Gerardo Aldana y Villalobos and Edwin L. Barnhart, editors, *Archaeoastronomy and the Maya*

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This book has its origins in the 72nd Society for American Archaeology Annual Meeting's Symposium on New Perspectives on Ancient Maya Archaeoastronomy (Session 143), held in 2007 at Austin, Texas. This symposium was sponsored by Maya Exploration Center and its aim was to "present the new perspectives and discoveries in ancient Maya astronomy that have resulted […] from ongoing studies of architectural alignments, codices, epigraphy, iconography, ethnography, and calendrics" (Society for American Archaeology 2007). The symposium was organized by Edwin L. Barnhart and Harold H. Green, with a post-conference meeting held at the Radisson hotel. The meeting was attended by 15 participants plus Anthony F. Aveni, who agreed to act as a panel discussant. Unfortunately, the long delay before publication has meant that many contributions are not in the present volume.

The volume includes a foreword and an introduction written by both editors (separately), seven specific chapters, and an epilogue, again written by one of the editors, Aldana y Villalobos. The cultural and geographical scope of the book obviously covers the ancient Maya culture, geographically located in southern Mesoamerica.

In his introduction, Gerardo Aldana y Villalobos briefly describes the history of archaeoastronomy in the field of ancient Maya studies. Today it is evident that when, in the 1920s and 1930s, the decipherment of Maya writing was still incipient and limited to calendrical and mathematical information, scholars often utilized astronomy and calendar to get insights into the mysteries of this ancient script. However, the role of astronomy in Maya culture was greatly exaggerated and the popular view which presents Maya priest-astronomers as great observers of the night skies is incorrect. Aldana rightly observes that systematic archaeoastronomical research headed by Anthony Aveni and Horst Hartung helped to establish new rigorous criteria for the study of ancient Maya astronomy, avoiding various pitfalls associated with earlier interpretations.

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In the first chapter, "Cosmic Order at Chocolá: Implications of Solar Observations of the Eastern Horizon at Chocolá, Suchitepéquez, Guatemala", Harold Green explores the possible origins of Mayan timekeeping at the Preclassic site of Chocolá, a large political and ceremonial Preclassic center located in southwestern Guatemala. Chocolá developed during the Preclassic Period (Middle and Late Preclassic, 1000 BC–200 AD), occupying a strategic location to control the routes between the Guatemalan Highlands and the Pacific Coast. The site extends roughly along a north–south axis and consists of the architectural assemblages known as North, Central and South groups (Valdés 2006, 2–3, 9). Archaeologists suggest that the North Group had elite residences and the Central Group was a great administrative center, while the South Group consisted of the residences of commoners, workshops and agricultural plots (see Kaplan and Valdés 2004).

The site is placed at the foothills (Bocacosta) of the Sierra Madre ridge and not far from Izapa and its latitude of 14.8° north, where according to Vincent Malmström (1973, 1981), the 260-day count was invented. As is known, Malmström argued that the 260-day *tzolk'in* calendar originated from the marking of the passage of time between two solar zenith passages on 13th August and 30th April observable at this latitude, which divided the solar year into 260 and 105 days.

As Green rightly points out, the plain where the site is situated is located just below the volcanic ridges that extend to the north and east, creating an impressive and unique undulating skyline. Its western horizon comprises of coastal plains "sweeping to the Pacific" (Kaplan and Valdés 2004, 78) and appears to be astronomically implausible. It is precisely the eastern horizon observed from Chocolá Mound 1, one of the highest structures located in the Central Group, that attracted his attention, because it is possible to accommodate all its characteristic landmarks to make them coincide with the sunrise dates that mark the 260-day interval, indicating the dates of both solar zenith passages at Chocolá. As observed in the numerous illustrations provided by the author, it is easy to establish various sightlines to the positions of the Sun on the eastern horizon from the location of Mound 1. It is reasonable to assume that prominent peaks of the local horizon served as natural markers of sunrises on certain dates.

