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The Paris Codex: Decoding an Astronomical Ephemeris

GREGORY M. SEVERIN

THE AMERICAN PHILOSOPHICAL SOCIETY

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PREFACE

Several years ago while writing a term paper comparing the cosmogonies of the Maya and the Egyptians, a curious thought came to mind. I wondered whether the Maya had a zodiac with wondrous mythical beings who crossed the nighttime sky and consorted with the moon and the planets, as did the Egyptians. I wondered also whether they had ages ruled by one of those beings, and whether the Maya priest-astronomers, fascinated by the march of time, recorded calculations of the precession of the equinoxes. I had read that in a certain Paris Codex pictures of beings appeared on a partially destroyed page which may have been a representation of a zodiac. I thought this Paris Codex must have been a wonderful book; a great pity it was no longer intact. I was sure that if a Maya zodiac ever turned up, it would have not twelve but thirteen constellations—surely thirteen, the sacred number of the Maya.

About a year later, I discussed some of my ideas with an archaeologist, Dr. Gordon Ekholm, of the American Museum of Natural History in New York. When I mentioned the Paris Codex, he withdrew from his shelves an old book with yellowed pages. It was then that I first beheld the Paris Codex. To my sheer delight, not only the page about which I had asked but the previous page as well contained two rows of strange beings hanging from a band which represents the sky. Without counting I was sure there were thirteen and perhaps the table between the pictures was an astronomical reckoning related to the zodiac. Dr. Ekholm kindly made a copy of the manuscript for me which I examined very closely that very night. Thus began my fascination with the Paris Codex and the writings of the Maya.

Since my initiation into Maya studies, numerous people have helped further my research. Actually, my debt extends back to my childhood when my father, the late Harry M. Severin, introduced me to the joys of Egyptian dynastic history and the decipherment of hieroglyphics; it was then that I developed my first love for the knowledge of the ancients. I would like to extend a token of gratitude, however inadequately this may be expressed, to all those who have aided and encouraged my pursuit of scientific truth.

The late Dr. Joachim Otto Fleckenstein, my *Doktorvater* at the University of Basel, Switzerland, was a constant source of encouragement and inspiration. He was instrumental in securing my admission to the university where this monograph developed from my dissertation research. His erudition in several fields of science never ceased to amaze me, and I have benefited immensely from our association. His untimely death in February, 1980, was a great personal loss.

My appreciation is extended to Dr. Thomas S. Barthel of the University of Tübingen, West Germany, a co-referee of my dissertation at Basel, for his meticulous analysis and critique of my work. Our research interests crossed unusually in several areas, an example of which I am proud to elaborate in one of the appendices to this monograph. My scholarship has been greatly enhanced through our contact.

A note of gratitude is owed to Dr. Floyd Lounsbury of Yale University and Dr. David Kelley of the University of Calgary, Canada. It was these gentlemen who listened to my ebullient exposition of a half-baked theory on the Paris Codex at a meeting at Yale in March, 1977. Their comments and criticisms greatly encouraged me in pursuing the course of research I had outlined.

Many thanks are due Dr. Anthony Aveni of Colgate University. His detailed and always constructive critiques of several drafts of my work have been of great aid in refining and supplementing my arguments. Dr. G. A. Tammann and Dr. U. Steinlin of the Astronomical Institute of the University of Basel have supplemented my knowledge and assurance in the realm of astronomy.

My intellectual acknowledgment would not be complete without mention of the late J. Eric S. Thompson. I regret never having made his acquaintance, but his books and articles have served as my textbooks in Maya research. Several times in the following pages I take exception to his opinions or hypotheses. However, I have been impressed by the acknowledgment of his own errors in print, and know that he would have given my arguments impartial judgment. I hope to admit error with the same grace.

I would also like to thank several people whose efforts helped make this monograph possible. My mother, Augusta Severin, has given ceaseless faith and has tirelessly typed several drafts of the manuscript. My appreciation is extended to Mr. and Mrs. Walter Ellenberger of Hägendorf, Switzerland, a family to me during my stay in Switzerland. And to all my colleagues and predecessors whose work has influenced the development of my own thought, I acknowledge my profound gratitude.

March, 1981 GREGORY M. SEVERIN

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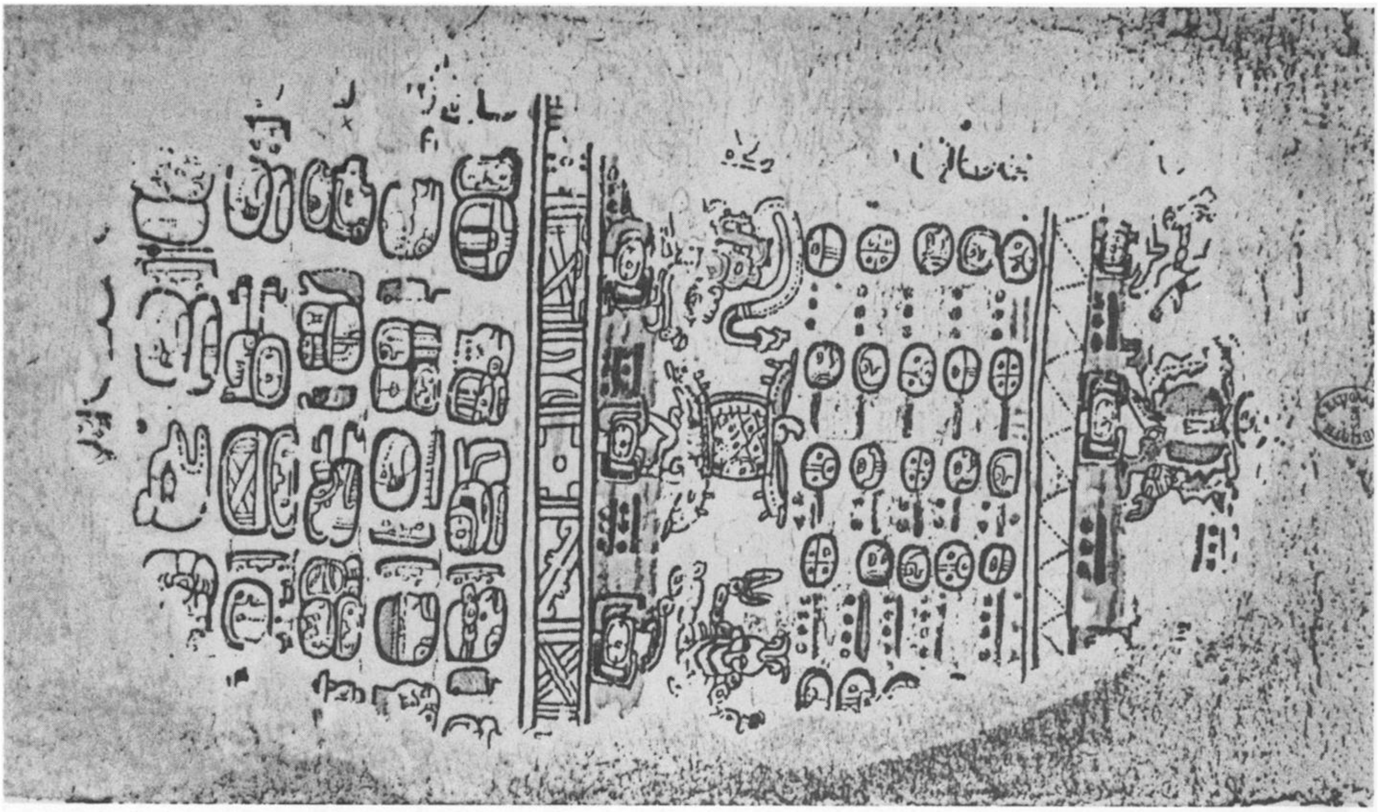
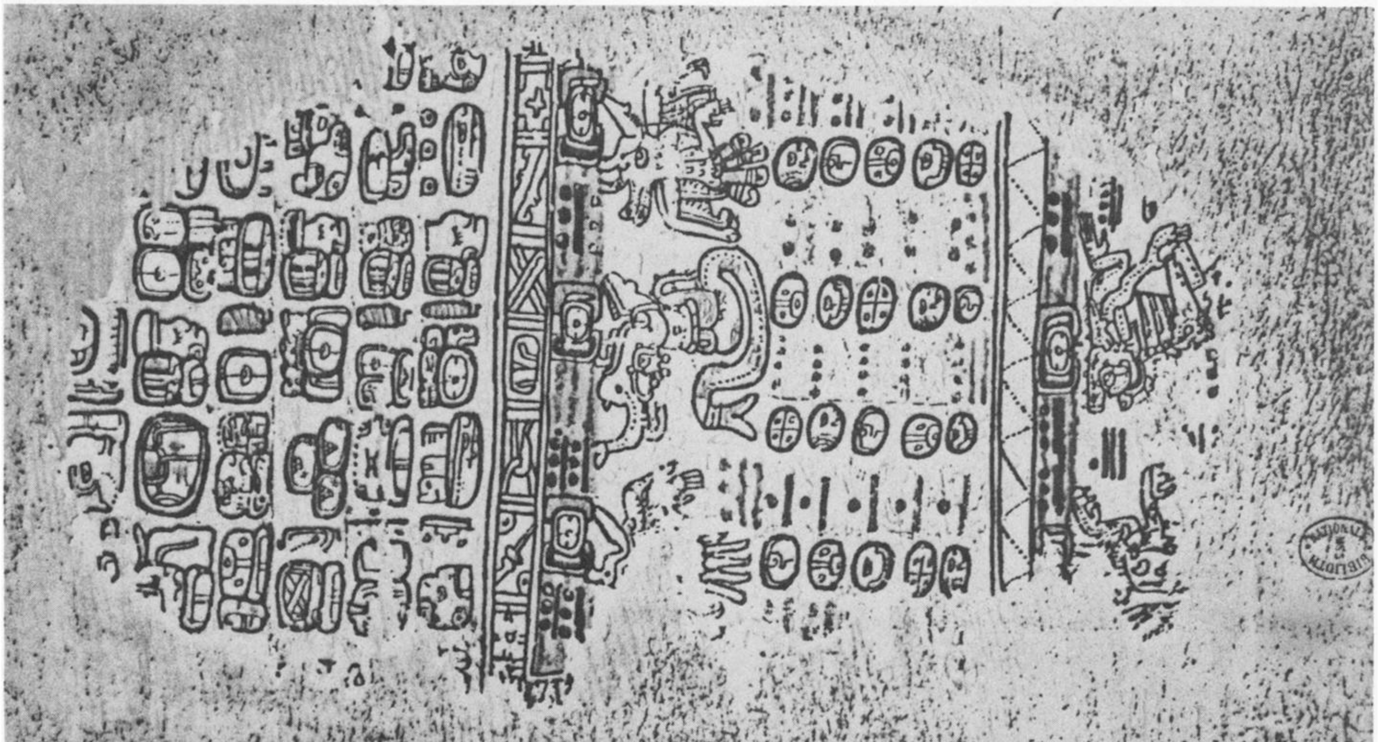




THE PARIS CODEX:

DECODING AN ASTRONOMICAL EPHEMERIS

GREGORY M. SEVERIN

CONTENTS

INTRODUCTION

The Paris Codex, a Maya manuscript of dubious provenience, has not offered up very much about its contents since it came to light in a dusty corner of the Bibliothèque Nationale de Paris in 1859. The present state of our knowledge about it can be summed up as follows: 1) the first half of the manuscript contains a sequence of *katuns* accompanied by the ceremonies and prophecies pertinent to each, much in the manner of the *Chilam Balam*; 2) pages 19–20 deal with the year bearers; 3) the table on pages 23–24 contains a septuple almanac arranged in thirteen columns of five day glyphs each, with a regular interval of 28 days between each succeeding position; this is the lowest common multiple of the *tzolkin* and the 364-day computing year (1,820 = 7 × 260; 5 × 364); the table is accompanied by a picture of beings hanging from a celestial band which may be a representation of a Maya zodiac.

In this monograph, I propose a radically new look at the Paris Codex and indeed our entire understanding of Maya astronomy. None of the above concepts will be challenged, but rather expanded and developed. It is my contention that there is far more here than meets the eye.

My analysis has been interdisciplinary, involving primarily the methods of epigraphy and astronomy, as well as ethnohistory and archaeology. Along with this combined methodology is a strict adherence to the rules of hypothesis testing. I consider this the most powerful tool of a researcher: without a concretely formulated idea of what to look for, the connections between individual pieces of data remain elusive and insignificant. Also, the pitfalls of forcing data to fit a preconceived hypothesis are largely avoided when the data are tested prior to their interpretation.

In the following pages I have attempted to bring to fruition a theory which began as a "hunch." My approach has been a bold one, making predictions and searching out the evidence through myriad permutations of the data. This type of approach, with an initial risky postulation, was necessary since the main thrust of Maya calendrical research has sidetracked the Paris Codex in preference to the almanacs of the Dresden and Madrid manuscripts. The initial postulation which formed the guideline for this analysis is as follows: the beings on Paris 23–24 represent a zodiac of thirteen constellations, and the table which accompanies the illustrations relates to the reckoning of the precession of the equinoxes.

In part I the following concepts will be explored: 1) the Maya possessed an ecliptic-based system of positional coordinates for the sun, moon, and planets; 2) calculations and corrections for the precession are embodied in the table on pages 23–24; 3) how the table was used as an ephemeris for the prediction of solar and lunar ecliptic longitude over a time span of 26,000 years. To anyone familiar with positional astronomy the corrections for the precession of the equinoxes are a necessary part of the accurate determination of celestial coordinates. The analysis will proceed by laying the basic foundation in chapter 1; the elucidation of the mechanism for deriving celestial coordinates is the subject of chapter 2.

Part II is an application of the Paris data to the correlation question: chapter 3 concerns itself with the long-standing problem of the lunar series; the analysis of astronomical passages in the Paris Codex and in the inscriptions is the subject of chapter 4. The goal of part II is to test the various correlations against astronomical events, and to see which yields results consistently in agreement with interpretations of the glyphs. I am particularly confident of the outcome of this investigation because the object was to determine which correlation fitted the reading of selected glyph passages, not which glyphs could be forced to conform to an interpretation demanded by a particular correlation.

Part III explores the implications of the Paris data in relation to the collapse of Classic Maya civilization. A new hypothesis for the collapse is introduced and documented with evidence derived from the codex, Olmec civilization and Late Classic period monuments. This is the most theoretical section of this work because it is an attempt to glean evidence from the hieroglyphic inscriptions themselves. The hypothesis advanced is based on the concepts outlined in part I. Its strength lies, I believe, in the fact that it was developed through hypothesis testing, and its implications lend themselves to further testing. The practically untestable nature of many theories about the collapse have led to the "your guess is as good as mine" situation which has colored this branch of Maya research. Despite reams of data collected over the past century we are almost as much in the dark about the actual reasons behind the decline of this splendid culture as the day when Stephens first glimpsed the ruins of Copan.

The following astronomical arguments are at times involved and tedious. The reader will need a basic understanding of the phenomena being discussed. However, all efforts have been made to assure clarity of presentation with minimal mathematical involvement. The summaries at the end of each chapter highlight the major arguments and present a synopsis of the technical details on a more conceptual level.

It is my hope that the reader will find much of a new and challenging nature in the following pages. It is at present taken quite for granted that the Maya developed a marvelous system of astronomy and we have recently become aware of astronomical alignments in the architecture for measuring phenomena at the horizon. This is of great importance to our understanding, but how could they have calculated and manipulated with such precision without a zodiac and a system of celestial coordinates? This is a work of synthesis dedicated to finding some answers.

PART I: THE PARIS CODEX

1. DEVELOPMENT OF THE HYPOTHESIS

What properties does the Paris Codex exhibit which could give one the idea that it may be a sophisticated astronomical almanac? The best place to begin is to determine the identities of the beings on Paris 23–24 and see if they correspond to any known Maya constellations. This harks back to the Hagar-Spinden controversy of some sixty years ago. Spinden (1916) saw the Paris beings as the most probable representation of a Maya thirteen-constellation zodiac. Hagar (1912) and also Reko (1936) attempted to force the Maya cosmology into the twelve-constellation system of the Greeks (and their Babylonian and Egyptian predecessors) to which we have become heir. These authors equated the stars listed in the *Motul Dictionary* as *zinan ek*, the "scorpion stars," with the constellation Scorpio, for which there is no evidence. However, given the paucity of Maya ethno-astronomical data and the popularity of theories of cultural diffusion from the Old World at this time, these misconceptions are understandable.

The *Motul Dictionary* lists but two Maya constellations with their known counterparts in the Greco-Babylonian zodiac: *tzab*, the "tail of the rattlesnake" known to us as the Pleiades, part of the constellation Taurus; and *ac ek*, the "turtle stars," which correspond in part to stars in the constellation Gemini, adjacent to Taurus. The unmistakable forms of a rattlesnake and a turtle appear on the upper celestial band on Paris 24. Thus, the sequence Taurus/Gemini corroborates the sequence Rattlesnake/Turtle and shows that the beings on Paris 23–24 represent constellations in the sequence they are seen in the sky. However, it is the position of the vernal equinox at the beginning of the long count which is the telling argument in assigning the boundaries of Maya constellations.

I digress a moment to discuss the vernal equinox as a means to delineate the boundaries of the constellations. In other cosmological systems, notably the Hindu *kalayugas* and that of the Greco-Babylonian tradition, the initial date of the calendar is at the start of a world age. The constellation-being in which the vernal equinox then resided became the major iconographic symbol of each age. For example, the fish became the symbol of Christianity because the vernal equinox had entered the constellation Pisces shortly before the birth of the Messiah. It is thus very logical, given a highly developed cosmological system, to assign the position of the vernal equinox at 13.0.0.0.0

4 Ahau 8 Cumku as the dividing line between two Maya constellations.

This assignment is somewhat dependent upon the correlation used to determine the equivalent Julian day at the beginning of the long count. However, because of the slow pace of the precession, an error in the correlation of within ±300 years will produce a shift in the position of the equinox of not more than ±4 degrees in the sky. At this stage of the analysis the effect on the boundaries of Maya constellations is decidedly noncritical. Thus my use of the Thompson correlation as an initial estimate will allow enough leeway to satisfy the proponents of other correlations and in no way implies advocacy of, nor dependence on, the Thompson correlation.

According to the Thompson correlation, the long count began in 3113 B.C. At this time the vernal equinox was at a point on the ecliptic near the bright star Aldebaran, α Tauri. Beginning at this point, I have divided the ecliptic into thirteen equal divisions or "houses" (endplate). In the endplate the Pleiades and most of Taurus fall in the section labeled "Rattlesnake," and the adjacent constellation, the "Turtle," contains stars belonging to the western part of Gemini. This is acceptable insofar as the *Motul Dictionary* is concerned, which lists the turtle stars as: "the stars which are in the sign of Gemini, which with others form the outline of a turtle" (Thompson 1950: p. 116). However, an informant of Thompson's (1950: p. 116) pointed to Orion as the constellation of the Turtle. Orion, although not situated on the ecliptic, is squarely within the section of sky adjacent to the Rattlesnake. The two references, colonial and modern, can be reconciled and neither need be ignored: the stars forming the Turtle fall in that one-thirteenth section of sky encompassing part of Gemini, and Orion. Thus, the two most assuredly documented Maya constellations, the Turtle and the Rattlesnake, fall neatly into adjacent "houses."

The identities of several of the constellation-beings on Paris 23–24 are problematical because of the lamentable partial obliteration of many pages of the codex. Spinden (1916) assigned identities to many of the Paris beings and noted that the Monjas façade at Chichen Itzá contains representations of many of the same beings. Unfortunately, the Monjas façade with its beings and any corresponding glyphic text is no longer intact. However, enough evidence can be gleaned to assign identities to the Paris beings with reasonable certainty.

As noted, the constellation-beings appear on Paris 23–24 in their correct celestial sequence. Thus, reading from right to left we are following the ecliptic eastward along the path followed by the sun during the course of the year. Reading from the right of Paris 24 across the upper celestial band, the sequence continues on the lower celestial band in the same order, ending on the lower left corner of Paris 23. Following this sequence (frontispiece), the beings will be discussed and their identities ascertained:

1. Jaguar: although this being is almost entirely obliterated, several lines of evidence point to its identification as a jaguar. A "jaguar star" was surely known among the Maya, and Kelley (1976: p. 39) illustrates the jaguar god attached to a star glyph (half Venus sign of previous nomenclature). Several of the beings on Paris 23–24 are seen on other pages of the codex, particularly pages 1–13 in relation to the *katun* regent. Two certain jaguars appear on Paris 11 and 19. However, this identification requires lengthy discussion.

A passage in the *Chilam Balam of Tizimin* (Makemson 1951: p. 150) is helpful in locating the Jaguar: "At that time Ahaucan[1] the Rattlesnake was lifted high on the back of the Leopard Chacbolai." Since the leopard is not native to Mesoamerica, the reference must be to the only spotted cat in the Maya area, the jaguar.[2] *Chac-bolay* is the name of *Felis hernandesii goldmani* Mearns, the jaguar (Roys 1967: p. 111), corresponding to the codical glyph T800 (Thompson 1972: p. 68).

The astronomical situation pertinent to the preceding passage most likely occurred around the winter solstice when the ecliptic constellations cross the meridian near the zenith each night at the latitude of the Maya. When the Jaguar crossed the meridian and dipped down toward the western horizon, the next constellation eastward, the Rattlesnake, would indeed appear to be lifted high on the Jaguar's back. However, the location of the Jaguar constellation is securely corroborated in two Mexican sources.[3]

In a passage of the *Crónica Mexicana de Tezozomoc* (quoted in Seler 1902–1923: **I**, p. 618), Moctezuma, newly chosen king of Mexico, is given a lecture on his royal duties. Among advice of a political and religious nature, he is admonished to rise at midnight to study the movement of the stars. Among the stars he is charged with observing are the *yohualitqui mamalhuaztli*, "the fire drill," the *tianquiztli*, "the Pleiades," and the *colotl ixayac*, "the scorpion."

As Seler (1902–1923: **I**, p. 619) points out, the Tezozomoc manuscript equates the *yohualitqui mamalhuaztli* (the fire drill) with the Keys of Saint Peter, which José María Vigil, the editor of Tezozomoc, identifies with the star α Aries.[4]

[1] *Motul Dictionary*: *ahau can*—a snake with rattles on its tail, the bite of which is fatal.

[2] During the colonial period the Maya language was transliterated into Latin script along with many Spanish loan-words. The conquerors used the nearest equivalent in their own language before native words found their way into the synthesis of Mexican dialect.

[3] The remarkable parallels between Maya and Mexican deities and astronomical concepts is beyond the scope of this work. Suitable discussion can be found in the works of Seler, Thompson and Kelley, listed in the bibliography, to name just a few of the authors who have commented upon this situation.

[4] In the Middle Ages an attempt was made to replace the ancient pagan names of the constellations with pious Christian names. The constellation Aries in our zodiac was assigned to the apostle Peter and the bright star Hamal (α Aries) was designated as his "keys."

In chapter 3 of his *Historia General de las Cosas de Nueva España* Sahagún (1956) throws light upon the *mamalhuaztli*. This excerpt deserves quotation in the original Spanish:

Hacía esta gente particular reverencia y particulares sacrificios a los Mastelejos del Cielo, que andan cerca de las Cabrillas, que es el signo del Toro. . . . Despuês de haberles ofrecido incienso decían: Ya ha salido Yoaltecutli, Yacauitztli, ¿qué acontecerá esta noche? . . . Tres veces ofrecían incienso, y debe ser porque son tres estrellas; la una vez a prima noche, la otra a hora de las tres, la otra cuando comienza a amanecer. . . . Llaman a estas tres estrellas mamalhuaztli, y por este mismo nombre llaman a los palos con que sacan lumbre, . . . (Sahagún 1956: p. 262).

The pith of Padre Sahagún's remarks are as follows. The *Mastelejos*, "sticks for rubbing fire," were three stars called *mamalhuaztli*. The location is given as "near *las Cabrillas* (the Pleiades), which is the sign of the Bull (Taurus)." Sahagún probably meant to write ". . . *las Cabrillas, que es* **en** *el signo del Toro*" (. . . the Pleiades, which is *in* the sign of Taurus). However, as the statement stands, the Pleiades and the constellation Taurus are held apart from the *mamalhuaztli*: had he wished to say that the Pleiades and the *mamalhuaztli* were both in Taurus, the sentence would have been quite differently formulated. As we shall see, this is where Seler went astray.

Not being an astronomer (and probably not having been guided in observation of these stars at the time of receiving this information), Sahagún neglected to mention in which direction the *mamalhuaztli* lay in their position "near" the Pleiades. This, as we shall see, left the door open for Thompson's guess. The padre's descriptions were more precise in the realm of worldly matters, but fortunately, the account of Tezozomoc has been preserved.

However, Sahagún left us one other piece of evidence which is far more significant than his incomplete location of the *mamalhuaztli*, namely, their identity. On three occasions during the night, at rising, at midnight (probably meridian passage) and before sunrise, the three stars were offered incense and hailed "now you have risen *Yoaltecutli, Yacauitztli*." The former name means "lord of the night"; the latter is undoubtedly another form (probably less correctly transliterated) of the appellative *yohualitqui*, "bringer of the night" of the Tezozomoc manuscript. *Yoaltecutli* is a distinctive Aztec deity whose identity we will now determine.

Thompson, discussing one of the Venus gods in the Dresden Venus table (which bear marked Mexican attributes) identifies *Yoaltecutli*:

Yoaltecutli, the lord of the night, was a Nahua deity who seems to have been a night manifestation of the sun, for his festival was on 4 Olin, the sun's day. The night sun in Maya thought was the jaguar god of number seven, whereas the deity depicted here has, as noted, the head of a jaguar or puma and wears a jaguar skin complete with tail (note the encircled three spots on the skin). Sahagún (1950–1969: bk. 7, ch. 3) implies that the constellation of three stars forming the fire drill *mamalhuaztli*, near the Pleiades, is to be identified with him (Thompson 1972: p. 68).

Thompson is being circumlocutory in saying that Sahagún "implies" the *mamalhuaztli* are to be identified with *Yoaltecutli*: Sahagún is quite specific that the stars were hailed as the deity himself. However, Thompson's astute identification of *Yoaltecutli* as the jaguar god of the night sun is accurate. For almost 2,000 years down to the end of the Classic period the patch of sky occupied by this constellation (see endplate) was occupied by the position of the vernal equinox.[5]

Let us then assemble the data in Tezozomoc and Sahagún: the three stars of the *yohualitqui mamalhuaztli* (the fire drill constellation) lying near the Pleiades and ruled by *Yoaltecutli*, the jaguar god as the manifestation of the night sun, were equivalent to the Keys of Saint Peter, or the constellation Aries in our zodiac. This seems to locate the fire drill in the zodiac to the west of the Pleiades in the constellation Aries, and implies close association with the jaguar.

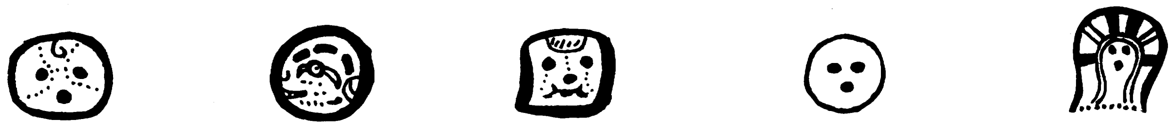
Curiously, Thompson (1972: p. 68), "despite the views cited by Seler (1902–1923: **I**, p. 619)" is inclined to identify *mamalhuaztli* with Orion's belt; and Seler, despite both Tezozomoc and Sahagún expresses the opinion that it "corresponds perhaps to Aldebaron (α Tauri) with the Hyades." Let us examine these opinions more closely.

As Thompson himself notes (1950: p. 116), Orion has a close relationship to the Turtle, and he ignores the much stressed association of *Yoaltecutli* with the jaguar (presumably because he knew of no Jaguar constellation).

Seler (1902–1923: **I**, p. 619) identifies the fire drill with Aries, but with curious logic recants this opinion on the very next page based on a speculation that the Spanish word *llave*, "key," was confused with *nave*, "ship," in Tezozomoc's reference to the Keys of Saint Peter.

What escaped the attention of both these authors is that "the encircled three spots on the skin" worn by *Yoaltecutli* on Dresden 48e, the characteristic symbol of the pelt of the jaguar, are the same three spots which occupy a central position in the well-known drill glyph (T589, which combines with various affixes, particularly the flame or smoke affix T93, to denote what kind of drilling is intended). These three spots also appear on the glyph for the day Ix, closely associated with the jaguar, and on Madrid 45c Ix appears as the head of a jaguar (fig. 1). Furthermore, as Spinden (1916: p. 63) notes, a jaguar (*ocelotl* in

[5] In a subsequent section of this chapter we will concern ourselves with the vernal equinox and its relations to the constellation-beings on Paris 23–24.



Ix normal form in codices — Ix Madrid 45c — Ix Dresden 44b — Three spots on *Yoaltecutli* Dresden 48e — Drill glyph T589

FIG. 1. Three Spots as the Jaguar Skin.

Nahuatl) head with three star symbols (round "eyes") appears on a page of the Mexican *Bodleian Manuscript* dealing with stars and constellations.

Thus, I submit that the fire drill constellation and the Jaguar constellation were part and parcel of the same group of stars which lies on the ecliptic around the region of the constellation Aries, the star α Aries in particular.[6]

The *tianquiztli* of the Aztec and the *tzab* of the Maya both represent the Pleiades, the "tail of the rattlesnake" according to the *Motul Dictionary*. Thus, the first two star groups Moctezuma was admonished to observe were the fire drill and the Pleiades; the adjacent being on Paris 23–24 is (Pleiades included) the Rattlesnake. The fire drill/Jaguar rises in the east ahead of the Rattlesnake and, as we have already noted, when the Jaguar was near the western horizon the Rattlesnake appeared to be lifted high on its back (fig. 2).[7] On the endplate the section of sky labeled "Jaguar" contains the constellation Aries and lies adjacent to the section labeled "Rattlesnake" which contains the Pleiades. We have thus extended the surely documented sequence Rattlesnake/Turtle to Jaguar/Rattlesnake/Turtle.

I offer a reconstruction of the jaguar on Paris 24 based on drawings on Dresden 8 and Paris 19 (in seated position), and fragmentary details on Paris 11 (fig. 3). The posture of my reconstruction agrees with that of beings #12 and #13. The identity of the jaguar has ramifications of extreme importance which will be discussed in part III.

2. Rattlesnake: the rattles on the tail make this identification certain. As mentioned previously, *tzab*, the "tail of the rattlesnake," is listed in the *Motul Dictionary* as the Pleiades.

3. Turtle: an obvious identification; listed in the *Motul Dictionary*, as discussed previously.

4. Scorpion: a fairly obvious identification; the *Motul Dictionary* lists *zinaan ek*, the "scorpion stars," with no counterpart in our zodiac.

5. Moan Bird: my identification is based on the head and tail markings, seemingly identical to those characteristic of the moan bird. Spinden (1916) calls this the king vulture for reasons not made clear; and Seler (1902–1923: **IV**) thought it was a turkey. At any rate we agree it is a bird. There are ample celestial associations of the moan to justify a constellation (see chapter 4).

6. Marine Monster (Xoc?): I agree with Spinden's (1916) identification of this being as a mythical beast of indeterminate species, possibly the *xoc* fish (see chapter 4).

7. Vulture: this being is assuredly a bird, but is difficult to identify as to species. It is probably the same bird appearing in the middle of the left column on Paris 19; the beak suggests a flesh-eating bird. The Maya, like the Aztec, appear to have lumped such fowl (vulture, eagle, etc.) into the same category, but it is the vulture which has strong celestial associations (Thompson 1972).

8. Frog: similarity with representations of the frog on Madrid 31 and 101 make this identification certain.

9. Bat(?): the identification of this being is problematical. It appears to have wings, and bears a strong resemblance to the butterfly depicted on Madrid 8. It also bears, however, what may be an eye with Akbal infix, which would make identification as a bat more likely. Spinden (1916) calls this a deer, an untenable identification, but perhaps a misprint. I have a slight preference for the bat, but no reasonable interpretation can be ruled out (for the present at least: see chapter 4 and appendix C).

10. Peccary: this being is totally obliterated. However, a peccary appears on the Monjas façade which I consider a certain indication that one should also have existed on Paris 23–24. There are only two positions which a peccary could have occupied, #10 or #11. On Madrid 30 appears a goddess with outstretched arms: in her left hand sits a jaguar and in her right, a peccary. In the table on Paris 23–24 the interval between the day glyphs is 28 days, thirteen of which form one row equal to 364 days (this will be fully discussed further on). Three beings intervene between the peccary(?) and the jaguar on Paris 23–24, which correspond to three Maya "zodiacal" months of 28 days each, or a total of 84

[6] In this area of the sky south of the ecliptic near the celestial equator is a most remarkable red star, Mira (o Ceti), a variable star with a period of about 330 days between maxima. Mira spends most of the year as a visible star, and at maximum magnitude occasionally rivals the bright red Aldebaran (α Tauri), but for several months wanes to below sixth magnitude and is not visible to the naked eye. We may speculate that the behavior of Mira (the type-star of long-period variable stars) engendered the concept of the kindling of fire.

[7] It is interesting to note that the *colotl ixayac*, "the scorpion," was the third group Moctezuma was urged to observe. If these three star groups were meant to form a sequence according to their order of rising in the east, then only the turtle has been left out (unintentionally?) in the Tezozomoc account. The Aztec sequence fire drill/Pleiades/(turtle?)/scorpion would concord exactly with the Paris sequence Jaguar/Rattlesnake/Turtle/Scorpion, which I am sure was the case. In any event, the Tezozomoc list does not deal exclusively with the zodiac as evidenced by the presence of such stars as the *citlaltlachti*, "the north and its wheel," which correspond to circumpolar stars in the neighborhood of the Big Dipper (Ursa Majoris). Much to his credit, Seler (1902–1923: **I**, p. 623) did not fall into the old trap of equating *colotl ixayac* with our constellation Scorpio, as Hagar (1912) did with *zinaan ek*, the Maya equivalent.

