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[N55 III:3] THE "SERPENT-NUMBERS" AND THE "TROPICAL YEAR" IN THE MAYA DRESDEN CODEX.

On pages 61, 62 and 69 of the Dresden Codex, there are ten numbers, which are written in the coils of five serpents. They are equivalent to about 34,000 years. On the open faces of the serpents one sees drawings of deities and animals. Furthermore there are two hieroglyphic columns to the left of the serpent numbers on pages 61 and 69 of the Codex. In the first column on both pages we can see, sign seven of the upper part, the hieroglyph that corresponds to the Maya number 16 (face-number), and also in the second column sign seven, the hieroglyph *Kin*, that means "day." In the lower part of page 69 first column, sign 13; and second column sign 122, there are ciphers forming the number 61. On page 69, first column, sign 12 in the lower part, is situated the sign one *Pictun*. Now I think we have here the calculation of the tropical year. After one *Pictun* has passed in the Maya calendar, which is almost 8,000 years in the Christian calendar, there is necessary a correction of 61 days within the Julian calendar, to agree anew with the tropical year. 4×61 are 244 days. In other words, four *Pictun* of the Maya calendar require a Gregorian-like correction of 244 days. Five to six *Baktun* later on needs another correction of 16 bissextile days minus. That means a whole Maya *Tzolkin* must be omitted. This point is situated near or within the ten serpent-numbers of the Codex. Therefore I believe the base-date of the serpent numbers to be a starting-date for a leap-day calculation of the tropical year. [R. P. C. Schulz]

[N56 III:3] THE HIEROGLYPHS OF THE LUNAR TABLE ON PAGES 51-58 OF THE MAYA DRESDEN CODEX.

The lunar series in the Dresden Codex starts on the upper part of page 53, and goes from left to right to the lower part of page 58. Upon each number there is always a group of two hieroglyphs. This table is universally interpreted as a series of eclipse-intervals. Now the distribution of these hieroglyphs shows a certain degree of symmetry. In a

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letter from Dr. Linton Satterthaite Jr., Philadelphia, there is a valuable observation relative to the problems connected herewith. I have the kind permission of Dr. Satterthaite to publish here this portion of our correspondence. The first problem that arises is the striking resemblance in the lower part of group 16, 32 and 64 of the hieroglyphic series (the hieroglyph *Yax* in group 64 with an *Imix* above).

The following is the text from Dr. Satterthaite's letter (this might possibly refer to eclipse intervals):

"The intervals between the tzolkin days corresponding to these glyphs are equivalent to 94 or 188 lunations (2775 or 2776 days for 94 lunations). Note the following sample fit against selections from Willson's table of eclipses possibly visible to the Maya:

Julian Day					
1,796,798	visible	0			
2,775		2,776	94 luns.		
1,799,573	visible	2,776		16th Entry	*Yax*-glyph
2,776		2,776	94		
1,802,349	visible	5,552	188	32nd Entry	*Yax*-glyph
2,776		2,775	94		
1,805,125	not visible	8,327	282	48th Entry	*Sky*-glyph
2,776		2,776	94		
1,807,901	visible	11,103	376	64th Entry	*Yax*-glyph

"The fact that the *Yax*-glyph is spaced by 16 entries or its double is paralleled by the fact that they are spaced by 94 lunations or its double; and using the double interval may possibly be connected with past observations of visible eclipses in which the 94-lunation interval seemed to define a series."

Annotation of Dr. Satterthaite: "I should first inform the reader that it depends on the assumptions that the Codex Table deals in visible eclipses; that the eclipses are solar so that Willson's table is applicable; and on the assumption that patterns in the glyph forms reflect patterns

of eclipses actually seen by the Maya, or at least that some of these patterns do so. I should also note that the hypothesis also requires me to consider that the Codex Table is not a predicting one, or else to assume that the author considered that there was some reason for correlating a pattern of past visible eclipses with a set of intervals predicting future ones.

To really inform a reader I ought also to advise him that Willson had sought a similar explanation of the *picture* intervals, getting very much more striking results; that his list of 'visible' eclipses includes doubtfully visible ones; and that my sample pattern is found by arbitrary selection from a great many of Willson's visible or possibly visible eclipses."

* * *

Now there are to be investigated the other hieroglyphs of the series. The groups 38, 39, 52, 53, 60 could mean visible eclipses, but this time not in distances of 16 parts, but in those of seven parts. In such a case, 59 means "non-visibility"; 45 and 46 mean perhaps "same distance but not visible, bad weather or only partially visible." The group 58 must contain a mistake in this connection and should probably be replaced by group 36. Then the groups 66 and 67 are likely to mean "the same distance repeats itself, but we have not seen anything any more" (*Aḳbal*-Glyph). However, at these dates something is to be expected in the future in distances of 11,960 days. In this connection, the lower glyph in the groups 10, 20, 35, 36, 57 may mean "we have not seen anything in good weather."

