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# THE MAYA LUNAR COUNT[1]

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MY subject concerns certain aspects of the indigenous calendar of the Maya Indians of Middle America. This time count consisted of named days and months associated with short number series which, in principle, is closely similar to our own calendar. The dates thus obtained, analogous to our term "Tuesday, the 29th of December," were located, during the earlier period of their civilization, in a count of days from an hypothecated starting point in a manner identical to the system used by European astronomers when they compute in terms of "Julian days." Because of this "Long Count" the many dates recorded in stone during the earlier period are accurate to within a day with relation to one another. For further details concerning the mechanics of this calendar, I refer you to a number of publications.[2]

An outline of the history of the remarkable Maya civilization has been obtained in terms of this native calendar. Because of the influence which this group of people exerted both directly and indirectly upon the majority of the indigenous civilizations of the New World it is of great importance that the Maya calendar be expressed in terms of the European calendar. The problem is to determine the numerical con-

[1] Address of the vice-president and chairman of Section H—Anthropology, American Association for the Advancement of Science, New Orleans, December 29, 1931.

[2] S. G. Morley, "An Introduction to the Study of the Maya Hieroglyphs," Bureau of American Ethnology, Washington, Bulletin 57, 1915; H. J. Spinden, "The Reduction of Mayan Dates," Papers of the Peabody Museum of American Archeology and Ethnology, Harvard University, Vol. vi, No. 4, 1924; J. E. Teeple, "Maya Astronomy," Carnegie Institution of Washington; Contributions to American Archeology, No. 2, Publication 403, pp. 29–115, 1930.

stant which must be added to the Long Count to obtain the equivalent Julian Day.

Offhand, the obvious suggestion is to search early Spanish records for a statement of a date in both calendars. Unfortunately, the Mayas had abandoned the use of the Long Count before the Spaniards encountered them. Such dates as are given in both calendars give only the Maya cyclic dates, which repeat themselves at regular intervals in the Long Count. The interpretations of these data offered by specialists give several different values for the constant to which I have referred, the two most acceptable ones differing from one another by nearly 260 years. This situation has given rise to what is technically known as the "Correlation Problem."

Since the post-contact records are inconclusive in themselves, it is necessary to seek additional data in the more ancient inscriptions in which the Long Count is recorded. The only phenomena which were surely observed by both the Maya Indians and the Europeans prior to the sixteenth century were astronomical. Hence such Maya records as appear to be of this character have undergone a severe scrutiny. The technical problems involved excited my interest, and have caused me to review at least some of the indigenous records referring to the moon.

The problem before us is such that two specific questions concerning the Maya records of the moon are of particular importance. The first of these is, "What phase of the moon was used as the beginning of the Maya lunar month?" and the second "Did the Mayas, during the period of the inscriptions, use a computed calendar which approximated the periodicity of lunations, or did they record the beginning of the lunar month from direct observation?" These are the two questions I lay before you.

The first of these may be studied from several viewpoints, namely, customs of similar civilizations, the European-Maya records, and the indigenous native records. A survey of lunar calendars over the world discloses that while a majority of them contain months beginning at the new moon phase, several use the full moon phase for this purpose. Since both customs do exist we must dismiss this line of attack as failing to yield conclusive data.

As far as I know now, the only definite statement on this subject yet found in the early Spanish records is made by Bishop Landa, the first Bishop of Yucatan, when he states that the Mayas counted from the time the new moon rises till it disappears. Certain statements made by the Bishop on a number of subjects have been either accepted or proved as correct. At first sight, then, this would appear to be good evidence. A further consideration reveals that some of Landa's statements are incorrect. Moreover, all the Spanish records are subject to the criticism that they record the interpretation of a native civilization by a group of persons tending to be unsympathetic towards non-European customs, influenced by European habits, and untrained in obtaining accurate ethnological records. Dr. Ludendorff suggests that this record of the new moon as the beginning of the lunar month may be the result of a leading question on Landa's part, which is possible.[3] Therefore, with all due consideration for Landa's mental honesty and acumen, which is so clearly illustrated in his work, we must conclude that while this evidence is more probably correct than false, we can not consider it as conclusive.

