Mediterranean Archaeology and Archaeometry, Vol. 16, No 4,(2016), pp. 41-49

10.5281/zenodo.220897

ANOTHER LOOK AT THE LUNAR SERIES AT DOS PILAS, GUATEMALA[1]

Stanisław Iwaniszewski[1]

[1]Posgrado en Arqueología, Escuela Nacional de Antropología e Historia – Instituto Nacional de Antropología e Historia, Mexico

Received: 01/03/2016
Accepted: 10/03/2016
Corresponding author: siwanisz@yahoo.com

ABSTRACT

Astronomical observations of the ancient Maya consisted of a determination of various calendar cycles commensurating with the synodic cycles of the relevant celestial bodies. This practice of commensuration – of converting distinct synodic cycles into a single calendrical cycle – was a common practice in the life of the Maya day-keepers. By quantifying the multiples of synodic revolutions along a single scale of the Calendar Round combined with the Long Count, the Maya skywatchers created relationships easily represented and compared. The Lunar Series consisted of six glyphs, referred to by letters, E, D, C, X, B, and A and represented the attempts to create the cyclical calendrical structure capable of predicting the synodic period of the Moon. In this paper, I am providing a method of detecting possible intercalations needed to fit the lunar motion and a possibility of the use of a 4784-day period, derived from the Xultun Lunar Table, as a lunar correction cycle. By this means, all Lunar Series from Dos Pilas receive reasonable explanations.

KEYWORDS: Maya Astronomy, Lunar Theory, Lunar Series, Xultun Lunar Table, Dos Pilas monuments.

[1] The paper read at the 23rd SEAC Meeting at Rome was titled "Another Look at the Lunar Series from Dos Pilas and Naranjo". Due to the lack of space, I decided to withdraw the description of the Lunar Series at Naranjo. Instead, I expanded arguments aimed at reconstructing of the lunar correction cycle based on the Xultun Lunar Table. The Naranjo material will be published elsewhere.

1. INTRODUCTION

There is no evidence that the ancient Maya ever had a formal lunar calendar like in the ancient Near East or China. Instead, they devised a complex system of recording lunar months known as the Lunar Series. The Lunar Series is the phrase that contains six glyphs, called E, D, C, X, B and A by Sylvanus Morley (1916) and may briefly be read as

> "n (days after) the Moon (= one of the 18 lunar months) arrived. Glyph X is the (either young or sacred) name of 29 or 30" (see Zender and Skidimore 2012: 8-9; Kinsman n.d.).

This brief statement brings together information about the age of the current lunar month (Glyphs E and D), the number of a completed lunar month grouped in subsets of 6 or 18 differentiated months (Glyphs C), and the record whether the month is 29 or 30 days long (Glyphs A).

This evidence seems to support the idea that each lunar month began at the moment when the lunar crescent was first visible and sighted. Glyphs E and D just record the number of days after the moon has been sighted and we can safely interpret the moon's arrival as referring to her first visibility in the western sky. Changes in Glyphs C, X, and A indicate that the Maya experienced the appearance of the first moon as a sign that they should start a new time unit called "moon" or "month".

As already stated, Glyph A records the length of a lunar month. In each case, it has a coefficient of 9 or 10 while any other coefficients are unattested in the inscriptions. It, therefore, indicates that the length of the month was just either 29 or 30 days. The incorporation of Glyph A into the Lunar Series evidently marks attempts made by the Maya scribes to control the lunar count (Teeple 1931: 63). It may be supposed that their long-term experimentations produced regular and easily predictable sequences, providing strings of alternating 30-day and 29-day lunar months that are fully attested in the Late and Terminal Classic (600-1000 CE) texts, and which could mechanically be predicted in advance (but see below).

As the Maya scribes began to record historical events from an arbitrarily chosen starting point, identified by modern scholars with the year of 3114 BC, their count of days, known as the Long Count, was used both to record the political and religious statements and the movements of the heavenly bodies.

The Lunar Series was attached to dates written in the Long Count, always between the dates expressed by 260-day and 365-day calendars, and often in the company of other calendric-numerical series (the cycles of 7, 9, 63, and 819 days). Together with other dates and calendrical cycles, the Lunar Series functioned as a temporal adverbial part of the whole phrase.

Recorded on public monuments, both strings of differentiating glyphs, those representing the Long Count date and those representing the Lunar Series, visualized the temporal structure of the universe as the sequential flow of events represented by the changing shapes of glyphic forms.