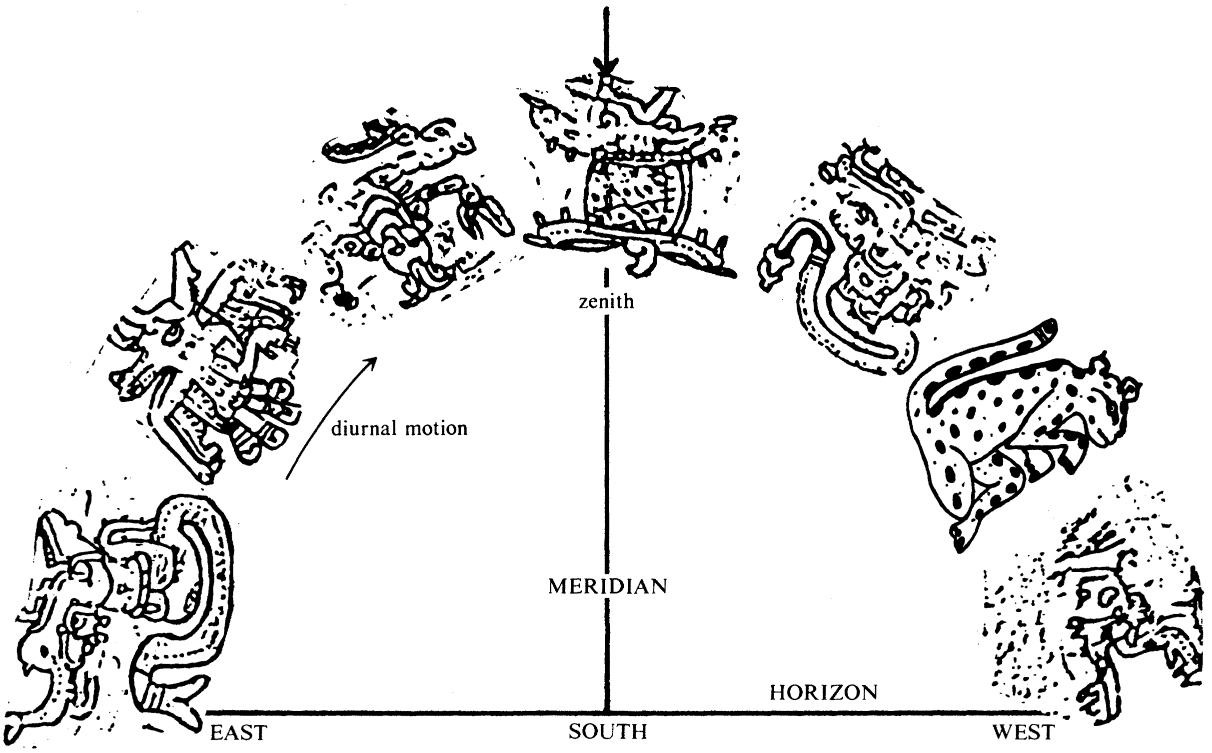


FIG. 2. Rattlesnake High on the Back of the Jaguar. This is a pictorial representation of the ecliptic constellations as visualized by the Maya about three to four hours after sunset at the winter solstice. The diagram could also pertain to a time just before sunrise at the autumnal equinox, and several other times throughout the year.

days. In the stream of water between the legs of the goddess on Madrid 30 appears the following formula: red 4 (vertical) over black 4 (horizontal). Due to its unusual disposition (vertical red 4 in water stream) this number may not only represent the distance to the next day position (red 13 + black 4 → red 4) but the number 84 as well. This is the interval of the sun's passage between the two constellations. Note also that with the exception of Death (#12) the two constellations about to be proposed as neighbors of the Jaguar and Peccary, the Canine (#13) and the Deer (#11) respectively, are also conspicuously displayed on this page.

11. Deer: the only remaining fragment of this being appears to be a cloven hoof. A representation of a seated deer, with cloven hooves to the left, on Paris 5 would fit admirably in this position. Thus I suggest the sequence #10/#11 can be reconstructed as Peccary/Deer with only slight reservations that the order be reversed.

12. Death: I agree with Spinden (1916) in this identification. This being bears death eyes and prominent skeletal ribs, the characteristic markings of God A, and corresponds to the skull with star infix on the Monjas.

13. Canine: this being has unretracted claws and a tail which appears to be thick and bushy. These characteristics tend to rule out identification in the feline category. Spinden (1916) identifies this being as a peccary, contradicted flatly by the presence of claws not hooves, and Seler (1902–1923: **IV**, p. 473) calls this the jaguar. In the original Paris Codex the characteristics of this being are more clearly defined than in any photographic reproduction. I reached the conclusion that this being is a dog which bears jaguar markings. The combination of jaguar markings with those of other animals is not uncommon, in particular the dog and the snake. The uncertainty of identification as jaguar or dog led Thompson (1962) to christen several glyphs (T757 and related glyphs) the "jog," and the melding of the jaguar with the Chicchan snake is evident in glyph T762 (Thompson 1972). This combination of attributes is a problem of iconographic significance to be taken up in part III. I am confident that the dog on Madrid 30b (see above #10) and the dog hanging from the celestial band on Dresden 40b are representations of the Canine constellation (see chapter 5).

What we find on Paris 23–24 are the mere drawings of animals, but to the Maya these were the very gods of the stars who took part in the drama of heavenly movement. I am reminded of the myth which tells of the moon's infidelity to her husband, the sun (Thompson 1970a). Her consorting with the sun's brother, Venus, underlies a real astronomical truth, for the moon is indeed the most errant and difficult to predict of heavenly bodies. The Maya recorded these truths not only in legend but in observational ephemerides as well.

In the aforegoing discussion I have established that the beings appearing on these pages represent a thirteen-constellation zodiac in the correct celestial sequence. The identities of the beings were discussed and it was noted that the position of the vernal equinox at 13.0.0.0.0 4 Ahau 8 Cumku lay between two of these constellation-beings.

It is now time to take a first look at the table on Paris 23–24 and establish its connection to the zodiacal beings which accompany it, and to other pages of the codex. Reconstruction of the obliterated portions of the table reveals a total of 65 day glyphs with coefficients, arranged in thirteen columns of five day glyphs each (fig. 4). Entering the table on the day 12 Lamat at the upper right and reading right to left across the rows, the day 10 Ahau is reached at the lower left. From 10 Ahau the cycle repeats, beginning anew at 12 Lamat, each interval between consecutive day glyphs being always 28 days. Thus from 12 Lamat to the next 12 Lamat are 65 regular intervals of 28 days. Each row of thirteen-day glyphs yields a period of 364 days; the five rows totaling 1,820 days ($5 \times 364 = 1{,}820$ days). This method of reading the table has been noted by Spinden (1916), who states that the presence of a reentering cycle implies that the table and its associated beings is complete and does not continue onto Paris 25 which is totally defaced.

The only significance attributed to this reading of the table is that it appears to correlate the so-called computing year of 364 days with the *tzolkin*, $5 \times \mathbf{364}$ and $7 \times \mathbf{260}$ both being equal to 1,820. Such comparison of cycles was a beloved device of the Maya for simplifying calculations. However, the real significance is that with a thirteen-constellation zodiac, only a 364-day year will give a nonfractional approximation of the time spent by the sun in each constellation on its course around the ecliptic. As an estimate of the Maya zodiacal month, 28 days remains sufficiently accurate for the better part of a year, but the table would accumulate an error of 1.25 days after each row, and an error of 6.25 days after the completion of the full round of 1,820 days. This is decidedly not good enough for accurate positional astronomy: we know the Maya were capable of far greater accuracy over much longer time spans. How suitable accuracy was attained is a question to which I will return.

Were it not for the presence of thirteen *modifying coefficients* associated with each column of the table, a single reading of 1,820 days could be accepted at face value. In each column all five day glyphs bear the same coefficient. These numerals are written in red ink. The *modifying coefficients* appear either above or below each column and are always six less than the day coefficient. These are written in green ink. If a connection exists between these coefficients and the *katun* coefficients on Paris 1–13, the implications could be stated as follows: the green coefficients somehow modify the table and expand the time scale to far more than 1,820 days.[8]

[8] As early as 1891 Seler (1904: p. 21) thought the green coefficients (which he calls "blue," and are actually a blue-green in the original) were some sort of correction or interpolation.

FIG. 3. Reconstructed Jaguar.

It has long been known that Paris 1–13 contain prophecies and astronomical data pertaining to a sequence of thirteen *katuns* (see Thompson 1950). The coefficients on many pages are defaced, but on Paris 4, 5 and 10 appear the coefficients 11, 9 and 12 associated with drawings of the *katun* regents. This is enough to establish that these pages deal with a chronological sequence of thirteen *katuns*.

Two Ahau glyphs with coefficients also appear on each of these pages. Many of these are also destroyed but enough remain to establish a sequence: on Paris 5 appears 10 Ahau over 4 Ahau; on Paris 8, 11 Ahau over 5 Ahau; and at least one Ahau coefficient on Paris 4, 6, 7 and 11. By extrapolating the available data to the missing coefficients a table of concordance can be constructed (table 1). In this ordering of the data, the day coefficient and *modifying coefficient* of each column on Paris 23–24 match the upper and lower Ahau coefficients of one of the pages 1–13, respectively. Reordering the lower half of the table (table 1a) so that the *modifying coefficients* match the *katun* coefficients, the column numbers on Paris 23–24 fall in reverse sequence to pages 1–13.

Barthel (personal communication) considers the

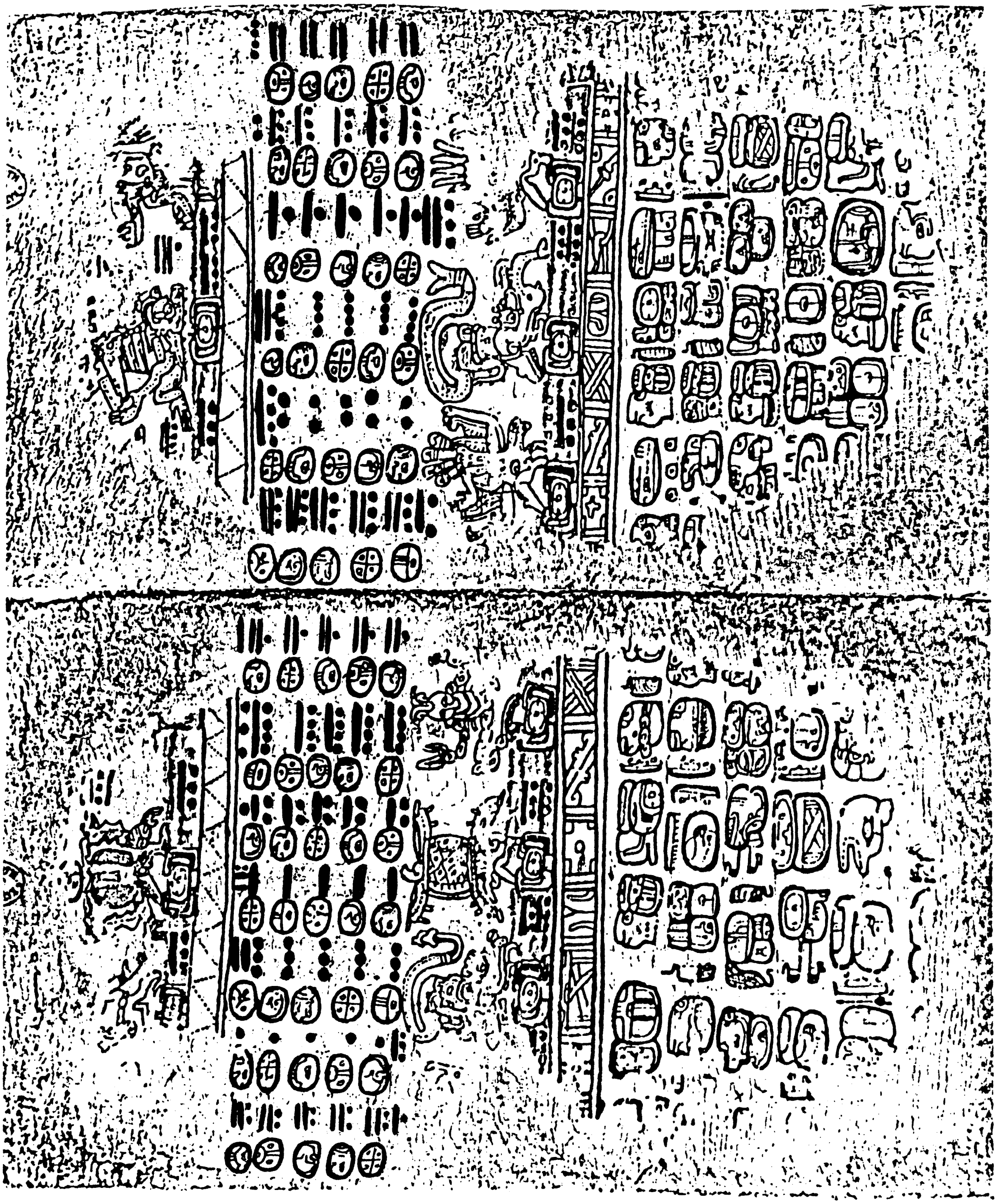


FIG. 4. Reconstruction of Paris 23–24.

TABLE 1

CONCORDANCE OF COEFFICIENTS IN PARIS CODEX

Paris 1–13													
Page	1	**2**	3	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	13
Katun No.	4	2	13	**11**	**9**	7	5	3	1	**12**	10	8	6
Upper Ahau No.	13	9	**5**	1	**10**	6	2	**11**	7	3	12	8	4
Lower Ahau No.	7	3	**12**	**8**	**4**	**13**	**9**	**5**	1	10	**6**	2	11
Paris 23–24													
Day Coeff. (red)	**13**	**9**	**5**	**1**	10	**6**	**2**	11	**7**	**3**	12	**8**	**4**
Modifying Coeff. (green)	**7**	**3**	**12**	8	4	**13**	**9**	5	**1**	**10**	6	2	**11**
Column No. (right to left)	**8**	**6**	**4**	**2**	13	**11**	**9**	**7**	**5**	**3**	1	**12**	**10**

TABLE 1a

REORDERED COEFFICIENTS

Paris 1–13													
Page	1	**2**	3	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	13
Katun No.	4	2	13	**11**	**9**	7	5	3	1	**12**	10	8	6
Upper Ahau No.	13	9	**5**	1	**10**	6	2	**11**	7	3	12	8	4
Lower Ahau No.	7	3	**12**	**8**	**4**	**13**	**9**	**5**	1	10	**6**	2	11
Paris 23–24													
Day Coeff. (red)	10	**8**	**6**	**4**	**2**	**13**	11	**9**	**7**	**5**	**3**	**1**	**12**
Modifying Coeff. (green)	4	2	**13**	**11**	**9**	**7**	5	**3**	**1**	**12**	**10**	**8**	**6**
Column No. (right to left)	13	**12**	**11**	**10**	**9**	**8**	**7**	**6**	**5**	**4**	**3**	**2**	1

Note: boldface numbers denote existence in the codex; others have been reconstructed.

upper and lower Ahau coefficients as part of a thirteen-*tun* sequence within each *katun*. But most significantly, the green *modifying coefficients* have an unmistakable relationship to the series of *katuns* on Paris 1–13. The implications are that each *katun* may have been under the symbolic regency of one of the zodiacal beings,[9] and the table on Paris 23–24 conveys a far longer timespan than previously thought. The precise function of the green *modifying coefficients* will be clarified in chapter 2.

Before returning to the reading of the table in chapter 2, I would like to devote some attention to the hieroglyphic text on Paris 23–24. These glyphs, like the table, are also arranged in thirteen columns, of six glyph blocks each. However, it is the disposition of these glyphs which is particularly striking: most of these glyphs face to the right and are mirror images of their normal counterparts. This is most noticeable in the head variants shown in profile and is contrary to the usual left-facing placement of these glyphs. This situation begins on Paris 21 and is the only example of a considerable text which exhibits this transposition. This possibly implies a reversed reading order as well.

There are isolated cases of individual glyph reversal but, to my knowledge, the only other occurrences of reversal of part of a text are on the west jamb of the south doorway and the east jamb of the north doorway of Temple II at Copan (Morley 1920: pl. 29). However, as Morley (1920: pp. 314–315) notes: ". . . the priests had to depart from regular left-to-right order in two of the panels, so that in entering the two exterior doorways the inscriptions on all four jambs could be read going in." Thus, this appears to be a decorative affectation which surely does not apply to the Paris Codex.

The question remains: what was the function of the glyph reversal on Paris 21–24? The table and, possibly, the glyphs as well on Paris 23–24 are to be read right-to-left, contrary to the usual practice. The zodiacal beings are also to be read right-to-left if one follows the *eastward* course of the sun around the ecliptic. Thus the structure of the table seems to be concerned with the sun's path through the zodiac. However, in order to correctly predict the long-range ecliptic position of the sun, one must be capable of taking into consideration the motion of the one astronomical cycle (with the exception of short periods of planetary retrograde motion) which proceeds counter to all others: the precession of the equinoxes which alone moves *westward* against the background of fixed stars.[10] Thus the glyphs themselves are a clue to the presentation of a retrograde cycle.

Each of the zodiacal beings on Paris 23–24 grasps

[9] Roys (1967: pp. 151, 184–185), commenting on the *katun* prophecies resembling those of the *Chumayel* in the hieroglyphic books apparently seen by Avendaño, states that "the 'face of the *katun*' is evidently that of the god himself as he appears in the heavens, possibly a constellation."

[10] Only one directional glyph appears on Paris 23–24: *west* with "brilliance" affix on Paris 24.

a "winged" *kin* glyph which is pendant from the celestial band. These glyphs deserve careful scrutiny. Thompson (1950: p. 260) suggests that this glyph conveys the meaning of "sun darkened" which could apply equally to stormy weather or to an eclipse. In his catalog Thompson (1962) lists the occurrences of this glyph (T326) but does not classify them according to their most significant feature: the color of the "wings."

On Paris 23–24 the left "wing" of each glyph is black, the right "wing," white.[11] However, there are four distinct varieties of this glyph occurring in the codices:

variety 1: both "wings" white
variety 2: both "wings" black
variety 3: left "wing" white, right "wing" black
variety 4: left "wing" black, right "wing" white

We are only concerned here with the meaning of variety 4 but to establish an acceptable reading, all will have to be investigated.

There also exist four varieties, in which the lunar glyph substitutes for the *kin* glyph, which are the counterparts of the four solar varieties. To make things interesting, on Paris 5 a curious profile face, glyph T731, appears between "wings" of variety 1; an Akbal glyph between "wings" of variety 4 on Dresden 45b; and a *quincunx* between "wings" of variety 1 on Madrid 32a.

A reading of "eclipse" for the "winged" *kin* is seemingly supported by its appearance in illustrations accompanying the eclipse table of the Dresden Codex. It follows from this that the "winged" moon signifies "lunar eclipse." But what would the "winged" T731, *quincunx* or Akbal signify in this scheme? It must also be pointed out here that the illustrative glyphs on the Dresden eclipse pages are variations on the basic theme, some with crossed bones and other appendages, and included among them are glyphs of varieties 3 and 4. They cannot all mean simply "eclipse."

Before returning to the "eclipse" reading, I would like to introduce two significant observations regarding the "winged" moon: 1) the "winged" moon never occurs alone in a text or illustration; it is (with one exception, moon/*quincunx*, discussed below) always immediately preceded by the "winged" *kin*; 2) when this occurs, the configuration of the "wings" of both glyphs is always of the same variety.[12] In table 2 I have tabulated all occurrences in the codices of "winged" *kin* and moon glyphs according to variety with the exception of those on Paris 23–24. The first row lists occurrences of the *kin*/moon combination as delineated above; the second row, occurrences of the "winged" *kin* alone as part of a hieroglyphic text; the last row, occurrences of the "winged" *kin* as part of an illustration (not contained in the hieroglyphic text) which include those on the Dresden eclipse pages. Table 2 demonstrates that all possible combinations are represented in the codices. If my varieties possess significant differences, this implies that something else is being noted which does not necessarily exclude eclipses but does exclude the meaning of "eclipse" attributed to an individual "winged"glyph.

There is, however, one combination of glyphs which can surely be taken to indicate "solar eclipse." On Dresden 58b appears the "winged" *kin*/moon of variety 3 appended to a celestial band. Hanging from these glyphs is an inverted figure whose head is replaced by the Venus glyph. Such upside down figures have long been thought to represent the *tzizimimi*,

[11] Actually, the right "wing" is red, but this serves, I believe, to emphasize the west to east motion of the sun through the zodiac, the directional colors being black and red, respectively. This situation is found only in the Paris Codex which is uniquely concerned with zodiacal motion.

[12] These rules can be expanded to include all "winged" glyphs: the "winged" Akbal is directly preceded by the "winged" *kin*, both of variety 4; the "winged" T731 is preceded by the "winged" *kin* a few glyph blocks back, both of variety 1; the "winged" moon/*quincunx* combination (Madrid 32a) is illustrative (*kin*/Akbal and *kin*/T731 are textual), both of variety 1; the "winged" *kin* illustrative occurs twice as a pair, Madrid 12b, both *kin* of variety 1, and Madrid 71a, both *kin* of variety 2. Thus, a general statement concerning the occurrence of all "winged" glyphs can be formulated: only the "winged" *kin* appears alone; all other "winged" glyphs come in pairs; both members of any pair are of the same variety.

TABLE 2

"WINGED" *KIN* AND MOON GLYPHS IN THE CODICES

Variety	1 (wh./wh.)	2 (bl./bl.)	3 (wh./bl.)	4 (bl./wh.)	Total
Kin/moon combination[a]	1	1	8[b]	4	14
Kin alone	1	1	2	2	6
Kin illustrative	3	4	4[c]	5	16
Total	5	6	14	10	36

[a] Actually two glyphs, taken as a unit here for tabulation.
[b] Three of these (Dresden 55a, 56a, 57a) are damaged, but assuredly belong to this group.
[c] *Kin* is replaced by a possible "skull" (Thompson 1972: p. 76) in one example from the eclipse table (Dresden 57a).

mythical monsters who plunge to earth head first during solar eclipses. The most prominent of these is Venus which appears in the darkness during an eclipse. The glyph of the *tzizimitl* (T227.510b) appears in the first glyph block of the accompanying text followed, after a record of thirteen *tuns* and two glyphs of evil portent, by the "winged" *kin*/moon combination of variety 3, as in the illustration. Thus, text and illustration are complementary and refer to the same phenomenon.

In a similar passage on Paris 5 (also accompanied by glyphs of evil portent) appears the "winged" *kin*/moon combination followed directly by the *tzizimitl*. Here, however, the "wings" of the *kin*/moon combination are of variety 1.

It is an inescapable conclusion that both *kin*/moon/*tzizimitl* passages refer to eclipses.[13] I thus propose that the "winged" *kin*/moon combination be read "sun/moon interaction"; the *tzizimitl* signifies that the nature of the interaction is an eclipse of the sun.

It is notable that in both passages which can assuredly be read "solar eclipse" the only significant difference between the three major glyphs is the variety of the "wings" (Dresden 58b, variety 3; Paris 5, variety 1). This means that the variety of the "wings" conveys some additional information concerning the time or position of the eclipse.

There are four varieties of the "winged" glyph series and only one astronomical phenomenon which could logically fit such a quadripartite division: the stations of the year. Thus the significance of the varieties of "winged" glyphs is as follows:

variety 1: "sun (or moon) at the summer solstice"—the two white "wings" denote the greater duration of the day.

variety 2: "sun (or moon) at the winter solstice"—the two black "wings" denote the prevalence of night.

variety 3: "sun (or moon) at the autumnal equinox"—the white/black configuration of the "wings" denotes the equality of day and night. Reading left to right, the black "wing" follows the white "wing" leading forward to the black-"winged" winter solstice.

variety 4: "sun (or moon) at the vernal equinox"—again, equality of day and night. The white "wing" to the right looks forward to the white-"winged" summer solstice.

Confirmation of the above readings necessitates an excursion into the Dresden Codex. An almanac consisting of thirteen *t'ols* (subdivisions) extends between Dresden 65a and 69a (see Thompson 1972: p. 81, almanac 69). Two rows of numbers, one above, the other below the hieroglyphic text, carry the total of each row to 91 days in *t'ol* 13; the table reaches a total of 182 days between the *lub*, 3 Chicchan, and 3 Manik after one complete round.[14] Thus, any position in the table will be reached again after 182 days.

In *t'ol* 5 the "winged" *kin*/moon of variety 3 occupies the first two glyph blocks; below, in the picture accompanying this division, the "winged" *kin*/moon of variety 4 hangs from a celestial band. According to our analysis these can be read "interaction of the sun and moon" at the autumnal equinox and vernal equinox, respectively. Their juxtaposition is no mistake, but rather quite intentional: if upon reaching *t'ol* 5 on the first reading of the upper row of numbers the autumnal equinox is encountered, the second arrival at the upper row in *t'ol* 5 will be 182 days later, one half year away, at the vernal equinox; a third reading will bring us forward another 182 days, or 364 days from the original position, back again to the autumnal equinox.

This alternation of the equinoxes confirms the assignment of varieties 3 and 4 to these stations of the year but does not answer the question: which is which? The glyphs of variety 4 on Paris 23–24 could not have been reversed without changing their meaning, but do they correspond to the autumnal equinox, or the vernal equinox as I suggest? This is an extremely important point which recalls my assumption earlier in this chapter that it is the vernal equinox at 4 Ahau 8 Cumku that marks the boundary of two Maya constellations.

An eleven-*t'ol* almanac extends between Dresden 38b and 41b. In the first *t'ol* a being with a vulture head stands in a stream of water issuing from a celestial band. Above the picture are four glyph blocks: the first two are occupied by the "winged" *kin*/moon of variety 3; the third by *ti imix*, translated "in the water" by Thompson, and referring to the stream of water in the picture below; and the fourth contains the glyph of the vulture (T747). Thus the picture and the glyphs refer to the same phenomenon. As Thompson (1972: p.100) notes, "one is reminded of the reference amid rains of little value to 'rains from a vulture sky' (*kuch caan chacil*) in a prophecy of the *Chilam Balam of Chumayel*."

Since the rains do not normally commence until about forty days after the vernal equinox, "rains from a vulture sky" would be more logically associated with

[13] The data on Paris 5 and Dresden 58b are of even greater significance. The thirteen *tuns* of the Dresden text correspond to the thirteen-*tun* sequence (upper and lower Ahau numbers) on each page of Paris 1–13. Thirteen *tuns* is equal to 27 eclipse half-years as well as 8 Venus cycles + 8 days; this means that an eclipse occurring with Venus at or near heliacal rising could repeat after thirteen *tuns*. This is but one of the links between the Venus and eclipse pages of the Dresden Codex and the Paris Codex.

[14] The table must be read ten times to reach the *lub* 3 Chicchan again, the grand total being 1,820 days with major subdivisions of 91 days. This table and the table on Paris 23–24 are both concerned with this 5 × 364-day period, and here, the breakdown of the 364-day year into four divisions (4 × 91 = 364) bespeaks preoccupation with the stations of the year. This table is directly preceded by a table of multiples of 364 and is one of several in the codices which share the 91-day scheme, one of which is directly below on Dresden 65b–69b.

the autumnal equinox. Fine, cold spray rains accompanied by rainbows falling at the beginning of October (about ten days after the autumnal equinox) are known among the Chorti Maya as "urine of the rainbow" (Girard 1969: p. 264), and are damaging to the crops. According to our plot of Maya constellations (see endplate), during the entire span of the Classic period and for almost one thousand years thereafter, the autumnal equinox resided in the Vulture constellation. The reference on Dresden 38b to "rains of little value" which fall when the sun resides in the Vulture constellation confirms the assignment of variety 3 to the autumnal equinox, and thus variety 4 to the vernal equinox, variety 1 to the summer solstice, and variety 2 to the winter solstice. From the aforegoing we can safely conclude: it is the symbol of the *sun at the vernal equinox* which is grasped by each of the zodiacal beings on Paris 23–24.[15]

The Paris Codex contains a considerable number of unique or very rare glyphs. Three of these appear in just one column on Paris 23. I am not certain of the reading order on these pages, whether in pairs of columns from the left or right, or possibly in individual columns. The number of columns seems to have been intentionally set at thirteen; the seven on Paris 23 being closely spaced, the six on Paris 24 more openly spaced. This arrangement is opposite to that of the beings and day glyphs in the table below.

Whatever the reading arrangement, the first and last of the three glyphs to be considered are separated by a minimum of two, and a maximum of five, intervening glyph blocks. They thus belong to a single passage with a unified theme. The general tenor of this passage is what is now of concern and, judging by the rarity of the glyphs, must be of uncommon import.

The first glyph, T725, is unique and represents cords within a cartouche; its importance is that it ties the vernal equinox to several iconographic concepts in the second half of the Paris Codex.

This glyph is undoubtedly a glyphic representation of the green cords which run around and through the illustration on Paris 22 which contains the continuation and the head of the serpent *cum* celestial band on Paris 23–24. The associations of the vernal equinox with green cords and the color green are particularly striking and warrant close inspection.

Two important observations follow from a cursory look at Paris 22–24: 1) the background for the *sun at the vernal equinox* glyphs and black coefficients beneath the celestial bands on Paris 23–24 is green; 2) on Paris 22 (lower right) a section of green cord runs directly into a *sun at the vernal equinox* glyph, establishing some sort of association.

On Paris 22 four human figures with *Bacab* headdresses (see Thompson 1970) sit upon or near the celestial band. They undoubtedly represent the four *Bacabs*. One of the *Bacabs* sits on and is almost completely enclosed by the green cord, and is himself covered with green markings. The four *Bacabs*, as the sky-bearers at the four corners of the sky, have a close relationship to the stations of the year. That only one *Bacab* is given the "green treatment" may indicate his predominant position and association with the vernal equinox.

Landa (Tozzer 1941), in his discussion of the new year's ceremonies, tells us there was indeed a chief *Bacab*. The sixteenth-century Maya of the Yucatan peninsula, upon whom Landa reported, used a different set of year bearers than those used in the Classic period. In the Yucatec system, the year bearers were moved up one place from their positions in the Classic period, which may have gone into effect as early as 9.12.0.0.0 in Campeche (see Thompson 1950: appendix II). Comparing the two systems we can see the relationships clearly in figure 5:

Classic period[1]	Ben	Etznab	Akbal	Lamat
16th century Yucatan[2]	Kan	Cauac	Ix	Muluc
Associated color	red	yellow	black	white
Associated direction	east	south	west	north
Presiding deity[3]	*Bolon Tz'acab*	death god	*Itzamna*	*Kinich Ahau* (sun god)

[1] As given in codices Dresden and Paris, and the inscriptions.
[2] Also in Campeche earlier (see above) and in the Madrid Codex.
[3] The four *Bacabs* of the respective world directions and colors shared this rule.

FIG. 5. The Year Bearers.

[15] We can now offer explanations for other "winged" glyphs: T731 is found in profusion, several times carrying a coefficient, on the Venus pages of the Dresden Codex. It is thus very likely that it has something to do with the Venus cycle, possibly denoting heliacal rising. The "winged" T731 of variety 1 found on Paris 5 may thus be read "Venus cycle at the summer solstice," an intriguing question. The *quincunx* as a symbol for Venus as morning star (as opposed to evening star) is well documented (Thompson 1950: pp. 171–172). Thus, I suggest that the moon/*quincunx* combination of variety 1 on Madrid 32a represents an "interaction" (conjunction, occultation?) involving the moon and Venus at the summer solstice. The "winged" Akbal is problematical but conforms to the rules delineated for "winged" glyphs (footnote 12, p. 16): it directly follows the "winged" *kin* and both are of variety 4. Most interestingly, this combination is directly preceded by the glyph of the controversial "Mars Beast" (T794) on Dresden 45b. A full interpretation will not be offered here, but it is apparent that an "interaction" at the vernal equinox, probably involving a planet, is depicted. In any event, the so-called "Mars table" on Dresden 44b–45b deserves thorough reanalysis.

Landa relates that Muluc years were of felicitous prognostication because they were ruled by the greatest of the four *Bacabs*. Muluc years, as well as their counterparts the Lamat years, were ruled by the white *Bacab* of the north. But why should the *Bacab* of the north be accorded this honor?

The greatness of this *Bacab* seems to be tied to the concept of the north as the central point of heaven, more specifically, the pole star, the pivot around which all other stars move. This in turn is related to God C:

> God C, whose head is the main element of the glyph for the north, usually has the mouth of a monkey, . . . and it has been suggested that the Maya may have regarded the constellation of the Great Bear as a monkey (Thompson 1950: p. 80).

Thus, the Maya appear to have had a concept similar to "the north and its wheel" of the Aztec, with which God C was associated. Indeed, Schellhas (1904) identified God C with Polaris itself in the role of *Xaman Ek*, the "guide of merchants."

Maya religion was filled with an abundance of dualism: on one hand, we must distinguish between the celestial and terrestrial aspects of the various deities, and on the other we must recognize their essential unity. In relation to the celestial realm, the north with its associated color white, was considered the center or pivotal point. However, in the terrestrial realm, the center was represented by the color green. As we shall soon see, Paris 15–18 are filled with pictures of a green God C.[16]

The white *Bacab* of the north, chief among his brethren, when assuming a terrestrial role undoubtedly donned robes of green. This would imply a fifth *Bacab* or, in dualistic terms, three *Bacabs* plus a two-in-one chief *Bacab*. In support of this notion we may observe that the glyph of the *Bacabs* is affixed not only with a coefficient of 4, but also with a coefficient of 5 (see Zimmerman 1956; Thompson 1970). I thus suggest that the green *Bacab* was associated with the vernal equinox and was chief of the *Bacabs*; and by extension, the vernal equinox was the chief station of the year.

The green *Bacab* is but one of many green gods in the second half of the Paris Codex. On Paris 21 groups of day glyphs are boxed off by green cords and accompanied by two deities with green markings. One of the green cords terminates in a circle with an infixed *kin* glyph, and four hummingbird(??) heads extending from it. This configuration is suspended in green "rain" falling from the celestial band through which the green cord passes, and is poised over the gaping jaws of a serpent. The *kin*/sun bound by the twisted green cord is noteworthy.

On Paris 15a–18a and 15b–18b are the remains of two (or more) almanacs. In every nonobliterated *t'ol* is a green god, with one exception God C, where identification is possible. Most of these green gods hold one or more Kan glyphs in their hand: Paris 15a, the arm of a green diving god with Kan; 15b, green God C holding triple Kan; 16b, green God C with Kan; 17b, green diving God D with Kan; 18b, green God C with Kan.

Among these green gods on Paris 15–18 are three enlightening combinations. On Paris 16b a green God C sits in the branches of a green tree which issues from a representation of a cenote. What he holds in his outstretched hand is obliterated but most probably a Kan glyph: a Kan glyph surmounted by an iguana appears in the fifth glyph block of the text above. The second, third and fourth glyph blocks contain the glyph of God C, *ti imix*, "in the water," and T591, the glyph of the cenote in the picture.

In the next *t'ol* a green God C holding a Kan glyph sits in a green tree which terminates below in two serpent heads. In the second glyph block is the glyph of God C; in the third, the tree is identified: T59.17:87, *ti yaxte*, "at the ceiba." The sacred ceiba tree (representing the fifth world direction and color, the center and green, respectively) stands at the center of the earth, its roots penetrating into the underworld, its branches into the thirteen layers of the sky.

On Paris 17b, what is most probably a green God D appears as a diving god holding a Kan glyph.[17] In the fifth glyph block appears a triple Kan. Curiously, the glyph of God C appears in the second glyph block (as usual in the other *t'ols*) although God D is depicted below. God D as a diving god is interesting: diving gods, such as are found on the murals of Tulum, are usually appended with foliaceous motifs. The glyph of God D appears twice on Paris 23–24, once directly below the unique T725 now under discussion.

In all these green gods we are dealing with a concept of prime importance: the fifth world direction, the terrestrial center and the manifestation of vegetative life and growth, of the corn in particular, which has long been known to be symbolized by the Kan glyph. The terrestrial-agricultural aspects of these gods are, as we have noted, an integral part of Maya religious dualism.

The almost mystical quality of the Maya's love and

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[16] On Madrid 34b (lower left) appears a squatting God C holding a torch. He has two faces looking in opposite directions reminiscent of the Greek god Janus. Above God C is a seated figure whose head is a Caban glyph (a symbol of the earth) with an axe at the eye. The major theme of this almanac appears to be agricultural: note the triple Kan glyph in the pot and the figure with digging stick in the act of sowing what are most probably corn kernels. This seems to be an aspect of the dualistic nature of God C. Also of note is that on occasion God C bears the color prefixes of four world directions (Thompson 1950: p. 171), and on Madrid 43b and 43c his glyph is associated with numbers and the colors of the *five* world directions (including the center, green).

