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ECLIPSE COUNT, CALCULATION OR PREDICTION ACCORDING TO THE HUICHAPAN CODEX

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RESUMEN

El texto discute un fragmento de la glosa del Códice Huichapan (Siglo XVII) que parece hacer referencia a una fórmula matemática para calcular y contabilizar los eclipses. Se analiza dicha glosa en términos de los modelos calendáricos de Mesoamericana, la idea de que los otomís eran ávidos seguidores de los ciclos lunares y, finalmente, de acuerdo a la estructura cronológica del propio códice y los eclipses que en él se registran.

ABSTRACT

This article discusses a gloss fragment of the Huichapan Codex (17th Century) that appears to make reference to a mathematical formula for calculating and/or counting eclipses. The gloss is analyzed in terms of the Mesoamerican calendar models, the idea that otomí astronomers were avid moon cycle followers and, finally, in accordance to the internal chronologic structure of the actual codex and the eclipses in it registered.

Key Words: archaeoastronomy

1. INTRODUCTION

The present discussion centers on a gloss fragment of the Huichapan Codex (17th century), which seems to be a mathematical formula for eclipse count and prediction. From this perspective, such gloss fragment, as in fact the whole codex, becomes not only a source to understand the Mesoamerican calendar structure, but a testimony of Otomi (*Hñähñüs*) astronomical knowledge and a path to understand the importance that this culture gave to the moon and how eclipses explain such relevance in their calendar structure.

The present work presents, along with the analysis of the codex gloss fragment as a formula to predict and count eclipses, the results obtained by applying this formula to the different solar eclipses registered in the same codex.

The Huichapan Codex was created near the year 1632 by an otomí named Juan de San Francisco. The document includes two chronologic periods, both colonial (from 1539 to 1632) and prehispanic (from 1403 to 1528), in which different historical events related to Huichapan and Jilotepec are accounted, as well as toponymic glyphs related to leaders or places and, most importantly, the structure of the otomí calendar and certain cosmological events, such as eclipses (Lastra, 2005:34).

Several researchers have analyzed the Huichapan Codex from a calendaric and astronomical point of view (Caso, 1928, 1967; Soustelle 1937; Carrasco, 1950; Aguilera & Galindo, 1991; Prem, 2008). Most of them have acknowledged significant contradictions in the calendaric structure of the codex, such as the fact that the Mesoamerican dates applied from the year 1451 to 1502, apply one extra numeral, which is absent from the Mesoamerican dates applied from years 1403 to 1450 and from the years 1503 to 1528. This means that Caso's Mesoamerican/Western correlation can't be applied to the years that run from 1451 to 1507.

Contrary to the academics that see in these contradictions no more than mistakes regarded to the ignorance of the Codex's author, I will try to explain them as inconsistencies that play an important role as hints; as clues that help us deconstruct the translations made from the Mesoamerican to the Western calendaric systems and vice versa.

The codex registers three different eclipses associated to three different dates of the Western calendar. Results show that these years registered in the codex still refer to the Julian Western calendar, although the catholic reform that substituted this calendar for the Gregorian one occurred in 1582. Also, the dates presented in the codex correspond to the 15th and 16th centuries.

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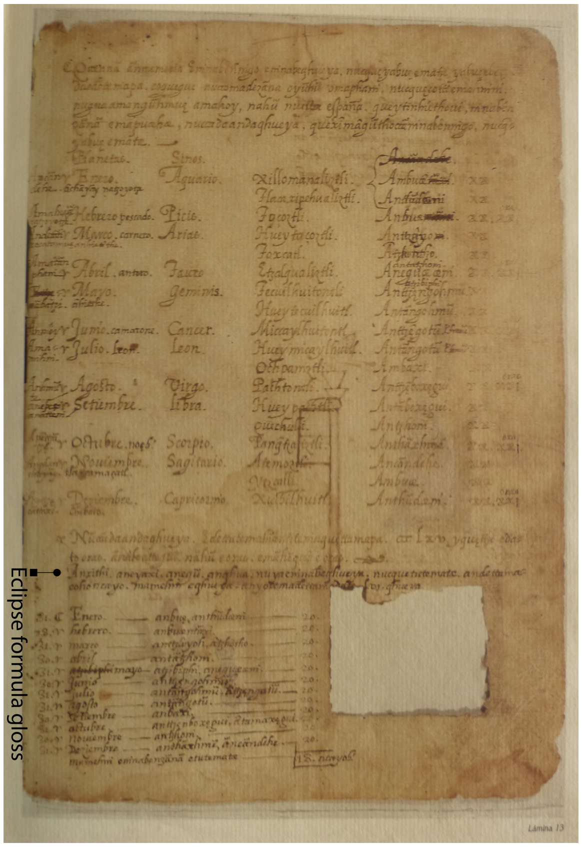

Fig. 1. Fragment of the 7th folio (page 13) of Huichapan Codex.

