THE MAYAN AND OTHER ANCIENT CALENDARS

Geoff Stray
Surviving Manuscripts

The vanity of Spanish bonfires

The Mesoamericans recorded information via stone inscriptions and books with painted glyphs and images. On arrival, the Spanish declared all local writings to be “works of the devil” and made huge bonfires of any books they found. Today, just fifty pre-Columbian manuscripts survive, and only four of these are Maya codices.

The surviving four codices (shown opposite) all date to the Post-Classic period, and are probably from the Yucatan peninsula. The Dresden Codex is the best preserved and most important of the four. Bought for Dresden library in 1739 from a private collector, it suffered some water damage in World War II when Dresden was bombed, but was recovered. Its 39 leaves are a treatise on divination and astronomy, with Sun, Moon, and Venus tables. Dated to the early 13th century, it is probably partially copied from earlier books.

The Paris Codex was rediscovered in the Paris library in 1859, and is in very poor condition—only the central glyphs and pictures on its 11 leaves have survived. It contains a katun sequence (a series of thirteen 20-year cycles), with associated deities and ceremonies and a partial depiction of a thirteen-sign Maya zodiac, with scorpion, turtle, rattlesnake, and bat all remaining visible.

The Madrid Codex was found in two parts in Spain in the 1860s, and consists of 56 leaves. Full of horoscopes and almanacs, it contains fewer astronomical tables than the Dresden Codex. The year-bearers are shifted forward one day from the ones shown in the other codices, indicating a possible origin in West Yucatan.

Discovered in Mexico in 1965, the 11-page bark-paper Grolier Codex is a simple Venus almanac. It may well be a clever forgery.
**THE NUMBERING SYSTEM**

*fingers and toes*

The counting system we use today is called *place numeration*, in which there is a position for units, and further placed positions for multiples of those units. This ingenious technique is thought to have originated in India around the 8th century, passing via Arabia to Moorish Spain. However, we now know that place numeration and the concept of zero had already been in use in Mesoamerica for over a thousand years. Our decimal, or base-10 system, has units, 10's, 100's, 1000's, and so on; the Maya instead used a vigesimal, or base-20 system, with units, 20's, 400's, 8000's, etc.

In our decimal system, the positions increase by a factor of ten from right to left, and are read from left to right. In the Mayan system, the positions increase by a factor of twenty from bottom to top, and are read from top to bottom. There is an exception—when recording dates in the long count calendar, the third position represents only 18 times the second position, giving a 360-day unit instead of a 400-day one, and thus approximating the solar year.

The Maya used three types of notation for recording numbers. These were the bar-and-dot numerals (opposite top), the rarer head-variant numerals (see caption opposite top), and the very rare full-figure glyphs (lower opposite). Zero is represented by a shell glyph in the codices, and by half a quatrefoil flower (below) in the inscriptions. The full quatrefoil represents the 260-day calendar in the Fejevarny Codex and the Madrid Codex (see page 27).

The dot-bar system probably originated using stone, twigs and seashells, with a stick representing the number 5. In the head-variants a different human head represents zero to twelve, except for ten, which is a death's head or skull. For the teens, thirteen to nineteen, the heads of numerals three to nine are used with an additional fleshless jawbone from the skull of number ten.

introducory 9 baktuns 15 katuns 5 tuns 0 uinals

0 kin 10 Ahau moon phase 8 Chen undeciphered

Full figure glyph numerals depict the heads with bodies attached. For example, zero uinals is a man with a forehead attachment and a head-jaw (zero) shown wrestling with an amphibian (uinal).
INcredible calendars
where did they come from?

The Maya used a bewildering number of different cycles in their calendar, the reasons for which will become clear later. In the reference table (opposite) these are given with their day–counts and algebraic relationships. As a day-count, the Maya system can compute many millions of days into the past or future, but is not linked to the seasons like the Gregorian calendar, since there is no intercalation. The Maya tracked various cycles, including the solar year, but uniquely, they didn’t try to combine them into one calendar—they cross-referenced their calendars instead.

Scholars are still unsure as to the exact origins of this complex system, particularly the central Tzolkin–Haab device. The history of the ancestors of the Maya stretches back to the Palaeo-Indian period (20,000 – 8,000 BC) when Siberian hunter-gatherers colonized the New World, slowly settling during the Archaic period (8,000 – 2,000 BC), domesticating maize and building permanent settlements. In the Pre-Classic (Formative) period (2,000 BC – 250 AD) civilization began, with small towns and fertility cults.

Elements of the calendar may date back to the earliest civilizations of Mesoamerica (the so-called “Olmec”), as early as 1500 BC, or the Zapotec (600 BC onwards) before being perfected by the Maya themselves (200 BC onwards). The oldest Long Count date is from an Olmec site but Tzolkin dates from 600 BC and 650 BC have been found at Zapotec and (recently) Olmec sites respectively.

