MAYAN CALENDAR SYSTEMS. II

BY

CYRUS THOMAS

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MAYAN CALENDAR SYSTEMS. II

By Cyrus Thomas

PREFATORY NOTE

When the paper entitled Mayan Calendar Systems, published in the Nineteenth Annual Report of the Bureau of American Ethnology, was written, the parts of Maudslay's work[a] relating to the ruins at Quirigua had not been received, and hence these important ruins could not then be considered, except so far as they were referred to by Goodman.[b] As these parts of Maudslay's work are now at hand, it is my purpose to supplement my previous paper by some notes on the inscriptions at Quirigua, and to discuss points omitted or but lightly touched in it. One of the points but briefly noticed is the value of the different face numerals. As was stated, the determination of the value of these symbols necessitated a careful comparison of the series of the various inscriptions in which they are used, especially the initial series. This examination has been made, and the results are now given.

INITIAL SERIES OF MAYAN INSCRIPTIONS

The first inscription to which attention is called is that on the west side of Stela F. This is shown in the photograph (plate XXXIX) and the drawing (plate XL) in part 12 of Maudslay's Archaeology, volume 2, and in our plate LXXI. In regard to it Mr Goodman remarks as follows:

> Initial date: 54–9–14–13–4×17—12 Caban–5 Kayab. The period numbers here are expressed by face numerals. Following this date are fifteen indeterminable glyphs. They do not include the usual initial directive series, but they probably serve the same or a similar purpose, for we can distinguish a number of period symbols with accompanying numerals, though unable to determine their meaning here. Then comes a reckoning which reads, reversing the order of periods for convenience, as I shall do in all cases when necessary: 13–9×9, from 12 Caban–5 Kayab, the initial date, to 6 Cimi–4 Tzec.

The first, or initial, time series, 54–9–14–13–4–17, 12 Caban 5 Kayab, is, as has been explained in my preceding paper, to be interpreted as

[a] Maudslay, A. P. Biologia Centrali-Americana: Archeology. London, 1889-1902.

[b] Goodman, J. T. Archaic Maya inscriptions (appendix to the preceding). London, 1897.

follows: Fifty-fourth great cycle, 9 cycles, 14 katuns, 13 ahaus, 4 chuens, and 17 days, to 12 Caban 5 Kayab, counting forward from 4 Ahau 8 Cumhu, the first day of the fifty-fourth great cycle, as Goodman has numbered these supposed time periods.

It is proper, however, to mention at the outset that the terms "great cycle," "cycle," "katun," "ahau," and "chuen" are used merely for convenience in comparisons with Goodman's renderings, and that I do not accept them as appropriate, or in any way adopt his theory that they denote real time periods, because I believe them to be nothing more than the orders of units in Mayan numeration; nor must it be understood that I accept his theory of a separate Mayan chronologic system. As the application of these terms has been fully explained in my previous paper, it is only necessary to restate here their numerical value:

1 chuen	20 days (1×20)
1 ahau	360 days (18×20)
1 katun	7,200 days (18×20×20)
1 cycle	144,000 days (18×20×20×20)

The great cycle as given by Goodman equals 1,872,000 days or 18×20×20×20×13, but should, as I shall endeavor to show, be counted as equal to 2,888,000 days, or 18×20×20×20×20. The number 54 standing in the great-cycle place in the above series (54–9–14–13–4–17) is to be considered as having no numerical value; it is not to be read "54 great cycles," but "the fifty-fourth great cycle" (according to Goodman's method of numbering these supposed time periods), while the other numerals, 9, 14, etc., are to be used as true numbers—that is, 9 cycles, 14 katuns, 13 ahaus, 4 chuens, 17 days—the 54 being entirely omitted from the calculation. The sum of the series will therefore be as follows, the day being the unit:

9 cycles (each 144,000)	1,296,000 days (9×20×20×20×18)
14 katuns (each 7,200)	100,800 days (14×20×20×18)
13 ahaus (each 360)	4,680 days (13×20×18)
4 chuens (each 20)	80 days (4×20)
17 days	17 days
Sum of the series	1,401,577 days

After the initial series the next number-series (reversed), 13–9–9, or 13 ahaus, 9 chuens, and 9 days, is found in the compound glyph numbered 16 in Maudslay's drawing, the numbering of which has been retained in our plate LXXI. The date which follows—6 Cimi 4 Tzec—is found in the right-hand portion of glyph 18 and the left-hand portion of glyph 19.

As all the numbers of the initial series, including that attached to the month and day forming the terminal date, are face characters, and are considerably worn and dim, the question arises, How did Goodman ascertain their number value?

Although some of these characters are so dim and imperfect that

INSCRIPTION ON THE WEST SIDE OF STELA F, QUIRIGUA

MAUDSLAY, PART 12, PLATE XL

their details can not be traced with certainty, I will overlook this for the present and will try to get the data necessary to determine their value.

Let us suppose at first that the number value of no one of them has been ascertained. The first step will be to count back from the date following the next numeral series, in which the numbers are of the ordinary type. Although the symbol interpreted Tzec is too much worn to be determined from the photograph, I accept the drawing, which seems to indicate this month, as the artist had an opportunity of inspecting the cast. The date will therefore be 6 Cimi 4 Tzec. The preceding number series is 13–9–9, or 13 ahaus, 9 chuens, 9 days, and equals 4,869 days. By counting back from 6 Cimi 4 Tzec (year 1 Akbal) we reach 12 Caban 5 Kayab (year 13 Ben), the concluding date of the initial series as given by Goodman. This, if the month symbol of the second date has been correctly interpreted Tzec, gives us the value of the number symbols attached to the first date, 12 Caban 5 Kayab (glyphs 6 and 7, plate LXXI). Although these glyphs, as seen in the photograph, are scarcely distinct enough to be used in comparison, they are more clearly shown in the drawing, and present some characteristics which will assist us, especially that one (glyph 7) denoting 5, attached to the month symbol, where the superfix is a form of the ordinary ahau symbol. As neither of these is repeated in the initial series, they afford us no aid in determining other face numerals of the series.

It may be well, before proceeding farther with our examination of the series, to ascertain what data are necessary to determine the numbers of the time periods in an initial series, and this can best be done by examples. Here we have, supposedly, as the initial date, 4 Ahau 8 Cumhu (year 8 Ben), the first day of Goodman's fifty-fourth great cycle; and 12 Caban 5 Kayab is the concluding date of the series. That these two items are not sufficient to determine the intermediate time periods will be admitted without question.

Let us suppose, as a means of further test, that the numbers of chuens and days, "4 chuens 17 days," given by Goodman, are correct. That 9 cycles, 14 katuns, 13 ahaus, 4 chuens, and 17 days, when counted forward from 4 Ahau 8 Cumhu, will bring us to 12 Caban 5 Kayab, as is maintained by Goodman, is true, as may easily be seen by making the calculation.

	Days
9 cycles	1,296,000
14 katuns	100,800
13 ahaus	4,680
4 chuens	80
17 days	17
Total	1,401,577
Subtract 73 calendar rounds	1,385,540
Remainder	16,037

Subtracting from this remainder the 17 days which remain in the year 8 Ben, after 4 Ahau 8 Cumhu, and dividing the remainder by 365, we obtain 43 years 16 months and 5 days. Counting forward this length of time (in the manner explained in my previous paper) from 4 Ahau 8 Cumhu, year 8 Ben, brings us to 12 Caban 5 Kayab, year 13 Ben.[a]

The "calendar round" is, as has been explained in my previous paper, the term Goodman applies to the 52-year cycle, at the end of which period, counting from any point, the same date as that from which we count returns. The casting out of these calendar rounds, each of which amounts to 18,980 days, does not affect the result, as counting the remainder from the initial to the terminal date will give precisely the same result as counting the entire sum of the series—except that to determine the lapse of time, the number of years covered by the calendar rounds cast out must be added. For example, in case of the above-mentioned series, as 73 calendar rounds were cast out, 73×52 years must be added to the result obtained by dividing the remainder by 365, in order to ascertain the real lapse of time from the initial to the terminal date.

Having the date 12 Caban 5 Kayab and (supposed) the 4 chuens (or months) and 17 days, we turn to my condensed calendar or to Goodman's "Archaic Annual Calendar," and search through the tables of years until we find the year in which 12 Caban is the 5th day of the month Kayab. This in Goodman's tables is found to be the 51st year, or, in my table, the year 13 Ben. Counting back on the table of this year 4 months and 17 days, we reach 6 Ahau, the 8th day of the month Ceh, which, according to Goodman's scheme, will be the first day of an ahau. Turning now to Goodman's "Archaic Chronological Calendar" and to his 54th great cycle, we hunt for the place where 6 Ahau is the 8th day of the month Ceh. We find this in the 9th cycle, 14th katun, and looking at the column at the left margin we ascertain that it is the 13th ahau, which agrees exactly with the initial series as given above (54–9–14–13–4–17).

This seems to be confirmatory; however, before accepting it as conclusive let us examine a little further. Without any change, or supposed change, from the date and numbers of chuens and days used in the preceding calculation, we look farther in Goodman's "Archaic Chronological Calendar" to see if 6 Ahau 8 Ceh can be found elsewhere, confining our examination to his 54th great cycle. We do find it in the 13th cycle, 4th katun, 17th ahau, which gives the series 54–13–4–17–4–17.

Remembering that the 13th cycle, according to his scheme, is the first cycle of his great cycle, and must, therefore, be omitted from the calculation, and counting forward 4 katuns, 17 ahaus, 4 chuens, and 17 days from 4 Ahau 8 Cumhu, the first day of the great cycle, we

[a] For condensed calendar and table of years see the end of this paper.

reach 12 Caban 5 Kayab, the required date, as with the preceding series. Looking farther we find 6 Ahau 8 Ceh in the 2d cycle, 12th katun, 6th ahau, giving the series 54–2–12–6–4–17, which also carries us to the proper date (12 Caban 5 Kayab). The date 6 Ahau 8 Ceh is also found in the 4th cycle, 19th katun, 15th ahau, and other places in the 54th great cycle, each of which gives the proper result. But this is not all, as we also find 6 Ahau 8 Ceh in the 53d great cycle in the 1st cycle, 7th katun, and 12th ahau, giving the series 53–1–7–12–4–17, which, counted from 4 Ahau 8 Zotz, the first day of the 53d great cycle, brings us to 12 Caban 5 Kayab, the required date. Other series which will give the proper result might be noted, but these will suffice to show that the initial and terminal dates and the chuens and days do not afford sufficient data by which to determine the series. It is necessary, therefore, to know the numbers attached to one or more of the other time periods of the series, and these must be ascertained in every instance by inspection and by a previously obtained knowledge of the value of one or more of the face numerals.

Referring again to the initial series under consideration—54–9–14–13–4–17, 12 Caban 5 Kayab—and holding to our assumption that the number of the chuens and days is correct, the date being satisfactorily determined, we proceed to learn what additional data are necessary to determine the series.

If inspection and a knowledge of the face numbers prove the one attached to the cycle in this instance to be 9, then the series as given above is the only one that will agree with the data, and we are thus enabled to determine the value of the face numerals attached to the katun and ahau symbols; and should that giving the number of days be imperfect or obliterated, it would still be possible to determine the series, as the date with the other items mentioned (number of chuens and cycles) is always sufficient to fix the other numbers in the series. If the number attached to the chuens be unknown, then the series could not be determined with the other data mentioned.

Suppose the number (9 in this case) attached to the cycle symbol to be imperfect or unknown, but that attached to the katun (14 in this instance) to be known, the series given above is the only one that will agree with the data. If the numbers attached to the cycle and katun be indeterminable, but that attached to the ahau symbol (13 in this instance) be known, the series can still be determined, and will be as given. It is apparent, therefore, that, with the initial and terminal dates and chuens and days known, the number attached to one of the other elements in the series is necessary in order to determine the series. It is also demonstrable that with these data the series can be at once determined by Goodman's tables, though this, as I shall show, does not prove that his theory of the Mayan time system or his method of numbering the cycles or great cycles is correct.

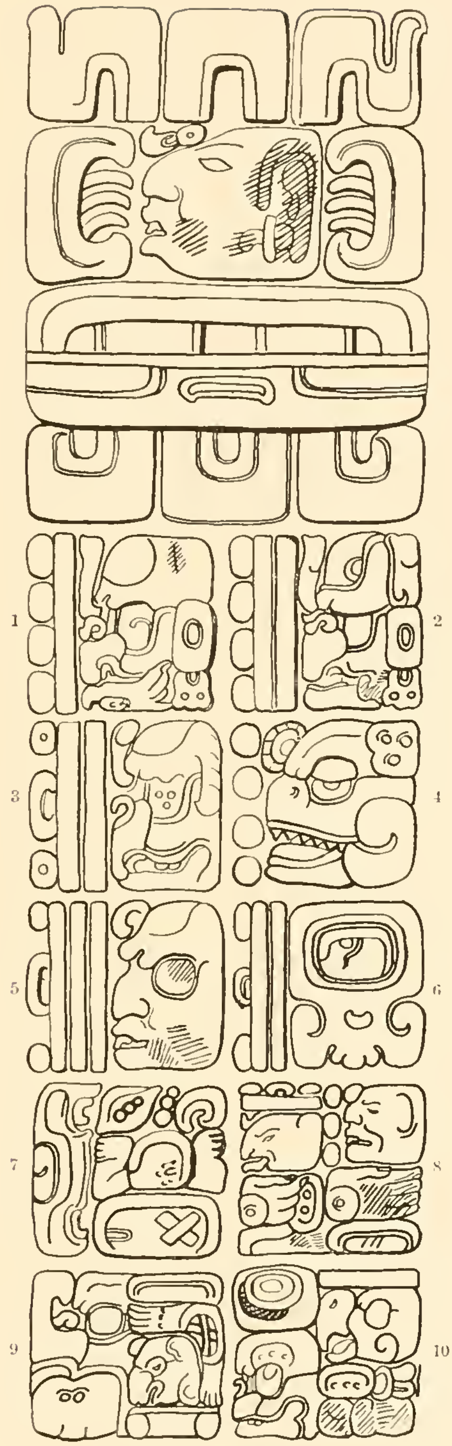
Continuing our investigation of the data necessary to determine the series, still referring to the one under consideration, we will next suppose that the number of chuens can not be determined by inspection.

The terminal date being given—12 Caban 5 Kayab (which falls in a Ben year)—it is readily seen, by reference to Goodman's "Archaic Annual Calendar," 51st year, or to my condensed calendar, that it requires 17 days, counting back, to reach an Ahau which falls on the 8th day of the month (Goodman begins the count with 20 Eb, but this gives Ben as the 1st day of the month, and the result is the same), hence the Ahau to be used depends on the number of chuens—if 0 chuens 17 days, it will be—as seen by the table referred to—8 Ahau 8 Pax; if 1 chuen 17 days, th n 1 Ahau 8 Muan; if 2–17, then 7 Ahau 8 Kankin; if 3–17, then 13 Ahau 8 Mac; if 4–17, then 6 Ahau 8 Ceh; if 5–17, then 12 Ahau 8 Zac; if 6–17, then 5 Ahau 8 Yax; if 7–17, then 11 Ahau 8 Chen; if 8–17, then 4 Ahau 8 Mol; if 9–17, then 10 Ahau 8 Yaxkin; if 10–17, then 3 Ahau 8 Xul; if 11–17, then 9 Ahau 8 Tzec; if 12–17, then 2 Ahau 8 Zotz; if 13–17, then 8 Ahau 8 Zip; if 14–17, then 1 Ahau 8 Uo; if 15–17, then 7 Ahau 8 Pop; if 16–17, then 9 Ahau 8 Cumhu; if 17–17, then 2 Ahau 8 Kayab. The fact that Ahau is the 8th day of the month in each case greatly limits the range of possibilities.

Suppose that, in addition to the terminal date, the numbers of cycles and katuns are also known (9 and 14 in this instance); the series can be definitely determined, and will be as given above. If the numbers of cycles (9) and ahaus (13) are known and the number of katuns is unknown, the series "54–9–14–13–4–17" will give the correct date, but there is one other—53–9–13–13–13–17—which will also give the correct date, 12 Caban 5 Kayab. In this case the correct determination of the series depends on the initial day of the great cycle, to which attention will be called farther on.

We next take the case where, in addition to the dates and the number of days, the numbers of katuns and ahaus are known, and the number of cycles is unknown. In the series under consideration the number of katuns is 14, of ahaus 13. These data are sufficient to determine the series, and in this instance the result is as given above.

The next inquiry relates to the data necessary to determine the terminal date where this can not be recognized by inspection, or where that given is erroneous. Where neither the day nor the day of the month is known, it is necessary to have the entire numeral series—that is, 54–9–14–13–4–17, in the example we have been using—in order to determine the date. If the day of the terminal date of the series can be ascertained by inspection, then the date can be determined without knowing the number of days; thus 54–9–14–13–4–?, ? Caban ? (month) will be sufficient to ascertain that this terminal date is 12 Caban 5 Kayab. Turning to Goodman's "Archaic Chronological Calendar," 54th great cycle, 9th cycle, 14th katun, 13th ahau, we find



INSCRIPTION ON THE WEST SIDE OF STELA E, QUIRIGUA

MAUDSLAY, PART 12, PLATE XXXI

6 Ahau 8 Ceh. Searching through his "Archaic Annual Calendar" we find that 6 Ahau 8 Ceh occurs only in the 51st year, and that Caban is the 5th day of the month in this year. Counting forward 4 months from Ceh brings us to Kayab, where 12 Caban is the 5th day. We thus ascertain that 12 Caban 5 Kayab is the date sought.

If the number of days, the name of the day of the terminal date, the month, and day of the month be unknown—thus in our example 54–9–14–13–4–?, 12 (day) ? (month)—it is possible to limit the result to one of two days, in this case to 12 Kan 12 Pax, or 12 Caban 5 Kayab. In the first case, the number of days will be 4, and in the second 17. If the number of chuens and the day and month of the date be unknown, but the number of the day and the day of the month known, the date can be determined.

There are occasional side aids which may be taken advantage of in the investigation of the face numerals. One example which we will notice, bearing on the series which has been under consideration (initial series 54–9–14–13–4–17, west side Stela F, Quirigua), is as follows: The initial series on the west side of Stela E, Quirigua (plate LXXII), is, ordinary numerals being used throughout, and all distinct, 54–9–14–12–4–17, 12 Caban 5 Cayab. This is identical with the other series, except that there are only 12 ahaus, while in the other there are 13.

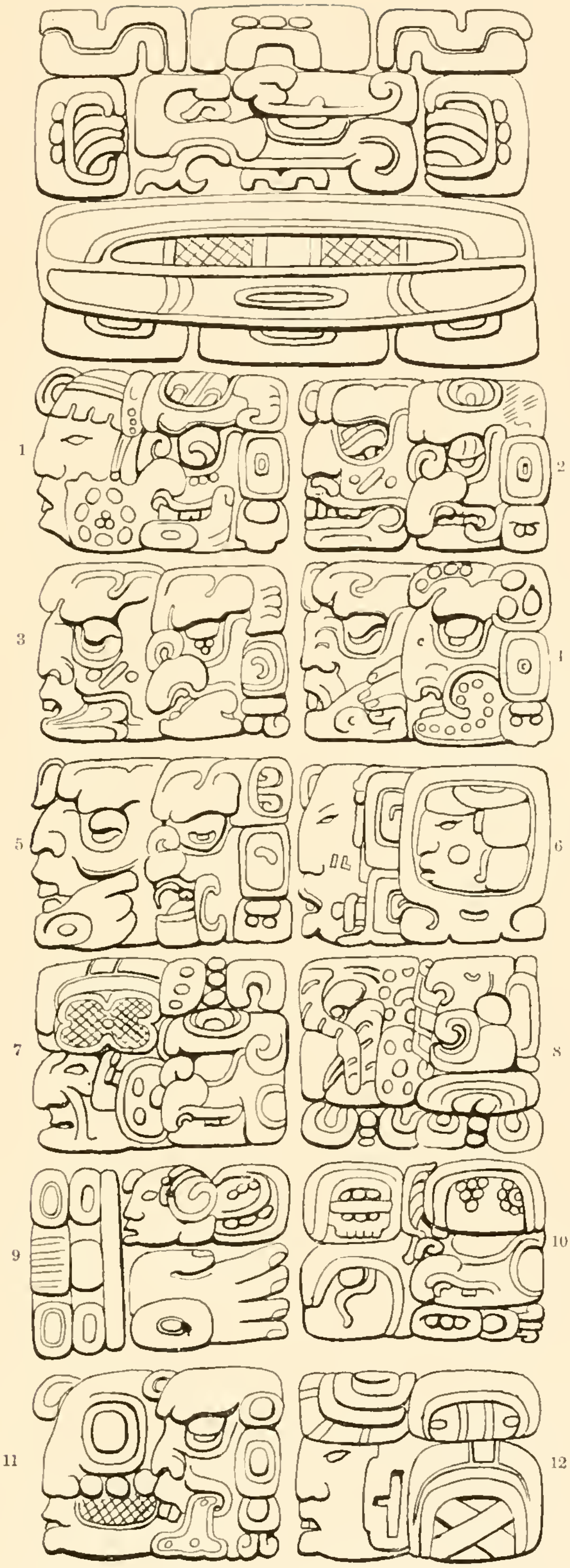
Although all that is positively known in regard to the first series (so far as our present investigation has extended) is the initial and terminal dates, the number of the days, and the day of the month on which the Ahau falls, we also know that the series as given above will agree with these items. If the 12 ahaus in the second series given above should, in fact, be 13, there will be perfect agreement with that on the west side of Stela F. It is evident from what has been shown above that, with all the items of the series save one being known, that item can be determined although wholly obliterated or incorrect. Enough is given to show that, counting back 4 months and 17 days from 12 Caban 5 Kayab, we reach 6 Ahau 8 Ceh. By calculation, or by referring to Goodman's "Archaic Chronological Calendar," 54th great cycle, 9th cycle, and 14th katun, it is seen that 6 Ahau 8 Ceh can only be in the 13th ahau, and is not found in the same cycle and katun in either the 53rd or 55th great cycle. The question as to whether Goodman's tables cover the range of the initial series will be considered farther on, when we have investigated more series. However, the fact that the series on the west side of Stela E, when the number of ahaus has thus been corrected (as calculation also shows 12 to be wrong), agrees precisely with the rendering given of that on the west side of Stela F is not proof that this rendering is correct, it only adds a degree of probability, supposing that Goodman has based his determination on an examination of the face characters. The fact may be noted, also, that some two or three other inscriptions at this place, where the numerals are of the ordinary form, commence with 9 cycles.

As the numbers in the inscription on the east side of Stela E are all of the ordinary form, nothing in regard to the face numerals can be learned from it.

The numbers in the initial series on the east side of Stela F (plate LXXIII) are all face characters, including those attached to the terminal date. Goodman interprets them as follows: "54–9–16–10–18–20, 1 Ahau 3 Zip." As will be seen by reference to my former paper, the 18 chuens 20 days are to be understood and counted as 0 chuens 0 days, and we shall hereafter write them so. Goodman omits, probably by printer's mistake, the 9 cycles, but the other numbers which he gives make them necessary.

As none of the numbers in this case correspond with any on the west side of the same Stela, excepting the 9 cycles, the glyph for which is too nearly obliterated for determination, we gain nothing by comparison; and nothing can be learned from other inscriptions of this locality which present no face numerals; these are passed over without notice.

Turning to plate XLIV in part 12 of Maudslay's work we find drawings of the inscriptions on the "Monolithic Animal G." As the numerals in the initial series are face characters, with the exception of that attached to the month of the terminal date, and have not been noticed by Goodman in his work, I call attention to them (figure 123). As the cycle in most of the initial series at Quirigua appears to be numbered 9, we will assume that to be the number in this case. But this is not a mere assumption without any other basis, as the glyph is not inconsistent with that on the west side of Stela F and agrees with the type given (see figure 132) in having the circle of dots on the cheek. Although this does not amount to demonstration, it renders the interpretation highly probable. Having determined the cycle our examination is very much restricted. However, as we know as yet no way of determining the great cycle by an inspection of the symbol, our examination must extend to the three given by Goodman. But without other data the examination on this line is vain. Examining the series, we notice that the face glyph attached to the katun symbol immediately under the cycle is partially obliterated and as yet is unknown. Passing to the upper pair in the next group to the right hand, we notice that the numeral resembles somewhat closely that attached to the month (glyph 7) of the terminal date in the inscription on the west side of Stela F (plate LXXI), which was found to denote 5. The symbol on the monolith differs in having the skeleton jaw, which Goodman says denotes 10, though we have not as yet found the proof of this, and we therefore assume that it denotes 15 (10+5) (see figure 138*b*). The hand on the face immediately below, which is attached to the chuen glyph, as also on the glyph



INSCRIPTION ON THE EAST SIDE OF STELA F, QUIRIGUA

MAUDSLAY, PART 12, PLATE XL

attached to the symbol for days in the upper pair of the group to the right, denotes, according to Goodman, full count or 20 when days and 18 when chuens (see figure 143). However, I consider it, as heretofore stated, a symbol for naught. Immediately below the latter is the day (probably Ahau) of the terminal date, with the face symbol for 5, already determined, prefixed (figure 128*a*). The first glyph of the lower pair of the group to the right has the ordinary character for 3 prefixed. This we take to be the month symbol, though it is unusual and indeterminable by inspection. The series, therefore, so far as made out, is as follows: 54?–9–?–15–0–0, 5 Ahau 3 (month).

FIG. 123. Part of inscription on "Monolithic Animal G," Quirigua. Maudslay, part 12, plate XLIV.

It is evident that the 5 Ahau of this series must be the beginning day of an ahau, as there are neither chuens or days, and hence it should be found in Goodman's "Archaic Chronological Calendar." Turning to this publication, we find that 5 Ahau 3 (month) can occur as the beginning of the 15th ahau in the 9th cycle in the following places only—53d great cycle, 9th cycle, 17th katun; 54th great cycle, 9th cycle, 4th and 17th katuns. In the first it falls in the month Pop, in the second in Yaxkin, and in the third in Muan. As the month symbol, so far as it remains, does not admit of interpretation as the first or second of these, we conclude that it must stand for the third if the date is within the range of Goodman's calendar. This gives as the series 54–9–17–15–0–0, 5 Ahau 3 Muan, which works out correctly by calculation.

The "full count" or "naught" symbols require some discrimination in our attempts to interpret them. In a series given by Goodman, as 54–9–17–15–18–20, or 54–13–20–20–18–20, 18 and 20, being so-called "full counts," should in every instance be counted as naught, and the cipher (0) should be introduced in their place; and this is true in every case where the symbols are used to represent prefixed numbers, except in one place. Where they are used to denote the day of the month, as 5 Eb 20 Zotz, they denote 20, but there are special characters used for this purpose, as is shown in figure 145. It appears probable also that the hand across the jaw in the face-forms of the cycle and great cycle is to be interpreted as indicating the use of 20 as a multiple, though in face-forms of prefixed numbers it undoubtedly signifies naught. Goodman is possibly right in insisting that these are not absolutely naught symbols, as is our 0, but are used to indicate that the count in the given denomination is complete and has been carried into the next higher denomination. Nevertheless they are—with the exceptions mentioned—equivalent to naught and must be so considered and used in calculating time and numeral series.

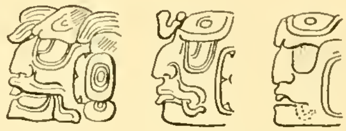
a b c d e

FIG. 124. Face numerals for 1

FIG. 125. Face numeral for 2.

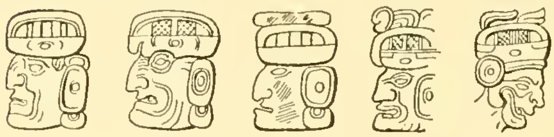
a b c d

FIG. 126. Face numerals for 3.



a b c

FIG. 127. Face numerals for 4.



a b c d e

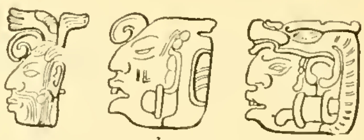
FIG. 128. Face numerals for 5.

a b

FIG. 129. Face numerals for 6.

a b c d

FIG. 130. Face numerals for 7



a b c

FIG. 131. Face numerals for 8.

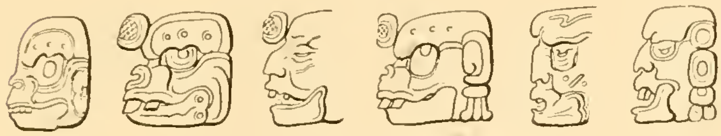
I insert here, in figures 124 to 145 inclusive, the types of face numerals selected by Goodman from the inscriptions. I have found them to be correct, with some two or three exceptions in regard to which there is considerable doubt; these will be noticed in the proper connection. Some additional examples will appear as we proceed.

The next inscription of this locality to which attention is called is that on Stela J (see Maudslay's drawing, part 12, plate XLVI, our plate LXXIV). All the numbers of the initial series except that of the day of the month in the terminal date are face characters. The series as given by Goodman is as follows: ?–9–16–5–0–0, 8 Ahau 8 Zotz. The number of the great cycle is omitted, though it is necessarily 54 according to his system. He says there are no other reckonings in the inscription, but this is a mistake, as there are two more numeral series, each followed by a distinct date. These, however, afford no assistance in determining the initial day, as they do not connect with it; moreover, a large number of glyphs intervene.

All the evidence bearing on the value of the face numerals in this instance may be stated as follows: the symbol connected with the cycle, interpreted 9, shows the distinguishing features of the others

a b c d

Fig. 132. Face numerals for 9.



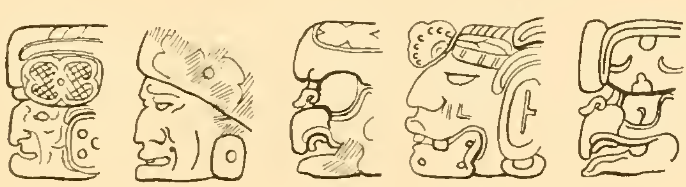
a b c d e f

Fig. 133. Face numerals for 10.

Fig. 134. Face numeral for 11.

a b c d e

Fig. 135. Face numerals for 12.



a b c d e

Fig. 136. Face numerals for 13.

noticed which are interpreted 9. This, taken in connection with the fact that most of the inscriptions of this locality begin the initial series with 9, renders the interpretation probable. We have as yet no evidence that 16 is the correct rendering of the character attached to the katun glyph, Goodman's example (figure 139*b*) being the very symbol found here; but the 5 attached to the ahau glyph agrees with that determined from the inscription on the west side of Stela F, and therefore may be accepted as correct. The face number attached to the day (Ahau) of the terminal date, which is interpreted 8, is as yet undetermined in our investigation; it is *c* of our figure 131. The day of the month and the month (8 Zotz) are distinct and easily recognized, the number being of the usual form. In regard to the chuen and day symbols, all we can say is that the hand across the face which appears to indicate full count (18 and 20) or naught (0) is seen in each of the attached glyphs. Assuming this to be correct, it follows that the date 8 Ahau 8 Zotz must be the first day of a 5th ahau.

FIG. 137. Face numeral for 14.

Turning in Goodman's Archaic Chronological Calendar to the 9th cycle of the 53d great cycle, we find that 8 Ahau 8 Zotz is not the beginning of any 5th Ahau in this cycle nor in the 9th cycle of the 55th great cycle, but is the beginning of the 5th ahau of the 16th katun in the 9th cycle of the 54th great cycle. Even omitting the number of the day Ahau we can reach the same result from the data given, and that result only. The evidence therefore appears to be sufficient. This gives one example of the face character for 16 (see figure 139 *b*). As to the value and reliability of Goodman's tables in the respect noticed I will speak hereafter; at present I assume them to be reliable, and I may state here that they may be accepted, so far as our present tests are concerned, as correct in regard to the relation of the several time periods up to and including the cycle—without, however, accepting his theory in regard to the great cycle or the number of cycles forming one of these great periods.

a *b*

FIG. 138. Face numerals for 15.

a *b* *c*

FIG. 139. Face numerals for 16

We must therefore accept as determined with reasonable certainty the value of the following face numerals: that on Stela J (glyph 1, Maudslay's plate XLVI, our plate LXXIV) prefixed to the cycle glyph, interpreted 9; that (glyph 3) affixed to the katun glyph, interpreted 16; that (glyph 5) prefixed to the ahau glyph, interpreted 5; those (glyphs 7 and 9) prefixed to the chuen and day glyphs, interpreted full count or naught; and that (glyph 11) prefixed to the day of the terminal date (Ahau, in this instance), interpreted 8. One distinguishing characteristic of the symbol for 9 is the circle of

a *b* *c*

FIG. 140. Face numerals for 17.