Now, drawing on earlier work of various Mesoamerican archaeoastronomers, Green not only finds that these dates mark 20-day intervals (or their multiples) but also are separated by intervals of 20 days (or their multiples) from the dates of the zenith and nadir passages (displayed in tables 1.1 and 1.2). He correctly finds out the lack of symmetry between the intervals of nadir and zenith passages and the corresponding solstices. While the solar zenith passage is 52 days apart from the summer solstice day (30th April + 52 days = 21st June; 21st June 21 + 52(3) days = 13th August), there are only 50 days between nadir days and the winter solstice (1st November + 50 days = 21st December; 21st December + 50 days = 9th February). This asymmetry produces two well-known calendrical cycles, that of 260 days (13th August–30th April) and that of 265 days (9th February–1st November) already described by various researchers. (In fact, this also provides two schemes of dividing the year of 365 days into two parts: that of 260/105 days and that of 265/100 days).

Green utilizes this asymmetry to create a dichotomy between 360-day and 365-day cycles. Observing that the intervals between two nadir passages (100 days of five winals, or units of 20 days) and two zenith passages (105 days or five winals plus five days) differ by five days, he concludes that the five extra days found between zenith passages may correspond to five "extra" days found in the Mesoamerican 365-day calendars (composed of 18 20-day units plus five days). According to Green, the symmetry between nadir and zenith dates would have created the 360-day *haab'* and eventually the whole Long Count system. This is an interesting suggestion and an important starting point to studying the origins of the Long Count.

However, in my opinion, the methodology applied by Green seems to be biased by his own hypothesis. To be clear: the study of the natural horizon form is fine, although I am not sure about the names of the mountains identified in illustrations. The major problem is that unfortunately Green does not report any architectural alignments. The lack of any architectural alignments associated with the natural landmarks substantially weakens his arguments about the intentionality of horizon calendar observations. It is important to highlight that all authors cited by Green reported on the architectural alignments that were inserted into the scheme of regular 20-day intervals found on the horizon. The structure which is oriented to a horizon position of the Sun on a date that fits one of the 20-day intervals substantially strengthens arguments about the intentional use of the horizon. Examples of alignments between various mounds are briefly discussed by Valdés and Vidal (2005, 39–40) and Valdés and colleagues (2004, 431); however, they are not discussed by Green. I think it might be useful to study the eastern horizon near to Mound 15 where a five-stone deposit was found, presumably symbolizing the quadripartite Sun-oriented ritual space (Valdés and Vidal 2005, 44).

Also, the archaeological dating of the Mound 1 that places this structure into the Late Preclassic Period (400 BC–200 AD – Valdés *et al.* 2004, 427) seems to assign a relatively late date to the horizon calendar activities. It means that horizon observations carried out from Mound 1 may not be old enough to propose Chocolá as the place of the origin of calendar-making.

In the opinion of this reviewer there is no need to refer to "nadir" in labelling the sunrise dates of 9th February and 1st November. The term "nadir" is misleading, since it implies that the Preclassic sunwatchers were already familiar with this concept. The dates of 9th February and 1st November were undoubtedly important to ancient Mesoamericans, because we find them encoded in many alignments of architectural structures throughout Mesoamerica. They can be reached through calendrical arithmetic, and Green himself appears to suggest that calendar computations were done to break down the 260-day and 365-day calendars into smaller units of 20 days or their multiples. Moving within calendar numeromancy, Green correctly identified cycles of 260 days separating local zenith passages. They can be divided into two cycles of 130 days each:

> Since 23th August + 260 days = 30th April, then
> 13th August + 130 days = 21st December; 21st December + 130 days = 30th April

Moving on further, both 130-day intervals may be divided into smaller intervals of 81 (9 x 9) and 49 (7 x 7) days:

> 13th August + 81 days = 2nd November; 2nd November + 49 days = 21st December;
> 21st December + 49 days = 8th February; 8th February + 81 days = 30th April

The division of 130 days into two smaller groups of 81 and 49 days is observed in the Borgia group codices (Borgia 1–8 and Cospi 1–8) and contemporary Mixe rituals (Boone 2007, 75), and is inferred from some Teotihuacan cross-circle figures (implied by the alignments of TEO 30 and TEO 31 and the number of holes of TEO 32 – see Iwaniszewski 2005). This may suggest that the chronology of events might be quite different. The Chocolá system was established in an area with a good view of the eastern horizon first to observe the rising Sun on zenith passages, and only later was its usefulness extended to other peaks in order to meet the requirements of numeromancy.

