Chapter 3: Pre-Columbian America

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Broadly speaking, our understanding of indigenous astronomical knowledge in the Americas through the ages is derived from historical accounts by Spanish chroniclers, reports by ethnographers and anthropologists working among native groups during the last 150 years, several well-presented archaeological and historical sites, numerous rock-art sites and the living traditions of indigenous peoples.

North and South America

As in other parts of the world, observations of the recurrent phenomena perceived in the sky aided the development of time reckoning among all Native American groups. The methods of time reckoning used by Native Americans often consisted of a crude designation of different periods of time arranged in a definite succession. The calendars they used were not intended for recording the number of days, months or years from any particular date; they only served to mark the passage of time within the current year.

Most populations in the Americas used a lunar calendar. While all native populations doubtless used a variety of natural events and also the stars for the determination of time, the observation of the phases of the moon might well have been instrumental in shifting attention from irregular time indicators to continuous time reckoning. Generally, two types of lunar time reckoning were used: the descriptive lunar series and the astronomical lunar series. The first type refers to a series of lunations named after the events or activities that served to be synchronized with them. People kept track of the succession of lunations with their distinguishing names, but not of the number of days in one lunation or the number of lunations within one year. In several cases, however, the counting of the moons became attached to a fixed point in the year, which served to mark the beginning of the annual cycle. Some Native Americans employed landmarks to fix the place on the horizon where the solstitial sunrise or sunset occurred; such an event would be followed by a sequence of lunations, twelve or thirteen of which would pass before the sun reached the solstitial point again.

In some cases, shadows cast by, or light-and-shadow phenomena produced by, a range of natural or artificial features were employed to mark the solstices. In many places, houses made of perishable materials such as wood, cane, and hide functioned as rudimentary solar calendars, with arrangements of posts or holes allowing for the accurate determination of the solstices, dates of zenith passage, or other dates especially important for their inhabitants. Since almost nothing remains of such structures above the ground, only careful archaeological excavations can inform us about their specific alignments with the sun. Only a small number of native populations recognized the importance of the equinoxes, and this knowledge was not used in their time-reckoning systems.

Another astronomical method of reckoning the time derived from observations of the stars or planets. The (heliacal) rising of specific constellations or asterisms (most commonly the Pleiades or the stars of Orion) served to mark the beginning of the year.

The creation of order is a feature common to all Native American societies and its physical manifestations may be perceived in a wide range of material remains left by them. A common characteristic is that actions such as centring settlements, ordering dwellings and aligning burials stem from a shared knowledge of origins ('origin myths') and communal world-views that embody a variety of astronomical and cosmogonic principles. The ability to design and orient dwellings, shrines, temples, palaces or burials according to the annual movements of the sun is testimony to the knowledge of the sky possessed by many Native American groups.

While Amerindian societies had notions of days, months and even years, these were not usually clearly bounded units, and time reckoning tended to be in terms of qualitatively distinct types of recurring events. There is really no evidence that time was conceived as a uniform, abstract and continuous flow; qualitative aspects are always present in Native American notions of time. In other words, time concepts are concerned with the succession of events or the relation of these successive events with the present. There is no evidence of the development of the idea of abstract time as a dimension within which several processes may be coordinated.

Many Amerindian societies recognized the division of space into four quarters. These were usually conceived statically, based on the rising and setting positions of the sun at the solstices. The division of the surrounding world into four quadrants is a common feature of all Native American groups, up to the present (see Chapter 4). The cardinal points were (and are) not so much abstract directions as value-laden localities associated with different supernatural entities and ordering principles. Even astronomical-calendrical cycles are seen as embedded in the life-space of Native American groups, since they are often represented by a symmetrical space of cardinal (or inter-cardinal) directions modelled after the sun (and the stars).

North America

In broad terms, solstitial-lunar calendars existed among the hunters and gatherers of the Northwest, the horticultural and hunting communities within the Mississippi River valley, the agricultural groups of the Southwest, and the nomadic groups in northern Mexico. A variety of solstitial observation stations have been discovered in each of these areas.

A few claims have been made that some North American groups noted the 18.61-year (node) cycle of the moon.

The constellation of Ursa Major, the Pole Star, the belt of Orion, the Pleiades and the Hyades were known among North American communities, as were several bright stars such as Sirius, Aldebaran, Antares, Altair and Fomalhaut, together with the planets. In spite of this, most Northern American communities seem to have paid less attention to the stars, knowing the names only of a few.

