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Astronomy and Calendrics on the Coast of Peru

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THE "TRADITION" of archaeo-ethnoastronomical studies that has developed in recent years in Peru[1] has centered on the astronomical and calendrical systems of the Incas and the contemporary Quechua-speaking Indians of the Department of Cuzco. Whether the focus has been on pre-Columbian or contemporary times, the principal concern has been with understanding the calendrical systems that were adapted to the rugged, essentially vertical Andean world. Our studies of Quechua astronomy in the highlands reflect a pattern of the correlation, within a single calendar system, of a wide range of natural cycles pertaining to a variety of ecological zones and astronomical phenomena. However, one would expect that highland Peruvian calendrics would differ in some respects from the calendrics of the coast. Along the strip of dry coastal desert, resources vary horizontally (i.e., the alternation of stretches of desert and river valleys). As one moves eastward toward the nearest range of coastal mountains, the horizontal variation gives way slowly to the highland pattern of vertical variation. Therefore, one would, perhaps, expect to find significant differences between highland and coastal calendrics, given the respective vertical and horizontal variation in the distribution of resources. However, it is also reasonable to expect some blending or convergence of traditions with regard to the astronomical periodicities encoded in the calendar systems of these two regions given the fact that the coast and the highlands lie within the same latitudinal boundaries.

The coast of Peru stretches from 3° to 18° south latitude and between 70° and 81° west longitude. There are a number of environmental and climatic differences along the coast from the extreme north to the ex-

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treme south; in general, the coastal strip is characterized by an increasing dessication as one moves from north to south. On the north coast, for instance, the Moche valley receives an annual precipitation of 0.5 cm, primarily in the form of winter season mists; the lack of precipitation on the south coast is even more extreme. The aridity of the coastal environment is a result of the cold northward-flowing Peru (or Humboldt) Current, which cools and dessicates the prevailing southwesterly winds. The cool air is condensed, then warms up as it passes over the coastal desert. The warmer air results in fog, particularly prevalent during the winter, which is deposited not along the coast but rather along a "fog belt" on the western slopes of the coastal mountain range. The fog belt supports a seasonal, highly specialized vegetation called the lomas.[2] Concerning the seasonality of the lomas: "The temporal availability of lomas products was irregular. . . . The microcyclic or seasonal bloom of the lomas stands extends from about July to November, with various products becoming accessible at different times. . . . However, by December the lomas completely disappear and the stands revert to desert."[3] The extent of the lomas vegetation during pre-Columbian times, and the degree to which it was actively exploited by early populations, are matters of some debate, but it is clear that its resources and seasonality had a significant effect on the subsistence strategies of coastal populations.

Another seasonal factor in the subsistence systems on the coast is the periodic change in the amount of water available in the numerous rivers that descend from the coastal mountain range and flow across the dry coastal desert. As these rivers run full only during the summer months (December–March), their seasonality represents a periodicity that has been of considerable importance to survival along the coast. With the development of intensive irrigation agriculture along the coastal river valleys, which began between 2000 and 1500 B.C.,[4] the temporal variations in the amount of surface water were an increasingly important cycle for incorporation in the coastal calendar systems.

The most stable food source, although not the most abundant,[5] throughout the long history of human occupation of the Peruvian coast derives from the sea. Marine fish and shellfish, in addition to shorebirds, appear in the refuse of shoreline fishing villages beginning around 12,000–10,000 B.C. Variations in what is referred to as "microcyclic" availability of marine foods is a subject of some controversy. In general, we can accept Moseley's observation that ". . . most near-shore fish, seafowl, and algae are available throughout the year . . . ," but must reject his further qualifying statement that the availability of these resources

was not subject to significant microcyclic fluctuations. Moseley's observation is insupportable in light of recent studies;[5] but, more importantly, very few intensive studies have been carried out on the biological and tidal (e.g., diurnal, semi-diurnal, lunar, semi-lunar) rhythms of marine fauna and flora off the Peruvian coast.[6] From comparative studies,[7] we know that calendars that integrate biological and lunar/tidal cycles are extremely complex and, until we know more about the tidal and marine biological rhythms off the Peruvian coast, we cannot assume that minor fluctuations did not exist and did not serve as important temporal markers in the calendars that were adapted over time to the coast of Peru.