[17] God D as a diving god in the company of other diving gods with foliage growing out of their heels and elbows is found on Dresden 15a. The passage on Dresden 26b may have a bearing on his role here: *ben-ich hel; Kinich Ahau* (sun god); God E (corn god) with God D (*Itzamna*) prefix. As Thompson (1950: p. 117) notes, the dragon monsters, the *Itzamnas*, were associated with rain and agriculture, and were offered sacrifices to insure good crops.

devotion to their corn is expressed in one of the names of the corn god, *Ah Mun*, "Tender One." The *yax*-Kan compound, read "green corn" or "new corn," found several times on the new year's pages of the Dresden Codex, symbolizes the newly sprouted corn, the tender green shoots. On Paris 19, one of the parallel pages in the Paris Codex dealing with the year bearers, a cob of corn appears above the head of what is most likely a vulture. Below, adjacent to the jaguar, may be the corn god, God E (or impersonator): an oblate Kan glyph within a foliated headdress supports this identification. On the other side of Paris 19 appears a human figure with a similar but less ornate headdress (here the Kan glyph is better preserved) and a red cord extending from a slit in his belly. Miller (1972: p. 175) suggests that the Maya custom of cutting the umbilicus over an ear of corn may apply to the iconographic interpretation of this page. A sacrificial victim with entrails may be applicable as well: the vegetative growth symbolism is also evident in the sacrificial scene on Dresden 3, where the glyph of God E is also found. In any event, both of these were most probably fertility rites for the benefit of the corn.

Returning to the green cords, these seem to be the symbolic representation of concepts concerning the fertility and growth of the most important Maya plant, the corn. The vernal equinox, the chief station of the year, is the natural beginning of all agricultural endeavors: the milpa must be prepared and planted in readiness for the first rains. This connection of green cords with the growth of corn and the vernal equinox is symbolized by the unique glyph T725 and the glyph which stands above it, the glyph of the corn god (T1006b). The sun at the vernal equinox, which precedes the rainy season, and the young green corn—the dependence of the earth and mankind on the benevolence of the celestial powers—is of concern on all these pages. Thus, the symbolic union of heaven and earth is represented by the green cords. Miller (1972: p. 173) relates all cords symbolically to the umbilicus, which in his view represents the concept of familial lineage as well as the allegorical heaven and earth union. These concepts may all be appropriate here; their iconographic significance will be expanded in part III.

I think that I have adequately demonstrated the dominant role of the vernal equinox and that the green cords represented by T725 relate to the symbolic union of heaven and earth, particularly in the realm of agriculture. In the last analysis, the Maya were an agricultural folk whose ultimate success was heavily dependent on the blessings of nature.

The second glyph of rare occurrence (T528: 528.528) is the "triple Cauac," which certainly represents a unit of time. The double Cauac with various affixes has long been recognized as a part of the glyphs for the *baktun* and higher periods. Kelley (1976) reads the double Cauac phonetically as *cuc*, "cycle," and Thompson (1950) reads the single Cauac as *haab*, "year." Cauac can apparently substitute for the *tun* glyph at times as in the name glyphs of the *Bacabs* (the various Gods N; Thompson 1970) who presided over the five Uayeb days at the year's end. Thus, an association of Cauac with some reckoning of the year is certain.

The "triple Cauac" appears in revealing context on Madrid 71a, upon the back of the turtle, one of the zodiacal beings. The turtle hangs by dotted lines between two *sun at the winter solstice* glyphs attached to a celestial band. None of the known glyphs of the turtle are in the text above the illustration but the glyph of another animal appears in the third glyph block, preceded, significantly, by IV.64:528, the name glyph of the four *Bacabs* (Thompson 1970). The glyph in question is a head with a long, rounded snout and an Akbal infix at the eye. The long-snouted glyph seems to be a variant of a glyph below on Madrid 71b (T792), in which crossed bands replace the Akbal infix. It could also be a version of T1036c, while all three glyphs share the characteristic snout and the Akbal or crossed bands infix. A glyph which has the snout but appears only in the inscriptions (T754) has been suggested to be a peccary (Thompson 1962). I accept the peccary identification of these glyphs on the basis of their most prominent feature, the rounded snout.

It is more than reasonable to accept a middle to late post-Classic origin of the Madrid Codex. At this time, the vernal equinox had moved well into the Canine constellation; this places the winter solstice squarely in the Peccary and the summer solstice in the easternmost quarter of the Turtle.[18]

The significance of all this is that the Turtle had just recently become the residence of the summer solstice, the halfway point between two successive winter solstices in the Peccary: the two *sun at the winter solstice* glyphs indicate the passage of one year (from winter solstice to winter solstice); the turtle suspended between them represents the halfway position (exactly one half year from the winter solstice), the summer solstice in the Turtle constellation. The "triple Cauac," I suggest, is the glyph for that reckoning of the year best suited to calculating the zodiacal position of the stations of the year: the sidereal year. How this was calculated is the subject of the next chapter.

The last glyph to be discussed lies directly under

[18] According to our plotting of the Maya constellations, as yet independent of the correlation question, the zodiacal positions of the stations of the year are as follows: vernal equinox, Canine; summer solstice, Turtle; autumnal equinox, Vulture (discussed previously); winter solstice, Peccary (see endplate). These positions pertain to the post-Classic period. Because of the precession of the equinoxes, the Classic period positions of the stations of the year were several degrees eastward, and in two cases have crossed constellation boundaries. The Classic period positions are thus: vernal equinox, Jaguar; summer solstice, Scorpion; autumnal equinox, Vulture; winter solstice, Peccary.

the "triple Cauac." It is unique. At the center is an element which appears to be identical to the one found in the *ich* glyph; four curved elements in the corners give an impression reminiscent of the *quincunx*. The glyph may have been bordered by a dotted circle, the presence of the subfix and the condition of the left edge making this uncertain. At present, I will not attempt a reading of this glyph; it is the coefficient to the left upon which I focus attention.

Both the Thompson (1962) and Zimmermann (1956) catalogs attribute the coefficient to the glyph to the left (not to our glyph) and assign a value of 6.[19] The argument, I assume, is that given glyph reversal on Paris 23–24, the coefficients must also be reversed. There are good grounds to doubt this premise: although the glyphs are reversed, the conventions for writing numerals still apply.[20] The element to the left of the coefficient is not the main element in its glyph block; I intend to show that coefficients are extremely rarely found to the right and, in such special cases, are always attached to the main element.

The only glyph to which coefficients (from 1 to 19) are normally attached to the right is Glyph A of the lunar series. This is logical since Glyph A really acts as a symbol for 20 which properly would go to the left of a smaller unit. This was noted by Morley (1920: p. 312) in his discussion of the glyph reversal on Temple II at Copan. Here, the coefficients of glyphs of the initial series and lunar series, including Glyph A, are reversed. However, as previously discussed, this was intentionally designed for its visual effect, and especially with an initial series or lunar series, no doubts would arise as to the disposal of the coefficients which are all attached to main elements (period glyphs, etc.).

The augural glyph good tidings (T567) appears on Paris 23 with what seems to be a coefficient of 3 to the right. At first glance this seemingly supports the contention of concurrent glyph/coefficient reversal. However, the *ox* coefficient, when attached to this glyph, appears to function as a linguistic device used to indicate the superlative. As Thompson (1950: p. 129) states in his discussion of the glyph:

> . . . *ox* surely does not have any directly numerical connotation, but rather has an intensificatory value, the term being attached to various words to add emphasis, more or less as in our own expressions "a thousand thanks," "a thousand times no", or "ten times better."

Thus the *ox* affix could be reversed on Paris 23, as could any non-numerical affix, without violating any rules of Maya numerical notation. The noncritical nature of this reversal is confirmed on Madrid 65a and 37d, where *ox* appears on the right. The scribe of the Madrid Codex may have suffered from partial dyslexia (Kelley 1976) as evidenced by his many mistakes; he even writes T567 with a coefficient of 4, twice on Madrid 11a.

Aside from T567 and Glyph A, I know of only two examples of coefficients written to the right of glyphs. These occur with Imix (501.XVI) and T607 (607.IV:59) on the Holmul cylinder vase and the Kabah mural, respectively (Thompson 1962). These examples do not involve serious calendrical efforts and were probably drawn by artists not trained in mathematics and calendrics.[21] One of the artists was in all likelihood a simple village potter. I am thus inclined to view these examples as the exceptions which prove the rule: numerical coefficients are never placed to the right of glyphs.

Curiously, Thompson's (1962) notation of the glyph to the left of the coefficient is VI.24.17:521?, and the glyph on the upper right corner of Paris 24, VI.24.17?:521, ostensibly the same configuration. Even taking into consideration my own as well as Thompson's doubts, the two glyphs would really be mirror images, only the latter being in correct notation. This latter glyph clearly has a coefficient to the left and may be identical to glyphs on Dresden 49e and Paris 3(?).[22] It seems that Thompson assigned the coefficient to the left-hand glyph on the basis that the combination T24.17:521 seems to always have a coefficient of 6. On Paris 21 the same glyph and affixes, but in a different configuration, has a coefficient of 6, here as a superfix. Thompson's notation of this is VI.24.17:521 whereas the positions of T17 and T521 should be reversed.

What Thompson is doing is juggling the reading order in the hope of compensating for the glyph reversal on Paris 21–24. He even draws the unique T725, the first glyph discussed, as its mirror image, not as it truly appears. The effect of this is to confuse the two glyphs on Paris 23–24, attributing a coefficient to a defaced glyph based on a superficial resemblance and the juggling of reading order.

I see no reason to equate the two glyphs. This would be a gross inconsistency from which none of the other

[19] Gates (1909) placed the coefficient with our glyph but assigned no numerical value.

[20] This was just as necessary in Maya mathematics as it is in ours to preserve the consistency of mathematical place notation: seventy-five is never written 57 and, although rarely done, could be understood as $^{7}_{5}$, but never $^{5}_{7}$.

[21] The Imix 16 on the Holmul cylinder vase is an impossible combination to the left or right. On the Kabah mural T607 appears with a coefficient of 4 to the right. The glyph is itself reversed, which Thompson (1962: p. 231) thinks may account for reversal of the coefficient. This assumption in relation to Paris 23–24 is demonstrably false (see following discussion). In any event, stelae and codices, not murals were the showplaces of calendrical acumen, and T607 is a noncalendrical glyph, probably a variant of T589, the drill glyph.

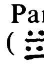
[22] The coefficient of this glyph on Paris 24 is clearly an aberrant example and could equally well be a 5 with a superfluous black fleck, or an intentional correction to a 6 squeezed in after the passage was completed.

glyphs on Paris 23–24 suffer. Note that there are at least seven pairs of identical or nearly identical glyphs (including the glyph of God D) which are the same on both pages: except for small changes in affixes, no two glyphs of the same type are drawn differently.[23]

The numerical coefficients of all glyphs on these pages are consistently to the left.[24] These include coefficients of the supposed matching glyph (VI.24.17:521) on Paris 24 as well as those of the 65 day glyphs in the table (which are also reversed, as proved by the Eb glyph which faces right). Even on the strength of visual inspection alone,[25] the coefficient  appears to belong to the unique glyph to its right.

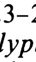
The individual glyph blocks on Paris 23–24 were at one time separated by fine red lines. On page 23 of the original Paris Codex appear several barely visible fine red remnants of what I believe was once the line separating the two glyph blocks. These appear to the left of the coefficient. This observation may make the preceding argument superfluous, but I feel that these points regarding the placement of Maya numerals deserve to be made. The coefficient belongs without doubt to the unique glyph to its right and can now be interpreted.

The Paris Codex exhibits a high degree of mathematical sophistication. On Paris 15–18 are several series of complex calculations written in four different colors: black, red, green, and yellow. By contrast, both the Dresden and Madrid codices show only black and red. Color alternation is used to separate two sets of numbers, as in the serpent series on Dresden 61–62 and 69, but mathematical place notation (i.e., 1's, 20's, 360's, etc.) is normally not indicated in this way.

On Paris 15–18 color alternation also apparently functions as a means to separate, in this case, as many as four sets of numbers. When two or more coefficients of the same color are stacked one upon the other the intent is to convey numbers greater than twenty. This is also true on Paris 23–24 where the long accepted reading of 168 () is written in black alone. Thus, Paris numbers greater than twenty are written in one color, which appears to be the rule throughout the codices.

The usual Maya practice in recording vertical numbers is to place the dots to the left of the bars when recording a number of less than twenty. Several times in the Madrid Codex dots are placed to the right of a bar as on Madrid 19b where the following appears:

Also, vertical coefficients are quite often squeezed haphazardly into available spaces, while the great majority are written horizontally. However, in the entire Madrid Codex there are but two more examples where dots are placed to the right of a bar: Madrid 44c, red 7; 47a, black 6. These aberrant forms appear nowhere else in the codices, and are assuredly artifacts of the corruptness of the Madrid Codex which departs from conformity to normal writing conventions for hieroglyphics as well as coefficients.

The Paris Codex, without exception, scrupulously follows the convention of placing dots to the left of bars in vertical numbers less than twenty. This convention also holds, most importantly, on Paris 23–24. The green *modifying coefficient* of column 4 of the table on Paris 23–24 is a **12,** written in the usual way, *regardless of glyph reversal*: 

I have devoted considerable discussion to establishing the following: 1) The coefficient belongs to the unique glyph in the column to the right. 2) Paris numbers greater than twenty are written in one color. 3) Paris numbers less than twenty have the dots to the left of the bars. The above facts remain valid in the presence of glyph reversal and now enable us to read this coefficient and the glyph to which it is prefixed.

The coefficient is **101** and the glyph, I suggest, is the symbol for the 13-*katun* cycle on Paris 1–13. Reduced to a number, 101×13 *katuns* is equal to 9,453,600 days, which is an excellent approximation of the cycle of the precession of the equinoxes.

As Kelley (1976) notes, long Maya calculations are usually accompanied by serpents with open jaws, such as the serpent series on Dresden 61–62. The Paris table is no exception: on Paris 22 appear two such serpents and, with the exception of the scorpion, the beings on Paris 23–24 have open jaws. However, the scorpion is not really an exception: the jaws of animals, or the beaks of birds, are their primary weapons; the weapon of the scorpion is the stinger on the end of its tail. Thus, all the zodiacal beings are bound by a common

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[23] For example, there are four occurrences of the *kaz* glyph (T648) on Paris 23–24, which form two distinct pairs. One of these pairs is on Paris 24, to the left and below the glyph with the aberrant 6 coefficient. The configuration is clearly 648.1:24 but is reversed in the Thompson catalog (1962: p. 354) to 1.648:24. The other pair (one member on Paris 24, the other, partially obliterated but recognizable, on the top of Paris 23) has the *u*-bracket (T1) to the left instead of to the right, and sits on the comb affix (T25) instead of the *il* affix (T24). This combination, 1.648:25, is however not listed in reversed notation by Thompson because it is one of 62 such examples "in all three codices." Although these two examples are not exact replicas of a common configuration in the codices (due to reversal of the *kaz* element) Thompson has quite arbitrarily decided against reversed notation in this case which would have been 648.1:25, had he been thoroughly consistent. Thus, Thompson's attempted compensation for glyph reversal on Paris 23–24 is misleading and fallacious.

[24] There is a possible coefficient of 1 appearing above the head glyph of the black spotted dog (T801) on Paris 24. With glyph reversal, the normal position, above the bridge of the nose, has been retained and although now reversed is more properly considered as an example of a superfix, if it is at all a numeral coefficient and not a stray blemish, or part of the defaced glyph block above.

[25] If a straight edge is placed along the left margin of the vertical bar, the resulting line clearly separates the two columns and just grazes the affix belonging to the glyph below and to the left. This is not unusual since most columns on Paris 23–24 are not perfectly vertical and show a degree of overlap, the two columns here being among the straighter alignments.

concept. The symbolism here implies some sort of "power" over the vernal equinox by each of the zodiacal beings. But can these beings have "power" over the vernal equinox at the same time? At any given time the vernal equinox is lòcated in just one of these constellation-beings, and for about 2,000 years.

If the table is not related to the precession of the equinoxes we must answer one vexing question. Assuming, for a moment, that we have just an ordinary depiction of the Maya zodiac, we could expect to find the following in relation to the stations of the year glyphs: 1) only one of the beings would be grasping the vernal equinox glyph; the Canine, which became the residence of the vernal equinox at the end of the Classic period, after it passed out of the Jaguar; 2) the Vulture would be associated rather with the autumnal equinox, and in like manner, the Peccary with the winter solstice, and the Turtle with the summer solstice, as seen in the Dresden and Madrid codices; 3) none of the other beings would logically be grasping any one of the stations of the year glyphs.

The question is then: what are all these beings doing grasping the vernal equinox? The only logical answer is that we are dealing with the one astronomical cycle in which each constellation in turn exerts "power" over the vernal equinox, the precession of the equinoxes.

Conclusion

This chapter concerned itself with indications that the Paris Codex is far more complicated than hitherto imagined. There are several properties of the codex which have confounded prior attempts at figuring out what this enigmatic manuscript is all about. The arguments in this chapter were directed at elucidating these properties and preparing the way for a full explanation. The Paris zodiac has long been discussed, both pro and con, without raising its status above the level of a possibility. By making the assumption that the vernal equinox at the start of the long count marked the dividing line between two constellations, I was able to show that the constellation-beings appear in their actual celestial sequence.

The arrangement and 1,820-day reading of the table have long been known, but the function of the green coefficients in each row has never been explained. My demonstration that these green *modifying coefficients* have a close relationship to the thirteen-*katun* cycle on Paris 1–13 prepares us for the idea that these numbers enter into the operation of the table and allow expansion to far above 1,820 days.

The next problem to be engaged was why my earlier critical assumption in assigning constellation boundaries should even involve the precession of the equinoxes, and the vernal equinox in particular. By a thorough analysis of all "winged" glyphs in the codices I was able to demonstrate that the thirteen glyphs by which the constellation-beings hang represent the *sun at the vernal equinox*. The argument for the constellation boundaries and that for the glyphs of the stations of the year proceeded from two separate trains of thought. Thus, for example, the assignment of a specific section of the sky to the Vulture constellation, and the assignment of the "winged" *kin* of variety 3 to the autumnal equinox, could not be expected to find corroboration in their unambiguous association (on Dresden 38b) unless both independent lines of reasoning were essentially correct. The interlocking nature of the data will continue to bear out the original assumptions: in chapters to come, the identities and positions of the Maya constellations will be tested against data from the codices and the inscriptions.

The last section of this chapter dealt with the sequence of rare and unique glyphs on Paris 23. In order to establish a Maya estimate for the duration of the precession of the equinoxes, the reader was led through a discussion of these glyphs and in particular the unique T725 (symbolizing the associations of the vernal equinox with green and the fertility of the corn), and the unique glyph with the coefficient of 101. The rules of Maya mathematical notation were discussed to determine how the coefficient should be read. The most telling arguments, I believe, are the small green *unreversed* 12 (dots to the left!) on Paris 24, and the black 168 appearing several times on Paris 23–24.

Here again, I assume that the unique glyph represented the thirteen-*katun* cycle, and that together with its coefficient of 101 yields the 1313-*katun* Maya estimate of the precession. However, it was pointed out that the association of the vernal equinox glyph with all the constellation-beings at the same time is illogical unless this is meant to refer to the 26,000-year cycle of the precession of the equinoxes. If the reader will indulge, I am sure that this assumption will be fully justified in the next chapter, which takes up the torch from here.

2. THE READING OF THE TABLE ON PARIS 23–24

In the previous chapter I have established the groundwork to understanding the Paris table. In this chapter we will be concerned with the operation and functions of the table, or how it was used as an astronomical ephemeris. The key to the decoding of the table is that its operation is analogous to that of a simple clock. On the face of a clock each major division can represent either one hour or five minutes: these time units are read on two coinciding scales with a "hand," or counter, for distinguishing between them. The Paris table also operates on this principle: each interval can be read on either of two time scales; the counters (corresponding in function to the hands of a clock), which denote which scale is being referred to, are the red and green coefficients. We already know that one of the intervals of the Paris table is 28 days, the approximation of one Maya sidereal month. It is the other interval which I would now like to introduce.

The interval between any two successive day glyphs in the Paris table can be expressed by the following formula: I = 28 + ($n \times 260$). Similar formulae can be written for intervals in other Maya tables and here n is always equal to 0. In the familiar reading of the Paris table, $n = 0$ also, and the interval is 28 days. However, in the second interval of the Paris table n = 1, thus:

$$I_2 = 28 + (1 \times 260)$$

$$I_2 = 288 \text{ days}$$

The day names and their red coefficients remain the same but the interval increases to 288 days when read in conjunction with the green *modifying coefficient* of each column. The 288-day interval is at the heart of the Paris table, the basis for which I will now explain.

We have already seen (tables 1 and 1a) that the green *modifying coefficients* have a connection to the *katun* cycle on Paris 1–13. This connection can now be clarified. A glance at the *katun* coefficients shows that the coefficient of each successive *katun* decreases by two; after thirteen *katuns* the coefficients repeat. Beginning on Paris 1 the *katun* coefficients are: 4, 2, 13, 11, 9, 7, 5, 3, 1, 12, 10, 8, 6. Let us now take an example to see how this operates in the table.

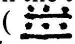
Assigning the date 4 Ahau (column 10) as the terminal date of a *katun*, the next *katun* in chronological order will end on 2 Ahau (column 9). Counting forward from 4 Ahau we reach 2 Ahau after 25 intervals in the table. That is, 25 intervals of the second kind (I_2), thus: 25 × **288** = 7,200 days (1 *katun*). It is also notable that the green *modifying coefficient* also decreases by two between column 10 (4 Ahau) and column 9 (2 Ahau). Thus the green *modifying coefficients* act as counters to indicate the shift to I_2 mode and conveniently locate successive *katuns*. Before integrating the two operative modes of the table, the entire sequence in I_2 mode can now be reconstructed. To this end we recall the 13-*katun* cycle on Paris 1–13 and the coefficient of 101 by which it is multiplied.

In the table, one cycle of 65 I_2 intervals gives a total of 18,720 days (65 × 288 = **18,720** days). This is equal to 52 *tuns* (52 × 360 days) and is also just 260 days (1 *tzolkin*) short of the calendar round of 18,980 days (52 × 365).[1] However, it is only after five repetitions of the I_2 cycle that we reach 93,600 days, which is equal to 13 *katuns* (5 × 18,720 = **93,600** days); and after 505 (5 × **101**) repetitions, the full cycle of 1,313 *katuns* (13 × **101**) is reached: 505 × 18,720 = **9,453,600** days. It should be noted here that a calculation of the precession of the equinoxes is almost meaningless unless, as I will soon demonstrate, it can be put to practical application.

TABLE 3

FACTORS OF 9,453,600 AND 9,434,880

9,453,600 =	26,260 × **360**
(505 × 18,720) =	36,360 × **260**
9,434,880 =	26,208 × **360**
(3 × 168 × 18,720) =	36,288 × **260**
=	25,920 × **364**
=	11,520 × **819**
=	5,184 × **1,820** (1 **I** cycle)

I digress a moment to consider 9,453,600 as a Maya number. Aside from being a multiple of the *katun* (and *tun*), it is only divisible by one other Maya cycle, the *tzolkin*. There is, however, another number derivable from the table which fares much better. The number 168 (), appearing several times between the *sun at the vernal equinox* glyphs, has some interesting properties. It seems to function in both modes of the table: it is a multiple of the I mode (6 × **28** = 168); and when multiplied by one repetition of the I_2 mode yields a close approximation to one third of the full cycle:

3(**168** × 18,720) = **504** × 18,720 = 9,434,880 days

(precessional cycle = **505** × 18,720 days)

The number derived from this manipulation is a multiple of several major Maya time cycles (table 3).[2]

Returning to the table, the two operative modes of 28 days (I) and 288 days (I_2) can now be integrated. Together they function as an astronomical ephemeris through which the ecliptic longitude of the sun can be calculated on any given date future or past. This determination of ecliptic coordinates is accomplished using only simple mathematics and with an error of less than one day's mean solar motion (about 1.0 degree longitude).

Looking at the table in I mode (28 days), it is easily seen that if a calculation is begun on any one day, all multiples of the 364-day zodiacal year fall in the same column. For example, starting at 4 Ahau at the top of column 10, successive intervals of 364 days bring us to 4 Kan, 4 Lamat, 4 Eb, 4 Cib, back to 4 Ahau, and so on indefinitely.

---

[1] After one I_2 cycle plus 260 days the day and coefficient remain the same (i.e., 4 Ahau → 4 Ahau). In this regard, I do not think it accidental that the year bearers appear on Paris 19–20 with several of the zodiacal beings.

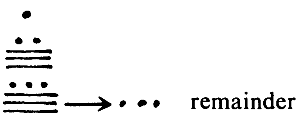
[2] It would have been quite logical for the Maya to utilize fractions of the whole precessional cycle, especially if they correlated with other cycles. On the lower right of Paris 22, directly next to a section of green cord, is a barely legible formula on the border of the totally defaced area:

13:glyph(?):2:12(?). . . ?

Interestingly, one fifth of the full cycle is equal to 1,890,720 days which reduces to Maya notation as 13.2.12.0.0.

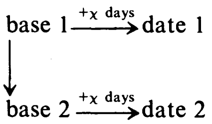
Using a simple shortcut, one can determine the day reached after any number of multiples of 364: i.e., to find the day reached from 4 Ahau after 718 zodiacal years, just divide by 5 (the number of days in the column); then, with the remainder, in this case 3, count down the column to the day 3 places below: 4 Eb. This can be confirmed quickly by simple arithmetic and a table of the *tzolkin*. The calculation is even simpler in Maya arithmetic: cast out all bars, then all dots except those in the 1's place. This can be illustrated for the above example:

$$\mathbf{1} \times 360 = 360$$
$$\mathbf{17} \times 20 = 340$$
$$\underline{\mathbf{18} \times 1 = 18}$$
Total **(1.17.18)** 718



It may be asked: how does one make such calculations for days not listed in the table? The answer is quickly obtained by noting that all the days of the *tzolkin* stand in an ordered relationship to the days in the table. Since one cycle in I mode is equal to seven *tzolkins* (7 × **260** = 1,820 days), each day is implicitly embedded in the table seven times at various points. In the case of the five base days, six of these occurrences are implicit, only one occurrence being counted as a base. The most important point is that each day is always between 0 and +27 days from one of the bases: 0 when it is itself a base; +27 when it is one day before the next base.

In order to calculate from any implicit date, one merely has to find its relationship to a desirable base within one zodiacal year, complete the calculation from the base, and then duplicate the relationship counting from the second base:

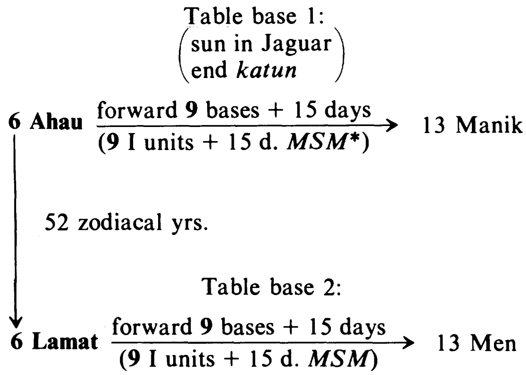


For example, let us make a calculation with the day 13 Manik which lies 267 days after a *katun*-ending date 6 Ahau. A day 13 Manik occurs seven days after base 6 Ahau, three days after base 10 Kan, as well as in five other positions. However, only one of these positions corresponds to the relationship 6 Ahau $\xrightarrow{+267}$ 13 Manik.

Let us further assume that we wish to calculate forward 52 zodiacal years from 13 Manik. The first part of the operation is just as shown before in the shortcut for zodiacal year determinations. We need not even find 13 Manik in the table—just remember its relationship to base 6 Ahau from which it is calculated (6 Ahau $\xrightarrow{+267}$ 13 Manik).

By the shortcut, we reach the day 6 Lamat after 52 zodiacal years. To reach the day 52 zodiacal years from *13 Manik*, the relationship 6 Ahau $\xrightarrow{+267}$ 13 Manik must be reconstructed from the new base, 6 Lamat. This gives us an ideal illustration of operation in I mode in the table. To find the day 267 days after 6 Lamat the interval is divided by 28, which gives the number of bases to move forward, and a remainder: 267 ÷ 28 = **9** bases + 15 days. Counting forward 9 bases from 6 Lamat (column 11) brings us to 11 Ahau (column 7). The desired date lies 15 days forward from 11 Ahau: 13 Men in the *tzolkin* table.

This is all very useful for calculating zodiacal years but let us take a step further. Assume that on the *katun*-ending date 6 Ahau the sun had just entered the Jaguar constellation and we wish to calculate its positions on 13 Manik and 13 Men. Referring to figure 6, we see that there is no problem from 6 Ahau to 13 Manik but we run into difficulties after 52 zodiacal years:



* *MSM* = mean solar motion.

FIG. 6. Calculating within one Zodiacal Year.

In solving for the sun's position at 13 Manik, let us formulate a few rules of operation. When calculating from a date with known solar position, the position is given as the number N (from 1 to 13) of the constellation of residence, plus the number of days of mean solar motion past its western boundary: solar position = constellation $N + \chi$ days *MSM*. The operative interval of 28 days (let us call these I units) is equivalent to 28 days *MSM* and is the distance between the western boundaries of successive constellations towards the east. The addition of I units is, in effect, moving eastward along the ecliptic from one constellation to the next. Adding n amount of I units is accomplished with the following formula:

$$\text{Solar position}^{\dagger} + n \text{ I units} = \text{const. } (N + n)$$

† For simplicity, 0 days *MSM* are assumed.

Substituting constellation names for *N*, the position of the sun at base 6 Ahau can be described as *Jaguar* + *0 days MSM*. Solving the equation, we reach the position of the sun at 13 Manik: *Jaguar* (const. 1) + *0 days MSM* + (**9** I units + 15 days *MSM*) = *Peccary* (const. 10) + *15 days MSM*. Thus, after 267 days *MSM* the sun is located 15 days *MSM* past the western boundary of the Peccary.

So far the table works well: it is obvious that 9 I units + 15 days is equivalent to 267 days *MSM*; so long as we operate within one zodiacal year, the error will not exceed 1.25 days *MSM* (about 1.25 degrees longitude). The calculation 6 Ahau → 13 Men, however, is another matter. The relationship 6 Lamat → 13 Men is the same as 6 Ahau → 13 Manik (both are **9** I units + 15 days), but the position of the sun at 6 Lamat must first be found.

The interval 6 Ahau → 6 Lamat is 52 zodiacal years. If this interval were **52** *sidereal years*, the solar position would be the same at both dates and the calculation 6 Lamat → 13 Men would be as easy as 6 Ahau → 13 Manik. This is because the sun returns to the same position only after multiples of the sidereal year of 365.25636 days. Applying the sidereal year to the 6 Ahau → 13 Men calculation, we find that the sun is about as far as it can go from its original position at 6 Ahau, about halfway round the zodiac:

52 zodiacal yrs. + 267 days = 19,195 days

19,195 ÷ 365.25636 = 52.55 sidereal yrs.

If, however, by means of a correction factor, the zodiacal year could be made to function like the sidereal year, we would have a way to calculate the solar position on any given day. There is such a correction factor inherent in the clockwork mechanism of the table: the I_2 mode.

The vernal equinox returns after one synodical year of 365.2422 days. The time between successive equinoxes is used to reckon the calendar year because it keeps the seasons in line, a very important consideration. However, the earth makes one complete orbit of the sun in one sidereal year of 365.25636 days which brings the sun back to the same position against the background of fixed stars. The difference between these reckonings, amounting to but 0.01416 day (about twenty minutes) per year, is due to the precession of the equinoxes and must be considered in the calculation of celestial coordinates. The Maya, who are not known to have computed fractional coefficients, did not have a direct means to represent either of these cycles. Thus a correction factor would have to be added to a whole-number approximation of the year to bring the fractional sidereal cycle into alignment.

The only two candidates for such a position are the vague year of 365 days and the zodiacal year of 364 days. The vague year with its grouping of eighteen months of twenty days plus five Uayeb days is unlikely to have anything to do with the celestial realm, and its connection to the calendar year has received much attention since Teeple's (1930) determinant theory. It can thus be eliminated from consideration. On the other hand, the zodiacal year with its thirteen equal divisions of 28 days is ideally suited to positional astronomy in a thirteen-constellation zodiac.

If, then, a correction is to be applied to the zodiacal year, it must possess two properties: 1) it must be a whole number; 2) it must not be very large. The first condition is self-evident in terms of Maya arithmetic; the second is logical in that a correction applied at long intervals would allow the determination to fall far out of step with actual celestial position.

Many Maya cycles are correlated by a number which is divisible into whole-number (or nearly so) multiples of both cycles. Witness the eclipse table in the Dresden Codex in which the cycle of 11,960 days is equal to 405.004 lunations and 69.009 eclipse half-years (passages of the nodes). The total error is less than two days in over 32 years of operation. However, the use of such a scheme in correlating χ sidereal years with y cycles of another type would be extremely impractical considering the day by day adjustments required by positional astronomy.

The Dresden Venus table is thought to have been corrected by subtracting several days after the completion of a certain number of Venus revolutions. This was done in such a way as to retain the base of the cycle on the day 1 Ahau (Thompson 1950). Whether or not this scheme was used exactly as suggested by Thompson is of little consequence. The point is that we are dealing with a ubiquitous Maya astronomical concept: the *lub*, the base of a cycle which is allowed to run slightly out of step before corrections are applied.

The concept of the *lub* is indeed applicable to the Paris table. The number of days between each table *lub* of 12 Lamat is a multiple of the *tzolkin* in both operative modes (7 in I mode: 7 × **260** = 1,820; and 72 in I_2 mode: 72 × **260** = 18,720) but the corrections applied have nothing to do with the retention of the *lub*. How these corrections between the zodiacal and sidereal years were made can now be reconstructed.

If the zodiacal year is used as the equivalent to the sidereal year, after one cycle the former is 1.25636 days behind the sidereal year. After four sidereal years the error would be 5.02544 days, a good approximation to a whole number. Thus a correction of five days added to four zodiacal years yields practical equality with four sidereal years:

4 zod. yrs. = 1,456 days

Correction: 1,456 + **5** = **1,461** days

4 sid. yrs. = **1,461**.02544 days

The accuracy achieved is admirable. However, since the Maya did not calculate with fractional coefficients, they would of necessity calculate the elapsed time in zodiacal years and then convert to sidereal. This would involve inversion of the equation.

This inversion can be visualized as follows: the shorter zodiacal year represents the longer sidereal year; thus the zodiacal year completes the cycle 1.25636 days *before* the sidereal year. In this scheme the correction is subtracted from the elapsed time in zodiacal years to yield the equivalent in sidereal years (let us call these Zs units):

Elapsed Time:	4 zod. yrs. + 5 days = **1461** days
Correction:	(4 zod. yrs. + 5 days) − **5** days = **4** Zs units + **0** days
Actual:	1461 ÷ 365.25636 = **4** sid. yrs. + **0** days

From this it is easily seen that elapsed time measured as N zodiacal years ($+\chi$ days) can be converted to n Zs units ($+y$ days) which are equivalent to n sidereal years ($+y$ days).