In Chapter 2, "Teotihuacan Architectural Alignments in the Central Maya Lowlands?", Ivan Šprajc reports on his archaeoastronomical investigations carried out in south-western Campeche. Since most of his research has been already published elsewhere, Šprajc selected alignments belonging to the so-called "17° family orientation" (Aveni and Gibbs 1976) to study in detail its presence in southwestern Campeche. As is known, Mesoamerican archaeoastronomers have identified various groups of pre-Hispanic orientations clustering around different azimuths or calendrical dates. The "17° family orientation" is perhaps the most widespread alignment group in Mesoamerica, ranging from about 105° to 108° of azimuth (Aveni and Gibbs 1976), and related to the division of a 365-day year into two segments: that of 260 days (sunrise dates falling around 12th February and 30th October, sunset dates falling roughly between 13th August and 30th April) and that of 105 days (sunrise dates between 30th October and 12th February, sunset dates falling roughly between 30th April and 13th August). The agricultural meaning of these four dates has long been discussed by various scholars and Šprajc also provides a short discussion of the possible meaning of them for supposed farming activities of Maya peasants (pp. 45, 48). The origin of this family of orientations has been traditionally attributed to Teotihuacan (Aveni 1991, 266–268), where these dates are recorded by the same alignment, but in Campeche this is not the case, leading Šprajc to conclude that sunrise dates were the intended ones (p. 48); that is, the dates of 12th February and 30th October. Now, since some of the surveyed structures are archaeologically dated to the Late Preclassic Period (c. 300 BC–250 AD), it follows that they predate the earliest Teotihuacan alignments by roughly two centuries (p. 52), leading the author to question Teotihuacan origins of those orientations. In sum, Campeche alignments shed new light on the origins of astronomical-calendrical practices in Mesoamerica showing the early phase of the development of the "17° family orientation". We see that at Yaxnohcah (Structures A–1, C–1 and E–1), and Las Delicias (Structure 2) observational schemes are functional only on the eastern horizon, while the complex observational scheme was fully developed later at Teotihuacan (first century AD), comprising eastern and western horizons. Since the same alignment was also identified at the Preclassic site of El Mirador (Šprajc *et al.* 2009), its origin was in the Maya region. Of course, his conclusions have a tremendous effect on traditional Teotihuacan archaeoastronomical thinking that associates the orientations of the Sun Pyramid at Teotihuacan to sunsets on 12th–13th August and the commemoration of the starting date of the Maya Long Count in 3114 BC. This topic however, lies beyond the scope of Šprajc's contribution. His chapter is well illustrated by computer-generated site plans.

In Chapter 3, "Astronomical observations from the Temple of the Sun", Alonso Mendez and his colleagues analyse the astronomical properties of a single architectural monument: the Temple of the Sun at Palenque. Through their careful recording of the changing sunlight illumination, observed throughout the year, they argue that the structure was designed to mark the positions of the rising Sun on specific days of the year. They focus on astronomically important events (solstices, equinoxes, zenith and nadir solar passages, and lunastices) and study the position of the structure in relation to the neighbor topography and architecture. Their observations support the idea that astronomical referents were effectively encoded in the design and orientation of the Temple of the Sun.

The Temple of the Sun is the smallest of the three temples comprising the famous Cross Group at Palenque. It was dedicated to the so-called GIII god, a solar god associated with warfare. It was built and inaugurated by K'inich Kan Bahlam, the son of the famous K'inich Janab Pakal, in 692 AD, on 9.12.19.14.12 5 Eb' 5 Kayab' (8th January, 692 AD) together with the Temples of the Cross and of the Foliated Cross. In the second part of this chapter, the authors discuss the possible astronomical meaning of the dates found in the Temple of the Sun hieroglyphic texts. Using the GMT calendar correlation constant, the authors move on to study astronomical events linked with the dates, discovering multiple layers of interpretation. They conclude that the building "functioned as a commemorative structure for ritualized astronomical observations which served to reaffirm the ruler's central place in the cosmic order" (p. 72).