From the above description, we are provided with two ways of seeing astronomy and calendrics on the Peruvian coast. First, the cycles that were first organized in coastal calendar systems were no doubt those which were of most immediate, local importance in securing a livelihood. This would have included such periodicities as marine cycles, the seasonal flowering of the lomas, and seasonal differences in the amount of fresh water available in the coastal river valleys. In the historical development of coastal cultures, the local calendar systems that developed within each river valley would have been subsequently integrated, through trade, pilgrimage, and so on, with other such systems operating within adjacent and distant valleys. Second, as coastal, marine-oriented groups began to exploit resources further up the coastal valleys with the development of irrigation agriculture, one would expect the appearance of some rather complex transitional systems adapted to a wider range of subsistence activities combining fishing, gathering, and intensive agriculture within multiple ecological zones. For example, I would suggest that the lines on the plain of Nazca may reflect such a transitional system and that the complexity of this system may derive from the integration of coastal and highland patterns of calendrics, astronomy, and agricultural organization.[8]

In constructing a hypothesis for the calendrical organization of activities on the coast and suggesting how observations of celestial phenomena were integrated into the calendar, we can best begin by outlining the contemporary calendars operating within this zone and compare these temporal patterns and observational data with those that may have existed in pre-Columbian times. To be clear from the outset, we are not proposing that purely indigenous calendars are still used on the coast. Since the time of the Spanish conquest, there have been tremendous changes in the utilization of the coastal valleys for agricultural purposes. The impact of Spanish culture and the wholesale extermination or replacement of the aboriginal population has been much more complete on the coast than in the sierra, although there are still small fishing villages in which limited knowledge of the pre-Spanish languages of the coast survive.[9] Despite the disappearance of the aboriginal populations and the introduction of new crops and capital-intensive, mechanized farming practices, there are certain elements of continuity, especially in terms of environmental factors, which constrain the contemporary economy just as they did in the pre-Columbian period.

It should be pointed out that, in addition to the same environmental setting and the same subsistence system, the coastal farmers and fishermen today are exposed to the same astronomical phenomena at the same times of the year as the pre-Conquest populations. Therefore, we would expect that stars used in navigation by fishermen off the coast of Peru, whether the fishermen are Indian, mestizo, or Spanish, are not stars related to navigation in some other part of the world (e.g., Spain), but rather are those stars and constellations which are most efficient for determining one's bearings in traveling to and from good fishing locations off the Peruvian coast at different seasons of the year.[10]

In the traditional fishing village of Huanchaco, located on the north coast in the Moche valley, there are fishermen who consider themselves descendants of the Chimu, the people who occupied the Moche valley at the time of the Spanish conquest. Just offshore, these fishermen still fish in caballitos (small reed boats); farther out at sea, they fish in both sailboats and small motorized craft. If we suppose that the modern-day location and periodicity of shoals of fish off the north coast are similar to their location and periodicity in pre-Columbian times, we would expect that the contemporary system of navigation would be very similar to that of the Chimu fishermen who worked these waters during pre-Spanish times. As for contemporary navigational and fishing techniques:

> The knowledge of the sea . . . is acquired during apprenticeship and by direct experience, such as with the recognition of the appearance of shoals of fishes. This is related to the movements of the moon, the seasons of the year, the coloring of the waves, the temperature of the water and the air, the relative position of stars in the sky, and the debitage that has been cast up on the beach.[11]

In 1944, John Gillin undertook six months of ethnographic fieldwork in the communities of Moche and Huanchaco,[12] both of which are located in the valley of Moche. The Moche fishermen use no watercraft, and all fishing is done either from the shore, in the Moche river, or in the irrigation ditches. The only offshore fishing done by the Moche fishermen is during the summer months (November to May) when fishing boats from the village of Huanchaco pick them up and the two groups fish together in the waters off Moche. The fishermen of Huanchaco are important for this study because of their deep-water fishing techniques and navigation by astronomical orientations. Huanchaco is thought of as a "Moche" village. The Moche (or Mochica) occupied the north coast before the Chimu, who were their descendants. The center of the Moche kingdom was in the Moche valley, although their influence, as evidenced by the archaeological record of the distribution of Moche-style art, architecture, and pottery, covered much of the north coastal area during the period from about 200 B.C. to A.D. 600.