INSCRIPTION ON THE BACK OF STELA J, QUIRIGUA

MAUDSLAY, PART 12, PLATE XLVI

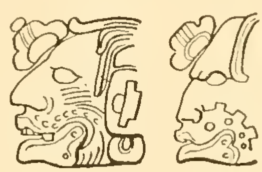
dots on the cheek (figure 132); two characteristics of the symbol for 16 are the skeleton jaw and the hatchet in the eye (figure 139); those of the symbol for 5 are the ahau symbol on the head and the absence of the skeleton jaw (figure 128); that of the symbol for full count or naught is the hand across the face or lower jaw (figure 143); those of

a b c d

FIG. 141. Face numerals for 18.

the symbol for 8 do not appear to be well defined—Goodman says they are the lobed ear ornament projecting on the cheek and the form of the forehead ornament, but neither of these appears to be exceptional.

It should be stated that by counting forward in each of the given examples from the initial date (4 Ahau 8 Cumhu) the number of days indicated by the numeral series we will reach the terminal date.



a b

FIG. 142. Face numerals for 19.

Our next reference is to the inscription on Stela A, Quirigua, the drawing of which is given in plate VII, part 11 of volume II, Maudslay's Archaeology (our plate LXXV).

In this instance the numerals attached to the cycle, katun, and ahau, and the month of the terminal date of the initial series are of the ordinary form, and those attached to the chuen, day and the day of the terminal date are either face forms or unusual forms. The series as given by Goodman is 54–9–17–5–0–0, 6 Ahau 13 Kayab, which is certainly correct, as the data given are sufficient, as has been shown, to determine the series. It agrees with Goodman's tables and also with calculation.

a b c d e

FIG. 143. Face numerals for 20.

By this we ascertain that the unusual numerals (glyphs 4 and 5) prefixed to the chuen and day symbols, each of which consists of a scroll above, a hand in the middle, and a bean-shaped character below, denote naught (figure 144, number 7). The face numeral prefixed to the day Ahau (figure 129 *b*) resembles that denoting 16 (see figure

139 *b*, *c*), excepting that it is without the skeleton jaw, thus apparently confirming Goodman's statement that this characteristic has the value of 10. In figure 144 are shown some forms of the symbols for naught (0). Numbers 1, 2, 3, 4, 5, and 6 in some of the types are of frequent occurrence in the inscriptions, as are also numbers 7 and 8.

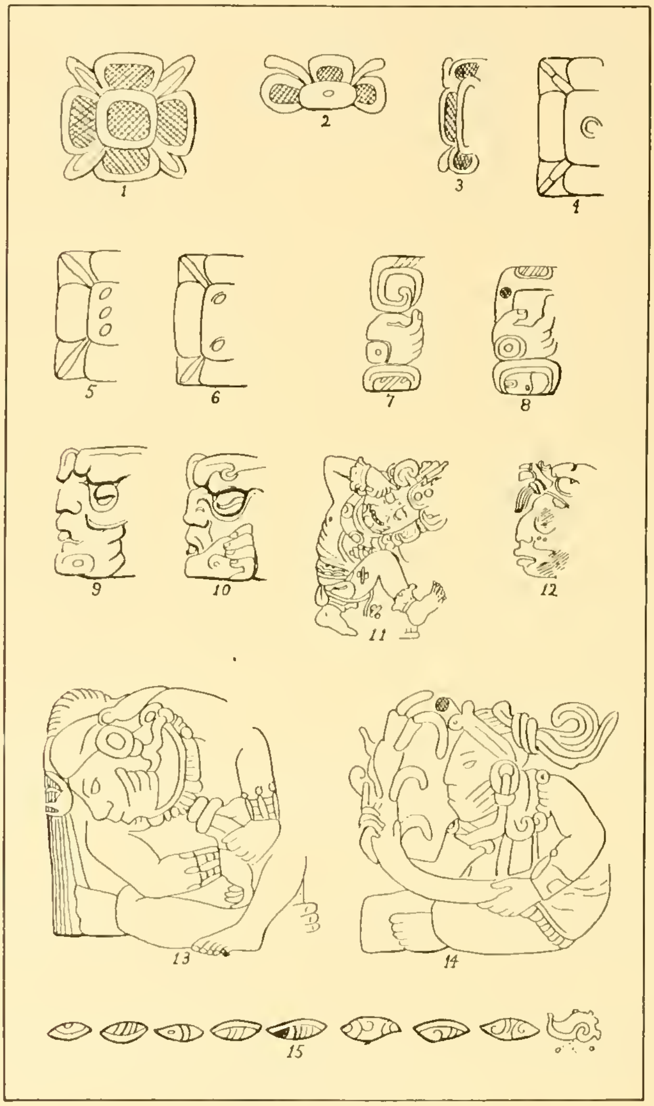
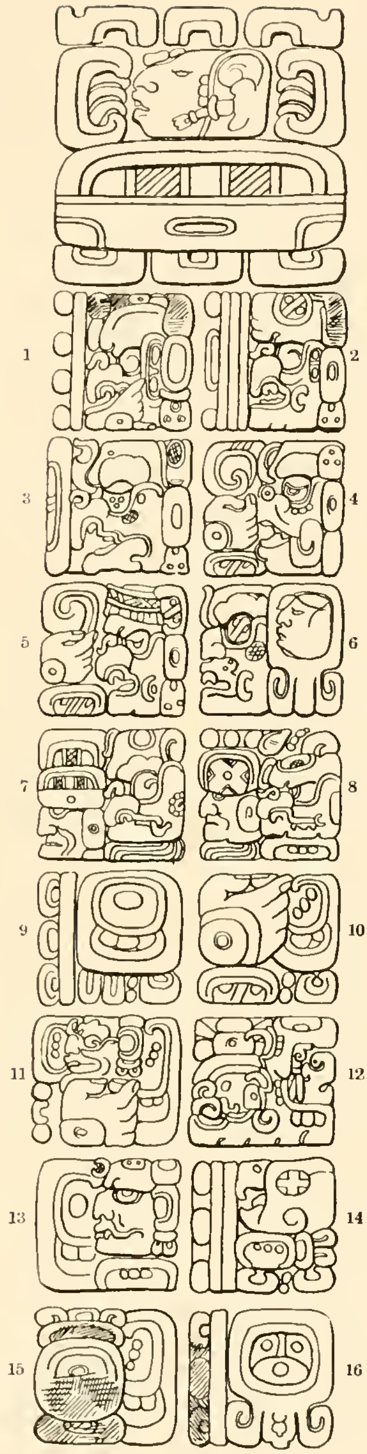


FIG. 144. Symbols for 0, or full count.

Numbers 9 and 10, which show the hand across the lower jaw, also represent a common type. Number 12 has been found only in the inscription on the Palace steps, Palenque. Number 11 is from Monolithic Animal B, Quirigua, and numbers 13 and 14 are from Stela D,



INSCRIPTION ON THE EAST SIDE OF STELA A, QUIRIGUA

MAUDSLAY, PART 11, PLATE VII

Copan. The small figures of number 15 are from the Dresden codex, and represent a common type: the slight variations in detail are numerous and appear to have no significance.

In figure 145 are shown the symbols for full count, or 20, not shown in figures 143 or 144. *A*, *b*, *c*, and *d* are more or less common in all the codices; *e* is from the Dresden codex; *f*, *g*, *h*, and *i* are from the left slab, Tablet of the Cross, Palenque.

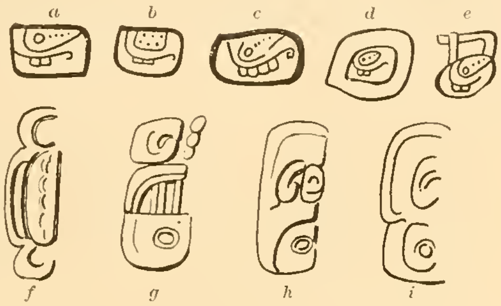


FIG. 145. Symbols for full count, or 20.

The inscription on the east side of Stela C presents some particulars worthy of notice (see figure 146). The prefix to the cycle symbol is 13 in the ordinary form; those to the katun, ahau, and day are of the coil and hand form, above described as indicating full count, or, in other words, naught; that to the chuen is of the usual form for full count in the inscriptions (see number 3, figure 144). The date is 4 Ahau 8 Cumhu with ordinary numerals. Therefore the series, according to Goodman's method of writing, will be ?–13–20–20–18–20, 4 Ahau 8 Cumhu, which is as he gives it, excepting that he places it in his fifty-fourth great cycle. Our method of writing it would be 53–13–0–0–0–0, 4 Ahau 8 Cumhu. I give 53 as the great cycle, according to Goodman's method of numbering these periods, as by counting back 13 cycles, or 1,872,000 days, from 4 Ahau 8 Cumhu we reach 4 Ahau 8 Zotz, the first day of his fifty-third great cycle. His remark in regard to it is: "This date is the beginning of the fifty-fourth great cycle." As he interprets the great cycle 54, he virtually makes the series 54–0–0–0–0–0. It must be borne in mind, as will be seen by reference to my former paper, that instead of counting 20 cycles to the great cycle, following the vigesimal system, which I believe to be correct, he counts 13. However, this

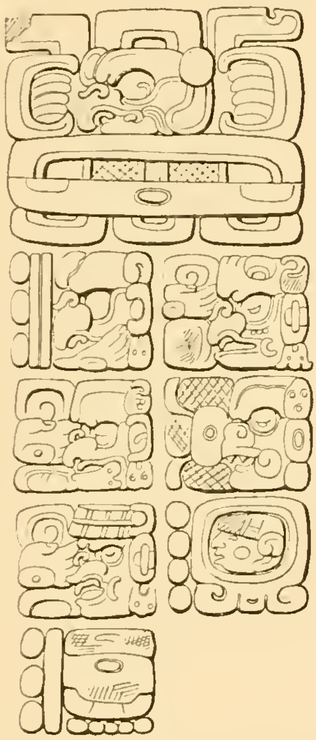
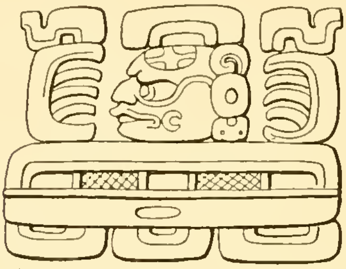


FIG. 146. Part of inscription on the east side of Stela C, Quirigua. Maudslay, part II, plate XIX.

subject will again be referred to. At any rate, we find further confirmation of the signification of the number symbol—the combined coil, hand, and bean shaped character—in this inscription.

The inscription on the west side of Stela C (figure 147 *a*) is interpreted by Goodman as follows: 9–1–0–0–0, 6 Ahau 13 Yaxkin, the number of the great cycle being omitted. As the numerals attached to the cycle, katun, and day and month of the terminal date are of the usual form, and the symbols for full count, or naught, attached to the ahau and month glyphs are of the usual type, we have sufficient data to determine the face character attached to the day glyph. Omitting from consideration the number attached to the day symbol and counting back from 6 Ahau 13 Yaxkin, year 4 Lamat,



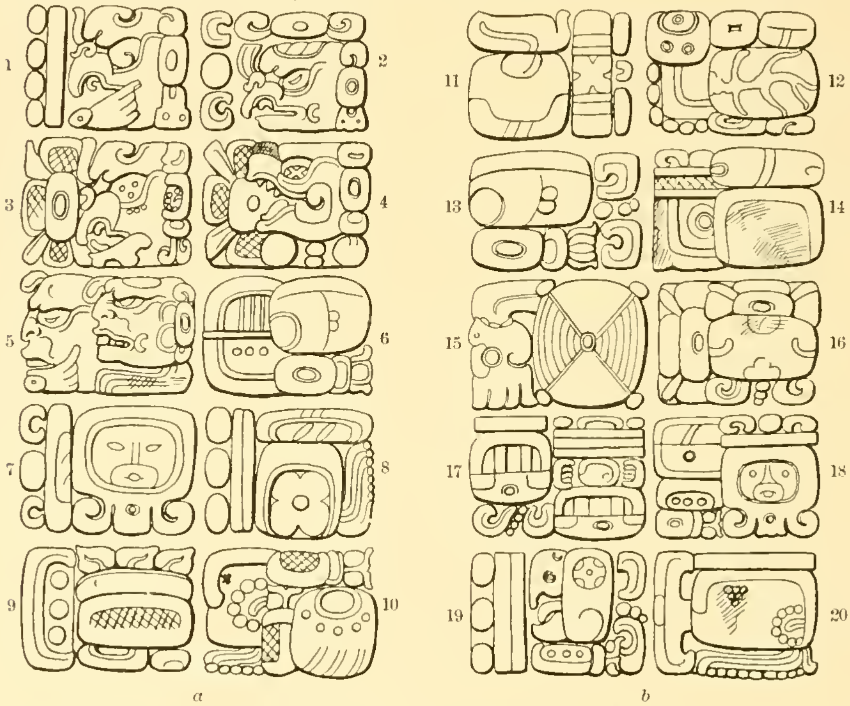


FIG. 147. Part of inscription on the west side of Stela C, Quirigua. Maudslay, part II, plate XIX.

9 cycles and 1 katun, or 1,303,200 days, according to the method given in my former paper, we reach 4 Ahau 8 Cumhu, the first day of the fifty-fourth great cycle. Turning to Goodman's Archaic Chronological Calendar, to the ninth cycle of the fifty-fourth great cycle, we find that 6 Ahau 13 Yaxkin is the first day of the first katun. Thus it is seen that both the tables and calculation agree with the interpretation of the series. By this we have a further confirmation of the

interpretation full count (or properly 0) of the face numeral with the hand over the lower jaw. It may be mentioned here that Maudslay agrees with me in designating these so-called "full counts" as given by Goodman as "no count," or, in other words, naught (see his text, part 11, page 9).

Referring to inscriptions in other localities, the following facts are noted in reference to the value of the different face numerals: the initial series of the Foliated Cross at Palenque (see figure 2, previous paper) appears to be as follows: 54–1–18–5–4–0 to 1 Ahau 13 Mac. Following this date, after some intervening glyphs, is the brief numeral series 14 chuens 19 days, immediately after which comes the date 1 Cauac 7 Yax.

Counting back 14 chuens 19 days from the latter date, we reach 1 Ahau 13 Mac, the terminal date of the initial series. This gives the value 1 to the face glyph attached to the Ahau symbol. This face glyph (figure 124 *b*) agrees in its features, excepting the ear pendant, with the face glyph attached to the cycle symbol (figure 124 *a*), showing it to be 1, which agrees with the above interpretation. As the face glyph attached to the ahau period symbol agrees with the symbol we have heretofore interpreted 5 (see figure 128 *a*); and the number attached to the month symbol is of the ordinary form; and that attached to the day glyph has the hand across the lower jaw, we have the following numbers of the series: ?–1–?–5–?–0, 1 Ahau 13 Mac.

These items are not sufficient to give the remaining numbers of the series; but assuming that it falls in the 54th great cycle, as is most probable, the other numbers will be as given above. As the face character attached to the chuen symbol, interpreted 4 (figure 127 *b*), presents some features of the one interpreted 4 on the west side of Stela F at Quirigua (left part of glyph 4, plate LXXI), and this will suffice to determine the other numbers, we are perhaps justified in concluding that the series is given correctly. That the face character attached to the katun symbol (figure 155 *c*), which is interpreted 18, is some number greater than 10 is shown by the skeleton jaw.

Turning to the inscription of the Temple of the Sun, as shown in Maudslay's plate LXXXIX, part 10 (see plate XLI, Nineteenth Annual Report of the Bureau of American Ethnology, 1900), where the numbers of the initial series are all face characters except those designating the day of the month in the terminal date, we will try to determine them from the data so far obtained. As those attached to the cycle (figure 124 *c*), katun (figure 141 *c*), and ahau (figure 128 *b*) symbols are evidently the same as those in the inscription of the Foliated Cross, and the day of the terminal date is ? Cimi 19 Ceh, we have the following items of the series: ?–1–18–5–?–?, ? Cimi 19 Ceh.

These data are not sufficient to determine the remaining numbers. One other item is necessary for this purpose. Assuming the great cycle to be that commencing with the day 4 Ahau 8 Cumhu, the so-called 54th, the remaining numbers may be determined thus: Cimi may be the 19th day of the month only in the years in which Ahau is the 13th day of the month. By turning to Goodman's "Archaic Chronological Calendar," 54th great cycle, cycle 1 and katun 18, we see that the 5th ahau begins with the day 12 Ahau 13 Chen. Turning to his "Archaic Annual Calendar," we find that 12 Ahau 13 Chen falls in the year he numbers 34 (equivalent to the year 9 Lamat in my condensed calendar). Cimi is the 19th day of the month in this year, but the month can not be determined until the day number attached to Cimi is ascertained. As the face numeral attached to the chuen symbol in the inscription is without the skeleton jaw we infer that it does not exceed 9, and as it has none of the signs of full count or naught it can not be 0. As Cimi comes 6 days after Ahau, then we must count forward in the table of the year 34 until we reach the 19th day of the month Ceh. This count we find to be 3 months and 6 days, and the number attached to Cimi is 13. Therefore the entire series is 54–1–18–5–3–6, to 13 Cimi 19 Ceh, which is as it is given by Goodman. The weak point in this solution is the assumption of the 54th great cycle. Even without this, we can, by a range of nine trials, determine that no other numbers than those given can be found within the scope of Goodman's three great cycles (53d, 54th, and 55th), but this, though strengthening the conclusion, is not absolute demonstration, as the objection to his method of counting the cycles, hereafter noticed, and the uncertainty as to the scope of his tables, come into the problem. As will be seen later, the only certainty in regard to the tables of his "Archaic Chronological Calendar" is the orderly and correct succession of dates and periods and the fact that 4 Ahau 8 Cumhu is the first day of a great cycle. Assuming for the present that the series has been correctly determined, we gain evidence as to the value of two additional face numerals, 3 (figure 126 *a*) and 6 (figure 129 *a*).

Goodman's interpretation of the initial inscription of the Tablet of the Cross, which is 53–12–19–13–4–0, 8 Ahau 18 Tzec, is not satisfactory. The face numeral attached to the cycle symbol, which he interprets 12 (figure 135 *a*) has, as a superfix, a figure very much like the superfix to the face character which he has correctly interpreted 5 (as is shown by the evidence I have presented) (figure 128 *a*). In his representation of face numerals no one save those denoting 5 or 15 have a superfix of this kind, excepting one for 12, and that one is the character of this inscription (figure 135 *a*). Moreover, it lacks the skeleton jaw, which is true of some others above 10 as given by him. As has been shown in my previous paper, where this inscription is discussed at length, and as is admitted by Goodman, there is no connection between the terminal date of the initial series and any of the dates which follow, if the numeral series which intervene be taken as given in the inscription.

In addition to the suggestions offered by Goodman and those presented in my previous paper in regard to correcting the manifest error somewhere in these series, the following is added as a possible solution: Change the terminal date of the initial series from 8 Ahau 18 Tzec to 1 Ahau 8 Muan, and the following numeral series will then connect the succeeding dates with it, and the 1 Ahau 18 Zotz will come 1–8–0 (1 ahau 8 chuens) or 520 days after the terminal date of the initial series, instead of being placed back of it as Goodman's correction requires. This, however, will slightly change the initial series from the numbers given by Goodman. By referring to the inscription as given in Maudslay's drawing, we notice at C5 the symbol for 13 cycles (figure 148). As this is not connected with a series, and follows immediately after the date 4 Ahau 8 Cumhu, we are justified in interpreting it as an indication that up to this point 13 cycles have been passed over from the initial date of the inscription, which must be 4 Ahau 8 Zotz. The calculation is correct. Subtracting the series 8–5–0 (1D 2C) from 13 cycles the remainder is 12–19–11–13–0.

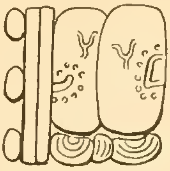


Fig. 148. Symbol for 13 cycles. Maudslay, part 10, plate LXXV, glyph C 5.

13–0–0–0–0
8–5–0
12–19–11–13–0

If this correction be justified the initial series will be 53–12–19–11–13–0, 1 Ahau 8 Muan, which will fit into Goodman's tables. The chief objection to this is that it compels us to assume that the aboriginal artist made a mistake in his calculation, as the month symbol is clearly Tzec and the face numeral shows the skeleton jaw, indicating that the number as given is above 10. However, we must admit that the error has not, as yet, been satisfactorily explained, and consequently the value of but two of the face numerals—those attached to the cycle and katun glyphs—can be determined by the inscription. Twelve (see figure 135*a*) for the cycle and 19 (figure 142*a*) for the katun, as given by Goodman, must apparently be accepted on any theory as to the correction. It will be observed that the symbol attached to the ahau glyph, which Goodman interprets 13 (figure 136*d*), is widely different from any of the other symbols for 13 given by him, as is seen by reference to our figure 136, which is a copy of the examples given by him on page 49 of his work. So far, therefore, as comparison shows, it may as well be interpreted 11 as 13; but, in fact, is more like 19 (see figure 142) than either. Nor can his interpretation (4) of the character attached to the chuen symbol be clearly sustained by comparison, though it must be conceded that it does not resemble the determined types of 13.

The initial series on Stela D of the Copan inscriptions (Maudslay, plate XLVIII, part 2, our plates LXXVI and LXXVII) is peculiar in having the usual face characters replaced by full forms. The cycle symbol (glyph 1) is composed of a human figure (the numeral) and a bird apparently of the parrot species (the cycle); the katun (glyph 2) of the human form (the numeral) and a bird of a rapacious species (the katun); the ahau (glyph 3) of the human form (the numeral) and a nondescript animal (the ahau); the chuen (glyph 4) of a human form (the numeral) and a frog-like animal (the chuen); the day (glyph 5) of two human forms, that to the right with the monkey-like face turned backward (the day); the day of the date (glyph 6) (presumably Ahau) of a human form (the numeral) with a cartouch inclosing another form (the Ahau); the month of the date (glyph 13, plate LXXVII) of a human form (the numeral) and a full-formed leaf-nosed bat (the month).

Goodman's interpretation of the series is as follows: 54–9–5–5–0–0, 4 Ahau 13 Zotz. The dots on the chin of the human face of the cycle symbol (plate LXXVI, glyph 1) and other characteristics probably justify us in interpreting it as 9. The hand across the lower jaw in the chuen symbol (plate LXXVI, glyph 4) and day symbol (plate LXXVI, glyph 5) indicate full count or naught (0). But Goodman's rendering 5 and 5 of the number characters of the katun (plate LXXVI, glyph 2) and ahau (plate LXXVI, glyph 3) symbols is questionable, as the skeleton jaw denoting 10 is quite distinct in the former and is not present in the latter. The rendering is therefore inconsistent with Goodman's own statements in regard to the characteristics of the face numerals, and must have been reached in some other way than by inspection of the glyphs. If the figures with ahau symbols on the head are face numerals, and this must be admitted, then that of the katun (glyph 2) should be 15, and that of the ahau (glyph 3) should be 5, if Maudslay's colored drawing is correct. However, it must be admitted that the drawing of the face numeral prefixed to the katun symbol is very doubtful. In figure 149 is given a drawing of the head alone, made from Maudslay's plate XLIV, which is the autotype of the same inscription.


FIG. 149. Type of face numeral.

This inscription is the most interesting one in some respects that has been found in Mayan ruins. Entire bodies, instead of conventional heads, are given, and though they are to some extent grotesque, yet they seem to indicate the aboriginal idea of the origin of these symbols. Maudslay's happy idea of distinguishing the prefixed numerals from the period symbols (cycle, katun, etc.) by difference in color brings out very clearly the forms and characteristics of the latter symbols. The cycle and katun symbols are both rapacious birds; the former owl-shaped, with a crest; the latter eagle-shaped, with feathers hanging over the front of the head. The ahau symbol is the skeleton form of a nondescript bird-like animal with a large

PART OF INSCRIPTION ON STELA D, COPAN

MAUDSLAY, PART 2, PLATE XLVIII

PART OF INSCRIPTION ON STELA D, COPAN

MAUDSLAY, PART 2, PLATE XLVIII

fang; the chuen glyph is a frog-like animal. The month symbol of the date (glyph 13, plate LXXVII) is, as stated above, a leaf-nosed bat with a human face. As the name of the latter, Zotz, or "Bat," corresponds with the form, it is possible that the forms of the other symbols have some reference to the names. However, I am unable to point out this reference; though possibly as "uinal" in Maya signifies "month" or "period of 20 days," and "uo" "frog," the symbol may have some reference to the name. Be this as it may, it will be seen by reference to figures 163 and 164, showing the types of the ahau and katun symbols, that the face forms retain to a large extent the bird-like features, one of the katun symbols, figure 164*a*, having the feather fringe over the forehead. We notice also in some of the symbols of both the ahau and katun little patches of cross-hatching, which are feather marks in the full forms of Stela D.

These facts are noticed in passing merely to call the attention of students to them as possibly forming some clew to the relation between these symbols and what is represented by them.

Attention is called next to the inscription on Stela I, Copan. The numerals attached to the cycle, katun, ahau, and chuen symbols are of the ordinary form; that to the day glyph is of the disk and hand type (figure 144) denoting naught (0); and that to the day (Ahau) of the terminal date, the face charact r with the ahau headpiece denoting 5. Whether the month symbol is distinguishable, or is one of the obliterated glyphs which follow, as Goodman asserts, is doubtful. The series is therefore ?–9–12–3–14–0, 5 Ahau ? (month). Goodman says 54–9–12–3–14–20, 5 Ahau ? (month), leaving the month blank, but adds that we know it must be 8 Uo.

The correctness of the last statement may be questioned on the following grounds: Taking, in Goodman's own tables, the 55th great cycle, 9th cycle, 12th katun, and 3d ahau, we find that the first day of this ahau is 11 Ahau 8 Uo; by counting forward 14 months from this date we reach 5 Ahau 8 Pax, a result which calculation shows to be correct, the initial date of this great cycle being 4 Ahau 3 Kankin. The positive determination depends therefore on the proper determination of the great cycle, or of its initial day, for his numbering of these supposed periods, as we shall soon see, is without proper grounds.

The initial series of the inscription on the east side of Stela P (figure 150), same locality as the preceding, is given as follows: 54–9–9–10–0–0, 2 Ahau 13 Pop. The numbers attached to the cycle, katun, and ahau are face characters, those attached to the chuen and day symbols are of the type shown in numbers 4, 5, and 6, figure 144, but much abbreviated, and those of the terminal date are of the ordinary form. The month symbol, which Goodman interprets Pop, is apparently a variation of the usual type. As enough of the prefix to the chuen symbol remains to indicate full count or naught (0), it may be assumed that the prefix to the day symbol, of which there seems to be a slight remnant, is the same; therefore the terminal date will be the first day of an ahau. The skeleton jaw in the prefix to the ahau symbol, not well shown in Maudslay's drawing (plate LXXXIX of his

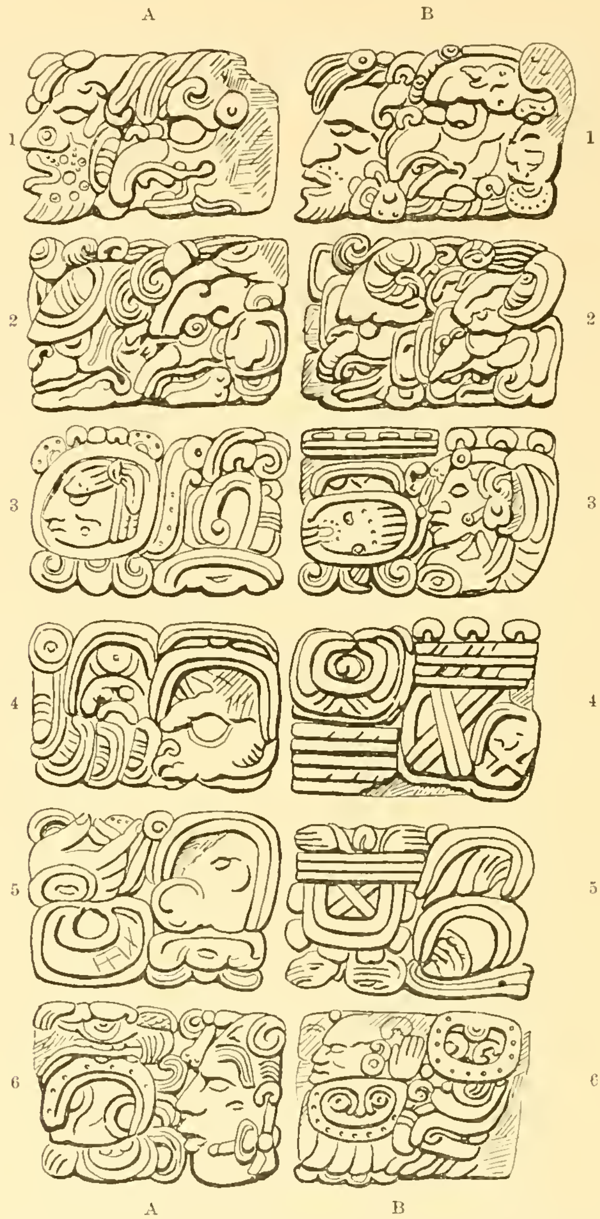


FIG. 150. Part of inscription on the east side of Stela P, Copan.

work, part 4), but distinct in his photograph, would indicate 10 or some number above 10 (see figure 150). The face numerals of the cycle and katun are evidently the same, and one of them shows quite distinctly the circle of dots on the cheek, indicating 9 (see figure 132). Therefore the series so far as satisfactorily made out—assuming the number attached to the day Ahau to be 2—is as follows: ?–9–9–?–0–0, 2 Ahau 13 Pop. This is sufficient to determine the series, and shows the above rendering to be correct.

Fig. 151. Part of inscription on the east side of Stela P, Copan. Maudslay, part 4, plate LXXXIX.

Although the drawings in Maudslay's work are in most cases of unusual excellence, giving details with wonderful accuracy, that of this inscription and the one on altar Q (part 4, plate XCIII) are not up to the usual standard, failing in some instances to bring out as clearly as might be done some of the minor details. There is some doubt as to the value of the face numeral prefixed to the ahau symbol (A2, figures 150 and 151), as it is unusual, being in some respects unlike any other face numeral that I have observed in the inscriptions. Seler (Zeitschrift für Ethnologie, Heft 6, 1899, page 722) interprets it 13, and gives as the terminal date 3 Ahau 3 Uayeb. This would make the series, omitting the great cycle, 9–9–13–0–0, 3 Ahau 3 Uayeb; however, the number attached to the month symbol is certainly 13. If this series is counted from 4 Ahau 8 Cumhu, it will reach 3 Ahau 3 Uayeb in the year 5 Ezanab. The number attached to the day Ahau is very uncertain, seeming more like 1 or 3 than 2; apparently 1. I have therefore given an exact copy of Maudslay's photograph (figure 151), and a carefully made drawing (figure 150), using Maudslay's and Seler's drawings and the photograph (autotype) for this purpose. I am rather inclined to the opinion that Goodman's rendering is correct. It seems that Seler has been influenced in his determination of the number placed over the Ahau symbol by Maudslay's drawing. His interpretation is not justified by the photograph, which indicates "1 Ahau" instead of "3 Ahau," making the date 1 Ahau 13 Uo, or 1 Ahau 13 Pop.

The whole inscription, as well as the inscription on the front and back of the same monument, is strange, and, as will be noticed farther on, shows some of the features of the Chichen Itza inscriptions.

It is perhaps unnecessary to follow this subject further, as it is apparent that the value of the face symbol and other numeral symbols can be satisfactorily obtained. It appears that Goodman's determinations, where the data are sufficient, are as a rule correct; though there are a few cases, as has been shown, where his rendering is doubtful, and some where the series given are largely guess work, the data being insufficient. When the number of the great cycle is a necessary factor, another question arises, which will be discussed farther on.

Before discussing the numbers of the cycles and great cycles, which subject was referred to in my previous paper, I will notice some of the secondary numeral series of the Quirigua inscriptions not at hand when my previous paper was written.

SECONDARY NUMERAL SERIES OF THE QUIRIGUA INSCRIPTIONS

Returning to the inscription on the west side of Stela F (plate LXXI), we pass over the first subordinate series (glyph 16), leading on to 6 Cimi 4 Tzec (glyphs 18 and 19), as this has already been noticed. At glyph 25 follows a date, 3 Ahau 3 Mol, but without any recognizable intermediate numeral series, though there are some numbered glyphs. Passing on we find at glyph 29 the date 4 Ahau 13 Yax, and immediately following (glyph 30 and first half of 31) the numeral series 3 days, 13 chuens, 16 ahaus, 1 katun, and following this two dates, 12 Caban 5 Kayab (the same as the terminal date of the initial series) and 1 Ahau 3 Zip, though the number attached to the day in the latter is not the ordinary symbol if intended for 1 (figure 152). Counting the series given forward from 3 Ahau 3 Mol and 4 Ahau 13 Yax brings us to no given date; nor will counting back from 12 Caban 5 Kayab reach any previous given date. If, however, we count back from 1 Ahau 3 Zip, we reach 12 Caban 5 Kayab, showing that the connection is made with the terminal date of the initial series, as given by Goodman. It would seem from this that the insertion of this date, after this second numeral series, is for the purpose of showing that the count is to be made from this date, as we found in our preceding paper to be true in some instances.