European records of associated and later times should also be considered. Dr. Willson has written, "the fact is known that the ancient Mexicans did not make use of lunar eclipses,"[4] but does not give his source for the statement. Of course lunar eclipses can only occur at time of full moon. Dr. Willson used solar eclipses in his work, which meant that he supported the use of the new moon as the beginning of the lunar month. It is probable that his statement is based upon early Spanish sources from Mexico, which may be more definite, but to which the additional objection may be raised that they concern a different, even though closely related, civilization. In short, the evidence from other European records is also not definitive.

There remain the data from the native records, *i. e.*, the inscriptions and the manuscripts. The only apparent clue to this problem in the inscriptions was suggested by Mr. J. E. Thompson in the course of a conversation during the past month, and embodied in a letter to me from which I quote: "The lunar glyphs themselves might be construed as possible evidence of the Maya lunar count of the inscriptions having started from new and not full moon.

"Glyph C represents a completed moon, but the lunar element of this glyph is of crescentic shape. If the lunar month was completed at new moon one would expect the moon to be shown as crescentic, but if the moon was completed at full moon, one would expect Glyph C to show a full moon. Such is not the case. Similarly, if the moon count starts at new moon, one would expect Glyph D to be represented by a new moon; but if the lunar month starts at full moon, one would expect the full moon element to occur in Glyph D. Actually it is shown as cres-

[3] H. Ludendorff, "Das Mondalter in den Inschriften der Maya," Sitzungsberichten der Preussischen Akademie der Wissenschaften, Phys.-Math. Klasse, 1931, iii.

[4] R. W. Willson, "Astronomical Notes on the Maya Codices," Papers of the Peabody Museum of American Archeology and Ethnology, Harvard University, Vol. vi, No. 3, 1924.

centic. Glyph E, following the Maya vigesimal count, represents twenty days after the start of the lunar month. If this is counted from new moon, Glyph E should be a full moon, since at 20 days after new moon, the moon is considerably closer to full than to crescentic. If the count was from full moon, Glyph E, on the same line of argument, should be shown as crescentic. Actually it is shown as full. Glyph A, of course, is nothing more than Glyph E with a coefficient placed in a different position. This does not denote addition, as has been suggested, for in that case Glyph E would also have its coefficient placed below or to the right. I think this change in the position of the coefficient serves to differentiate Glyph A from Glyph E.

"This evidence of the glyphs themselves is not conclusive, but does, I think, give support to the thesis that the Maya lunar count of the inscriptions started from new moon." Mr. Thompson's suggestion is valuable, and in accordance with our admittedly inadequate knowledge of Maya psychology. It is still only a hypothesis and can not be considered irrefutable until a careful comparative analysis has been made of all existing examples of these glyph forms.

A somewhat indirect form of evidence is found in the manuscripts and has been referred to by Dr. Teeple.[5] There is reason to believe that the Maya Venus count was from the time the new Venus appeared after conjunction with the sun. By analogy, according to Teeple, we expect the moon count to be from new moon immediately after conjunction. Dr. Willson explains the Venus configuration referred to and adds "This conjunction is called 'inferior conjunction' and is much more striking than that between second heliacal rising and first heliacal setting on account of the great brilliancy of the planet and of the rapidity with which it passes from evening star to morning star."[6] Both Drs. Spinden and Ludendorff feel that the analogy is not well taken, but give no specific reasons.[7] The analogy between the two phenomena which Dr. Teeple probably had in mind was the first appearance of both celestial bodies after conjunction with the sun. But with that, the analogy ceases, for the actual observational phenomena do not seem to be similar, because Venus, after inferior conjunction, first appears on the eastern horizon just before sunrise, and, rising earlier each day, appears to be moving westward away from the sun with the passage of time; while the moon, after conjunction, first appears as a crescent on the western horizon just after sunset, and, rising later each day, appears to be moving eastward away from the sun with the passage of time. The validity of the analogy is a matter of opinion, and does not serve, therefore, as conclusive evidence.