The villagers of Huanchaco are primarily fishermen, although they also cultivate land inland from the village. Gillin has provided a good description of the fishing paraphernalia and practices in Huanchaco, but I will concentrate here on the astronomical knowledge he records. The best fishing months off the coast of Huanchaco are from late November to early June. During this period, the fishermen either fish off the waters in front of the Moche valley or fish much farther out at sea. During the best fishing season, the boats leave at noon and stay out all night.

> The boats stay out at sea . . . until dawn of the following morning. . . . Time is kept by the stars. For example, according to Felipe Carranza, the *Lucero de la Mañana* appears in November at about 4 a.m.; *Las Cabrillas* (Pleiades) about 3 a.m.; and *El Arado* sets between 3 and 4 a.m., at about the same time that the *Cruz de Mayo* appears. When these astronomical signs show that the hour is between 3 and 4 o'clock in the morning, the boats begin to return to port. Usually the boats are out about 16 to 20 miles. . . .[13]

There are several problems with Gillin's description of the astronomical observations made in November. First, he says that the *lucero de la mañana* rises at about 4 A.M. in November. In Spanish, *lucero* refers specifically to Venus as the morning-star. However, in November 1944 (the year of Gillin's fieldwork), neither Venus nor any other planet appeared as the morning-star.[14] Therefore, the "*lucero*" *de la manana* was probably a bright star, perhaps Regulus or Spica.

Second, Gillin says that the Pleiades (*las cabrillas*—"the little goats") rise in November at about 3:00 A.M., but, in fact, they set just before sunrise and rise just after sunset at this time of the year.

Third, the statement that *el arado* ("plow") sets between 3 and 4 A.M. is difficult to interpret because Gillin does not identify the constellation. In highland Quechua astronomy, the "plow" is either the constellation of Scorpio or the Big Dipper.[15] In November, the Big Dipper rises about 3 A.M., while Scorpio rises at about the same time as the sun. With the limited description at hand, therefore, it is impossible to choose one identification over the other.

Fourth, Gillin says that the *cruz de Mayo* ("cross of May") appears between 3 and 4 A.M. Cruz de Mayo is not, to my knowledge, a European, Spanish, or Andean constellation.[16] Since the villagers of Huanchaco celebrate the festival of Cruz de Mayo (the Invención de la Santa Cruz) on 3 May, I suspect that an indigenous "cross" constellation was given the name of the principal Catholic festival devoted to the cross (the Cruz de Mayo of 3 May). As the Southern Cross rises just before sunrise in mid-November, and rises at sunset in late April, I would tentatively identify this constellation as the Cruz de Mayo. When we recall that the period from November to late May is the period of the best fishing off Huanchaco, it is clear that the Southern Cross could represent an important constellation in the coastal fishing calendar. It should be noted as well that *las cabrillas*, the Pleiades (at right ascension 3 hr 40 min), are located opposite the Southern Cross (R.A. 13 hr 30 min); therefore, the appearance and disappearance of these opposed constellations can be observed together to time the best fishing season off the coast of Moche.

Having discussed some of the astronomical phenomena observed by the fishermen of Huanchaco during the month of November, we can look more closely at the calendrical periods and saints' days associated with the fishing cycle, and conclude this section with an outline of the combined fishing and agricultural calendar on the north coast.