Here again we find admirable accuracy. However, this accuracy holds only when corrections are applied after 1,461 days when the cumulative difference between multiples of 364 and 365.25636 is very close to five days. This raises two serious objections: 1) 1,461 days cannot be easily located in the table, being neither a multiple of the I nor I_2 units; 2) prior to application of corrections, the count would differ from reality by as much as five days, an error of about 5 degrees longitude.

However, if these corrections were spaced so they could be applied one day at a time, the accuracy could be considerably improved. This can be equated from the total error (5.02544 days) after four sidereal years (1,461.02544 days) from the following ratio:

$$\frac{1}{5.02544} = \frac{\chi}{1461.02544}$$

$$\chi = \mathbf{290.72587}$$

Thus, after 290.73 days, a one-day correction would equilibrate the zodiacal and sidereal years.

If the Maya were to use this corrective interval, it would have to be rounded to 290 or 291, both of which have very few factors and otherwise no unusual properties. However, we already have a number in the table which is an excellent approximation of this interval: the I_2 unit of 288 days. The properties which make 288 the ideal compromise are: 1) by virtue of its being 1 *tzolkin* (260 days) greater than the I unit (28 days), both units can be incorporated into the same scale with the day names and their coefficients remaining the same for each (remember the clock; one hour or five minutes); the red and green coefficients mark the corresponding scales; 2) it is exactly 1/25 of the *katun* which, as we have seen, is what Paris 1–13 is all about; after one *katun* of elapsed time 25 correction days are subtracted, making calculation easy.

We now have all the necessary information for full operation of the table. Use of the table can continue for over eighty years before the error exceeds one day. We can now return to the calculation involving 52 zodiacal years, which had previously stymied us, and solve for the remaining positions. Before proceeding, though, it would be advantageous to formulate rules of operation.

To find the solar position on a day anterior or posterior to any date with known solar position, we will need to perform four operations (table 4). In each

TABLE 4

OPERATIONS FOR USE OF PARIS EPHEMERIS

Operation 1: $\frac{\text{E.T.}}{288} = \mathbf{C\ I_2\ Units} + I_2$ remainder

The correction (C) is computed and carried to operation 2; the I_2 remainder is ignored.

Operation 2: $\frac{\text{E.T.} - \text{C}}{364} = \text{Zs units} + \mathbf{Zs\ rem.}$

The correction (C) is applied and the modified E.T. is converted to Zs units (sid. yr. equivalents); the Zs rem. is equivalent to the distance in days *MSM* from the original solar position; all Zs units are ignored for further calculation purposes and the **Zs rem.** is carried to operation 3.

Operation 3: $\frac{\text{Zs rem.}}{28} = \mathbf{n\ I\ units + I\ rem.}$

The Zs remainder is converted to **I units** plus **I remainder** which are processed further in operation 4.

Operation 4: Original coordinates: *const.* $N + \chi$ *days MSM*
To find new coordinates: *const.* $(N + n) + y$ *days MSM*

a) Add χ *days MSM* (from original coordinates) to **I rem.** (from operation 3):

χ *days MSM* + **I rem.** = y *days MSM**

* if y *days MSM* > 28:
1) y *days MSM* − 28 = y' *days MSM*
2) **n I units** + 1 I unit = **n′ I units**
3) substitute y' and n' for y and n respectively below.

b) Add **n I units** (from operation 3) to *const.* N:

const. N + **n I units** = *const.* $(N + n)$*

* If $N + n > 13$: subtract 13

c) Combine the results of steps a and b:

New coordinates = *const.* $(N + n) + y$ *days MSM.*

To locate new constellation in the sky: count right to left across the beings starting at original constellation in the Paris table (i.e. Jaguar-Rattlesnake-Turtle, etc.) or clockwise (*eastward*) on the endplate; 1 I unit = 1 constellation.

TABLE 5

MULTIPLES OF 364, 288, AND 28

No.		Mult.		Total	Maya No.
364	×	1	=	364	1. 0. 4
	×	2	=	728	2. 0. 8
	×	3	=	1,092	3. 0.12
	×	4	=	1,456	4. 0.16
	×	5	=	1,820	5. 1. 0
	×	10	=	3,640	10. 2. 0
	×	50	=	18,200	2.10.10. 0
	×	100	=	36,400	5. 1. 2. 0
	×	1000	=	364,000	2.10.11. 2. 0
288	×	1	=	288	14. 8
	×	2	=	576	1.10.16
	×	3	=	864	2. 7. 4
	×	4	=	1,152	3. 3.12
	×	5	=	1,440	4. 0. 0
	×	25	=	7,200	1. 0. 0. 0
	×	500	=	144,000	1. 0. 0. 0. 0

No.		Mult.		Total	Maya No.
28	×	1	=	28	1. 8
	×	2	=	56	2.16
	×	3	=	84	4. 4
	×	4	=	112	5.12
	×	5	=	140	7. 0
	×	6	=	168	8. 8
	×	7	=	196	9.16
	×	8	=	224	11. 4
	×	9	=	252	12.12
	×	10	=	280	14. 0
	×	11	=	308	15. 8
	×	12	=	336	16.16
	×	13	=	364	1. 0. 4

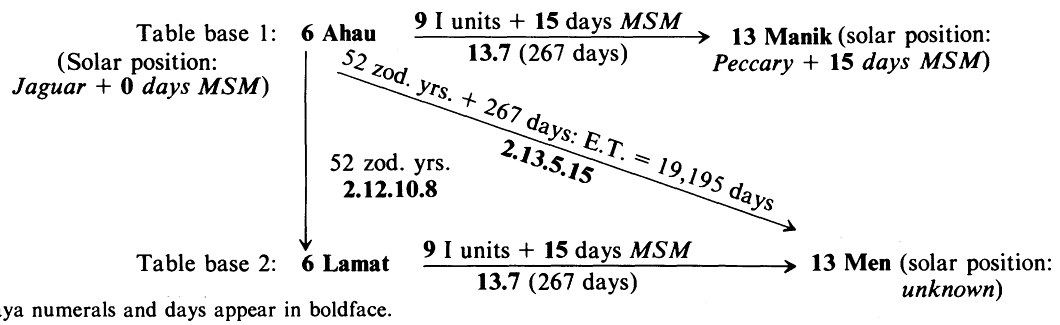
operation only the part in boldface is necessary to the next step; the other parts can be separately tabulated. All these operations can be accomplished with simple arithmetic involving the numbers 28, 364, and 288. Since Maya mathematics is geared to the calendar, these operations can be just as easily performed on Maya numerals; all that is required is a table of multiples of the above numbers (table 5).

It will be noticed that only the first five multiples of 288 are given in table 5. This is all that is necessary due to the neat relationship of the I_2 unit to the *katun*; one fifth of the *katun* (4 *tuns*) is the lowest common multiple of 288 and 260.

Thus, for each *baktun*, 500 (20 × 25) correction days are applied; for each *katun*, 25; and for each 4 *tuns*, 5: the remainder less than 4 *tuns* can be found in the table of multiples. The notation system of the long count makes these corrections very simple to calculate.

Very few multiples of 364 are necessary since these can be combined in various ways to calculate any number of zodiacal years. I have listed all thirteen multiples of 28 although only the first seven would be absolutely necessary. I submit that these multiplication tables were to be found on Paris 25 or following pages (in our numbering scheme) now missing or destroyed.[3] This is, however, a moot point since operation of the table is demonstrably quite simple in any event.

Let us now return to the problem of calculating the solar position at 13 Men which lies 52 zodiacal years + 267 days forward from a known solar position at 6 Ahau. We will solve this problem using only Maya numerals as the Maya themselves would have done. Here is the diagram again (fig. 7):



Note: Maya numerals and days appear in boldface.

FIG. 7. Calculating in Sidereal Year Equivalents.

We could, if we wished, solve for 6 Lamat and then 13 Men but it is now only necessary to know the elapsed time between the base with known solar position and the date in question. We will proceed with the four operations, following the progress parenthet-

[3] Multiplication tables, notably the 364-day tables on Dresden 63–64, precede the almanacs to which they refer. In the presence of reversal of the glyphs, as well as the reading order of the table, on Paris 23–24, it is logical to assume that Paris 25 was the preceding page in Maya eyes.

ically with Arabic numbers:

Operation 1

$\left(\frac{\text{E.T.}}{288}\right)$ Elapsed Time: **2.13.5.15** (19,195 days)

a) **2** *katuns* × **1.5** = **2.10 I_2 units** (25 I_2 units/*katun*; table 5)
(2 × 25 = 50)

b) [**13** *tuns* − **12** *tuns* = **1** *tun* (carried to remainder in step c)]
12 *tuns* ∴ **3** × **5** = **15 I_2 units** (5 I_2 units/4 *tuns*; table 5)
(=**3** × **4** *tuns*) (3 × 5 = 15)

c) Remainder:

1. 5.15 (475)		
− **14. 8** (288)	**1 I_2 unit** (table 5)	
9. 7 (187)	I_2 rem. − ignored	

Addition of I_2 units: (steps a, b, and c)

	2.10 (50)	
+	**15** (15)	
+	**1** (1)	
	3. 6 (66)	**I_2 units total**

Thus, a correction (C) of **3.6** (66) is taken to operation 2.

Operation 2

$\left(\frac{\text{E.T.} - \text{C}}{364}\right)$

Elapsed Time:	**2.13. 5.15**	(19,195)	
Correction:	− **3. 6**	(− 66)	
Modified E.T.	**2.13. 2. 9**	(19,129)	
	2.13. 2. 9	(19,129)	
	− **2.12.10. 8**	(− 18,928)	52 Zs units (table 5)
	10. 1	(201)	**Zs rem.**

Actually, 52 zodiacal years have been subtracted, but by virtue of the correction (C) they are now equivalent to 52 sidereal years; only the Zs rem. is carried to operation 3.

Operation 3

$\left(\frac{\text{Zs rem.}}{28}\right)$

10. 1	(201)	Zs rem.
− **9.16**	(− 196)	**7** I units (table 5)
5	(5)	**I rem.**

Zs rem. is converted to 7 I units + 5 days *MSM* which is the distance from the original solar position at 6 Ahau. 7 I units + 5 I rem. is carried to operation 4.

Operation 4 Original coordinates: *Jaguar + 0 days MSM*

a) **0** *days MSM*
+ **5** **I rem.**
5 *days MSM* (*y* days *MSM* < 28 ∴ no further manipulation)

b) const. **1** − *Jaguar*
+ **7** I units (7 constellations to the east)
const. **8** − *Frog*

c) new coordinates = *Frog* + **5** *days MSM*

Thus, after 2.13.5.15 (19,195 days) elapsed time, the sun is five days *MSM* past the western boundary of the Frog constellation. We can compare this reckoning with a modern calculation:

Elapsed Time = 19,195 days

	sidereal years	days *MSM*
Maya:	52 Zs units	+201
Modern:	52 sid. yrs.	+201.669

The total error of the Maya method is 0.7 day, quite respectable after 52 years of operation. However, the major point of this demonstration is that the Paris table can be used to predict the ecliptic longitude of the sun, and the arithmetic involved (both Maya and modern) is practically child's play.

So far I have demonstrated the following about the Paris table: 1) it contains a reckoning of the precession of the equinoxes; 2) it has a mechanism for converting zodiacal years into sidereal year equivalents; 3) it can be used to predict the motion of the sun through the zodiac with a simple system of celestial coordinates. It would now be of interest to turn our attention to the *lub* of this cycle and see where it begins.

A logical day for the table to begin would be a day 4 Ahau, the beginning date of the Maya calendar near the transition of the vernal equinox from the Turtle to the Rattlesnake. But it does not; it begins on a day 12 Lamat. There is, however, an excellent reason for this.

The opening day, 12 Lamat, seems to have been closely associated with the moon and was a lunar, not a solar *lub*. It is also the very day which begins the Dresden eclipse table. These associations are indeed noteworthy but where is 4 Ahau, the day of the sun?

If we count forward from 12 Lamat, we reach 4 Ahau after nine intervals in the table: 9 I_2 units, that is. If this first occurrence of 4 Ahau really corresponds to 4 Ahau 8 Cumku, this puts the date 12 Lamat 2,592 days (7.3.12) before the beginning of the Maya calendar. This in itself is not unusual. The Maya are known to have calculated from *lubs* prior to 4 Ahau 8 Cumku; for example, the Dresden Venus table. If this is another example of such a *lub*, the Paris table then opens on the date 12.9.12.14.8 12 Lamat 11 Pax.

What makes this interesting is that the interval 2,592 is 200 days greater than one fifth of the eclipse interval (11,960 days), which was a standard reckoning for the moon: 2,392 days = 81 lunations. If we assign the date 12 Lamat 11 Pax as a new moon, we reach a moon age of 23 days at 4 Ahau 8 Cumku, 2,592 days later. Teeple (1930) was of the opinion that the moon age at 4 Ahau 8 Cumku was calculated as 24 days at Palenque, and 22 days at Copan. Allowing disagreement between Copan and Palenque in a 4,000-year back-calculation (see chapter 3), the Paris table puts the moon age right between the two at 23 days.

There is a date on the Temple of the Cross at Palenque which reads 12.19.13.4.0 8 Ahau 18 Zec. This date lies 152 days after 12 Lamat 11 Pax and has the following lunar series: G8, **5D**, 2C, X3, 9A. Counting from 12 Lamat 11 Pax as new moon, we reach the five-day moon age (5D) given on the tablet of the Temple of the Cross. However, the ultimate confirmation of 12 Lamat 11 Pax as a lunar *lub* comes from Stela 1 at Coba: moon age 23 days at 4 Ahau 8 Cumku (Morley 1937–1938: **I**, p. 316).

The number 2,592 has a property which is far more interesting than being merely the interval that leads up to 4 Ahau 8 Cumku. If the table runs a grand total of 9,453,600 days (101 × 13 *katuns*), but the official beginning of the Maya calendar was placed 2,592 days after the initial date of the table, it would be logical to view this interval as a distance number meant to be subtracted from the full cycle. Thus, the interval from 13.0.0.0.0 4 Ahau 8 Cumku to the end of the table would be 9,451,008 days. This turns out to be 0.325 day short of 25,875 sidereal years, and 0.866 day over 25,874 synodical years. The cycle of the precession of the equinoxes comes to a close when the difference between the sidereal and synodical years adds up to one full year.

This is precisely the type of cycle correlation mentioned in relation to the Dresden eclipse table, a fixed amount of elapsed time which reduces to whole-number multiples of two cycles of unequal length: in this case 25,874 sidereal and 25,875 synodical years, respectively.

There is yet another lunar *lub* in the Paris table. Counting forward from 4 Ahau (8 Cumku), this time in I units, we again reach 12 Lamat after 56 intervals. The date reached is 1,568 days (56 × **28**) after 4 Ahau 8 Cumku, at 13.0.4.6.8 12 Lamat 11 Zec.

The interval between the two *lubs*, 12 Lamat 11 Pax before, and 12 Lamat 11 Zec after, 4 Ahau 8 Cumku, is 4,160 days. Interestingly, this interval is equal to sixteen *tzolkins* but also has other notable properties. The last property will be discussed later[4]; for now, the main point of interest is that the interval from 12 Lamat 11 Pax to 12 Lamat 11 Zec is just 0.56 day longer than 24 eclipse half-years, and the latter *lub* ties directly to the Dresden eclipse table.

The base of the eclipse table is at 9.16.4.10.8 12 Lamat 1 Muan. The interval between the *lub* 12 Lamat 11 Zec in the Paris table and the Dresden table base is exactly 118 multiples of the eclipse table. It makes excellent sense to situate a *lub* near 4 Ahau 8 Cumku which is separated from a contemporaneous *lub* by multiples of the cycle in question: the known *lub* of the Venus table near 4 Ahau 8 Cumku lies at a distance of 36 multiples of the Venus great cycle from the contemporaneous *lub*.

Thompson (1950: p. 235) notes that although the 11,960-day interval is an excellent estimate of 405 lunations, it nonetheless incurs an error of about one day every nine repetitions. He finds evidence that the

[4] The 4,160-day interval is 3.8 days short of 141 lunations. This in itself is not particularly promising but will play a large role in the discussion of the two lunar *lubs* in relation to the lunar series, to be taken up in the next chapter.

Maya added periodic corrections which had the dual benefit of adjusting the accuracy to almost modern standards while retaining the *lub* at 12 Lamat. The formula he suggests is as follows: 70,460 days = 2,386 lunations. If this is divided out to yield the length of each lunation, the error incurred is in the sixth decimal place:

$$\begin{array}{r} 70{,}460 \div 2{,}386 = 29.530595 \\ -\ \underline{29.530589}\ \text{(modern)} \\ 0.000006\ \text{day error in over 192 years} \end{array}$$

Let us apply Thompson's formula to the interval between 12 Lamat 11 Pax and the 12 Lamat at the end of the full cycle 9,453,600 days later:

$$9{,}453{,}600 \div 70{,}460 = (\mathbf{134} \times 70{,}460) + \mathbf{11{,}960}\ \text{days remainder}$$

We can now see how many lunations the Maya attributed to this interval and compare it with the modern calculation:

Maya:

$$\begin{array}{rl} \mathbf{134} \times 2{,}386 & = 319{,}724\ \text{lunations} \\ +\ \mathbf{11{,}960}\ \text{days} & = \underline{405}\ \text{lunations} \\ \text{total} & \ \ \mathbf{320{,}129}\ \text{lunations} \end{array}$$

Modern:

$$9{,}453{,}600 \div 29.530589 = \mathbf{320{,}129}\ \text{lunations} + 2.073\ \text{days}$$

Thompson's formula does indeed fit neatly into the full Maya precessional cycle. And although speculative, there is further reason to believe the Maya were so accurate regarding the moon.

Two dates appear on Altar V at Copan (Morley 1920: pp. 296–298); one of these is that of the now defunct "astronomical convention" at 9.16.12.5.17 6 Caban 10 Mol which appears no less than eight times at Copan. This was an exceedingly important date at Copan and was associated with several other dates including *katun* anniversaries. It is the associated date 9.16.5.3.6 9 Cimi 14 Yaxkin on Altar V which concerns us here.

My original investigation of the Copan dates was aimed at finding the interval 2,592 days which, as we have seen, has interesting solar properties. I found instead many suggestive lunar intervals and the date 9 Cimi 14 Yaxkin: this date goes back 2,571 days before the important date 6 Caban 10 Mol. At first I was quite disappointed; the interval was 21 days short. Besides, 9 Cimi is among the least popular days on the monuments, presumably because of its death associations, and 2,571 is a closer approximation to the lunar cycle (87 lunations + 1.8 days). There must, however, be some reason for its existence.

Beginning with 6 Caban 10 Mol, I assumed that the Maya may have wished to calculate the repetition of an important astronomical event on the occasion of this important date. There is considerable evidence that 6 Caban 10 Mol was the inauguration date of the Copan ruler called "New-Sun-at-Horizon" (Kelley 1962). There are no obvious solar associations if 6 Caban 10 Mol is taken alone, but the interval back to 4 Ahau 8 Cumku is 0.375 day short of 47,938 lunations.

In the absence of the "birthday" glyph and granting the short interval to inauguration, the associated date 9 Cimi 14 Yaxkin seems to have nothing to do with the lifetime of New-Sun-at-Horizon but rather with the suggested lunar calculation (see also chapter 4).

When the interval 2,571 is taken as a distance number and treated in the same manner as 2,592, the resulting number is equal to 320,042 lunations:

$$9{,}453{,}600 - 2{,}571 = 9{,}451{,}029\ \text{days}$$

$$9{,}451{,}029 \div 29.530589 = 320{,}042\ \text{lunations} + 0.236\ \text{days}$$

If these data can be plugged into the Paris table as I suggest, attributing phenomenal accuracy to Maya lunar calculations, an interesting question is raised: why do not the lunar series associated with dates within a relatively short timespan agree with each other? This discussion must be delayed until the next chapter.

The major implication of the foregoing discussion is that the Paris table shows an equal concern with the lunar cycle. Indeed, knowing the solar position and the moon age on any given date, the position of the moon can be easily calculated, for example, by reference to a table of the sidereal lunar month. Such a table already exists, as shown by Barthel's (1968) work on Dresden 4–10.

The eclipse period, which ties the sun to the cycles of the moon and the nodes, is also inherent in the functioning of the table. When Kelley (1976: p. 49) suggests that " . . . this table is also particularly concerned with eclipses," he is right. As previously shown, the "sun darkened" glyph, whose four varieties I have reinterpreted as the *sun at the stations of the year*, does not in and of itself mean "eclipse." However, if any of the eclipse warnings extracted from the Dresden table are computed in the Paris table, the ecliptic longitude of the impending eclipse can be easily calculated. Astrologically, the consequences of an eclipse were undoubtedly affected by its position in the zodiac.

Thus, while the Paris table is primarily concerned with the determination of solar ecliptic longitude, when used in conjunction with other astronomical tables the position of any relevant event can be predicted. This holds especially well with the Dresden Venus table.

It is very suggestive that the 65 base days in the Paris table are the very days of the 65 heliacal risings of Venus during one great cycle. In early stages of this work I reached an impasse in pursuing this connection in relation to the precession. However, one interesting observation regarding Venus and the zodiac resulted from this investigation (fig. 8).

Figure 8 shows that every fifth Venus heliacal rising

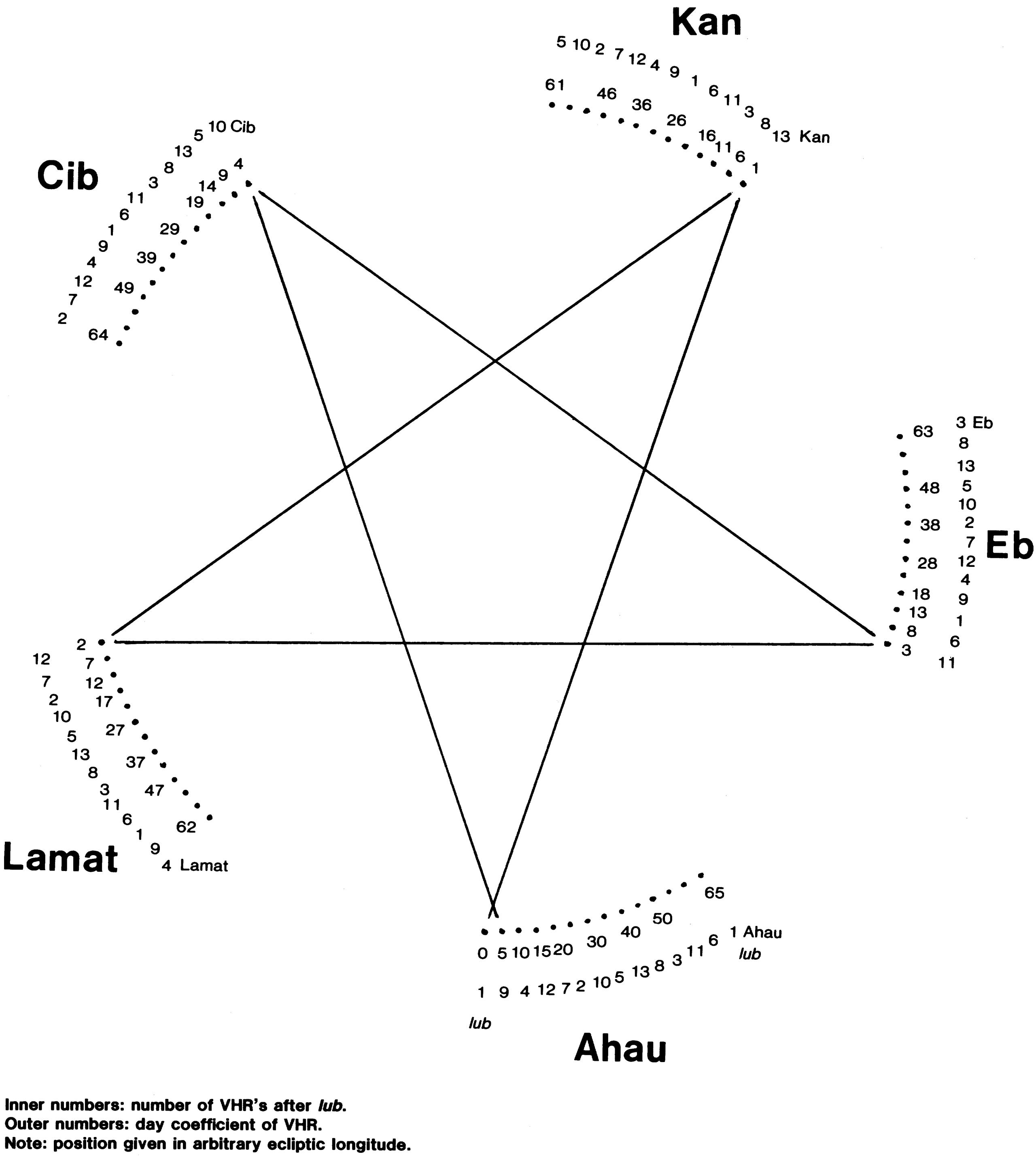


FIG. 8. Venus Heliacal Risings.

(VHR) returns to practically the same ecliptic coordinates. Thus, successive VHR's officially falling on the same day of the *tzolkin* lie in a row which gradually extends westward, the entire pattern forming an almost perfect pentagram rotating slowly through the zodiac.

This situation makes the determination of the ecliptic coordinates of successive VHR's exceptionally easy. All that is necessary is to determine the position of one of those VHR's, the rest will obey the set pattern.[5] Using such a system, excellent accuracy could be attained with minimal calculation. The layout of the Dresden Venus table supports the idea that such a system was actually in use: VHR's falling on the same official day are grouped together in five sets; Kan, Lamat, Eb, Cib, Ahau, corresponding to their order of occurrence in the celestial pentagram. Each set is accompanied by a "spearing episode" (i.e., Dresden 47: spearing of the jaguar on Lamat VHR's) which ties together the official VHR days. Possibly, the zodiacal position of a VHR determined who was to be speared at the time the Dresden Codex was written.

Dresden 24 shows that the Venus cycle was counted from a *lub* 2,200 days before 4 Ahau 8 Cumku. This date, 12.19.13.16.0 1 Ahau 18 Kayab, can also be located in the Paris table: counting fourteen I units from 12 Lamat 11 Pax, the Venus *lub* at 1 Ahau is reached.[6]

From the preceding argument one fact stands clear: the operation of the Paris table seems to have been intentionally designed for positional astronomical calculations involving the three major heavenly bodies which occupied the attentions of the Maya: the sun, the moon, and Venus; and these calculations were extremely accurate.

So far I have dealt mainly with the sidereal year as a means for calculating solar ecliptic longitude and, by extension, the longitude of the moon or Venus. There is, however, a way in the table to correlate the indirectly calculable sidereal and synodical years with their directly calculable counterparts, the zodiacal and vague years. This involves further corrections to the table which extend its accuracy over the full cycle.

The formula 9,453,600 − 2,592 = 25,875 sid. yrs. suggests that the table was used effectively over its entire 26,000-year range. I have already demonstrated its use over a 52-year span and alluded to its accuracy without further correction over more than eighty years. However, in light of the previous discussion, there must be further corrections to allow extended use. These corrections are not so obvious as the I_2 mode.

Before continuing it is necessary to make one small refinement to the table. During the first 364 days of operation, each day corresponds exactly to one day *MSM*. Thus, a correction after 288 days in this case is superfluous. The correction (C) calculated in operation 1 is therefore one day too many. The whole situation has arisen because we are subtracting a correction from elapsed time to yield sidereal year equivalents rather than adding to 364 to yield true sidereal years. The correction taken to operation 2 should then be (C − 1). Let us rename this the α correction.

Let us now use the revised formula to review the performance of the table at one-*katun* intervals for seven *katuns* (table 6). In the first three *katuns* the error is well under +1 day; at the fourth *katun*, the table falls −1 day off the count and remains close to this error until the seventh *katun* when it drops −1.9 days behind. This is quite impressive performance after nearly 140 years, but when operating near the end of the cycle, a considerable error will accumulate.

Also included in table 6 is the solar formula 9,453,600 − 2592 = 25,875 sidereal years, discussed previously. Here the error has risen to 308 days, the better part of a year. It is mildly suggestive that eleven I units (11 × **28** = 308 days) are the exact correction necessary to make the table fully operative over 26,000 years.

If the table is to remain with ±1 day accuracy, it is obvious that a correction is needed at some time after the fourth *katun* of operation. Since the interval at which a correction of one day would equilibrate the zodiacal and sidereal years is actually 290.72587 days, the correction at 288 days is a bit too early. This situation will eventually produce an α correction one day too great, and the table will begin to fall more than one day off the true count. When this occurs can be extracted mathematically by the following formula:

$$\frac{\chi}{288} - 1 = \frac{\chi}{290.72587}$$

Solving for χ, we find that it is just 36 days longer than 84 *synodical years*:

$$\begin{aligned} \chi &= 30{,}716.45163 \text{ days} \\ &- \underline{30{,}680.34470} \text{ (84 synodical yrs.)} \\ &\quad 36.10693 \text{ days} \end{aligned}$$

I say synodical years here because 84 of them rounded to 30,680 (as would have been necessary to the Maya) are equal to 118 *tzolkins*. A secondary correction to the table at this point would have, in Maya eyes, the virtue of being extraordinarily easy to compute.

The number 84 is in itself interesting. It is one half of the number 168 associated with the *sun at the vernal equinox* glyphs below the celestial band on Paris 23–24. If this association is taken literally, we have

[5] Since the pattern is pentagonal, the longitudes of the four following VHR's can be determined by the addition or subtraction of 72 "days" (2 I units + 16 days) or 144 "days" (5 I units + 5 days) to the known longitude; the fifth VHR would be moved two or three "days" (0 I units + 2 or 3 days: subtract when moving westward) from the original position and the process would repeat. Actually, not "days" but degrees are being added or subtracted: the system relates longitudinal distance to the motion of the sun, which is more regular than that of the moon or planets; in this case, the distance "72 days" is used to express the distance the sun moves in that time, equivalent to about 72°, or one fifth of the celestial circumference at the ecliptic (360° ÷ 5 = 72°).

[6] Also of interest is Thompson's (1950) key emendation to Venus cycle multiples on Dresden 24: 9,360 days = 16 Venus cycles + 16 days; the interval (26 *tuns*) is exactly one half of one repetition of the table in I_2 mode.

TABLE 6

CUMULATIVE ERROR IN PARIS TABLE

Katun	Elapsed time	Maya calculations		Modern calculations		Sidereal error[4]
		α[1]	Zs[2]	Syn. yrs.[3]	Sid. yrs.	
1	7,200	24	19 yrs. + 260 days	19 yrs. + 260.129 days	19 yrs. + 260.398 days	−0.398
2	14,400	49	39 + 155	39 + 155.554	39 + 155.002	−0.002
3	21,600	74	59 + 50	59 + 50.710	59 + 49.875	+0.125
4	28,800	99	78 + 309	78 + 311.108	78 + 310.004	−1.004
5	36,000	124	98 + 204	98 + 206.265	98 + 204.877	−0.877
6	43,200	149	118 + 99	118 + 101.421	118 + 99.749	−0.749
7	50,400	174	137 + 358	137 + 361.819	137 + 359.879	−1.879
1313 − 2595 days	9,451,008	32,815	25,874 + 57	25,876 + 0.866	25,874 + 364.931	−307.931

[1] $\alpha = \frac{\text{E.T.}}{288} - 1$

[2] $\text{Zs} = \frac{\text{E.T.} - \alpha}{364}$

[3] For comparison only.

[4] The irregular intervals in this column are an artifact of rounding off the Zs equation, a consequence of the Maya's use of whole numbers only.

here a representation of 168 repetitions of the vernal equinox or, in other words, 168 synodical years.

If the logical correction were applied at 84 synodical years, but its multiple of two is displayed in the table, there must be a reason. Before seeking this reason, let us examine the properties of 30,680 as a basis for a secondary correction (let us call this β). Of particular interest is its relationship to the table.

Table 7 shows the relationship of 30,680 to various cycles. In this discussion they are best seen when rounded to the nearest whole number in the case of fractional periods:

30,680 days (84 synodical yrs.)

= 1,039 lunations − 2 days

= 177 eclipse half-years + 4 days

(177 itself is one of the eclipse intervals in the Dresden Codex)

= 84 sidereal years − 1 day }
= 84 Zs units − 2 days } difference = **1**

= 84 vague years + 20 days

The first two relationships are interesting in their own right, but it is the other three which offer an extraordinary opportunity in correlating the sidereal and synodical years.

As predicted, the Zs equation falls one day behind the true sidereal year. However, at this point the sidereal year slips just over one day behind the synodical year. One β correction brings the Zs/sidereal system into balance; and the subtraction of one day (30,680 − 1 = 30,679) also brings the synodical year into alignment with Zs/sidereal. In other words, 84 complete sidereal and synodical cycles are within one day of each other after 30,680 days.

Thus, the conversion synodical → sidereal is extremely easy and is equally facile in the table itself. If we started on 4 Ahau, we could go through all the operations to reach the day and position after 30,680 days, but this is hardly necessary. Since 30,680 has the wonderful properties of being 118 *tzolkins* and 84 sidereal years minus one day, we are brought right back to where we started, 4 Ahau: to find the actual sidereal position, we merely subtract one day, yielding 3 Cauac.

However, with the Zs equation as it now stands, we have overcompensated one day and have reached 2 Etznab instead. The application of the β correction

TABLE 7

RELATIONSHIPS OF 30,680 AND 61,360

Cycles	30,680 (84 syn. yrs.)	61,360 (168 syn. yrs.)
Lunations (29.530589 days)	**1,038** + 27.25 days	**2,077** + 24.97 days
Eclipse half-yrs. (173.3100155 days)	**177** + 4.13 days	**354** + 8.25 days
Venus synodical cycles (583.92166 days)	**52** + 316.07 days	**105** + 48.23 days
Zodiacal yrs. (364 days)	**84** + 104 days	**168** + 208 days
Vague yrs. (365 days)	**84** + 20 days	**168** + 40 days
Synodical yrs. (365.2422 days)	**83** + 364.90 days	**167** + 364.55 days
Sidereal yrs. (365.25636 days)	**83** + 363.72 days	**167** + 362.19 days
Zs years	**83** + 362 days*	**167** + 359 days*

* The Zs equation falls 1.72 and 3.19 days respectively behind the sidereal year. This is again an artifact of rounding introduced into the Zs equation, the actual average errors are 1 and 2 days respectively after the given intervals.

brings us back up to 3 Cauac, the true position. This involves a final refinement to the Zs equation.

Since the correction at 288 days is a bit too early, the accumulated α correction will, after 30,680 days, overcompensate one day, allowing the count to fall behind. Thus the β correction is subtracted from the α correction. The equation in operation 2 for finding sidereal year equivalents now is:

$$Zs = \frac{E.T. - (\alpha - \beta)}{364}$$

We have seen how a secondary correction applied every 30,680 days further adjusts the Zs equation to yield accurate sidereal year equivalents and also correlates with the synodical year. The vague year too has a special relationship to its counterpart, the synodical year.

Since 84 vague years is twenty days ahead of 84 synodical years at this point, it retains the same day name but the coefficient is increased by six. Thus, after 30,680 days it is not only a good place to apply a β correction but is also a meeting point for all the cycles of the year.