Though during the Postclassic (1000-1542 CE) the major part of Maya chronological notations, including the Lunar Series, was abandoned, a kind of lunar notation was apparently in use at the time of Spanish Conquest. In his Relación de las Cosas de Yucatán Diego de Landa (Tozzer 1941[1566]: 133-134) notices the following

> "They divide it [= year] into two kinds of months, the one kind of thirty days and called *u*, which means "moon", and they counted it from the time at which new moon appeared until it no longer appears. They had the other kind of months of twenty days, and they called *uinal hunekeh*; of these it took eighteen to complete the year, plus five days and six hours."

2. THE PROBLEM

Because the lunar month is determined by a mechanical alternation of 29-day and 30-day units, the lunar record expressed by the Lunar Series continuously shifts about the synodic moon at a rate of about one day in 32.7 lunations. For the Lunar Series to keep up with the lunar synodic period, it was necessary to add (intercalate) a day to one of the 29-day months every 32-33 months. The practice of intercalation of a day to one of the 29-day months is attested both in the Eclipse Table of the Dresden Codex and in the Lunar Table from Xultun where the groups of 6 months sometimes yield 178 days instead of 177. These examples are sufficiently clear to conclude that intercalations consisted of the juxtaposition of 30-day months, eventually causing the interruption in a regular alternation of 30- and 29-day months. While the Dresden Codex intercalations appear to have been quite irregular, those recorded in the early ninth century Xultun Lunar Table were made at regular intervals of 886 days (Iwaniszewski 2014). Naturally, the Classic period Lunar Series recorded hundreds of years before the Xultun Lunar Table, may display irregular or *ad hoc* made patterns or different schemes of intercalation, and it may be difficult to find any regularity in the distribution of intercalary months. Be that as it may, scholars who have studied how these intercalations were made proposed different short-term or long-term solutions (Teeple 1931: 64-69; Beyer 1933, 1935, 1937; Satterthwaite

1947: 86-106; Barthel 1951: 233; Lounsbury 1978: 775-776; Justeson 1989: 88-90; Brauer 2007).

3. METHODOLOGY

In the present paper, I will adopt the emic perspective (i.e. the understanding of the other's ways of life in their own terms). While this point of view is often found in the anthropology of contemporary peoples, in archaeoastronomy we are dealing with past societies and cultures and the emic perspective cannot be directly approached. However, the ancient Maya perception and conceptualization of the lunar cycle may be derived from their written texts and from analogies based on the elements of colonial or contemporary Maya culture. It means that I will not attempt to correlate the recorded lunar dates with the European calendar, nor will I calculate them from a single arbitrarily assumed base. Since my research limits itself to the developments observed at a particular site, I will not compare the lunar data derived from one site with those found at all locations and times.

Throughout the paper, I am using the term of intercalation which applies to the recording of the lunar synodic period. By this, I mean the practice of adding of a day to a 29-day month in a sequence of alternating 29-day and 30-day months.

Finally, I will avoid if possible, modern values of the synodic lunar month, rather, I will employ the average length of 29.5 days as resulting from the regular alternating between 29 and 30 days. The structure of the Lunar Series utilizes a pattern of 30 and 29-day lunar months, and their terms will be used in this paper. For example, in each cycle of 6 lunar months, there are three 30-day and three 29-day months, in total, 177 days. I assume that raising a 29-day month to a 30-day one is the simplest way to intercalate, one intercalation implies there are four 30-day and two 29-day months, in total, 178 days.

My methodology is simple. In most cases during the Late Classic period (600 – 800 CE) the structure of the Lunar Series appears to be fixed, and the sequence of Glyph C head variants followed a predetermined pattern. Since the Lunar Series is always attached to a particular Long Count date, it is easy to determine the number of days separating two Lunar Series. Those intervals are then divided by 29.5 days. If the remainder is zero, it is interpreted that the number of 30- and 29-day months is the same (no intercalations made). If on the other hand, the remainder is found, it is not interpreted regarding mistakes made by the Maya scribes but rather concerning intercalations. The remainder is then analyzed to conclude how many more 30-day months were taken than those of 29 days. This result serves to find a suitable arrangement of the sequence of 30- and 29-day months. For instance, the number of 885 days divided by 29.5 equals to 30 without remainder indicates no intercalations. Now, the number of 886 days divided by 29.5 equals to 30 plus one day revealing that one intercalation was made (i.e. a day is added to one of the 29-day months). Therefore, the number of 886 days is composed of 30 lunar months, but in this case, there are 16 30-day and 14 29-day months (16 x 30 + 14 x 29 = 886). The Lunar Table at Xultun covers 4784 days, which divided by 29.5 produces the remainder of 5, indicating that five intercalations were made (86 x 30 + 76 x 29 = 4784). The Dresden Codex Eclipse Table covers 11960 days, which divided by 29.5 days yields the remainder of 12.5 days suggesting that 12 or 13 intercalations were made (215 x 30 + 190 x 29 = 11960). These numbers are the multiples of the 2392-day period of Teeple (1931), known as the Palenque formula. These numbers mean that the intercalations were made every 956.8 days (2.6196 tropical years, or 2.6214 *haab'* years) and that the synodic period had 29.5308642 days.