Although all North American groups possessed some knowledge of the sky, in several cases specialized time-keepers or star-gazers were needed to observe the exact time of the rising of a star. Sometimes specialists were required to watch the sun. In most cases, it was the duty of a few elderly men, who represented the wisdom of a whole society, to watch the sky. In other communities the timekeepers were the priests, who used their observations of the sun or moon to determine the proper time for agricultural activities as well as for religious ceremonies. In many cases these religious officials made anticipatory observations to forecast ceremonial dates ahead of time.

Several observation stations have been recorded and described in the specialist literature. Sometimes they consisted of rock art depictions of the sky as it was perceived by native groups. These rock art representations deserve attention, since they can inform us about native constellations, asterisms, and bright stars and planets.

The starting point for counting of the days of the lunar month was the first appearance of the lunar crescent in the western sky just after the sunset. The lunar month was commonly divided into two halves, but some North American groups who used the decimal system of

counting divided the lunar month into three ten-day periods. Although lunar calendar sticks and rock-art tallies are extremely rare, they nevertheless tell us about the methods used by specialized skywatchers to track the lunar cycle over larger time intervals (see Case Study 3.1).

South America

South American communities, like their North American counterparts, used the moon to reckon time. Descriptive sequences of lunations, similar to one another, are found among Amerindian societies living in the tropical forest of Amazonia and in Patagonia. However, the observation and naming of the lunar phases remained quite unsystematic. Three divisions of the lunar month were generally identified—waxing, culmination, and waning—with numerous activities being tied to them, while the period of the dark (invisible) moon was avoided.

Unlike North American groups, Amazonian and Patagonian communities frequently used constellations and asterisms to determine the time of important seasonal activities or to mark the starting point of subsistence activities. The Pleiades signalled the rainy season and the need to start clearing for planting. The stars of Orion marked the manioc season. Among other stars known in Amazonia are Sirius, Aldebaran, Capella, Castor and Pollux, the stars of Auriga, the Southern Cross, Scorpio and Centaurus. The Milky Way was particularly important, with its dark rift located near Scorpio and Sagittarius, as were the Magellanic Clouds. In short, the determination of time from the stars seems to have been much more common in South America than in North America.

Moreover, Amazonian societies often used interior light-and-shadow effects and shadow casting to determine the time of day. Their buildings were designed so that beams of sunlight could be observed moving across the walls and floors. The course followed by such beams also changed gradually from day to day, corresponding to the seasonal changes in the sun's trajectory across the sky.

Anthropological studies show that knowledge of the sky was important because of the relationship they perceived between human societies and celestial objects. Amazonian Indians perceived themselves to be a part of a universe in which humans, animals, plants and astronomical objects formed a single community, constantly intercommunicating. Astronomical objects were used to mediate between the individual and subjects of concern to all. Activities such as stargazing or time-keeping were seen as part of the collective life of the community and often used to designate individual and collective identities. Calendrical and astronomical knowledge was embedded in a variety of religious rituals, agricultural ceremonies, political discourses and world-view beliefs, and was embedded in mythological storytelling, ceremonial dances, the organization of domestic space and other social activities. Some social organizing principles may also have been derived from the material surroundings and embodied in the dwellings and burials of various American groups.

Mesoamerica

The painted codices and manuscripts of prehispanic Mesoamerica are perhaps the best examples of calendrical-astronomical speculations and computation ever made by the populations of ancient America. The Mesoamerican calendrical system is displayed in the form of many different permutations, which are usually connected to divinations; but besides tracking temporal cycles these codices are aimed at the explanation of temporal and supernatural forces that gave form and structure to the surrounding world. In a sense, they expressed the universal laws governing the world as it was then conceived. Different sections of these codices refer to astronomical observations of the planets, eclipses, computations of the tropical year, and native cosmogonies. Astronomical practices by the Maya or by the Aztecs sometimes attain the level of systematic observations and theoretical modelling of celestial movements. There is no doubt that they should be regarded as examples of non-Western systems of knowledge.

The Mesoamerican system of time-reckoning is exceptional. A period of 260 days in combination with the 365-day year cycle, producing a 'Calendar Round' (cycle of roughly 52 years), is a method of marking the passage of time unique in the history of humankind. So also is the vigesimal system of time-reckoning that produces the Long Count, a continuous count of the days from mythical beginnings (and is responsible for current fears that the end of the world will occur in 2012).