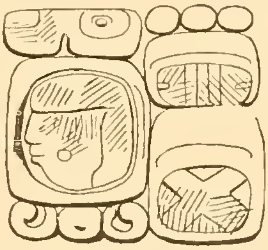


FIG. 152. Glyph 33, west side of Stela F, Quirigua. Maudslay, part 12, plate XL.

Our next reference is to the inscription on the east side of Stela F (Maudslay's plate XL, part 12). Here the initial series (plate LXXIII), as heretofore stated, is 54–9–16–10–0–0, 1 Ahau 3 Zip. Goodman, in his comment (page 125), says:

> The glyphs that immediately follow are so fantastic and unfamiliar that I can make nothing of them until the sign indicating a date to be some score days in the 19th katun is reached. The date is 5 Ahau 13 Mol [glyph 24]. As that begins the 1st ahau, the number of score days indicated must be 18. Two unintelligible glyphs follow, succeeded by what I believe to be this reading: 3 cycles, 8 katuns, and 19 ahaus, a reckoning embracing 26 calendar rounds and extending 360 8-score days into the 13th cycle, to 1 Ahau 13 Yax, the beginning of a 360-bissextile count and of a katun also.

It is somewhat difficult to understand these statements, but I will try to explain them, as I desire to offer one or two criticisms. The actual interval between 1 Ahau 3 Zip, the terminal date of the initial series, and 5 Ahau 13 Mol (if the first following occurrence of this date be assumed as the one intended) will be 18,360 days, or 2 katuns, 11 ahaus. This will bring us to 5 Ahau 13 Mol, the first day of ahau number 1 in the 19th katun of cycle 9 (as numbered by Goodman)—the one now under consideration. What he means by 18-score days is that the count extends 360 days into the 19th katun, bringing us to the commencement of the second ahau, which, according to his method of numbering, is 1.

FIG. 153. Part of inscription on the east side of Stela F, Quirigua. Maudslay, part 12, plate XL.

For some unexplained reason, Goodman makes no mention of the numeral series between the terminal date of the initial series 1 Ahau

3 Zip and 5 Ahau 13 Mol. This, unless I am wrong in my interpretation, is found in glyphs 21, 22, and 23 (figure 153), as numbered by Maudslay. The prefixed numerals with one exception (that prefixed to the ahau) are of the ordinary type. However, as the exception, which is a face numeral, shows the hand across the lower jaw we must assume, according to what has been shown, that it denotes full count or naught (0). With this assumption, the series appear to be 3 days, 11 chuens, 0 ahaus, and 19 katuns, or –19–0–11–3, the number of chuens being uncertain; but this series will not connect any preceding with any following date. Could this have been Goodman's reason for omitting notice of the series?

It is noticeable also that the symbol he interprets 5 in the date 5 Ahau 13 Mol (glyph 24, figure 153) is precisely the same as the one he interprets 1 in the date 1 Ahau 3 Zip in the inscription on the west side of this stela (glyph 33). In the next place it is exceedingly doubtful, judging from an inspection of the characters, whether his supposed series "3 cycles, 8 katuns, and 19 ahaus" can be found in the space indicated—that is between glyphs 24 and 29. There is not in it, with one exception, a single glyph that in any way resembles any of the forms of time periods he has noticed. The exception is the first part of glyph 26, which is like the ordinary form of the chuen symbol; but the character over it is like that over Ahau in the date he gives as 5 Ahau 13 Mol, elsewhere interpreted as 1. There is a numeral, 13, of the ordinary form over the first part of glyph 28, but there is no 13 in the series he gives. We take this series, therefore, to be purely imaginary, made up from his tables. According to Maudslay's drawing, the month symbol in the following date—1 Ahau 13 Yax—is really the symbol for Yaxkin. But an examination of the photograph does not bear out the drawing, the glyph being as much like the Yax as the Yaxkin symbol.

According to his statement, this imagined series extends "360 8-score days into the 13th cycle to 1 Ahau 13 Yax." He must, of course, allude to the 13th cycle of his 55th great cycle; with this understanding his count is correct, if he had anything to base it on.

We turn next to the inscription on the west side of Stela E, the drawing of which is shown in Maudslay's plate XXXI, part 12. The terminal date of this initial series (see plate LXXII), the number of ahaus being corrected from 12 to 13, as already noticed, is 12 Caban 5 Kayab. The first numeral series which follows is in glyphs 14 and 15 (figure 154 *a*), and is 6–13–3 (reversed), equal to 2,423 days. The date which follows (glyph 16) is 4 Ahau 13 Yax. The count is correct, as 2,423 days from 12 Caban 5 Kayab, year 13 Ben, bring us to 4 Ahau 13 Yax, year 7 Lamat. The next series is found in glyph 18 and, according to the method of reading the chuens and days so far followed—that is, counting the number at the left side of the chuen symbol as days and that above it as chuens—is, in reverse order, 1–6–14, but

Goodman, without any explanation, changes it here to 1–14–6. The date following (glyphs 19 and 20), is 6 Cimi 4 Tzec. The time given in this instance will not reach from one of these dates to the other. As Goodman is certainly right in his correction in this instance, if the date 4 Ahau 13 Yax be correct, we will examine it. The initial series of this inscription, including the terminal date, is, when the correction noted has been made, precisely the same as that of the inscription on the west side of Stela F, and the first following date there is the same as the second here, 6 Cimi 4 Tzec. As the intervening series is too short to allow for a second return of the latter date, it is evident that the numeral series must be the same. As that of Stela F is 13–9–9, then by subtracting, in the inscription on Stela E, the 6–13–3 extending from 12 Caban 5 Kayab to 4 Ahau 13 Yax, from this series (13–9–9) the remainder, 6–14–6, must give the lapse of time from 4 Ahau 13 Yax to 6 Cimi 4 Tzec, the third date, and calculation shows that it does. Therefore the correction from 1–6–14 to 1–14–6, and the 1 to 6, giving 6–14–6, may be accepted as justifiable if the date 4 Ahau 13 Yax be correct. At any rate, it is certain that this change is correct or that an equivalent change in the preceding series 6–13–3, must be made and the date altered to suit. I am therefore inclined to accept the correction made by Goodman.

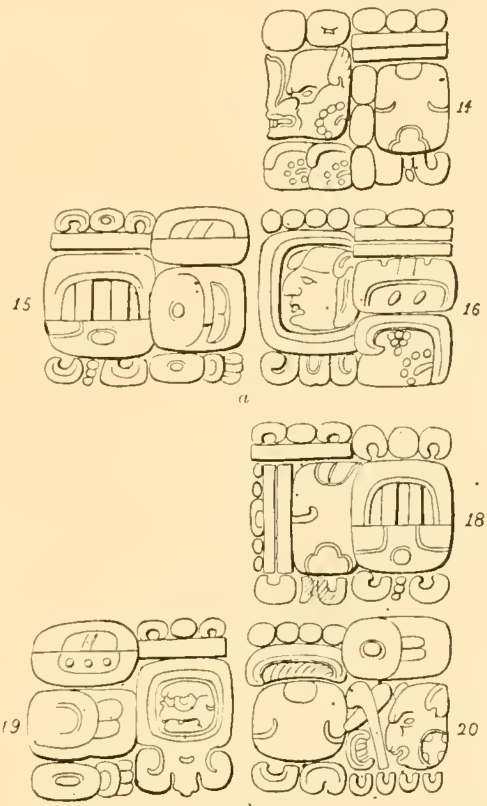


FIG. 154. Part of inscription on the west side of Stela E, Quirigua. Maudslay, part 12, plate XXXI.

Following the last date at glyphs 21 and 22 (figure 155) is the series 15 days 18 chuens 1 ahau 1 katun, or in reverse order 1–1–18–15. The numbers are distinct and of the ordinary type, and are given correctly, as is shown by inspection both of the photograph and drawing. That there is an error here (18 chuens being full count) seems apparent, unless the number at the left side of the chuen symbol refers to chuens and that above to days, which can not be accepted without proof. Goodman reads "1–1–16–15," but the number over the symbol is 18 and not 16. The two outer of the three units are certainly balls, and not rings or semicircles. This series is followed at glyphs 23 and 24 (figure 155) by the date 11 Imix 19 Muan, and whether we count 18 or 16 chuens or consider the 15 as chuens and the 18 as days, it fails to connect the preceding with the following date. Before attempting to find the solution of the difficulty we will pass on to the next series and date and count back.

Passing on to glyphs 27 and 28 (figure 156) we find the series 8–19–4, followed (glyph 29) by the date 13 Ahau 18 Cumhu, and this is followed immediately (glyph 30) by the symbol for 17 katuns, apparently inserted, as it is followed by no date, to show that the date just preceding it is in the 17th katun, or that 17 katuns have been passed over from the commencement of the cycle, most likely the latter. As Goodman does not discuss this series, although he mentions it, I give my own explanation. That there is an error here, if the number over the chuen symbol is intended to indicate chuens, as there are but 18 chuens in an ahau, is apparent. Let us try the count with the day and chuen numbers reversed—that is, on the supposition that the series should read 8–4–19. This equals 2,979 days, which number counted backward from 13 Ahau 18 Cumhu brings us to 11 Imix 19 Muan, which apparently justifies the change and proves the date "11 Imix 19 Muan" to be correct.

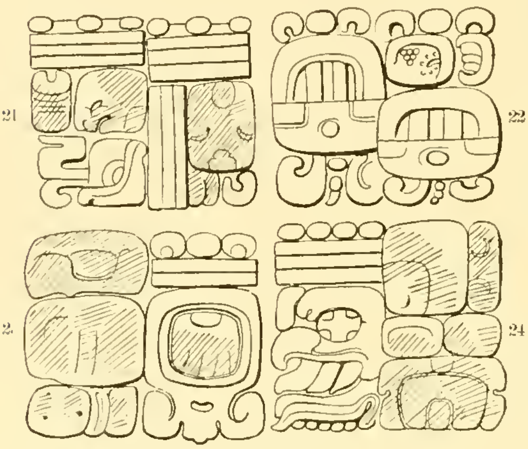


Fig. 155. Part of inscription on the west side of Stela E, Quirigua. Maudslay, part 12, plate XXXI.

Turning to Goodman's "Archaic Chronological Calendar," to the 9th cycle of his 54th great cycle, in which the series of this inscription are located, we find that 13 Ahau 18 Cumhu is the first day of the 17th katun according to his method of numbering. However, it must be remembered that he begins the count of katuns with 20, following with 1, 2, etc., up to 19; therefore 13 Ahau 18 Cumhu is really the first day of the 18th katun, 17 entire katuns having been passed over from the initial date of the inscription (8 Ahau 13 Ceh, the first day of the 9th cycle). This verifies our conclusion as to the signification of the symbol for 17 katuns in glyph 30.

For the purpose of determining the third minor series given in the inscription as 1–1–18–15, followed by 11 Imix 19 Muan, we will count from the initial date of the inscription, placing side by side the series as given in the inscription and as corrected.

	As given	As corrected
Initial	9–14–12–4–17	9–14–13–4–17
Second	6–13–3	6–13–3
Third	1–6–14	6–14–6
Fourth	1–1–18–15	
Fifth	8–19–4	8–4–19
	9–16–11–6–13	9–15–15–1–5

If we subtract 9–15–15–1–5, the sum of the right column (omitting the 4th series), from 9–17–0–0–0, or, omitting the cycles, 15–15–1–5 from 17–0–0–0 (17 katuns), the remainder is 1–4–16–15, or 1 katun 4

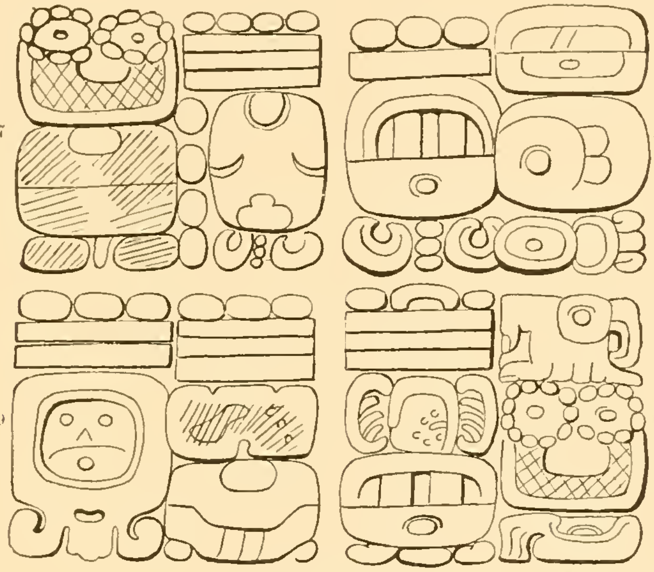


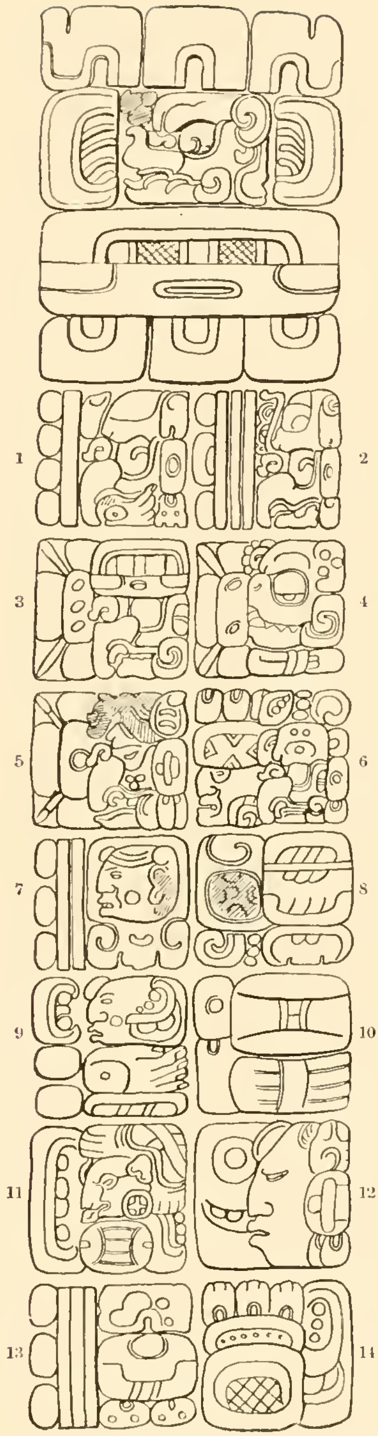
FIG. 156. Part of inscription on the west side of Stela E, Quirigua. Maudslay, part 12, plate XXXI

ahaus 16 chuens and 15 days. This, if the preceding corrections are justified, should be the 4th series, and should connect (counting forward) the dates 6 Cimi 4 Tzec and 11 Imix 19 Muan, and calculation shows that it does. The 4th series should therefore be 1–4–16–15, or 8,975 days.

It will be seen from our examination of this inscription that some correction has been made in the 1st, 3rd, and 4th series, and that the day and chuen numbers have been reversed in the 5th. It must be admitted that this does not present a very favorable showing for the theory, yet I am convinced that the corrections in this instance are justified; but a single variation is possible (that of the 3rd date) which would involve greater changes than those which have been made. That the number at the left of the chuen symbol sometimes denotes chuens and the one over the top sometimes denotes days is mentioned by Maudslay, yet it is very unusual and is probably due to carelessness. There is evidence of carelessness in this inscription in the writing of 18 and 19 chuens, and in giving 12 ahaus in the initial series instead of 13, as it evidently should be.

The next inscription referred to is that on the east side of Stela E, the drawing of which is shown in Maudslay's plate XXXII, part 12 (our plate LXXVIII). The initial series is 54–9–17–0–0–0, 13 Ahau 18 Cumhu. Goodman does not mention this inscription. It ends precisely where the preceding inscription ended. Although there are distinct dates scattered through it, and what appear to be partial series, I am unable to determine the latter from the unusual symbols of which they are formed, if they are present. The inscription appears to end, so far as dates are concerned, with 13 Ahau 18 Cumhu, the same as the terminal date of the initial series, which does not occur again in Goodman's tables until the beginning of the 9th ahau 4th katun 12th cycle is reached. This gives a lapse of 2–7–9–0–0 from the terminal date of the initial series. As nothing further in regard to the series can be learned from this inscription, we turn to that on Stela A, Maudslay's plate VII, part 11.

The initial series on Stela A is, as has been shown, 54–9–17–5–0–0, 6 Ahau 13 Kayab. Immediately following the month symbol of the date (glyph 16) is the symbol for 6 Ahau. This, I believe, is to show that the preceding date is the beginning of the 6th ahau, and so it is if we count the ahaus 1, 2, 3, etc., from the commencement of the katun, instead of 20, 1, 2, 3, etc., as Goodman counts them. It is my belief that the numbers expressed in the series denote, at least as a general rule, completed periods and not incomplete ones. Take, for example, the numbers in the initial series in this inscription, omitting the great cycle—9–17–5–0–0, that is, 9 cycles, 17 katuns, 5 ahaus, 0 chuens, 0 days. This may be read just as I have given it here, or as follows: The 5th ahau of the 17th katun of the 9th cycle. If it should be read as I have given it, it shows that Goodman's method of counting—beginning that of the cycles with 13 following with 1, 2, 3, etc., that of the katuns and ahaus with 20, and following with 1, 2, 3, etc.—is erroneous. If we read 9 cycles, 17 katuns, and 5 ahaus, the meaning is that 9 full cycles, plus 17 katuns, plus 5 ahaus must be counted to make the sum of the days between the preceding and following date, and this is in fact the method Goodman uses, and which must be used in making the calculation. On the other hand, according to his system, the series 9–17–5–0–0 would indicate that the date sought is the 1st day of the 5th ahau of the 17th katun of the



INSCRIPTION ON THE EAST SIDE OF STELA E, QUIRIGUA

MAUDSLAY, PART 12, PLATE XXXII

9th cycle, but the symbol 6 Ahau (glyph 16) denotes, if we have correctly interpreted it, that 6 Ahau 13 Kayab is the first day of the 6th ahau; nevertheless, Goodman's method of counting gives the correct result. Attention will again be called to the subject further on.

Returning to our inscription, we find in the 20th glyph the brief series 19 ahaus followed by the date 6 Ahau 13 Chen or 13 Zac, but the series does not connect the dates. There are no other recognizable series in the inscription.

The inscription on the west side of Stela C—the drawing of which is shown in Maudslay's plate 19, part II (our figure 147)—has, as heretofore stated, the initial series 54–9–1–0–0–0, 6 Ahau 13 Yaxkin. Following this date, at glyphs 16 and 17, is the numeral series 17–5–0–0, that is, 17 katuns, 5 ahaus, 0 chuens, 0 days, though in the usual reverse order of days, chuens, ahaus, katuns. This is in turn followed by the date 6 Ahau 13 Kayab. If we count this series as 16 katuns and 5 ahaus, it will exactly express the lapse of time from 6 Ahau 13 Yaxkin, the preceding date, to 6 Ahau 13 Kayab, the date which follows. But turning to Goodman's "Archaic Chronological Calendar," 54th great cycle, we find that the latter date, according to his numbering, is the 5th ahau of the 17th katun of the 9th cycle. Shall we accept this as the proper reading, or shall we conclude that there is an error in the number of katuns? 6 Ahau 13 Yaxkin is the first day of the 1st katun of the 9th cycle, according to Goodman's method of counting (though the 2nd, in fact, if the count began with 1), and 6 Ahau 13 Kayab is the first day of the 5th ahau, as Goodman counts (6th in fact), of the 17th (18th) katun. Counting from one date to the other gives just 16 katuns 5 ahaus, as the following subtraction shows:

9–17–5–0–0
9– 1–0–0–0
16–5–0–0

It is proper to bear in mind that by Goodman's method of numbering, the number given always expresses the number completed; thus, as he begins with 13 in numbering the cycles, his 1st cycle is in reality the second, one cycle having been completed and the 2nd entered upon. I am therefore disposed to correct 17 katuns in the series just examined to 16.

As these are the only series of the Quirigua inscriptions to which it is desirable to call attention at present, the next subject of examination is the great-cycle symbols, but in order to enter upon this intelligently it is necessary to discuss some points of Goodman's system not fully examined in my previous paper. In doing this it will be necessary to go to the very base of his system.

MAYA CHRONOLOGICAL SYSTEM

The theory that Goodman has adopted, so far as it relates to the scale of units or time periods, as he terms them, may be expressed in the following series, the day being the primary unit:

Day	1 day
20 days make 1 chuen	20 days
18 chuens make 1 ahau	360 days
20 ahaus make 1 katun	7,200 days
20 katuns make 1 cycle	144,000 days
13 cycles make 1 great cycle	1,872,000 days
73 great cycles make 1 grand era	136,656,000 days

This scheme is, as was explained in my previous paper, precisely the same as that generally accepted, so far as the numbers are concerned, until, in ascending the scale, the number of cycles, or units of the 5th order, forming a great cycle, or unit of the next higher order, is reached. At this point Goodman abandons the vigesimal system and introduces in one step 13 and in the other 73 as multipliers—numbers which are absolutely necessary to his theory; for if either be dropped, his theory falls with it. If these supposed time periods are, as I contend, nothing more than orders of units in the system of numeration, then we must assume that the vigesimal system was followed. To this point attention is directed, and although it is discussed somewhat at length in my previous paper, there is other evidence bearing on the question, which will be introduced here. It was shown there that one series in the Dresden codex recognizes 20 cycles to the great cycle (I shall continue to use these terms merely for convenience, to indicate the orders of units). A more careful study of that codex shows that there are other series which also furnish conclusive evidence on this point.

The theory, therefore, which I shall attempt to show is the correct one is that in both the Dresden codex and the inscriptions the vigesimal system was maintained throughout, except only in the second step; not only that 20 ahaus make 1 katun and 20 katuns make 1 cycle, but also that 20 cycles make 1 great cycle and 20 great cycles 1 next higher step, should the count extend so far.

Before we consider the examples which are to be introduced as evidence in support of this theory, it will be best, in order to see more clearly the bearing and the force of this evidence on the question, to present an explanation of the order of succession of the great cycles when the vigesimal system is followed, that is, when 20 cycles are counted to the great cycle.

As the day Ahau is found to be the first day of several, in fact most, of the initial series of the inscriptions, and is that adopted by Goodman as the beginning of his grand era, as also of his great cycles, I, for the present, assume it as the initial day of the latter periods.

According to his scheme of counting 13 cycles to each of these periods, they all begin with the day 4 Ahau. If the first day of the ahaus is Ahau, then it is certain that the first day of each of the higher periods will be Ahau, though we count 13 or 20 cycles to the great cycle. As the days of the calendar are numbered 1, 2, 3, etc., up to 13, the count then beginning again with 1, and this numbering is continued in regular order, and as Ahau will return only every 20th day it is apparent that it will receive different numbers. If the days are written out in regular succession and the series is made of sufficient length, it will be found, if we select a 13 Ahau and begin our count with it and count 360 days (1 ahau) to each step, that the numbers attached to the days (which will of course be Ahaus) will come (the count being forward) in the following order: 13, 9, 5, 1, 10, 6, 2, 11, 7, 3, 12, 8, 4, 13, 9, 5, etc., this order being maintained wherever in the series we may begin.

As it takes 20 ahaus or units of the 3rd order to make one of the 4th, it follows that if the day numbers are written out in succession in the order above stated, the first days of the katuns will be those of the 20th ahaus, their numbers will therefore come in the following order: 11, 9, 7, 5, 3, 1, 12, 10, 8, 6, 4, 2, 13, 11, 9, 7, etc., the order remaining the same regardless of the point at which the count begins. As 20 katuns make 1 cycle, the numbers of the first days of the cycles will be the same as those of the 20th katuns, and will be as follows: 13, 12, 11, 10, 9, 8, 7, 6, 5, 4, 3, 2, 1, 13, 12, etc. The beginning point in these series is arbitrary.

It may also be shown by simple calculation that the order of the day numbers of the first days of the higher periods or orders of units will be as given above. As the numbers of the first days of the ahaus vary successively by 4, if we multiply 4 by 20 (20 ahaus being required to make a katun) and divide by 13, the remainder is 2; hence, if the first day of a given katun is 9, the first day of the one which follows will be 7 Ahau, the difference being subtracted if counting forward, and added if counting backward. When the number of the day is less than 3 we add 13, and then subtract in counting forward, and in counting backward subtract 13 when the sum is greater than this number. As it takes 400 ahaus to make 1 cycle, we multiply the difference, 4, by this number, and divide the product by 13. This leaves a remainder of 1, hence we subtract 1 from the number of the first day of a given cycle to find the first of that which follows, or add 1 to find the first of that which precedes.

As, according to Goodman's theory, 13 cycles make a great cycle, then it requires $20\times20\times13$ ahaus to make 1 great cycle. We multiply 4 by $20\times20\times13$ (or 5,200) and divide by 13. This leaves no remainder, and hence, according to this scheme, the day numbers of the first day of all the great cycles will be the same, and so Goodman gives them in his "Perpetual Chronological Calendar." Here the question of number arises. Is it 1 Ahau, 2 Ahau, or 3 Ahau, etc., to

13 Ahau? Goodman says 4 Ahau. He bases this, doubtless, on the fact that many of the initial series of the inscriptions have as their first day 4 Ahau 8 Cumhu, which he assumes, apparently correctly, is the first day of a great cycle. It is apparent, following his method of numbering, that if one great cycle begins with 4 Ahau, all the rest do.

As yet we have not introduced the year as a factor, but before this is done attention is called to the result of following the vigesimal system in counting the higher orders of units, or time periods, as Goodman considers them. According to this system, which, as I have stated, prevails in the Dresden codex, not only does it take 20 ahaus to make 1 katun and 20 katuns to make 1 cycle, but also 20 cycles to make 1 great cycle. The order in which the numbers of the initial days of the ahaus, katuns, and cycles follow one another will be the same in the one scheme as in the other and as already given. The difference between the two theories appears in the numbers of the initial days of the great cycles. Following the method of calculation indicated, we multiply 4 by $20\times20\times20$ (or 8,000) and divide by 13. This gives a remainder of 7. The order of the numbers is therefore 13, 6, 12, 5, 11, 4, 10, 3, 9, 2, 8, 1, 7, 13, 6, 12, etc., and this is found to be correct by the absolute test of writing out the numbers of the first days of the cycles in proper order and taking every 20th one. The initial dates of a sufficient number to cover all probable requirements are given here, 4 Ahau 8 Cumhu being adopted as the basis or check point from which to count forward and backward. In this calculation we must bring into the problem the year factor.

Initial days of the great cycles, following the vigesimal system

1	5 Ahau 8 Muan,	year	4 Ben
2	11 Ahau 13 Zotz,	year	4 Lamat
3	4 Ahau 3 Ceh,	year	3 Ezanab
4	10 Ahau 8 Pop,	year	3 Ben
5	3 Ahau 18 Mol,	year	2 Akbal
6	9 Ahau 8 Pax,	year	1 Ben
7	2 Ahau 13 Tzec,	year	1 Lamat
8	8 Ahau 3 Mac,	year	13 Ezanab
9	1 Ahau 8 Uo,	year	13 Ben
10	7 Ahau 18 Chen,	year	12 Akbal
11	13 Ahau 8 Kayab,	year	11 Ben
12	6 Ahau 13 Xul,	year	11 Lamat
13	12 Ahau 3 Kankin,	year	10 Ezanab
14	5 Ahau 8 Zip,	year	10 Ben
15	11 Ahau 18 Yax,	year	9 Akbal
16	*4 Ahau 8 Cumhu*,	year	8 Ben
17	10 Ahau 13 Yaxkin,	year	8 Lamat
18	3 Ahau 3 Muan,	year	7 Ezanab
19	9 Ahau 8 Zotz,	year	7 Ben
20	2 Ahau 18 Zac,	year	6 Akbal

As no larger number of great cycles has been recorded than 14, in one of the Copan inscriptions, 6 being the highest given in the Dresden codex, the initial dates given will probably suffice for all requirements. But this supposition rests on the theory that the range counting by great cycles, is not more than 14 from 4 Ahau 8 Cumhu. Our numbering (left column) is, of course, purely arbitrary, given merely for convenience of reference, the great cycles being, on the theory I have presented, in precisely the same relation to the next higher order of units—provided the Mayan count extended so far—as the cycles to the great cycles, the katuns to the cycles, etc. In other words, when, in counting, 20 cycles are completed, one great cycle is completed and the count passes into the 2nd; and when this is completed we pass into the 3rd, etc., in precisely the same manner that we pass in our decimal system from one decimal to the next higher.

Our next step is to test the theory advanced by appeal to the high series which reach to the great cycles, beginning with those of the Dresden codex. These are found on plates LXI, LXII, and LXIX. As the determination of the point in question is of vital importance, the details of the demonstration will be given somewhat fully.

Taking first plate LXII of the codex (our plate LXXIX), we observe four numeral series running upward in the folds of two serpent figures, two of these series being in black numerals of the ordinary form, and two in red, also of the ordinary form. The two series in the left serpent (one black and the other red) are as follows reading from the top down:

Red	4–6–11–10–7– 2. 3 Cimi 14 Kayab
Black	4–6– 7–12–4–10. 3 Ix 7 Pax (?)

That is to say, the red series is 4 great cycles, 6 cycles, 11 katuns, 10 ahaus, 7 chuens, 2 days, to 3 Cimi 14 Kayab. The symbols of the dates as we give them are seemingly reversed as compared with their positions on the plate, but the zigzag order of the series must be borne in mind. The symbol of the month Pax is somewhat unusual.

The red series changed into days is as follows:

	Days
4 great cycles (of 20 cycles each)	11,520,000
6 cycles	864,000
11 katuns	79,200
10 ahaus	3,600
7 chuens	140
2 days	2
Total amount	12,466,942
Subtract 655 calendar rounds	12,450,880
Remainder	16,062

Using this remainder and counting forward from 9 Kan 12 Kayab (year 3 Ben)—the date standing over the head of the figure seated on the serpent—we reach 3 Cimi 14 Kayab, year 8 Ben, the date standing below.

We have positive evidence, therefore, that in this instance 9 Kan

12 Kayab is the initial day of a great cycle and that 20 cycles are counted to the great cycle, since the number 11,520,000 is obtained as follows:

1 cycle	144,000 days
Multiplied by	20
1 great cycle	2,880,000 days
Multiplied by	4
4 great cycles	11,520,000 days

If we follow Goodman's method and count only 13 cycles to each great cycle, 4 of the latter, together with the minor periods of the series as given above, will amount to 8,432,942 days. Subtract 444 calendar rounds, and there remain 5,822 days, which, counted from 9 Kan 12 Kayab, bring us to 7 Cimi 14 Pax. This is not correct as to the number of the day or as to the month. The same day should be reached, for the number of cycles is the only thing in the series changed.

We take next the black series of the same pair, to wit, 4–6–7–12–4–10, 3 Ix 7 Pax. This changed into days is as follows:

	Days
4 great cycles (of 20 cycles each)	11,520,000
6 cycles	864,000
7 katuns	50,400
12 ahaus	4,320
4 chuens	80
10 days	10
Total	12,438,810
Subtract 655 calendar rounds	12,431,900
Remainder	6,910

Using this remainder and counting forward from 9 Kan 12 Kayab, year 3 Ben, the same initial date as before used, we reach 3 Ix 7 Pax, year 9 Lamat. This is correct.

The series in the folds of the right serpent (same plate as the preceding) are as follows:

Black	4–6–9–15–12–19, 13 Akbal 1 Kankin
Red	4–6–1– 9–15– 0, 3 Kan 16 (?) Uo

Changing the red series into days, we have the following result:

	Days
4 great cycles (of 20 cycles each)	11,520,000
6 cycles	864,000
1 katun	7,200
9 ahaus	3,240
15 chuens	300
Total	12,394,740
Subtract 653 calendar rounds	12,393,940
Remainder	800

PLATE LXII OF THE DRESDEN CODEX

Using this remainder and counting forward from 9 Kan 12 Kayab (same initial date as before), we reach 3 Kan 17 Uo, year 6 Lamat. This is correct, as it gives the date below, except as to the day of the month—which is given as 16 Uo in the original, but should be 17 Uo, as Kan is never the 16th day of the month. What is meant by the calendar rounds and the reason for subtracting them was fully explained above and in my previous paper.

The black series of the same pair changed into days gives the following numbers:

	Days
4 great cycles (of 20 cycles each)	11,520,000
6 cycles	864,000
9 katuns	64,800
15 ahaus	5,400
12 chuens	240
19 days	19
Total	12,454,459
Subtract 656 calendar rounds	12,450,880
Remainder	3,579

Counting forward this number of days from 9 Kan 12 Kayab, year 3 Ben, we reach 13 Akbal 1 Kankin, year 13 Akbal. This also is correct.