This point needs particular emphasis. To some extent, examples mentioned above may be misleading since they all refer to the same moon age. The computing procedure is not as straightforward as it appears to be and must be sensitive to the record of different moon ages (see below).

Finally, it must be said that sometimes the Initial Series date specifies the day when a monument was commissioned; sometimes we may expect that the Lunar Series was calculated by the Maya scribes backward from the date on which this monument was dedicated. Needless to say, this circumstance enables us to reconstruct their cognitive-computational procedures.

4. DOS PILAS

By the mid-seventh century, Dos Pilas was emerging as a regional capital extending its hegemony over the Pasión River Valley to control its trade routes. It rose under the guise of B'ajlaj Chan K'awiil who was born at Tikal in 625 CE but at the age of four (in 629 CE) was sent and installed on Dos Pilas throne to establish presumably the Tikal hegemony in the region and to substitute the local ruling families. Dos Pilas was never powerful enough to become an entirely independent polity but always was able to produce balanced and nuanced links with Tikal and Calakmul, the two Maya superpowers. The Lunar Series at Dos Pilas is recorded on six monuments erected within the period between 682 and 735 CE, covering the time span of 53 years (see Table 1). Five records of the Lunar Series are found on stelae and two on Hieroglyphic Stairway 4. Three Lunar Series texts are attached to the IS dates that commemorate period endings (stelae 14, 15, and 2) while four are associated with non-period-ending dates. Basic information is provided in Table 1.

During that time Dos Pilas was ruled by three lords: B'ajlaj Chan K'awiil (Ruler 1), Kokaaj K'awiil (formerly Itzamnaaj K'awiil, Ruler 2), Vega Villalobos 2012) and Ucha'an K'in B'alam (Ruler 3).

The earliest known Lunar Series at Dos Pilas is known from the Hieroglyphic Stairway 4 (see Table I). This monument was dedicated in 682 by B'ajlaj Chan K'awiil (Ruler 1) to commemorate half Period Ending (Step II: 9.12.10.0.0 9 Ajaw 18 Sotz' or 8.05.682). About two and a half years later another step was added (Step I) to celebrate his third k'atun anniversary (see Table 2; Symonds et al. 1992: 215; Guenter 2003).

Table 1. Dos Pilas summary. IS = Initial Series, LS = Lunar Series, DD = Dedicatory Dates, HS = Hieroglyphic Stairway, PE = Period Ending; Entries: 1, 2 – according to Guenter 2003: 34-36; 5 – Mathews 2001 [1979]. The letters E, D, C, X, B, and A stay for Glyphs E, D, C, X, B, and A respectively. Combined with Glyph C, are its lunar patrons denoting, s- skull (God A), m - Young Maize (Tonsured) God, and j - Jaguar God of the Underworld. Numerical coefficients with Glyphs E, D, and A stay for the number of days, numerical coefficients with Glyph C denote numbers of lunar months. Finally, the nomenclature for Glyph X is: Roman number designate three main classes associated with three lunar patrons of Glyph C while their numerical coefficients are linked to those of Glyph C.

No	Monument	IS Date	LS	Event	Protagonist	DD
1	HS4 Step II	9.12.10.0.0 9 Ajaw 18 Sotz'	2ED 3Cm II.3 A10	half-PE, Stairway 4 construction	B'ajlaj Chan K'awiil	9.12.10.0.0
2	HS4 Step I	9.12.12.11.2 2 Ik' 10 Muwan	20ED 5Cs I.5 A10	60th tuun birthday, dance	B'ajlaj Chan K'awiil	9.12.12.11.2
5	Stela 8	9.12.[0.10].11 13 Chuwen 19 Kayab [9.12.6.15.11 11 Chuen 4 Sip]	3D 3Cs	Birth of Kokaaj K'awiil	Ucha'an K'in B'alam "Master of Sun Jaguar"	9.14.15.5.15
3	Stela 14	9.14.0.0.0 6 Ajaw 13 Muwan	16D 3Cm	PE, "stone binding" *k'altuun* ritual	Kokaaj K'awiil	9.14.5.3.14
4	Stela 15	9.14.10.0.0 5 Ajaw 3 Mak	17D 5Cj	half-PE casting incense ceremony	Kokaaj K'awiil	9.14.10.4.0
6	Stela 5	9.15.0.0.0 4 Ajaw 13 Yax	11D 1Cm II.1 A10	PE-celebration	Uch'an K'in B'alam	9.15.0.0.0
7	Stela 2	9.15.4.6.4 8 K'an 17 Muwan	10D 1Cm II.1 A10	War against Seibal "star-over-Seibal"	Uch'an K'in B'alam	9.15.5.0.0