Despite the photographs and illustrations submitted by the authors that convincingly display the changing patterns in light and shadow on important astronomical dates, I am not convinced about the authors' arguments. The authors start with the idea that the Temple of the Sun was carefully positioned to allow direct sunlight illumination into its interiors on pre-selected dates, and then provide a series of illustrations showing the sunrise sunlight entering the building on those chosen dates. The criteria by which they choose dates and alignments are not made explicit, leaving the reader with questions about the selection of dates. Why should the Temple of the Sun alignments be related with the astronomically important dates and not with the dates with specific calendrical meaning? Their approach received criticism from Šprajc (2013, 333), and I will not repeat his arguments here; instead I would like to question their use of zenith and nadir days. The dates of zenith and nadir solar passages at Palenque are miscalculated and should be reassessed: the true dates for zeniths are 9th May and 2nd–3rd August and for nadir are 11th November and 31st January. While I agree with the authors on the importance of solar zenith passages among the Maya, I cannot support their methods proposed to mark nadir days: it is not possible to use the arithmetic method of counting the days from the summer solstice to zenith and then the same number of days from the winter solstice to nadir as the authors propose (p. 65). Nadir and zenith days are not symmetrically temporarily positioned with respect to solstices, due to the changes of the Earth's velocity around solstices (strictly speaking, around perihelion and aphelion). This asymmetry is shown by Palenque dates where solar zenith passages occur 43 days before and after the summer solstice (21st June) and nadirs occur 40/41 days before and after the winter solstice (22nd December), respectively. Also, measuring the angle between the summer solstice and zenith sunrises in order to compose the same angle with respect to the winter solstice sunrise would be a wrong method because the horizon is neither flat nor symmetrical (p. 65).

Alonso Mendez and Carol Karasik in Chapter 5, "Centering the World: Zenith and Nadir Passages at Palenque", focus on zenith and nadir passages at Palenque during the reign of K'inich Kan B'ahlam II (684–702 AD), following some of the methods already described in Chapter 3. Regrettably, they again miscalculate zenith and nadir days (see Chapter 3). It's really very unfortunate to illustrate zenith and nadir sunrise and sunset events using dates which are misplaced by two or three days. The solar disc is moving fast on those days, yielding a shift of about 32 arc minutes (one solar diameter); thus one may ask whether some of the dramatic Sun-and-light events illustrated by the authors can be reproduced two days later. This remark especially refers to the views through small openings in the form of an IK Glyph in House C (p.105).

The concern with the nadir can be debated. As stated on many occasions, solar zenith passage alignments are sometimes encoded in Mesoamerican monumental architecture (e.g. Milbrath 1999, 65–70), while nadir alignments are not recorded. Whereas among some Maya communities we can find words describing solar zenith passages, no terms were recorded for the nadir (e.g. Vogt 1997, 111). The words phrased as "up" and "down" just mean "up" and "down" and do not necessarily denote "zenith" and "nadir" as the authors claim (pp. 64, 97).

In Chapter 6, "The Venus Almanac in Mesoamerica", Susan Milbrath examines representations of Venus in Mesoamerican imagery. Observing that the quincunx pattern and year sign may stay for symbols of the synodic period of Venus, Milbrath, following other scholars, emphasizes multiple associations of this planet with rain or the rainy season. This observation allows her to analyse the seasonality of Venus events in codices. Developing this idea, Milbrath studies the seasonal tables in the Madrid Codex pages 12b–18b. The tables depict the 260-day *tzolk'in* days assigned by the author to the period extending between February and October, or the 260-day agricultural cycle, still to be found in some ethnographic monographs (e.g. Girard 1948). Identifying the Chicchan Serpent with the Pleiades and Chac with a year sign with Venus, Milbrath then attempts to find a better chronological fit for this almanac. She also interprets Borgia Codex pages 27–28, where she finds the images of Tlaloc with a year sign, and Borgia Codex pages 29–46, where she attempts to correlate the synodic cycle of Venus with the annual cycle of calendrical ceremonies in 1496 AD. Finding a seasonal distribution of Venus events in Dresden Codex pages 24–29, she then applies this same approach to the analysis of different Venus depictions at Chichen Itza (Temple of the Jaguars, Temple of the Warriors, and Venus Platform) Mayapan (Structures Q161, Q9) and other Yucatan sites. Milbrath's paper is based on her other studies of seasonal Venus events.