There is fascinating evidence that the Berber peoples of north-west Africa also used a cycle of 520 days (twice a Tzolkin) on the Atlantic islands of Tenerife and Grand Canary.

<table>
<thead>
<tr>
<th>NAME</th>
<th>LENGTH</th>
<th>COMPOSITION</th>
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<tr>
<td><strong>Basic units</strong></td>
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<td>7 days</td>
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<td>b Lords of the Night</td>
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<td>f Two moon cycle</td>
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<td><strong>Planet Cycles</strong></td>
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<td>k Venus cycle</td>
<td>584 days</td>
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<td>l Mars cycle</td>
<td>780 days</td>
<td>3 tzolkins (g)</td>
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<td>m Jupiter/Saturn cycle</td>
<td>819 days</td>
<td>ab</td>
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<td>n 3 Eclipse Year cycle</td>
<td>1040 days</td>
<td>4 tzolkins (g)</td>
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<td><strong>Rounds</strong></td>
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<tr>
<td>p Calendar Round</td>
<td>18,980 days</td>
<td>52 haabs (f), 73 tzolkins (g)</td>
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<tr>
<td>q Venus Round</td>
<td>2 Calendar Rounds</td>
<td>65k, 104j, 146g</td>
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<td>r Mars Round</td>
<td>6 Calendar Rounds</td>
<td>146l, 195k, 312j, 438g</td>
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<td>s Katun</td>
<td>7,200 days</td>
<td>20 tun (h)</td>
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<td>t Baktun</td>
<td>144,000 days</td>
<td>20 katun (s), 400lt</td>
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<td>u Sun</td>
<td>5,125 years</td>
<td>13 baktun (t), 260s, 5200h</td>
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<td>v Precessional</td>
<td>25,626 years</td>
<td>5 suns (u), 260008h, 36000g</td>
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The Tzolkin

260 days

The Tzolkin is a sacred 260-day almanac that determined the ceremonies and prophecies of the Maya. Each day the day-numbers and day-sign progressed by one, so that 1 Imix was followed by 2 Ik, 3 Akbal, and so on (see diagram opposite). The two qualities influencing any particular day in the cycle of 260 were believed to determine the character traits and destiny of anyone born on that day, and they were often named after the combination. The 13-day period within which a person was born is today called a trecena.

This 13 x 20 day-count has been in daily use by the Quiche calendar priests, or daykeepers of the Guatemala highlands, in an unbroken chain since Classic times. The Quiche call it the ch'olk'ij, “count of days” (“Tzolkin” in Yucatec). The Mexico, or Aztecs of central Mexico, also followed the 260-day count, calling it the tonalpohualli, with similar signs on the same days as the Maya.

The Quiche Maya say the Tzolkin is actually based on the period of human gestation and the maize agricultural cycle. The system was also used as an augury, the daykeeper being consulted to divine whether or not a day was suitable for performing various activities.

Scholars believe the day was once counted from sunrise, but the present-day Jacalteca and Ixil Maya groups both count from sunset.
The Haab
(18 x 20) +5 = 365 days

The vague year or Haab (xiiipohualli to the Aztecs), consisted of eighteen months of twenty days each (shown below), plus a nineteenth month of five unlucky days, known as Uayeb, (nemontemi to the Aztecs). The Haab thus totaled 365 days (no leap days were added).

Each month ran from 0-19, with the first day termed a seating day. For the Maya, the signature of time cycles could be detected in advance, so the last day of each month was the seating of the next.

The Maya New Years Day was on 1 Pop and the year-bearer was the day in the Tzolkin that corresponded to this in the Haab, and gave its name (and influence) to the Haab that followed. Only four of the day-signs coincide with 1 Pop and in Classic times these were Akbal, Lamat, Ben and Etznab. Given the 13 number variations of each sign, there were thus 4 x 13, or 52 possible year-bearers. In fact, there are five theoretically possible year-bearer groups, (since 4 x 5 = 20; the number of day-signs), but only four are known to have been in use. For example, the year-bearers shifted forward one position in Post-Classic times (to Kan, Muluc, 1X and Cauac) in the Yucatan peninsula, for unknown reasons.

Some groups (including the Aztecs), used a terminal year-bearer system, in which the year is named after the 360th day.
The Calendar Round

52 years

The same combination of day positions in the Tzolkin and Haab calendars does not recur until 52 haabs, or 73 tzolkins have passed, a total of 18,980 days (see opposite top). The Maya name for this 52-year period is lost, though the Aztecs called it xiuwmolpilli “year fire bundle” (below), and Mayanists today term it the Calendar Round.