The best months for fishing in the waters off Huanchaco are from late November to early June. During the months from July to October, the fishermen of Huanchaco fish to the south of the Moche valley, in some cases going as far south as the Santa river. There are three principal festivals celebrated during the year in Huanchaco. The festival of San Pedro, patron saint of fishermen, is celebrated on 29 June, a time when there is relatively poor fishing in the area of Huanchaco. Secondly, the village has a cross cult and celebrates the Invención de la Santa Cruz (Cruz de Mayo) on 3 May. The third major festival takes place once every five years when La Virgen de Socorro, who is said to take a special interest in the village of Huanchaco, is taken on a pilgrimage from Trujillo to Huanchaco. The pilgrimage begins on 30 November, the day of San Andrés, and arrives in Huanchaco on 24 December.[17]

I will hypothesize that the three festivals celebrated today in Huanchaco are the result of the syncretism of Spanish Catholic festivals with local, pre-Spanish celebrations related to the beginning and ending dates of the fishing and agricultural cycles as they are timed by the heliacal rise and set of the Pleiades. As for the importance of the Pleiades, Gillin states that they are observed by fishermen in November, but we know as well that the Pleiades were important in this area during early colonial times. In 1638, Antonio de la Calancha published an account of the history and beliefs of the indigenous population in the Pacasmayo valley, which is north of the Moche valley. These people, the direct descendants of the Chimu, spoke a language called Yunga by the Quechua-speaking Indians of the highlands.[18] In the language of the Yungas, the Pleiades were called Fur:

> They [the Chimu] do not count the year by Moons, nor by the course of the Sun, but rather from the rise of the stars which we call the *Cabrillas* [the Pleiades] and which they call Fur. The reason for this is found in a long fable, which is none of my concern. It was a law that they counted the year thusly, because these stars gave them food and nurtured their crops, for their livelihood, therefore, they had to begin the year from the time they saw it appear and it gave them sustenance.[19]

If we accept that the Chimu year was calculated by the heliacal periodicities of the Pleiades, how does this relate to the saints' days celebrated today in the village of Huanchaco? The Pleiades begin to rise at sunset on 18 November. They then undergo heliacal setting (at dusk) on 19 April, are invisible for about 45 days, and reappear in the east in the early morning of 3 June. Therefore, the rise of the Pleiades just after sunset near the day of San Andrés (30 November) marks the beginning of the good fishing season and their heliacal rise in the early morning hours of 3 June marks the approximate end of the good fishing season. If we combine the fishing cycle with the agricultural cycle in the Moche valley, we will arrive at a better understanding of the 45-day period of disappearance of the Pleiades from late April till early June.

The Mocheros plant and harvest two crops a year. The "wet season crop" is planted in early December and harvested in May; the harvest festival is celebrated on the day of San Isidro (15 May). The "dry season crop" is planted in early June and harvested in October; the harvest festival of this crop is on the day of the festival of Cristo Rey, on 22 October.[20] If we combine the agricultural and fishing cycles, we find that their boundaries closely correspond to the heliacal rising and setting times of the Pleiades as outlined above (FIGURE 1).

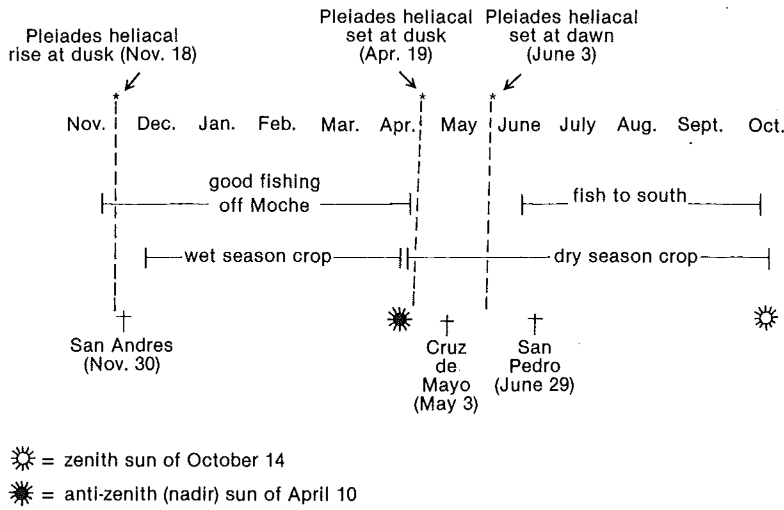

FIGURE 1. Moche/Huanchaco calendar.