Both dates are separated by 942 days and the same number of days is observed between two Lunar Series. The sequence of Glyph C head variants combined with Moon Age records (Glyphs D and E) indicates that the lunar months should have followed a regular order of 30 and 29 days. It is easy to compute that 942: 29.5 = 31 plus 27.5 days indicating the Maya scribes calculated 16 months of 29 days and 15 months of 30 days plus 28 days. There is no place for an intercalation. The number of 942 days may be structurally represented as 531 + 177 + 177 or 885 + 57 = 942 days.

Table 2. Monuments with the Lunar Series commissioned by B'ajlaj Chan K'awiil

Entry	Monument	IS Date	Days	Difference (in days)	LS recorded	Computed LS
1	HS4 Step II	9.12.10.0.0	1,386,000	942	22 3Cm 30	22 3Cf 30 + 942 = 20 5Cs 30
2	HS4 Step I	9.12.12.11.2	1,386,942		20 5Cs 30	

Kokaaj K'awiil (formerly known as Iztamnaaj K'awiil, Ruler 2, 673 – 726 CE, Vega Villalobos 2012), was the son of B'ajlaj Chan K'awiil and ascended to the throne in 698. My first step in analysis is to compare the last LS record of B'ajlaj Chan K'awiil (HS4 Step I (V)) with the first record of the LS of Kokaaj K'awiil (Stela 14, see Table 3). The time interval between two IS dates yields 9,858 days, indicating there were 334 months of 29.5 days plus five days, or 167 x 30 + 167 x 29 days plus 5 days. However, the difference between the LS computed and recorded amounts to 9 days (25D computed against 16D recorded, see Table 3) implying that nine intercalations were made. For better clarity, this may be provisionally interpreted either as (9 x 532 + 9 x 531 + 177 + 89 + 25) or (9 x 886 + 2 x 885 + 89 + 25).

Table 3. The last rectord of B'ajlaj Chan K'awiil (HS4 Step I) compared with the first record of Kokaaj K'awiil (Stela 14)

Entry	Monument	IS Date	Days	Difference (days)	LS recorded	Computed LS
2	HS4 Step I	9.12.12.11.2	1,386,942	9,858	20 5Cs 30	20 5Cs 30 + 9,858 = 25 3Cj 30
3	Stela 14	9.14.0.0.0	1,396,800		16 3Cj	

Table 4. The Lunar Series recorded during the reign of Kokaaj K'awiil

Entry	Monument	IS Date	Days	Difference (in days)	LS	Computed LS
3	Stela 14	9.14.0.0.0	1,396,800	3600	16 3Cj	16 3Cj + 3600 = 17 5Cm
4	Stela 15	9.14.10.0.0	1,400,400		17? 5Cm	

Kokaaj K'awiil commissioned stelae 14 and 15 with the Lunar Series to commemorate period intervals and to describe his military achievements and document famous shell-star wars (Houston 1993: 111). In first years of his reign, he defeated Tikal, however, for unknown reasons, the Maya scribes recorded the abbreviated LS resembling the Early Classic Tikal system of registering the lunar data. The time elapsed between the IS dates and Lunar Series is in agreement (3,600 days) supporting the reading of the Moon Age on Stela 15 as 17 days (see Table 4). These data are sufficient to deduce that no effort was made to add intercalary days within this period.

After his death in CE 727 at Dos Pilas throne was installed Ruler 3 (Ucha'an K'in B'alam, possibly as a regent for K'awiil Chan K'inich (Ruler 4). This ruler left the Lunar Series on three monuments.

Following my previous procedure first I compare the latest Lunar Series registered during the reign of Ruler 2 with the earliest Lunar Series of Ruler 3. Both rulers commissioned monuments commemorating period endings (Stelae 15 and 5). My computations indicate that between those dates seven intercalations occurred (see Table 5).