After 168 synodical years, $2 \times 30{,}680$ is still accurate to within 0.69 day but after three multiples of 30,680, the error is over one day: two is the last multiple of 30,680 that can be used as a multiple of the synodical year. The 30,680-day interval could continue to be used as a Zs/sidereal correction but the relationship to the synodical year would slowly shift. Thus, 168, along with its other desirable properties (see chapter 1), is the Maya estimate of utility before the error becomes too large.

There are two things which are most convincing that 30,680 is a corrective interval. This is exactly double the formula found by Seler (1901: p. 179; 1963: **II**, pp. 101–103) on Codex Borgia 49–52[7]:

$$42 \text{ syn. yrs.} = 59 \times 260 = 15{,}340 \text{ days}$$

Also noteworthy is its fit with the full cycle:

$$9{,}453{,}600 \div 30{,}680 = 308\,\beta + \mathbf{4160} \text{ days.}$$

The remainder is the interval between the two lunar *lubs* in the table. The official zero day for application of the β correction would be at the 12 Lamat 11 Zec *lub*; the corrections would fall in 308 intervals till the end of the table was reached. As mentioned before, 308 is equal to eleven I units, the kind of regularity adored by the Maya.

In positional astronomy over long periods, the calculation of the β correction would be added to operation 1:

$$\beta = \frac{E.T.}{30{,}680} \quad \text{(remainder ignored)}$$

Using the emended operations (table 8) the results of calculations over the full range of the table are shown in table 9. It will be noted that the error incurred barely exceeds one day in nearly 26,000 years.

As we will see in part II, the Paris Codex contains records of specific astronomical events. Applying the data from the Paris table to the Paris records, as well as the inscriptions, will enable us to pinpoint Maya astronomical observations in the long count. From there, the object will be to find their equivalents in real time. This necessitates an assault on the correlation question.

[7] The formula is conceived as a ten-day correction to 42 vague years yielding 42 synodical (tropical) years: $(42 \times \mathbf{365}) + 10 = 15{,}340$ days.

TABLE 8

EMENDED OPERATIONS

Operation 1: $\alpha = \frac{E.T.}{288} - 1$ (fractional part ignored)

$\beta = \frac{E.T.}{30{,}680}$ (remainder ignored)

Operation 2: $\frac{E.T. - (\alpha - \beta)}{364} = \text{Zs units} + \textbf{Zs rem.}$

Operation 3: $\frac{\text{Zs rem.}}{28} = \textbf{n I units} + \textbf{I rem.}$

Operation 4: Original coordinates: *const. N* + χ *days MSM*
To find new coordinates: *const. (N + n) + y days MSM*

a) Add χ days *MSM* (from original coordinates) to I rem. (from operation 3):

χ *days MSM* + **I rem.** = *y days MSM**

* If *y days MSM* > 28:
1) *y days MSM* − 28 = *y′ days MSM*
2) **n I units** + 1 I unit = **n′ I units**
3) substitute *y′* and *n′* for *y* and *n* respectively below.

b) Add **n I units** (from operation 3) to *const. N*:

const. N. + **n I units** = *const. (N + n)**

* If *N* + *n* > 13: subtract 13

c) Combine the results of steps a and b:

New coordinates = *const. (N + n) + y days MSM.*

To locate new constellation in the sky: count right to left across the beings starting at original constellation in the Paris table (i.e. Jaguar-Rattlesnake-Turtle, etc.) or clockwise (*eastward*) on the endplate; 1 I unit = 1 constellation.

Conclusion

This chapter demonstrated the operation of the table on Paris 23–24. The key to understanding the table is its clockwork arrangement: the well-known 28-day interval is but one of two operative modes; the other interval of 288 days is incorporated into the same scale, the green *modifying coefficients* serving to distinguish the shift to the second (I_2) mode. Using the relationship of the green *modifying coefficients* to the 13-*katun* cycle on Paris 1–13 established in chapter 1, it was shown that 25 I_2 intervals mark off exact periods of one *katun* (25 × **288** = 7,200 days). This is a neat relationship which certainly can be used to expand the table to more than 1,820 days, but the 288-day interval has a loftier astronomical significance.

The 288-day interval is at the heart of a mechanism which allows the Paris table to be used as an astronomical ephemeris for calculating the ecliptic longitude of the sun. It was demonstrated that this is the interval at which a one-day (α) correction enables the zodiacal year to function as the equivalent of the sidereal year. I assume the reader has an understanding of the difference between the synodical year and the sidereal year and its cause, the precession of the equinoxes; the sidereal cycle is of paramount importance in positional astronomy.

For purposes of calculating the ecliptic longitude of the sun on any given date, it is of no consequence whether the sun has completed 1.2 or 1000.2 sidereal revolutions from its original longitude. After the completion of each sidereal year the sun returns exactly to the same longitude from which it began; thus we are interested only in the fraction of the cycle which is left over, in this case 0.2 sidereal years. Since the sun moves through the zodiac at a rather uniform rate averaging just under one degree longitude per day, the remainders left after calculating the number of full cycles (in our example: 1 and 1000, respectively) are exactly equal, and can be converted into distance in degrees from the original longitude (in our example: 360° × 0.2 = 72°). Thus, after 1.2 or 1000.2 sidereal years the sun lies 72 degrees east of its original longitude.

The system of Maya positional coordinates and related calculations are summarized as a sequence of operations (tables 4 and 8). The best way for the reader to grasp this system is to calculate the given example along with the text, and perhaps to calculate the position of the sun with his own example using the Maya method. I feel this is important because it demonstrates the simplicity with which the Maya mastered a very sophisticated astronomical problem.

Attention was then directed to the *lub* of the Paris table. It was determined that this is actually a lunar *lub* which yields a ritual moon age of 23 days at 4 Ahau 8 Cumku as given on Stela 1 at Coba. A second lunar *lub* was also found which ties directly to the Dresden eclipse table. These lunar *lubs* will be discussed in chapter 3 and their nature and significance confirmed. It is also of great importance that the links between the Paris table and both the eclipse and Venus tables of the Dresden Codex enable the determination of ecliptic longitude to be extended to the moon, eclipses, and planets.

The last section elucidated a secondary (β) correction to the Paris ephemeris. The formula is basically the same as the one found in the Mexican Codex Borgia: 84 synodical years = 30,680 days. The β correction in conjunction with the α correction (at 288-day intervals) makes the Paris table operative over 26,000 years with remarkable accuracy.

My demonstration of the use of the Paris table shows that the Maya were well aware of how to calculate the sidereal year, and were fully cognizant of the duration and effects of the precession of the equi-

TABLE 9

PARIS TABLE: OPERATION OVER FULL CYCLE

		Maya calculations						Modern calculations		
				Corrections						
Katun	Elapsed time	Vague years	Zodiacal years	α	β	$(\alpha-\beta)$	Zs	Syn. years	Sid. years	Sid. error
13	93,600	256 yrs + 160 days	257 yrs + 52 days	324	3	321	256 yrs + 95 days	256 yrs + 98 days	256 yrs + 94.37 days	+0.63
101	727,200	1,992 + 120	1,997 + 292	2,524	23	2,501	1,990 + 339	1,991 + 2.78	1,990 + 339.84	−0.84
202	1,454,400	3,984 + 240	3,995 + 220	5,049	47	5,002	3,981 + 314	3,982 + 5.56	3,981 + 314.43	−0.43
303	2,181,600	5,976 + 360	5,993 + 148	7,574	71	7,503	5,972 + 289	5,973 + 8.35	5,972 + 289.02	−0.02
404	2,908,800	7,969 + 115	7,991 + 76	10,099	94	10,005	7,963 + 263	7,964 + 11.13	7,963 + 263.60	−0.60
505	3,636,000	9,961 + 235	9,989 + 4	12,624	118	12,506	9,954 + 238	9,955 + 13.91	9,954 + 238.19	−0.19
606	4,363,200	11,953 + 355	11,986 + 296	15,149	142	15,007	11,945 + 213	11,946 + 16.69	11,945 + 212.78	+0.22
707	5,090,400	13,946 + 110	13,984 + 224	17,674	165	17,509	13,936 + 187	13,937 + 19.47	13,936 + 187.36	−0.36
808	5,817,600	15,938 + 230	15,982 + 152	20,199	189	20,009	15,927 + 162	15,928 + 22.26	15,927 + 161.95	+0.05
909	6,544,800	17,930 + 350	17,980 + 80	22,724	213	22,511	17,918 + 137	17,919 + 25.04	17,918 + 136.53	+0.47
1010	7,272,000	19,923 + 105	19,978 + 8	25,249	237	25,012	19,909 + 112	19,910 + 27.82	19,909 + 111.12	+0.88
1111	7,999,200	21,915 + 225	21,975 + 300	27,774	260	27,514	21,900 + 86	21,901 + 30.60	21,900 + 85.71	+0.29
1212	8,726,400	23,907 + 345	23,973 + 228	30,299	284	30,015	23,891 + 61	23,892 + 33.39	23,891 + 60.29	+0.71
1313 − 2592 days	9,451,008	25,893 + 63	25,964 + 112	32,815	308	32,507	25,875 + 1	25,876 + 0.87	25,875 − 0.33	+1.33
1313	9,453,600	25,900 + 100	25,971 + 156	32,824	308	32,516	25,882 + 36	25,883 + 36.17	25,882 + 34.88	+1.12

noxes. This is indeed very sophisticated astronomy, but should really not come as a surprise. The Greek astronomer Hipparchus, credited with discovering (or rediscovering) the precession of the equinoxes around 150 B.C., had access to astronomical instruments no more sophisticated than those the Maya may be presumed to have used. That the Maya possessed such instruments is evident in the work of Hartung (1977) and Digby (1975), among others.

The Paris table is the most sophisticated example of Maya astronomical acumen yet uncovered. As we shall see in following chapters, the implications of the data found therein go far beyond the bounds of the codex itself, and extend into every realm of Maya philosophy and religion.

PART II. IMPLICATIONS OF THE PARIS DATA: THE CORRELATION

3. THE LUNAR SERIES

The Paris table is an astronomical ephemeris of amazing complexity, but disarming simplicity of operation, and contains a wealth of astronomical data. Armed with these data, we now focus on the Maya record of lunar motion. A problem of long standing is the true nature of the lunar series on Classic period monuments. Teeple (1925; 1930) was the first to elucidate the nature of Glyphs D, E, and C, the core of the lunar series. He showed that Glyphs D and/or E gave the current moon age at the date of the corresponding initial series.

At any given date there is only one true moon age (χ days past conjunction); thus, if a certain monument listed a specific moon age on one long count date, the moon age of any previous or subsequent date should be calculable. This is true in some cases, but many dates list moon ages which differ by three or more days as calculated from this standard. Teeple's (1930: pp. 46–47) explanation is that such disagreement would be expected if these lunar series moon ages were based on observations of the moon. This would be a concomitant of the natural variance of the lunar cycle around its mean, and of the vagaries of observation, such as weather conditions and the astronomical skill of the observer. On the other hand, a ritual count having nothing to do with real observations would not be expected to exhibit such irregularity, especially in the lunar series of one Maya center.

Teeple's argument for an observational basis of the lunar series was certainly good, but had he been totally convincing, the Spinden correlation would have been rejected forty years ago. Spinden's arguments are in no way reconcilable with the lunar series as observations. Spinden (1930) was forced to postulate a ritual lunar calendar formally counting from full moon to bolster his position. Thompson (1950: pp. 236–237), who had his own axe to grind, argued that no American Indian group is known to calculate moons from full moon, but rather from or near new moon, astronomical conjunction.

It seems more credible that the lunar series are based on observation, but problems still exist with this interpretation. Teeple (1930) demonstrated that many of the moon ages listed fell within a three-day range of variation which, he felt, is consistent with maximum possible errors stemming from actual observation. However, as Satterthwaite (1951) points out, the range of variation is more like seven days. Thus, too many moon ages (even allowing a few transcriptional errors) fall outside Teeple's three-day limits, and seem to deal a serious blow to the observational hypothesis.

Let us now reexamine the observational hypothesis in light of the Paris table, which has two lunar *lubs: lub A*, 12.19.12.14.8 12 Lamat 11 Pax, 2,592 days before 4 Ahau 8 Cumku; and *lub B*, 13.0.4.6.8 12 Lamat 11 Zec, 1,568 days after 4 Ahau 8 Cumku. The presence of two *lubs* in the Paris table gives an indication that perhaps the Maya calculated moon ages from two different bases. Kelley (1977: p. 61), sees such evidence in the very glyphs of the lunar series:

> . . . the Maya inscriptions count the days of the lunar month from a base marked either by a hand (probably to be read *lah* "end" and referring to disappearance before conjunction) or by a frog-head glyph which is almost certainly to be read *pok* "be born" and which refers to the first appearance of heavenly bodies after conjunction, hence, in this case, to new moon.

Astronomically, the interval between disappearance before conjunction and appearance after conjunction is about three days: the waxing crescent becomes visible about one day after conjunction, while the waning crescent disappears about two days before conjunction; this is because the sun illuminates many *mares* in the last quarter which appear as gray areas on the otherwise silvery surface, rendering the waning crescent distinctly less bright.

The time of year also affects the visibility of the crescent moon. Near the winter solstice, the moon's path rises at a steep inclination from the horizon at both sunrise and sunset which makes observation less subject to atmospheric disturbances near the horizon. This is significant in Mesoamerica where December is among the months of the dry season when observational conditions are in any event at an optimum. The combined effects of these factors produce considerable differences in observability.

If the Maya actually counted moon age from two bases (corresponding to about one day after conjunction, *pok*, and two days before conjunction, *lah*), and the basis of the count was observational, we would be justified in expecting to find the moon ages of the lunar series clustering around two separate means about three days apart: the *lah* observations would show an average moon age three days greater than the *pok* observations. However, all known Maya astronomical cycles have within them a ritual element which cannot be ignored. This is where the Paris table enters the picture.

We have already seen that *lub B* of the table at 12 Lamat 11 Zec connects to the Dresden eclipse table by 118 multiples of the eclipse interval (118 × **11,960** days). This interval is very practical, but nonetheless has a distinctly ritual aspect because it retains the *lub* at 12 Lamat despite a slight error with each repetition. If the formula 11,960 days = 405 lunations is used to compute the moon ages at both the Paris and Dresden *lubs*, we can compare the results with those obtained with the modern reckoning of the lunation:

Maya: 11,960 × 118 = 47,790 lunations
Modern: 1,411,280 ÷ 29.530589 = 47,790 lunations
+ 13.15 days

The ritual formula is thirteen days off the mark, so both *lubs* could not have been at new moon. However, all indications are that the *lub* of the Dresden eclipse table was at or near new moon, and this is in general agreement with the lunar series on the monuments. The concept of the *lub* also implies the ultimate beginning of a cycle; Paris *lub B* at 12 Lamat 11 Zec must therefore have been assigned as an official new moon, regardless of the fact that it was closer to full moon. This raises the possibility that the Maya chose a *lub* near 4 Ahau 8 Cumku from which calculation in ritual cycles would produce a cumulative error of such magnitude which allowed the estimation of true moon age at the time of observation, almost 4,000 years later. There is a precedent for such a ritually determined *lub* in the Dresden Venus table.

If we accept Teeple's (1930) and Thompson's (1950) evidence, the Maya must have realized that the ritual Venus cycle of 584 days, with a contemporaneous *lub* at 9.9.9.16.0 1 Ahau 18 Kayab, was a bit too long. Therefore, they must also have been aware that the ritual *lub* located 2,200 days before 4 Ahau 8 Cumku was nowhere near a Venus heliacal rising. This *lub*, 12.19.13.16.0 1 Ahau 18 Kayab, is removed from 9.9.9.16.0 by 36 multiples of the Dresden Venus table (36 Venus great cycles). However, counting forward in ritual cycles yielded what most authorities agree must have been a Venus heliacal rising at or near 9.9.9.16.0 1 Ahau 18 Kayab. Thus, the 4,000-year cumulative error in the ritual cycle approximates the date of an observational phenomenon.

In this light let us examine the two lunar *lubs* in the Paris table. The interval between *lub A* at 12 Lamat 11 Pax and *lub B* at 12 Lamat 11 Zec is 4,160 days. As determined in the previous chapter, the moon age at *lub B* is 3.8 days less than that of *lub A*. The ritually determined difference in moon age between *lubs A* and *B* can be determined with a variation of the 11,960-day formula as follows. The elapsed time is divided by one fifth of the cycle (2,392 days = 81 lunations; a formula in its own right). The remainder is then treated according to Teeple's (1930) demonstration of groups of six lunations of alternate 30- and 29-day months given by Glyphs C and A of the lunar series: thus we divide by 177 (3 × **30** + 3 × **29** = **177** days = 6 lunations). From the further remainder we subtract alternate 30- and 29-day months until a number less than 30 is reached; this is the moon age as ritually determined. The procedure can be illustrated in three steps using the distance *lub A* → *lub B* as an example:

Ritual moon formula

Step 1) elapsed time ÷ 2,392 = *n* × 81 lunations + rem. 1
e.g.: 4,160 ÷ 2,392 = **1** × 81 lunations + **1,768** days

Step 2) rem. 1 ÷ 177 = *n* × 6 lunations + rem. 2
e.g.: **1,768** ÷ 177 = **9** × 6 lun. + **175** days

Step 3)		
	rem. 2	e.g. **175**
	−30	−30
	−29	−29
	−30	−30
	etc.	−29
		−30
	= moon age	**27**-day moon age

The 27-day moon age at *lub B* is two days before ritual new moon in a 29-day month. Even if the order of subtraction is reversed in step 3, −29, −30, etc., we reach 28 days in a 30-day month, still two days before ritual new moon. I have chosen to subtract 30 first because the great majority (about 80 per cent) of lunar series within Teeple's period of uniformity in which the coefficient of both Glyphs C and A are legible list 30-day months (Glyph 10A) with odd numbered lunations (Glyph 1, 3 or 5C), and 29-day months (Glyph 9A) with even numbered lunations (Glyph 2, 4 or 6C). Also, the first two intervals of the Dresden eclipse table are 15 days each, yielding 30 days.

If *lub A* is assigned to new moon, and *lub B* is 2 days ritually, and 3.8 days astronomically younger, either figure, or the average of 2.9 days is a good working estimate of the disappearance of the moon during conjunction. It is thus logical to assume that *lub A* was assigned to first appearance after conjunction (*pok*), and *lub B* to disappearance before conjunction (*lah*).

Let us formulate an hypothesis to test against the record left by the Maya, the lunar series of the Classic period. The hypothesis and the predicted results can be stated as follows:

Hypothesis: the moon ages of the lunar series consist of two systems of observation counting from either first appearance after conjunction (*pok*), or disappearance before conjunction (*lah*); *lub A* and *lub B* were the official starting points of the respective counts.

Predictions: 1) the moon age at any given date will correspond closely to a ritual count from either *lub A* or *lub B*; the deviation from a standard moon age of moon ages better estimated from *lub A* (*system A*) will form a statistically significant group as opposed to those derived from *lub B* (*system B*).

2) the mean of the deviations from standard of *system B* will be about three days greater than the mean of the deviations of *system A*, corresponding to *lah* and *pok* observations, respectively.

3) the standard deviation (σ) about the means of both groups will correspond roughly to Teeple's three-day limits for observational error.

The standard moon age to be used in the analysis of this hypothesis is borrowed from the Thompson correlation. Any standard could be used since it is the difference in the mean deviations of two groups of data which is being tested, not the standard. However, this standard yields moon ages which are in general agreement (seven-day limits) with the lunar series. Thus, the standard moon age at each Maya date will be calculated from a moon age of 11 days at 4 Ahau 8 Cumku.

All the data for the analysis are listed in table 10[1] and organized in ten columns:

Column 1) Site
2) Monument
3) Long count date
4) Lunar series: the coefficients of Glyphs D and/or E, C, and A; an asterisk (*) is postfixed to Glyph C if the lunar series is within Teeple's uniform system.
5) Moon age given in the lunar series: determined by the coefficient of Glyphs D and/or E; when Glyph D appears alone, its coefficient is the current moon age; when Glyph E appears, 20 is added to its coefficient to give the moon age; an asterisk by Glyph D denotes cases where Glyph E is recorded but it is well established that Glyph D is intended. CM denotes "completion of moon," assumed to designate conjunction.
6) Ritual moon age *A*: derived from *lub A* (12 Lamat 11 Pax) using the ritual moon formula.
7) Ritual moon age *B*: derived from *lub B* (12 Lamat 11 Zec) with the ritual moon formula.
8) Standard moon age: calculated from a moon age of 11 days at 4 Ahau 8 Cumku.
9) Deviation from standard: the difference between the moon age given in the lunar series (column 5) and that of the standard (column 8).
10) Ritual system: before analysis, each moon age given in the lunar series (column 5) is assigned to *system A* (ritual count from *lub A*), or *system B* (ritual count from *lub B*) according to which system yields the better estimate (or exact concordance); enclosure in parenthesis denotes assignment after statistical analysis.

Let us examine table 10. It will be noted that the ritual count from *lub B* (column 7) yields a moon age that is always greater than that from *lub A* (column 6); the range is between one and five days with a median value of three days. This is consistent with my assignment of *lubs A* and *B* to first appearance after conjunction and disappearance before conjunction, respectively. Lunar series moon ages (column 5), with very few exceptions, fall not more than two days from one of the ritual estimates (columns 6 and 7), and many coincide exactly.

Of the 131 entries in table 10, 103 will be used in the statistical analysis. Of the remaining 28 entries, only five will be entirely excluded from the analysis; these 28 entries will be treated as follows. While in principle all lunar series could be assigned to one or the other system, there are five which fall as little as three days, and as much as thirteen days, from one of the ritual counts. For example, Structure 1 at Quirigua lists a moon age of two days whereas the ritual counts are 15 and 19, respectively. Teeple (1930) thought this was a mistake for a 19-day moon age which would correspond exactly to my *system B*. However, I think it better to exclude this and other seeming aberrants from the statistical analysis rather than skew the results with a few extreme entries. These entries, denoted by an interrogation point in column 10, will be relegated to the realm of possible Maya transcriptional errors.

There are seventeen entries which although showing differing degrees of deviation from the standard, fall between the two ritual counts. For example, on Stela J at Quirigua the lunar series moon age of four days falls one day from both ritual counts of three and five days, respectively. This leads to an ambiguous situation in assigning a system. Thus, for statistical purposes, these entries will be temporarily excluded from the initial analysis. However, the assignment of a system can be made later on the basis of deviation from standard if the presence of two statistically significant groups can be ascertained.

The first six entries enter the analysis, but not statistically. The first five are so far before the Classic period that they can be ascribed to the mythical past. They will be used in the analysis of the system as a whole, but are not relevant to the analysis of lunar series coeval with the Classic period. The sixth entry is the opening date of the Dresden eclipse table which lists no lunar series, but is agreed to be at or near new moon by most authorities. Being connected directly to *lub B*, it is to be expected that its deviation from standard would place it in *system B* after the analysis is performed, and is thus a check on the results.

Let us begin the analysis of the dates in table 10. The first three are from Palenque; all the moon ages of these dates in the remote past are reached exactly by the ritual moon formula from *lub A*. The first date, however, is almost 750 years before the others. That all three can be reached exactly through the ritual moon formula indicates that they were not back-calculated attempts at reproducing observational data, but rather, were purely ritually determined. The latter two dates are actually the birthdates of two of the gods known as the Palenque Triad (Berlin 1963), proving their religious significance, and by extension the ritual nature of *lub A*. This will become important when examining Teeple's uniform system.

The fourth date, on Coba Stela 1, is none other than 4 Ahau 8 Cumku, the beginning date of the long count. The moon age of 23 days is exactly as expected from *lub A*, a purely ritual determination.[2]

[1] Much of these data were taken from Teeple (1930: table 3, pp. 50–51) and checked against descriptions, photographs and drawings by Morley (1920; 1937–1938). In the few disagreements which arose (Xultun, Stela 6; Quirigua, Stela A; and Yaxchilan, Lintel 46), Morley's original data were followed. Additional data were drawn from Morley, and Thompson (1950).

[2] Significantly, Coba, although a Classic period occupation, is located in northeast Yucatan, well out of the central area. Stela 1 actually lists two other dates (Morley 1937–1938), one of which,

The fifth entry, from Stela C at Quirigua, is extremely important. The date is 4 Ahau 8 Cumku and the moon age of 26 days is three days off the count from *lub A*, but exhibits the ideal difference (+3 days) to be expected between the two systems according to this hypothesis. This is part of a situation remarked upon by both Teeple (1930) and Thompson (1950); the lunar series at Quirigua seem to be quite confusing. However, out of this confusion will come the confirmation that two systems for counting moon age were actually in use, and that they have nothing to do with the uniform system.

We may now proceed with the statistical part of this analysis. Using a t-test for two means (Senter 1969: p. 167), it will be determined whether the moon ages assigned to *system A* form a separate population as opposed to those assigned to *system B*. This is achieved by analyzing the deviations of both groups from the standard moon age. The null hypothesis is that the means of both populations are not significantly different:

$$H_0: \bar{X}_A = \bar{X}_B$$

The t-statistic is calculated and compared to values in a table of the t-statistic. The results of this analysis are as follows:

System	No. of cases	Mean	Std. dev.	Range (low/high)	Total range
A	51	0.61	.95	3.97: −1.79/2.18	7.25
B	52	3.17	.86	3.68: +1.78/5.46	

Total cases = 103

Degrees of freedom = 101

t = 14.24 ∴ Probability < .01

(t = 2.62 needed for rejection of null at .01 level)

The null hypothesis is defeated well below the .01 level: there is less than one chance in a hundred that both sets of data belong to the same population; their means differ by 2.56 days, consistent with the use of two observational systems. Significantly, the standard deviations (σ) of both groups attest that most cases fall within ± 1 day from the mean; the overlap of both systems is but 0.4 day, and the range of each system, even including extreme cases, is less than four days. This shows that both groups are in accordance with Teeple's three-day limits of variance due to observational methods. The range of the combined systems (7.25 days) is what the whole problem of observation versus ritual was all about.

The Dresden eclipse table date falls squarely in *system B* as predicted. Thus, all predictions have been adequately met. The seventeen ambiguous cases can now be assigned to either *system A* or *B* on the basis of their deviations from standard; whether it is above or below the mean of the means, 1.89 days. Repetition of the analysis with the inclusion of all assigned values slightly increases the value of the t-statistic to 14.39, yet higher above the value necessary to rejection of null at the .01 level.

What we have here are two separate groups of observations, *system A* counting from first appearance after conjunction (*pok*), and *system B* from disappearance before conjunction (*lah*). This is not to imply that the Maya actually used the ritual counts to aid in moon age determinations. The two *lubs* are merely the chronologically remote starting points for their respective counts and furnished the means to pry the two systems apart. Just as the Maya knew that Venus heliacal risings very rarely took place exactly on the date determined by the ritual count, this was to be expected for new moon as well. Thus, the ritual systems would not be expected to yield more than a close estimate in most cases: 36 out of 125 analyzed lunar series are direct hits from either *lub A* or *B*; the rest are at most two days off.

There are only three Maya cities from which we have extensive lunar series: Copan, Piedras Negras, and Quirigua. Yaxchilan, Pusilha and Naranjo show moderate samples, but the rest yield but few lunar series. Of these cities with relatively large samples, only one appears to have used one system fairly consistently through time: Piedras Negras, *system B*; with the exception of the two earliest dates, all dates analyzed lie in *system B*; of the six ambiguous dates assigned after analysis, only two fall to *system A*.

The "confusing" lunar series of Quirigua seem to show no particular preference through time for either system. An individual analysis of Quirigua lunar series would be in good agreement with our conclusions, but here two of the extreme entries in table 10 are found: Stela H, +1.78 *system B*; Stela D, −1.79 *system A*. Quirigua seems to have vacillated between the extremes of both systems, never quite making up its mind. This state of affairs is unequivocally displayed on Stela K (9.18.15.0.0) where the moon ages of both systems are given side by side: 21 days *system B*; 18 days *system A*. The three-day difference is exactly as predicted and confirms the use of two separate lunar counts.

The reasons behind the use of two observational systems are still obscure; the lunar series do, however, exhibit an interesting historical progression. The earliest extant lunar series at each site are, with one exception, invariably in *system A*; at Naranjo *system B* shares the honor. At both Pusilha and Yaxchilan the progression is rather clearcut, with *system B* superseding *system A* at around *katun* 11 and *katun* 13,

9.12.10.5.12, is the date upon which, according to Teeple, the central area city of Naranjo adopted the uniform system. This is recorded on Stelae 24 and 29 at Naranjo. The link between these two Classic sites is important in that the Paris Codex is thought to stem from Yucatan (see Thompson 1972).

TABLE 10

ANALYSIS OF LUNAR SERIES

Site	Monument	Long count date	Lunar series	Moon age: Lun. ser.	Moon age: Ritual count lub A	Moon age: Ritual count lub B	Moon age: Standard	Deviation from standard	System
Palenque	T. Cross	12.19.13.4.0	5D 2C 9A	5	5	(8)	22.04	+12.49	A
	T. Sun	1.18.5.3.6	6E 4C 10A	26	26	0	15.67	+10.33	A
	T. Fol. Cross	1.18.5.4.0	10D 5C 10A	10	10	15	0.14	+9.86	A
Coba	St. 1	13.0.0.0.0	3E C 10A	23	23	(27)	11.00	+12.00	A
Quirigua	St. C	13.0.0.0.0	6E 3C	26	23	(27)	11.00	+15.00	B
Dresden		9.16.4.10.8	—	Near 0	27	0	27.03	+2.50	B
Copan	St. 20	9.1.10.0.0	5E 2C	25	24	28	23.38	+1.62	A
	H.S.D.1	9.5.19.13.0	5E 5C 9A	25	19	20	16.91	+8.09	?
	St. 9	9.6.10.0.0	5E 5C 10A	25	26	1	25.59	−0.59	A
	H.S.D.3	9.7.5.0.8	2D 2C 9A	2	1	5	29.49	+2.04	A
	St. 7	9.9.0.0.0	13D 4C 10A	13	13	16	11.93	+1.07	A
	St. P	9.9.10.0.0	9D 3C 10A	9	9	14	9.20	−0.20	A
	H.S.D.5	9.9.14.17.5	3E 4C 10A	23	22	27	22.36	+0.64	A
	St. 23	9.10.18.12.8	5D 1C 10A	5	3	5	1.49	+3.51	B
	St. 10	9.10.19.13.0	3E 6C 9A	23	21	22	19.12	+3.88	B
	St. 19	9.10.19.15.0	4D 9A	4	2	4	0.06	+3.94	B
	St. 13	9.11.0.0.0	5D 3C 9A	5	0	5	1.00	+4.00	B
	Alt. St. 5	9.11.15.0.0	8E 3C 9A	28	26	1	26.43	+1.57	A
	St. 1	9.11.15.14.0	12D 5C	12	11	15	11.13	+0.87	A
		9.12.3.14.0	CM 4C	0	27	2	26.66	+2.87	B
	Alt. H′	9.12.8.3.9	2E 5C* 9A	22	21	25	21.01	+0.99	A
	St. 6	9.12.10.0.0	2E 10A	22	23	27	22.34	−0.34	A
	Alt. K	9.12.16.7.8	CM 2C 9A	0	27	2	26.95	+2.58	B
	St. J	9.13.10.0.0	18D 1C* 10A	18	17	22	16.87	+1.13	A
	St. 5	9.13.15.1.0	8D 3C* 9A	8	6	10	5.98	+2.02	(B)
	St. A	9.14.19.8.0	15D 6C* 9A	15	16	18	15.39	−0.39	A
	St. D	9.15.5.0.0	9D 2C*	9	8	10	7.31	+1.69	(A)
	H.S.D.11	9.15.12.10.10	4E	24	22	24	20.50	+3.50	B
	St. M	9.16.5.0.0	5D 5C 10A	5	3	5	1.85	+3.15	B
	St. N	9.16.10.0.0	1D 1C 10A	1	0	5	0.48	+0.52	A
Palenque	St. 1	9.12.6.5.8	19D 5C 10A	19	21	22	19.21	−0.21	A
	Ruz	9.14.8.14.15	CM 3C 9A	0	29	4	29.37	+0.16	A
Piedras Negras	St. 30	9.5.0.0.0	5D 5C 10A	5	6	8	4.25	+0.75	A
	St. 25	9.8.10.6.16	3D 3C 9A	3	4	8	3.01	−0.01	A
	St. 26	9.9.15.0.0	13D 5C 9A	13	8	12	7.83	+5.17	B
	St. 36	9.10.6.5.9	4D 4C 9A	4	3	5	1.61	+2.39	(B)
	Lnt. 2	9.11.6.2.1	19D 5C 9A	19	18	20	16.74	+2.26	(B)
	St. 35	9.11.9.8.6	14D	14	11	15	10.98	+4.02	B
	St. 8	9.11.12.7.2	6D 5C* 10A	6	5	7	3.88	+2.12	(B)
	St. 37	9.12.0.0.0	6E 5C 9A	26	24	28	25.07	+0.93	(A)