This discussion raises a point which, as far as I know, has never been discussed. If the Maya began their Venus count when Venus first appeared as morning star just before dawn, is it possible that the lunar month was begun on the day that the crescent moon was last seen in the east just before dawn—that is, just *before* the moon's conjunction with the sun? If such were the case, Mr. Thompson's suggestion would be strengthened, for then full moon would be more nearly twenty days after the beginning of the lunar month.

The final group of data applicable to this question is found in the lunar table of the manuscripts. The following brief statement of the characteristics of this table on pages 51 to 58 of the Dresden Codex contains only such points as are agreed upon by all students. It consists of a series of numbers constantly increasing in value by intervals of 148, 177 and 178 days. We know these intervals refer to days because associated with each total are the proper three consecutive days from the repeating 260-day calendrical cycle. The three intervals are close approximations of five and six lunations and are so arranged that the recorded totals agree with modernly computed eclipse intervals with an error of not more than one day over a total period of 11,960 days, slightly more than 33 years. The record is unquestionably an eclipse record, and therefore the intervals were counted from either new or full moon, the only phases at which eclipses can occur. Is there any internal evidence to show to which phase of the moon the table refers?

Before proceeding further it is necessary to present certain data concerning eclipses as used in modern astronomy, and tabulated in Oppolzer's canon.[8] Examination of these tables, without reference to a specific locality, makes apparent at once that there is a definite periodicity in the phenomena. Lunar eclipses may occur at six lunation intervals five, six or seven times in succession. Then follows a period of no eclipses which usually covers 17 lunations, but sometimes only 11. This is followed again by lunar eclipses at six lunation intervals. There is also a larger periodicity permitting a grouping of 88, 94, 135, 223, 270 and other multiples of lunations.

The situation with regard to solar eclipses is similar. Such eclipses occur at six lunation intervals five, six or seven times in succession. In the inter-

[5] Teeple, *loc. cit.*, p. 49.

[6] Willson, *loc. cit.*, p. 9.

[7] Ludendorff, *loc. cit.*, 1931, p. 13; H. J. Spinden, "Maya Dates and What They Reveal," The Museum of the Brooklyn Institute of Arts and Sciences, *Science Bulletin*, Vol. iv, No. 1, 1930, p. 41.

[8] Th. von Oppolzer, "Canon der Finsternisse," Denkschriften Keiserl. Akad. Wissensch. Math.-Naturw. Klasse. lii, Wien, 1887.

vening 17 lunation periods there may be three to five eclipses at 5, 6, 11, 12 and 17 lunations. Those within one lunation of each other are never visible at the same point on the earth. It is clear that since these smaller intervals are the same as in lunar eclipses the larger groupings apply equally well to both solar and lunar eclipse phenomena.

It is relatively simple to explain the absence of lunar eclipses over a 17 lunation period, and the presence of solar eclipses in a similar period by modern astronomical knowledge, and an exposition of the concept of the "moon's node." The manuscript lunar table contains five lunation intervals, but no definite 11 or 17 lunation interval.

Dr. Teeple has presented a detailed and scholarly exposition of the thesis that the table can only be a solar eclipse table.[9] By plotting the dates given in the table upon a chart showing their occurrence in the 260-day calendrical period, two of which closely approximate one and one half eclipse years, he demonstrates that certain of the dates given fall beyond the limits of possible lunar eclipses, but are possible dates for solar eclipses. He reasons that, since these dates are recorded, and since a variation in the symmetry of the table in the last third prevents one of them from falling beyond the limits of solar eclipses, the table definitely concerns solar rather than lunar eclipses.

There is no single locality at which all solar and lunar eclipses are visible. Speaking in general, solar eclipses are more frequent than lunar ones, but with reference to a single locality, lunar eclipses are far more frequent than solar ones because of the narrow paths of the latter. From a knowledge of eclipse phenomena with reference to a specific locality it is evident that eclipses of either kind could not have been visible in the Maya area at each of the dates given in the manuscript in succession. The manuscript lunar table is, then, a compendium of eclipse knowledge, irrespective of the question of whether or not it refers to a specific series of eclipses. A number of the dates in the text could not record eclipses during any given 11,960 day period.