Little is known of the Mayan customs around the Calendar Round, but the Aztec traditions are well preserved. They expected the world to end at the close of a Calendar Round, and every 52 years, on the last night, the inhabitants of Tenochtitlan (where Mexico City now stands), extinguished all their fires, swept their houses, threw their statues into water and gathered at an extinct volcano known as the Hill of the Star. The priests climbed the hill at sunset to observe the stars. A captive warrior was sacrificed and his heart torn out. A new fire was kindled in his chest cavity and torches were taken from this to re-light all the temple fires and from these, the hearths in all the homes. Much feasting followed.

The event is known as the New Fire ceremony and scholars now think it started with the people who built Teotihuacan, later being passed on via the Toltecs to the Aztecs. The Maya were also practicing the ceremony in late Classic times at Chichen Itza.

Above: After 52 haabs, when the Tzolkin and Haab positions once again reach the same combination as when you were born, the Maya and other Mesoamerican cultures considered you become an elder. In the Gregorian calendar this is 32 days before your 52nd birthday (since the haabs exclude leap days).

Below: The Aztec city of Tenochtitlan, site of Mexico City. Buildings were relayered every 52 years.
VENUS IN THE CALENDAR

It all makes sense

Venus was known to the Maya as Noh ek or Xux ek - the "great star" or "wasp star" respectively, and it is in the light of the motions of Earth's closest planetary neighbor that the unadjusted Haab really makes sense as a calendrical unit. The bright sparkling point of light that is Venus disappears into the glare of the sun for about two weeks as it passes in front, before rising as the morning star, disappearing again for 13 weeks behind the sun, and then reappearing as the evening star. This is the synodic cycle of Venus, and it repeats five times over eight years (see opposite). The average time between synods (conjunctions with the sun) is 583.92 days, which the Maya rounded off to 584 (there was a system by which to correct the accumulated error). The Mayan glyph for Venus was a wriggly line with "eyes" or, sometimes, a four-pointed star (below).

Five synodic cycles of Venus repeat after 2920 days (584 x 5), exactly eight haabs (8 x 365 = 2920), almost exactly 13 Venus years (13 x 224.7 = 2921.1 days), and very close to 90 lunations.

After two Calendar Rounds (104 haabs or 146 tzolkins), exactly 65 Venus cycles, or 13 Venus pentagrams will have occurred (see opposite). This period is therefore known as the Venus Round (Huichuutiliztli to the Aztecs), and small adjustments were made at this time.
The lunar month (lunation) is 29.53059 days in length. In the Dresden Codex, the eclipse table (opposite) consists of 405 lunations, equating to exactly 46 tzolkins. This and other extremely accurate Mayan formulations are shown in the table (lower opposite).

The Dresden Codex shows how the lunar months were arranged, with alternating lunations of 29 days and 30 days, plus interpolated extra 30-day months to keep the discrepancy below one day at all times. The Codex records 405 consecutive lunar months in 60 groups of six lunations each, plus nine interpolated groups of five lunations each. Fifty-four groups of the 60 consist of three 29-day months and three 30-day months (54 x 177 days), the other six consisting of two 29-day months and four 30-day months (6 x 178 days). The nine groups of five lunations consist of two 29-day months and three 30-day months (9 x 148 days). In all this totals 11,958 days, two days less than 46 tzolkins (11,960 days).

Since 3 eclipse years (of 346.62 days) are almost exactly equal to 4 tzolkins, eclipse prediction was especially simple for the Maya.

A series of nine Gods of the Lower World (Night Lords, Lords of the Underworld), the Bolontiku, ruled each day in turn (below). On stelae, the Night Lord is usually depicted after the long count and Tzolkin date, before the lunar glyphs and Haab date. The beginning/end day of every tun coincides with Night Lord Nine, since 360 = 9 x 40.

Below: Various moon glyphs.
Mars, Jupiter and Saturn
the mysterious 819-day cycle

Mars has a synodic cycle of 780 days, multiples of which are recorded in the Dresden Codex. This, importantly, is equivalent to three tzolkins. The Codex also shows 78-day periods of retrograde movement of Mars, with "Mars Beasts" suspended from sky bands (see page 21) when this occurred while crossing the Milky Way.

After six Calendar Rounds (three Venus Rounds), the Mars cycle again comes into synchronization with the Tzolkin and Haab. This is the Mars Round. 146 Mars cycles = 312 haabs = 438 tzolkins.

The earth itself had seven layers, and seven corresponding gods, possibly called Ah Unx-Cheknal. The Thirteen Gods of the Upper World, the Nine Lords of the Underworld, and the Seven Earth Gods together ruled a period called the 819-day cycle (7 × 9 × 13 = 819), the coincidence of their three periods. 819 is also 9 × 91.