	St. 39	9.12.5.0.0	7E	C	10A	27	24	27	23.70	+3.30		B		
	St. 6	9.12.15.0.0	5E	4C*	9A	25	20	25	20.97	+4.03		B		
	St. 2	9.13.5.0.0	1E	6C*		21	19	21	18.24	+2.76		B		
	St. 4	9.13.10.0.0	E	1C*	10A	20	17	22	16.87	+3.13		B		
	St. 1	9.12.2.0.16	8E	3C	10A	28	23	27	22.80	+5.20		B		
	St. 3	9.12.2.0.16	7E	2C*	9A	27	23	27	22.80	+4.20		B		
		9.14.0.0.0	17D	3C*	10A	17	13	18	14.14	+2.86		B		
	St. 5	9.14.5.0.0	16D	4C*	9A	16	14	16	12.77	+3.23		B		
	St. 7	9.14.10.0.0	14D	5C*	10A	14	12	16	11.41	+2.59				(B)
	St. 23	9.14.15.0.0	13D	6C*		13	9	14	10.04	+2.96		B		
	St. 11	9.15.0.0.0	10D	C*		10	8	12	8.68	+1.32			(A)	
	St. 10	9.15.10.0.0	9D*	3C*	10A	9	6	11	5.94	+3.06		B		
	Lnt. 3	9.15.18.3.13	9D	1C	10A	9	7	8	5.89	+3.11		B		
	St. 16	9.16.15.0.0	4D*	2C*	9A	4	28	3	28.65	+4.88		B		
	St. 13	9.17.0.0.0	CM			0	26	1	27.28	+2.25		B		
	St. 14	9.18.0.3.1	6E	2C*	9A	26	23	27	23.75	+2.25		B		
	St. 12	9.18.5.0.0	3E	6C	10A	23	21	23	20.43	+2.55		B		
Naranjo	St. 29	9.12.10.5.12	19D	6C	9A	19	16	21	16.21	+2.79		B		
	St. 24	9.12.10.5.12	18D	1C*	10A	18	16	21	16.21	+1.79	A			
	St. 23	9.13.18.4.18	15D	1C	10A	15	13	15	12.28	+2.72		B		
	St. 30	9.14.3.0.0	4D	4C*	9A	4	2	6	1.51	+2.49				(B)
	St. 18	9.14.15.0.0	11D	6C		11	9	14	10.04	+0.96	A			
	St. 13	9.17.10.0.0	7E	4C*	9A	27	25	29	24.55	+2.45				(B)
	St. 14	9.17.13.4.3	7D		9A	7	5	10	6.32	+0.68	A			
	St. 8	9.18.10.0.0	1E	2C*	9A	21	19	23	19.08	+1.92				(B)
Quirigua	St. E (#1)	9.14.13.4.17	7D	3C*	10A	7	6	8	7.18	−0.18			(A)	
	St. S	9.15.15.0.0	5D	4C*	10A	5	4	8	4.58	+0.42	A			
	St. H	9.16.0.0.0	5D	5C*	10A	5	2	7	3.21	+1.78		B		
	St. J	9.16.5.0.0	4D	6C*	9A	4	3	5	1.85	+2.15				(B)
	St. F	9.16.10.0.0	CM	6C	10A	0	0	5	0.48	−0.48	A			
	St. D	9.16.13.4.17	4E	4C*	9A	24	24	29	25.79	−1.79	A			
	St. E (#2)	9.17.0.0.0	CM	2C	9A	0	26	1	27.28	+2.25		B		
	St. A	9.17.5.0.0	6E	2C	10A	26	26	29	25.91	+0.09	A			
	Zoom. B	9.17.10.0.0	7E	2C	9A	27	25	29	24.55	+2.45				(B)
	Zoom. G	9.17.15.0.0	3E	5C*	10A	23	23	27	23.18	−0.18	A			
	Alt. O	9.17.14.16.18	CM			0	0	5	1.18	−1.18	A			
	Zoom. O	9.18.0.0.0	4E	6C	10A	24	20	25	21.82	+2.18		B		
	Alt. P	9.18.5.0.0	3E	4C	9A	23	21	23	20.45	+2.55		B		
	Zoom. P	9.18.5.0.0	3E	4C	9A	23	21	23	20.45	+2.55		B		
	St. I	9.18.10.0.0	16D	2C	9A	16	19	23	19.08	−3.08			?	
	St. K	9.18.15.0.0	1E	3C	10A	21	17	22	17.72	+3.28		B		
			18D			18				+0.28	A			
	St. 1	9.19.0.0.0	2D	4C	10A	2	15	19	16.35	−14.35			?	
Yaxchilan	Lnt. 21	9.0.19.2.4	7D	3C*	9A	7	7	9	5.41	+1.59	A			
	St. 6	9.11.3.10.13	6E	2C	9A	26	24	29	24.19	+1.81	A			
	Alt. 44	9.12.8.14.1	7E	4C	9A	27	26	1	26.29	+0.71	A			
	Lnt. 46	9.12.9.8.14	14D	2C	10A	14	14	18	13.53	+0.48	A			
	Lnt. 29	9.13.17.12.10	15D	5C*	10A	15	12	16	11.00	+4.00		B		
	Lnt. 26	9.14.17.12.0	8E	4C*	10A	28	25	1	25.06	+2.94		B		
	Lnt. 56	9.15.6.13.1	11D	5C*	10A	11	7	12	8.17	+2.83		B		

TABLE 10—(*Continued*)

Site	Monument	Long count date	Lunar series	Moon age: Lun. ser.	Moon age: Ritual count *lub A*	Moon age: Ritual count *lub B*	Moon age: Standard	Deviation from standard	System
Yaxchilan (cont.)	Alt. 9	9.16.0.0.0	6D 5C 10A	6	2	7	3.21	+2.79	B
	St. 11	9.16.1.0.0	12D* 4C 9A	12	8	13	8.85	+3.15	B
		9.16.1.0.0	12D* 5C* 10A	12	8	13	8.85	+3.15	B
	Alt. 3	9.16.1.9.3	17D 5C 10A	17	14	19	14.66	+2.34	B
	St. 1	9.16.10.0.0	3D 1C* 10A	3	0	5	0.48	+2.52	B
Pusilha	St. O	9.7.0.0.0	5E 6C 9A	25	24	27	22.86	+2.14	A
	St. P	9.7.0.0.0	3E 3C 9A	23	24	27	22.86	+0.14	A
		9.10.15.0.0	3D* 3C 9A	3	2	6	2.37	+0.63	A
	St. D	9.10.15.0.0	3D 3C 9A	3	2	6	2.37	+0.63	A
	St. Y	9.10.15.0.0	3D 3C	3	2	6	2.37	+0.63	A
	St. H	9.11.0.0.0	4D* 9A	4	0	5	1.00	+3.00	B
	St. K	9.12.0.0.0	1D 3C	1	24	28	25.07	+5.46	B
	St. M	9.14.0.0.0	16D	16	13	18	14.14	+1.86	B
	St. E	9.15.0.0.0	11D 2C 9A	11	8	12	8.68	+2.32	B
Altar de Sacr.	St. 12	9.4.10.0.0	8D 3C 10A	8	7	12	6.98	+1.02	A
	St. 8	9.9.15.0.0	10D	10	8	12	7.83	+2.17	(B)
(El Pabellón)	St. 1	9.10.0.0.0	8D 5C 10A	8	8	10	6.46	+1.54	A
	St. 4	9.10.3.17.0	11D 4C 9A	11	9	14	9.00	+2.00	A
Balakbal	St. 5	8.18.9.17.18	9D 4C	9	9	14	8.24	+0.76	A
Naachtun	St. 23	9.4.10.0.0	7D	7	7	12	6.98	+0.02	A
	St. 1	9.9.10.0.0	9D	9	9	14	9.20	−0.20	A
Ichpaatun	St. 7	9.8.0.0.0	19D	19	19	21	17.39	+1.61	A
Macanxok	St. 6	9.9.10.0.0	9D 2C 10A	9	9	14	9.20	−0.20	A
	St. 5	9.11.10.0.0	CM 1C 9A	0	28	3	27.80	+1.73	A
Toniná	St. T8	9.12.10.0.0	2E 10A	22	23	27	22.34	−0.34	A
Xultun	St. 6	9.13.17.0.0	5E 4C	25	27	2	26.77	−1.77	A
Itsimte	St. 5	9.15.0.0.0	10D 9A	10	8	12	8.68	+1.32	(A)
	St. 2	9.15.10.0.0	10D 6C	10	6	11	5.94	+4.06	B
La Florida	St.	9.15.0.0.0	11D 3C 10A	11	8	12	8.68	+2.32	B
Xkalamkun	T. Init. Ser.	9.15.12.6.9	2D 2C	2	29	2	28.09	+3.44	B
El Cayo	Lnt. 1	9.16.0.2.16	3E 1C* 10A	23	29	4	0.15	−6.68	?
Los Hijos	St. 1	9.17.10.7.0	18D 10A	18	17	22	16.90	+1.10	A
Ixkun	St. 2	9.17.9.0.13	5D 3C 10A	5	2	7	2.38	+2.62	B
	St. 1	9.18.0.0.0	4E 6C* 9A	24	20	25	21.82	+2.18	B
Poco Uinic	St. 3	9.17.19.13.16	CM	0	25	29	26.41	+3.12	B
Chichen Itza	T. Init. Ser.	10.2.9.1.9	5E 5C 10A	25	20	25	20.60	+4.40	B

respectively, of *baktun* 9. The last division of table 10 shows a similar preference for *system A* up to *katun* 15 at various sites with small samples. It would be enlightening to determine whether these changes in lunar system reflect a conflict between two schools of priest-astronomers, a conflict reaching political proportions in Teeple's view.

There remains one thing to investigate in light of this analysis: Teeple's uniform system. Teeple (1930: pp. 57–58) claims that events surrounding the adoption of the uniform system hinged on a disagreement between the leaders, Copan and Palenque, as to the most accurate lunar formula for extended calculations. Palenque supposedly came out the loser and thus went out of business quite prematurely before 9.19.0.0.0.

Although no reckoning of moon age at 4 Ahau 8 Cumku is extant at either Copan or Palenque, Teeple attributed slightly different formulas to each city and extrapolated lunar series of 22 days/6 moons (2E, 6C) at Copan, and 24 days/6 moons (4E, 6C) at Palenque. This is seemingly only a two-day difference, hardly anything to squabble about. However, Teeple (1930: pp. 65–69) claims that the difference is actually about 31 days, or two days plus one whole lunation. This was supposedly due to a disparity in the respective lunar formulas used, yielding errors of about +12 days (Palenque) and −18 days (Copan) from the true moon age at that date.

Let us examine Teeple's reason for making this claim. There are allegedly three cities which commemorate the date of their adoption of the uniform system. Each date is listed twice, once with its lunar series in the old system, and once in the uniform system; these dates are: 9.12.2.0.16 on Stelae 1 and 3 at Piedras Negras; 9.12.10.5.12 on Stelae 24 and 29 at Naranjo; and 9.16.1.0.0 twice on Stela 11 at Yaxchilan. On all three dates (see table 10) the coefficient of Glyph C changes by one in making the transition to the uniform system. This presumably led Teeple to believe that an extra moon of 29 or 30 days had been inserted into the count. However, let us look at the changes in these lunar series more closely.

On the respective dates the moon age decreases one day at Piedras Negras and Naranjo, and remains the same at Yaxchilan. This could be consistent with the addition of one lunation, but could also be explained by a shift in the duration of the current month, given by Glyph A, which also changes. Thus, at Piedras Negras the moon age was, in reality, retained at two days before official new moon: the transition is from 28 days in a 30-day month (8E, 10A) to 27 days in a 29-day month (7E, 9A).

The coefficient of Glyph C *increases* by one at Naranjo and Yaxchilan, but *decreases* by one at Piedras Negras. To me, this implies moving into the uniform system from two directions (+1 moon → uniform system ← −1 moon), making the disagreement among these cities more like 60 days than 31 days. Moreover, the moon age at 4 Ahau 8 Cumku on Coba Stela 1 of 23 days/1 moon (3E, C) disagrees with both Copan and Palenque (2/4E, 6C, according to Teeple), the supposed leaders, by at least one moon (6C + 1 moon → C), yet another system not alluded to by Teeple.

Here again, the telling argument comes from Quirigua. On Stela C the moon age at 4 Ahau 8 Cumku is given as 26 days/3 moons (6E, 3C). This would imply a huge 90-day difference in lunar counts in Teeple's scheme (6C + 3 moons → 3C). Indeed, Teeple dodged the issue entirely by falling back on the "confusing" lunar series at Quirigua. However, the three moons (3C) are explicable in that this is exactly how many moons derive from a count beginning at *lub A* in the Paris table: the distance forward to 4 Ahau 8 Cumku (2,592 days) is equal to 87 moons plus 23 days, which breaks down to 14 groups of 6 moons, plus 3 *moons*, plus 23 days. The moon age of 26 days (6E) derived from *lub B* is the only anomaly here, which is quite acceptable coming from Quirigua (the city which could not decide which system to use), but no longer so "confusing" nor demanding of elaborate explanations.

Invoking Occam's razor, there is a simpler explanation for all this: Teeple's supposed furor over the uniform system leading to the downfall of Palenque (failure to establish its lunar calculation through warfare?) is a chimera. Not possessing knowledge of *lub A*, Teeple could not have known that inscriptional moon ages in the neighborhood of 4 Ahau 8 Cumku were purely ritually determined, which effectively eliminates the premise of the supposed combat.

Without wishing to detract from Teeple's contribution, I would suggest the following about the uniform system: it was an attempt to find the most convenient means of grouping lunations, which probably included experimentation with several *lubs* near 4 Ahau 8 Cumku. Teeple (1930: p. 59) is probably right in saying that the Maya eventually decided in favor of grouping moons in short uneven eclipse intervals as done in the Dresden eclipse table (following *system B*, apparently the dominant system by *katun* 16). Inaugurating such a system would produce the observed changes in Glyph C and other glyphs of the lunar series, but would not replace a count based on the interval of 11,960 days which remained, as always, a predominantly ritual cycle. The possibility remains that the fate of the uniform system (as well as *systems A* and *B*) did involve politico-religious infighting, but sharing neither the reasons, nor the consequences imputed by Teeple; in other words, the variation in lunar ideals reflects a manifestation rather than a cause of dynastic strife.

It is an inescapable conclusion that the Maya were capable of extreme accuracy in lunar calculations. They possessed a sophisticated writing system and must have kept lengthy astronomical records for at

TABLE 11

LUNAR TEST OF CORRELATIONS

Correlation	Ahau equation[2]	Moon age[3] at 4 Ahau 8 Cumku	Pass lunar test (9.6–13.6 days)
	Correlations[1] in agreement with colonial sources		
—	356,523	20.52	
—	375,503	12.36	*Pass
Bowditch	394,483	4.19	
—	413,463	25.55	
—	432,443	17.38	
—	451,423	9.21	
—	470,403	1.04	
Spinden	489,384	23.40	
—	508,363	14.24	
—	527,343	6.07	
—	546,323	27.43	
—	565,303	19.26	
Thompson	584,283	11.09	*Pass
—	603,263	2.92	
—	641,223	16.12	
—	660,203	7.95	
Vaillant #1	679,183	29.31	
Dittrich	698,164	22.14	
—	717,143	12.97	*Pass
—	736,123	4.80	
—	755,103	26.16	
Vaillant #2	774,083	18.00	
—	793,063	9.83	*Pass
—	812,043	1.66	
—	831,023	23.02	
	Correlations[1] based solely on astronomical data		
Willson	438,906	13.18	*Pass
Bunge	449,817	27.39	
Smiley #1	482,699	12.32	*Pass
Makemson	489,138	13.65	*Pass
Dinsmoor	497,879	13.59	*Pass
Smiley #2	500,210	11.68	*Pass
Mukerji	588,466	0.75	
Kreichgauer	626,927	12.92	*Pass
Escalona Ramos	679,108	13.37	*Pass
Weitzel	774,078	13.00	*Pass

[1] The correlations in this table are taken from a list in Kelley 1976: table 4, p. 31.
[2] The Ahau equation is the difference between the Maya day and the corresponding Julian day:

$$\text{Maya day} + \text{Ahau equation} = \text{Julian day}$$

(The Maya day is the elapsed time since 13.0.0.0.0 4 Ahau 8 Cumku)
[3] Moon age at 4 Ahau 8 Cumku is calculated from a moon age of 20.33 at Julian day 0 using the average length of the lunation (29.530589 days; American Ephemeris and Nautical Almanac) according to the following equation:

$$\text{moon age} = (\text{Ahau equation} + 20.33) \div 29.530589$$

least the duration of the Classic period. Thompson's (1950) lunar formula 70,460 days = 2,386 lunations (which fits so admirably into the Paris table) could have been reached using records compiled over a mere 193 years, less than ten *katuns*. The problem can be viewed from another perspective: if the Maya did not keep records, how then were the Dresden tables compiled? Certainly not by oral transmission. Furthermore, how would one logically expect a complicated astronomical system to operate (with necessary observations on and above the horizon) without some system of positional coordinates? There is no precedent for this in the entire history of astronomy. The Paris Codex removes the Maya from this dubious situation.

What relevance does our lunar series analysis have to the correlation question? To answer this, we must examine the standard moon age in relation to the deviations of *system A* from standard. Since *system A* begins its count about one day after conjunction, we would expect day zero to fall at conjunction. This would mean that if the standard were exactly at conjunction, the average deviation from standard of *system A* would be effectively zero. However, the average deviation is +0.61 day. Thus, adding 0.61 day to our standard moon age at 4 Ahau 8 Cumku, would produce an average *system A* deviation of zero. Allowing some leeway, we could be reasonably certain that the actual moon age at 4 Ahau 8 Cumku was between 11 and 12 days, according to analysis 11.61 days.

To be statistically certain, we could spread the limits by ± 1 standard deviation ($\pm 1\sigma$) or about one day in either direction. We would then be quite confident that the true value lay between 10.61 and 12.61 days. However, let us be even more generous and allow a spread greater than $\pm 2\sigma$: statistically, we can be almost absolutely certain that the true value lies between 9.61 and 13.61 days.

This signifies that all proposed correlations which do not yield a moon age between these limits at 4 Ahau 8 Cumku can be dismissed, with thanks. Table 11 shows the moon ages reached by all proposed correlations. The survivors, including the Thompson, but not the Spinden, correlation are denoted by an asterisk. This narrows the field considerably. Only those correlations which passed this lunar test will be considered viable and be further tested against astronomical data from the Paris Codex in the following chapter.

Conclusion

The nature of the lunar series has been a bone of contention since the elucidation of its principal glyphs over fifty years ago. The resolution of this problem hinges on whether the lunar series are based on observation as Teeple first proposed, or on a ritual count having nothing to do with actual contemporaneous moon ages as Spinden would have liked to see. The argument in this chapter proceeded from the hypothesis that both elements are represented in the lunar series.

As we discovered, the Paris table contains two implicit lunar *lubs*. From evidence developed in chapter 2, *lub A* at 12.19.12.14.8 12 Lamat 11 Pax was assigned to first appearance after conjunction (*pok*) and *lub B* at 13.0.4.6.8 12 Lamat 11 Zec to last appearance before conjunction (*lah*). These *lubs* were used as the basis for a statistical analysis of the lunar series of the Classic period. This analysis showed that there are indeed two separate bases for lunar calculations used by the Maya, and the lunar series fall into two statistically significant groups per the observational hypothesis. Stela K at Quirigua provided an incontrovertible example of the lunar series of both systems written side by side.

The analysis also yielded one other very important result. With one exception, all dates in the neighborhood of 4 Ahau 8 Cumku were reached exactly by a count from *lub A* (the *lub* of the Paris table). The one exception, from Quirigua, the city of the "confusing" lunar series, yielded a moon age three days greater than the count from *lub A*, the ideal difference between respective counts from each *lub*. Thus, the purely ritual nature of moon ages associated with dates in the remote past (i.e. the Palenque Triad) has been clarified by *lub A* of the Paris table.

Teeple's uniform system was then examined in the light of the aforementioned. Demonstration of the ritual nature of moon ages in the mythical past removed all reason for the reputed disagreement between Palenque and Copan as to the most accurate lunar formula for extended back-calculations. It was concluded that the uniform system is most probably all that remains to be seen of experimentation with several lunar *lubs* near 4 Ahau 8 Cumku as bases for grouping lunations. Regarding this experimentation, it should be pointed out here that any *lub* near 4 Ahau 8 Cumku connected to the *lub* of the Dresden eclipse table (by multiples thereof) would have yielded the same results in our statistical analysis: *lub B* found its way into the Paris table no doubt because of its ease of calculation. Whether or not *lub B* is in fact the unfortunately obliterated *lub* of the Dresden eclipse table is of little consequence; they both undoubtedly shared a common feature, i.e. removal from the contemporaneous Dresden *lub* by an exact multiple of the eclipse table. *Lub B*, lying at 118 multiples, has much to recommend it as the missing Dresden *lub* since 118 is itself a number of lunar significance (four lunations).

Interestingly, *system B* seems to have supplanted *system A* in estimating moon age during roughly the same period attributed by Teeple to the ascendancy of the uniform system. Thus, this time appears to have been devoted to intense experimentation with lunar data. However, the purposes and underlying religious or political motivations of this empiricism remain obscure. Although his cause and effect are highly suspect, Teeple's suggestion of the political ramifications of astronomical data may not be totally erroneous (see also chapter 6).

The major conclusion of this chapter is that all correlations which do not closely agree with the lunar series as observations can be unequivocally eliminated. We have thus narrowed the field considerably with the elimination of the Spinden correlation and others, and can set to work choosing *the* correlation in the next chapter.

4. ASTRONOMICAL EVENTS

The fact that each page of Paris 1–13 contains prophecies and events pertaining to an individual *katun* presents us with a unique opportunity: specific astronomical events are awaiting placement not only in Maya chronology, but in real time as well. In order to analyze astronomical passages in the Paris Codex, we must make two determinations: the first is to set the approximate time of origin of the codex; the second, and most important, is to place the sequence of thirteen *katuns* on Paris 1–13 within the framework of the long count.

It has long been felt that this edition of the Paris Codex is a post-Classic copy of a Classic document (Thompson 1950: p. 25). During the Classic period, perhaps around 9.12.0.0.0 (Thompson 1950), the year bearers were changed; sometime between the Terminal Classic and the Spanish conquest they were changed again. The Paris Codex lists the year bearers known to have been in use during the Late Classic: Akbal, Lamat, Ben and Etznab.

The golden age of Maya knowledge was reached during the Classic period. Afterwards, there seems to have been a general decline in Maya standards of excellence. In other words, the great works of the Classic period, particularly codices Dresden and Paris, were venerated and maintained, but their content was either not fully understood, or was too lofty to be improved. This state of affairs is somewhat analogous to the situation in medieval Europe prior to the Renaissance. The scientific, and often pseudo-scientific works of the Greco-Roman tradition to which Europe became heir, were meticulously and unquestioningly copied in monasteries throughout the continent. It was not until the Renaissance that this heritage was seriously scrutinized and the chaff separated from the grain.

The Maya knew no renaissance. Their evolution as a society was abruptly terminated during the Spanish conquest.

Evidence of post-Classic decline is to be seen in the Madrid Codex. The workmanship of the Madrid document is, be it copy or not, quite crude. Much of the information here seems to be reduced to magical formulae so that any bean-casting shaman could determine the luck of the day, or prescribe the rites of propitiation to the gods.

Another line of evidence for post-Classic copying comes from the Dresden Codex. The *lubs* of the Dresden tables are well back in the Classic period, too far removed to be of practical value. The Maya undoubtedly calculated from more up-to-date bases during the post-Classic. These were surely derived from Classic period *lubs*, but are not listed in the surviving edition of the Dresden Codex. A lively controversy has ensued as to the long count positions of these inferred secondary *lubs*. The whole interpretation rests upon the correlation question.

This argument is not to imply that the Maya recorded no new observations of astronomical events in the three surviving codices. On the contrary, we would expect to find references to important contemporaneous phenomena, not merely slavishly copied historical records. However, the basis for these data still adheres to a Classic period framework.

It is especially significant that the Paris Codex is thought to stem from Yucatan.[1] As we may glean from the evidence at Coba, thriving provincial centers outside the central area were in operation as early as the Middle Classic period. Some of these became centers of learning (or repositories of Classic knowledge) after the abandonment of the central area. One such center was Chichen Itzá.

Chichen Itzá is extremely interesting from our perspective. It is in reality two "towns," separated by the modern road which passes through the site. The "old town" is in the pure Maya tradition. As we have seen, on the Monjas in the heart of the "old town" are inscribed many of the same beings appearing in the Paris table. The "new town" is in the mixed Maya-Toltec style developed after the Toltec conquest of Yucatan under the legendary *Kukulkan* (*Quetzalcoatl* in Nahuatl speech). According to the Maya chronicles (Roys 1967), Chichen Itzá became the center of Toltec hegemony in Yucatan. This decisive event occurred in a *katun* 8 Ahau.

The Toltec domination was potentially disruptive to the Classic tradition. Resistance to cultural change would certainly have continued, but with the consolidation of Toltec power, we would expect to find Mexican influence gradually cropping up in Maya tradition. This is seen in the Dresden Codex where several gods accompanying the Venus table show distinct Mexican attributes (see p. 76, footnote 25). I am aware of no such influence upon the Paris Codex. Such a codex, of post-Classic origin, would be expected to list astronomical data (precession, etc.) compiled during the preceding period (Late Classic). Thus, the Paris Codex probably originated in Yucatan, and either antedates or postdates the Toltec invasion by no more than a few *katuns*.

What this means in historical perspective is that the sequence of *katuns* on Paris 1–13 must lie somewhere between the Late Classic and the Toltec invasion. This is not to imply that these pages refer to the *katuns* in question only in the historical sense. This would be to deny the Maya concept of time as an endlessly repetitive cycle. We are assured of finding mythological and apocalyptic references to *katuns* bearing the same coefficient. Witness the *katun* prophecies of the *Chilam Balam* (Roys 1967) which often contain a confusing mixture of history and prophecy. It is only astronomical phenomena recorded on these pages which will be assigned to these *katuns*, phenomena which could be recorded only through observation at the time of occurrence.

Let us then locate these thirteen *katuns* in the long count. The first in the sequence is *katun* 4 Ahau on

[1] Zimmermann (1956: p. 30) brought to light evidence of east coast Yucatan affinities: there are but two occurrences of his glyph Z103 (Thompson's glyph T702), Paris 5 and the Santa Rita mural. Thompson (1972: p. 16) sees stylistic affinities with Tulum and also Mayapan.

Paris 1. This is significant in that it is an anniversary of the *katun* in which the Paris table begins, the *katun* ending on 4 Ahau 8 Cumku. However, there are only three *katuns* 4 Ahau near the end of the Classic period which could possibly begin a historical sequence. These *katuns* end on the following dates:

1) 9. 2.0.0.0 4 Ahau 13 Uo

2) 9.15.0.0.0 4 Ahau 13 Yax

3) 10. 8.0.0.0 4 Ahau 13 Cumku

The last known date of the Classic period recorded in the central area was 10.3.0.0.0 (Xultun, Stela 10; Xamantun, Stela 1; Uaxactun Stela 12). The Toltec invasion occurred in a *katun* 4 Ahau shortly after the Terminal Classic (Thompson 1950; Roys 1967), and thus must be placed in a *katun* ending slightly prior to date 3 above, which commences over forty years after the last dates of the central area.

There is only one date from which a thirteen-*katun* sequence could bridge the Late Classic and early post-Classic and still end before the complete Toltec domination of Yucatan: date 2 fulfills all the requirements admirably. The time span covered by this sequence is therefore between the following dates:

9.14.0.0.1 7 Imix 14 Muan: begin *katun* 4 Ahau, Paris 1

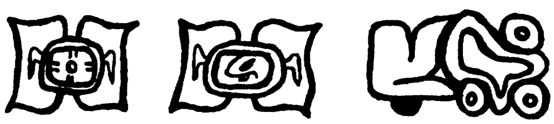
10.7.0.0.0 6 Ahau 8 Zec: end *katun* 6 Ahau, Paris 13

The astronomical phenomena in our analysis can be assigned with reasonable confidence to *katuns* falling within the sequence delimited by the above long count dates.[2]

We may now proceed with the analysis according to the following scheme. The glyphs of astronomical passages will be interpreted as specific phenomena and when they were expected to have occurred. These Maya observations will then be tested against real-time phenomena occurring within a specific *katun*. Naturally, this depends upon which correlation is used. Therefore, all the survivors of our lunar test will be given a chance here. The object of the analysis is to see which, if any, correlations yield a real-time phenomenon which accords with the reading of the glyphs. Since the first two phenomena are solar and lunar eclipses, they can be checked conveniently in Oppolzer's (1887) *Canon der Finsternisse*. A successful analysis will provide a double check, on our reading of the glyphs as well as the various correlations.

The first test case comes from Paris 4, which is concerned with a *katun* 11 Ahau. According to our determination, *katun* 11 Ahau lies between the long count dates 9.17.0.0.1 and 9.18.0.0.0. The glyphs which depict the phenomenon appear in the following order:

Paris 4-katun 11 Ahau



This sequence of glyphs is already familiar; it is the one which I proposed in chapter 1 as corresponding to the illustration and text on Dresden 58b, and assuredly to be read "solar eclipse." Now we can make this reading much more specific.

According to the analysis in chapter 1, the "winged" *kin* and moon glyphs of variety 1 have the following meaning: "interaction of the sun and moon at the summer solstice." The next glyph, the *tzizimitl*, shows that the nature of this "interaction" was a solar eclipse in which the stars became visible during the day. For the stars to become visible during the day, this eclipse must have been at or near totality in most of the Maya area. Thus, our first test case can be specified as follows:

Phenomenon: solar eclipse—at or near totality
Time: at the summer solstice

The conditions of the test are as follows. In order to allow maximum leeway to our interpretation, and the various correlations, the following limits have been set: a positive result will be scored if a correlation yields an eclipse within that quarter of the year centering upon the summer solstice (that is, Julian equivalent to Gregorian June 21/22 ± 45 days), and the path of totality passes through any part of Maya, or immediately adjacent, territory. (Any result which falls even slightly outside the 90-day limits, and/or its path of totality lies within five degrees latitude or longitude of Maya territory (about 350 miles), will be reported with an interrogation point.) The result of

[2] It is also possible that *katun* 4 Ahau ends the sequence and belongs to Paris 14 but would still function as an anniversary *katun* of the beginning of the long count. This would also indicate that the Paris Codex was written just prior to, or slightly later than the Toltec invasion of *katun* 8 Ahau. The probability of placement on Paris 14 would be greater if it can be shown that Paris 15–18 form a complete unit between the *katun* sequence and later pages of the codex. In terms of our astronomical readings this is immaterial while both Paris 1 and 14 are missing, and the rest of the *katuns* retain their respective positions. The long count positions of the *katuns* on extant pages of the Paris Codex are as follows:

Paris page	*Katun*	Long count
2	2 Ahau	9.15.0.0.1-9.16.0.0.0
3	13 Ahau	9.16.0.0.1-9.17.0.0.0
4	11 Ahau	9.17.0.0.1-9.18.0.0.0
5	9 Ahau	9.18.0.0.1-9.19.0.0.0
6	7 Ahau	9.19.0.0.1-10.0.0.0.0
7	5 Ahau	10.0.0.0.1-10.1.0.0.0
8	3 Ahau	10.1.0.0.1-10.2.0.0.0
9	1 Ahau	10.2.0.0.1-10.3.0.0.0
10	12 Ahau	10.3.0.0.1-10.4.0.0.0
11	10 Ahau	10.4.0.0.1-10.5.0.0.0
12	Extant, but destroyed.	

test case 1 is as follows:

Test case 1: solar eclipse, *katun* 11 Ahau

Correlation	Date of eclipse	Path of totality	Julian day	Long count date
584,283	July 16, A.D. 790	central area	2,009,802	9.17.19.13.19

Supporters of the Thompson correlation must be quite pleased, especially since the resulting long count date is just three days removed from the date recorded on Stela 3 at Santa Elena Poco Uinic (9.17.19.13.16), which gives all indications of being an eclipse date as first noted by Teeple (1930: p. 115). Poco Uinic is in Chiapas, and lay within the path of totality of this eclipse. Those who have carefully followed the analysis in the previous chapter can already offer an explanation of the three-day discrepancy.

The Thompson correlation has indeed come out the uncontested victor in this test case. However, there are two more test cases which become progressively more specific.

The data from Santa Elena Poco Uinic raise an interesting question which I would like to draw into the analysis: which date in the Dresden eclipse table was at node passage? The first two intervals in the table are fifteen days each; the dates are as follows:

Date		Interval
1) 9.16.4.10. 8		
2) 9.16.4.11. 3	—	15 days
3) 9.16.4.11.18	—	15 days

Teeple (1930: pp. 86–93) is usually interpreted as having assigned node passage to within a day or so of date 1, the base of the eclipse table. However, let us look at the implications of this determination.

If date 1 is both at new moon (see chapter 3) and at node passage, what could we expect in the way of eclipses? The extreme limits for an eclipse are ±18 days from node passage. Thus, there would be a possible solar eclipse on date 1, followed by a possible lunar eclipse on date 2. However, the third possible member of this eclipse sequence is not included in the table: date 3 is too far from node passage to be an eclipse; a lunar eclipse fifteen days before date 1 could occur, but that is before the table begins. Thus, if we accept date 1 as node passage, date 3 is a *non sequitur* in terms of an eclipse forecast.

Teeple showed that the calendar round dates in the Dresden table cluster around certain days of the double *tzolkin* (520 days) in such a way that node passage would have to fall in the middle of these clusters if they were to act as eclipse forecast days. Since the double *tzolkin* is an excellent approximation of three eclipse half-years (519.93 days) the days assigned to node passage would remain set in the *tzolkin* for over twenty years. During the time of operation of the table (33 years) the node day would have receded by about 1.61 days.

Thompson (1950: p. 234) postulated that when the table was actually in use (i.e. post-Classic), recession of the nodes had moved it back from the position it had originally occupied (date 2) when the three long count dates were contemporaneous (i.e. Classic period): in other words, 9.16.4.10.8 was not the true base of the post-Classic table, but rather 10.11.3.10.8, which lay nine multiples of the table forward.

Makemson (1943) also places node passage at date 2, making all three dates possible eclipse syzygies. She went on to propose a correlation based on an attempt to impose a sequence of eclipses visible in Maya territory on the intervals in the Dresden table. (This correlation is one of the survivors currently being tested.)

The Thompson and Makemson correlations differ by almost 260 years, but both agree on node passage at date 2. Teeple's argument has been construed that he set date 1 as contemporaneous node passage (see above), which has given rise to the controversy noted by Kelley (1977: p. 60). In point of fact, Teeple (1930: p. 98) notes that ". . . node day was either 9.16.4.10.7 11 Manik, or some time within the next nineteen days." Also, Teeple himself did not believe the three dates were contemporaneous when the Dresden table was written and, presumably, functioned with reasonable accuracy. Teeple (1930: p. 90) compares the Dresden intervals with a series of eclipses beginning on January 16, A.D. 1116, which he sets as zero date, or the functional base of the table. But most important, Teeple (1930: p. 104) favors the same date the Thompson correlation gives as the equivalent of date 1: November 8, A.D. 755, Julian day 1,997,131. Thus, we can compare Thompson's explicit statement with Teeple's implicit placement of node passage:

	Classic *lub*	Post-Classic *lub* (at node passage)	Interval
Thompson:	9.16.4.10.8 J.D. 1,997,131	10.11.3.10.8 J.D. 2,104,771	107,640 (9 × 11,960 days)
Teeple:	same	(no long count given) J.D. 2,128,692	131,561 (11 × 11,960 + 1 day)

The only difference here is the removal of the functional *lub* by either nine or eleven multiples of the table from the Classic period *lub* at 9.16.4.10.8. Sharing the same Julian day, both schemes place date 1 (9.16.4.10.8) about 19.5 days before node passage and, by extension, date 2 (9.16.4.11.3) about 4.5 days before the nodes. Thus, there is no fundamental disagreement in these interpretations: node passage is at or near date 2, and Teeple's excellent analysis of the relationship of node passage to the double *tzolkin* remains valid.

The whole confusion is probably best explained by post-Classic copying and the adaptation of Classic period sources during the compilation of the Dresden Codex. Zimmermann (1956) has shown that the Dresden Codex was written by as many as nine different scribes. This is certainly more consistent with compilation from various Classic sources than with an original manuscript. However, the question remains why the Classic Maya did not choose node passage as the *lub* of the eclipse table: a date near the outside limits of an eclipse before node passage seems to have been preferred. The answer to this question must come from an understanding of what the Maya were looking for in astronomical phenomena.

The Maya intellect devoted considerable energy to finding idealized patterns for irregular phenomena. This is reflected in the concept of the *lub*, which has impressed its mark on all of Maya astronomy. What the Maya sought I shall term the *perfect manifestation*. Since the manifestations known as eclipses are really the interactions of the sun with the moon and the cycle of the nodes, neither new moon nor node passage were in themselves the embodiment of a *perfect manifestation*; only their interaction could yield such perfection. What then was the nature of the *perfect manifestation* regarding eclipses?