In FIGURE 1, I have included the periods of the fishing cycle, the two agricultural cycles, the rising and setting periods of the Pleiades and the dates of one zenith and one nadir passage of the sun. The importance of the latter two dates will be discussed later. I would suggest that FIGURE 1 illustrates well Calancha's statement that the Pleiades were thought by the Chimu of the north coast to be responsible for their livelihood. The periods of transition in the various subsistence activities are correlated rather closely with the times of the heliacal rise of the Pleiades (at both dusk and dawn).

It may be hypothesized from FIGURE 1 that, in the process of syncretizing the Spanish Catholic calendar of saints' days with the indigenous calendar based on the Pleiades, San Andrés correlated well with the heliacal rise at dusk of the Pleiades; the period from Cruz de Mayo to San Pedro was associated with the period from the disappearance of the Pleiades until their heliacal rise at dawn in early June. It should also be recalled here that, as mentioned by Gillin, Cruz de Mayo refers to a constellation, probably to the Southern Cross. As I have mentioned, the Southern Cross and the Pleiades are in opposition to each other and, therefore, as the Pleiades set at dusk (on 29 April), the Southern Cross set at dawn (13 April). I would suggest that, in the indigenous calendar of the Chimu, the transitional period related to the end of good fishing, the harvest of the wet season maize crop, and the planting of the dry season crop, was bracketed by the period from the heliacal rise of the Southern Cross until the heliacal rise of the Pleiades.

In FIGURE 1, I included the dates for one zenith and one nadir (i.e., midnight nadir) passage of the sun. From our research on Andean astronomy, we know the importance of the zenith and nadir passages of the sun in connection with the agricultural calendar.[1] I will suggest that the same was, and still is, true in the agricultural calendar of the north coast. The village of Santiago de Cao is located at 7° 40′ south latitude in the delta of the Chicama river, the next major river valley north of Moche. The agricultural cycle in Santiago de Cao has been studied and described extensively by Jose R. Sabogal Wiesse.[11] The single crop of maize produced today in Santiago de Cao is planted in March and harvested 5½ months later. The agricultural cycle, from planting to harvesting, is correlated with the phases of the moon. The timing begins with a series of injunctions concerning the time to plant and harvest:

a) plant during the month of March
b) plant maize just after the new moon; some say 3–4 days after, some say 6–7 days. In general, maize should be planted during the waxing moon; it is bad to plant during the waning, fourth quarter of the moon
c) Maize should be planted on, or by, Domingo de Ramos, the Sunday before Easter
d) Maize matures in 5½ months and should be harvested during the full moon.[21]

The only date that is "fixed" in the series of injunctions concerning the time to plant is the date of Domingo de Ramos (Palm Sunday). However, Domingo de Ramos itself is not actually a fixed date since it is celebrated on the Sunday before Easter, and the latter is celebrated on the Sunday after the first full moon after the equinox of 21 March. Since Easter can fall anytime during the period from 22 March to 25 April, Domingo de Ramos falls one week earlier (i.e., from 15 March to 18 April; the full moon always comes between Domingo de Ramos and Easter. If the campesinos of Santiago de Cao say to plant maize during the waxing moon and to be finished planting by Domingo de Ramos, the new moon at the beginning of the planting cycle will move through the calendar eight days before Domingo de Ramos and fifteen days before Easter. Therefore, the actual date of planting, the new moon associated with the March equinox, will vary between 7 March and 10 April (i.e., 22 March to 25 April minus fifteen days, one-half a lunar cycle.

If we assume that the dates for planting maize in Santiago de Cao, from 7 March to 10 April, were also the dates for planting the principal maize crop in pre-Columbian times, how would the boundaries of this period have been reckoned in the indigenous calendar? I will hypothesize that the dates of the zenith and nadir passages of the sun were important in the coastal agricultural calendar. At a latitude of 7° 40′ south, the sun passes through the zenith of Santiago de Cao on 12 October and 3 March, and it passes through the nadir point at midnight on 9 April and 7 September.