Our knowledge of the astronomical practices of prehispanic peoples in Mesoamerica derives from prehispanic written records as well as the other sources mentioned at the beginning of the chapter—Spanish historical reports, numerous well-preserved archaeological sites, and the living cultural traditions of indigenous populations. A number of Mesoamerican sites with important astronomical connections are already inscribed on the World Heritage List, including:

- *Pre-Hispanic city of Chichen Itza, Yucatan, Mexico, no. 483, inscribed in 1988 under criteria (i), (ii) and (iii).* A regional civic-ceremonial polity by the end of the 6th century AD. It developed towards the Late Classic and the Terminal Classic periods (roughly 10th and 11th centuries). It declined after 1221 (because of a civil war). Visitors come in considerable numbers on the day of the spring equinox.

  Archaeoastronomical elements: **El Castillo** (*Temple of Kukulcan*) which displays the equinox phenomenon**; El Caracol** (solstice sunset alignments, sunset on the day of zenithal passage, the northernmost setting position of Venus, sunset at the equinoxes, sunsets on April 29 and August 13, etc—there are multiple orientation possibilities); the **Great Ball Court** (***Temples of the Jaguar*** – pointing to the sunsets on April 29 and August 13); **Las Monjas** (pictorial representations of the Maya zodiac); **Temple of Venus** (iconographic representation of 8 solar years equalling 5 Venus cycles); etc.
- *Maya Site of Copan, Honduras, no. 129, inscribed in 1980 under criteria (iv) and (vi).*
- *El Tajin Pre-Hispanic city, Veracruz, Mexico, no. 631, inscribed in 1992 under criteria (ii) and (iv).* A Totonac ceremonial-civic polity that developed around the 1st century AD and peaked between 600 and 900.

  Archaeoastronomical elements: the **Pyramid of the Niches,** an architectural model of the world (it contains a series of 365 niches).
- *Historic Centre of Oaxaca and Archaeological Site of Monte Albán, Mexico, no. 415, inscribed in 1987 under criteria (i), (ii), (iii) and (iv).* A ceremonial-administrative centre situated on the top of an artificially-levelled ridge over the valley floor. The city was founded around 500 BC and later became the capital of a Zapotec polity that interacted with other regional states such as Teotihuacan. Largely abandoned around 900–1000 AD.

  Archaeoastronomical elements: the unusually oriented **Structure J** towards the stars of the Southern Cross and Centaurus on one side and towards the heliacal rising position of Capella on the other; vertical shaft (zenith sighting tube) of **Structure P** (for observations of the zenith passage of the sun); several astronomically oriented stelae; **Stelae 12 and 13**, with first inscriptions referring to a solar year, orientations attesting the division of a 260-day calendar into 4 minor cycles (*cocijos*) of 65 days each, etc. Examples of Zapotec hieroglyphic writing (*Danzantes* stones).
- *Pre-Hispanic City and National Park of Palenque, Chiapas, Mexico, no. 411, inscribed in 1987 under criteria (i), (ii), (iii) and (iv).* One of the most important Mayan sites, it reached its height between 500 and 750 AD.

  Archaeoastronomical elements: inscriptions referring to the conjunction of planets (Jupiter, Saturn, and Mars and the Moon) and the birth of three ancestor patron gods I, II, and III and the First Mother, in July 690; the **Temple of Inscriptions** (with the tomb of Janaab´ Pakal); the **Palace** and the **Group of the Cross**.

Fig. 3.0.1. El Caracol, Chichen Itza. Photograph © Clive Ruggles.

- *Archaeological Park and Ruins of Quirigua, Guatemala, no. 149, inscribed in 1981 under criteria (i), (ii) and (iv).*
- *Pre-Hispanic City of Teotihuacan, Mexico, no. 414, inscribed in 1987 under criteria (i), (ii), (iii), (iv) and (vi).* Founded before 150 BC and collapsed after 550 AD.