Since the 135 and 405 lunation interval is equally applicable to the periodicity of both types of eclipses, it is possible to coordinate the manuscript table with lunar eclipses. When this is done and the lunar eclipse dates charted upon a form similar to that used by Dr. Teeple, it is found that those dates on which no lunar eclipses can occur are those adjacent to the 148-day intervals in the manuscript, *i.e.*, the 11 or 17 lunation period is represented in the table by one or two six-lunation groups and a five-lunation group. This situation is characteristic of each of every one of the five-lunation groups.

[9] Teeple, *loc. cit.*, pp. 86–93.

It is known that the Mayas counted by six-lunation intervals several centuries prior to the creation of this table. Since the table corresponds so closely to eclipse phenomena, the Mayas probably knew of the 11 or 17 lunation interval without lunar eclipses. Because of the Maya habit of grouping in six-lunation groups, and knowing that every group in the table could not represent an eclipse date at any given time, the division of the 11 or 17 lunation interval into one or two groups of six lunations and one of five lunations is to be expected. The only other way of constructing a lunar eclipse table of this type would be to use the 11 or 17 lunation interval as a unit between groups of five, six or seven intervals of six lunations each. It might even be argued that the relation to solar eclipses of those dates adjacent to the five-lunation interval is only a coincidence, were it not for the conspicuous display in the "introduction" to this table, of Tzolkin dates fifteen days apart, covering, a two-lunation interval. I assume it is clear that, since solar and lunar eclipses can only occur at new or full moon, the interval between any given solar and the nearest lunar eclipse is a multiple of complete lunations plus approximately fifteen days.

It is evident, then, that the lunar table in the manuscript may be correlated with either solar or lunar eclipses. This has been done for solar eclipses by Drs. Willson[10] and Teeple,[11] and for lunar eclipses by Dr. Ludendorff.[12] Dr. Willson found that noteworthy coincidences between the manuscript record and the modern table of solar eclipses occurred seventeen times in about fifteen centuries.[13] Dr. Ludendorff placed the manuscript lunar table at one point in the Julian Day count at which there is complete agreement with lunar eclipses, except for one date. Had he placed it 3,987 days earlier he would have had complete agreement. He also found that equally satisfactory agreement could be obtained at 46 places over a period of about 400 years.[14]

The lunar table of the manuscripts, therefore, not only fails to give conclusive evidence regarding which phase of the moon was used as the beginning of the Maya lunar month, but also is found to be an eclipse table so accurately computed and so complete that it can be integrated into the Julian Day count at a large number of places, and still be in agreement with either solar or lunar eclipses. It is a computed table rather than a table of observed phenomena.

Our investigation of the question whether the

[10] Willson, *loc. cit.*, pp. 13–16.

[11] Teeple, *loc. cit.*, pp. 87–91.

[12] H. Ludendorff, "Uber die Reduktion der Maya-Datierungen auf unsere Zeitrechnung," Sitzungsberichten der Preussischen Akademie der Wissenschaften, Phys.-Math. Klasse. 1930. xviii, pp. 7–9.

[13] Willson, *loc. cit.*, p. 16.

[14] Ludendorff, *loc. cit.*, 1930, p. 9.

Mayas counted lunar months from new or full moon has revealed that the data at present available in comparative chronology, European-Maya records, and indigenous Maya records are not conclusive. It is clear that the phases of the moon at which eclipses might occur were used as the starting point for the Maya lunar month. But no irrefutable evidence has yet been found to indicate which of the two phases of new or full moon was used. The major part of the evidence tends to indicate that the Maya probably began their lunar months at new moon, but no proof of this has yet been found.

Therefore, the exclusive use of either phase of new or full moon as the beginning of the Maya lunar month is not a valid premise at the present time upon which to base conclusions concerning Maya astronomical records.