The groups 26, 37, 54, 65 could all have been at least a little visible. These groups around a center point in group 45 and 46; this: 46 minus 20 equals 26. 45 plus 20 equals 65. 45 minus 8 equals 37. 46 plus 8 equals 54. Likewise: 26 plus 28 equals 54. 37 plus 28 equals 65.

For all that, I am thinking of a certain position of the starting date of the table. If other positions are being taken, everything is displaced of course. Generally speaking, it must be stated that the basis of the table could only have been lunar eclipses, not solar eclipses, inasmuch as lunar eclipses are relatively frequent and easy to be observed. Total solar eclipses occur very, very seldom for a definite point of the earth. Partial solar eclipses, as a matter of fact, are not very perecptible.

LUNAR ECLIPSES

Table	Julian Day	In Maya-territory	Magnitude
starting-date	2,117,427	visible	total
	2,775		
Group 16	2,120,202	visible	total
	2,776		
Group 32	2,122,978	visible	11.5
	2,776		
Group 48	2,125,754	not visible	—
	2,776		
Group 65	2,128,530	visible	1.6
starting-date	2,134,406		
	6,586		
Group 38	2,140,992	visible	7.6
	177		
Group 39	2,141,169	visible	total
	1,034		
Group 45	2,142,203	visible	9.3
	177		
Group 46	2,142,380	not visible	—
	1,034		
Group 52	2,143,414	visible	4.7
	176		

Group 53	2,143,590 1,034	visible	5.6
Group 59	2,144,624 177	not visible	—
Group 60	2,144,801 1,034	visible	8.9
Group 66	2,145,835 177	not visible	—
Group 67	2,146,012	visible	0.6

(The last eclipse group 67 is very small, practically invisible.)

With the same starting-date 2,134,406:

Group 26	2,138,925	visible	5.2
Group 37	2,140,815	visible	5.9
Group 54	2,143,768	visible	total
Group 65	2,145,686	Ending visible, a little	

The glyphs of the groups 33, 34, 35 repeat themselves nearly exactly in groups 55, 56, 57 of the table. This is a proof that the *Tzolkin*-dates below group 58 have been put back *one* ostensibly after 22, not 23 distances.

The animal head glyph, similar to *Xul* in group 69, is very similar to the glyph located in the introduction page 51a above the number 18×11,960, and could mean, that 18×11,960 days earlier, of course with a divergence of one lunation, an eclipse was visible. The same glyph is placed also at the last of the 10 pictures in the corner at the right.

The remarkable glyph in the lower half group 3, 15, 17, 23, 24, 29, 30, 40, 44, 51, 63 perhaps also in 42 below and 49 above, gives possible a symmetrical scheme. Thus:

3 — — 17 — 24
15 — — 29
23 — 30 — . — 44 — 51 (30 — 37 — 44)
42 — 49 — — 63

Connected with other groups:

37 — — 51 — — 65
26 — — 40 — — 54 (see above the eclipse example)

From group 24 to group 42 we have two times 9 distances, from group 17 to group 49 we have two times 16 distances, etc., etc. Group 3 marks the first picture, group 15 marks the same *tzolkin* day from the beginning of the table. The other hieroglyphs in group 65 and 54 mark the last picture and the same *tzolkin* day before the ending of the table respectively.

To my regret I have at present very little hope of finding more meteorological notices within this hieroglyphic series.

The *tun* glyph, group 31, below, could mean that 13 *tun* later a solar eclipse is reached. On the other hand, that 26 *tun* earlier, a starting date is located with a lunar eclipse, for a table which ends at group 46 of the current table. The distance of these two dates from each other amounts to 14,040 days. In other words we have another starting date for the table in group 30 or 31 with a divergence of not more than three days within the *tzolkin-row*, comparing it with the other starting date of the table. [R. P. C. Schulz]

[N57 III:3] THE SO-CALLED "RING-NUMBERS" OF THE MAYA DRESDEN CODEX.