The next series noticed is the one consisting of black numerals in the folds of the serpent on plate LXIX of the Dresden codex (our plate LXXX). This is as follows: 4–5–19–13–12–8, 4 Eb ? (month); the month symbol is obliterated. As the black and red are not zigzagged in this instance, the date belonging to the black series stands immediately under it. Changed into days, the series gives the following result:

	Days
4 great cycles (of 20 cycles each)	11,520,000
5 cycles	720,000
19 katuns	136,800
13 ahaus	4,680
12 chuens	240
8 days	8
Total	12,381,728
Subtract 652 calendar rounds	12,374,960
Remainder	6,768

In this instance, as on plate LXII of the codex, the date 9 Kan 12 Kayab stands above the serpent. Counting forward 6,768 days from this date, we are brought to 4 Eb 5 Chen, year 9 Lamat, which agrees with the unobliterated part of the date given below.

We have, therefore, in the data presented positive proof that in five instances in the Dresden codex the day 9 Kan 12 Kayab is the first day of a great cycle, and that twenty cycles are counted to one great cycle. In these instances 9 Kan 12 Kayab is the initial day of the first or more remote of the four great cycles counted in the series which have been noticed. The four here, however, has no reference to the numbers applied to the high periods, if, in fact, any were applied, but is merely the number of one of the orders of units used in counting, just as we say "4 thousands, 5 millions," etc. However, the idea intended to be set forth here will be more fully explained farther on.

In order to show that 9 Kan, as used in the series examined, is the initial day of the most remote of the four great cycles of these series, the following proof is presented.

If we arrange the last-mentioned series perpendicularly in ascending order, as in the original, except that we separate the great cycles, it will stand as follows:

4th great cycle (completed)
3rd great cycle (completed)
2nd great cycle (completed)
1st great cycle (completed)
5 cycles
19 katuns
13 ahaus
12 chuens
8 days

The reader must keep in mind all the way through that, although Goodman's terms are used, they are to be understood as representing merely orders of units. Hence, 4th great cycle, 3rd great cycle, etc., are intended to convey the same idea that is conveyed by "4th million, 3rd million," etc. These terms are used merely as convenient designations in numeration. Each and every series in the inscriptions and codices signifies nothing more nor less than so many days, the day being the unit.

Our separation of the great cycles is therefore nothing more than separating the millions and lower denominations in the expression "4,234,600," just as has been done above. The object of this separation is to ascertain the beginning day of each of these numbers which Goodman calls time periods, as this forms a check on our calculations. For example, if I assert that 4,000 days from Thursday, January 1, 1889, will reach Saturday, December 18, 1899, by counting 1,000 days we reach a certain date, and 1,000 more a certain other date, etc. If the fourth 1,000 brings us to the same date as counting at once 4,000, we thereby check the one calculation by the other. The separation is to be understood as signifying nothing more than this, and not as implying real time periods of a chronological system.

If we can ascertain the first day of the first of these great cycles, and count forward from the date so obtained, one by one, 4 great

PLATE LXIX OF THE DRESDEN CODEX

cycles, 5 cycles, 19 katuns, 13 ahaus, 12 chuens, and 8 days, we should, if my theory be true, reach the same date (4 Eb 5 Chen, year 9 Lamat) as by counting the whole series, thus obtaining a check on our calculation.

	Days
Multiply 1 cycle	144,000
by 20	20
1 great cycle of 20 cycles	2,880,000
Subtract 151 calendar rounds	2,865,980
Remainder	14,020

Counting forward this number of days from 9 Kan 12 Kayab, year 3 Ben, we reach 2 Kan 17 Xul, year 3 Lamat. This should be the initial day of the 3rd great cycle, as numbered above. Counting forward 14,020 days from 2 Kan 17 Xul, year 3 Lamat, brings us to 8 Kan 7 Kankin, year 2 Ezanab. This should be the first day of the 2nd great cycle, as numbered above. Counting forward 14,020 days from the latter date (8 Kan 7 Kankin, year 2 Ezanab), we reach 1 Kan 2 Zip, year 2 Ben. This should be the first day of the 1st great cycle, as numbered above, and with the subordinate periods gives the series 1–5–19–13–12–8, or 1 great cycle, 5 cycles, 19 katuns, 13 ahaus, 12 chuens, 8 days. Counting forward from 1 Kan 12 Zip, year 2 Ben, should bring us to 4 Eb 5 Chen, year 9 Lamat, the date obtained by counting the entire series from 9 Kan 12 Kayab, year 3 Ben.

In order to test it we make the calculation; reduced to days, the result is as follows:

	Days
1 great cycle (of 20 cycles)	2,880,000
5 cycles	720,000
19 katuns	136,800
13 ahaus	4,680
12 chuens	240
8 days	8
Total	3,741,728
Subtract 197 calendar rounds	3,739,060
Remainder	2,668

Counting forward this number of days from 1 Kan 12 Zip, year 2 Ben, we reach 4 Eb 5 Chen, year 9 Lamat, the date at the bottom of the series, and the same as that obtained by using the entire series and counting from 9 Kan 12 Kayab.

As a further test, we count forward 14,020 days from 1 Kan 12 Zip, year 2 Ben, and reach 7 Kan 2 Zac, year 1 Akbal. This should be the first day of the incomplete great cycle in which the minor periods fall. Therefore, by taking the sum of these periods and counting forward from this date, we should reach 4 Eb 5 Chen, yeaı 9 Lamat.

Reducing these periods (5 cycles, 19 katuns, 13 ahaus, 12 chuens, 8 days) to days, we get the following result:

	Days
5 cycles	720,000
19 katuns	136,800
13 ahaus	4,680
12 chuens	240
8 days	8
Total	861,728
Subtracting 45 calendar rounds	854,100
Remainder	7,628

Counting forward 7,628 days from 7 Kan 2 Zac, year 1 Akbal, we reach 4 Eb 5 Chen, year 9 Lamat, which is the proper date.

The demonstration therefore seems to be complete that Kan, in the cases referred to, is the first day of each of the great cycles. It is also important to notice that the numbers of these Kans follow one another in precisely the same order as do those of the Ahaus when 20 cycles are counted to the great cycle (see page 236) to wit: 9, 2, 8, 1, 7, and, if the series is continued by calculation, 13, 6, 12, 5, 11, 4, 10, 3, 9, 2, etc.

If we arrange these first days of the great cycles in the order in which they come, adding the days of the month on which they fall, they will be as follows—the numbering (column at the left) being, of course, purely arbitrary:

1	2 Kan 17 Cumhu,	year 10 Lamat
2	8 Kan 2 Mol,	year 10 Akbal
3	1 Kan 12 Muan,	year 9 Ben
4	7 Kan 17 Zotz	year 9 Lamat
5	13 Kan 7 Ceh,	year 8 Ezanab
6	6 Kan 12 Pop,	year 8 Ben
7	12 Kan 2 Chen,	year 7 Akbal
8	5 Kan 12 Pax,	year 6 Ben
9	11 Kan 17 Tzec,	year 6 Lamat
10	4 Kan 7 Mac,	year 5 Ezanab
11	10 Kan 12 Uo,	year 5 Ben
12	3 Kan 2 Yax,	year 4 Akbal
13	9 Kan 12 Kayab,	year 3 Ben
14	2 Kan 17 Xul,	year 3 Lamat
15	8 Kan 7 Kankin,	year 2 Ezanab
16	1 Kan 12 Zip,	year 2 Ben
17	7 Kan 2 Zac,	year 1 Akbal
18	13 Kan 12 Cumhu,	year 13 Ben
19	6 Kan 17 Yaxkin,	year 13 Lamat
20	12 Kan 7 Muan,	year 12 Ezanab

This is calculated from 9 Kan 12 Kayab as a basis, because we have found it to be such for some of the series of the Dresden codex.

In order to add proof to our explanation and calculation of the series in the serpent figures of plate LXII of the codex, I show the result of calculating the differences between the series and passing from one of the final dates to the other. I had tried this before, but, not allowing for the zigzag course of the series, I failed to get the dates at the bottom in right relation to the series.

Take first the series in the right-hand serpent, as follows:

Black	4–6–9–15–12–19.	13 Akbal 1 Kankin
Red	4–6–1– 9–15– 0.	3 Kan 16 (17) Uo
Difference	8–5–15–19	

This difference, counted forward from 3 Kan 17 Uo (the 16 being an error), should reach 13 Akbal 1 Kankin.

Reducing to days, we have the following result:

	Days
8 katuns	57,600
5 ahaus	1,800
15 chuens	300
19 days	19
Total	59,719
Subtract 3 calendar rounds	56,940
Remainder	2,779

Using this remainder and counting forward from 3 Kan 17 Uo, year 6 Lamat, we reach 13 Akbal 1 Kankin, year 13 Akbal. This is correct, and proves that we should read 17 Uo instead of 16.

The two series in the other (left-hand) serpent are as follows:

Red	4–6–11–10–7– 2,	3 Cimi 14 Kayab
Black	4–6– 7–12–4–10.	3 Ix 7 Pax
Remainder	3–18–2–12	

This remainder, counted forward from 3 Ix 7 Pax, which is the date belonging to the black series, will bring us to 3 Cimi 14 Kayab, which is the date belonging to the red series.

The relation between the pairs of the two serpents is between the like colors. For example, by using the difference between the red series of the right serpent and that of the left, and counting forward from 3 Kan 17 Uo, we reach 3 Cimi 14 Kayab. By using the difference between the black series, and counting forward from 3 Ix 7 Pax, we reach 13 Akbal 1 Kankin. These results serve to confirm the results of the calculations when the entire series is taken into the count.

There are five other high series in the Dresden codex, to which I have not as yet alluded—four in the serpent figures on plate LXI, and the red series in the serpent on plate LXIX. The reason for passing over them temporarily is that some of them require correction, and others present difficulties to successful calculation and satisfactory interpretation which I have not as yet been able to overcome. As the object in view is to discover the truth and not merely to support a theory, it is proper that these difficulties should be explained to the reader that he may judge whether they have any bearing on the question under discussion.

The first of these series to which reference will be made are the black and red in the left serpent on plate LXI of the codex (our plate LXXXI). These, as they stand on the plate, are as follows:

Black	4-6-14-13-15-1, 3 Chicchan 13 Pax
Red	4-6- 0-11- 3-?, 3 Chicchan 18 Xul

In this instance, as on plate LXII, the dates under the series are here seemingly reversed by the zigzag arrangement of the series—a fact which is to be borne in mind; therefore, that which is apparently under the black belongs to the red. The last (lowest) number of the red series denoting days is obliterated, but calculation soon makes it apparent that it was 1. The initial date here is the same as that of the other series of this codex heretofore referred to, to wit, 9 Kan 12 Kayab, which stands in the text above the serpent.

Calculating the series as they stand in the original, counting from the initial date (9 Kan 12 Kayab), we find, whether we assume 20 or 13 cycles to the great cycle, that neither of the dates standing below will be reached. The proper day, and even the day of the month, may be reached, but not the full date as given. Counting 20 cycles to the great cycle, we are brought by the black series to 1 Chicchan 18 Chen, year 6 Lamat; the red series (adding one day) brings us to 5 Chicchan 13 Mac, year 13 Ben. The result in both cases is wrong. Counting 13 cycles to the great cycle in the black, we reach 3 Chicchan 13 Kayab, year 9 Ben; and the red series brings us to 7 Chicchan 3 Zip, year 4 Akbal. Both results are wrong, though the first is apparently within one month of being correct—the day, day number, and day of the month being right. However, the two dates are in reality 32 years apart. We might assume the number of months (chuens) to be 14, instead of 15 as given in the original, if this would bring both series in harmony; or we might change the month from Pax to Kayab, if this would meet the difficulty throughout. The two series, black and red, are evidently related, and the difference between them must connect the dates reached by counting each series from the initial date (9 Kan 12 Kayab). The difference in this case, 13 cycles being counted to the great cycle, brings the red series to 7 Chicchan 3 Zip, year 4 Akbal, which is wrong.

With seeming inconsistency, I propose a correction more radical than either of those suggested above. I believe the aboriginal artist by inadvertency made an exchange between the black and red series in the ahaus and chuens, and that, instead of being as given above, they should be as follows:

Black	4-6-14-11- 3-1, 3 Chicchan 13 Pax
Red	4-6- 0-13-15-1, 3 Chicchan 18 Xul

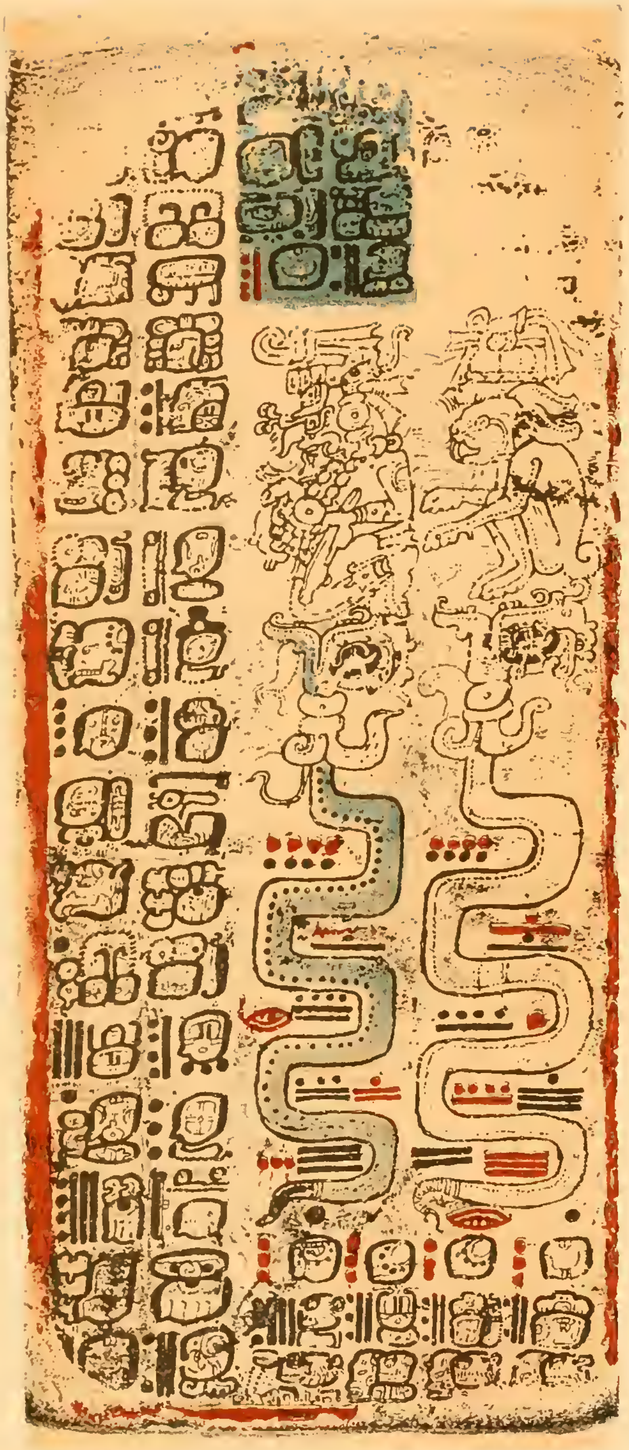


PLATE LXI OF THE DRESDEN CODEX

The series evidently requires that the days of the terminal dates shall each be 3 Chicchan.

Counting forward from 9 Kan 12 Kayab, year 3 Ben, the amount of the black series (equaling 12,488,821 days), we reach 3 Chicchan 13 Pax, year 3 Ben; and counting from the same initial date the red series (equaling 12,388,981 days), we reach 3 Chicchan 18 Xul, year 3 Lamat. Both results are correct, and counting from 3 Chicchan 18 Xul, year 3 Lamat, the difference between the two series as thus corrected (equaling 99,840 days), we reach 3 Chicchan 13 Pax, year 3 Ben, the terminal date of the black series.

Neither of the series in the right-hand serpent of this plate brings the count to either of the dates which stand below them. As yet I am unable to find in what the error consists. As the text above this right-hand serpent has been obliterated, it is possible, though I do not think probable, that a different initial date is given. As both series counted backward reach a 9 Kan, but of different months, I am inclined to believe that the error consists in one or both month symbols of the terminal dates.

The other series which has not been considered is the red one in the serpent on plate LXIX, Dresden codex. The difficulty in this case arises from the insufficient data, the number in the katun place having been omitted or obliterated, and the month symbol of the terminal date being too nearly obliterated for anything positive in regard to it to be determined. If the month symbol could be determined by inspection, the data would be sufficient to give the number of katuns correctly; but with the series in its imperfect condition, we can only state that, by a trial substitution of the numbers from 1 to 19 in the katun place, we find that this number must be either 1 or 14. If it be 1, the terminal date is 9 Ix 12 Zip; if it be 14, the terminal date is 9 Ix 12 Zac. As the fragment of the month symbol, small as it is, apparently forbids the supposition that it is Zac, it is probably Zip.

Taking the difference between the red series, as thus corrected, and the black series, and counting back from 9 Ix 12 Zip, we reach 4 Eb 5 Chen, year 9 Lamat, which agrees with the result of counting the black series from the initial date. The solution, therefore, appears to be satisfactory.

As Dr Seler raises another question in regard to these high series of the Dresden codex, we will consider it before passing on. It will be noticed that in the text (double column) at the left of the serpents on plates LXI and LXIX, there is, in each case, a numeral series given in symbols in the same form as those in the inscriptions. The one on plate LXI is 15–9–1–3, or 15 katuns, 9 ahaus, 1 chuen, 3 days; that on plate LXIX is 15–9–4–4, or 15 katuns, 9 ahaus, 4 chuens, 4 days. The date following in each case is 9 Kan 12 Kayab, and the date preceding is in each case is 4 Ahau 8 Cumhu. Now, Dr Seler, if I rightly understand him, contends that this series belongs to, or is connected with, the series in the serpent figures, and is to show that the count is carried back to 4 Ahau 8 Cumhu as the initial date, though he has failed to make connection between the dates by the series in the text.

As the initial and terminal dates (4 Ahau 8 Cumhu and 9 Kan 12 Kayab) are the same on both plates, and the number of the katuns and ahaus the same in both, it is certain there is a mistake in one or the other in regard to the number of chuens and days—one being 4 chuens, 4 days, and the other 1 chuen, 3 days—as the terminal date can not occur twice in the lapse of time between one and the other, that is, in 61 days. However, neither series will connect the two dates. The series on plate LXIX when reduced to days is as follows:

	Days
15 katuns	108,000
9 ahaus	3,240
4 chuens	80
4 days	4
Total	111,324
Subtract 5 calendar rounds	94,900
Remainder	16,424

Counting this number of days forward from 4 Ahau 8 Cumhu, year 8 Ben, we reach 9 Kan 7 Cumhu, year 1 Ezanab—a date 37 years later than the proper one; nor will counting backward give the proper result. It is apparent from the problem itself that the numeral series must be materially changed in order to connect these dates, if this was the object of the aboriginal artist. That the two dates are too prominent for either to be changed will be admitted. As 4 Ahau 8 Cumhu falls in the year 8 Ben, and 9 Kan 12 Kayab in the year 3 Ben, the lapse of time from the former to the latter, counting forward (the necessary direction on Seler's assumption) is 2,904 days (plus any number of calendar rounds); while the number of days over and above the calendar rounds in one of the series (plate LXIX) is 16,424 days, and in the other (plate LXI) is 16,263 days. The difference between 16,263 and 2,904 is 13,459. Therefore, correcting the series, as the dates can not be changed, involves dropping out 13,459 days, or nearly 37 years. It is impossible to make this correction by any change in the number of chuens and days, and as the katuns and ahaus are the same on both plates, it is presumable that they are as they were intended to be. Therefore, while the positions of the dates in the text in relation to the numeral series would seem to indicate that they were intended to be connected by it, no justifiable correction or reasonable manipulation of the series appears to bear out this theory. It would seem from these facts that the data do not sustain Seler's assumption.

Suppose, however, that it was the intention of the aboriginal artist to connect the dates by these short series, and that each of them contains some error, and when corrected would make the connection, let us see what the result would be. The entire series on plate LXIX—taking that in the text as it stands, and the black one in the serpent figure, making 15–9–4–4 plus 4–5–19–13–12–8, 4 Eb ? (month)—would throw back the initial date 12,493,052 days, or a little over 34,226 years, previous to the terminal date 4 Eb of the series. This is wholly inconsistent with the idea expressed by Seler (quoted farther on) that the terminal dates of the inscriptions indicate, respectively, the time of the erection of the monument, and that these dates fall within or after the 10th cycle (Goodman's 9th of the 54th great cycle). If the 4 Ahau 8 Cumhu of this series is the same 4 Ahau 8 Cumhu in actual time as the first of Goodman's 54th great cycle—or, as Seler calls it, the "normal date"—then the series must run far into the actual future, or all the dates of the inscriptions must be far back in the past, and are merely theoretical. The only other supposition is that the 9 Kan 12 Kayab in the columns at the left is not identical with the 9 Kan 12 Kayab that stands above the serpent, and with which the series in the folds are undoubtedly connected.

As the final date in the series referred to in the preceding paragraph is incomplete, in lacking the day of the month, we will try the one on plate LXI. Using the black series in the folds of the left serpent, as this is the largest of the four great series on this plate and hence presumably the last (though the rule, if correct, should hold good with any of the series), we have 15–9–1–3 plus 4–6–14–13–15–1 (as they stand on the plate). Counting 20 cycles to the great cycle and changing to days, we arrive at the following result:

	Days
4 great cycles	11.520.000
6 cycles	864.000
14 katuns	100.800
13 ahaus	4.680
15 chuens	300
1 day	1
	12.489.781
Add amount of short series	111.263
Total	12.601.044
Subtract 663 calendar rounds	12.583.740
Remainder	17.304

Using this remainder and counting forward from 4 Ahau 8 Cumhu, year 8 Ben, we reach 9 Imix 9 Mol, year 4 Ben. This is wrong. Let us use the series as corrected on a previous page, to wit: 4–6–14–11–3–1, or 12,488,821 days. Adding the shorter series and counting forward from 4 Ahau 8 Cumhu, we reach the date 4 Kan 2 Yaxkin. This again is wrong. Using the larger series as corrected and counting from 9 Kan 12 Kayab we reach, as has already been shown, the correct date, 3 Chicchan 13 Pax. It is therefore fair to conclude that there are no sufficient grounds for Seler's supposition.

These erroneous conclusions arise chiefly from the mistaken idea that these numbers, ahaus, katuns, etc., are real time periods. Moreover, it does not necessarily follow, where such high numbers are used, that 4 Ahau 8 Cumhu is what Seler calls the "normal date"; that is to say, the initial day of Goodman's 54th great cycle. But this does not matter in the present case, as the date can not be connected with any of the others given in the series.

Even could the series be reasonably changed so as to make the connection between the given dates, we still have staring us in the face the fact that 9 Kan 12 Kayab is actually and beyond question used in the codex as the initial day of the so-called great cycle in six instances, and that a Kan is the initial date in 3 times 6 other instances. It is true that these so-called great cycles are but orders of units, steps in numeration, and not real time periods; nevertheless, they are just as real when counting from a Kan as from an Ahau.

In order that the reader may clearly understand the object in view in introducing these calculations, and see the bearing they have on the question, it is necessary again to refer to the basis of Goodman's theory of the Mayan time system, and especially of his supposed separate "chronological calendar."

Goodman maintains that in addition to their regular annual calendar in which time was counted by years, months, days, etc., the Mayas made use of another time system which he terms the "chronological calendar." In this system, according to his theory, they counted time by certain determinate periods, which, according to the nomenclature arbitrarily adopted by him, are termed chuens (each of 20 days); ahaus (each of 18 chuens or 360 days); katuns (each of 20 ahaus or 7,200 days); cycles (each of 20 katuns or 144,000 days); great cycles (each of 13 cycles or 1,872,000 days), and a grand era equal to 73 great cycles. These he believes to be real time periods, as truly so as the years, etc., of the annual calendar, systematically arranged and all above the chuens always (so far as time count in the inscriptions is concerned) beginning with a day Ahau, the great cycles always with the day 4 Ahau. It is in this supposition that Goodman's great error lies, and, in order to support his premise, he changes two of the steps of the Mayan numeral system without the slightest evidence on which to base the change, and he also introduces factors into the numeral system which are wholly unknown to it. If these statements which I make can be maintained by satisfactory evidence, then his theoretic "Archaic Chronological System" falls to the ground, though his discoveries as to the signification of certain glyphs and the manner in which they were used be genuine, and his calculations of series be correct, and though his tables be also correct in the main.

The annual calendar system, which is that one long ago explained and accepted (that of months, years, etc.), is not in dispute. It is his theory of another time system, his so-called "Chronological Calendar," which I assert is without basis of fact. This calendar, which he says he "finally deduced," he expects will be challenged, but he "leaves it to defend itself, conscious that it is as infallible as the multiplication table."

Before referring to the proof bearing on this subject already presented, we shall call attention again to Goodman's method of numbering these periods. The chuens he says were numbered 18, 1, 2, 3, etc., up to 17; the ahaus and katuns were numbered 20, 1, 2, 3, etc., up to 19; the cycles, 13, 1, 2, 3, etc., up to 12; and the great cycles, 73, 1, 2, 3, etc., up to 72. On this subject he remarks as follows:

> Another consideration which must be constantly borne in mind is that all Maya dates relate to elapsed time. When a date is given it must be remembered that it is not the beginning of a period yet to run its course, but the beginning of one denoting a period already concluded. The ingenious numeration of their periods was designed to prevent confusion in this regard. The first day, chuen, ahau, katun, cycle, and great cycle is not numerated 1, but 20, 18, 20, 20, 13, 73, as the case may be, denoting that the full round of the period has run and that this is the commencement of a new count. In other words, these beginning numerals are equivalent to naught or no count, the periods being designated only until after they had fully passed. It is very difficult to keep track of this style of numeration—so difficult, in fact, that familiar as I am with it I am distrustful of having made some lapses in these pages.

That he has made a mistake in this statement, in order to fit the facts with his theory, and that he carries this mistake throughout his entire work, is easily shown, and will appear from what follows.

That the count is forward to some date in the future, as compared with the initial date, in most of the series of the inscriptions, is apparent from the examples given by Mr Goodman in his work; and that it is forward to some future date, as compared with the initial day, in every initial series, must be admitted. Therefore, his assertion can not be intended to contradict this fact. What he intends to declare is this, that when a date is given, as the first day of the 2nd katun or ahau, we must understand that it is really the first day of the 3rd katun or ahau, the 2nd being completed; or when 2 ahaus and 3 chuens are mentioned, we are to understand 2 completed ahaus and 3 completed chuens.

Let us see if we can ascertain how this strange method of numbering these so-called periods originated. It must be remembered that this numbering is the consecutive numbering, as that of the days of the month, and not the numbering (in the 13 series) of the day Ahau as mentioned above. I quote again from his work (pages 12 and 13):

Poor Don Pio! To have the pearl in his grasp and be unaware of its pricelessness—like so many others! But I must not exult too much yet. The succession of the katuns, reckoned according to this principle, is yet to be ascertained before my fancied discovery can be established by a crucial test. I score the ahaus off in the foregoing order, and, sure enough, the twentieths give the desired result: 11, 9, 7, 5, 3, 1, 12, 10, 8, 6, 4, 2, 13. Eureka! The perturbed spirit of the Maya calendar, which has endeavoured so long to impart its message to the world, may rest at last.

But, though confident I had discovered the secret of the ahau and katun count, when I tried the plan on the dates and reckonings of the inscriptions it proved totally inapplicable. There were periods into whose nature I had no insight, and if those I surmised to be ahaus and katuns were really so the former would not come in the right order, while the latter were excessive and numerated in a way quite unintelligible. It was discouraging, but I did not lose faith in my discovery. The inapplicability of the Yucatec scheme to the reckonings of the inscriptions, probably, was simply owing to different methods of computing the ahaus and katuns. There was no alternative but a patient and exhaustive analysis of the Archaic dates and time reckonings.

It would be tedious as useless to recount trials—failure outranking success a thousand fold—the results of which constitute the bulk of this book. I will only state, in brief, that I determined the character of the chuen and great cycle periods; that I discovered the first chuen was numerated 18, the first ahau, katun, day and day of the month, 20, and that the first cycle of the great cycle was numbered 13—the unit attaching to the second period in all instances; that I ascertained the cycle was composed of twenty katuns, numerated 20, 1, 2, 3, etc., up to 19, instead of according to the Yucatec order; that I finally deduced a chronological calendar whose perfect accord with the principal dates and reckonings throughout the inscriptions is proof of its correctness, and by reversing the process succeeded in reconstructing the outlines of the entire Archaic chronological scheme. I expect my calendar to be challenged. It would be without precedent in the history of discovery if it were not. But I leave it to defend itself, conscious that it is as infallible as the multiplication table, and knowing that all antagonists must finally go down before it.

By reading between the lines of this quotation, and noting the difficulties he encountered, we readily see that his theory was outlined before the difficulties presented themselves. Why should he find it necessary to number the first chuen 18, the first ahau 20, and the first cycle 13 were this not so? Take the short series 13–9–9 from 12 Caban 5 Kayab to 6 Cimi 4 Tzec, which he mentions, and says works out all right. There is no difficulty if we count it 13 ahaus plus 9 chuens plus 9 days, just as we might say 13 hundreds 9 tens and 9. If we read it as it really is, 13 units of the 3rd order (360 each) plus 9 units of the 2nd order (20 each) and 9 units of the 1st order (1 each), there is no difficulty in showing that it is an exact measure of the lapse of time between the given dates.

The difficulty, as we may safely assume, arose from the fact that the count would not fit in with the theory he had formulated but had not perfected. He had probably outlined the tables of his "Archaic Chronological Calendar," but instead of numbering them as we find them now given in his work, the cycles were numbered 1, 2, 3, etc., up to 13; the katuns, 1, 2, 3, etc., to 20, etc. Conceiving the idea that the numbers in the series (as the 13–9–9) should express the numbers in his scheme—that is to say, should be read the 13th ahau, the 9th chuen, and 9th day—he found that it would not give the correct result. Here indeed was a difficulty, a difficulty of fitting facts to a theory, but not one in reality, for the series taken as it stands works out correctly. In order to overcome this difficulty and at the same time save his theory he seemingly hit upon the ingenious device of a supposed Mayan method of numbering periods somewhat as the surveyor numbers his stations, beginning with 0 (naught), or what gives the same result and avoids the use of the cypher, which he contends was not used by the Mayas, of bringing forward the last number of the preceding period to be the first of the one following. Thus in his "Archaic Annual Calendar" he has pushed down one step the true dominical days, Akbal, Lamat, Ben, Ezanab, although retaining their proper numbers, and has brought forward, with the number 20 attached, the preceding days, Ik, Manik, Eb, Caban, and begins the numbering of the chuens with 18, of the ahaus and katuns with 20, etc. This, of course, overcomes the difficulty, as what is numbered the first ahau, etc., is, in fact, the second, and in the example given the 13th ahau is, in fact, the 14th, and the 9th chuen the 10th, and hence, by his method of numbering, the 13th ahau, 9th chuen, 9th day is equivalent to 13 complete ahaus, plus 9 complete chuens, plus 9 days. This plan will undoubtedly preserve the proper order of succession. The only real errors it introduces, if considered merely a method of numbering, is in making the wrong days dominicals and in carrying the last day of one month forward to become the first day of the next. one or two examples of which are pointed out in my previous paper. These examples have since been more fully discussed by Mr. Bowditch, with the result of strongly inclining him to accept Goodman's theory in this respect. They are noted in my Maya Year (figure 20), though not discussed there as to the point here raised.

As further evidence bearing on this question, I add the following: There is no such method of numbering found in the inscriptions, or in the codices. Mayan or Mexican, unless in the examples above referred to, and there is no such method mentioned by any of the early writers. Perhaps, however, the most important point to be decided in this connection is the query, Did the Mayas in fact number these so-called periods? How many were to be taken was indicated by symbols, but there is no evidence, so far as I am aware, that they were numbered, except in a single instance found on the north and south faces of Stela J at Copan. Here, it is true, we find a succession of ahau symbols of the usual type, placed in somewhat regular order and numbered in regular succession from 1 to 16, beyond which the remaining glyphs (only two, however) are obliterated. Whether these numerals are intended as a successive numbering or intended merely to indicate so many ahaus, is not known; however, it looks like regular numbering, and is so accepted. But, unfortunately for Goodman's theory, the series clearly begins with number 1. To get around this difficulty he assumes that it is to be understood that 1 ahau has passed, yet he admits that the symbol on that numbered 1 signifies "beginning." Thus the only example of numbering these so-called periods found in all the records is emphatically against his theory, in order to sustain which he literally begs the question by saying it must be assumed as understood that 1 ahau has passed. We are justified, therefore, in regarding his scheme of numbering as wholly unnecessary to explain the numeral and time series of the inscriptions, for considering his so-called time periods merely orders of units will give a full explanation, so far as the counting is concerned, in every case.