Fig. 2. 7th Folio / verse (page 14) of the Huichapan Codex. Eclipse of 1403-1404.

I would like to start by describing the gloss fragment, its implications in the context of the lunar cycle, its apparent relation to the Mesoamerican calendar of 260 days (*Tzolkin*, *Tonalpohualli*) and its importance for the understanding of the 52 years Mesoamerican cycle. In the second part I will explore the connections between these ideas and the three eclipses registered on the codex, while trying to find out which eclipse is the codex referring to.

2. ECLIPSE CALCULATION FORMULA IN THE HUICHAPAN CODEX

It is on the 7th folio (page 13) of the Huichapan Codex where the structure and names of the 20 days month of the otomí calendar are presented, along with their corresponding Mexica and Western months (Figure 1). This folio is headed by what seems to be the formula for eclipse count, calculation or prediction:

Anxithi aneyaxi anegũ anqhua nuyaeninab'eqhueya nucquetutematö andettema-	*caña, pedernal, casa, conejo, [son los signos de la cuenta de los años —del calendario] [de] los muertos ancianos [antepasados] diez más*
*Cohoncayo. mamhni eqhueya. anyotemad'ettamadat[o] lvi qhueya.**	*dos divisiones total del año: cuarenta más diez más seis, 56 años (Ecker, 2003).*

*Ecker (2003:102) provides important information regarding number names for the otomí. For example, 2: *yoho*, *yo-*; 4: *koho*, *kü*; 6: *da-to'na-to*, *ra-to*; 20: *da-te*; 40: *yo-te*; 40+10=50: *mayotemadetta*.

First, we have as reference the fact that otomies called their *veintenas zäna* (moon), which suggests a year count through lunations, even though the veintena structure is maintained.[2] Even more suggestive is the gloss that iterates a sequence of "ten plus two divisions of a total year". This means: two divisions of 177 days (6 lunations), which multiplied by 2 equals 354, and by adding 10 gives 364 days total.[3]

Following this "*diez más dos divisiones total del año*" gloss, we find a more complex fragment of the formula: "*cuarenta más diez más seis, 56 años*" (forty plus ten plus six, 56 years).

As an exercise, I applied the formula described above to one of the eclipses registered in the codex for the year 1455. The formula was applied backwards. This is, taking into account that if they used to add forty plus ten plus six years, I would have to subtract first six, then ten and then forty years.

By applying this logic, the calculation of total annular or partial eclipses -many of which were visible from Mesoamerica-, became evident. It was also evident that the 40, 10, 6 year range did not correspond to tropical solar years, but to specific sequences of lunations. Basically, between 493 and 494 lunations in 40 years (14,558 or 14,588 days), between 123 and 124 lunations in 10 years (3,632 or 3,662 days) and between 76 and 77 lunations in 6 years (2,244 or 2,273 days) (see Tables 1 and 2).

Why would 56 years be divided in fractions of 40, 10 and 6 years?

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2.1. *The 56 year cycle*

The nodical month of the moon, also known as draconic month, lasts 27.21222 days, time in which the moon returns to the same node of its orbit. Also, the line of the nodes moves over the ecliptic in 18 years and 214 days, 18.61 years or 6,798.3633 days (normally expressed as 18.6 years), a period known as precession of the nodes of the moon, nodal revolution or draconic cycle.

Three nodal revolutions represent 20,395.08 days (6,798.36 x 3) or **56.03 years of 364 days**, 55.87 years of 360 + 5 days, or 55.83 tropical years of 365.24 days.

Thus, the most understandable reason the otomis decided to calculate their calendaric cycles in sequences of 56 years −as presented in the codex− is explained by the systematic calculation of the position of the nodes or by the intersection between the orbit of the moon and the ecliptic (the apparent plane of the movement of the sun).

It is also worth considering that although the nodal revolution period is not exactly equal to the synodic month (29.53 days), it does have a close resemblance to the relationship between the synodic month and the eclipse year. Let's remember that 223 synodic months (Saros cycle) and 19 years of eclipses of 346.62 days only differ by 11 hours. The difference between this two cycles and the draconic cycle ranges between 212 and 213 days:

223 synodic month =	6,585.32 d. =	6798.3633 d. - 6,585.32 d. = 213.0433 d.
346.62 eclipse year (x) 19 =	6,585.78 d. =	6798.3633 d. - 6,585.78 d. = 212.5833 d.