The problem is that in their impressive monograph on *Astronomy in the Maya Codices*, Victoria and Harvey Bricker (2011) assign different dates to the codical pages analysed by Susan Milbrath. While the seasonality of Venus appearances is not in question, interpretation of the dates and calendar intervals is different. In part, those interpretations depend on the copies of documents utilized by scholars. I must admit that very few people can discuss these problems in detail.

Without any doubt, Venus was of great importance to the ancient Mesoamericans and was represented under different aspects, but always endowed with agentive abilities and rational will. In Chapter 4, "An Oracular Hypothesis: The Dresden Codex Venus Table and the Cultural Translation of Science", Gerardo Aldana y Villalobos looks at the Dresden Codex Venus Table (Dresden 24–29), one of the emblematic Mesoamerican documents revealing Maya astronomical capabilities. As is known, the structure of the table defines a synodic period of Venus as a length of 584 days, while this cycle actually varies between 579.6 and 588.1 days (Aveni 2005, 118 note 17). The Venus Table provides the dates of first and last appearances of the planet, either as Morning or Evening Star for a period of 65 consecutive Venus cycles, or 37,960 days, thus providing a greater accuracy for long-term dates than for short-term ones. Drawing on earlier works of Floyd Lounsbury, Anthony F. Aveni and Victoria R. and Harvey M. Brickers, Aldana attempts to resolve the problem of accuracy, proposing a model describing celestial observations as divinatory activities. According to Aldana, the role of the table was to warn the diviner of the possibility of Venus' arrival or departure from the sky, but whether it really happened some days in advance or afterwards was taken as an omen. In other words, the Venus Table is a kind of a divinatory matrix enabling the diviners (identified by Aldana as *ajk'uhuunob'*) to communicate with the planet, which was conceived as an animated entity. The table goal was to produce omens rather than to predict its appearances or disappearances. So whether the planet appeared/disappeared earlier or later than the table predicted, it was considered to have either a positive or negative influence on human life. Since the real date of the planet's appearance/disappearance could not have been predicted, this lack of precision added an aspect of uncertainty to the divinatory process. As Aldana observes, the table is associated with the East, so the table's omens are rather connected with the planet's heliacal rise. In other words, according to Aldana, Maya skywatching was celestial divination rather than astronomical observation.

Aldana's hypothesis shows the usefulness of the Venus Table in the context of mantic practices. His analysis suggests that the Postclassic knowledge of the synodical cycle of the planet was already systematized, and correlations between planetary phenomena and the events presaged by them re-assessed. It does not eliminate the possibility of applying the table to astronomical prognostications. After all, the Venus Table has initial series dates enabling observers to anchor observations made in real time.

Finally, in Chapter 7, "Glyphs G and F: The Cycle of Nine, The Lunar Nodes, and the Draconic Month", Michael Grofe revives the lunar hypothesis, explaining the functioning of G glyphs. Grofe argues that the sequence of Glyphs G1 through G9 corresponds to an eclipse pattern encoded in *tzolk'in* days. As is known, Maya inscriptions on Classic monuments sometimes contained a standardized series of glyphs called the Supplementary