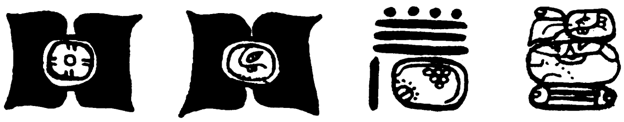
If my feeling for Maya astronomy is correct, the *perfect eclipse manifestation* is what I shall dub the *triple play*: three consecutive eclipse syzygies. What better day could mark the beginning of a possible *triple play* than a day fifteen days before passage of the nodes? If full moon or new moon fell within three days of this date, the Maya could look forward (undoubtedly with trepidation) to a possible *triple play*. Even if the ultimate terrible expression of perfection were never observed, the very possibility would have been intriguing.

Each passage of the nodes could bring as few as none or as many as three eclipses. According to our argument, we could expect the following regarding Maya eclipse observations: 1) eclipses worthy of mention would be as close to the *perfect manifestation* as possible—either a pair of eclipses, or at minimum, a possible *triple play*; 2) only very important total solar or lunar eclipses would be excepted from condition 1. These inferences can be tested in our analysis, which brings us back to the eclipse at Santa Elena Poco Uinic.

The eclipse of July 16, 790 was total across the central area and within a day of node passage. This means that this eclipse lay between two possible lunar eclipses, the *triple play*. Oppolzer (1887) does not list any lunar eclipses on the corresponding days. However, when full moon falls near the outside eclipse limits, penumbral lunar eclipses may result. Eclipses which occur only in the penumbral portion of the earth's shadow are simply not listed in the *Canon der Finsternisse*. Thus, it is quite possible that these two minor eclipses occurred. However, the Maya may never have seen the *perfect manifestation*, but rather, kept careful watch for any possibility of its occurrence.

Let us now continue with test case 2 on Paris 10. According to our analysis, Paris 10 deals with *katun* 12 Ahau, which falls between 10.3.0.0.1 and 10.4.0.0.0 in the long count. The glyphs appear as follows:

Paris 10–katun 12 Ahau



Here again the first two glyphs are the "winged" *kin* and moon, of variety 2. This combination can be read "interaction of the sun and moon at the winter solstice."

The third glyph, Cauac with coefficients, will tell us when this particular winter solstice occurred in *katun* 12 Ahau. However, we temporarily skip this glyph to examine the fourth glyph.

The fourth glyph is a compound (T15.736:758:110) which tells us the nature of the "interaction" of sun and moon. The lower part of the compound (T758:110) is the major portion of the usual form of Glyph B of the lunar series (Thompson 1962: p. 356, no. 117), with an Akbal, "darkness," infix; the presence of affix T110 makes this reading a certainty (Thompson 1962: p. 359). The upper part of the compound consists of the death glyph (T736), with the "death eyes" prefix (T15). The death symbolism and Akbal infix with a lunar glyph leave no doubt what is being conveyed here: the "death" of the moon, which could be nothing other than a lunar eclipse.[3] Judging by the abundant references to death and darkness, this must have been a total lunar eclipse.

Let us return to the third glyph. This is undoubtedly the variant of the Cauac glyph which is to be read *haab*, "year" (Thompson 1950; Kelley 1976: p. 157):

[3] The "wings" of the *kin* and moon glyphs are actually a dark red (text and footnote 11, p. 16), possibly emphasizing the blood-red color, or the easterly rising of the (full) eclipsed moon.

with two coefficients it could never be the day Cauac. Although *haab* may occasionally substitute for *tun* in nonspecific contexts, it is much more likely that it is to be read "year" in the full sense of the word. One of the major associations of the *haab* glyph is with rain and storms, and it is a part of the drought glyph compound read *kintunyaabil* (Thompson 1950). These associations are with seasonal phenomena, making it quite certain that *haab* represents the year of the seasons: the Maya vague year of 365 days.

Turning to the coefficients of *haab*, this looks like a straightforward case of glyph suppression: the coefficient of a lesser time period is affixed to the glyph of a greater time period, the glyph of the lesser period being eliminated for brevity (Thompson 1950: figure 30). Thus, the total time indicated could be read either 5 *haab* 19χ, or 19 *haab* 5χ. Since we are operating within the confines of one *katun*, the latter reading is less likely: the *katun* is just over 19.7 *haab*, so any reference to be counted forward or reverse to a convenient base (usually a *katun*, sometimes a *lahuntun*, ending) could be accomplished most efficiently with less than ten *haab*. We know we must be dealing with some sort of distance number because of the suggestive presence of the *ben-ich hel* "succession" glyph directly preceding our excerpt, and the "forward to" glyph three glyph blocks following (Thompson 1962: p. 281, glyph T679, no. 66). This leaves us with 5 *haab* 19χ as our distance number. The unknown lesser time period could not be the *uinal* since there are but eighteen units of twenty days in any variant of the year. Therefore, this must refer to the *kin*; we may now complete the distance number:

5 *haab* + 19 *kin* = **5** × 365 + **19** × 1 = **1,844** days

The four glyph blocks following our excerpt are damaged, but convey some useful information. The first is a *uinal* glyph with a T172 prefix (T172.521); T172 is read "woe to" by Thompson (1972); the other two affixes are illegible. This must signify a dire aspect of the current *uinal*, very appropriate in an eclipse context.

The next glyph is totally destroyed, but the third (see above) is the "forward to" glyph (posterior date indicator; T679). This indicates that the *haab* distance number is counted forward to reach the terminal date of this calculation, which could logically not be anything but the end of *katun* 12 Ahau. This is a safe assumption, even though all that remains of the next glyph is what appears to be the "bundle" (T103) prefix; all subsequent glyphs are destroyed.

We are now ready to formulate a testable hypothesis to apply to the various correlations. This test will be so specific that failure to elicit an unambiguous answer can be interpreted in only two ways: the glyphs have been falsely interpreted; or the true correlation is not among those being tested. The test is specified as follows:

Phenomenon:	lunar eclipse—at or near totality
Time:	at the winter solstice, 1,844 days before 10.4.0.0.0 (10.3.14.15.16)
Limits of uncertainty:	either the eclipse or the winter solstice will fall on, or very close to the specified date; ideally, both will be very close.

The test will commence by finding the Julian day corresponding to 10.3.14.15.16 in each correlation. If this day is within our ±45-day limits from a winter solstice, all eclipses visible in Maya territory (as in test case 1), solar and lunar, will be noted. Instructions for determining the geographic visibility of eclipses are found in the *Einleitung* to Oppolzer's (1887) *Canon der Finsternisse* and have been followed carefully.

Table 12 lists the results of test case 2. Only three correlations gave a date within the ±45-day limits from a winter solstice. The Willson correlation (438,906) was almost exactly on the target, but no lunar eclipses were visible within the limits: a partial solar eclipse occurred about 39 days before the winter solstice, but the partial lunar eclipse occurring fourteen days earlier (closer to the autumnal equinox), was not visible to the Maya. The Smiley correlation (482,699) yielded a date thirty-seven days before the winter solstice and a total lunar eclipse seven days later. These two dates are acceptably within our limits but their placement in relation to the solstice could hardly be called ideal.

But here again, the Thompson correlation comes up with what could be construed as the ideal answer: a total lunar eclipse which lies twenty days before 10.3.14.15.16, and the eclipse as well as the long count date derived from the *haab* distance number fall ten days before and after the winter solstice, respectively. I am unabashedly impressed with this performance. Test case 1 was not extremely specific, but is supported by an actual recorded date just three days from the expected date. But test case 2 was quite specific and it appears that the proverbial nail has been hit upon the head.[4]

Let us pause here to take a closer look at the performance of the Thompson correlation in these two test cases. In the first example, the long count date at Santa Elena Poco Uinic falls three days before the actual date of the total eclipse. Rather than dismissing this as a Maya transcriptional error, let us determine

[4] I must stress here that each test was executed without bias, according to the principles of hypothesis testing; I had no idea of the outcome of any correlation before the results were calculated. In other words, these tests were specifically conceived for testing all viable correlations, not for "proving" a pet correlation.

TABLE 12

TEST CASE 2: LUNAR ECLIPSE, *KATUN* 12 AHAU (10.3.0.0.1–10.4.0.0.0)

Correlation	Julian day 10.3.14.15.16	Winter solstice[1]	Lunar eclipses ± 45 days[1] (Julian day)
375,503	1,842,459	+148 days	—
584,283	2,051,239	+10	Total: Dec. 7, 903* (J.D. 2,051,219)
717,143	2,184,099	−79	—
793,063	2,260,019	−129	—
438,906	1,905,862	−1	None[2]
482,699	1,949,655	−37	Total: Nov. 19, 625* (J.D. 1,949,662)
489,138	1,956,094	−172	—
497,879	1,964,834	+168	—
500,210	1,967,166	−58	—
626,927	2,093,883	−80	—
679,108	2,146,064	−128	—
774,078	2,241,034	−121	—
489,384[3]	1,956,340	+74	—

[1] Limits: ±45 days from the winter solstice.
[2] Visible *solar* eclipse Nov. 11, 505 (J.D. 1,905,824).
[3] Spinden correlation included gratis.
* Note: dates in the Julian calendar do not correspond to dates since the Gregorian reform of A.D. 1582 (i.e., winter solstice in the Julian calendar is not on Dec. 21/22 as in the Gregorian calendar). The data in column 3 (winter solstice) were calculated from the Julian day of the standard vernal equinox of 1950.

if it is justifiable in terms of our analysis and the Thompson correlation. If this is truly an eclipse date, why is it recorded three days before the eclipse occurred?

Temporarily playing Thompson's advocate, I offer the following explanation. The monument was erected at some date after the eclipse, most probably several years later. The Maya knew that solar eclipses occur only at new moon; thus the eclipse would be recorded on a date which is also a new moon date. If for some reason (be it religious, numerological, or an actual mistake) this new moon/eclipse was recorded as new moon in *system B* (disappearance before conjunction; see chapter 3), the date arising would expectedly be about three days early. I cannot explain why this may have happened, only that the possibility existed.

In test case 2, the Thompson correlation yields two dates equally spaced around the winter solstice. There are two observations which support both my reading of the glyphs and the Thompson correlation. The first is that the long count date (10.3.14.15.16) derived from the *haab* distance number is extremely interesting from a numerological standpoint. Aside from the coefficients 14-15-16, a sequence is formed by the dot portion of each of the Maya numerals: 0-3-4-5-6, possibly of great significance in Maya eyes.[5]

The second observation which supports the Thompson correlation is the interval between the eclipse and 10.3.14.15.16, exactly one *uinal*: I have previously remarked upon the presence of a suggestive *uinal* glyph of dire omen directly following the analyzed excerpt. A very free translation of the entire passage can now be rendered: "at the winter solstice; total lunar eclipse; woe to the *uinal* (beginning on the day of the eclipse) ending on 10.3.14.15.16; forward 5 *haab* 19 *kin* to end of *katun* 12 Ahau."

Barthel (personal communication) is inclined to translate this *haab* distance number *vac cub haab*, signifying positions of the year within the current *katun*. Whatever the translation, this *haab* series is well represented on Paris 1–13 and bespeaks a remarkable shorthand system.[6] Naturally, we would prefer to see full long count dates, but these were hardly necessary to the Maya.

Let us now look at the correlations which have been tested. Most of these are "astronomical" correlations (table 11, lower section) which have attempted to align Maya astronomical data (eclipse predictions, Venus heliacal risings, *et cetera*) with a pattern of visible phenomena. But the thing which sets these apart from the others (that is, the Thompson and Spinden correlations) is their complete rejection of data in the colonial sources, notably the various books of *Chilam Balam* and Landa's *Relación de las Cosas de Yucatan.*

[5] This observation had nothing to do with the interpretation of the *haab* distance number, and was only noted during the tabulation of results. In itself it supports no particular correlation. However, the fact that the eclipse and the date occur ten days before and after a winter solstice in the Thompson correlation is convincing: a lunar eclipse at the winter solstice is precisely what we are looking for.

[6] See appendix A for further examples of the *haab* distance number.

The arguments concerning the colonial sources are beyond the scope of this work, and suitable discussion is given in Tozzer (1941), Roys (1967), and Thompson (1950). However, one of the most important statements stemming from these sources is that a day 12 Kan 1 Pop was equated with July 15, 1553 Julian. Since the combination 12 Kan 1 Pop repeats once in every 52-year calendar round (18,980 days), there are many possible positions in the long count in which it could fit. Thus, all possible correlations which give a 12 Kan 1 Pop within a day or two of July 15, 1553, are strung out at intervals of 18,980 days. Only two of these have enjoyed continuing support from Maya scholars, the Thompson and Spinden correlations.

The crucial assumption of these correlations is that the Maya calendar was an unbroken chain of days from the Classic period down to July 15, 1553. A discontinuity in the calendar round would leave us between Scylla and Charybdis, just as a break in our Julian day system would wreak havoc on astronomical back-calculations. There is absolutely no evidence for such a discontinuity, but neither is there absolute proof for a continuous sequence.

But even in the absence of complete proof to the contrary, is it logical to deny the continuity of the Maya calendar? The Maya were practically obsessed with the idea of finding regular repeating cycles, both astronomical and ritual, within the inexorable march of time. Every time period down to the day was conceived as a sacred burden borne by a god. Given such a mentality, any interruption in the sacred flow of time would be sacrilege of the highest order.

The three codices which survived the *auto-da-fé* of sixteenth-century Yucatan pointedly display this reverence for time. These codices, which were undoubtedly in use at the time of the conquest, were tied to the long count of the Classic period through such bases as are found in the Dresden manuscript. In order for these codices to be of any practical use, an interruption in the calendar could not have occurred. To argue that they were merely revered manuscripts from a glorious past, no longer of any practical value, implies some catastrophic event which completely disrupted Maya culture.

There occurred no event of such proportions. The Classic collapse was certainly a serious disruption, but the evidence for the continuity of Classic knowledge in Yucatan is irrefutable. Subsequently, the Toltec presence was merely a temporary situation. The Toltec acquired a legendary reputation as warriors and statesmen, but nowhere is their astronomical acumen of mention. Thus, the major influence of calendrical knowledge undoubtedly flowed mainly in the opposite direction, from the Maya to the Toltec.

Even the codex-burning zealots of the Inquisition scarcely had enough time to totally eradicate Maya calendrical knowledge by 1553, a mere decade after the conquest of Yucatan. Indeed, ample evidence points to the survival of much ancient knowledge down to the present day. Thus, there is no event in the archaeological or historical record which could possibly account for a catastrophic interruption of the Maya calendar. To even suggest that the Maya did it themselves is a contradiction to all we know of the Maya mentality: the Maya could never have tolerated an equivalent of Pope Gregory XIII. The year bearers were exchanged, but the sacred flow of the calendar round was never interrupted.

All scholars who accept the validity of the colonial sources will find only four viable correlations among those that have been tested. The Spinden correlation was eliminated in chapter 3, but was nonetheless included in our test cases. It fared no better than any other correlation which showed no significant result, and should be resoundingly rejected. This leaves us with the Thompson correlation and three others. The latter three, to my knowledge, are not supported by a single Maya scholar, but this is hardly grounds for rejection.

The 717,143 correlation places the end of the Classic period at around A.D. 1250. This contradicts the *katun* records of the *Chilam Balam* which places thirteen *katuns* (256 years) between the Toltec conquest and the Itzá occupation of Chichen Itzá. As we have seen, the Toltec presence began at least eighty years after the Classic period, during the first post-Classic *katun* 4 Ahau. Thus, the 717,143 correlation would place the Itzá occupation at the time of the conquest, an impossible situation historically. The archaeological record also requires a depth of at least three centuries before the conquest.

The 793,063 correlation places the Terminal Classic yet another 200 years forward, and can be forthrightly eliminated.

The 375,503 correlation puts the Terminal Classic near A.D. 300. This is well outside the range of reliable radiocarbon dates for this period, and thus eliminates this correlation.

We are left with the one correlation which consistently yields acceptable results. However, before the Thompson correlation is stamped *quod erat demonstrandum*, it must pass one other test which I have devised. If the Thompson correlation is accurate, then from this point on it is inextricably bound to the hypothesis developed in these pages. It must thus yield acceptable results with the analysis yet to come as well as with important principles previously outlined. The obverse is also true: my analysis must accord with the Thompson correlation. Thus, the following test case is not only a test of the Thompson correlation, but a test of this hypothesis as well.

In chapter 1 (see endplate) I delineated the tentative boundaries of the Maya constellations. These boundaries can now be exactly set according to the Thompson correlation: the boundary between the Turtle and the Rattlesnake is the position of the vernal equinox (the first point of Aries) at 4 Ahau 8 Cumku, in B.C. 3113, lying 70.7 degrees longitude east of the position of the first point of Aries at the standard equinox of A.D. 1950; from this point the ecliptic (and neighboring area) is divided into thirteen equal parts. The constellation boundaries are given in degrees longitude (table 13); zero degrees longitude is the first point of Aries in 1950.

I stated in part I that the Maya used the thirteen constellations as the basis for a system of positional coordinates. According to my hypothesis, we should then find references to heavenly bodies within the boundaries of these constellations among the inscriptions. Such references must fulfill the following requirements: 1) contain a glyph which can reasonably be interpreted as the sun, the moon, or a planet; 2) contain a glyph whose identity with one of the zodiacal beings is well established; 3) be in unequivocal context within a securely dated inscription.

A glyph block which meets the above criteria is found on Lintel 3 of Temple IV from Tikal, which resides in the Museum für Völkerkunde in Basel, Switzerland. Lintel 3 contains two calendar round dates separated by a distance number: 9.15.10.0.0 3 Ahau 3 Mol and 9.15.12.2.2 11 Ik 15 Chen. These dates have been securely placed in the long count (Morley 1937–1938; Satterthwaite 1961). The Tikal lintels were investigated by Brack-Bernson (1975) who determined that the latter was the date of the solar eclipse of July 25, 743 according to the Thompson correlation; the path of totality of this eclipse crossed

TABLE 13

BOUNDARIES OF MAYA CONSTELLATIONS (at the ecliptic)

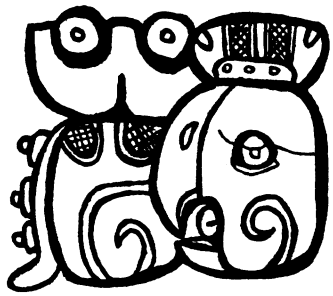
	1950 Coordinates*		
	Ecliptic (β = 0)	Equatorial	
Constellation	λ	R.A.	Declination
Jaguar	15.28	0^h56^m	6°.02
Rattlesnake	42.97	2^h42^m	15°.74
Turtle	70.67	4^h36^m	22°.05
Scorpion	98.36	6^h36^m	23°.18
Moan	126.05	8^h34^m	18°.77
Xoc	153.74	10^h23^m	10°.14
Vulture	181.44	12^h05^m	−0°.57
Frog	209.13	13^h48^m	−11°.17
Bat	236.82	15^h38^m	−19°.45
Peccary	264.51	17^h36^m	−23°.33
Deer	292.20	19^h36^m	−21°.62
Death	319.90	21^h29^m	−14°.85
Canine	347.59	23^h14^m	−4°.91
	15.28	0^h56^m	6°.02

* Based on the standard position of the first point of Aries (vernal equinox) on March 21, 1950 (J.D. 2,433,361.7): 0^h0^m right ascension, 0°.0 declination, equatorial coordinates; 0°.0 λ (longitude), 0°.0 β (latitude), ecliptic coordinates.

the Pacific coast of Chiapas and Guatemala, just south of the central area. Her analysis leaves no doubt as to the overwhelming astronomical significance of Lintel 3.

Let us examine Lintel 3 (fig. 9). In A1–B1 the date 3 Ahau 3 Mol is given, followed directly by the distance number 2.2.2 in A2–A3, written, as usual, in ascending order; the *kin* glyph is suppressed, its coefficient being attached to the *uinal* glyph in B2. In B3–A4 appears the date 11 Ik 15 Chen, and in the next glyph block, B4, appears our zodiacal coordinate:

Tikal Temple IV, Lintel 3, B4



The left half of this glyph block consists of the star glyph above a shell element (T575). The right half is the turtle glyph (T743) surmounted by an affix. Kelley (1976: p. 42) reads the left half of this glyph block "shell star," and suspects it to be a "particular planetary name." Commenting on this glyph block, Kelley (1976: p. 50) also suspects that the turtle glyph is a reference to the Turtle constellation, roughly equivalent to Gemini. These comments are particularly apropos to our analysis.

The affix above the turtle is extremely interesting; it has been read by both Kelley (1976) and Brack-Bernson (1975) as *yax*. However, I see this as a *chac* affix; these two affixes are often difficult to distinguish, and have been confused in the Thompson catalog. My reading is based on two observations. The first is that our affix does not bear the spiral element and/or raised area on the upper border, which seem characteristic of the *yax* affix, particularly in the month sign Yaxkin. The following appears to be a "typical" *yax* affix:

Yax:

Note the spiral, and "raising of the roof" above the vertical black bars; most examples have at least one of these features.

The second observation is that our affix bears a far greater resemblance to the *chac* affixes found, most significantly, on the pages of the Dresden Venus table.

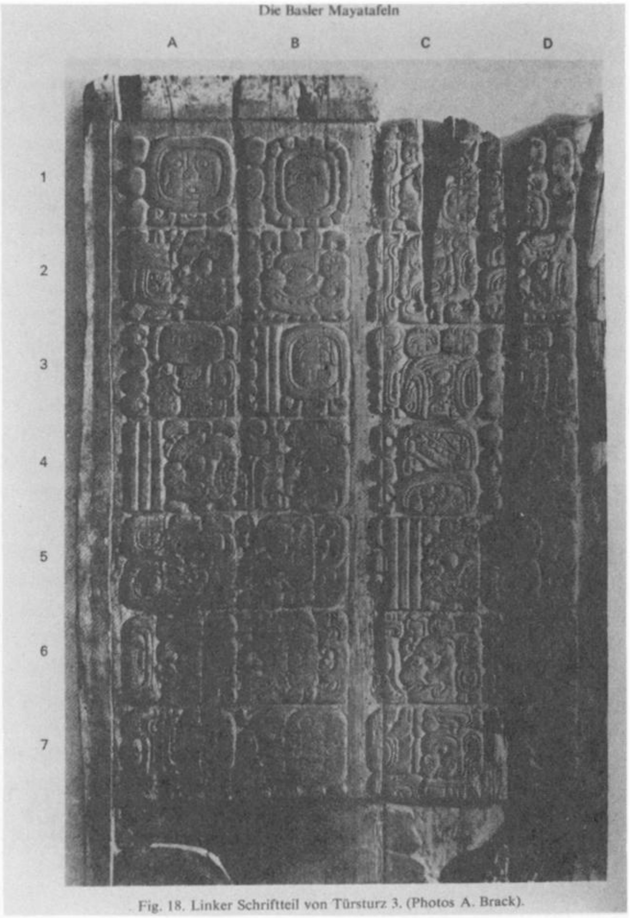


FIG. 9. Lintel 3 (left side), Temple IV Tikal (Brack-Bernson 1975).

Chac has long been known to mean "great" or "red," and the Venus glyph certainly corresponds to the Yucatec word for Venus: *chac ek*, "great star." On Dresden 24 and 46–50 the *chac* affix itself never varies, but it occurs in two distinct positions: to the left or above the star glyph (and also inverted with both positions); on Dresden 46, in a row of four Venus glyphs, the *chac* affixes are not in identical positions, which may in itself be significant. Note also the "typical" *yax* affixes on Dresden 46; in Yaxkin, and the down-balls/*yax* compound (directional glyph for south). Be that as it may, the "typical" *chac* affix looks like this:

Chac:

Note ovoid border and dots instead of the spiral element.

I think it quite evident that our affix is in fact merely a slightly atypical *chac*. Accepting this reading, we may now make another interesting observation: the top half of our glyph block is really a *reversed* Venus glyph. Jumping the gun a little, where have we seen reversed glyphs before?

Our glyph block directly follows the latter date, 11 Ik 15 Chen, and thus is logically a reference to that date. However, since the initial date, 3 Ahau 3 Mol, leads directly to 11 Ik 15 Chen through a distance number and has no accompanying text, our glyph block might apply equally well to 3 Ahau 3 Mol. In fact, this glyph block seems to be a double reference to reversed(?) Venus and yet another planet, at a position in the Turtle constellation: one planet on 3 Ahau 3 Mol, the other on 11 Ik 15 Chen. Reading this glyph block in normal order seems to imply that the Venus reference is to the former date. The following sums up our expectations for planetary positions on the two dates:

Hypothesis:

1) Venus in the Turtle on 3 Ahau 3 Mol

2) unknown planet in the Turtle on 11 Ik 15 Chen

This hypothesis can be tested by the calculation of planetary positions, according to the Thompson correlation, on the respective dates.

Calculations which are accurate to within about one degree longitude are easily accomplished; the reference point of zero degrees longitude is the first point of Aries at the standard equinox of 1950 (Julian day 2,433,361.7). At this point, however, I must issue a word of caution to calculators of solar, lunar, and planetary longitudes. Appendix B gives the procedure for obtaining longitudes which agree with the present (1950) coordinates of the fixed stars. This procedure must include a correction for the precession of the equinoxes which, as we have seen in part I, was an integral part of the Paris table.

Let us now proceed to the results. Figure 10 shows the positions of the sun, moon, and the five naked-eye planets on 9.15.10.0.0 3 Ahau 3 Mol. There is only one heavenly body within the Turtle constellation: Venus, as predicted; there is nothing else even close to the boundaries of the Turtle. But how did Venus arrive in this position? On 3 Ahau 3 Mol Venus was about fourteen days past inferior conjunction, which occurred at the Turtle/Scorpion boundary. This means that on 3 Ahau 3 Mol Venus was about ten days past heliacal rising and in a period of *retrograde* motion that carried it westward, well back within the Turtle constellation.

In chapter 1, I offered an explanation for the glyph reversal on Paris 23–24: these pages deal with the precession of the equinoxes, which is a retrograde phenomenon, proceeding westward, against the general flow of celestial traffic. In this light the reversal of the Venus glyph in our glyph block makes excellent sense: *Venus retrograding.*

Figure 11 shows the celestial picture on 11 Ik 15

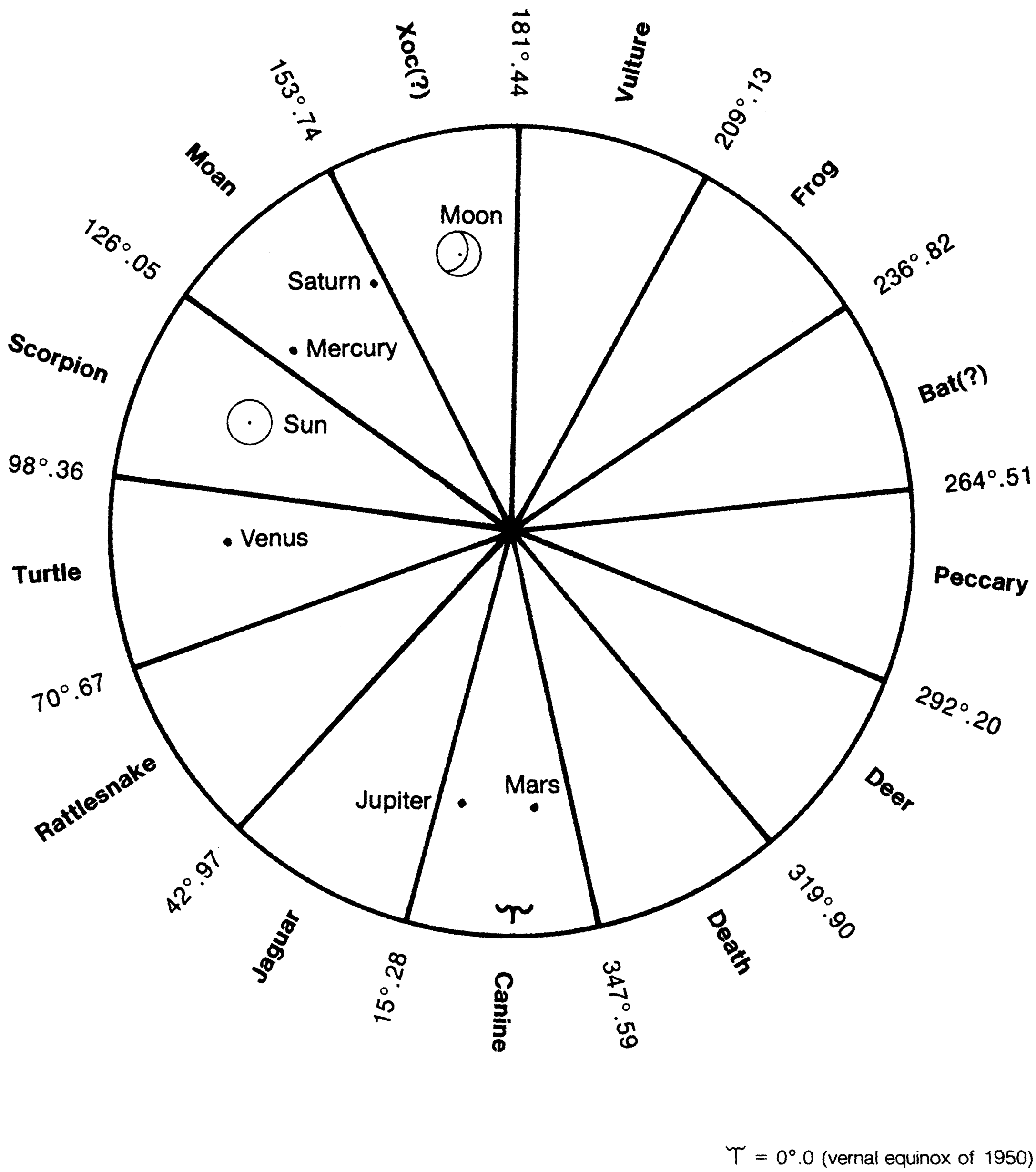


FIG. 10. The Sky on 9.15.10.0.0.

Maya date:	9.15.10.0.0 3 Ahau 3 Mol
Julian day:	1,991,883
Date:	June 24–25, 741*
Remarks:	Venus retrograding in the Turtle.

* The Julian day begins at noon and thus encompasses two half-days of the civil calendar.

Note: this diagram is a schematic representation of the Maya zodiac. The planetary positions shown are in degrees of ecliptic longitude (λ) counted eastward (clockwise) from the first point of Aries of 1950 (♈). The constellation boundaries are delineated in table 13, and correspond to the heavy spokes radiating from the center. See appendix B for details on the calculations involved.

Chen. Here again the answer is quite unambiguous: there is but one planet squarely planted in the Turtle constellation, Jupiter. Kelley's "shell star" is the glyph for the planet Jupiter, whose magnitude is second only to Venus. This will be adequately confirmed later, but let us now carry our analysis of Lintel 3 a few glyph blocks further.

According to Brack-Bernson's (1975) analysis, the

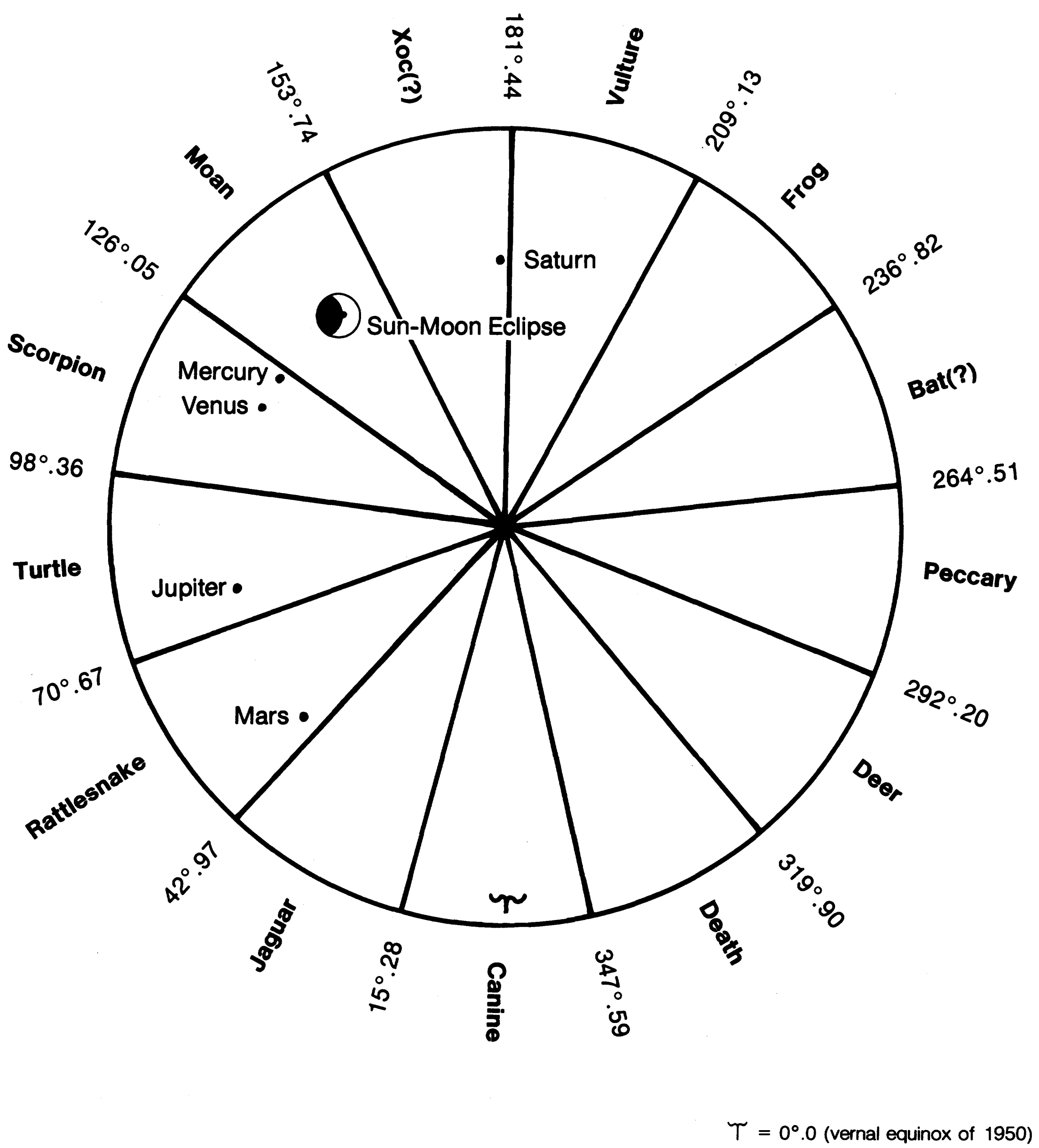


FIG. 11. The Sky on 9.15.12.2.2.

Maya date:	9.15.12.2.2 11 Ik 15 Chen
Julian day:	1,992,645
Date:	July 25–26, 743
Remarks:	solar eclipse near totality in central area; Jupiter in the Turtle.

Note: the Thompson correlation places 11 Ik 15 Chen one day after the eclipse, an overshoot we can allow at this point. The absolute value of the correlation cannot be resolved until it is known exactly when the Maya day began, and to what extent the Maya "edited" astronomical events to conform to important secular or religious events.

next several glyph blocks deal with the near total eclipse at Tikal celebrated on 11 Ik 15 Chen. Directly following our Venus/Jupiter/Turtle compound are the glyph of the mythical *xoc* fish (T738c) with "east" prefixed, and the glyph of the death god (T1045) with lunar postfix (fig. 9, A5–B5).