As the sun (apparently) moves northward toward the equinox of 21 March, it passes through the zenith of Santiago de Cao on 3 March (near the 7 March limit of the planting new moon), and continues its journey until it stands in the nadir at midnight on 9 April (very near the 10 April boundary date of the planting new moon). Therefore, if maize is planted on the new moon that falls between the zenith sun of 3 March and the nadir sun of 9 April, the maize planting will always occur during the waxing moon and will, therefore, be completed (in the calendar in use today on the coast) by Domingo de Ramos.

If we return now to FIGURE 1, we can suggest, as a possible corrolary of the relationship between the agricultural cycle and the zenith/nadir sun in Santiago de Cao, that, in the Moche valley, the zenith sun of 14 October may be used to time the harvest of the dry season crop and the planting of the wet season crop. The nadir sun of 10 April is rather far from the time of either harvest or planting, but we may hypothesize that its observation could have been important in timing the synodic cycle used in planting the dry season crop.

Before leaving this discussion of astronomy and calendrics on the north coast and turning our attention to the central coast, we should mention the other Chimu astronomical data given by Calancha. The Indians of the north coast worshiped the Moon (Si) over the Sun. At the new moon, the Indians said that the moon had gone to the underworld to punish thieves and that it was aided in this work by six stars, two of which, collectively called Pata, were the outer stars of Orion's belt. Pata holds the middle star, which represents a thief, captive. The moon orders Pata to turn the thief over to be eaten by four vultures, represented by four (unidentified) stars below Orion's belt.[22] Finally, Calancha says that the Indians of the coast took as their progenitors four stars, two of which begat the nobles, the other two of which begat poor people. The four ancestral stars were sent by the creator god Pachacamac.[23]

That the various river valleys along the Peruvian coast were connected during pre-Columbian times by a web of political, trading, pilgrimage, and other ties has been recognized for some time. It is apparent from both the archaeological and ethnohistorical record that interchanges were effected either along coastal land routes or by means of merchants and fishermen who plied the waters off the coast.[24] In addition, some of the valleys of the coast were related to each other by ties of kinship. We are made aware of the kinship ties among the central and south coastal valleys by a document written by Cristóbal de Albornoz around 1583. According to Albornoz, each coastal valley had its own set of *huacas* ("holy sites") which were worshiped by the Indians of that valley. The principal *hauca* of the coast was the large oracle/ceremonial center of Pachacamac, in the Rimac Valley. Another *huaca* mentioned by Albornoz was a star called Cundri, which was adored by the merchants of the valley of Chincha.[25] Given the importance of the Southern Cross in establishing orientations when traveling on the open sea off the Peruvian coast,[26] this constellation may well have been the stellar "holy site" worshiped by the Chincha.

At this poiint, I will indicate some future directions that our studies of coastal astronomy might take through an examination of the calendrical and astronomical data coded in one of the major bodies of myths pertaining to the central coast. The myths were collected in Huarochirí by Francisco de Avila.[27] Huarochirí is located about 100 km east of Lima at the head waters of the Mala river. The connection between the mountains and the coast is explicit in the mythology collected by Avila in Huarochirí.[28]

The creator/classifier god of Huarochirí was Cuniraya Viracocha. Cuniraya once visited the central coast, near Pachacama, in search of a young woman (Cavillaca) whom he had impregnated. Cuniraya arrived at Pachacamac and there found two young women, the daughters of Urpihuachac (according to Albornoz, Urpihuachac was the wife of Pachacamac). Cuniraya slept with the older daughter and just as he was about to sleep with the younger one, Urpihuachac appeared and converted her daughter into a dove who flew away. Now it happened at this time that there were no fish in the sea; the only fish that existed were kept by Urpihuachac in a small pond near her husband, the sanctuary of Pachacamac. Cuniraya was so angry at Urpihuachac that he tossed all the fish into the sea.[29]