There are a quantity of number series in the Codex, resembling the Long-Count-Series of the monuments. Nearly all of them are connected with a secondary number, which is enclosed within a ring. Generally they are connected with the zero-date 4 *Ahau* 8 *Cumhu* and most of them lead to another calendar-round date which likewise is expressed in the codex. Spinden and Beyer have read these numbers subtracting the ring-number from the 4 *Ahau* 8 *Cumhu* and connecting the obtained

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date with the other calendar-round date mentioned above. Vice verse Förstemann and Morley have read these numbers starting with 4 *Ahau* 8 *Cumhu* and subtracting the ring-number from the other calendar-round date mentioned above. I personally think no dogma may be established. Here we have before us secondary arithmetic exercises of the Maya priests. The ring-numbers generally form groups of two of each, and the theme is varied every time in a different direction.

One of the ring-numbers we have on page 58 of the codex (251 days). Here results the following sketch:

9	12	11	11	0,	4	*Ahau*	9	18	2	2	0,	4	*Ahau*
			12	11						12	11		
9	12	10	16	9,	13	*Muluc*	9	18	1	7	9,	13	*Muluc*

9	18	1	7	9,	13	*Muluc*	
	1	16	15	0			equal to 11,960+1,300
9	16	4	10	9,	13	*Muluc*	
	1	16	15	0			
9	14	7	13	9,	13	*Muluc*	equal to 2×11,960+2,600
	1	16	15	0			
9	12	10	16	9,	13	*Muluc*	

The second date 13 *Muluc* corresponds to the dates 9 16 4 10 8, 12 *Lamat* 1st *Muan* on page 52 of the Codex. 2,600 days form an interval that is very important in the table of 11,960 days. There are 15 lunar groups from the initial date of the table, also in group 54 we have 15 groups before the end of the table in group 69. In the same way there lead twice the groups with an intercalation of 178 days, with a variation of two days to the same *Tzolkin* day. These are the groups 14 to 29 and 37 to52 of the table. (Also 1,300 days correspond nearly to 44 lunations.)

The other ring-number (511) on page 58 of the codex probably was connected with a division in three portions of a *Tzolkin* period (780 days).

Here we have a ring-number clearly connected with an astronomical (lunar) calculation. On page 24, too, the ring-number 2,200 is connected with an astronomical (Venus) calculation.

More difficult is the solution of the other ring-numbers on the reverse side of the codex. Here we have the strikingly large number 7, 2, 14, 19=51,419 days on page 63 of the codex. These could mean the accumulated distance between two Long-Count-Series. Thus:

8, 16, 3, 13, 0=1,268,540 — 17 = 1,268,523

10, 13, 13, 3, 2=1,538,342

1,268,523 + 109,200 = 1,377,723 (within Baktun 9)

1,538,342 — 1,486,923 = 51,419=ring-number

15, 3, 6, 0

(page 43) 1,377,723 + 109,200 = 1,486,923 13 *Akbal* 1 *Kankin*

+ 91

8, 16, 14, 15, 4=1,272,544 — 104 = 1,272,440, 4 *Ahau* (+ seven calendar-rounds)

132,860 + 91 bissextile days?

(within *Baktun* 9) 1,405,391 + 132,860 + 91 bissextile days? = 1,538,342

The same distance lies between 9, 7, 3, 5, 0=1,347,580, 4 *Ahau* 8 *Cumhu* and 9, 0, 0, 8, 1 · 13 *Imix* 9 *Uo*. Have the Maya known this?

On page 63 we have the ring-numbers 0, 17=17 and 11, 15=235. 17 days correspond possibly to the distance 8 *Cumhu* till 0 *Pop*, here counted to the other side, backwards instead of forwards. 235 days correspond possibly to 365 days=one year minus half a *tzolkin*=130 days (bissextile days for 10 calendar-rounds?).

On page 62 we have the ring-numbers 1, 4, 16=456 days and 6, 1=121 days. The 456 days correspond possibly to one year=365 days + 91 days (bissextile days?). The 121 days correspond possibly to 182 days (bissextile days?) minus 61 days. (See the hieroglyphic column on page 69.)

For the rest of the ring-numbers of the codex, I restrict myself to

note that the number on page 70 of the codex 4, 10, 6=1646 days could possibly mean the accumulated amount of Venus-correction-days for the serpent numbers. [R. P. C. Schulz]

[N58 III:3] THE STARTING DATE AND THE FINAL DATES OF THE SERPENT NUMBERS OF THE MAYA DRESDEN CODEX.

The first investigator of this material, Ernst Förstemann, has seen already that the calendar-round date 9 *Kan* 12 *Kayab* written above the ten serpent numbers of the codex is the starting date of most of them. The two numbers on page 69 of the codex seem to be correct, although the month positions in the calendar-round final dates are effaced. Likewise the four numbers on page 62 seem to be correct. We have to amend not more than one non-essential point in the month date of one of the serpents and the exchange of the month-glyph in another.