Table 5. The latest LS of Ruler 2 compared with the earliest LS of Ruler 3

Entry	Monument	IS Date	Days	Difference (days)	LS recorded	Computed LS
4	Stela 15	9.14.10.0.0	1,400,400	3,600	17 5Cm	17D 5Cm + 3600 = 18D 1Cm A30
6	Stela 5	9.15.0.0.0	1,404,000		11 1Cm A30	

Now, the magnificent Stela 8 shows that Ruler 3 was enthroned only 76 days after the death of Ruler 2. This monument describes important dates in the life of Ruler 2, including his birth and death, and probably ends with the celebration of the 15th k'atun ending (at 9.15.0.0.0, AD 731, Mathews 1979[2001]: 404) under the auspices of Ruler 3. The text on the back of Stela 8 begins with the IS date referring to the birth of Kokaaj K'awiil to which the abbreviated LS is added (that is, 9.12.0.10.11, or AD 673). This date is recorded as 9.12.6.15.11, but corrected as 9.12.0.10.11. This correction is made on calendrical grounds (see for details Mathews 2001[1979]: 397-398, Martin and Grube 2008: 59; Vega Villalobos 2012 58-59). The lunar date is probably backward computed from the monument's last presumed date, 9.15.0.0.0 (see Table 6). If we assume that the last date on Stela 8 marked the period ending at 9.15.0.0.0, then the Lunar Series would be computed backward from this last date, covering the time span of more than 58 years (21,389 days). Fortunately, the lunar data for the date 9.15.0.0.0 are given by Stela 5 dedicated by Ruler 3 to commemorate k´atun ending, and I think it is reasonable to suppose that the same information was known to the scribes who made computations on Stela 8 (see Table 6). The number of days (21,389) divided by 29.5 yields 725 with the remainder of 1.5 days. The Lunar Series counted backwards (362 x 30 + 362 x 29 + 31) arrive at 9D 2 Cs, whereas the recorded data yield 3D 3Cs.

The difference between these two records amounts to 23 days, indicating that between 9.15.0.0.0 and 9.12.0.10.11 the Maya scribes made 23 intercalations (see Table 6).

Table 6. The comparison of the Lunar Series on Stelae 8 and 5

Entry	Monument	IS date	Days	Difference (days)	LS recorded	Computed LS
5	Stela 8	9.12.0.10.11	1,382,611	21,389	3 3Cs	11 1Cm 10 – 21,389 = 9 2Cs 9
6	Stela 5	9.15.0.0.0	1,404,000		11 1Cm A30	

The first conclusion that can be drawn from this analysis is that Rulers 2 and 3 made intercalations with very irregular frequency. Columns 2 and 3 in Table 8 clearly show that periods without intercalations were followed by periods when intercalations were often made. It seems that after their accession both rulers were tempted to add days to avoid shifts in relation to the synodic month, but later the lunar data followed this shifting again. These data suggest there was no regular pattern at all. It is interesting to observe that number of intercalations between a first date and the last one is the same as displayed in columns 3 and 5. While intercalations in column 3 were presumably made in irregular fashion, those in column 5 seem to follow an unknown numerological model.

A few years after the celebration of the 15th k'atun, Ruler 3 commissioned Stela 2 which begins with the IS date recording 9.15.4.6.4 (AD 735). The IS date on Stela 2 falls 1,564 days after the last Period Ending at 9.15.0.0.0 recorded on Stela 5 (see Table 7), whereas the Lunar Series calculable from the same date is wrong. The Lunar Series of 9.15.4.6.4 would have been 11D 6Cs A29 if the scribes reckoned the lunar months without intercalations. Instead, Stela 2 carries the Lunar Series read as 10D 1Cm A10, which indicates that the lunar count has the Long Count position of 9.15.4.7.12 or 1,592 days after the Period Ending at 9.15.0.0.0. What happens is that the IS date refers to the interval of 53 lunar months (18+18+17), but the LS event relates to the period of 54 lunar months (18+18+18). In other words, the 54th lunar month is being ascribed to the IS date of the 53rd lunar month and one lunar month is suppressed (consult Table 7). One of the units of 6 or 18 lunar groups is shortened to contain only 5 or 17 such months. Now, the interval 1564 days equals to 27x30 + 26x29.