Urpihuachac, the wife of Pachacamac, can be seen as a creator of both fish and doves.[30] In the language spoken in Huarochirí, Quechua, the word for "dove" is *yutu* (Sp. *tinamous*). In another section of his chronicle, Avila tells us that the people of Huarochirí had at least two "dark cloud" constellations. One was a large black llama (Yacana) and the other was a small dark cloud that moved before the llama (Yutu).[31] The constellation of Yutu is the dark spot located at the foot of the Southern Cross.[15] I would hypothesize that, in the astronomy of Huarochirí and of the coast, the Southern Cross and Yutu represented, respectively, Urpihuachac and her daughter the dove. Given this, we would expect to find that the mother of fish and doves, the Southern Cross, was important to coastal fishermen and perhaps for timing the fishing season. In the discussion of the Chimu astronomical data provided by Calancha, we have seen the importance of the Pleiades as a creator constellation, and we have shown the opposition between the Pleiades and the Southern Cross. If we now argue that the Southern Cross may be identified as Urpihuachac, the mother of doves and fishes, how might she be related to the Pleiades in the mythology of Huarochirí? That the Pleiades were important in Huarochirí, and that they played a role similar to that found in the Moche valley (i.e., as the one who nourishes plants and animals) is indicated by the following passage from Avila:

> And when the Pleiades (*las Cabrillas*) appear very large, they say, "This year we are going to have an excellent ripening of the fruits," but when they appear very small they say "We are going to suffer."[31]

The creator of mankind in Huarochirí was the god Pariacaca, the principal god of the highlands and the coast. Pariacaca had six sisters, one of whom was called Chaupiñamca. Chaupiñamca and her five sisters were consulted as oracles by the people of San Pedro and other villages. As we have suggestions from elsewhere in the Andes that the stars of the Pleiades were considered to be a group (*qutu*) of young girls,[32] and as the Pleiades were observed (consulted) in divination and prognostications in Huarochirí and elsewhere, I would hypothesize that Chuapiñamca and her sisters were represented in the sky by the Pleiades. We have found in the data from Calancha that the rise of the Pleiades in early June and mid-November was important in the calendar of the Chimu. A parallel connection can be established in the mythological data from Avila.

After Pariacaca, the brother of Chaupiñamca, established himself as the principal god of the coast and the highlands, he instituted three festivals. He commanded that boys from the communities (*ayllus*) be given the responsibility for his worship. The boys were called *huacasas*. The times when the *huacasas* worshiped Pariacaca were determined by a group of old men (*yañcas*) from the *ayllu* of Cacasica. These old men were especially adept at making solar observations. A special wall was

constructed for observing the sun and when, from their place of observation, the sun arrived at the wall, the *yañcas* would indicate to the *huacasas* and the populace that it was time to go worship Pariacaca. People came for the celebration from the highlands and the coast. Three annual festivals were determined by the *yañcas*: (1) *Auquisma*: the festival of Pariacaca that was celebrated, in Avila's time, on Easter or Pentecost. (2) *Chaucosma*: the festival of Chaupiñamca that coincided with Corpus Christi, but which, Avila's informants said, was always celebrated in June in pre-Spanish times. (3) The festival of San Andrés, on 30 November, when they did a dance called Chanco.[33]

Before proceeding, we should note the heliacal setting and rising dates for the Pleiades:

18 November	The heliacal rise at dusk
19 April	The heliacal rise at dusk
3 June	The heliacal rise at dawn

And the dates of the zenith/nadir passages of the sun in Huarochirí (12° 10′ south latitude):

Zenith	16 February	Nadir	19 August
	26 October		22 April

As Avila says that Auquisma could be celebrated on either Easter (21 March–25 April) or Pentecost (49 days after Easter), it may be assumed that the date of celebration of the festival in pre-Spanish times was probably not a fixed solar date (or else it could have been syncretized with a fixed saints' day in the Catholic calendar); rather, it must have been a festival celebrated at a time that depended upon solar, lunar, and stellar periodicities. Given the importance of the full moon in determining the dates of festivals in the Andes,[34] and given the importance of the Pleiades and the zenith/nadir sun in Andean calendrics, I would hypothesize that the festival of Pariacaca (Auquisma), was celebrated on the first full moon after the heliacal set of the Pleiades (19 April) and the passage of the sun through nadir (22 April). The relationship of the dates of the celebration of Easter, Pentecost, and Auquisma are diagramed in FIGURE 2.