But these items do not show all the errors in the above-quoted statement from Goodman's work. That but 13 cycles were counted to the great cycle, I have shown by mathematical demonstration is untrue, so far, at least, as the Dresden codex is concerned. I have shown that this codex, instead of counting 13 cycles to the great cycle, counts 20, thus following regularly, as would naturally be supposed, the vigesimal system. It is true that Goodman admits that the codices belonging to what he calls the Yucatec group not only count 20 cycles to the great cycle, but count from some three or four different initial days. This admission, however, does not avail him anything in the way of clearing his theory of the difficulty presented. In the first place, the Dresden codex can not be classed with the so-called Yucatec group. This group, which includes the Troano and Cortesian codices, and the codex used by Landa, makes Kan, Muluc, Ix, and Cauac the dominical days; while the Dresden codex, from which the examples given above showing the use of 20 cycles to the great cycle were taken, follows the system of the inscriptions in using throughout Akbal, Lamat, Ben, and Ezanab as dominical days. Moreover, it gives high series wholly unknown to the Troano and Cortesian codices; and it introduces in some three or four places, as numerical characters, precisely the same symbols as those of the inscriptions named by Goodman katun, ahau, and chuen, and in one or two places uses a face character to represent the ahau.

What grounds, therefore, can Goodman have for asserting that the system used in the inscriptions is different from that used in the Dresden codex, which he evidently includes under the term "Yucatec system"? There is nothing in either the Troano or Cortesian codex by which to determine the number of cycles they count to the great cycle. What system was used in the Yucatan inscriptions is not positively known, but, as is shown below, they probably agreed with the Troano and Cortesian codices. Goodman says he has been unable to find a single Yucatec inscribed date. After careful inquiry and examination of the casts of inscriptions in the chief eastern museums and all the photographs, drawings, and figures in reach, without finding one, I have had my attention called by Mr Saville, of the New York Museum of Natural History, to a photograph by Mahler, taken at Xcalumkin, in Yucatan, which is reproduced in Le Plongeon's "Queen Moo," which, if I correctly interpret it, may be an indication of the system used in the Yucatec inscriptions. This is shown in figure 157 from a copy of the photograph kindly furnished by Mr. Saville.

FIG. 157. Inscription at Xcalumkin, Yucatan. From a photograph by Mahler.

The day (A11) is evidently 8 Caban, the 4th day, apparently, of the month Zotz, though the month symbol is somewhat unusual in form. If the day symbol is properly interpreted Caban, of which there can scarcely be a doubt, then, as the 4 dots over the month symbol are very distinct, it is certain (whether we can determine the month symbol or not) that the year must begin with the day Ix, hence the dominical days must be Kan, Muluc, Ix, and Cauac. This is the calendar system of the Troano and Cortesian codices and also of the codex followed by Landa. This result I must confess is contrary to my expectation and carries back the Yucatec calendar system to the days of the inscriptions. It is true that a single inscribed date is a slender basis on which to reach a decision, but we must accept it until other evidence on the point is forthcoming. Goodman suggests that the Cocomes, Xius, Chels, and Itzas had each their own "chronological system, using a common calendar." On what he bases this opinion, which is equivalent to saying they had different numeral systems, I am not aware. That the system in vogue at Tikal (in the Itza region of the Peten district) was the same as that of the inscriptions at Palenque, Copan, and Quirigua is well known.

Let us return to the exceptional series of the Copan inscriptions mentioned above (west side of Stela N). Although it was discussed at some length in my previous paper, a reexamination has brought to light some facts overlooked in the first examination, which have an important bearing on the question involved; and they will be noticed here. This series reversed is as follows: 14–17–19–10–0–0 to 1 Ahau 8 Chen (figure 158). Written out it is 14 great cycles, 17 cycles, 19 katuns, 10 ahaus, 0 chuens, 0 days, to 1 Ahau 8 Chen. Changed into days it gives the following result, counting 20 cycles to the great cycle:

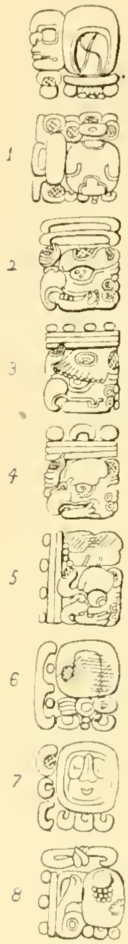


FIG. 158. Part of inscription on the west side of Stela N, Copan. Maudslay, part 4, plate LXXIX.

	Days
14 great cycles	40,320,000
17 cycles	2,448,000
19 katuns	136,800
10 ahaus	3,600
Total	42,908,400
Subtract 2,260 calendar rounds	42,894,800
Remainder	13,600

If we count back this number of days from 1 Ahau 8 Chen, year 3 Ben, it brings us to 12 Ahau 13 Zotz, year 5 Lamat, which will be the first day of the first, or most remote, of the 14 great cycles, counting the series in this manner upward from the 15th:

1st great cycle
2nd great cycle, etc., to
14th great cycle
(15th great cycle)
17 cycles
19 katuns
10 ahaus
0 chuens
0 days

If we count back from the same date (1 Ahau 8 Chen) the 17 cycles, 19 katuns, and 10 ahaus, we reach the first day of the (incomplete) 15th great cycle as we have numbered them above. This day is 5

Ahau 8 Cumhu, year 9 Ben. If we count back the great cycles one by one (counting 20 cycles to a great cycle), we shall find the initial dates to be as follows—the numbers given the great cycles being, of course, arbitrary:

1st great cycle...... 12 Ahau 13 Zotz, year 5 Lamat
2nd great cycle...... 5 Ahau 3 Ceh, year 4 Ezanab
3rd great cycle......11 Ahau 8 Pop, year 4 Ben
4th great cycle...... 4 Ahau 18 Mol, year 3 Akbal
5th great cycle......10 Ahau 8 Pax, year 2 Ben
6th great cycle...... 3 Ahau 13 Tzec, year 2 Lamat
7th great cycle...... 9 Ahau 3 Mac, year 1 Ezanab
8th great cycle...... 2 Ahau 8 Uo, year 1 Ben
9th great cycle...... 8 Ahau 18 Chen, year 13 Akbal
10th great cycle...... 1 Ahau 8 Kayab, year 12 Ben
11th great cycle...... 7 Ahau 13 Xul, year 12 Lamat
12th great cycle......13 Ahau 3 Kankin, year 11 Ezanab
13th great cycle...... 6 Ahau 8 Zip, year 11 Ben
14th great cycle......12 Ahau 18 Yax, year 10 Akbal
15th great cycle...... 5 Ahau 8 Cumhu, year 9 Ben

This result shows our calculation to be correct, taking the day of the inscription (1 Ahau 8 Chen) as that from which to count back. As there are 14 complete great cycles, which we estimate at 20 cycles each, and the minor periods (17 cycles, 19 katuns, and 10 ahaus), the latter must fall in the 15th great cycle, which is incomplete. Counting back these minor periods, we reach, as has been stated, 5 Ahau 8 Cumhu, year 9 Ben, as the first day of this 15th great cycle. Counting back from this latter date 20 cycles (or 1 great cycle) we reach 12 Ahau 18 Yax, year 10 Akbal, the first day of the 14th great cycle, and so on to the initial day of the first, which we find to be 12 Ahau 13 Zotz, year 5 Lamat, giving exactly the same result as our calculation of the whole as one single series. By both methods the first day of the entire series, and hence the first great cycle as numbered above, is found to be 12 Ahau 13 Zotz. But this, though correct so far as calculation is concerned, is not proof, as the results given must necessarily follow if the date counted from is 1 Ahau 8 Chen, and 20 cycles are counted to a great cycle. This is unsatisfactory, as it fails to bring in as the first day of a great cycle 4 Ahau 8 Cumhu, which was a normal date at Copan.

I am strongly inclined to believe that the terminal date of the series instead of 1 Ahau 8 Chen, as given in the inscription, should be 13 Ahau 8 Chen, which falls in the year 2 Ben. If we count back from this date 17 cycles, 19 katuns, 10 ahaus, 0 chuens, 0 days, it will bring us to 4 Ahau 8 Cumhu, year 8 Ben, as the first day of the 15th great cycle, as we have arbitrarily numbered them above. If we count back the entire series, 14–17–19–10–0–0, from 13 Ahau 8 Chen, year 2 Ben, it brings us to 11 Ahau 13 Zotz, year 4 Lamat, as the first day of the 1st great cycle as numbered above. The first days of the great cycles would then be as follows:

1st great cycle	11 Ahau 13 Zotz, year 4 Lamat
2nd great cycle	4 Ahau 3 Ceh, year 3 Ezanab
3rd great cycle	10 Ahau 8 Pop, year 3 Ben
4th great cycle	3 Ahau 18 Mol, year 2 Akbal
5th great cycle	9 Ahau 8 Pax, year 1 Ben
6th great cycle	2 Ahau 13 Tzec, year 1 Lamat
7th great cycle	8 Ahau 3 Mac, year 13 Ezanab
8th great cycle	1 Ahau 8 Uo, year 13 Ben
9th great cycle	7 Ahau 18 Chen, year 12 Akbal
10th great cycle	13 Ahau 8 Kayab, year 11 Ben
11th great cycle	6 Ahau 13 Xul, year 11 Lamat
12th great cycle	12 Ahau 3 Kankin, year 10 Ezanab
13th great cycle	5 Ahau 8 Zip, year 10 Ben
14th great cycle	11 Ahau 18 Yax, year 9 Akbal
15th great cycle	4 Ahau 8 Cumhu, year 8 Ben

The method of numbering the great cycles must be understood as wholly arbitrary, given merely for convenience, and to include the 15 that are referred to in the count. I do not believe that there was any consecutive numbering of these supposed time periods in the sense indicated by Goodman; in fact, as I expect to show, they were not time periods in any true sense of the term.

The reason for believing that the date following the inscription should be 13 Ahau 8 Chen instead of 1 Ahau 8 Chen is that 4 Ahau 8 Cumhu, as appears from the inscriptions at Copan and Quirigua, was the favorite initial date, most of the initial series going back to it, and that counting back the minor periods of the series from 13 Ahau 8 Chen brings us to 4 Ahau 8 Cumhu. If we turn to Goodman's "Archaic Chronological Calendar" and count forward, from the beginning of his 54th great cycle, 17 cycles, it will bring us to the 4th cycle of his 55th great cycle, and to the 19th katun of this cycle and the 10th ahau of this katun, where we find the day to be 13 Ahau 8 Chen. We are therefore of the opinion that the terminal day of the long series should be 13 Ahau 8 Chen, and that Goodman is wrong in rejecting it. As there are 17 cycles, it proves, as it stands, that the authors of the inscriptions counted 20 cycles to the great cycle, which is consistent with their system of numeration. I have shown in my previous paper why 4 Ahau 8 Zip can not be the initial date of this series.

As bearing on the explanation of this series, the following facts in regard to the symbols are worthy of special notice. It will be seen by an inspection of the series shown in figure 158 that the great cycle symbol (glyph 5) is a face character very much like that of the cycle, except that it has a superfix, which unfortunately is too nearly obliterated to be traced. However, it is noticeable that in both it and the cycle symbol the hand figure is across the lower jaw. According to Goodman, "the hand on the cheek, the thumb or wrist forming the lower jaw, usually characterizes the face sign for 20" (page 52), and this conclusion is sustained by the evidence we have given above. Goodman's perverseness in contradicting his own evidence in order to maintain his theory is shown in reference to this sign. It is found almost universally on the cycle face characters, as may be seen in his examples on page 25 of his work. It is true that it may be contended, as Goodman in fact does contend, that it signifies that 20 of the next lower order make one of this order. Admit this; it follows that when the same sign is found on the great cycle symbol, it signifies that 20 of the next lower order (or cycle) make one great cycle. Although but one example of the great cycle face symbol has been found, it bears clearly and unmistakably this hand sign, and not only is this not denied by Goodman, but is accepted by him and copied as an example of the symbol of this period on page 25 of his work.

Thus it will be seen that from whatever side we view the evidence bearing on this question, it is against Goodman's theory of only 13 cycles to the great cycle. However, before closing the discussion of this point I desire to call attention to one other series, found on Stela C of Quirigua, which seems to have a bearing on the question. This is as follows: 54–13–0–0–0–0, 4 Ahau 8 Cumhu—in other words, 54th great cycle, 13 cycles, 0 katuns, 0 ahaus, 0 chuens, 0 days, to 4 Ahau 8 Cumhu, the 13 being the ordinary numeral symbols, dots and short lines, and very distinct. Goodman's only comment (page 127) is, "This date is the beginning of the 54th great cycle." As 4 Ahau 8 Cumhu, is, according to his reckoning, the initial day of the 54th great cycle, the series, according to this explanation, covers no lapse of time whatever. Yet, according to his theory, the numbers in these series always relate to time which has elapsed. Hence the 13 cycles relate to 13 of these so-called periods which have passed and still signify no time whatever. This is a palpable contradiction into which he has been led in his effort to maintain an erroneous theory. If he had written the series "53–13–0–0–0–0 to 4 Ahau 8 Cumhu," it would have been correct so far as the count is concerned.

Dr Seler in his able article, "Die Monumente von Copan und Quirigua und die Alter-Platten von Palenque" (Zeitschrift fur Ethnologie, Heft 6, 1899, pages 670–738), makes some remarks in regard to the series above noticed to which it is desirable to call attention.[a]

It appears from this article that he follows Goodman in counting 13 cycles to the great cycle, or 13 units of the 5th order to make one of the sixth (I repeat again that Goodman's terms are used merely for convenience). Moreover, he seems to look upon these as real time periods. That he, who is so familiar with the subject, has not

[a] This article was not received by me until all this paper, except the last few pages and the notices of it which have been inserted, had been written. As I have seen no reason, because of Seler's article, to change anything previously written, I make this statement as due to myself.

entered into a careful examination of the basis on which Goodman's theoretical "Chronological System" rests, and that he has accepted Goodman's theory of 13 cycles to the next higher period, without thoroughly testing it, and noting the 20 cycles of the Dresden codex, is somewhat surprising to me. However, he may have reserved the discussion of these points for a future article.

In speaking of the series last referred to, 54–13–0–0–0–0, 4 Ahau 8 Cumhu, he says:

> Here one sees that the final date is the normal date itself. Its distance from the normal date can be placed only at 0 or the above-named immense period of 18,720 years. The builders of the monuments have done neither. They have provided all the lower multiplicands, or smaller periods, with the index 0, but to the highest and greatest they have placed the multiplier 13. Thirteen is the number of the index figures which are possible with the tun, the katun, and the cycle names. If, consequently, here at the beginning of the initial series the thirteen cycles are named, nothing else is meant than "the periods or epochs generally." And the whole initial series would consequently give about the following idea: "This is a chronological monument. The beginning of the numbering is the day 4 Ahau 8 Cumku." And the fact that on the west side of the same stela another definite date and its distance from the normal date is named agrees very well with this.
>
> Similarly, in my opinion, are to be understood the thirteen cycles which are chiseled on the two sides of Stela C of Copan, immediately under the katun signs, the initial and chief hieroglyphs.

It seems clear from this that he has adopted Goodman's interpretation of the series, unaware of its incongruity with the interpretation of all the other initial series, and the fact that it stands in opposition to his own conclusion stated a little farther on in the same article. As proof of the latter statement, I refer to the quotation from his article given hereafter (page 292).

Now, it is apparent that, if the series be interpreted as signifying no lapse of time, but as a mere assertion that the date of the event commemorated was 4 Ahau 8 Cumhu the first day of the 54th great cycle, which interpretation Seler adopts, then the monument must have been erected 3,550 years before the beginning of the cycle which he numbers the tenth (Goodman's ninth). It is apparent, therefore, that he has failed to see the contradiction between this statement and that which places the erection of the monuments of Copan and Quirigua in the tenth cycle. He objects to the lapse of 3,160 years between the erection of the monuments of Palenque and those at Copan and Quirigua, as improbable, but here admits, by his interpretation, a lapse of 3,550 years between monuments at Quirigua.

I have stated above that Goodman's so-called time periods, chuens, ahaus, katuns, etc., are in reality nothing more than orders of units, or steps in numeration. Although this point has been discussed to some extent in my previous paper, I will add here some further evidence bearing on it.

As a means of illustrating the use of numbers by the Mayas, in relation to time, the following example—which is part of a series on plate LIX of the Dresden codex (figure 159)—is presented:

13 Caban	13 Cauac	13 Imix	13 Akbal	13 Chicchan	13 Manik

As this series ascends toward the left hand the forward count will be in that direction. Starting with the column at the right hand, we subtract it (3–18) from the next one to the left, and this one from that immediately to the left of it, and so on to the last.

The difference in each case is found to be 3–18; that is, 3 twenties (3×20) plus 18 equal 78 days, the day being the unit. Counting for-

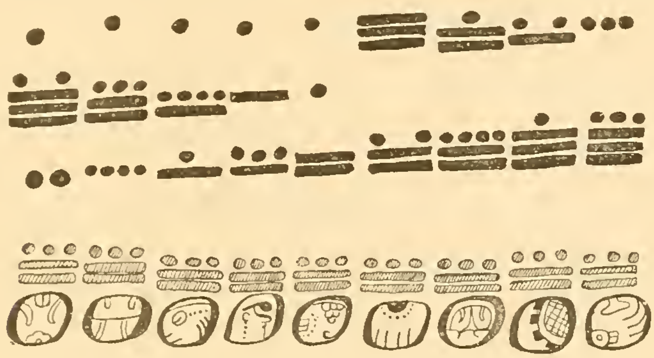


FIG. 159. Lower division of plate LIX, Dresden codex.

ward 78 days from 13 Manik of any year (say 13 Manik 20 Zotz, year 12 Lamat) we reach 13 Chicchan (in this case 18 Mol, same year). Counting forward 78 days from the last date we reach 13 Akbal 16 Ceh, same year; 78 more (always counting from the last date), 13 Imix 14 Pax, same year; 78 more, 13 Cauac 7 Uo, year 13 Ben. If we count back 78 days from 13 Manik 20 Zotz (first column at the right hand), we reach 13 Muluc 2 Pop, year 12 Akbal, which is the initial day of the whole series, the month and year of the first given day being as assumed above.

Attention is called to this series not because it presents any peculiar feature, but to show that considering the numerals merely as numbers in respective orders of units will furnish a full and satisfactory explanation of their object and use. I take for granted that the simplest explanation, if it meets every requirement and presents nothing inconsistent with the known facts regarding the Maya time and numeral systems, should be accepted rather than a theory which introduces new and hitherto unknown features.

If we use ordinary numbers in place of the numeral symbols, and keep them in the relative positions given above, the result will be as follows:

3rd order of units......	1				
2nd order of units......	1	15	11	7	3
1st order of units......	10	12	14	16	18
	13 Cauac	13 Imix	13 Akbal	13 Chicchan	13 Manik

If we assume these to be successive orders of units indicated by relative position, increasing upward, the day being counted as the primary unit and the vigesimal system being used, except in passing from the second to the third order, where the multiple is 18, all the requirements of the series will be met. Thus, in the first, or right-hand, column, we have 18 units of the 1st order and 3 of the second, or $3\times20=60$, making together $60+18=78$; and in the second column 16 of the 1st order and 7 of the 2nd order, or $7\times20=140$, making together $140+16=156$, and so on to the fifth column, where we find 10 of the 1st order, 1 of the second, or $1\times20=20$, and 1 of the 3rd order, or $18\times20=360$, making together $360+20+10=390$. These numbers give correct results, as, counting 78 days from 13 Muluc, we reach 13 Manik; counting 156 from the same initial date, we reach 13 Chicchan, or counting 390 days, we reach 13 Cauac. It is clear, therefore, that if we take these numerals to indicate the number of different orders of units, the orders being indicated by relative position, all requirements of the series are satisfied and the proper results are obtained.

If we take one of the high series we find that precisely the same rule obtains, as, for example, one of those on plate LXII, Dresden codex (see plate LXXIX):

4 of the 6th order of units..........	4
6 of the 5th order of units..........	6
9 of the 4th order of units..........	9
15 of the 3rd order of units..........	15
12 of the 2nd order of units..........	12
19 of the 1st order of units..........	19

This is upon precisely the same principle as our method of expressing numbers, except that it is according to the vigesimal system, while we use the decimal. Take the number 643,527, where the relative positions express the relative values, it becomes possible to represent the number thus:

6 hundred thousands
4 ten thousands
3 thousands
5 hundreds
2 tens
7 units

If, instead of adding the written names, simply the figure should be given, the relative positions being maintained and understood, we would have the Maya method, and the value would be known as well as by our ordinary method of writing numbers horizontally.

I have given these details of elementary rules and principles in order to lead up to this point, viz, that symbols may be used to indicate orders of units instead of position. In the last example given above, a symbol may be adopted for the "hundred thousands," another for "ten thousands," another for "thousands," etc. They may then be grouped in any regular order most convenient, and yet be as correctly read as by position. This is precisely what has been done in the inscriptions. Symbols have been adopted to indicate the orders of units, as it was inconvenient to do this by means of relative position alone with the dots and short lines—at any rate it is apparent that the latter method is not so well adapted to the glyph form in the inscriptions; but even here we see a strong tendency to maintain the relative position which almost universally obtains and is often the only means of determination. If we take Goodman's work and go through it from beginning to end and substitute in every series where they occur "units of the 2nd order" for his chuens, "units of the 3rd order" for his ahaus, "units of the 4th order" for his katuns, "units of the 5th order" for his cycles, and "units of the 6th order" for his great cycles, the result will be correct in every instance. I am fully aware that this will be true whether we call them real time periods or orders of units. The point, however, for which I am contending is, that as the Mayas had a system of numeration and must have used it in expressing numbers in the codices and inscriptions, and this numeral system corresponds exactly with Goodman's supposed time periods so far as these are given numerically correct by him, there is no necessity or reason for the theory of a separate Maya chronological system (identical so far as correctly given with the Maya numeral system as used in counting time), differing from their calendar system.

From the evidence given in the earlier part of this paper and what has been presented in my preceding paper, the following conclusions appear to be clearly justified:

That Mr Goodman has discovered independently the signification and numeral values of the symbols found in the inscriptions which he designates by the names cycle, katun, ahau, chuen, and calendar round, though this had been already done in part by others.

That he has discovered that certain face and other characters are number symbols, and has ascertained their values.

That he has determined the object and use of the numeral series, and the method of counting by the same series from the preceding and following dates, as well as to them.

It is also equally apparent that his theory of a Maya chronological system, distinct from the Maya calendar system—the Mayan method of numeration in counting time—and his method of counting 13 so-called cycles only to the so-called great cycle and 73 great cycles to his so-called grand era are not justified by the facts, nor is his method of numbering the cycles, katuns, etc., beginning with 73, 13, and 20, satisfactorily proved; and also that his selection of Ik, Manik, Eb, and Caban as the dominical days is erroneous, the true dominical days being Akbal, Lamat, Ben, and Ezanab, both in the inscriptions and Dresden codex.

Let us turn next to his method of numbering the so-called great cycles. According to his theory, as we have seen, 73 great cycles are counted to what he calls the grand era, the common multiple of all the factors of the calendar system and supposed "chronological system." The reason why he adopted this theory is explained in my previous paper, and the explanation need not be repeated here, except so far as merely to state that in order to find a common multiple of the various time periods, one must include the number 365, which contains the prime number 73.

That there was in the Maya system a number or order of units corresponding with Goodman's great cycle is certainly true, but this pertained to their numeral, and not their time, system. It is also admitted that the large quadruple glyph that usually heads the initial series is the symbol used to represent this number or order of units. But, as has been shown, there is no reason whatever for believing that they were numbered otherwise than in accordance with the vigesimal system; that is to say, 20 cycles to the great cycle, and 20 great cycles to the next higher unit. It is necessary, therefore, for Goodman, before his theory can be accepted, to show by satisfactory evidence that, on reaching the cycles and great cycles, the ordinary method of proceeding by the vigesimal system was abandoned and other multiples were introduced. That there was a change from this rule in passing from the 2nd order of units, or chuens, to the 3rd order, or ahaus, where 18 was made the multiple, is proved by incontrovertible evidence and hence must be admitted, even though we may not be able to show by absolute demonstration why the change was made. Nevertheless, we are justified in believing that, in this instance, the method of numeration was made to correspond with the number of months in the year. But no such reason appears for Goodman's proposed change in the higher orders of units; we are, therefore, justified in rejecting the idea until other proof, besides its necessity to support a theory, is shown. It must be made evident by proof that the series can not be otherwise explained, which we have shown is not the case, or it must be shown that the great cycle symbols present, by their forms, the numbers assigned them.

Before referring to the numbers of the great cycles as obtained by a study of the forms of the symbols, I introduce the following quotation from Goodman's work (page 38):

The number and diversity of these signs and the fantastic character of some of them—notably the face series—suggest a hieratic design to conceal the purport of the inscriptions from the uninitiated; but I think the determinative feature of their numeration, the desire to give symmetry and grace to their glyphs, and the possible purpose to avoid sameness and repetition, sufficiently account for the variety without ascribing it to a cryptogramic intention. It is probable, therefore, that all the other series of numerals were as intelligible to the populace as the simple one of dots and bars—being, as it were, a mere difference in the style of characters, such as is to be seen in fancy printing or ornamental sign-writing.

While it is likely that in most instances there is a full series of similar signs, just enough modified to distinguish them from each other, running from 1 to 20, I do not think this to be the case throughout. It will be found, I believe, that there are many sporadic signs, or signs without any serial connection. The frequent use of certain numbers accounts for this, and it is to designate these that solitary symbols are oftenest employed. There will probably be more signs discovered for 13, 18, and 20, than for any other number.

I do not claim that the value of any sign about to be given is correct beyond question. On the contrary, I think it very likely that in some instances I shall myself find reason for a change. But, as in most cases I shall explain why I have attached the value given to particular signs, the reader will not be misled, but can accept, reject, or modify my estimate, according to his own judgment. It will be only by persistent trial, assumption, alteration, and readjustment, until a figure that fulfils the requirement of every condition under which a character appears is hit upon, that we shall be able to fix the values of all the numeral signs.

That the great cycle symbol can be determined by position in a series, even though imperfect in form, is evident from what has been shown, but the number must be determined otherwise. In order to show on what Goodman bases his conclusion as to the numbers of the great cycles so far as determined by the form, I quote the following from his work (page 83):

ELEMENTS OF THE GREAT CYCLE SIGN

Here the reckoning reverts to the 5-day period. It is multiplied by 72, making an ahau; that by 20, making a katun; that by 20 again, making a cycle; and that by 13, making a great cycle. The last multiplier is the outflaring trinal character at the top [figure 160]. It is a 13 sign, duplicated to balance the glyph. The two 20 multipliers appear only in the first of the symbols given above—or, rather, only in that does the single one extend all the way to the bottom, as is commonly the case. There should be two separate signs, however, as shown in some of the glyphs; but I have selected these particular specimens for another purpose, which I shall presently state. The 20 sign in the first glyph looks like anything but the same sign in the other two, and resembles a fish more than anything else. Yet they are identical in character, both representing the feathered dragon, the fringed jaw alone of which, reduced to the cursive comb-like character, is the commonest sign for 20. The evolution of this character is so curious and interesting that I herewith give a series of glyphs, all taken from great-cycle symbols, showing the gradations [figure 161].

The reason why I selected the particular symbols given above, is that I think the number of the great cycle is specifically stated in them. Close observers will have noticed several peculiar things about the great-cycle character. The most peculiar of these is that, while the form of the katun symbol is preserved in it fully in every other respect, the *cauac* sign disappears from the superfix and is replaced by some other character. In more than three-fourths of the dates in the 54th great cycle a dragon's head occupies its place; a tiger's head predominates in the 55th, while the remainder is made up of faces and signs that may represent a day, a cycle, or some other period. Whatever their character, they have no

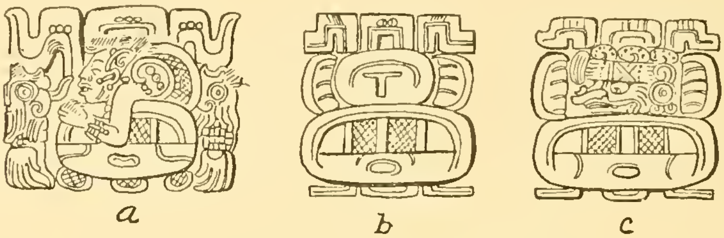


FIG. 160. Great cycle symbols. Goodman, page 83.

peculiarities that can at present be construed into numerals, except in case of the three glyphs here reproduced; so, if the others have any numeric value, it must be arbitrarily expressed. The three in question indicate the 54th great cycle, and I think that all of them announce that fact, but each in a different way. The center of the katun superfix in the first is composed of a sign for 18 and a face. If it were plainly the face for 3 we should be left in no doubt; but, in consequence of the defacement of the stone, it is impossible to determine if a band—the characteristic of the 3 head—extends across the forehead or not. In the second glyph the *ik* symbol—a sign for 6—appears in an inclosure that probably represents 9, but as the coil is not clearly discernible we are again left in uncertainty. The third glyph has the meaningless face, which elsewhere serves as a mere vehicle

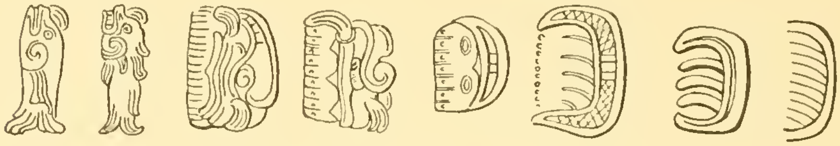


FIG. 161. Comb-like symbols for 20. Goodman, page 83.

for numerals, bearing a sign for 9, surmounted by three objects evidently intended for spheres, whose value is doubled by the dotted lines in them, rendering it probable that the combination was designed to express $9 \times 6 = 54$. I make no claim to absolute certainty in any of these cases; but, however uncertain the renderings may be separately, they collectively derive a high degree of probability from a single significant fact. The unmistakable numeral sign in each glyph is a divisor of 54. That these glyphs—the only ones with recognizable numerals—should contain signs for three out of the six numbers by which 54 is divisible, is a circumstance too singular to be attributed to accident when a more reasonable explanation is to be found in the theory that these three particular figures were chosen with the definite purpose of arriving at that number.

As Goodman admits in the passage quoted, it is only in the three great cycle signs presented (see figure 160) that the evidence of numbering is found; let us examine this evidence. "Here," he says, "the reckoning returns to the 5-day period. It is multiplied by 72, making an ahau," yet he fails to allude to anything in the figure to justify the statement. That the comb-like characters and their substitutes have the value of 20 is probably correct, the sign being duplicated, as Goodman suggests, for the sake of symmetry. The fair inference is that in the katun symbol they indicate that this time period or order of units is equal to 20 ahaus (20×360=7,200). This admission, however, as will be seen, is fatal to Goodman's theory.

The three figures given represent, according to this author, the 54th great cycle, and indicate by the details, but each in a different way, the number 54. This, he says, is shown in the first (*a*) in the center of the superfix, where he finds a sign of 18 and a face denoting 3—though he admits that the latter is too imperfect for positive determination. The fact is that he has presented no proof that the dotted coil denotes 18. He asserts in his explanation of the ahau series on Stela J, Copan, copied in full in my previous paper, that the double coil denotes 18, but gives no proof to sustain the statement. His symbol for 18 in the ear ornament (page 87) is wholly different. Moreover, the face in the superfix, so far as the details remain, corresponds in no respect with the face numerals for 3 given on page 43 of his work, but on the contrary bears a strong resemblance to at least two of the face characters for 1 (page 42). It is unnecessary to follow him in order to find the desired number in the other two figures (*b*, *c*), as not a particle of proof is offered to sustain his assertions. It is apparent from his language that he felt his attempt here was a failure, but it was necessary to offer something on the point in behalf of his theory. Why 54 was given as the number of this great cycle, which begins with the day 4 Ahau 8 Cumhu, is apparent from the great-cycle column of his "Perpetual Chronological Calendar"; but his reason for beginning the series with 4 Ahau 13 Yax will be referred to farther on.

In order to make clear what is stated below in regard to the forms and details of the symbols of the great cycle, katun, etc., a number of the types of the great-cycle symbol are shown in figure 162; of the ahau in figure 163; of the katun in figure 164; and of the cycle in figure 165.

That this symbol—several varieties of which are shown in figure 162 (also seen in figure 160, and as initials in plates LXXI–LXXIII, LXXV, LXXVI, and LXXVIII, and figures 146, 147, 151, and 158)—is built up from, or based on, the 360-day or ahau symbol of the ordinary form, as shown in number 9, figure 163, is evident. The katun symbol of the ordinary type (*k*, figure 164), has the same body form as the ahau symbol, but there is added a superfix consisting of a comb-like figure on each side, with a middle character usually resembling a Cauac symbol.