In considering the question of the existence of a computed lunar calendar at the time of the inscriptions it is necessary to analyze the available data. In order to simplify the problem I have used only the following two groups of indigenous data:—the manuscript lunar table and the Supplementary Series records during the Period of Uniformity, which have been made available in convenient form in Dr. Teeple's Table 3.[15] The following adjustments have been made in this table: Two dates have been omitted because of apparent contradictions, namely, those on Lintel 26 at Yaxchilan and on Lintel 1 at El Cayo; Two dates have been added, The Temple of the Initial Series No. 15 at Holactun, using Mr. Thompson's reading 9.15.12. 6. 9,[16] and Lintel 3 at Piedras Negras, newly discovered and beautifully exhibited by the University of Pennsylvania Museum. It bears the date 9.15.18. 3.13.

The manuscript gives an arrangement of five- and six-lunation groups, containing 148, 177 and 178 days. The inscriptions record that during the Period of Uniformity the lunations were arranged by sixes only.[17] Combining these two groups of data gives the first premise; During the Period of Uniformity the Maya lunar count was in groups of six lunations each, containing either 177 or 178 days, and an additional period of five lunations containing 148 days was used at the time of the writing of the manuscript.

The manuscript contains no information concerning any subdivisions of these groups. Glyph A of the Supplementary Series does record that these groups were divided into months of 29 and 30 days. There is no evidence of the use of any months of either 28 or 31 days.

[15] Teeple, *loc. cit.*, pp. 50–51.

[16] J. E. Thompson, ''Archeological Investigations in the Southern Cayo District, British Honduras,'' Field Museum of Natural History. Publication 301; Anthropological Series, Vol. xvii, No. 3, 1931, pp. 354–356.

[17] Teeple, *loc. cit.*, pp. 53–61.

Dr. Teeple gives a free reading of a combined Initial Series and Supplementary Series, from which I quote the interpretations of glyphs E, D, C and A: " . . . the age of the moon is 20 days from the last new moon, and it is 20 days and one moon since this lunar half year began; . . . and this present moon will probably end as a 30-day moon."[18] You will note that he includes a reference to new moon, which I feel is not justified. The readings of glyph E, D and C are in terms of elapsed time, that of glyph A in current time. The data of the Maya calendar are overwhelmingly in favor of the assumption that the Mayas counted in elapsed time only, at least during the days of the Old Empire. I therefore suggest a revised translation of these sections, as follows: " . . . the age of the moon is twenty days from the end of the last lunar month; there has been one complete month since the ending of the last lunar half-year; . . . the last complete month contained 30 days."

Dr. Teeple has pointed out that "Whenever glyph C has an odd coefficient, 1, 3 or 5, the chances are about three to one that glyph A will show 30 days; whenever glyph C has an even coefficient, 2, 4 or 6, the chances are about three to one for a 29-day glyph A."[19] If my reading of glyph A is correct, then this relationship indicates that normally the six-lunation periods were divided into six months arranged in alternation containing 30, 29, 30, 29, 30, 29 days each, thereby closely approximating actual lunations in terms of whole days. Moreover, such an alternation creates the totals of 177 and 148 for the lunation groups as found in the manuscript. My second premise is then: The five- and six-lunation groups were normally divided into an alternating series of 30 and 29 days, beginning with one of 30 days.

The manuscript lunar table states that at the time it was made the Mayas computed that 405 lunations equalled 11,960 days. Dr. Teeple has demonstrated that during the time of the inscriptions the Mayas used the equivalents of two other computations, namely, 149 lunations equaled 4,400 days, and 81 lunations equaled 2,392 days.[20] But an unbroken alternation of 30 and 29 day months for these periods give respectively 11,948, 4,396 and 2,390 days, *i. e.*, 12, 4 and 2 days less than the Maya records show. The Maya computations approximate the true lunation intervals more closely than the straight alternation. They must therefore have added intercalary days probably at more or less regular intervals. The existence of 178-day groups in the manuscript and the occurrence of two cases of even months with 30 days

[18] *Ibid.*, p. 64.

[19] *Ibid.*, p. 63.

[20] *Ibid.*, pp. 64–67.

in the Supplementary Series supports this conclusion.

Since no record exists of 179- or 180-day groups, and since no record exists of 31-day lunar months, my third premise is: The Mayas never added more than a single intercalary day in any six-month group, and this was done by changing a 29-day month to a 30-day month.