Table 7. The comparison of the Lunar Series of Stelae 5 and 2

Entry	Monument	IS Date	Days	LS recorded	Computed IS	Computed LS
6	Stela 5	9.15.0.0.0	1,404,000	11D 1Cm 30	11 1Cm 30 + 1564 = 11 6Cs 29	11 1Cm 30 + 1592 = 10 1Cm 30
7	Stela 2	9.15.4.6.4	1,405,564	10D 1Cm 30		

Though Dütting (1986:124) defined this interval as 8 x 6 plus 1 x 5 lunations, counted from 9.15.0.0.0, other explanations suggest an eclipse interest. The distance of 18, 18, and 17-month (together 53 lunar months) intervals implies that the 17-month period consists of subsets of 177, 177 and 148 days, and the presence of a 148-day interval may involve an eclipse computation. A rough confirmation of this possible explanation is found in the Dresden Codex Eclipse Table (Dresden 55b) where one of the intervals recording eclipses yields 1565 days. According to Aveni (1980: 80, Table 5), this number is useful to commensurate 53 lunar months with 57.5 draconic months (of 27.21222 days each) that mark the average interval between successive passages of the moon through the node: 57.5 x 27.21222 = 1564.70265 days. Here, the cycle of 57.5 draconic months implies that the moon is (was) observed at the opposite node. However, we do not know whether the number of 1564 days from Stela 2 has the same significance as the interval of 1565 days recorded in the Dresden Codex (but see below). It may or may not be interpreted as concerning eclipse watching.

The IS date refers to the event which is 28 days (roughly one lunar month) less than the date implied by the recorded Lunar Series. The moon age recorded on Stela 2 will be correct if we add 28 days more to the restored Lunar Series to arrive at 9.15.4.7.12, that is, 1592 days from the starting point at 9.15.0.0.0. It also means that the Maya did not reckon any intercalation during the period that started with the Period Ending at 9.15.0.0.0, and the date recorded on Stela 2.

Stela 2 commemorates the victory of Ruler 3 over Seibal and is known for the substitution of the Dos Pilas Emblem Glyph, which probably originated at Tikal, for its new version (Houston 1993: 98-99, Fig. 4-1; Martin and Grube 2008: 63). The conquest of

Seibal may, therefore, mirror attempts made by Ruler 3 to establish a more distinctive identity for Dos Pilas. The lunar data appear to herald significant changes affecting the structure of the Lunar Series, signaling its possible use to track the eclipses.

The "star over Seibal" war event mentioned on Dos Pilas Stela 2 is also recorded on Aguateca Stela 2. Unfortunately, the Aguateca monument does not include a Lunar Series. Both monuments also state that one day later, on 9.15.4.6.5 9 Chicchan 18 Muwan, Ruler 3 captured Yich'aaak B'alam, the ruler of Seibal. This date is separated by 1565 days from 9.15.0.0.0.

Together with many similar statements, the "star over Seibal" Emblem Glyph motif on Stela 2 gave rise to hypotheses that the Maya timed battles or other warlike events according to the stations of Venus (e.g. Lounsbury 1982; Schele and Freidel 1990). This date falls roughly one month after the superior conjunction and coincides with the day of the first appearance of Venus as Evening Star (Lounsbury 1982: 152-53; Aveni and Hotaling 1994: S27 Table 1). As already recognized by Kelley (1977: 64 Table 5.1, 65.) the Evening Star event may also be deduced from the Dresden Codex Venus Table base at 9.9.9.16.0. Supposing that the base date denoted the first appearance of Venus as Morning Star, its first evening appearance is marked as the 326-day of the whole cycle of 584 days (see Dresden 46). In other words, we have the following computing:

9.9.9.16.0 + 326 = 9.9.10.14.6 2 Kimi 19 Muwan + 70 x 584 = 9.15.4.6.6 10 Kimi 19 Muwan

But even, in this case, there is no obvious patterning of these dates. Both monuments, Dos Pilas Stela 2 and Aguateca Stela 2, do not record the date of 9.15.4.6.6 indicating that any reference to this event was not intended, or that the "star over Seibal" glyph referred to the observed phenomenon, not the computed one. While the planet Venus was believed to act a kind of patron of war, there is very limited evidence that Venus stations had ever been utilized to schedule military events (Aldana 2005; Bricker and Bricker 2011:245-248). The study of this topic is beyond the scope of the present paper.