Series that in turn encompassed a nine-day cycle composed of Glyphs G and F, the Lunar Series giving information about lunar cycles and rarely a seven-day cycle composed of Glyphs Y and Z, the 819-day cycle and fire rituals. Since on most monuments the nine-day cycle stays next to the Lunar Series, scholars sometimes analysed the usefulness of G Glyphs to mark important lunar events and eclipses. Following Teeple and Siarkiewicz (not cited), he notices a backward sequence of Glyphs G9 through G1 in relation to *tzolk'in* that creates a higher cycle of 2340 days equivalent to 86 Draconitic months (86 x 27.21222 = 2340.25092 ~ 2340 days), just returning "the moon exactly to the same node, but at a first quarter" (p. 140). So if Glyph G9 was used to help track eclipses, it could have been used by counting its positions backward by cycles of 260 days. Grofe suggests that the nine-day cycle was connected with a 260-day cycle to track the eclipse year and to mark the position of the Moon in respect to the Draconitic month. As some variants of Glyph 9 contain numerals, this could have been used to predict how many days there were to the eclipse, for example Glyph G1, containing a numeral of 9 would have announced that nine days were lacking to the nearest full Moon and eclipse, etc. (p. 154).

Of course, the major problem here is to find convincing evidence of the discovery of the Draconitic month among the Maya. One can find a solution to this problem in the technique employed in the Dresden Codex Eclipse Table, where the Maya attempted to relate the lunar month, the eclipse half-year and the 260-day *tzolk'in*. The table consists of 69 eclipse danger moments marked by the columns consisting of 60 six-month intervals and 9 five-month intervals, which together total 11,959 days; that is, 405 lunar months and one day less than 46 *tzolk'ins* (46 x 260 = 11,960). This yields an average half eclipse year of 173.319 days. The cycle of 2340 days is roughly equal to 13.5 half eclipse years, because 2340 ÷ 173.319 = 13.501. Furthermore, 2340 x 2 = 4680 ÷ 173.319 = 27.002 half eclipse years; observe also that 5 x 2340 = 11,700 + 260 = 11,960. It is interesting that 1329 x 9 = 11,961, so G Glyphs display similar retrograde movement (9 x 11,960) as is found in relation to *tzolk'in* (9 x 260). Perhaps, it is better to discuss a 173.31-day period instead of involving a concept of a Draconitic month.

In addition to his introduction, Gerardo Aldana y Villalobos also provides the epilogue, in which he discusses the content of the chapters in light of Bruno Latour's (1987) research on the production of scientific knowledge. The problem is that Latour's categories (inscriptions of scientific endeavors, skywatchers' labour, and the wider contexts in which astronomical knowledge was put) are practically undiscussed when confronted by individual papers. The primary resources for study of Maya astronomy is the record in Mayan codices recently published by Victoria and Harvey Bricker (2011), and this question might eventually be contested by them. The explicit astronomical references in Maya monuments are restricted to the Moon and a few other events, and still are not adequately treated to be able to adopt Latour's ideas of the production of scientific knowledge at one site and its acceptance or rejection in other Maya sites. Therefore, it is premature to apply Latour's proposal to Mayan archaeoastronomy. I agree with Aldana that the detailed examination of different classes of Maya priesthood may shed light on the social context of producing such knowledge.

The SAA session brought together scholars with different professional backgrounds interested in a wide range of topics in Maya celestial lore and divination, including the subfields of alignment studies and astronomical interpretations of the codices and hieroglyphic inscriptions. While chapters by Green, Sprajc and Milbrath involve some comparative analysis or synthesis of data, others are focused on extremely individual topics. However, there is little interaction between the chapters; they are prepared as though they existed in a vacuum rather than as creating a part of a regional archaeoastronomy. There are some contradictions between the conclusions reached by Green and Šprajc: according to Šprajc, alignments corresponding to sunsets on 30th April and 13th August do not appear in the Maya in the Late Preclassic sites, while Green emphasizes the importance of marking the sunrise on 30th April and 13th August at a site dated to the Late Preclassic Period. The Venus Table is either treated as an astronomical almanac (Milbrath) or as a divinatory matrix (Aldana). Certainly, these suggestions require much more critical evaluation.

The book is extremely well illustrated (often in colour), and the reader thereby gains a greater appreciation for Mayan archaeoastronomy. In my opinion the volume certainly provides important new insights about the astronomical realms of ancient Maya society. It certainly is a valuable contribution towards understanding astronomy in the context of culture.

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