2.2. *Let's analyze this factor*

Firstly, a synodic month –a concept that refers to the phases of the moon-, is the period of time in which the moon returns to its same phase, being its approximate duration between 29.27 and 29.83 days. These numbers pin down the range of lunations and must be considered in order to calculate eclipses. In addition, 29.53 days is a range present in a year division of two times 177 days.

Secondly, let's note that an eclipse year (346.62 days) differs from a tropical year (365.2422 days) by 18.6 days. It seems significant that an 18.6 factor repeats, even though the nodal revolution refers to 18.6 years and not days as in this particular case.

[2] The Mesoamerican calendar is composed of 18 "months" of twenty days known as *veintenas*, plus a 5 day segment to complete the solar cycle of 365 days.

[3] Note that the 177 days sequence also appears in the mayan Dresden Codex and that 173.33 is considered an eclipse season or half an eclipse year.

TABLE 1

SEQUENCE OF ECLIPSES.*

	days cycle lunations (6, 10, 40)	real days elapsed	lun	diff.	y	m	d	T	O	C	D	y	m	d	T	O	C	D
-	-	-	-	-	1455	4	16	2	1	3	2	1445	10	11	-	-	-	-
6	2244.28	2244	76	−0.28	1449	2	22	1	1		3	1449	8	18	-	-	-	-
10	3661.72	3662	124	0.28	1439	2	13	4	1	3	2	1439	11	8	-	-	-	-
40	14558.58	14558	493	−0.58	1399	4	6	4	1	2	1	1399	10	29	-	-	-	-
6	2244.28	2245	76	0.72	1393	2	11	4	1	1	1	1393	8	8	-	-	-	-
10	3661.72	3632	123	−29.72	1383	3	4	1	1	1	1	1383	8	28	-	-	-	-
40	14558.58	14557	493	−1.58	1343	4	26	1	1	2	3	1343	9	19	-	-	-	-
6	2244.28	2245	76	0.72	1337	3	3	1	0	0	0	1337	8	26	-	-	-	-
10	3661.72	3662	124	0.28	1327	2	22	4	1	2	2	1327	8	17	-	-	-	-
40	14558.58	14530	492	−28.58	1287	5	13	4	1	3	3	1287	10	8	4	1	1	1
6	2244.28	2244	76	−0.28	1281	2	20	1	0	0	0	1281	8	15	2	1	1	1
10	3661.72	3633	123	−28.72	1271	3	12	1	1	1	1	1271	9	6	2	1	3	3
40	14558.58	14558	493	−0.58	1231	5	3	1	1	1	1	1231	10	26	3	1	3	3
6	2244.28	2245	76	0.72	1225	3	10	2	1	1	1	1225	9	4	2	0	0	0
10	3661.72	3661	124	−0.72	1215	3	2	4	0	0	0	1215	8	26	4	1	4	2
10	3661.72	3632	123	−29.72	1215	3	31	4	1	2	3	1215	9	24	4	1	2	3
40	14558.58	14588	494	29.42	1175	4	22	4	1	2	2	1175	10	16	4	1	2	2
40	14558.58	14559	493	0.42	1175	5	21	4	1	2	1	1175	11	15	4	0	0	0
6	2244.28	2244	76	−0.28	1169	2	28	2	1	1	1	1169	8	24	1	0	0	0
10	3661.72	3632	123	−29.72	1159	3	21	1	1	4	2	1159	9	13	3	1	2	2
40	14558.58	14559	493	0.42	1119	5	11	2	0	0	0	1119	11	4	1	1	1	1
6	2244.28	2244	76	−0.28	1113	3	19	1	0	0	0	1113	9	11	2	1	2	3
10	3661.72	3662	124	0.28	1103	3	10	4	0	0	0	1103	9	3	4	0	0	0
10	3661.72	3633	123	−28.72	1103	4	8	4	1	2	2	1103	10	3	4	0	0	0
40	14558.58	14558	493	−0.58	1063	5	1	4	0	0	0	1063	10	24	4	0	0	0
40	14558.58	14529	492	−29.58	1063	5	30	4	1	2	2	1063	11	22	4	1	3	3
6	2244.28	2245	76	0.72	1057	3	8	2	0	0	0	1057	9	1	2	1	1	1
10	3661.72	3632	123	−29.72	1047	3	29	2	0	0	0	1047	9	22	1	0	0	0
40	14558.58	14558	493	−0.58	1007	5	19	1	0	0	0	1007	11	12	2	1	1	1

*Derived by applying the formula "less 6, less 10, less 40" to the 1455 solar eclipses. (diff.) difference between lunations and real days elapsed, (m) month, (d) day, (T) type of eclipse: (1) total, (2) annular, (3) hybrid, (4) partial, (O) possible observation of eclipse: visible (1) or invisible (0), (C) when was the eclipse observed: (1) all the time, (2) at maximum phase, (3) at the beginning, (4) at the end, (D) direction of the eclipse: (1) zenith, (2) east, (3) west.