The only data we have which may indicate the intervals at which the intercalary days were added is contained in the manuscript table. Such isolated examples of even numbered months of 30 days in the Supplementary Series are too widely separated in time to be of assistance. Following the method used in my article on the manuscript lunar table,[21] an alternating series of 30 and 29 days can be applied to this record, and the intercalary days arbitrarily added in such six- and five-month groups as are necessary to have the sequence conform to the totals given in the table. If the alternation is applied in 135-month groups, it is found that the intercalary days may be added in the same months in each third of the table, namely, the 32nd, 74th, 80th and 130th months. Unfortunately, there is no indication of which 29-day month in each group contained the intercalary day, so the possibility of the use of one of the other two 29-day months in each six-month group for this purpose must be kept in mind. Due to irregularities which must be taken into consideration it is necessary to use the entire 11,960-day table rather than one of one third this length.

But the manuscript table can not be applied to the record of the inscriptions as it stands because of the existence of five-month groups, which were not used during the Period of Uniformity. We can, however, group the month table which has been made to fit the data of the manuscript into six-month groups only, without altering either the sequence or the value of the months. 135 and 405 months are not divisible by six, but twice each of these periods are respectively 45 and 135 six-month groups, by the use of which a repeating cycle in six-month groups will be obtained. The six-month groups of the second, fourth and sixth thirds of the manuscript table begin with a 29-day month instead of a 30-day month, in disagreement with a part of my second premise.

It is, of course, clear that I am preparing to apply the manuscript lunar table to the record of the Supplementary Series. This latter record must also be analyzed. Glyphs E, D and C give the age of the moon at the time of the related Long Count date, in terms of months and days since the end of the last lunar half-year. In translating the months into days we must consider the possibility that any one of the 29-day months may have contained an intercalary day. Therefore, wherever glyph C records more than one month, we must use two adjacent values for the number of days corresponding to the month record. For example, if glyph C records three months, the number of days would normally be 30 + 29 + 30 or 89 days, but if the 29-day month contained an intercalary day, there would be 90 days in the three months. By subtracting the record of glyphs E, D and C from the associated Long Count date, the "lunar base" or the end of the last complete lunar half-year is obtained in terms of two adjacent dates in the Long Count.

We now have a table of months arranged in terms of lunar half-years, which conforms to the data of the manuscript lunar table, and a series of dates in the Long Count which record the ending of lunar half-years during the Period of Uniformity. These two groups of data may be charted in terms of lunar half-years and compared directly, by a method similar to that used by Dr. Willson.[22] In order to prevent confusion, the dates from the various cities have been charted separately.

There are 28 dates between 9.13. 5. 0. 0 and 9.16. 1. 0. 0 which conform to the requirements of the Period of Uniformity, and no dates which do not do so. Thirteen of these occur at Piedras Negras, giving us the best critical series for a test. The application of the manuscript lunar table in terms of 30- and 29-day months fits this group of dates from Piedras Negras exactly, with a single exception, that on Stela 5, where the reading for glyph D is uncertain. Dr. Teeple says of it, "the age is surely over 10 and not over 15, while 15 is expected."[23] The manuscript table demands glyph D have the number 16. A very slight adjustment in the manuscript table of the intercalary day in the 130th month of the sixth third will eliminate this possible error.

There is a day-for-day agreement, except for a single doubtful reading, between the record of glyphs E and D in the inscriptions at Piedras Negras during the Period of Uniformity, and a month-for-month arrangement of the manuscript lunar table.

When the entire range of the Piedras Negras dates conforming to the Period of Uniformity is considered, we have 19 dates ranging over a period from 9.11.12. 7. 2 to 9.18. 0. 3. 1, a total of 45,999 days, or nearly four times the length of the manuscript lunar table. There are only four of the 19 dates which do not give an exact correlation, and all four record a dif-

[21] C. E. Guthe, "A Possible Solution of the Number Series on Pages 51 to 58 of the Dresden Codex," Papers of the Peabody Museum of American Archeology and Ethnology, Harvard University. Vol. vi, No. 2, 1921, pp. 21–24.

[22] Willson, *loc. cit.*, pp. 13–15.