  Archaeoastronomical elements: the **Pyramid of the Sun** related to the mythical origins of the current era (on August 11–13, 3114 BC), to the dates (April 29–30, August 11–13) of the zenith passages of the sun at latitude 15° (e.g. at Izapa, Edzna or Copan in southern Mesoamerica) or to the days defining the agricultural year (February 11, October 29). Orientation pattern later diffused over the great part of Mesoamerica. Other astronomically oriented structures are: the **Avenue of the Dead,** the **Pyramid of the Moon**, the **Ciudadela** (Citadel, with calendar symbolism) and **cross-circle figures** pecked in stucco floors.
- *Tikal National Park, Guatemala, no. 64, inscribed in 1979 under criteria (i), (iii), (iv), (ix) and (x).*
- *Pre-Hispanic Town of Uxmal, Yucatan, Mexico, no. 791, inscribed in 1996 under criteria (i), (ii) and (iii).* A major Mayan centre, built between about 700 and 1100.

  Archaeoastronomical elements: the **Governor's Palace** (alignments to the Venus extreme positions, (eastward or westward), iconographic representations of the Venus cycle and of the Mayan zodiac; the **Nunnery Quadrangle** (astronomical imagery), visual relationships between the most important structures as viewed from the top of the **Adivino** (Pyramid of the Magician).

Fig. 3.0.2. The Pyramid of the Sun at Teotihuacan. Photograph © Clive Ruggles.

- *Archaeological Monuments Zone of Xochicalco, Morelos, Mexico, no. 939, inscribed in 1999 under criteria (iii) and (iv)*. Developed around 200 BC and flourished between 700 and 1000 AD.

  Archaeoastronomical elements: **Temple of the Feathered Serpent** (iconographic imagery referring to hypothetical calendar reform in the 7th century AD) with calendrically significant alignments; **vertical shaft** facilitating observations of the zenith sun or moon (latitude 18º 43´); one of the **ballcourts** permits equinox observations; stelae with calendrical inscriptions; etc.

A site not on the List but worthy of mention is *Uaxactun (Waxaktun), Guatemala*. Its **Group E** is the oldest architectural complex in the Americas ever analyzed from an archaeo-astronomical point of view (in 1924).

It is also important as having become the 'type site' for a group of structures now known as 'Group E structures'. These are Mayan structures of distinctive form—one western pyramid with two or three in a north-south line located to the east—that are found in the Petén and, like the one at Uaxactun itself, appear to have been associated with observations of sunrise at the solstices and equinoxes. Their importance as a group, if so, derives from the fact that some were clearly functional while others were, or became, non-functional, thus showing how actual observations may have become transformed into purely symbolic astronomy.[1]

[1] Paragraph added by CR.

The Andean area

The various Andean populations in South America had a good knowledge of the sky, though less advanced than those of Mesoamerica. All the Andean peoples used the decimal system of time-reckoning, were able to describe various astronomical phenomena such as eclipses and the heliacal risings of Venus and the stars, and constructed temples to display alignments with the sky.

In Inca times, the *ceque* system consisted of 41 lines emanating from the Inca Temple of the Sun called Coricancha in the Inca capital Cuzco. The ceque system defined 328 sacred places (*huacas*) and it has been argued that this was associated with the use of a lunar sidereal calendar.

In several cases, observatory devices were built to permit precise sun-watching. In the region of Cuzco a pair of vertical pillars located on a ceque line was observed from Coricancha. The pillars marked the course of the sun along the horizon. Several systems consisting of standing pillars are reported in the literature, including one—Chankillo—that predates the Inca empire by some 1500 years (see Case Study 3.3).

Around the Inca empire, platforms known as *ushnus* seem to have served to symbolize the authority of the Inca in various ways, and specifically as places for performing rites related to the sun and the calendar together with sacred elements in the surrounding landscape such as prominent mountain peaks (for an example see Case Study 3.4).

Our knowledge of the astronomical practices of prehispanic peoples in the Andean region derives from prehispanic 'written records' (such as the knotted string devices known as khipu) as well as the other sources mentioned at the beginning of the chapter.

Central America and the Caribbean

Unfortunately, all the indigenous groups that practiced sky-watching and calendar-making in this region in the remote past have disappeared. Very little information has been left by Spanish, French, Dutch or British chroniclers and archaeological research has not been directed to the study of astronomical alignments. Today the Caribbean is populated by diverse African-American groups that are culturally connected with African traditions. This means that their astronomical lore is likely to derive from the traditions of that continent rather than from the knowledge of the indigenous American populations. Only the south Caribbean area, which is connected to the South American tradition, has received significant attention from ethnoastronomers.