Other important aspects are also necessary to consider in relation to the calculations presented so far. First, we are starting by considering the premise that otomís, by naming their *veintenas zäna* (moon), counted their time through lunation sequences. Second, we should consider that this premise includes the gloss "ten plus two divisions of a total year", which is the same as 177 x 2 + 10= 364. This is, a year of 364 days and not 360 days + 5 (the Nahuatl *Xiuhpohualli*) or 365.24 days known as tropical year. Nevertheless, we should take into account that the same Huichapan Codex describes the *veintena* calendar division as well as a 5 day period

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TABLE 2

RELATION BETWEEN DAYS, LUNATIONS, THE 260 DAYS MESOAMERICAN CYCLE AND THE SOLAR CYCLE, IN PERIODS OF 56, 40, 10 AND 6 YEARS

Calculation options	Years	Lunations	Days (d)	364 day cycle (d/364)	360+5 day cycle (d/365)	365.2422 tropical year cycle (d/365.24)	260 day cycle (d/260)
1	40	493	14558	39.99	39.88	39.86	55.99
	10	123	3632	9.98	9.95	9.94	13.97
	6	76	2244	6.16	6.15	6.14	8.63
	56	**692**	**20434**	**56.14**	**55.98**	**55.95**	**78.59**
2	40	494	14588	40.08	39.97	39.94	56.11
	10	124	3662	10.06	10.03	10.03	14.08
	6	77	2273	6.24	6.23	6.22	8.74
	56	**695**	**20523**	**56.38**	**56.23**	**56.19**	**78.93**

TABLE 3

TIME DIFFERENCES BETWEEN SOLAR YEAR CYCLES OF 364, 365+5 AND 365.24 DAYS

20435 / 364	56.14	20435 / 364	56.14
20435 / (360+5)	55.98	20435 / 365.24	55.95
Years	0.15	Years	0.19
Days	**56.17**	Days	69.73
Moons	1.90	Moons	2.36

known as *dupa* (dead days), so we can not completely discard the use of a 360+5 days calendar in the Otomi culture.

It is interesting to realize in this sense that considering both cycles as simultaneous (364 and 360+5) in the context of the 40 + 10 + 6 = 56 year formula, we find that if we subtract the result of the years obtained with a 364 days cycle, to the result of years obtained with a 360 + 5 days cycle, we get a total of 0.15 years, which is equal to 56.17 days or 1.9 lunations. That is, the number 56 reappears although again referred to days instead of years (see Table 3).

2.3. *The 40 year and 10 year period related to the 260 days period.*

It is significant to note in Table 3 that the lunation period of 40 year cycle of 364 days is equal to a 56 cycle of 260 days, that is, between 493 and 494 lunations. This is the reason why a 40 year cycle was isolated in the eclipse calculation. On the other hand, 10 cycles of 364 days are equal to 14 cycles of 260 days or between 123 and 124 lunations.

2.4. *The 6 year period*

Once at the final 6 year period the congruence between the 364 cycle and the 260 days cycle is lost. The 6 year period aims at this fact as well as at the difference between the nodal revolution (3 cycles in 56 years) and the Saros cycle (3 cycles in 54 years). (Table 4).

As Philip S. Harrington (1997:17) explains, "we might think of a Saros cycle as a family of eclipses. Any two eclipses separated by 18 years and 11 days will generally share many common characteristics, such as

TABLE 4

TIME LINE OF LUNAR CYCLES RELATED TO ECLIPSE PHENOMENA AND THE 56 YEAR CYCLE

Cycle	1 cycle in days	3 cycles in days	364 days cycle in years	360+5 days cycle in years	365.2422 tropical cycle in years
Saros Cycle	6,585.32	19,755.96	54.27	54.13	54.09
Eclipse year	6,585.78	19,757.34	54.28	54.13	54.09
Nodal Cycle	6,798.36	20,395.08	56.03	55.88	55.84

duration, type, length and shape. But, since the synodic and sidereal months and the eclipse year are not exact multiples of one another, characteristics of eclipses within the same Saros will slowly change. First and most obvious, the dates of the eclipses advance by 11 days and 8 hours. As a result of that 8 hour span, the Earth will have shifted under the moon's shadow by a third of a day. Thus, the same family eclipse will be seen at 120°difference in latitude".

Not only there is a 56 and 54 year cycle implicit in the 6 year isolation formula; in addition, a 52 year cycle is also present.