Fig. 162. Types of great cycle symbols from the inscriptions. 1, Stela E, Copan, Maudslay, part 3, plate XLIX; 2, Stela 1, Copan, Maudslay, part 3, plate LXV; 3, Stela D, Quirigua, west side, Maudslay, part 12, plate XXVI; 4, Stela D, Quirigua, east side, Maudslay, part 12, plate XXV; 5, Stela J, Quirigua, Maudslay, part 12, plate XLVI; 6, Stela K, Quirigua, Maudslay, part 12, plate XLIX; 7, Monolithic Animal B, Quirigua, Maudslay, part 11, plate XIV; 8 and 9, Stela C, Copan, Maudslay, part 2, plate XLI (both specimens on this plate); 10, Stela A, Copan, Maudslay, part 2, plate XXX; 11, Altar S, Copan, Maudslay, part 4, plate XCIV; 12, Stela N, Copan, east side, Maudslay, part 4, plate LXXIX; 13, Stela N, Copan, west side, Maudslay, part 4, plate LXXIX, glyph 14, counting from the top; 14, supposed great-cycle symbol from the Dresden codex, plate XLIII.

numbers 2 to 12. Having worked out his system in tabular form, Goodman finds that 4 Ahau 8 Cumhu is the first day of his 54th great

FIG. 164. Types of the katun symbol.

cycle, assuming, as he does, that 4 Ahau 13 Yax was the first day of his grand era. The particular process by which he reached the con-

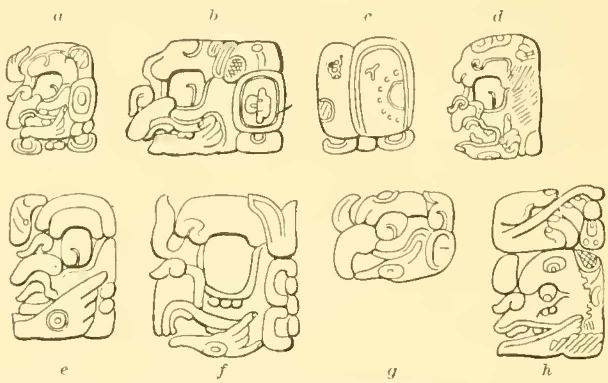


FIG. 165. Types of the cycle symbol.

clusion that 4 Ahau 13 Yax was the initial day of his first great cycle, and hence of his grand era, is not clear. The choice was apparently arbitrary, though it was necessary that the date chosen should make connection with 4 Ahau 8 Cumhu as the first day of a great cycle. His explanation of the grand era, on pages 26 and 27 of his work, shows the relation of the minor periods to it according to his theory, but does not give the reason for selecting 4 Ahau 13 Yax as the initial date. On page 34 he speaks of the date as an important one in the inscriptions, but still does not give the reason for making it the beginning of the grand era.

That any other 4 Ahau, which would bring 4 Ahau 8 Cumhu as the first day of a great cycle, would answer as well as 4 Ahau 13 Yax, even on his theory, is easily shown. As the Mayan time count is an orderly round, a given day recurring at the end of a certain period, it is evident, as everyone acquainted with the system knows, that the count of periods may begin at any point, unless some fixed point in the series is found with its proper number. One check in this respect found in the inscriptions is the fact just mentioned that, according to Goodman's system, 4 Ahau 8 Cumhu appears to be the initial day of a great cycle, and the initial dates of the other great cycles must fit correctly with this determined initial date—that is to say, following his theory and counting 13 cycles to the great cycle, these initial dates must all be a day 4 Ahau. Another possible check is the long series in the Copan inscription, which goes back 14 great cycles preceding that beginning with 4 Ahau 8 Cumhu.

Let us turn to Goodman's "Perpetual Chronological Calendar," to the great-cycle column. Suppose that instead of commencing with the date 4 Ahau 13 Yax, with which he begins the grand era, we begin with 4 Ahau 18 Zotz, the initial day of his 40th great cycle. The series will then be as follows, if we adopt his method of numbering:

73. 4 Ahau 18 Zotz
1. 4 Ahau 18 Cumhu
2. 4 Ahau 13 Kankin
3. 4 Ahau 8 Yax
4. 4 Ahau 3 Xul
5. 4 Ahau 18 Pop
6. 4 Ahau 18 Muan
7. 4 Ahau 13 Zac
8. 4 Ahau 8 Yaxkin
9. 4 Ahau 3 Zip
10. 4 Ahau 3 Kayab
11. 4 Ahau 18 Ceh
12. 4 Ahau 13 Mol
13. 4 Ahau 8 Zotz
14. *4 Ahau 8 Cumhu*
15. 4 Ahau 3 Kankin
16. 4 Ahau 18 Chen
17. 4 Ahau 13 Tzec
18. 4 Ahau 8 Pop
19. 4 Ahau 8 Muan
20. 4 Ahau 3 Zac
21. 4 Ahau 18 Xul
22. 4 Ahau 13 Uo
23. 4 Ahau 13 Pax
24. 4 Ahau 8 Ceh
25. 4 Ahau 3 Mol
26. 4 Ahau 18 Zip
27. 4 Ahau 18 Kayab
28. 4 Ahau 13 Mac
29. 4 Ahau 8 Chen
30. 4 Ahau 3 Tzec
31. 4 Ahau 3 Uayeb
32. 4 Ahau 18 Kankin
33. 4 Ahau 13 Yax
34. 4 Ahau 8 Xul

And so on to the 72d, the next being 4 Ahau 18 Zotz, with which the numbering began.

This will meet every requirement, including the limitations above mentioned, as fully and as completely as the series given by Goodman, even if we hold to his theory of 13 cycles to the great cycle and 73 great cycles to his grand era, and follow his own method of counting. The same thing is true if we select, as the first great cycle, any other of the 40 which precede that with which we began the count.

There is another fact which appears to conflict with Goodman's theory and, indeed, to be irreconcilable with it. According to this theory, the grand era, consisting of 136,656,000 days, is the least common multiple of all the different factors of the regular calendar as well as of his chronological calendar, at the beginning of which all the periods start anew on their grand round. That this number is the common multiple of all these periods or factors is true. But how are we to reconcile the theory with the fact that he begins this great era with the day 4 Ahau 13 Yax, which is certainly not the beginning day of a year or of a month? It is true the 136,656,000 days is an exact multiple of 365, but, starting the count of 365 with the day 4 Ahau 13 Yax makes the latter number a mere numeral factor; no regular Mayan year could begin with the day 4 Ahau or with the 13th day of the month Yax. From February 1, 1899, to the following January 31, in our time system, is a year's time, but the period is composed of parts of two calendar years.

Goodman's theory, in order to be correct and keep the time periods in proper order, if his grand era is a true and absolute rounding-out period of all the minor periods, absolutely requires that this great period shall begin with the 1st day (or 20th if he prefers this numbering) of the month Pop, and the first year of the 52-year cycle or calendar round. Otherwise, when the era ends, it will be in the middle of a year, as it will if it begins on 4 Ahau 13 Yax, and closes with 3 Cauac 12 Yax.

The question next in importance is, are his tables correct, though based on an erroneous theory? Those of the first series, termed the "Archaic Annual Calendar," are nothing more than the ordinary calendars of the 52 years of what has heretofore been termed a "cycle," but to which he applies the name "calendar round," each year being given separately. They are all contained in my condensed calendar. This is nothing new, as the method had been in use for a number of years before Goodman commenced his investigations. As his "Archaic Chronological Calendar" is nothing more than a continuous series of ahaus, or 360-day periods, using Ahau as the "initial day" through 39 of the 5th order of units, following one another in regular succession, it is correct—with certain exceptions to be noted—where Ahau is used as the initial day in the count, but will not apply when any other day is selected as the initial date. It is erroneous in counting 13 of the cycles or the 5th order of units to the next higher order, and in beginning the numbering of the so-called periods with 73, 13, and 20. His tables of years are also erroneous in the latter respect.

It is apparent to anyone at all acquainted with the Mayan time and numeral systems that, having a continuous series of days written out in regular order and of sufficient length, with the day numbers and month numbers attached, we may start at any point and count off the numbers given in the ahau, katun, and cycle periods, and we will have precisely what is given in Goodman's "Archaic Chronological Calendar," except that we may have some other initial day than Ahau. If it should be Kan it would at some point correspond exactly with the series of the Dresden codex which have been referred to; if Ahau, then the periods would agree with those of the inscriptions and some of those in the Dresden codex. Now, it is evident that in counting off a number in the next higher group above the so-called cycle, if we count off the latter periods by 20, instead of 13, the succession would be as regular as in the other case, there being nothing whatever in the system requiring or even suggesting 13. Hence we might take Goodman's tables, if more extended, and making 4 Ahau 8 Cumhu our starting point, count forward or backward by steps of 20 cycles each, and thus find the correct initial days of the great cycles as we have shown above. With the tables given in his work we can only count forward from the beginning of his 54th great cycle to the 7th cycle of the 55th great cycle as he has numbered them, showing that 10 Ahau 13 Yaxkin is the beginning day of the next great cycle, counting 20 cycles to the great cycle, which I have shown to be the correct method.

I shall not discuss Goodman's theory of the number values of the day and month symbols, as there does not appear to have been any use made of them as numerals.

Let us turn again to the order in which the numbers of the ahaus follow one another, to wit: 13, 9, 5, 1, 10, 6, 2, 11, 7, 3, 12, 8, 4, 13, etc. This has been fully discussed in one light in this paper, but the object at present is to view it in another light and with special reference to Goodman's theory in regard to it. That has also been noticed to some extent in my previous paper, but there are some points omitted in that discussion to which it is desirable to call attention. I quote in full Goodman's statement of his discovery of the order of succession:

Ymix is the day following Ahau: hence, I reasoned to myself, if a period begin with the former it must terminate with the latter; moreover, 1 succeeding 13 in the day count, if 1 Ymix begin a period 13 Ahau must end it; and, further, this period being composed of 13 lesser ones of 20 years each, it is at a distance of 260 years apart in the annual calendar that I must look for a corresponding 1 Ymix and 13 Ahau, recollecting that I need not expect to find them falling on any fixed date. But, as the order of the 13 subdivisions is given, with the terminal Ahau numbers, it is not necessary to attempt so extended a research, and prudence dictates that I keep my experiments within the narrowest possible limits to guard against mistake. I will, therefore, at the start proceed only to the end of the first 20-year period, or katun, and look for 11 Ahau. The trial is made. It proves abortive, as I anticipated. The Ahau number at the end of 20 years is 7 instead of 11. The desired 11 Ahau is 5 months away to the left. It is the same old story of failure over again. But wait a minute! Five months are equivalent to 100 days. To divide by 20 would take just 5 days from each of the 20 years of the katun. Years? What if they were not years at all that Landa was talking about, but only periods of 360 days? They may be the ahaus. Let me hasten to find out how the numbers will run in a division of this possible Katun into 20 such periods. Here it is: 9, 5, 1, 10, 6, 2, 11, 7, 3, 12, 8, 4, 13, 9, 5, 1, 10, 6, 2, 11. Ah, this is significant! That paragraph of Perez, what are its exact words? "The Indians of Yucatan had yet another species of cycle, but as the method followed by them in using it can not be found, nor any example by which an idea of its nature might be imagined, I shall only copy what is literally said of it in a manuscript, viz: 'There was another number which they called *ua katun*, and which served them as a key to find the katuns. According to the order of its march it falls on the days of the *uayeb yaab* and revolves to the end of certain years: katunes 13, 9, 5, 1, 10, 6, 2, 11, 7, 3, 12, 8, 4.'" Poor Don Pio! To have the pearl in his grasp and be unaware of its pricelessness, like so many others. But I must not exult too much yet. The succession of the katuns, reckoned according to this principle, is yet to be ascertained before my fancied discovery can be established by a crucial test. I score the ahaus off in the foregoing order, and, sure enough, the 20ths give the desired result, 11, 9, 7, 5, 3, 1, 12, 10, 8, 6, 4, 2, 13. Eureka! The perturbed spirit of the Maya calendar, which has endeavored so long to impart its message to the world, may rest at last.

That taking the day numbers of the first days of the ahaus in a katun will give the order of succession mentioned is certainly true, as we have shown, but the question to be discussed here relates to the statement of the authority quoted by Perez. According to this statement as given by Goodman, "There was another number which they called ua katun, and which served them as a key to find the katuns. According to the order of its march it falls on the days of the uayeb yaab, and revolves to the end of certain years; katunes 13, 9, 5, 1, 10, 6, 2, 11, 7, 3, 12, 8, 4."

It will be best, however, to give Perez's exact words as found in the appendix to Brasseur's edition of Landa's "De las Cosas," page 418:

"Habia otro número que llamaban *Ua Katun* el que les servia como llava para acertar y hallar los katunes, y segun el orden de sus movimientos cae á los dos dias del *Uayeb haab* y dá su vuelta al cabo de algunos años: Katunes 13, 9, 5, 1, 10, 6, 2, 11, 7, 3, 12, 8, 4."

Brasseur's translation is as follows:

"Ils avaient un autre chiffre qu'ils appelaient *Ua Katun*, qui leur servait comme de clef, pour ajuster et trouver les katun et suivant l'ordre de ses mouvements, il tombe aux deux jours du *Uayab haab* et retourne à la fin de quelques annees: Katun 13, 9, 5, 1, 10, 6, 2, 11, 7, 3, 12, 8, 4."

A closer translation than that by Goodman, which omits one important word, may be given as follows:

They have another number which they called ua katun, which served them as a key to regulate and find the katuns, and according to the order of its movements falls on the two days of the uayeb haab and returns at the end of certain years; katuns 13, etc.

The important word omitted by Goodman and which is usually omitted in English translations is the "two." Brasseur's translation contains it, and Perez recognizes it by his (erroneous) reference on the same page as the passage quoted, the "second" intercalary day. I called special attention to this important word in my "Study of the Manuscript Troano," page 55.

Now, it is certain that the unknown author of this passage was somewhat familiar with the Maya time system, otherwise he could not have hit upon this order of numbers which is found in at least three different relations in the system; and it is also certain that his reference is to true Mayan years (as is shown by the reference to the uayeb haab, or five intercalated days), and can not be made to apply to Goodman's ahaus.

As the term "years" in the passage quoted can have no other possible meaning than that of 365 days, the question arises, what is meant by the term "katun" as therein used? That it could not be Goodman's katun of 7,200 days, or 20 ahaus of 360 days each (which Seler also claims to have discovered), is evident. Although we may not be able to demonstrate what is meant by the term in this connection, we can show where and how this order of succession occurs, using the last of the intercalated days. As the number of the day with which the year ends is the same as that with which it begins, the order will be precisely the same as that in which the years are numbered. If the calendar of the inscriptions and the Dresden codex is used, whose dominical days are Akbal, Lamat, Ben, and Ezanab, the terminal days will be Manik, Eb, Caban, and Ik, and their numbers in the successive years will be as shown in the following table, which extends through the cycle of 52 years, after and before which the same series will be repeated:

Manik	Eb	Caban	Ik
1	2	3	4
5	6	7	8
9	10	11	12
13	1	2	3
4	5	6	7
8	9	10	11
12	13	1	2
3	4	5	6
7	8	9	10
11	12	13	1
2	3	4	5
6	7	8	9
10	11	12	13

Beginning at the bottom and running up the right-hand column, we find precisely the order of succession given in the quotation, to wit, 13, 9, 5, 1, 10, 6, etc. Precisely the same order will be found by running up either of the other columns. Each step, it is true, covers four years, but it forms a basis for easy and ready counting; moreover, the quotation says, "returns at the end of certain years." It does not say the "numbers" which so return are katuns, but that they "served as a key to find the katuns," clearly distinguishing between the "katuns" and "certain years." There is nothing, therefore, in the quotation which implies that the numbers in the series 13, 9, 5, etc., were the numbers of the katuns, nor is there any mention therein of the numbers of the katuns or of the number of years constituting a katun. It is to Landa that we must go for information on the latter point. According to his statement, which has been oft repeated, the Mayas counted their ages by 20 years,[a] but he says nothing in reference to the order of numbering.[b]

As the periods referred to are unquestionably years, the katuns must be periods of years; and writers who have so contended are correct in this respect, and 20 years is the number assigned to a katun by all the early authorities, whether right or wrong.

The direction of counting, it is true, is backward, but, as Goodman states, the reference among the Mayas is generally to past time, and the example Landa gives of counting time, in connection with the passage referred to, relates to what had passed. He says an elderly man of whom he had spoken could easily count back 300 years by means of the katuns or ages. This author, if I rightly understand his language, indicates that they had a still higher count of 13 × 20 years. His language is as follows:

> No solo tenian los indios cuenta en el año y meses, como queda dicho, y señalado atras pero tenian cierto modo de contar los tiempos y sus cosas por edades, las quales hazian de veynte en veynte años, contando XIII veyntes con una de las XX letras de los meses que llaman *Ahau*, sin orden sino retruecanados como pareceran en la siguiente raya redonda; llaman les a estos en su lengua *Katunes*.[a]

Thirteen times 20 is 260, or five cycles of 52 years each, the same number of years that there are days in their so-called sacred year. Possibly, however, he may refer here to the 260-day period.

When we free our minds entirely from any thought that ahaus, katuns, etc., represent or have any relation to time periods, and look upon them merely as numbers, just as we think of tens, hundreds, etc., the difficulties raised by Goodman's theory of a Maya "chronological calendar" vanish. The Mayas of one section, for some historical, traditional, or mythological reason, selected a particular initial date for their era, and, as a usual thing, counted long periods from it, and in doing so used numbers in accordance with their numeral system, and represented these in their inscriptions by certain symbols. This is all of Goodman's supposed wonderful chronological system—this and nothing more.

It would have been much better if he had used the real Mayan numeral terms as they stand (as Dr Brinton has suggested), or in a

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[a] Landa, De Las Cosas, p. 312.

[b] It will doubtless be recalled that in the "Study of the Manuscript Troano" I contended that the ahaus or katuns consisted of 24 years, basing my conclusion on the order given above; but a more careful study of the passage quoted above from Perez does not necessarily indicate that these periods were numbered according to the order given.

modified form, to indicate the variation of time numeration from the regular vigesimal system, thus:

20 units	= 1 kal in place of chuen.
18 kal	= 1 bak in place of ahau.
20 bak	= 1 pic in place of katun.
20 pic	= 1 calab in place of cycle.
20 calab	= 1 kinchil in place of great cycle.
20 kinchil	= 1 ahau in place of grand era.

It is true that above the kal the numbers would vary from the true vigesimal count in consequence of counting but 18 instead of 20 kal to the next higher order. This, however, might have been shown by prefixing "minor," thus, "minor bak," "minor pic," etc., but no real confusion would have resulted from using the simple names as Brinton has suggested. Seler suggests "uinal" in place of chuen; "tun" in place of ahau, but retains "katun" as applied by Goodman.

THE CAKCHIQUEL CALENDAR

If the "Annals of the Cakchiquels," written or supposed to have been written soon after the Spanish conquest by a member of the Xahila family, are to be trusted in regard to the Cakchiquel calendar system, this system was peculiar, differing in some important respects from that of the Mayas, which has been described in the preceding part of this paper. All that is known in regard to its peculiar features is found in these Annals, and must be gathered from incidental mention of dates. In order to place the data before the reader, I quote the more important of these mentions from the translation by Dr Brinton in the Library of Aboriginal American Literature, VI, "The Annals of the Cakchiquels," 1885.

As a noted revolt, described as the "revolt at Iximche," is selected by the author of the Annals as the era from which to reckon all subsequent events, we begin the quotations with the passages referring to and fixing the date of this event.

(1) The day of the revolt was appointed by this chief, Cay Hunahpu, and on this day, 11th Ah, the revolt broke out [page 157].

(2) Thirty-one days after the revolt, as the Quiches desired to destroy those of Tibaqoy, these Tukuches removed to Chiavar and put to death the Quiches, who yielded in a battle at a place named Yaxontzui, on the day 9th Caok [page 159].

(3) On the 36th day after the revolt Cinahitoh perished . . . on the day 11th Can [ibid.].

(4) One year less ten days after the revolt was hanged the chief orator Ahmoxnay on the day 11th Akbal [ibid.].

(5) The day 8 Ah was one year after the Revolt [page 161].

(6) The day 5 Ah was two years after the Revolt [ibid.].

(7) The day 2 Ah was three years after the Revolt [ibid.].

(8) The day 12 Ah completed the fourth year after the Revolt [ibid.].

(9) The 9 Ah completed the fifth year after the Revolt [page 163].

(10) The 6 Ah completed the sixth year after the Revolt [ibid.].

(11) On the 3 Ah there were seven years from the Revolt [ibid.].

(12) In the eighth year after the revolt, the Tzutuhils were defeated by those of Xeynup and Xepalica; they were slaughtered, Zakbin and Ahmak having perished in the action on the day 13 Ahmak [ibid.].

(13) On the day 13 Ah there were eight years from the revolt [ibid.].

(14) On 10 Ah there were nine years from the revolt [ibid.].

(15) Twelve days were lacking to complete the tenth year after the revolt . . . the day 8 Imox [ibid.].

(16) The day 7 Ah completed the tenth year after the Revolt [ibid.].

(17) On 4 Ah there were eleven years after the Revolt [ibid.].

(18) On 1 Ah there were twelve years [ibid.].

(19) On 11 Ah there were thirteen years after the Revolt [ibid.].

(20) The day 8 Ah completed the 14th year after the Revolt [page 165].

(21) The day 5 Ah completed the 15th year after the Revolt [ibid.].

(22) The day 2 Ah completed the 16th year after the Revolt [ibid.].

(23) The day 12 Ah completed the 17th year after the Revolt [page 167].

(24) The day 9 Ah completed the 18th year after the Revolt [ibid.].

(25) On the day 3 Caok the doves passed over the city of Iximche. . . . One hundred days after the doves had been seen the locusts came . . . on the day 2 Yg [ibid.].

(26) The day 8 [6?] Ah completed the 19th year after the Revolt [ibid.]

(27) The day 3 Ah completed one cycle [page 169].

(28) With the day 13 Ah another year was completed [ibid.].

(29) A second year was completed on the day 10 Ah, after the Revolt [ibid.].

(30) On the day 7 Ah was completed the third year of the second cycle after the Revolt [ibid.].

So far the dates given are in regular succession as found in the Annals; the others given are only those which are considered important.

(31) On the day 14 [12?] Camey died the King Hunyg [page 171]. . . . A hundred days after the death of the kings Hunyg and Lahuh Noh, there were elected as kings Cahi Imox and Belehe Qat, on the day 1 Can [page 173].

(32) Twenty days after the chiefs began to rule there was an insurrection . . . on the day 10 Queh [page 175].

(33) We married your mother, O my children, one year after the death of your grandfather [Hunyg]. We took her to wife on the day 12 Toh [pages 175–177].

(34) On the day 5 Ah was the eighth year of the first [second] cycle. It was during this year [meaning the year following?] that the Castilians arrived. . . . On the day 1 Ganal the Quiches were destroyed by the Castilians. . . . On the day 4 Qat three chiefs, the king and the next in rank, were burned alive by Tunatiuh [page 177].

(35) It was on the day 1 Hunahpu when the Castilians arrived at Iximche with their chief, Tunatiuh. . . . Only five days after, Tunatiuh went forth from the capital. Then the Tzutuhils were conquered by the Castilians. It was the day 7 Camey [page 179].

(36) Twenty-five days afterwards Tunatiuh went forth from the capital to Cuzcatan . . . On the day 2 Queh Atacat was slain . . . On the day 10 Hunahpu he [Tunatiuh] returned from Cuzcatan. He had been absent only 40 days [page 181].

(37) Our city [Iximche] was abandoned on the day 7 Amak . . . Ten days after we had left the city, war was begun by Tunatiuh . . . on the day 4 Camey . . . One hundred and eighty days after the desertion of the city was completed the ninth year (of the second cycle). On the day 2 Ah was completed the 29th year after the Revolt [page 183].

(38) There were lacking 120 days to complete two years since we had abandoned the capital when Tunatiuh came there in order to set fire to the city. On the day 4 Camey, two years less six months after the beginning of the war, he set fire to the capital and returned [page 185].

(39) On the day 12 Ah was completed the 30th year after the Revolt [ibid.].

(40) On the day 9 Ah was completed the 31st year after the Revolt [ibid.].

(41) In the course of the following year . . . Chiixot was abandoned. . . . Three hundred days after Chiixot was taken began the payment of tribute . . . on the day 6 Tzi [pages 185–187].

(42) It was two years less 120 days after the beginning of the tribute when died the chief Ahtun cuc Tihax . . . on the day 6 Akbal. . . . On the day 3 Ah was completed the 33d year [page 187].

(43) For 86 days these chiefs had hid in the woods. . . . On the day 7 Ahmak the chiefs decided to come forth. . . . On the day 13 Ah was completed the 36th [34th] year after the Revolt [page 187].

(44) On the 10th Ah was completed the 35th year after the Revolt. Forty days were lacking to complete three years from the date of the submission of the kings when Belehe Qat died . . . on the 7th Queh [page 188].

(45) On the 8th Ah was completed the 40th year after the revolt. On the 5th Ah was completed the first year of the third cycle [page 189].

(46) It was on the day 11 Ahmak that he [Tunatiuh] killed the Ah-tzib. On the day 2 Ah was completed the second year of the third cycle. One hundred and twenty days after the death of Ahtzib and of the return of Tunatiuh, the prince Mantunalo departed . . . Two hundred and sixty days after his return Tunatiuh hanged the king Ahpozotzil Cahi Imox, on the day 13 Ganel [pages 189–190].

(47) The day 12 Ah completed the third year of the third cycle. Two hundred and eighty days after the execution of the king Ahpozotzil he hanged Chuvy Tziquinu . . . on the day 4 Can [page 190].

(48) On the day 9 Ah was completed the fourth year of the third cycle after the revolt. . . . On the day 2 Tihax . . . the wife of Tunatiuh was drowned. One hundred and sixty days after this disaster there arrived our fathers of St. Dominic . . . on the day 12 Batz [page 190].

(49) On the day 8 Ah was completed the 13th year of the third cycle. . . . Ahtzil Juan Perez . . . died on the day 12 Tihax. Eighty days after . . . there was an eruption of the mountain Chigag . . . on the day 9 Ah . . . On the day 12 Ah was completed the 16th year of the third cycle [page 192].

(50) Died the chief Don Francisco Ahpozotzil . . . on the day 1 Can, a Monday, the 14th day of the month October [page 193].

(51) On the day 6 Ah was completed the 18th year of the third cycle. . . . In the 13th month the day of Sanctiago occurred on the day 1 Tziquin. . . . On that day was inaugurated . . . the Emperor Don Peliphe. . . . The day St. Francis [was] the day 7 Camey [pages 193–194].

(52) On the day 3 Ah was completed the 19th year of the third cycle after the revolt. The Alcaldes in the year 1557 were . . . The day 5 Ey [was] 20 days before the close of the third cycle. . . . On the day 13 Ah was completed the third cycle . . . in the year 1558 [page 194].

The foregoing notes and quotations contain, it is believed, all the data found in the "Annals" throwing any light on the Cakchiquel calendar. But in order that the reader, who may not have the works relating to this calendar at hand, may be furnished with the data necessary to follow me in my discussion, I introduce here a list of the days of this calendar in the order usually given, with those of the Maya calendar placed beside them in corresponding order.

Days of the Cakchiquel and Maya Calendars

	Cakchiquel days	Maya days		Cakchiquel days	Maya days
1	Imox	Imix	11	Batz	Chuen
2	Ig or Yg	Ik	12	Ee	Eb
3	Akbal	Akbal	13	Ah	Ben
4	Kat	Kan	14	Yiz	Ix
5	Can	Chicchan	15	Tziquin	Men
6	Camey	Cimi	16	Ahmak	Cib
7	Queh	Manik	17	Noh	Caban
8	Kanel	Lamat	18	Tihax	Ezanab
9	Toh	Muluc	19	Caok	Cauac
10	Tzii	Oc	20	Hunahpu	Ahau

As the author of the Annals ends the year with the day Ah, it must have begun with Yiz, if there was no arbitrary change in the succession of days. The following condensed calendar is therefore constructed on this basis as a means of counting time:

Cakchiquel Calendar

1 Yiz	1	8	2	9	3	10	4	11	5	12	6	13	7
2 Tziquin	2	9	3	10	4	11	5	12	6	13	7	1	8
3 Ahmak	3	10	4	11	5	12	6	13	7	1	8	2	9
4 Noh	4	11	5	12	6	13	7	1	8	2	9	3	10
5 Tihax	5	12	6	13	7	1	8	2	9	3	10	4	11
6 Caok	6	13	7	1	8	2	9	3	10	4	11	5	12
7 Hunahpu	7	1	8	2	9	3	10	4	11	5	12	6	13
8 Imox	8	2	9	3	10	4	11	5	12	6	13	7	1
9 Ik	9	3	10	4	11	5	12	6	13	7	1	8	2
10 Akbal	10	4	11	5	12	6	13	7	1	8	2	9	3
11 Kat	11	5	12	6	13	7	1	8	2	9	3	10	4
12 Can	12	6	13	7	1	8	2	9	3	10	4	11	5
13 Camey	13	7	1	8	2	9	3	10	4	11	5	12	6
14 Queh	1	8	2	9	3	10	4	11	5	12	6	13	7
15 Kanel	2	9	3	10	4	11	5	12	6	13	7	1	8
16 Toh	3	10	4	11	5	12	6	13	7	1	8	2	9
17 Tzii	4	11	5	12	6	13	7	1	8	2	9	3	10
18 Batz	5	12	6	13	7	1	8	2	9	3	10	4	11
19 Ee	6	13	7	1	8	2	9	3	10	4	11	5	12
20 Ah	7	1	8	2	9	3	10	4	11	5	12	6	13

In using this to count forward, we count on to the end of the right-hand column and then go back to the left-hand column. To count backward, the direction is reversed.

It will be observed from the quotations given that the years all end with the day Ah, that the numbering of the days is by 1 to 13 as usual, and that the terminal Ahs of the years succeed one another in the following order: 11 Ah, 8 Ah, 5 Ah, etc., giving the descending series 11, 8, 5, 2, 12, 9, 6, 3, 13, 10, 7, 4, 1, 11, 8, etc., the number of any given year being 3 less than that of the one which preceded.

It is apparent, therefore, that the year could not have consisted of

365 days, that is, of 18 months of 20 days each and 5 added days, for even the supposition that these added days were neither numbered nor counted does not give the order found in the Annals. Nor will Goodman's supposition that they counted 366 days to the year give this succession, though he counts the system alluded to in the Annals as distinct from the Cakchiquel Annual Calendar. Brinton says:

> The calendars in use were of two different kinds, the one called *qhol kih*, literally "the valuer or appraiser of days," which was employed exclusively for astrological and divining purposes, to decide on which were lucky and unlucky days, and *may kih*, "the revolution or recurrence of days," which was for chronological purposes.[a]

I find no other explanation of a calendar which would end in the manner mentioned in the Annals, than a year of 20 months of 20 days each, or 400 days, the days being numbered in the usual Mayan method of 1 to 13. Seler[b] gives this explanation and Goodman also adopts it for their chronological year. That if we count this number of months to the year the different years will end on the same day is evident, and that the day numbers will follow one another in the order mentioned above can be seen by reference to the above condensed calendar. If we count 20 months, the year beginning with 1 Yiz will end with 10 Ah, and the next year will begin with 11 Yiz; or if we commence with the column headed 11, and count 20 months, the year will end with 7 Ah, and the next year will begin with 8 Yiz; if we commence with the column headed 8, and count 20 months, the year will end with 4 Ah, etc. This appears to be the only explanation of this singular calendar, if we suppose the annalist to be correct in his statements as to the dates on which the years ended.

As proof that the annalist counted 400 days to the year we have the following evidence from the above quotations: By number 1, we learn that the Revolt, which he takes as the beginning of his era, took place on 11 Ah; by number 5 we see that the first year of the Revolt ended on 8 Ah; in number 4 it is stated that "One year less ten days after the revolt was hanged the chief orator Ahmoxnoy, on the day 11 Akbal." The day 11 Akbal will occur twice only in the ordinary year of 365 days, and twice only in the year of 400 days. As the Revolt occurred on 11 Ah, the first year thereafter must have begun with the day 12 Yiz. The day 11 Akbal would occur first at the end of 6 months and 10 days—or 130 days. That 10 days added to this could not have completed the year will be conceded. The next occurrence of 11 Akbal would be at the end of 19 months and 10 days, or 390 days, 10 days more reaching the day 8 Ah, the end of the first year. Although neither 140 nor 400 days correspond with any natural phenomena it is safe to assume that 400 days was the period the annalist referred to and not 140 days.

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[a] Annals of the Cakchiquels, Philadelphia, 1885, p. 31.

[b] Transactions Berlin Anthropological Society, June, 1889.