More difficult is the situation with the four serpent numbers on page 61. The first two numbers situated to the left side of this page were corrected fifty years ago by Cyrus Thomas. By means of the interchange of the *Katun* positions Cyrus Thomas attained the right numbers, which now connect correctly the starting date with the final dates. Hermann Beyer has attempted to rectify the two numbers situated to the right side of this page. He thinks that two miscalculations, the one of 13 *Tun*, the other of 2 *Tzolkin*, are to be amended. But this seems highly improbable. The desire of Beyer is to make the starting date agree with the two calendar round-final dates which are in the codex. But if the number is miscalculated, then the final date results are also wrong. Therefore I believe it more probably that the calendar-round-date is miscalculated, and that the number series probably is correct. Apart from this we have to keep in mind that even if the starting date and the final date of a number are correct there exists the other possibility that the number-series contains a miscalculation of whole calendar-rounds and nevertheless results wrong.

In 1915 in his book about the Maya-hieroglyphs Morley tried to define the starting date of the serpent numbers as 9, 15, 9, 9, 4 - 9 *Kan* 12 *Kayab*. Morley's conjecture was that a number-series on page 69 of the codex in the hieroglyphic column to the left of the serpent contains an error of the scribe. Beyer in his 1939 paper suggested that

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here a scribe's error is improbable, and that he therefore could reject the date 9, 15, 9, 9, 4 · 9 *Kan* 12 *Kayab*.

I think the truth is in between. We have here not a scribe's error but the distance between two calendar-round-dates both connected with the ninth *Baktun*. Thus:

page 61	page 69
9, 0, 0, 8. 1 · 13 *Imix* 9 *Uo*	9, 0, 0, 5, 0 · 4 *Ahau* 13 *Kayab*
15 9 1 3	15 9 4 4
9,15, 9, 9, 4 · 9 *Kan* 12 *Kayab*	9,15, 9, 9, 4 · 9 *Kan* 12 *Kayab*

The first series leads us to the important position 4 *Ahau*. The second series reflects the importana number 61.

It is possible that the starting date of the serpents is situated in a distant past, and that the final dates of the serpents correspond to Initial-series of the period of the monuments. But this is by no means certain. Possibly the Dresden Codex dates from a period or a region where the Long-Count was already in disuse or in decay. In this case it is possible that an old Initial-series 9, 15, 9, 9, 4 · 9 *Kan* 12 *Kayab* represents a starting date for a new count into the future. Likewise they could connect in later times old Initial-series with other calendar-rounds. On page 63 of the Dresden Codex there are above the dates 13 *Imix* 9 *Uo* and 13 *Xul*. The Ring-number 235 represents the distance from 13 *Xul* to 8 *Cumhu*. But are these numbers in their original position and connection?

Resembling the Long-count-like series, the serpent-numbers in the Dresden Codex form groups of two of each. The serpent-number for the day 3 *Kan* has been *written* twice in the codex. The first one is connected with a 13 *Akbal series*. The other one is connected with a 3 *Chicchan* series. There are animal pictures above these two serpents. The rest of the serpents have pictures of deities above them. The distance of the connected serpent-endings is equal to the distance between two of the number series on page 63 of the codex. Thus:

8	11	8	7	0		4	6	9	15	12	19		
	4	15	6	0				4	15	6	0	= 132	*Tzolkin*
8	16	3	13	0		4	6	14	11	0	19		
										2	2		
						4	6	14	11	3	1		

2 *Uinal* 2 *Kin* (42 days) form the distance between 13 *Akbal* and 3 *Chicchan* (Serpent-ending-dates).

Finally, the ending-date of the largest serpent-number (amendment of Cyrus Thomas) 3 *Chicchan* 13 *Pax* is situated 19 days before 9 *Kan* 12 *Kayab*. In other words, we have here nearly 658 complete calendar-rounds. The ending-date of the first serpent to the left (page 62) 3 *Cimi* 14 *Kayab* is situated 14 days before 4 *Ahau* 8 *Cumhu*. The ending-date in the neighboring serpent 3 *Chicchan* 18 (*Yax*) (on page 61) (without the Beyer-amendment) is situated 235 days before 4 *Ahau* 8 *Zotz*. Thus we have three serpent-ending-dates situated within a *Tzolkin* before important positions of the Maya-calendar. (Compare also the distances 4 *Ahau* 8 *Cumhu* + 6,483 days = 13 *Akbal* 1 *Kankin* and 4 *Ahau* 8 *Zotz* + 6,483 days = 13 *Akbal* 6 *Cumhu*: calendar-round-date on page 63 of the Dresden Codex even if in the wrong place.) [R. P. C. Schulz]

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