As it will be explained more broadly below, the Huichapan codex registers three different sun eclipses, divided by 52 years. The first eclipse seems to have taken place on January 12th, 1404, while the third, or last eclipse registered, took place on January 2, 1508 (Aguilera y Galindo, 1991:62 y 65). The lapse between the first and the third eclipse is equal to 37,976 days or 103 years 11 months and 21 days, or 1,286 lunations. Let's notice also that 37,976 days or 1,286 lunations represent 146 cycles of 260 days. This means that, actually, the correspondence between the 364 day cycle and the 260 day cycle remains up to the first 52 years, while the 54 and 56 years have to do with the eclipse phenomenon.

It seems that a cycle of two times 52 years (104 years) was used to place a sequence of three solar eclipses, the first and the last of which were separated by 10 days. This cycle was associated with the *Fuego Nuevo* ceremony and is consistent with the 20 day structure of the Mesoamerican month.

In synthesis, the 6 year isolation serves to record the rupture between the 364 day cycle and 260 day cycle while maintaining astronomical observations over the 54 year Saros Cycle and 56 year Nodal Revolution cycle related to eclipses.

3. ECLIPSES REGISTERED IN THE HUICHAPAN CODEX

3.1. *The 1403 and 1404 eclipses*

The first eclipse registered on the codex is placed under the years 1403 and 1404 of the Julian calendar, associated respectively with the 2 *Acatl* (reed) and 3 *Tecpatl* (stone knife) (Figure 2). The eclipse is described in the verse of the same 7th folio (page 14) as follows:

Quequa pitzoy nuccãmbetto anvixũy	*Aquí cayó primero [= por primera vez anocheció]*
Cobinu cobitimih nuvaedãnmitti ãnxithi	*Vió, se sentó en el trono aquí [el grande que empuña la caña o bastón de mando] Acamapichtli*
... yn Tonatiuh	*El sol [en mexicano]*
Otlayoua	*se comió*
Ecclipsi del sol	
Ecclipsado el sol	
Ucccciii años (1403)	*Uccciiii años*
[roto] años	*1404 años*
2 Caña	*3 cuchillo*

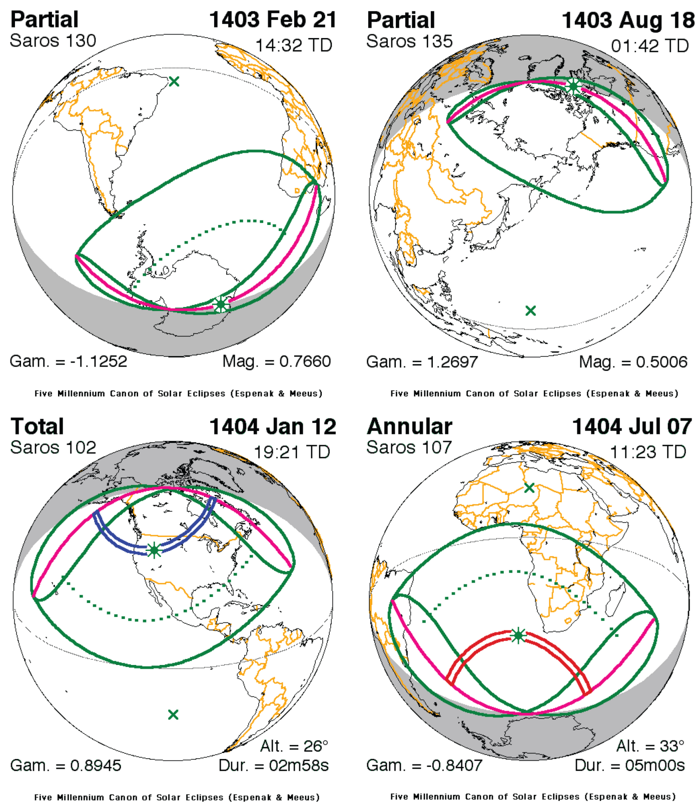

Fig. 3. Solar eclipses that occurred in 1403 and 1404.

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In order to find out to which exact eclipse is the codex referring, NASA's ephemerides were consulted, as well as the correlation of the glyphs with the Mexican, Julian and Gregorian calendars.

Two solar eclipses took place in the year 1403. The first one occurred in February 21 (1 *Tochtli*) and the second one in August 18 (2 *Acatl*). Both were partial eclipses and neither one was visible in Mesoamerican territory.

In the year 1404 a total sun eclipse took place in January 12, date still related to the bearer glyph 2 *Acatl*, although the year is not 1403 (Figure 3). As appreciated in NASA's graphic, the total phase of the eclipse was observed in North America, while in Mesoamerica the eclipse was actually observed as a partial one, being the sun covered by the moon by 35.3%, around 14:30 hours of the day.