Concerning the date of the celebration of Chaucosma, Avila says that it is now celebrated at the time of Corpus Christi (29 May–1 July), but that earlier, in pre-Spanish times, it was celebrated in June. As I have argued above, the fact that the people of Huarochirí did not syncretize indigenous festivals and fixed saints' days in the Catholic calendar suggests that they were movable dates in the pre-Spanish calendar. For the

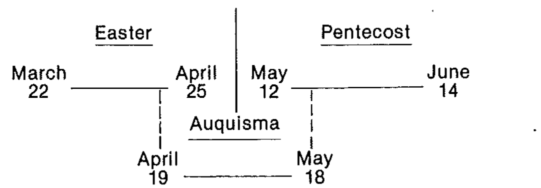

FIGURE 2. The calendrical correlation of Auquisma with Easter and Pentecost.

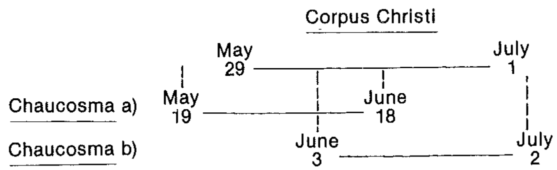

FIGURE 3. The calendrical correlation of Chaucosma with Corpus Christi.

date of Chaucosma, the festival of Chaupiñamca (the Pleiades), I would suggest either (1) the first full moon after Auquisma or (2) the full moon following the heliacal rise of the Pleiades on 3 June (FIGURE 3).

Having arrived at these hypothetical dates for the joint celebration of festivals by highland and coastal people, we can say that, since they are determined on the basis of the heliacal rising and setting dates of the Pleiades and on the basis of lunar periods fixed earlier in the year around the time of Easter, these dates correlate well with those discussed earlier for the calendar on the north coast. I would suggest, then, that these data and preliminary interpretations give us reason to investigate the ethnohistorical data more carefully in order to determine not only the calendrical cycles important in the integration of activities along the coast, but also those that were integral in correlating activities (e.g., pilgrimages, trading relationships, and subsistence activities) between coastal and highland communities.

In the preliminary study of coastal astronomy and calendrics presented here, several themes emerge that warrant further research.

First, in our description of the environmental cycles of the major resource zones of the coast (e.g., the seasonal bloom of the lomas and the periodicities of the most abundant river water and the best fishing), we have the seasonal boundaries that formed the "core" periodicities upon which more elaborate calendars, related to the exploitation of more diverse ecological zones, must have been integrated. It will be important

in the future to study carefully the range of environmental cycles between different coastal valleys and along individual rivers from the headwaters to the mouth, in order to determine the range of periodicities that would have had to be accounted for in local and regional calendars. A coastal society's ability to efficiently coordinate the resources and human activities of its river valley would have been a determining factor in the relative success or failure of its cultural tradition.

Secondly, one would suppose that, in the construction of large public or ceremonial structures, such as are encountered from the north to the south-central coast, orientations would have been chosen that related to celestial phenomena that rose, sat, or stood in the zenith at critical "boundary" times in the local and regional calendars of the populations serviced by those public or ceremonial buildings. From our study here, we are led to hypothesize that, along the Peruvian coast, the orientations incorporated in public architecture might include the rising and setting points of the Pleiades, the Southern Cross, Orion's belt, and the zenith and nadir sun (all of which will change with the latitude). In another study, Anthony Aveni and I have suggested that the zenith and nadir rising and setting points were important in the geometrical arrangement and astronomical alignment of the Nazca lines.

Finally, from our analysis of the ethnoastronomical data in the colonial documents and chronicles, it is clear that the ethnohistorical documents pertaining to different valleys or sections of the coast are important in the generation of hypotheses for investigating coastal astronomy and calendrics. The mythological data are particularly rich in this regard, but the coastal iconographic traditions may be equally important in providing orientations in the study of seasonal activities such as hunting and ritual.[35]

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