[23] Teeple, *loc. cit.*, p. 52.

ference of only one day from that expected. In each case this error of one day is adjusted during the next few lunar half-years of the table.

A similar examination of the four dates at Naranjo reveals complete agreement without exception. Of the seven dates at Copan, five are in exact agreement, and the other two are one and two days at variance respectively, but again are corrected during the following few lunar half-years. The starting date for the lunar table is a different one for each city. At Piedras Negras it is the lunar base for 9.12. 2. 0.16, which is recorded twice with different moon ages, and at Copan it is the lunar base for 9.12. 8. 3. 9, which is used as the basis for lunar computations on Altar H′.

At Piedras Negras two monuments record Initial Series identical to two at Copan. In the first case, 9.13.10. 0. 0, the moon age at Piedras Negras is given as two days more than at Copan. In the second, 9.15. 5. 0. 0, identical moon ages are recorded. All four of these dates fit exactly into the manuscript month series. The apparent contradiction is caused by the fact that the month grouping used is engaged into the Long Count at different points in the two cities.

It is demonstrable, therefore, that a 135-month cycle of 30- and 29-day months, so arranged as to conform to the groups of the manuscript lunar table, may be applied to the records of the inscriptions in such a way as to cause a day-for-day agreement between it and the records given in glyphs E, D and C of the Supplementary Series, with a very few exceptions, which are all corrected in succeeding lunar half-years. At Piedras Negras this 135-month cycle must be repeated twelve times.

As it is used, this 135-month cycle does not conform with the record of glyph A, because at every other repetition of the cycle the half-year group starts with a 29- instead of a 30-day month. By using twice this cycle, or one of 270 months, grouped in two parts of 134 and 136 months each, in which the intercalary days occur in the first 132 months of each part in exactly the same positions as in the first 132 months of the manuscript table, an agreement with the glyph A record can be secured.

It must not be overlooked that as soon as adjustments are made, the possibilities for alternative adjustments increase. The fitting of the manuscript table into the inscriptions demonstrates that the record given in glyphs E and D may be a computed record, and is not, therefore, necessarily an observational one. I am convinced that other computed cycles can also be found which will fit the mathematical records of the Supplementary Series.

This paper is of necessity a brief review of my findings, and does not attempt to be exhaustive. The indigenous records of the Maya lunar count still contain many interesting unsolved problems.

My general conclusions at the present time are: first, the Maya lunar month began at either new or full moon, but the data available at present does not permit the exclusive use of either phase for the beginning of the Maya lunar month as a premise in deducing conclusions regarding Maya astronomy; and second, it can be demonstrated that the numbers associated with glyphs E, D, C and A of the Supplementary Series of the inscriptions may have been obtained by the use of a computed lunar calendar, and need not, therefore, be records of current contemporaneous observations.

# OBITUARY

## EDWARD ORTON, JR.

GENERAL EDWARD ORTON, JR., died at his home in Columbus, Ohio, on February 10. With him a most distinguished and unique career is closed. He was the founder of the first course in ceramic engineering which he established at the Ohio State University in 1894. He was a powerful and able investigator in the field of economic geology, ceramics and silicate technology, in which he was a pioneer. In 1898 Orton founded the American Ceramic Society which he served as secretary and editor for many years, and was its president as recently as 1930–31. His efforts were mainly responsible for the creation of a fruitful American literature on the subject of ceramics. He served the Ohio State University twice as dean of the College of Engineering, was active in the establishment of the Engineering Experiment Station, and in 1916 was elected one of the university's two first research professors. He was state geologist of Ohio from 1899 to 1906, during which time he placed the Ohio Survey on a firm basis and published a series of monographs. General Orton created the Orton Geology Library at the Ohio State University in memory of his father. He left the university when America entered the war, and despite his age, he had gone to the Plattsburg training camp. He was subsequently commissioned a major and later a colonel. His work in the Motor Transport Division was of such an outstanding character that Congress awarded him the Distinguished Service Medal. He was later made a brigadier general in the reserve corps. General Orton received many honors. He was given the honorary D.Sc. degree by Rutgers University in 1922 and the LL.D. degree by Alfred University in 1931. He