Another solar eclipse, this time annular, took place in July 7, 1404, a date in fact related with the 3 *Tecpatl* Mexican glyph. Nevertheless, this eclipse was not visible in Mesoamerica, which suggests that the eclipse registered in the Huichapan Codex, and associated with the ascension of Acamapichtli, must have been the one of January 12th, 1404.

3.2. *The 1455 and 1456 eclipses*

The second eclipse registered in the codex was associated to the years 1455 and 1456, as well as to the bearer glyphs 3 *Acatl* and 4 *Técpatl*, respectively (Figure 4). This is particularly interesting because, in accordance with Alfonso Caso's correlation, the year 1455 would have to correspond to the glyph 2 Acatl and not 3 Acatl as the codex presents.

This eclipse is described in the 19th folio (page 38) as follows:

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Quequa pittzo nuccananyoho anvixũy co	*Aquí por segunda vez anocheció*
B [ilegible] nuonayã ecquettãdo coonayãbuü	*[ilegible] el caudillo era Ojo Machucado de allí*
[e]hanulmãnqhue yahnã, capihiaxama	*Después en este año iba mejorando*
hoy nuhnaantãthũhũ nuhnapatacha	*La gran hambre que hubo*
chaxinmanẽhẽmanpipuöxãtzehe nu	*y también iban a producir*
yethũhũ eccũ emũ eqhuü emay	*las sementeras [de chías, calabazas, fríjol y chile*
Chompitũhũ quenaguegue hinyü	*Y sembraron porque no había lluvia antes.*
Yehmũdo ttzepatapũnmãhã patabêti	*La semilla que antes se había perdido*
xinn nuyücotti egattza egattzi cotti-	*Todo para comer y beber todo*
Pipuöxãtzehe ttzematzhundotho nu-	*Se produjo muy hermoso. Esto*
Hnãpatacha nuhnãnqhueyahnã nu-	*Se hizo en este año*
Buümehiãxamahoy nuhnã antãthũhũ	*Al amanecer de la gran hambre*
Ecclipsi del sol	
Ecclipsado	
Sol nicâ oqualoc yn tonoatiuh otlayoua	*Fue comido el sol*
Ucccclv	*Uccclvi*
1455 años [con fondo negro]	*1456*
3 caña	*4 Técpatl*

As for the solar eclipses that took place in these years, we have two for 1455, one annular in April 16 and one total for October 11, both with a 2 *Acatl* glyph bearer.

In the year 1456 there were also two solar eclipses, the first one in April 5 and the second one in September 29, both with a 3 *Técpatl* bearer according to Caso's correlation.

Of these 4 eclipses, the only one that may have obscured the sun in Mesoamerica, is the one of September 29, when more than 60% of the sun was covered by the moon (Figure 6).

It is not clear why the correlation to Caso's calendaric proposal is lost in this year by one numeral. The fact is that in the Huichapan Codex this lack of congruence starts in the year 1425 and lasts until the year 1503, where the congruence is recovered. So from the starting codex year of 1403 to the year 1424 (21 years) there is congruence with Caso's correlation. From the year 1425 until the year 1503 (for 78 years) the congruence is lost. Finally, from 1504 until 1528 (for 24 years) the congruence is recovered.

3.3. *The 1507 and 1508 eclipses*

The third and last eclipse registered in the codex has the years 1507 (2 *Acatl*) and 1508 (3 *Técpatl*) as reference (Figure 5). It is described in the 30th folio (page 60) as follows:

[Quequ] a pi [ilegible] nucca dönga coatã	
Chayã ehmibãthã, coonayãbuü,	*Imexayac el caudillo allí*
Mahiũ anvixũynã xinpatathoti	*tres anocheceres*
[Glifo: coapantli 'serpiente-bandera']	
Nũye.	*El*
[Glifos]	
Ecclipsi del sol	
Ecclipsado sol. nican	
Oqualoc yn	*Aquí*
	se comió el

Tonatiuh	*sol.*
Otlayoua	*anochece*
iUdvii	
1507 años	
2 caña [fondo negro]	
iUdviii	
1508 años	
3 pedernal	

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Fig. 4. 19th Folio (page 38) of the Huichapan Codex. Eclipse of 1455 and 1456.

Fig. 5. 30th Folio (page 60) of the Huichapan Codex. Solar eclipses for the year 1507 and 1508.

The two solar eclipses that took place in the year 1507 where in fact not visible from Mesoamerica. So it would be the year 1508, with glyph bearer 2 *Acatl* and not 3 *Técpatl*, the calendaric referent to consider in the actual eclipse registered in the codex.