In number 15 it is stated that 12 days were lacking to complete the tenth year after the Revolt, etc., on the day 8 Imox; and in number 16 that the day 7 Ah completed the 10th year. As it is stated in number 14 that 10 Ah was the end of the 9th year after the Revolt, 8 Imox would occur 128 and 388 days thereafter. Counting 12 days from the latter brings us to 7 Ah and gives 400 as the number of days in the year. This result must be accepted, or we must decide that the year consisted of only 140 days, which is unreasonable. In number 24 it is stated that 9 Ah completed the 18th year after the Revolt, and in number 26 that 8 (?) Ah completed the 19th year (that this should be 6 Ah is evident, as 9 Ah precedes and 3 Ah (number 27) follows it). In number 25, which relates to the 19th year, it is stated that on the day 3 Caok the doves passed over the city of Iximche; and that 100 days after the doves had been seen the locusts came, on the day 2 Yg (or Ik). Now, the first occurrence of 3 Caok in the 19th year after the Revolt, that is, the year following 9 Ah (the year beginning with 10 Yiz), is 2 months and 6 days after the commencement of the year. One hundred days more bring us to 12 Caok, the 6th day of the 8th month, or 7 months and 6 days from the commencement of the year. This is not the day given, but counting 4 days more we reach 2 Yg or Ik, the day named. As 100 is a round number, the 104 may be assumed as correct. As this, even if the number be limited to 100, gives more than 140 days in this year we have evidence that a year of 400 days was counted by the annalist.

In numbers 31 and 32, and two or three items not given in the quotations, we have conclusive evidence that 400 days were counted to the year by the Annals. They are as follows:

> 1 Ah completed the 5th year of the second cycle (25th year) after the revolt (page 171).
>
> In the following year, ending on 11 Ah, Hunyg died on 12 Camey. (ibid. Brinton's translation gives 14 Camey, but this is wrong, as there could be no 14 Camey; the original says 12).
>
> 100 days after was the day 1 Can (page 173).
>
> 20 days later was 10 Queh (page 175).
>
> The day 11 Imox follows in this year (ibid.).
>
> The day 9 Batz occurs after this same year (ibid.).
>
> The year ends on 11 Ah (ibid.).

As the preceding year ended on 1 Ah, this year began with 2 Yiz, and 12 Camey would be the 13th day of the 12th month. One hundred and twenty days more (or exactly 119) and not 100, as the annalist says, would reach 1 Can, the 12th day of the 16th month; 22 days more would reach 10 Queh, the 14th day of the 17th month. The day 11 Imox would be the 8th day of the 18th month, and 9 Batz the 18th day of the 20th month, just two days before 11 Ah, the close of the year.

In the year following 5 Ah (number 34), that is to say, the year beginning with 6 Yiz, the following events, with dates, are mentioned (numbers 35, 36, and 37):

> On 1 Ganel the Quiches were destroyed.
> On 4 Quat the chiefs were burned by Tunatiuh (Alvarado).
> On 1 Hunahpu the Spaniards reached Iximche.
> Five days after, Tunatiuh left the capital; then the Tzutuhils were conquered on 7 Camey.
> Twenty-five days afterward Tunatiuh went forth to Cuzcatan and slew Atacat on the day 2 Queh. On 10 Hunahpu he returned, having been absent 40 days.
> Iximche was abandoned on 7 Amak.
> Ten days after, on 4 Camey, Tunatiuh began war.
> One hundred and eighty days after the city was abandoned the 29th year after the revolt was completed on 2 Ah.

The day 1 Ganel (or Kanel) was the 15th day of the 2d month; 4 Quat (or Kat) was the 11th day of the 3d month; 1 Hunahpu the 7th day of the 5th month. "Five days after" should be 6 to reach 7 Camey, the 13th day of the 5th month. "Twenty-five days afterwards" (after 7 Camey) should be 21 to reach 2 Queh, 14th day of the 6th month, and 10 Hunahpu is the 7th day of the 10th month, hence the 40 days, if counted from 2 Queh, would be wrong. The 7 Amak would be the 3d day of the 12th month, and 4 Camey the 13th day of the 12th month. From 7 Amak, the day Iximche was abandoned, to 2 Ah, the end of the year (still counting 400 days), was only 177, the round number given by the annalist being 180.

These items of evidence are sufficient to prove, beyond any reasonable doubt, that the annalist counted 400 days to the year, and that the years of the calendar which he used always began with the day Yiz. The beginning and ending days of the years would therefore be as follows if we start with 12 Yiz, the first year after the Revolt:

Beginning day Yiz	Ending day Ah	Beginning day Yiz	Ending day Ah
12	8	1	10
9	5	11	7
6	2	8	4
3	12	5	1
13	9	2	11
10	6	12	8
7	3	and so on.	
4	13		

The next question that arises, and the one of most importance in the discussion, is this: Was the writer justified in indicating that such a calendar as this was in use among the Cakchiquels at the coming of the Spaniards? On this point we must judge chiefly by internal evidence. As what is known in regard to the history of the manuscript is given by Brinton in his introduction, it is unnecessary to repeat it here. The writer claims to have been a descendant (grandson) of the ruling chief of the Cakchiquels at the time of the arrival of the Spaniards, and was then a youth of probably some 16 or 18 years. Judging by his method of giving dates, he seems to have been familiar with a calendar then in use. Moreover his station would indicate that he had been trained in the study of the chronology of his tribe. I am, therefore, inclined to accept as substantially correct his statements so far as they bear on the calendar system, though the traditional portion may be of very little or no historical value. If this view be accepted, it may throw some light on one troublesome feature of the Maya calendar—the introduction of the multiple 18 in counting the months. Why the change from the lunar period to a period of twenty days to the month was made, is not easily accounted for, except on the supposition that, having decided for ceremonial or other reason to abandon the lunar count, it was natural to follow the vigesimal system, hence the 20 days to the month, 20 months to the year, and 20 years to the cycle or ahau. The necessity, however, for some adjustment between the ceremonial and true year brought about at length the adoption of 18 months and 5 added days, and the substitution of 18 in place of 20 in time numeration. It seems possible, if the annalist be correct in his time count, that the peculiar native calendar may have come into use somewhat in this way.

I can find no grounds whatever for Goodman's assertion that the calendar year of the Cakchiquels consisted of 366 days. They may be in a historical mention which I have failed to find, but by no possible means can this year be made to agree with the calendar of the Annals without assuming an arbitrary break in the succession of the days at the end of each year.

MAYA METHOD OF CALCULATION

As I have, in my paper on the "Mexican and Central American Numeral Systems,"[a] brought up the question, How did the Maya priests actually perform their calculations relating to time series, some of them reaching into millions? I propose to discuss the subject somewhat more at length here. As was stated in that paper, these calculations sometimes required changing series of days, chuens, ahaus, katuns, cycles, and even great cycles (or more correctly units of the 1st, 2d, 3d, 4th, 5th, and even the 6th order in the vigesimal system), to years, months, and days, reaching from one given date to another. As such calculations could not possibly have been made mentally, the authors of the inscriptions and codices must have had some method of "ciphering," to use a school-boy term, or of making the calculation by marking on some object. As was stated in the paper referred to, the only allusion to the subject by an early authority, so far as is known, is the statement by Landa that they performed them "on the ground or some flat thing."

[a] Nineteenth Annual Report of the Bureau of American Ethnology.

As the different kinds of symbols used by the Mayas to express numbers have been referred to, I assume that the reader is familiar with them. That direct multiplication and division would seem to be impossible with their characters where both numbers included units above the first order, or, at most, first and second orders, will be admitted. The suggestion by Professor McGee (referred to in the paper on numeral systems) that these operations might have been performed by addition and subtraction seems to be the key to the problem, as I shall attempt to show.

That the Mayas could add and subtract numbers expressed in the ordinary numeral symbols (dots and short lines) is known from hundreds of examples in the Dresden codex; and that for these characters they could readily substitute equivalent symbols of other forms in use is evident. Take, for illustration, part of a series from plate XXIV, Dresden codex (see plate LXXXII), which has been reversed, so that it is to be taken from left to right instead of from right to left, as in the original. The date below each column is written out, and instead of the naught symbol a cipher (0) is inserted:

(1)	(2)	(3)	(4)	(5)	(6)
		.	.	. .	. .
. . .	. —	. . . .	. . —	0	. . .
. .	. . . .	.	. . .	—	. . —
0	0	0	0	0	0
9 Ahau	4 Ahau	12 Ahau	7 Ahau	2 Ahau	10 Ahau

If we write these in Arabic figures, preserving the relative positions and omitting the dates, as those given can be referred to, the series will be as follows:

		1	1	2	2
8	16	4	12	0	8
2	4	6	5 (8)	10	12
0	0	0	0	0	0

Doubling the first column (8–2–0) we get 16–4–0; adding again 8–2–0, we get 1–4–6–0; adding again 8–2–0, we get 1–12–8–0 (the 5 in this column should be 8, as by adding 8–2–0 to it as thus corrected we get 2–0–10–0, the 5th column, etc.).

If we write the equivalent of each number in days, maintaining the same relative positions, and give the sum of each column below (making the correction noted), the result will be as follows:

		7,200	7,200	14,400	14,400
2,880	5,760	1,440	4,320	0	2,880
40	80	120	160	200	240
0	0	0	0	0	0
2,920	5,840	8,760	11,680	14,600	17,520

By adding 2,920 to the first, we obtain the sum of the second column; and adding the same number to the sum of the second, we obtain the sum of the third, and so on. By counting forward 2,920 days from 9 Ahau, the date under the first column, we reach 4 Ahau, the date under the 2nd column, etc.

These primary steps are, of course, well understood by readers who have given any attention to the subject, but it is necessary to present them as leading up to the object in view in the discussion.

• • •

It is evident that • • , or 2,920, is the factor or added number used

0

in this series, but the process is carried on by addition. However, before we proceed, it is necessary to call to mind certain facts in relation to the calendar. The first is that a day of any given name returns at every 20th day, whether we count backward or forward, but not with the same number; the second, that any given day returns with the same day number at every 260th day, whichever way we count, but not in the same month nor on the same day of the month beyond the first year. As each count reaches Ahau in this instance, and 260 is not an even divisor of 2,920, the basal factor must be 20, and the day numbers will be different, as we find them to be. Although we may not be able always to state why particular factors or counters are selected, yet in this case it would seem that 2,920 was chosen because this is exactly the number of days in eight years. As the dates are therefore just eight years apart, they necessarily fall in years having the same dominical day, and, consequently, on the same day of the month. However, these specific features must be understood as applicable to this particular series, and not as of general application, for we shall find series in which there is no reference to the year; but these time periods have a bearing on the practical method used in Maya calculations.

Now, let us see theoretically how, starting with a given date, the initial date of a high series may be reached. Nine cycles and the lower fractional numbers, counting from 4 Ahau 8 Cumhu as the initial date, form the most frequent series of the Copan and Quirigua inscriptions. We will try to form such a series, selecting at random 3 Chicchan 18 Yax, year 1 Lamat, as the terminal date, and 4 Ahau 8 Cumhu as the initial date. As the former date must be the more recent on this supposition, it follows that the count was backward (though this is by no means necessary, as it could be forward as well); so our count in this case will be backward. In order not to make the series too long and tedious, we will select as our factor or sum to be added—

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• • •

0

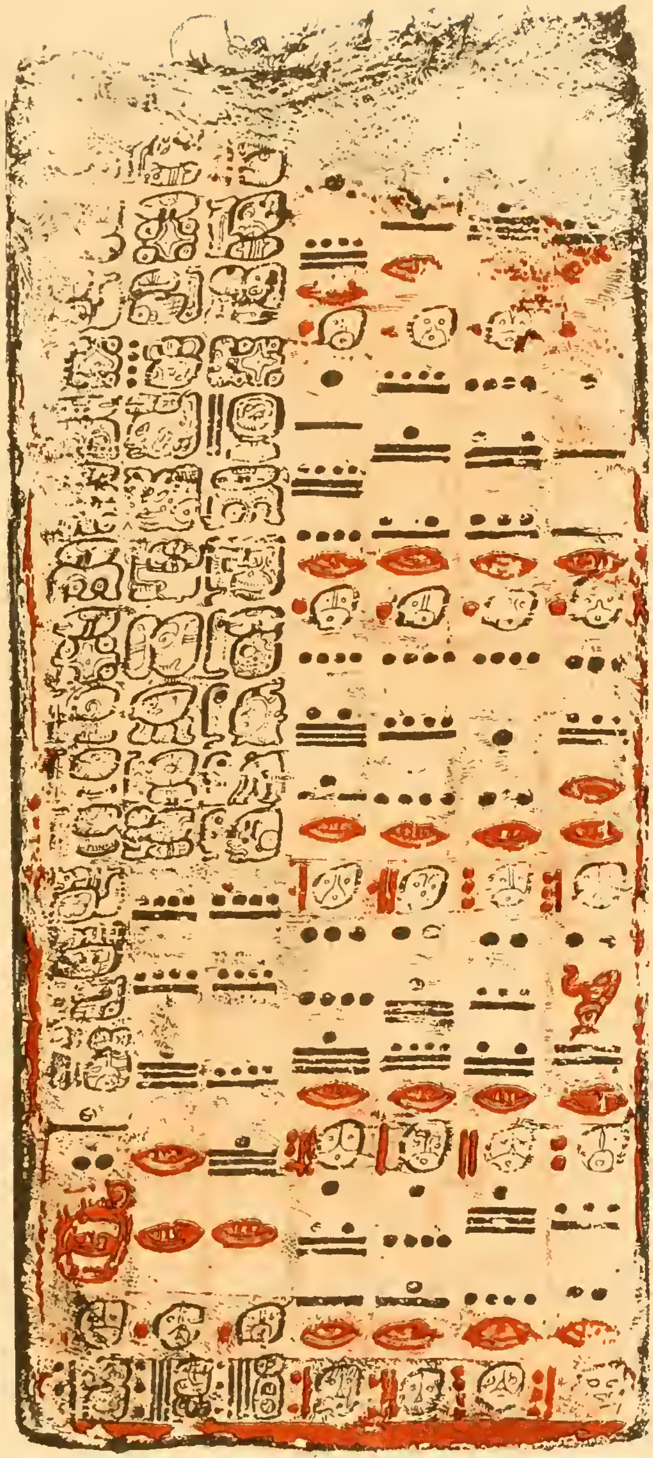
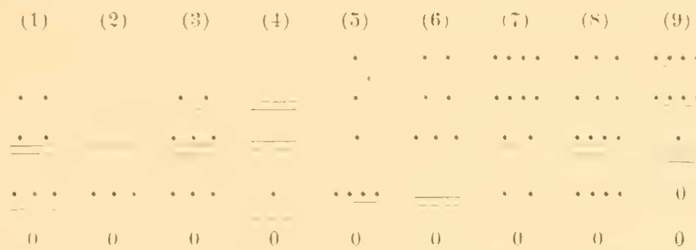


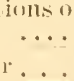
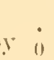
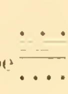
PLATE XXIV OF THE DRESDEN CODEX

This represents a calendar round or cycle of 52 years (18,980 days), the given date (3 Chicchan 18 Yax) returning at the end of this period. For convenience we make the series ascending toward the right, and after a few additions double the columns to make progress more rapid. The usual rule is followed; the counter is given as the first column; the columns are numbered as a means of reference.



The counter or first column is added to itself, or doubled, to form the second; the first is added to the second to form the 3rd; the first to the 3rd to form the 4th; but to hasten the process they are doubled successively from this point to the 8th. As doubling the 8th would raise the number above that contemplated, only the number necessary to give the 9 cycles is added, but this must be the counter (first column) or a multiple of it. The required number is found in the 5th column; this added to the 8th gives the 9th. The sum of the 9th column, if no mistake has been made, should, counting back from 3 Chicchan 18 Yax, bring us again to the same date.

As a count of a cycle of 52 years (our first column) includes the entire series of days and day numbers known to the system, 4 Ahau 8 Cumhu must be contained therein, and the count to it from the date reached must be less than the amount represented by our first column. Our next step, therefore, is to ascertain the lapse of time from our last date (3 Chicchan 18 Yax) to the next preceding occurrence (as we are counting backward) of 4 Ahau 8 Cumhu. Just what method the authors of the inscriptions and codices employed for this purpose, as there are more than one, I can not state positively, but give one which I am satisfied they could follow.

They could readily ascertain, as is shown by almost every numeral series with a date, that the day 3 Chicchan 18 Yax fell in the year 1 Lamat, and 4 Ahau 8 Cumhu in the year 8 Ben; hence they could easily tell, by counting on their fingers or making marks, that from the latter to the former is 18 years and the fractions of the two years—the fraction in the former being 198 days or  and in the latter 17 or . As the year is represented by  the 18 years would be .

By adding to this the  and , or together , we obtain the sum represented by . Add this to the 9th column, the result is the following number, to wit:  or 9 cycles, 10 katuns, 14 ahaus, 15 chuens, 5 days.

If no mistake has been made, this number, if we count back from 3 Chicchan 18 Yax, year 1 Lamat, should bring us to 4 Ahau 8 Cumhu, the first day of Goodman's so-called 54th great cycle. Trial proves it to be correct, thus:

	Days
9 cycles	1,296,000
10 katuns	72,000
14 ahaus	5,040
15 chuens	300
5 days	5
Total	1,373,345
Subtract 72 calendar rounds	1,366,560
Remainder	6,785

Counting back this number of days from 3 Chicchan 18 Yax brings us to 4 Ahau 8 Cumhu. Turning to Goodman's "Chronological Calendar," 54th great cycle, 9th cycle, 10th katun, and 14th ahau, we find the date is 10 Ahau 18 Mac. Fifteen months and 5 days from this just reaches 3 Chicchan 18 Yax. The series is therefore a correct one, formed upon the same plan as those of the Dresden codex, and without using anything not in the reach and comprehension of the aboriginal artist.

The series on plate XXIV of the Dresden codex (our plate LXXXII) appears to close with a minor addition (in the lower left-hand corner) to reach the desired date, just as the theoretic one given above, except that in this case the count is forward. The series includes the right half of the plate, and reads from right to left and by lines from the bottom upward, closing with the lines in the lower left-hand corner. Here the steps have been in part from 1 Ahau to 1 Ahau, hence with 260 as the primal factor. The last column is 9–9–16–0–0, then follows the number 6–2–0, 4 Ahau 8 Cumhu. The latter number changed into days is the lapse of time from 1 Ahau 18 Kayab, the last preceding date, to 4 Ahau 8 Cumhu. However, as there are some unusual features in regard to the additions in a part of this series, attention will again be called to it a little farther on.

In order to show that resort was had to increasing the added number to shorten the process, as was done in the theoretic example, the following example is given from plates LXX and LXXI of the Dresden codex. Ordinary numerals are used in place of the symbols, and the series, which in the codex ascends from right to left, is reversed; the days below the columns are also given:

(1)	(2)	(3)	(4)	(5)	(6)	(7)
			3	5	7	9
15	17	19	18	17	16	15
10	9	9	0	0	0	0
16	18	0	0	0	0	0
9 Oc	9 Eb	9 Ix	9 Ix	9 Ix	9 Ix	9 Ix

It will be seen by subtracting that the difference between the first and second columns and between the second and third is 1–17–2, or 1 ahau, 17 chuens, 2 days, equal to 702 days, while the difference between the 3d and 4th columns is 2–18–9–0, or 2 katuns, 18 ahaus, 9 chuens, 0 days—equal to 21,060 days; and that the difference between the 4th and 5th, the 5th and 6th, and the 6th and 7th is, in each case, 1–19–0–0, or 14,040 days. There is therefore an increase of the added number or factor in passing from the 3d to the 4th column.

It will be noticed that the days below the 1st, 2d, and 3d columns differ, while from this point onward they are all 9 Ix. The change in this respect requires a change in the counter. Why the counter was made larger in passing from the 3d to the 4th column than between the remaining columns is not clear, as the difference between the 3d and 4th columns would have reached the desired day, 9 Ix. It is possible that the month date, though it does not appear, was here taken into consideration. Assuming that the first 9 Ix (under the 3d column) was 9 Ix 2 Pop, year 8 Ben, the count forward of 1–19–0–0 would reach 9 Ix 12 Chen in the year 7 Akbal, while the count forward of 2–18–9–0 would reach 9 Ix 17 Mac, year 13 Ezanab. As the first counter (702) is not a multiple of 260 or of 20, it must have been based on 13, one of the factors of 260. The counters 14040 and 21060 are multiples of 260; and there is possibly something in the fact that the former (14040) is 54 times 260 and that the first counter (702) is 54 times 13. Although we are not able at present to solve all these problems, it is evident that the author of the codex increased the counter as he proceeded, presumably to shorten the process.

The series appears to close with two columns in the upper middle portion of plate LXX, the dates here having the month given. With these (notwithstanding the obliterated portion of the series) we might determine the true dates of the portion given above, and thus possibly solve, to some extent, the problems mentioned; but unfortunately there are so many errors in these two columns that it seems impossible to determine the true numbers and dates. The chuen number, or number in the place of the second order of units, is 18 or 19 (there being a space where one dot may have been obliterated), either of which is wrong. The date below one is 9 Ix 20 Pop, the other is 9 Ix 13 Pax or Tzec, both of which are wrong, as Ix is never the 13th or 20th of the month.

A good example of this method of increasing the counter as the series proceeds is found on plates LXX–LXXIII of the same codex. Although this runs from right to left, we give it here in reverse order and in ordinary figures as follows:

(1)	(2)	(3)	(4)	(5)	(6)
					[1?]
3	6	9	13	16	19[1?]
5	10	15	0	5	10
4 Caban	4 Ik	4 Manik	4 Eb	4 Caban	4 Ik

(7)	(8)	(9)	(10)	(11)	(12)
1	1	1	1	1	2
4	8	11	14	17	3
15	0	5	10	15	0
4 Manik	4 Eb	4 Caban	4 Ik	4 Manik	4 Eb

(13)	(14)	(15)	(16)	(17)
2	2	2	2	3
6	9	11 [12?]	16	1
5	10	15	0	5
4 Caban	4 Ik	4 Manik	4 Eb	4 Caban

(18)	(19)	(20)	(21)	(22)
3	3	3	3	3
4	7	11	14	17
10	15	0	5	10
4 Ik	4 Manik	4 Eb	4 Caban	4 Ik

(23)	(24)	(25)	(26)	(27)
4	4	4	4	4
2	6	9	12	15
15	0	5	10	15
4 Manik	4 Eb	4 Caban	4 Ik	4 Manik

(28)	(29)	(30)	(31)	(32)
			2	3
5	10	15	0	0
1	2	3	8	12
0	0	0	0	0
4 Eb	4 Eb	4 Eb	4 Eb	4 Eb

(33)	(34)	(35)	(36)	(37)
				1
4	5	6	8	0
0	1	1	1	12
16	2	6	10	3
0	0	0	0	0
4 Eb	4 Eb	4 Eb	4 Eb	4 Eb

The figures in parenthesis are merely arbitrary numbers given to the columns as a means of reference. The counter is 3–5, or 65 days, from the first to the 28th column; but here a change takes place; the amount at this point, being 5–1–0, or 1,820 days, is doubled to form the 29th column, and is again added to form the 30th. Here again occurs an increase in the counter, in this case a large one, viz, to 1–5–5–0, or 9,100 days; but at the next step the added number to form the 32nd column is only 1–0–4–0, or 7,280 days, just one-half of the 31st column. This counter is used to the end of the series; however, the 8 in the 36th column is an evident mistake; it should be 7.

The number 65 is a very common counter in this and other codices; in this case 13 is the basal factor. In the other counters 260 is the permanent factor. The first counter, which is just one-fourth of the second, always reaches a day with the same number, though not the same day—but repeating by series of four. However, aside from these questions, we have the fact of the increase of the counter in the process, to show which was the object of calling attention to the series.

Returning now to the series on plate XXIV (our plate LXXII), to which reference has been made, I call attention to the unusual changes in the counter or added number. The series in the fourth tier from the bottom, given in the way adopted above, is as follows:

(1)	(2)	(3)	(4)
			1
1	4	9	5
5	12	11	14
5	8	7	4
0	0	0	0
1 Ahau	1 Ahau	1 Ahau	1 Ahau

The values of the different units and sums of the columns are as follows:

			144,000
7,200	28,800	64,800	36,000
1,800	4,320	3,960	5,040
100	160	140	80
0	0	0	0
9,100	33,280	68,900	185,120

It will be found by trial that the greatest common divisor of these totals is 260, and that it is contained in the first total 35 times; in the second, 126; in the third, 265, and the fourth, 712 times. Although each step must have required long and tedious additions—no two having a common added number or multiple thereof—and the reason for thus varying the added number is not apparent, yet it is evident that the aboriginal scribe chose 260 as the factor to be used, and also that the desired result could be reached by successive additions. In fact, the series and the others we have noticed seem to be mere records of the steps in the process of determining the lapse of time between two widely separated dates.

These examples are sufficient to show that all the series in the codices and inscriptions could have been formed by the aboriginal authors with their numeral symbols by addition and subtraction. It may also be added that the evidence presented to show this is fitted to impress us with the belief that some, if not all, of the series of the Dresden codex are but records of the process of calculation.

There arises in connection with this examination a question, the proper answer to which may, if determined in accordance with a view that has been expressed, have an important bearing on the history of the Mayan tribes.

On several of the plates of the Dresden codex there are what appear to be supplemental series connecting with the so-called "normal date," 4 Ahau 8 Cumhu. However, the discussion of this question will come more appropriately under the next section, which relates to the signification of the series of the inscriptions.

SIGNIFICATION OF THE NUMERAL SERIES

Why were these series formed? What is their signification? These are questions impossible for us to answer satisfactorily with our present knowledge of the subject. It may be possible, however, to limit the inquiry by certain considerations.

Our first question is, Were they intended, by the initial or terminal days, to refer to actual dates bearing some relation to events in the history of the respective tribes to which they pertain? By the term "initial dates" I allude to the dates from which the series (whether initial or minor) were counted, and by "terminal dates" to those which follow the series in counting forward. The latter are assumed to be later in actual time than the former.

That the initial date may be thrown back any desired distance in time is admitted, as for example, we may take as our initial date the beginning of the Christian era (A. D.), or the supposed initial date of the world era (A. M.), or any other beginning date which, through fancy, tradition, or mythology, has been adopted or arbitrarily chosen by different peoples. It is not necessary, therefore, that we should assume that the initial dates of the Mayan codices and inscriptions have any reference to historical or even supposed historical events. That such an assumption would be preposterous is shown by the fact that several of these dates reach back in time 33,000 years, and a large proportion of those of the inscriptions nearly 4,000 years, and others to a still more distant time. The initial dates must therefore relate, as will be conceded, to some assumed date, traditional or mythological, or arbitrarily chosen, according to the fancy of the calculator.

Do the terminal dates refer to events or incidents in the history of the tribes—events which were noted down by the scribes sufficiently near the time of occurrence to give the proper or probable dates thereof?

If we take the terminal dates of the initial series at Quirigua (omitting from consideration those of the minor series) we find the difference between the earliest and latest, with two exceptions to be noticed, is only some 83 or 84 years. This difference is so moderate as to be entirely consistent with the idea that the dates were engraved near the time of the events or incidents to which they refer, if, in fact, this was the object in giving them. The two excepted are numbers 6 and 16 of the list given below. The calculation I give is based on what seem to be the reliable series and dates, leaving out of consideration the exceptional and doubtful series. Comparing the earliest and latest of those at Copan, we find the difference to be about 222 years. This is by no means extravagant, hence the dates may refer to historical events. When we come to those at Palenque, we find the difference—even excluding the most recent date, which Goodman admits is doubtful—to be over 3,800 years. Although a difference in dates as great or greater than this has been found in the inscriptions of the ruins of Egypt and Assyria and accepted as reasonably correct, no archeologist of the present day not carried away by some extravagant theory will believe that inscriptions were chiseled at Palenque at dates 3,800 years apart in actual time, the earliest (counting from the coming of the Spaniards) going back more than 2,200 years before the Christian era.

Now, it is the opinion of Goodman and Seler that the terminal dates of the inscriptions (the latter excepts those at Palenque, as explained below) refer to the times when the monuments were erected or the inscriptions chiseled. The assertion of the former on this point (pages 147–8) is as follows:

Particular emphasis is intended to be laid upon "initial" dates in the foregoing estimate. There are two kinds of dates in the Archaic inscriptions. The dates of one character, and those of most frequent occurrence, appear in the body of the texts, and designate the points from or to which the reckonings extend. Sometimes they are but a day apart; at others, they are a few months or years, while occasionally a flight is made over thousands of years and back again, with the ease and swiftness with which in Eastern story the couch of the prince is transported by genii. These dates have no significance beyond their relation to other dates and the corresponding reckonings.

But with the other class, the initial dates, as Maudslay has very appropriately named them, it is quite different. The inscription on nearly every temple, stela, and altar begins with one of them, reciting the great cycle, cycle, katun, ahau, chuen, month, and day. Such conspicuousness and circumstantiality, in my estimation, could have but a single purpose—that of recording the date at which the monument was erected. Some of the stelæ have different initial dates on opposite sides, but in these instances one date is reckoned from the other, the later one undoubtedly designating the time of dedication. I think there is nothing we can assume with more assurance of certainty than that these initial series mark the date of erection of the respective monuments.

Taking this for granted, also, we will turn to the inscriptions and see to what these conclusions lead. The latest initial date is found on a stela at Quirigua. It is 55–3–19–2–18×20—7 Ahau-18 Pop. That is 2,840 years subsequent to the average of initial dates in the other Quirigua inscriptions. The next latest initial date is on a restored stairway in one of the temples of Palenque. It is 55-3-18-12-15 · 12—8 Eb-15 Pop. That is 7,082 years later than the earliest initial dates at Palenque. These are long periods, but the limit is not yet reached. In the museum at Leyden is the misnamed "Yucatec" stone, exhumed in digging a cut on the line between British Honduras and Guatemala, about a hundred miles from Copan. It is a slim slab of jadite, about a foot long and four inches wide, if my recollection of it is correct. Both sides are inscribed in rather a rude manner, the rudeness apparently being more attributable to the hardness of the stone than to a lack of skill in the artist. The carving on the front represents a warrior trampling an enemy under his feet. The stone, therefore, is evidently a memorial of some victory or conquest. The inscription on the back consists of an initial date in the Archaic form and characters. It is 53-8-14-3-1 × 12—1 Eb-5 Zac. That is 8,383 years anterior to the latest initial date in Quirigua. Now, if in accordance with my theory respecting the era of the Archaic cities the 2,348 years that have elapsed since that Quirigua date was made be added to the above period, we shall arrive at the time when that ancient Maya conqueror trod his enemies under foot—10,731 years ago—the oldest historical date in the world.

Dr Seler's opinion on this point is expressed in the following quotation from his paper in the Zeitschrift für Ethnologie, Heft 6, 1899:

I have, in conclusion, now to speak of the relation in which the various monuments which we have become acquainted with stand to each other. Here at the outset is to be kept in mind the noteworthy difference which exists between the altar plates of Palenque and the remaining monuments. I have already mentioned that the initial series of all monuments which we are able to read contain in the first member the multiplier nine; and I can add that the same holds also for the stelæ of Quirigua (which I have not yet been able to treat of, as they have not yet been published in Maudslay's work) and for stela 6 of Copan, excavated by the engineers of the Peabody Museum. On the altar plates of Palenque, on the contrary, so far as we have been able to decipher them, there stands in the first member the multiplier one. If, as indeed is a priori most probable, the date designated at the end of the first series gives the time of erection of the monument in question, then we must conclude that all other monuments within the tenth cycle after the beginning and normal date 4 Ahau 8 Cumku—the Temple of the Cross II of Palenque, the Temple of the Sun, and perhaps also the Temple of the Cross I—were constructed within the second cycle after the beginning and normal date. In other words, we must conclude that between the time of the erection of the temples of Palenque and of all the other monuments there lies a period of about 3,160 years; that the temples of Palenque are about 3,160 years older than the monuments of Copan and Quirigua, and than the steps of the towering palace of Palenque not far from the temple. This is, in itself, not probable, and all the less so as one would, from the style of the hieroglyphs and figures, be rather inclined to explain the temples of Palenque as younger than the stelæ of Copan. The solution of the riddle may be a different one. It may be that, in the initial series of the temples of Palenque, the end date does not represent the date of erection of the temple, but an earlier sacred date which it had been determined to bring into view. It may, however, also be that the time of the erection of the monument was brought into view, not through notation of the actual traditionally accepted distance from the normal date, but as it were in arithmetical fashion through notation of *one* difference which led from the normal date to a day of this name.

The end dates of all the remaining monuments which we are able to read fall, as said, within the tenth cycle after the beginning and normal date 4 Ahau, 8 Cumku.