The 819-day cycle is thought to have originated in Palenque. It has a common factor of 21 (21 × 13 × 3) with the synodic cycles of both Jupiter (21 × 19 days) and Saturn (21 × 18 days), whose movements were tracked by the Classic Maya, and recorded in the inscriptions on occasions when the current katun-ending coincided with a solar or lunar relationship, or both.

Each 819-day cycle is associated with a direction and color, a set of four (red/east, yellow/south, black/west, white/north), making a larger 3276-day cycle. In less than 16 years, the Tzolkin aligns the synodic periods of the Moon and all visible planets to within 4.31 days. It is the perfect interlock cycle: 42 tropical years = 59 tzolkins; 405 lunar months = 46 tzolkins; 61 Venus cycles = 137 tzolkins; One Mars cycle = three tzolkins; 88 Jupiter cycles = 135 tzolkins.
The Calendar Round could only pinpoint a day within a 52-year period. To record dates centuries in the future and past, a more comprehensive system was required. By the first century BC, the Long Count calendar had been developed for this purpose. As in our own calendar, which counts from the birth of Christ, the Long Count starts at a base date, the first day of the current creation. According to Maya mythology, the world has gone through a series of eras, and the current era started on the day of creation—August 11th 3114 BC, recorded as 13.0.0.0.0 4 Ahau 8 Cumku.

Although the date would have originally been read from top to bottom, Mayanists today write the dates from left to right to ease interpretation and printing. Many also refer to the Day of Creation in 3114 BC as 0.0.0.0.0 rather than 13.0.0.0.0, to distinguish between the creation day at the start of the current 13-baktun cycle and the next one, at the end of it.

When the count reaches 13 baktuns, which is a period of 1,872,000 days, 5,200 tuns, or just over 5,125 solar years, a new creation occurs. The current 13-baktun cycle will be completed on 21st December 2012 AD, which is the next Day of Creation (for information on larger cycles, see appendix p.55).

20 KUNS = 1 UINAL = 20 DAYS
18 UINALS = 1 TUN = 360 DAYS
20 TUNS = 1 KATUN = 7,200 DAYS
20 KATUNS = 1 BAKTUN = 144,000 DAYS
13 BAKTUNS = 1 SUN = 1,872,000 DAYS

Stray’s Olde MAYAN LONG COUNT MECHANISM patent pending
The Stelae
carved in stone

Stelae are inscribed stone pillars, erected to commemorate events. At the top of a typical stela an introductory glyph announces the following glyphs as a Long Count date. A variable element at the center of the introductory glyph is usually the glyph of the deity who is patron of the relevant “month” of the Haab.

Under the introductory glyph can be found up to 20 rows of two glyph-pairs. The first five of these are generally the cycle glyphs and numbers that describe the position in the 13-baktun cycle when the stela was erected. Usually read from left to right and top to bottom, in most cases the glyph-pairs are followed by the number and glyph of the relevant Tzolkin day. Then come two glyphs relating to the relevant Night Lord—first the name of the ruling Night Lord, and next, it is thought, the title, “Night Lord.”

After these come a series of lunar glyphs describing the relevant moon age (or phase), the position of the lunar month in the lunar half-year, the name of the lunation (and a glyph meaning “it is named”), and then a glyph signifying whether the lunation is of 29 or 30 days. Finally, there is a glyph-pair that describes the Haab date. An example of a stela from Quiriguá is shown (opposite).

The next group of glyphs was originally called the Secondary Series, but they are now called “distance-number” dates. They are shorthand date calculations—counts of days to be added or subtracted from the “base date” or full Long Count date on the monument. They can record further dates as little as a day from the base date, or millions of years from it, and were often used by Maya lords to connect with their ancestry, legitimizing their rulership.
The dates for sowing and harvesting were, and still are, fixed by the Maya at the two annual zenith passage days of the sun, when the sun is directly overhead, when a gnomon casts no shadow at noon. At some Mesoamerican sites, such as Xochicalco and Monte Albán, there are buildings in which a zenith tube projects a vertical sunbeam onto the floor at midday (below). In the Yucatan, bottle-shaped underground chambers called chultunes may have served the same purpose.

There are two seasons—rainy and dry, starting in April/May and November. The onset of the rainy season coincides with the first zenith passage in May for much of the Maya area, and maize (corn) is planted shortly after. At the second solar passage a second maize crop is planted. At higher altitudes, maize and beans are planted in March and harvested 260 days later in December.

The solar nadir dates (when the sun passes directly underfoot) are spaced six months from the zenith passage dates and the November solar nadir coincides with the beginning of the dry season.

Zenith tubes may also have been used to observe the zenith passage of important constellations. There is evidence suggesting the Aztecs interpreted the conjunction of the Pleiades with the zenith sun as a signal for the end of one era and the start of the next.