Four eclipses took place in the year 1508, but only one of them was visible from Mesoamerica. This was the annular eclipse of January 2, which may have been noticed in the first minutes of the morning, when the sun appeared "eaten" by the moon, at least by 30% of it's circumference (Figure 7).

This eclipse shares several characteristics with the solar eclipse of January 12, 1404, where the glyph bearer was 2 *Acatl* and not 3 *Técpatl*. Note also that between both eclipses there is a 10 days difference congruent with the 20 days month Mesoamerican structure.

The "*coapantli*" glyph (serpent-flag) seems to make reference to the three eclipses registered in the whole codex. This glyph shows the body of a serpent attached to a rope that makes three circles or turns, while a

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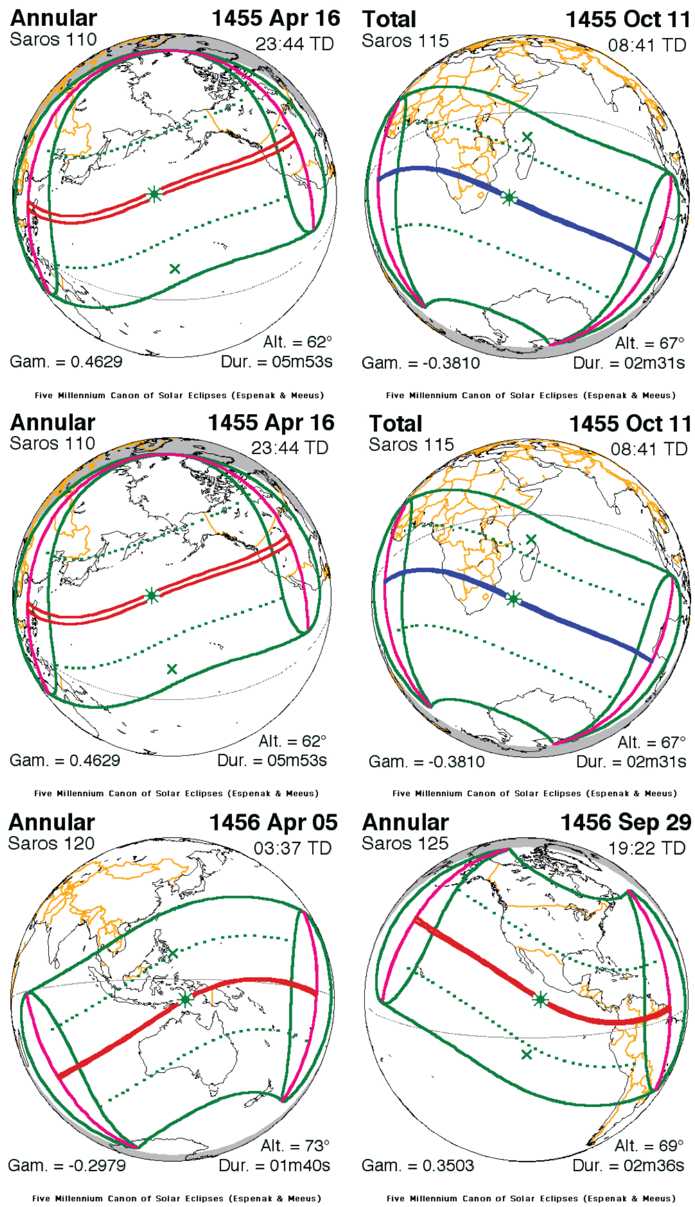

Fig. 6. Solar eclipses for the years 1455 and 1456.

flag stands on the center of its body. From its nose three volutes arise and above its head a three petal and four pistil flower is placed.

It is interesting to realize that between the first date 2 *Acatl* (1403) and the penultimate date 2 *Acatl* (1507), 104 years have taken place, while between the second date (1404) and the last date (1508) the same amount of years are registered. This corresponds, as we explained above, to two cycles of 52 years. There is also a cycle of 52 years between the year 1403 and the year 1455.