5. INTERCALATIONS

Table 8 lists all the lunar dates. The first column gives the recorded long count date while the second determines intervals separating two successive dates. The third column gives the estimated number of intercalations and below the average number of days between those intercalations (rounded off to the nearest full day). In general, within the span of 22,953 days, the Maya scribes presumably made 23 intercalations which the average of one intercalation per 998 days. The record registered on Stela 5 and given in the fourth column, which relates the number of 23 intercalations made within the span of 21,389 days offers an opportunity to infer the sequence of intercalations. We can guess that from 9.15.0.0.0 at Dos Pilas, the intercalation was fixed through the adoption of a 4784-day cycle (comprising 5 intercalations). At least, this cycle was used to perform backward lunar computations:

[9.15.0.0.0] 2D 3Cs 30 - 21, 389 days (= 4 x 4784 + 2 x 886 + 481) = [9.12.0.10.11] 2D 3Cs

This calculation predicts 22 intercalations: 5 with-in the each cycle of 4784 days and 1 within the cycle of 886 days. It is observed, however, that the final result varies 1 day from the recorded moon age: it has 2 days instead of 3 days displayed on Stela 5. One day difference may indicate that the Maya scribes already performed the 23rd intercalation, or that the lunar month (not indicated by Glyph A) has 29 days in-stead of 30 days advocated by the 4784-day cycle.

Table 8. Hypothetical intercalations at Dos Pilas.

IS Date	Duration (days) between neighbor dates		Intercalations made between neighbor dates /below are average intercalations per days		Duration between the dates on telae Stelae 8 and 5 days)	Intercalations made/average intercalations per day
9.12.0.10.11	3389		7		21389	23
9.12.10.0.0		942	484	0		930
9.12.12.11.2	9858		9			
9.14.0.0.0		3600	1095	0		
9.14.10.0.0	3600		7			
9.15.0.0.0		1564	514	0		
9.15.4.6.4						
total	22953		23 998			

It is also observed that all other intercalations inferred, those between Stelae 14 and HS Step I and between Stelae 15 and 5 cannot utilize the 4784-day intercalary mechanism. It may suggest that the Maya scribes could not afford a reasonably accurate model of intercalation or decisions to determinate intercalations were made *ad hoc*, at the will of the rulers or elite skywatchers.

6. CONCLUDING REMARKS

The study of celestial motions recorded by the Maya scribes has too often depended on a kind of correlation of the Long Count with the European calendars. The lack of references to the Julian Calendar dates or the concept of the synodic lunar month enabled my research to attempt to infer the rules of the Maya scribes for perceiving, recording and explaining the motion of the Moon. Such an approach helped to explain all variations observed in the moon age data, within the reasonable framework of hypothetical intercalations and confirmed the non-altered structure of the Lunar Series. It also allowed for the application of an intercalary scheme indicated by the Xultun Table. Finally, my study advocates the idea that most Late Classic lunar data were computed not observed.

ACKNOWLEDGEMENTS

The study of the Lunar Series at Dos Pilas and Naranjo was supported by the Instituto Nacional de Antropología e Historia (project 296 "La teoría lunar en astronomía maya"). I thank an anonymous reviewer who has found errors in my draft.

REFERENCES

Aldana, G. (2005) Agency and the "Star War" Glyph: A historical reassessment of Classic Maya astrology and warfare. *Ancient Mesoamerica*, Vol. 16, 305-320.

Aveni, A. F. (1980) *Skywatchers of Ancient Mexico*. Austin, University of Texas Press.

Aveni, A.F and Hotaling, L.D. (1994) Monumental Inscriptions and the Observational Basis of Maya Planetary Astronomy. *Archaeoastronomy*, Vol. 19 (supplement to the *Journal of the History Astronomy*, Vol. 25), S21-S54.

Barthel, T. S. (1951) Maya-Astronomie: Lunare Inschriften aus dem Südreich. *Zeitschrift für Ethnologie*, Vol. 76, 216-238.

Beyer, H. (1933) Zur Konkordanzfrage der Mayadaten mit denen der christlichen Zeitrechnung. *Zeitschrift für Ethnologie*, Vol. 65, 75-80.

Beyer, H. (1935) On the Correlation between Maya and Christian Chronology. *Maya Research*, Vol. 2, No. 1, 64-72.

Beyer, H. (1937) Lunar Glyphs of the Supplementary Series at Piedras Negras. *El Mexico Antiguo,* Vol. 4, No. 3-4, 75-81.

Brauer, T. (2007) A New Approach for Systemizing the Dates in the Maya Lunar Series. *Mexicon,* Vol. 29, No. 4, 99-102.

Bricker, H.M. and Bricker V.R. (2011) *Astronomy in the Maya Codices*. [Memoirs of the American Philosophical Society, Vol. 265), Philadelphia, The American Philosophical Society.

