamite occupation of Sumer and Babylon was short-lived, however. In 1155 BC, a prince of the Babylonian principality of Isin, moved against the Elamites, driving them out of the cities of both central and southern Mesopotamia. Once Babylon was secured, Marduk-Kabit-Ahheshu of Isin (1155-1146 BC) marched north against the Assyrians, capturing the city of Ekallatum. Thus began the so-called fourth Dynasty of Isin, which was centered at Babylon.

The next 121 years of the 4th Dynasty (1146-1025 BC) saw continuous sorties by the Babylonians against the Assyrians to the north, with the Assyrians retaliating against the Babylonians. The Babylonians attacked the Elamites to the south, and vice versa. Territory was not held long by either side; these were simply attacks of revenge and plunder. During this time, the tribes of the Arameans settled ever eastward, moving closer and closer to cities of both the Assyrians and the Babylonians, threatening their independence. Nabu-Shum-Libur (1033-1025 BC) was the last king of this ill-fated dynasty.

During the remainder of the Middle Babylonian Period, the 5th, 6th and 7th Dynasties of Babylon rose and fell in rapid-fire order. The 8th Dynasty, which was founded by Nabu-Mukin-Apli marked the end of the period.

Despite the pillaging and warfare that mark this period, the Babylonian calendar endured and remained the standard calendar of Mesopotamia. It was during this period of history that the ancient Sumerian month names were replaced by the Akkadian names which were later adopted by the Hebrew Calendar.

> But the familiar "equivalent" series of **Akkadian month names, beginning with *Nisannu* and ending with *A(d)daru*** did not emerge until the Middle Babylonian period [1150-900 BC]. During the Old Babylonian period [1894-1595 BC], at Sippar and elsewhere, documents are dated by local calendars, which had different sets of Akkadian month names.
>
> American Oriental Society: Abstracts of Communications of the 208th Annual Meeting. U of Michigan. 1998
>
> Greengus, Samuel. "New Data on the Old Babylonian Calendar of Sippar"
>
> http://www.umich.edu/~aos/abstr98.html

Calendar of the Middle Babylonian Period

1156-979 BC

	Akkadian Month Names	Number Days in Month	Julian Calendar Date (January-December)
1	Nisannu	29	March-April
2	Ayaru	30	April-May
3	Simanu	29	May-June
4	Du'uzu	30	June-July
5	Abu	29	July-August
6	Elulu/Ululu	30*	August-September
7	Tashritu	30	October-November
8	Arahsamna	30	October-November
9	Kissilimu	29	November-December
10	Tebetu	30	December-January
11	Shabatu	29	January-February
12	Addaru	30**	February-March

American Oriental Society: Abstracts of Communications of the 208th Annual Meeting. U of Michigan. 1998

Greengus, Samuel. "New Data on the Old Babylonian Calendar of Sippar"

http://www.umich.edu/~aos/abstr98.html

* Month intercalated in 17th year only.

** Month intercalated in other years.

Advanced Astronomical Calculations of Babylonian Astronomers

700 BC-75 AD

In the centuries that followed the Middle Babylonian Period, the astronomers of ancient Mesopotamia continued to observe and record the cyclical movements of the moon and other heavenly objects. These records, preserved on clay tablets, show a highly advanced level of astronomical expertise. With no modern telescopes or computers, these ancient astronomers were able to conduct detailed research and compile an astounding array of complex mathematical records:

> From about 700 B.C. onward we discover clay tablets recording amazingly sophisticated observations of the moon and planets, down to such details as the direction in which the earth's shadow sweeps across the moon in an eclipse….The later period of Babylonian astronomical research, from about 300 B.C. to 75 A.D., consisted of extraordinary achievements in the mathematical branch of astronomy. Around 300 tablets dealing with mathematical astronomy have been found in various excavations. These tablets are called ephemerides. They give numerical details of the motion of the moon and the planets. These calculations were so extensive and complicated that the Babylonians produced "instructional" tablets to explain how the numbers were to be calculated. Remarkably, modern astronomers have been able to interpret nearly all of the material on the ephemerides, despite the very different mathematical language of the Babylonians, by carrying out some mathematical detective work and considering the positions of the sun, moon, and the planets at specific times in the past.
>
> Unquestionably, the Babylonians contributed greatly to the history of astronomical knowledge. They not only observed the sky with precision, but they interpreted what they saw, all the while recording every specific of their findings.

Babylonian Astronomy and Other Very Early Celestial Knowledge
http://www.google.com/search?q=cache:onDeamexydYC:rampages.onramp.net/searcy/astro/babylon.html+babylonian+astronomy&hl=en

The records of history clearly bear witness to an advanced knowledge of the cycles of the moon and other celestial bodies by the early civilizations of the world. The successive city-states and empires that ruled the Ancient Near East all used the lunar cycle to determine the months of the year and all followed the principle of intercalation. Although the pattern of intercalary years varied among different peoples, all used the 19-year time cycle as a basis for calculating their lunar calendars. These ancient calendars span a period of many centuries before the institution of the Hebrew Calendar in the days of Moses.

The historical evidence leaves no room to argue that the 19-year cycle is an invention of men. It did not originate in the days of Meton, or in the days of the ancient sages of Judaism. Nor did it originate in the days of Hillel II. It is an absolute astronomical and mathematical reality instituted by the Supreme Designer and Creator of the heavens and the earth

Part II of this paper will trace the historical evidence of intercalation from the ninth century BC to the time of Christ. The disruptions of the time of Amos in the ninth century and Isaiah in the eighth century will be discussed. Both disturbances made it necessary to recalibrate all calendars to match the new realities of the solar system. The Babylonian Calendar of Nebuchadnezzar II made its appearance in the seventh century BC. After the fall of Babylon in 539 BC the Persians adopted the Babylonian calendar, but soon made a number of major changes. After a few decades the Persians reverted to a calendar similar to the one they inherited from the Babylonians. The Macedonians and the Seleucids adopted this revised Persian calendar in the fourth century BC. Finally, the Parthians adopted the Macedonian calendar in the third century BC, synchronizing it with their own.

An analysis of the evidence will show that both the Hebrew Calendar and the Babylonian Calendar were intercalated, but the two calendars did not use the same pattern of intercalation. The intercalary pattern of the Hebrew Calendar remained constant from the time of Ezra to the time of Christ and beyond. The intercalary pattern of the Babylonian Calendar adopted by the other nations, was not only different, but was not a standardized pattern. The refined intercalary pattern of the Hebrew Calendar was not discovered by the Persians until 380 BC. This pattern, utilized by the Hebrews at least since the time of Ezekiel and Ezra is the same pattern used by the Hebrew Calendar to this day. This fact will be demonstrated by presenting Scriptural, historical, astronomical and mathematical evidence.

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