The actual time that elapsed between the eclipse of January 12 1404 and the one of January 2, 1508 is of 37,976 days, or 103 years 11 months and 21 days, or 1,286 lunations or 104 years minus 10 days. While the actual time that elapsed between the eclipse of January 12, 1404 and April 16, 1455 was 18,722 days or 51 years, 3 months and 4 days, but 18,900 days or 51 years, 8 months and 29 days to the eclipse of October 11, 1455. This situation seems to emphasize that non-visible eclipses were also taken in account. (Table 5)

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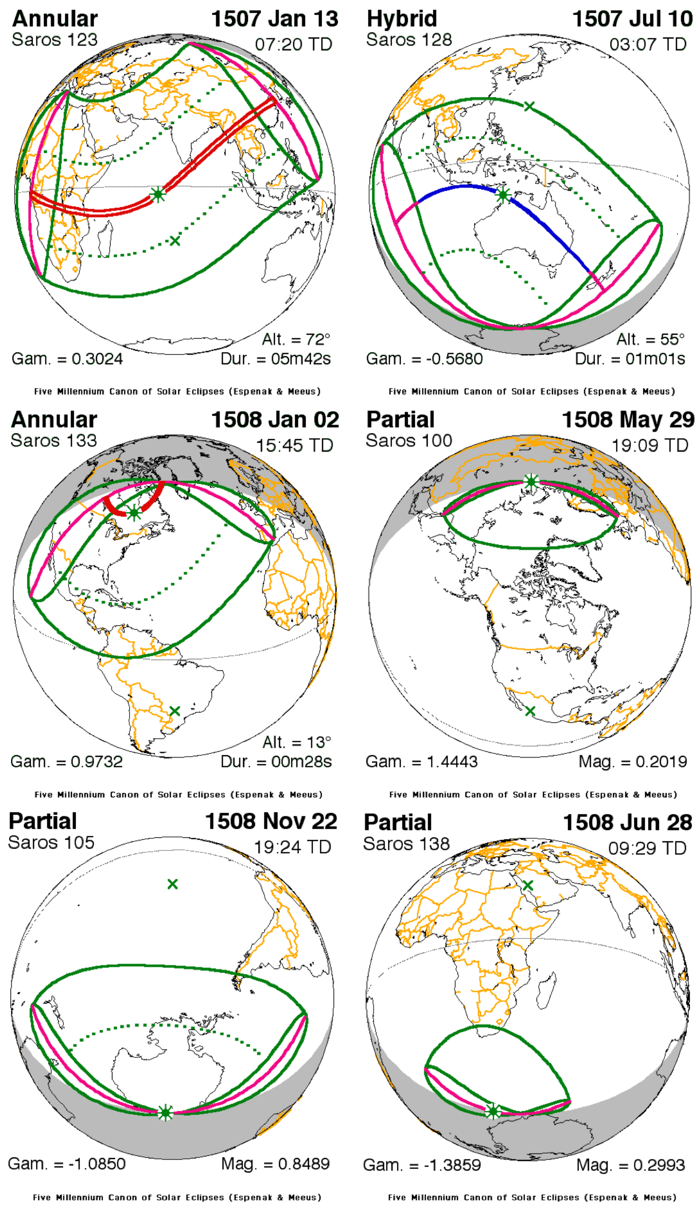

Fig. 7. Solar eclipses that took place in 1507 and 1508.

4. FINAL COMMENTS

The lack of congruence between the initial gloss of the Huichapan Codex and the actual eclipses registered in the same document does not necessarily mean an error on behalf of the codex author. It may well point towards the need for us, as scholars, to find better means to understand such inconsistencies in the context of models by which Mesoamerican astronomers organized time and its cycles, and how these models were adapted to convey actual historical events.

Through this exercise I have tried to establish the importance of a 364 day cycle for the otomí people. A cycle that allows any astronomer to follow the moon in relation to the sun in terms of a 10 day difference $(364 - 354 = 10)$. At the end of a 56 year cycle, a 56 day accumulation has been reached in regard to the 365

TABLE 5

GENERAL CALENDARIC STRUCTURE OF THE HUICHAPAN CODEX*

	from	to	Xihuitl Congruence	Eclipses		
48 years	1403	1424	congruent	January 12, 1404	13,976 days	103 years, 11 months, 21 days or 104years, minus 10 days
	22 years					
	1425	1426	1 numeral less			
	2 years					
	1427	1450	congruent	+19,254 days		
	24 years					
78 years	1451	1502	1 numeral more	September 29, 1456 +18,722 days		
	52 years					
	1503	1528	congruent	January 2nd, 1508		
	26 years					

*The Codex registers 126 prehispanic years, 52 of which have one numeral added to the Mesoamerican year expression, while two years express one numeral less. The 52 year cycle starts and ends with hunger (1451 – 1503). This is, four years before the eclipse, thus: 56 years.

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day cycle (*xihuitl*), as well as a 69.5 day accumulation in terms of the tropical year. So in fact, there is actually a very congruent internal structure in terms of the astronomical significance of the Huichapan codex gloss, which is also reflected in the 10 day difference between the first and last eclipse registered in the document. Finally, another internal congruence of Huichapan Codex's formula is the fact that a 40 year cycle equals a 56 tonalpohualli cycle.

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