Dütting, D. (1986) Lunar Periods and the Quest for Rebirth in the Mayan Hieroglyphic Inscriptions. *Estudios de Cultura Maya,* Vol. 16, 113-147.

Guenter, S. P. (2003) The Inscriptions of Dos Pilas associated with B'ajlaj Chan K'awiil. Mesoweb:<www.mesoweb.com/features/guenter/DosPilas.html.>

Houston, S. D. (1993) *Hieroglyphs and History at Dos Pilas: Dynastic Politics of the Classic Maya*. Austin, University of Texas Press.

Iwaniszewski, S. (2012) Los ciclos lunares y el calendario maya. *Arqueología mexicana*, Vol. 19, No. 118, 38-42.

Iwaniszewski, S. (2015) Counting Lunar Phase Cycles in Mesoamerica. In *Handbook of Archaeoastronomy and Ethnoastronomy*, Ruggless, C.L. N. (ed., New York, Springer Reference, 709-714

Justeson, J. S. (1989) Ancient Maya ethnoastronomy: an overview of hieroglyphic sources. In *World Archaeoastronomy*, Aveni, A.F. (ed.) Cambridge, Cambridge University Press, 76-129.

Kelley, D. H. (1977) Maya astronomical tables and inscriptions. In *Native American Astronomy,* Aveni, A.F. (ed.), Austin, University of Texas Press, 57-73.

Kinsman, H. (n.d.) Grammar in the Script: Nouns and Statives. Crabs and Glyphs "Maya Glyph Decipherment including Notes on Ancient Maya Astronomy. www.crabsandglyphs.com.org , text acceded 22.06.2015.

Lounsbury, F. G. (1978) Maya Numeration, Computation, and Calendrical Astronomy. In *Dictionary of Scientific Biography*, vol. 15, suppl. 1, Gillespie, C. C. (ed.), New York, Charles Scribner's Sons, 757-818.

Lounsbury, F.G. (1982) Astronomical Knowledge and Its Uses at Bonampak, Mexico. In *Archaeoastronomy in the New World*, Aveni, A.F. (ed.), Cambridge, Cambridge University Press, Cambridge, 143-168.

Martin, S., and Grube, N. (2008) *Chronicle of the Maya Kings and Queens. Deciphering the Dynasties of the Ancient Maya*. New York, Thames & Hudson.

Mathews, P. 2001[1979] Notes on the Inscriptions on the Back of Dos Pilas Stela 8. In *The Decipherment of Ancient Maya Writing,* Houston, S.D., Chinchilla Mazariegos, O. F., and Stuart, D. (eds.), Norman, University of Oklahoma Press, 394-415.

Morley, S. G. (1916) The Supplementary Series in the Maya inscriptions. In *Anthropological Essays. Holmes Anniversary Volume*, Washinton, J.W.Bryan Press, 366-396.

Satterthwaite, L., Jr. (1947) *Concepts and Structures of Maya Calendrical Arithmetics*. [Museum of the University of Pennsylvania and the Philadelphia Anthropological Society Joint Publication, 3].Philadelphia, University Museum.

Schele, L. and Freidel, D. 1990 *A Forest of Kings: the Untold Story of the Ancient Maya,* New York, William Morrow.

Symonds, S. Houston, S.D., and Stuart D. (1992) Implicaciones del descubrimiento de una nueva escalinata Jeroglífica en Dos Pilas, Petén. In *Simposio de Investigaciones Arqueológicas en Guatemala,1990,* J. P. Laporte, J.P., Escobedo, H. and Brady, S. (eds.), Guatemala, Museo Nacional de Arqueología y Etnología, 214-217.

Teeple, J. (1931) *Maya Astronomy*. [Publication 403], Washington, Carnegie Institution of Washington.

Tozzer, A. M. (1941) *Landa's Relación de las cosas de Yucatan*. Translated and edited by Alfred M. Tozzer. [Papers of the Peabody Museum of American Archaeology and Ethnology, Harvard University, vol. 18], Cambridge, Mass.

Vega Villalobos, M. E. (2012) Los dioses, el gobernante y la comunidad. Las estrategias político-religiosas del Gobernante 2 de Dos Pilas, Guatemala. *Estudios de Cultura Maya,* Vol. 40, 51-78.

Zender, M. and Skidmore, J. (2012) Unearthing the Heavens: Classic Maya Murals and Astronomical Tables at Xultun, Guatemala. *Mesoweb Reports*. www.mesoweb.com/reports/Xultun.pdf, electronic text consulted 1.12.2012.