It is apparent from these quotations that both Goodman and Seler hold the opinion that the terminal date in an initial series is intended to indicate the time when the monument was erected, though the lapse of time given by Goodman (who does not seem to object to long periods) to the dates of erection of the various monuments differs very widely from that allowed by Seler. The differences I have indicated are, as was stated above, limited to those which remain after rejecting those which seem doubtful.

Let us discuss this question on the data furnished by the inscriptions and Dresden codex, taking, where there are not good grounds for objecting to them, the interpretations of the initial series by Goodman and Seler. Differences in the numbers of the periods or orders of units below that which Goodman terms "katun" have no bearing in this discussion. In order that the reader may have the data before his eye, I give below a list of the initial series, retaining, for convenience, Goodman's great cycle numbers. The numbers at the left are merely for reference.

Palenque

(1)	53-12-19-13- 4- 0.	8 Ahau	18 Tzec.	Temple of the Cross.
(2)	54- 1-18- 5- 3- 6.	13 Cimi	19 Ceh.	Temple of the Sun.
(3)	54- 1-18- 5- 4- 0.	1 Ahau	13 Mac.	Temple of the Foliated Cross.
(4)	54- 9- 4- 0- 0- 0.	13 Ahau	18 Yax.	Temple of Inscriptions.
(5)	55- 3-18-12-15-12.	8 Eb	15 Pop.	Inscribed steps of palace.

Quirigua

(6)	54- 9- 1- 0- 0- 0.	6 Ahau	13 Yaxkin.	Stela C, west side.
(7)	54- 9-14-13- 4-17.	12 Caban	5 Kayab.	Stela F, west side.
(8)	54- 9-14-13- 4-17.	12 Caban	5 Kayab.	Stela E, west side.
(9)	54- 9-16- 5- 0- 0.	8 Ahau	8 Zotz.	Stela J, back.
(10)	54- 9-16-10- 0- 0.	1 Ahau	3 Zip.	Stela F, east side.
(11)	54- 9-16-13- 4-17.	8 Caban	5 Yaxkin.	Stela D, west side.
(12)	54- 9-17-10- 0- 0.	12 Ahau	8 Pax.	Animal B.
(13)	54- 9-17- 5- 0- 0.	6 Ahau	13 Kayab.	Stela A, east side.
(14)	54- 9-17-15- 0- 0.	5 Ahau	3 Muan.	Animal G.
(15)	54- 9-18-15- 0- 0.	3 Ahau	3 Yax.	Stela K.
(16)	54-13- 0- 0- 0- 0.	4 Ahau	8 Cumhu.	Stela C.
(17)	54- 9-16-15- 0- 0.	7 Ahau	18 Pop.	Stela D, east side.

Copan

(18)	54- 9- 5- 5- 0- 0.	4 Ahau	13 Zotz.	Stela D.
(19)	54- 9- 9-10- 0- 0.	2 Ahau	13 Pop.	Stela P.
(20)	54- 9-12- 3-14- 0.	5 Ahau	8 Uo.	Stela I.
(21)	54- 9-12-12- 0- 0.	1 Ahau	8 Zotz.	Stela J, west side.
(22)	54- 9-12-16- 7- 8.	3 Lamat	16 Yax.	Altar K.
(23)	54- 9-13-10- 0- 0.	(7 Ahau	13 Cumhu.)	Stela J, east side.
(24)	54- 9-14-10- 0- 0.	5 Ahau	3 Mac.	Stela F.
(25)	54- 9-14-19- 8- 0.	12 Ahau	18 Cumhu.	Stela A.
(26)	54- 9-15- 0- 0- 0.	4 Ahau	13 Yax.	Stela B.
(27)	54- 9-15- 0- 0- 0.	4 Ahau	13 Yax.	Altar S.
(28)	54- 9-16-10- 0- 0.	1 Ahau	8 Zip.	Stela N.
(29)	54- 9-16- 5- 0- 0.	8 Ahau	8 Zotz.	Stela M.
(30)	55- 2- 6- 0- 0- 0.	?	?	Altar L.
(31)	55-13- 2-18- 0- 0.	6 Ahau	18 Kayab.	Stela C.

The Leyden Stone

(32) 53– 8–14– 3– 1–12. 1 Eb 5 ?(Yaxkin?).

Goodman also mentions (p. 148) the following as at Quirigua:

(33) 55– 3–19– 2– 0– 0. 7 Ahau 18 Pop. Stela ?

Examining this list, we see that the terminal dates of 24 out of the 33 series fall in the 10th (Goodman's 9th) cycle from 4 Ahau 8 Cumhu, the initial day of Goodman's 54th great cycle. It can not be doubted, therefore, as we also find the same initial date the most prominent one in the Dresden codex, that, for some reason unknown to us, it was selected by the people who made the inscriptions and codex as their principal era date. As the 24 series ending in the 10th cycle run back from the earliest terminal date (number 6) 9–1–0–0–0, or 3,570 years, and from the latest terminal date (number 15) 9–18–15–0–0, or 3,920 years, it is evident, as has been stated above, that the normal date (4 Ahau 8 Cumhu) selected as the commencement of this era could have no reference to an historical event remembered by the Mayan people. Even if we suppose that the last of these inscriptions was not chiseled until the close of the fifteenth century, this would carry back the era date 2,400 years before the Christian era. The only safe and reasonable conclusion, therefore, is that the initial date was arbitrarily selected for some mythological, mystical, or arithmetical reason. It is especially worthy of notice, however, that the lapse of time between the terminal dates of the earliest and latest of these series is only about 350 years, and, if number 6 be omitted, less than 90 years. This fact would seem to give color to the suggestion of Goodman and Seler that the terminal dates of the initial series refer to the time the monuments were erected. Nevertheless, there are some serious difficulties to be overcome before this theory can be considered as satisfactorily established, some of which it will be my object now to point out.

So far as the foregoing list is concerned, all the series which begin with 9 cycles (the 54 indicating the so-called great cycle is omitted from consideration) have, beyond question, the initial date 4 Ahau 8 Cumhu. It must be remembered, however, that this date returns at the end of every count of 18,980 days, or 52 years. Now, the question arises (and it is a crucial one in this discussion), Does the count in each one of these series go back to identically the same 4 Ahau 8 Cumhu, or merely to any 4 Ahau 8 Cumhu? If, as I think I have successfully shown, the so-called ahaus, katuns, cycles, and great cycles are not absolute time periods, recognized as such in any Mayan time system, but are mere orders of units in the Mayan method of numeration, these counts would be precisely like the following in our ordinary time system: Thursday the 15th day of the 7th month of the 48th year of the century. What century? Or 1,025 years, 7 months and 15 days from December 25th to Thursday the 9th day of the 8th month. It is evident that without the first or last date being fixed in some recognized calendar the 1,025 years, etc., may be pushed backward or forward at will. Hence a Mayan scribe may write 9–15–0–0–0 from 4 Ahau 8 Cumhu to 4 Ahau 13 Yax (as in number 26); and 52 years later another may write the same series, as in number 27, and both will be strictly correct, but the 4 Ahau 8 Cumhu of the first will be 52 years earlier than that of the second. The mere fact, therefore, that 4 Ahau 8 Cumhu is reached by counting back the different numeral series is not evidence that in each case identically the same 4 Ahau 8 Cumhu is reached. Other evidence having some bearing on the question must be introduced to establish this identity. The only fact apparent in the series themselves which seems to favor the theory of identity is that each runs back 9 cycles plus the minor numbers. This undoubtedly favors the theory of identical date.

Let us turn now to the Dresden codex, and give attention to what I have termed subsidiary series; that is to say, short series apparently, as was suggested in the theoretical series given above, intended to connect with 4 Ahau 8 Cumhu. As I have expressed doubts as to the correctness of Seler's suggestion about that on plate LXIX, attention is called to the long compound series on plate XXIV (see our plate LXXXII). This series begins at the right-hand edge of the bottom section and runs leftward to the middle; it then passes to the next section above, and so on to the top of the page, the concluding column being that in the lower division of the left-hand portion. No months are given except at the bottom of the long number columns and the one short column in the lower left-hand portion of the plate. The last date standing in the lower left-hand corner is 4 Ahau 8 Cumhu, and over it is the number series 6–2–0 (the 0 symbol in a red loop). The next date to the right is 1 Ahau 18 Kayab; this stands under the numeral series 9–9–16–0–0. Counting back from 4 Ahau 8 Cumhu, the short series, 6 ahaus, 2 chuens, 0 days, or 2,200 days, we are brought to 1 Ahau 18 Kayab, while if we count forward from the same date it brings us to 7 Ahau 18 Cumhu, which shows the backward count to be the correct one, if the design of the artist was to connect the two series; moreover, the count of the long series, if made toward the right, is backward.

We know that in all the series given in the above list, where 4 Ahau 8 Cumhu is the principal date, it is the initial day and the numeral series follows it; in other words, the count must be backward to reach it. Taking number 15 of the list—Stela K of Quirigua—54–9–18–15–0–0—we find that the terminal date lies 3,920 years subsequent to 4 Ahau 8 Cumhu. Turning to the last column of the series on plate XXIV of the Dresden codex, which is 9–9–16–0–0, we find that the count, when the short series of 2,200 days is added, reaches backward from 4 Ahau 8 Cumhu 3,750 years. In other words, we count forward in the codex 3,750 years to 4 Ahau 8 Cumhu, and in the inscription series forward from this date 3,920 years, making the total lapse of time from the beginning date of one and the ending date of the other 7,670 years. Is it at all probable that the one 4 Ahau 8 Cumhu is the same in actual time as the other? That the count is necessarily forward in the codex series may be proved thus: The last column (that in the lower left-hand portion) reaches back to the initial date, which is found to be 1 Ahau 18 Kayab, the same as the terminal date which stands below the column. Now if the supposition be correct that, as is usual in this codex, this column is the sum of the series, and there is no mistake on the part of the aboriginal artist, the first number column, that in the extreme lower right-hand corner of the plate, 8–2–0, 9 Ahau (the symbol appears to be 8, but the fourth dot is hid by the red border line, as can easily be shown by the steps from date to date toward the left) should give the exact lapse of time from 1 Ahau 18 Kayab. Counting forward 8–2–0, or 2,920 days, from 1 Ahau 18 Kayab, year 2 Akbal, we reach 9 Ahau 18 Kayab, year 10 Akbal, the date under this first column. Counting forward 2,920 days (the difference between the first column and the next one to the left) from the last date (9 Ahau 18 Kayab), we reach 4 Ahau 18 Kayab, year 5 Akbal, the date under the second column. Counting back the sum of this second column—5,840 days—we reach, as we should, 1 Ahau 18 Kayab, the initial date.

As further proof that the series is continuous and the count forward, let us select at random the third column, counting from the right, of the third section from the bottom, to wit, 4–8–4–0, 11 Ahau. Counting forward 32,120 days, the sum of this column, from 1 Ahau 18 Kayab, we reach 11 Ahau 18 Kayab, year 12 Akbal—the day under this column. If we take the column immediately above (third from the right in the fourth division from the bottom of the page) which reads 9–11–7–0, 1 Ahau, equal to 68,900 days, and count forward from the initial date 1 Ahau 18 Kayab, we reach 1 Ahau 13 Mac, year 9 Lamat. Subtracting this column from that to the left of it—

1–5–14–	4–0
9–11–	7–0
16– 2–15–	0

we find the remainder to be 16–2–15–0, or 116,220 days. Counting forward this number of days from 1 Ahau 13 Mac, the date under the third column from the right, we reach 1 Ahau 18 Uo, year 3 Akbal, the date under the last or fourth column from the right, which proves the steps thus far taken to be correct.

Although the upper division is too nearly obliterated for any of its columns to be used to calculate forward to the final column, we can do this as correctly by subtracting the last column of the fourth division from the terminal column of the entire series, thus—

9–9–16–	0–0
1–5–14–	4–0
8–4– 1–14–	0

Using this remainder, which amounts to 1,181,440 days, subtracting from it 62 calendar rounds or 1,176,760 days, which leaves a balance of 4,680 days, and counting forward from 1 Ahau 18 Uo (the date under the left column of the fourth division), we reach 1 Ahau 18 Kayab, the date under the final column in the lower left portion of the plate. No doubt, therefore, is left that the count in this long series is toward the left and forward in time, and that the 1 Ahau 18 Kayab under the final column is 3,744 years later in time than the initial date, which is also 1 Ahau 18 Kayab.

Counting forward from this terminal date the short series in the extreme lower left-hand column (2,200 days), we reach 4 Ahau 8 Cumhu, the date in the corner below this short column. It is certain, therefore, that 4 Ahau 8 Cumhu is the terminal date of the long series on this plate. Is it the "normal date," the same initial 4 Ahau 8 Cumhu from which the series of inscriptions are counted? To show that Goodman's calculations agree exactly with this result, we have only to count back on his chronological tables from 4 Ahau 8 Cumhu, the first day of his 54th great cycle, the 9 cycles, 9 katuns and 16 ahaus of the final large column and the 6 ahaus of the short column. This will reach 2 Ahau 13 Pop, the first day of the 18th ahau of the 9th katun of the 3rd cycle of his 53rd great cycle. Counting back from this the two months of the short column we reach 1 Ahau 18 Kayab, the initial day of the long series of the codex plate.

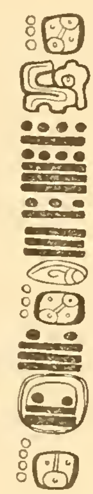


FIG. 166. Column from plate XLIII, Dresden codex.

This fact will tend to throw a strong doubt on the theory of Goodman and Seler in regard to the signification of the series. Moreover, if we turn to plate LXX of the codex we see high numbers, some reaching to 8 and others to 9 cycles, one being as high as 9–19–11–13–0. These are followed by a short subsidiary series ending with 4 Ahau 8 Cumhu. Here, then, this "normal date" comes after the long series of 3,937 years, and if Seler's idea that the 4 Ahau 8 Cumhu in the texts of plates LXI and LXIX is to be connected with the high series in the serpent figure be correct, then it must stand at the commencement of a period extending back from the terminal date some 33,900 years.

As an example clearly illustrating the statements in the preceding paragraph occurs on plate XLIII of the Dresden codex, I shall notice it here before passing from the point under discussion. This consists of a single column shown in figure 166. At the head of the column is the day 3 Lamat; immediately below is a figure with a turned-up nose, probably a conventionalized tapir head, which, as it occupies the same relative position as the great cycle symbol in the inscription, may, and in fact probably does, stand for the same purpose here. Following the latter, reading downward, is the series 9–19–8–15–0 (9 cycles, 19 katuns, 8 ahaus, 15 chuens, 0 days); next comes the day 3 Lamat, which is followed by the short series 17–12 (17 chuens, 12 days), the column ending with the day 4 Ahau, though no month symbol is given.

Assuming the date at the bottom to be 4 Ahau 8 Cumhu, we count back 17 months and 12 days(=352 days) from this date. This brings us to 3 Lamat 1 Uayeb in the year 7 Lamat. Counting back from the latter date 9–19–8–15–0, or 1,435,980 days, we reach 3 Lamat 11 Muan, year 12 Ezanab, the day standing at the head of the column. It is true that we have no absolute proof that the terminal date (4 Ahau) is intended for 4 Ahau 8 Cumhu, as the count will give the same result from any other 4 Ahau. The column given is the sum of—that is to say, includes—the long series which occupies the right portion of the middle section of plate XLIII and the left portion of the middle section of plate XLIV, and seems to be here precisely what an initial series is in the inscriptions. This supposition, which seems to be confirmed by the tapir-head symbol, which apparently stands for the great cycle, is in direct opposition to the assumption that

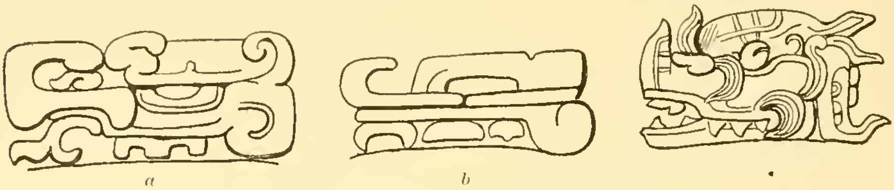


Fig. 167. Centerpieces of great cycle symbols.

the terminal 4 Ahau is the initial day of a great cycle. On the other hand, the assumption that it is the initial day of a great cycle, as Seler seems to think, necessitates the conclusion that the date 3 Lamat 11 Muan, from which the count of the series starts, is not the beginning of a great cycle, or that great cycles may overlap one another. The latter conclusion would indicate that the starting point is arbitrary, and that the supposed time-periods are simply orders of units in expressing numbers.

At any rate, if the 4 Ahau is assumed to be 4 Ahau 8 Cumhu, the whole of the series lies back of, or anterior to, the commencement of Goodman's 54th great cycle.

As an indication that the conventional tapir head on plate XLIII of the Dresden codex is used as a great cycle symbol, attention is called to the centerpieces of the three great cycle symbols shown in figure 167, the one marked *a* being from the east side of Stela F, Quirigua; *b* from Stela N, Copan, and *c* from Stela 6, Copan. The resemblance to the codex symbol is too strong to be overlooked.

In addition to these facts which seem to stand against, or at least to render doubtful, the supposition that 4 Ahau 8 Cumhu, when standing as the initial or terminal day of a series, is to be taken as the date of the chosen era, there is the additional fact that in quite a number of the inscriptions there are series connected with, but subsequent to, the initial series, sometimes running into the hundreds of years. If the terminal date of the initial series designates the date of erection, then the other subsequent dates must have been chiseled after the monument was erected. This would require the supposition that the tablets at Palenque were quarried and dressed to a particular size with a profound knowledge of or keen foresight as to the additional space that would be needed in the coming years.

Such are some of the difficulties that stand in the way of the theory advanced by Goodman and Seler as to the signification of the inscriptions. Nor are these all the difficulties; others appear when we discard Goodman's theory of a great chronological system and look upon his so-called time-periods as but orders of units, and count, as should be done, 20 of the 5th order of units (cycles) to one of the 6th order (great cycle). However, notwithstanding these serious difficulties, the theory, if a little more generalized, so as to apply to the latest date in the inscription as that denoting the time of erection or event commemorated, is perhaps the most acceptable which has been presented, though it be very doubtful. Many of the long series in the Dresden codex appear, in fact, to be records of the steps of calculation in finding the lapse of time between widely separated dates, seemingly for amusement or mystical purposes. The author of the Dresden codex seems to have been of a mathematical turn—far more so than the authors of the Troano and Cortesian codices, which fact probably accounts for the long series in the former; and it may be added that a strong mathematical turn of mind has probably led Mr. Goodman to form his grand but, unfortunately, imaginary Mayan chronological system.

INSCRIPTION AT XCALUMKIN, YUCATAN

Attention is called again to figure 157 (page 253), showing an inscription found at Xcalumkin, Yucatan, by Mahler and photographed by him. A copy was obtained by Dr Le Plongeon and published in his "Queen Moo" (page 80, plate XXV), but without any particulars or attempt at explanation. As Mahler has not, so far as I am aware, published any account of this discovery, and I am indebted to Dr Saville for the copy used, I can only refer to the inscription, which is certainly interesting in several respects.

It is apparent at a glance that the majority of the symbols differ very considerably from those at Palenque, Tikal, Copan, and Quirigua to which reference has been made in my previous paper and the first part of this paper. So great is the difference that we are unable to say whether the first symbols, A1 to B2, are numeral characters representing an initial series. That the part of A3 which is a cartouch inclosing a serpent is to be taken as a day symbol may be safely assumed. If this surmise be correct, it is a type different from any hitherto found in a Mayan inscription. If a Mayan day symbol, it must, beyond any reasonable doubt, represent Chicchan, which is the only day in the calendar that has received the interpretation "Serpent," and is that which corresponds in position with Cohuatl in the Mexican calendar. If this conclusion be correct, it confirms Brinton's interpretation of the name "Chicchan" (Native Calendar, page 25).

The important glyphs of this inscription are the two at the bottom, A6 and B6. These I think may safely be read "8 Caban 4 Zotz," and in this I am glad to say that Saville agrees with me. Whether the determination of the month symbol be correct or not, the four dots over it are clear and distinct, showing the day to be the 4th of the month. There can scarcely be any doubt that the day symbol is that of Caban, which can only be the 4th day of the month in years beginning with Ix. This conforms to the calendar of the Troano and Cortesian codices and that used by Landa, in which the dominical days are Kan, Muluc, Ix, Cauac.

FIG. 168. Two symbols from a Chichen-Itza inscription.

This is a very important fact, which, if corroborated by other discoveries, will carry back the use of the Yucatec calendar to an early date. I was inclined to the opinion that this calendar was of comparatively recent date, but this evidence, if accepted, must carry it back to the era of the inscriptions, and place it, in time, parallel with that of the other sections.

A single date, it is true, is slender evidence on which to base a conclusion of so much importance as this. However, as it is the only evidence as yet obtained bearing on the question, it must be accepted until other data are obtained. It is possible that one other date is given by Maudslay in plate XIX, part 5, in an inscription found at Chichen-Itza and shown in our figure 168. Possibly this may be intended for ? Ahau 2 Cumhu, and if so would be the second day of the month in Cauac years, and in accordance with the Yucatec calendar. It must be admitted, however, that this is very doubtful. It will be noticed that in the inscription from Xcalumkin the glyph B3, to the right of the supposed Chicchan symbol, consists of two faces, hence is presumably double, and over each are two large dots. If the first or left one be intended for a month symbol, there is still correspondence with the Yucatec calendar, as Chicchan is the second day of the month in Kan years. However, it must be admitted that as yet we are unable to solve the problem.

In regard to the types of the glyphs their nearest approach is to those on Stela P, Copan (see Maudslay, plate LXXXVIII, part 4).

INSCRIPTION ON STELA 6, COPAN

In figure 169 is given a copy of an inscription on Stela 6 at Copan. As the photograph of this inscription has been kindly furnished by Dr Saville, who may intend to publish further notice of it, I shall notice only the initial series.

This series is as follows (the great cycle being neglected): 9–12–10–0–0, 9 Ahau 18 Zotz. The chuen and day symbols are too indistinct to be determined by inspection. The symbol of the day 9 Ahau is the right-hand portion of glyph B2; and that of 18 Zotz is the right-hand portion of glyph B4. Changing the 9 cycles, 12 katuns, and 10 ahaus to days gives the following result:

	Days
9 cycles	1,296,000
12 katuns	86,400
10 ahaus	3,600
Total	1,386,000
Subtract 73 calendar rounds	1,385,540
Remainder	460

Counting back 460 days from 9 Ahau 18 Zotz, year 10 Akbal, we are brought to 4 Ahau 8 Cumhu, year 8 Ben, the initial day of Goodman's 54th great cycle. The series, as given above, may therefore be accepted as correct, and the lower part of glyph A2 as denoting 0 chuens, 0 days, or at least 0 chuens. Enough of the left half of the lower portion of this glyph remains to show beyond question the symbol of full count or naught.

Dr Saville has also presented me with photographs of inscriptions discovered at Seibal, Guatemala, but these are short and contain no initial series. The only peculiarity noticeable is the prominence at this place of the date 3 Ahau 3 Kayab, which stands at the head of some of the inscriptions. This shows that the calendar used here was the same as that in use at the other points not in Yucatan, to wit, that having Akbal, Lamat, Ben, and Ezanab as the dominical days.

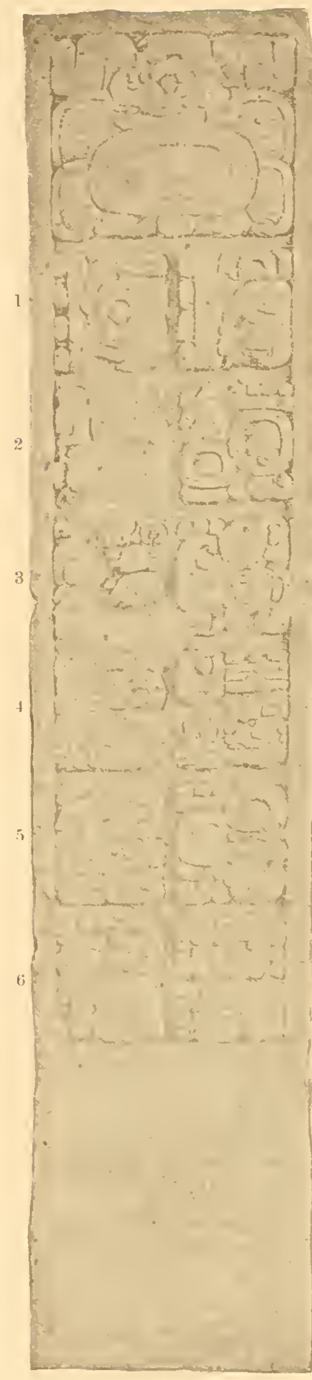


Fig. 169. Inscription on Stela 6, Copan. From photograph by Saville

THE NEPHRITE STONE OF THE LEYDEN MUSEUM

Reference is made to the inscription on this stone (figure 170), which has been frequently noticed heretofore, merely to show the date from which the initial series is counted. The series is as follows, omitting the great cycle: 8–14–3–1–12, 1 Eb 5 (month). The month symbol, though distinct, is unusual, in fact unique, unless it includes the "kin" glyph immediately below, which is very probable; in this case it is most like the Yaxkin symbol. Reducing the series to days and subtracting 66 calendar rounds, we have the following result:

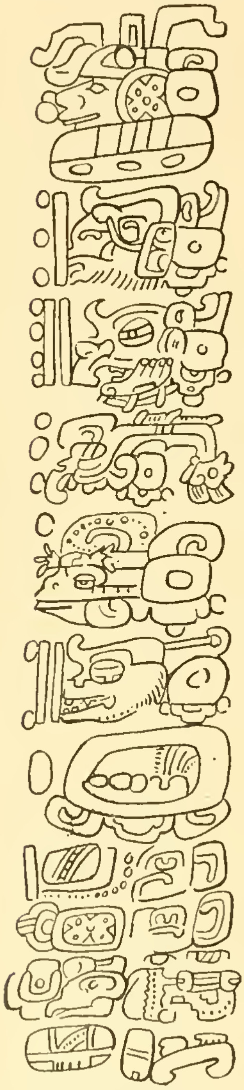


FIG. 170. Inscription on the nephrite stone in the Leyden Museum.

	Days
8 cycles	1,152,000
14 katuns	100,800
3 ahaus	1,080
1 chuen	20
12 days	12
Total	1,253,912
Subtract 66 calendar rounds	1,252,680
Remainder	1,232

Counting forward 1,232 days from 4 Ahau 8 Cumhu, the first day of Goodman's 54th great cycle, Seler's "normal date," we reach 4 Ix 10 Xul. This is wrong; but by counting forward from 4 Ahau 8 Zotz, the first day of Goodman's 53rd great cycle, we reach 1 Eb 5 Zac, which agrees with the inscription so far as the day and day number and the day of the month are concerned, but still leaves the doubt as to the month. This result also agrees with Goodman's tables and his interpretation of this series (page 148). Assuming it to be correct, we find the terminal date to be 618,088 days back of or anterior to the "normal date," 4 Ahau 8 Cumhu; and the commencement of the 10th (Goodman's 9th) cycle of the 54th great cycle stands 1,296,000 days after this normal date; hence the time of inscribing the series on the nephrite stone (assuming the terminal date to indicate this time) was 5,244 years anterior to the beginning of the 10th cycle, the anterior limit fixed by Seler for the date of the inscriptions. However, it must be remembered that this calculation is based on the theory that the series on this stone falls in one of the three great cycles tabulated by Goodman. This theory, as is apparent from what has been shown in this paper, is not entirely satisfactory. If the count be backward from 1 Eb 5 Yaxkin, the apparent date of the inscription, we reach, as the beginning day of the series, 4 Ahau 13 Cumhu, which is the initial day of Goodman's 11th great cycle; but it must be remembered that 4 Ahau 13 Cumhu will appear again and again, in fact hundreds of times, and at much more recent dates than this immense stretch of more than 224,500 years. Moreover, it is proper to bear in mind the fact that Goodman's list of 73 great cycles covers the list of ahaus or 360-day periods commencing with 4 Ahau; hence any date having 4 Ahau will be found somewhere in it.

CALENDAR AND NUMBER TABLES

Although the following tables are given in my previous paper, it is thought best to reinsert them on the following pages (303, 304) for the convenience of readers disposed to test the calculations made in this paper.

Days and months of the four series of years

Akbal year	Lamat year	Ben year	Ezanab year														Days of month
Akbal	Lamat	Ben	Ezanab	1	8	2	9	3	10	4	11	5	12	6	13	7	1
Kan	Muluc	Ix	Cauac	2	9	3	10	4	11	5	12	6	13	7	1	8	2
Chicchan	Oc	Men	Ahau	3	10	4	11	5	12	6	13	7	1	8	2	9	3
Cimi	Chuen	Cib	Imix	4	11	5	12	6	13	7	1	8	2	9	3	10	4
Manik	Eb	Caban	Ik	5	12	6	13	7	1	8	2	9	3	10	4	11	5
Lamat	Ben	Ezanab	Akbal	6	13	7	1	8	2	9	3	10	4	11	5	12	6
Muluc	Ix	Cauac	Kan	7	1	8	2	9	3	10	4	11	5	12	6	13	7
Oc	Men	Ahau	Chicchan	8	2	9	3	10	4	11	5	12	6	13	7	1	8
Chuen	Cib	Imix	Cimi	9	3	10	4	11	5	12	6	13	7	1	8	2	9
Eb	Caban	Ik	Manik	10	4	11	5	12	6	13	7	1	8	2	9	3	10
Ben	Ezanab	Akbal	Lamat	11	5	12	6	13	7	1	8	2	9	3	10	4	11
Ix	Cauac	Kan	Muluc	12	6	13	7	1	8	2	9	3	10	4	11	5	12
Men	Ahau	Chicchan	Oc	13	7	1	8	2	9	3	10	4	11	5	12	6	13
Cib	Imix	Cimi	Chuen	1	8	2	9	3	10	4	11	5	12	6	13	7	14
Caban	Ik	Manik	Eb	2	9	3	10	4	11	5	12	6	13	7	1	8	15
Ezanab	Akbal	Lamat	Ben	3	10	4	11	5	12	6	13	7	1	8	2	9	16
Cauac	Kan	Muluc	Ix	4	11	5	12	6	13	7	1	8	2	9	3	10	17
Ahau	Chicchan	Oc	Men	5	12	6	13	7	1	8	2	9	3	10	4	11	18
Imix	Cimi	Chuen	Cib	6	13	7	1	8	2	9	3	10	4	11	5	12	19
Ik	Manik	Eb	Caban	7	1	8	2	9	3	10	4	11	5	12	6	13	20

Working tables

Calendar rounds				Calendar rounds			
1	18,980	21	398,580	41	778,180	61	1,157,780
2	37,960	22	417,560	42	797,160	62	1,176,760
3	56,940	23	436,540	43	816,140	63	1,195,740
4	75,920	24	455,520	44	835,120	64	1,214,720
5	94,900	25	474,500	45	854,100	65	1,233,700
6	113,880	26	493,480	46	873,080	66	1,252,680
7	132,860	27	512,460	47	892,060	67	1,271,660
8	151,840	28	531,440	48	911,040	68	1,290,640
9	170,820	29	550,420	49	930,020	69	1,309,620
10	189,800	30	569,400	50	949,000	70	1,328,600
11	208,780	31	588,380	51	967,980	71	1,347,580
12	227,760	32	607,360	52	986,960	72	1,366,560
13	246,740	33	626,340	53	1,005,940	73	1,385,540
14	265,720	34	645,320	54	1,024,920	74	1,404,520
15	284,700	35	664,300	55	1,043,900	75	1,423,500
16	303,680	36	683,280	56	1,062,880	76	1,442,480
17	322,660	37	702,260	57	1,081,860	77	1,461,460
18	341,640	38	721,240	58	1,100,840	78	1,480,440
19	360,620	39	740,220	59	1,119,820	79	1,499,420
20	379,600	40	759,200	60	1,138,800	80	1,518,400

Ahaus		Katuns		Cycles	
1	360	1	7,200	1	144,000
2	720	2	14,400	2	288,000
3	1,080	3	21,600	3	432,000
4	1,440	4	28,800	4	576,000
5	1,800	5	36,000	5	720,000
6	2,160	6	43,200	6	864,000
7	2,520	7	50,400	7	1,008,000
8	2,880	8	57,600	8	1,152,000
9	3,240	9	64,800	9	1,296,000
10	3,600	10	72,000	10	1,440,000
11	3,960	11	79,200	11	1,584,000
12	4,320	12	86,400	12	1,728,000
13	4,680	13	93,600	13	1,872,000
14	5,040	14	100,800	14	2,016,000
15	5,400	15	108,000	15	2,160,000
16	5,760	16	115,200	16	2,304,000
17	6,120	17	122,400	17	2,448,000
18	6,480	18	129,600	18	2,592,000
19	6,840	19	136,800	19	2,736,000
20	7,200	20	144,000	20	2,880,000