The traditional skylore of the ancient Caribbean shows that important celestial events were associated with seasonal meteorological phenomena and agricultural activities. The Pleiades, Sirius and the constellations of Orion and Ursa Major appear to have been important in marking the onset of the cyclone season and the periods suitable for fishing, hunting and gathering. Unfortunately, the potential of stellar observations for the purposes of navigation has not been fully researched.

The calendar lore and astronomical activities of Central American peoples have not received adequate attention from scholars and, with just a few exceptions, have not been studied in a systematic way.

General considerations

'Western' scientific knowledge stems from the 'way of knowing' that characterised European societies from the 16th century onwards. It follows that each type of non-Western knowledge can only be reduced to the Western model (i.e., examined by those working within the Western tradition) at the cost of losing of some of its non-Western cognitive elements,

traditions or frameworks of thought. Non-Western sky-lore and astronomical knowledge, from the Western perspective, are bounded by their cultural frameworks, and were not meant to transcend any regional, cultural, ethnic or national boundaries. Astronomical knowledge in non-Western America is strictly connected to numerous cultural values and should be regarded as ethnocentric rather than as an abstract and universal system. By contrast, the scientific method developed by the West is a universal method. Unfortunately, among historians of science in general and historians of astronomy in particular, the influence of positivist thought still prevails—in other words, the model of Western science provides the standard against which all other non-Western science is judged. This model of science continues to impede the development of suitable frameworks within which non-Western science can be adequately understood. Only a post-positivist orientation in the history of science can offer a proper epistemological context within which the UNESCO astronomical heritage project can be adequately addressed.

In this context it must be emphasized that Native Americans developed various systems of sky-lore, perceived different objects and events in the sky from previously chosen observation stations, encoded celestial alignments in architectural structures, and studied the solar and lunar cycles to anticipate and regulate economic and ceremonial activities. Some of those societies needed specialists responsible for watching the sky, and celestial knowledge and the art of calendar-making were used to generate and sustain relations of power and social inequality. The astronomical knowledge of Native Americans has always been bounded by culture.

The study of astronomical properties in the Americas shows that numerous celestial objects may be depicted in rock-art sites. Most of them are in the form of motifs that represent lunar crescents, sun-discs or star-like objects. Rock-art motifs are often interpreted through mythical narratives, and relate implicitly to mythological storytelling that describes the concepts of the world, including origin myths. These mythical narratives are often connected to other ceremonial activities such as dance and rituals performed on specific occasions. These are often used to present origin myths (like the famous Deer-Dance in northern Mexico) in which different stories of the birth of the sun, moon and stars are recounted. There are songs intoned to the first visible lunar crescent, to the heliacal rise of a brilliant star, and so on. This intangible heritage related to astronomy is particularly abundant in areas where very little material heritage remains, such as the tropical rain forest areas of Central America, the Caribbean, and the Amazonian and Patagonian regions (for an exception see Case Study 3.2).

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[2] Supplied by CR.

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Case Study 3.1: Boca de Potrerillos, Mexico

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Presentation and analysis of the site

Geographical position: Municipality of Mina, State of Nuevo León, Mexico.

Location: Latitude 26º2´40˝N, longitude 100º 38´40˝W. Elevation 700m above mean sea level.

General description: The Boca de Potrerillos site is one of the most important petroglyph sites in Mexico. It consists of more than 4000 rock boulders and rock panels containing numerous petroglyphs located on mountain slopes within an attractive landscape typical of the deserts of north-eastern Mexico.

Inventory of the remains: The site covers approximately 435 ha and the archaeological remains are distributed within three main topographical features:

a. An extended alluvial fan located on the eastern part of the site with the remains of hundreds of prehispanic hearths called *fogones* and thousands of carved lithic and grinding artifacts, which are widely dispersed on the surface.
b. Another alluvial fan located on the western part of the site with the same kinds of dispersed artefacts, but on a minor scale.
c. The eastern flank of the El Antrisco and La Zorra mountains where there are thousands of rock boulders and loose rocks, all of them covered with petroglyphs on one or more sides.

History of the site: The site was first reported in 1963, by María Antonieta Espejo, an archaeologist from the Instituto Nacional de Anropología e Historia (INAH). In the 1980s it

[3] With notes supplied by Moisés Valadez Moreno, Regional Centre, National Institute of Anthropology and History, Monterrey, Nuevo León, Mexico.