The eclipse took place within the Moan constellation (see fig. 11). Directly in the upper middle of Lintel 3 appears what Thompson (1950: fig. 20, no.10) terms a "*moan* bird above celestial dragon." This in itself may not be a reference to the Moan constellation. However, in the *moan's* headband lodges an apparent

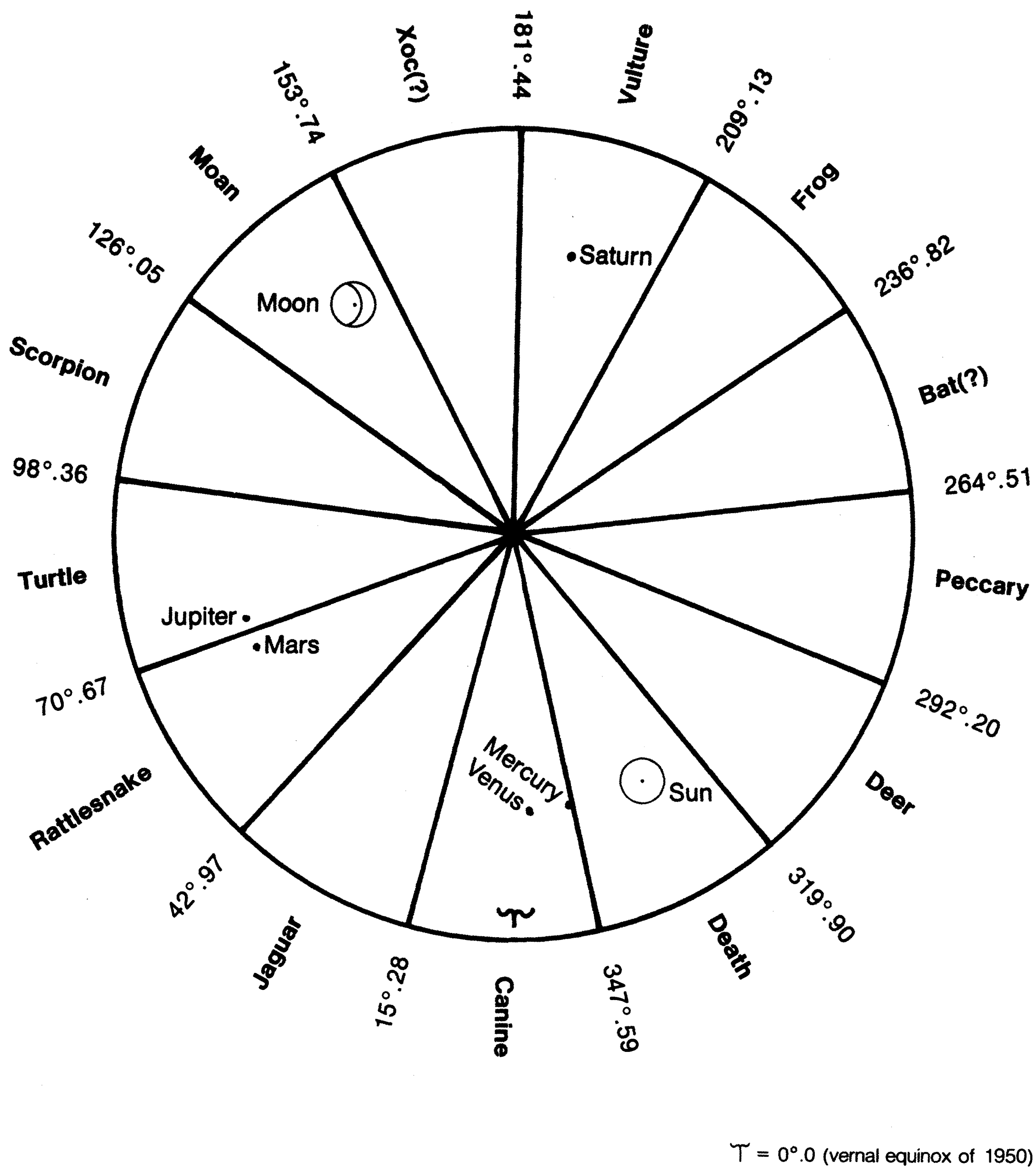


FIG. 12. The Sky on 9.15.12.11.13.

Maya date: 9.15.12.11.13 7 Ben 1 Pop
Julian day: 1,992,836
Date: Feb. 2–3, 744
Remarks: the moon and Jupiter return to the positions occupied on 9.15.12.2.2 11 Ik 15 Chen (see fig. 11).

Ahau sun face adjoined on three sides by a ring of circlets and surmounted by a star glyph; the ring of circlets is read by Kelley (1977) *mol*, "conjunction," in astronomical context. The symbolism here is, to say the least, highly suggestive.

If we imagine the Maya conception of a solar eclipse as the death god causing the "death" of the sun by moving the moon eastward across its face, the glyph blocks at A5–B5 make excellent sense. It is quite possible that, among its other duties, the *xoc* was none other than our Marine Monster (Xoc?) constellation. In A5 the directional locative "east" is prefixed to the *xoc* glyph, and the eclipse took place about eleven degrees west of the boundary of the Xoc(?); in less than a day, the easterly motion of the moon (the agent of the death god) would carry it into the Xoc(?). The day after the eclipse, 12 Akbal 16 Chen, appears at D4–C5 on Lintel 3, and the very next glyph, at D5,

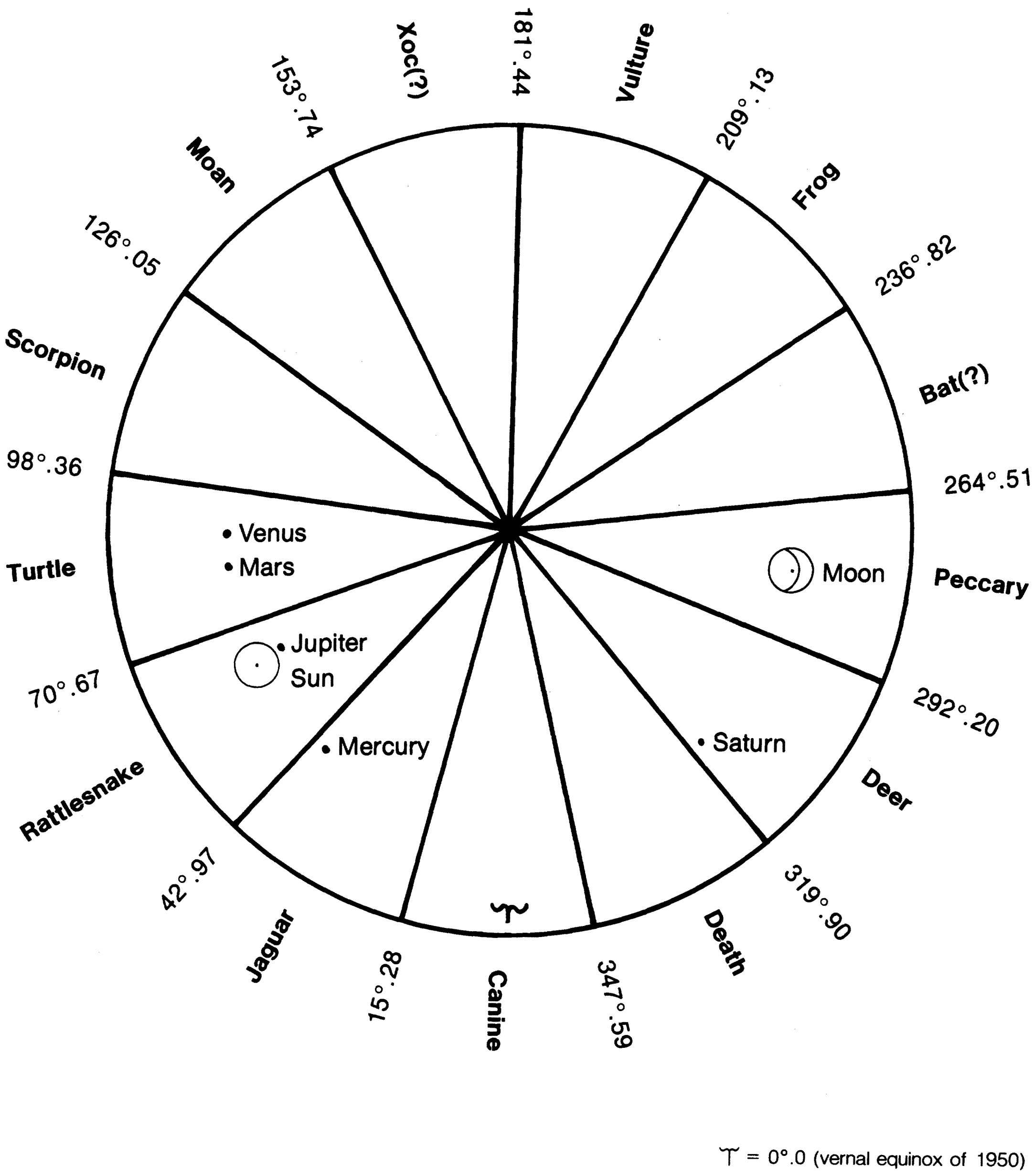


FIG. 13. The Sky on 9.16.4.1.1.

Maya date:	9.16.4.1.1 7 Imix 14 Zec
Julian day:	1,996,944
Date:	May 3-4, 755
Remarks:	Jupiter in conjunction with the sun.

is a lunar glyph. The implication is thus: the moon became visible as a crescent on 12 Akbal 16 Chen in the Xoc(?)[7] after eclipsing the sun in the Moan on 11 Ik 15 Chen. I suggest the following partial reading for A5–B5: "east into the *Xoc* runs the agent of the death god (the moon) . . ."

Let us consider this suggested translation more closely. Barthel (personal communication), in agreement with my conclusions, translates T130 (superfixed to the *xoc*) *aan*, "run," and had once suggested that the suffixing of T130 may signify "he who runs before." This interpretation would make the *xoc* the sub-

[7] This also corresponds exactly with its position on 3 Ahau 3 Mol (see fig. 10).

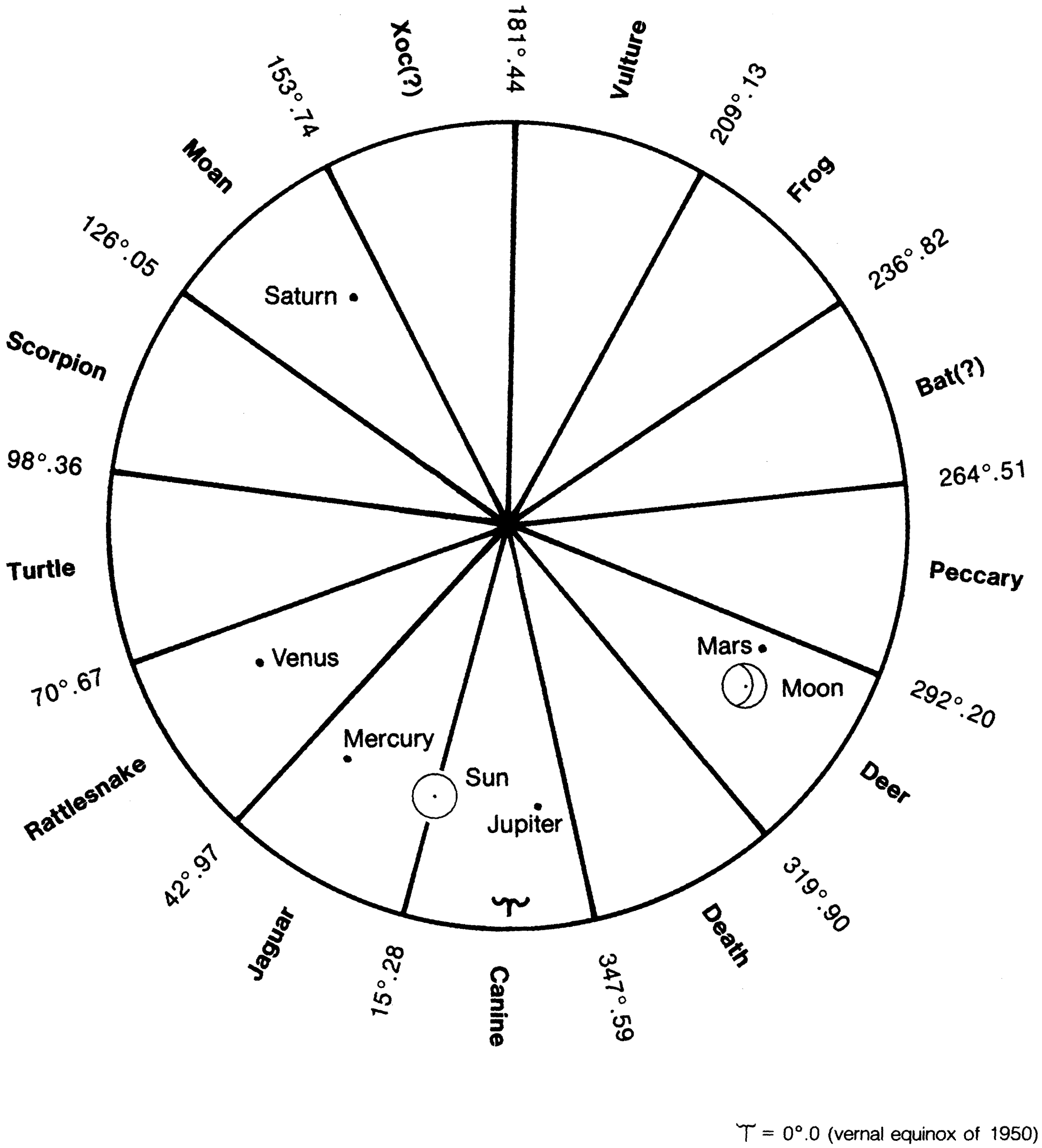


FIG. 14. The Sky on 9.15.9.13.0.

Maya date:	9.15.9.13.0 7 Ahau 3 Zip
Julian day:	1,991,783
Date:	March 16–17, 741
Remarks:	the moon and Mars "conjunction" in the Deer.

ject of the sentence with a reading along the lines: "the *xoc* runs to the east ahead of the death god/moon . . ." However, T130 is superfixed not suffixed, and T12 read by Barthel as *xul*, "end," or "falling down," occupies the suffix position. I thus entertain a slight preference for the *xoc* as the object of the sentence, into which the running is being done.

The lunar postfix (T181) with the head of the death god is possibly of dual significance: T181 has been read variously as the verbal suffix *ah* as well as *kal*, "an act," either of which would signify in effect "the death god's deed"; in this case I prefer to read anagrammatically *u*, "moon," which makes the moon a part of the death god's deed or his "agent." Whichever translation ultimately proves preferable, the passage in A5–B5 offers a good description of the astronomical events and is, I consider, confirmatory in respect to the Xoc constellation.

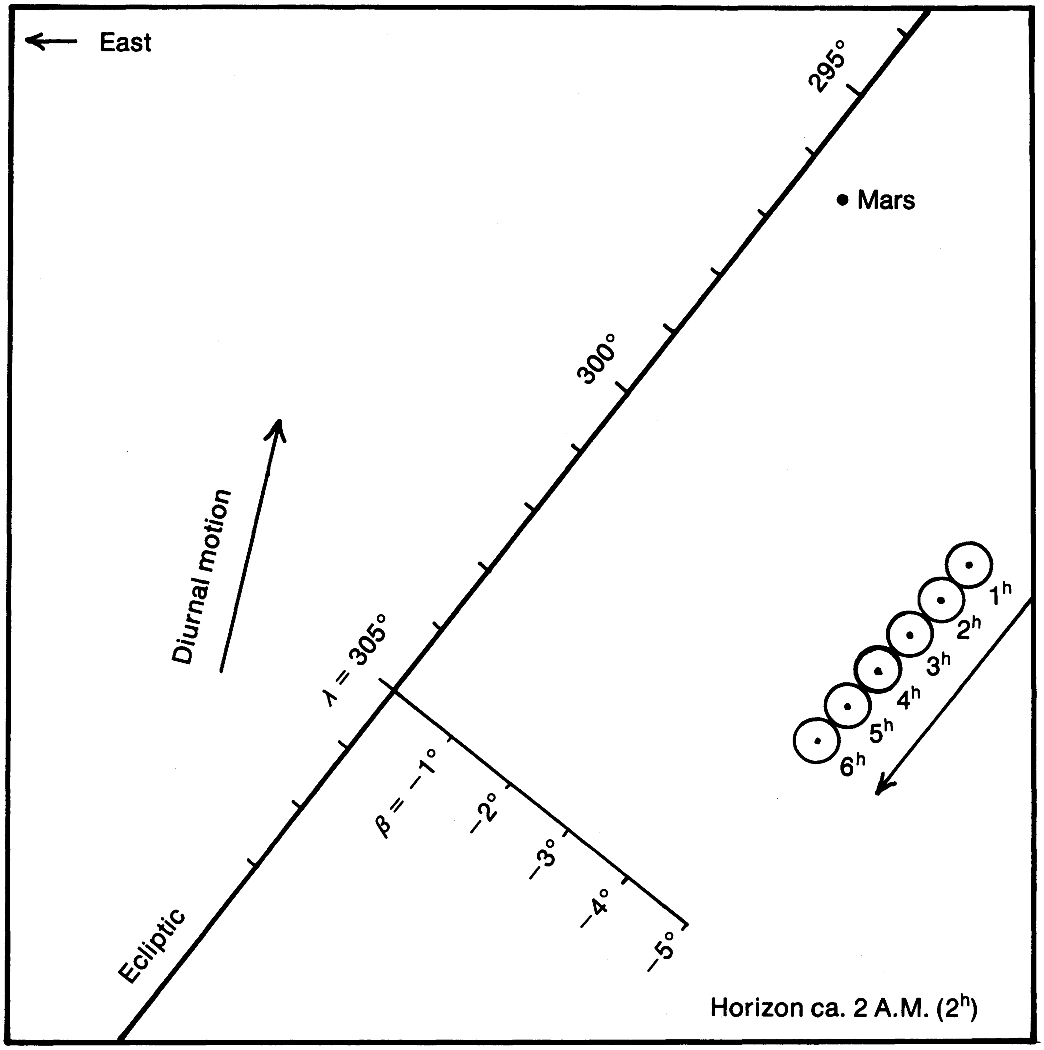


FIG. 15. Moon/Mars "Conjunction."

Maya date:	9.15.9.13.0 7 Ahau 3 Zip
Julian day:	1,991,783
Date:	March 17, 741 (morning of vernal equinox)
Time:	1 A.M.—6 A.M. local time (1^h–6^h)
Moonrise:	1:30 A.M.
Sunrise:	6 A.M.

The Maya's fondness for puns and double entendre is certainly carried over into the hieroglyphic writing. This has unfortunately led to scholarly debates in which any one of several positions is eminently defensible. I think that prospective translations should be kept as flexible as possible in cases where multiple meanings may be present.

Returning to shell star/Jupiter, we find it again mentioned, on Lintel 2 (Maudslay 1889–1902: **III,** plate 73, glyph B8) immediately following the date 9.15.12.11.13 7 Ben 1 Pop (B7–A8); the preceding day, 6 Eb 0 Pop, a new year's day, is found a few glyph blocks back at B3–A4; but again on Lintel 2 (A1–B1) the calculations begin from 3 Ahau 3 Mol. Brack-Bernson (1975) suggests a reason for the date 7 Ben 1 Pop: the moon returned to the same longitude where it had eclipsed the sun 191 days earlier. A glance at figure 12 shows that not only the moon, but Jupiter too, had returned to the same coordinates: Jupiter is once again in the Turtle, about five degrees from its position on 11 Ik 15 Chen.[8] Thus, the rationale

[8] I might add that 7 Ben 1 Pop lay fourteen days after the annular solar eclipse of January 19, 744. (J.D. 1,992,822) which passed through the heart of Yucatan just north of the central area, and there is an outside chance of a visible penumbral lunar eclipse on 7 Ben 1 Pop: Oppolzer lists two thirds of this possible *triple play* [partial lunar eclipse of January 4, 744 (J.D. 1,992,807) invisible in Maya territory]. A reference to these eclipses may yet be found on Lintel 2 which shows, unfortunately, a great deal of damage.

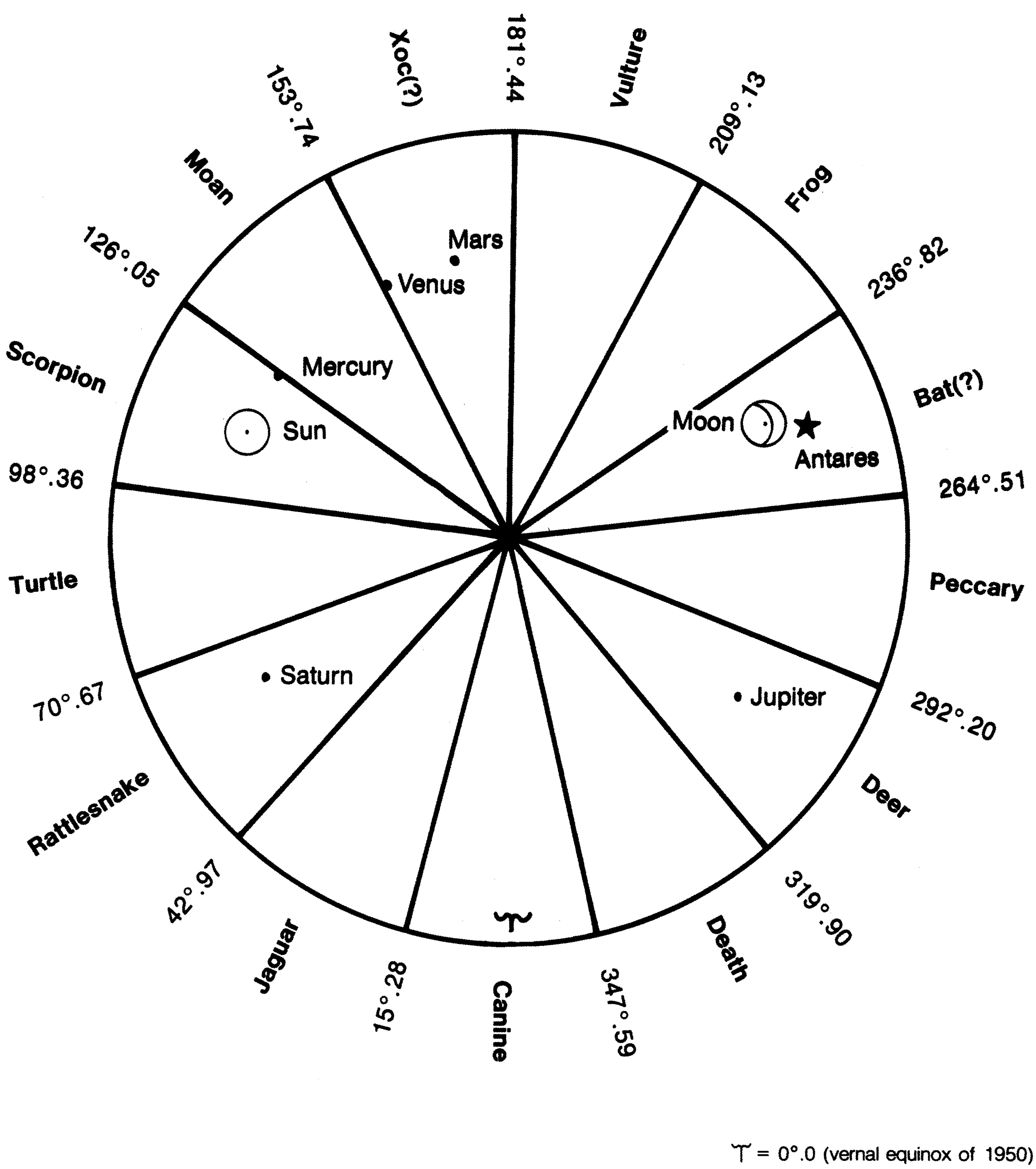


FIG. 16. TheSky on 9.16.12.5.17.

Maya date: 9.16.12.5.17 6 Caban 10 Mol
Julian day: 1,999,920
Date: June 26–27, 763
Remarks: moon and Antares conjunction. There appears to be no accidental connection between Antares, in the heart of the Bat constellation, and Copan, whose emblem glyph displays the head of the leaf-nosed bat (see appendix C, p. 91, footnote 3).

for this date may be the repetition of certain conditions pertinent to the eclipse on 11 Ik 15 Chen.

Evaluation of the preceding results leaves not the slightest doubt, in this writer's opinion, as to the verity of the Thompson correlation. For the further development of this hypothesis, the correct correlation is the very foundation. Thus, my choice of the Thompson correlation within the last two chapters was a matter of extreme personal importance. In a few instances, such as my reading of *haab* and the *chac* affix, I had to disagree slightly with previous interpretations. But a decision was reached, not without some soul-searching, before the tests were applied.

The preceding analysis has pointed out the necessity for great perspicacity in making astronomical readings. Every turtle glyph is surely not an astronomical

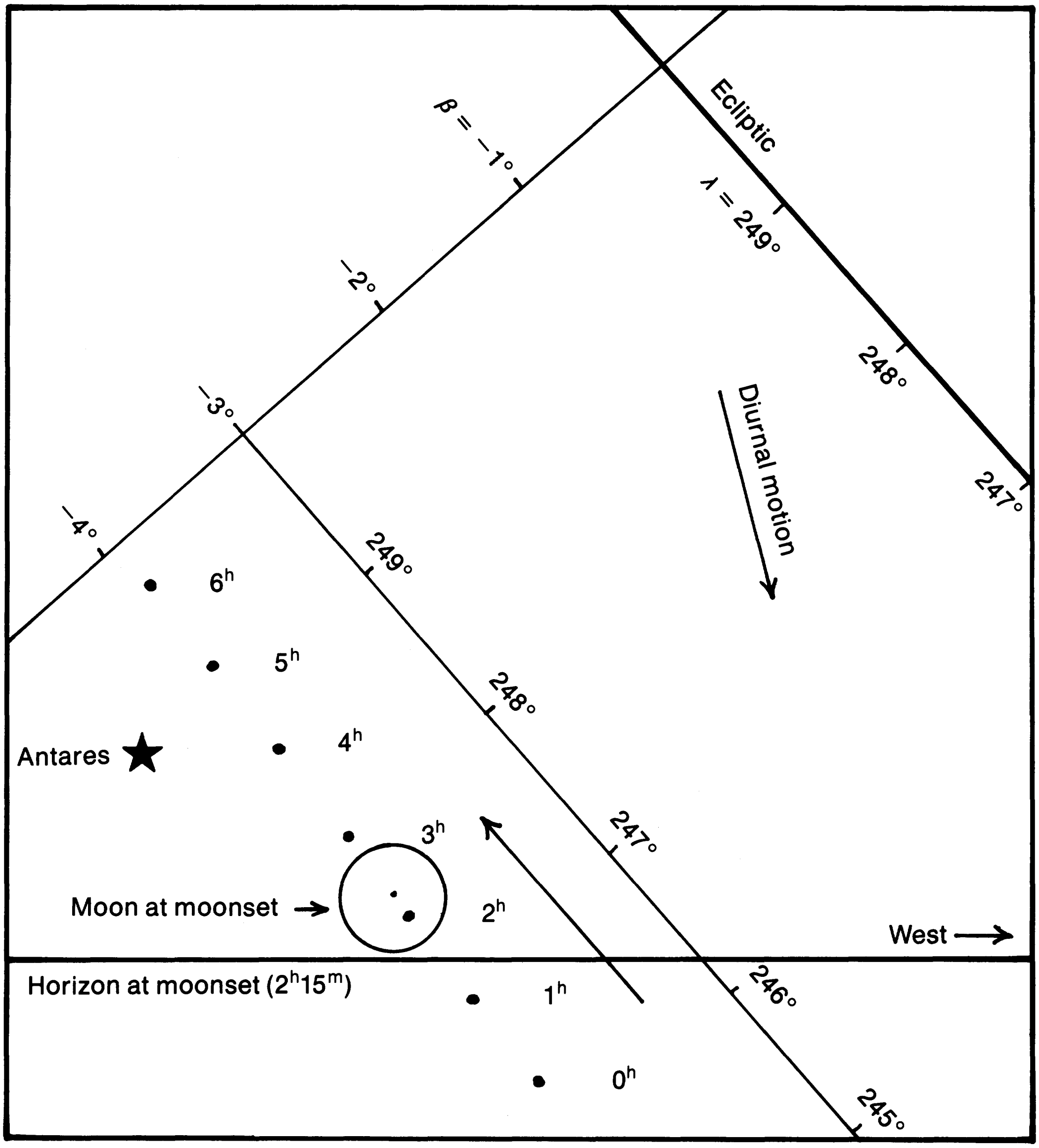


FIG. 17. Moon/Antares Conjunction.

Maya date:	9.16.12.5.17 6 Caban 10 Mol
Julian day:	1,999,920
Date:	June 27, 763
Time:	midnight-6 A.M. local time (0^h–6^h)
Moonset:	2:15 A.M.

coordinate, and the presence of anagrammatic references adds an interesting twist to those which are. The Maya seem to have taken pleasure in terse cryptic messages. To us this may be an annoying habit at times, but is probably an artifact of our incomplete control of the depth of Maya hieroglyphic writing.

In concluding this chapter, I would like to corroborate a glyph reading by Kelley (1977), and propose yet another planetary glyph. Kelley has offered an interpretation of a glyph which repeatedly appears in astronomical context:

The dotted circle surrounding a circle is the glyph for the month Mol and the word *mol* includes the meanings "join together, congregate." In astronomical usage, I suspect that the dotted circle infixing another glyph is to be read as *mol*, with the technical meaning of conjunction, though perhaps used somewhat differently than by western astronomers (Kelley 1977: p. 63).

On Yaxchilan Lintel 41 (Morley 1937–1938: **V**, plate 178b; Kelley 1977: p. 72) appear the following glyphs:

Yaxchilan Lintel 41

These two glyph blocks are part of a passage of four, the first two being the calendar round date 7 Imix 14 Zec. This date is interpreted by Morley (1937–1938: **II,** p. 481) as 9.13.11.6.1 although acknowledging other workers' preference for 9.16.4.1.1. The latter date now seems more acceptable (Kelley 1977); Morley's penetrating analysis has occasionally placed calendar round dates one or two cycles removed from their true long count positions, usually too early.

The first glyph of our excerpt is the by now familiar shell star/Jupiter; following this is a compound glyph. The first element appears to be either the day sign Etznab or possibly Lamat, with superfix. It also bears a curious resemblance to T625, a section of "turtle shell" which, however, usually has more divisions. A reference to the Turtle constellation is extremely dubious; head variants are at present the only acceptable references. The second part is a fist glyph, probably the death fist (T669b) rather than the fire fist (T672) since there is a curved line where the three circles of the latter would be. Above the fist is a cartouche with three vertical lines surrounded by a dotted circle (*mol*) whose lower edge is obscured by the fist.

I think it justifiable to read this glyph group: "Jupiter, 'death' at conjunction." A check of the planetary positions on this preferred date, 9.16.4.1.1 (J.D. 1,996,944), shows that Jupiter was indeed within one day of conjunction with the sun (fig. 13).[9] It is thus reasonable to conclude that Kelley's reading of *mol* as "conjunction" is appropriate in astronomical context.

There is another interesting occurrence of *mol* on Altar R at Copan (Morley 1920: p. 298; Kelley 1977: p. 71). This monument bears two dates, 9.15.9.13.0 7 Ahau 3 Zip and the famous 9.16.12.5.17 6 Caban 10 Mol. The glyph passage of interest is:

Copan Altar R

(After Maudslay 1889–1902: plate 94).

The first glyph is *mol* with affixes; the second, a variant of the lunar glyph; the third and fourth appear to be the glyph for Venus, *chac ek*. Let us assume that the third glyph is *chac*; there seems to be no more likely alternative. However, according to our analysis of *chac*, this is most assuredly an atypical variant. If this variation is a significant difference, it would be reasonable to suggest that the glyph is not to be read *chac*, "great," but as its homonym, *chac*, "red."

We would then have a reference to *red star*, which together with the *mol* and lunar glyphs, could be read: "conjunction, moon and *red star*." As a planetary body, *red star* could be none other than the "red planet," Mars. But let us not jump the gun here; there are many red stars in the heavens and, as we have just become aware, there are two possible dates of reference to *red star*. Our only alternative is to plot the heavens on both dates.

The first date, 9.15.9.13.0 (Julian day 1,991,783), yields some very interesting results. It begins the day before the vernal equinox. It is also nine days after the total lunar eclipse of March 7, 741 (Julian day 1,991,774) which was visible throughout Maya territory (Oppolzer 1887); Oppolzer also lists two solar eclipses fifteen days before and after this date which were not visible in Maya territory, nor indeed anywhere in the world due to the flattening of the earth at the poles. However, this was a definite *triple play* possibility.

But most interestingly, the moon on this day passed within a few degrees of the only planet in its immediate vicinity, Mars (fig. 14). The moon was about 24 days old, and about 75 degrees west of the sun. Around sunset the moon made its closest approach to Mars (about 4 degrees), which was invisible to the Maya; the moon and the planet had already set several hours earlier. However, in the early hours of the morning, in the pre-dawn sky before sunrise at the vernal equinox, an inspiring sight was visible to the Maya: Mars rose about 5 degrees above the moon, and just before dawn (6 A.M. local time) they stood vertically in the sky (fig. 15).

This event was not a true conjunction of the moon and Mars. However, as Kelley notes, *mol* probably does not signify "conjunction" in the sense conveyed by the modern astronomical term. The greatest significance of this "conjunction" in Maya eyes was probably its role as the herald of the equinoctial sunrise. Furthermore, the patron of the month Zip in which this event occurs is identical to the so-called "Mars Beast," and *Zip* itself is the name of a deer god (Thompson 1950: p. 105); be this coincidence or not, a "conjunction" involving Mars occurred in the Deer constellation, and seems to have been an important event. This all goes to prove that Maya astronomy cannot be measured on Western standards.

Turning our attention to the second date,

[9] Interestingly, the conjunction takes place in the Rattlesnake about seven degrees west of the border of the Turtle, but this may be coincidence.

9.16.12.5.17 (Julian day 1,999,920), the planetary positions (fig. 16) are not particularly promising. The date is ten days after the summer solstice, but the moon had passed Mars about six days earlier. Perhaps as compensation, the date is four days before the total lunar eclipse of June 30, 763 (Julian day 1,999,924) visible in Maya territory; Oppolzer lists two solar eclipses on either side of the lunar eclipse which again were visible nowhere on earth, but a *triple play* possibility.

But there is one remarkable observation which almost escapes attention: on this day the moon approached within two diameters (about 1.25 degrees) of one of the biggest, brightest red stars in the heavens before it set in the pre-dawn sky (figs. 16 and 17). The name of this star is Antares, which in Greek means "the rival of Mars."

Was this an observational error, or a purposeful Maya conceit? In other words, was the inauguration day of New-Sun-at-Horizon intentionally set on the date of a lunar conjunction with *red star, inter alia* the red planet?[10] I have previously suggested (chapter 2) the importance of 9.16.12.5.17 in lying an exact multiple of lunations from 4 Ahau 8 Cumku. In this light, such notable lunar events are hardly surprising on Altar R and other monuments at Copan. Furthermore, another glyph, not among those discussed here but upon the same monument associated with the same dates, has been identified by Barthel (personal communication) as a glyph of the planet Mars. This reading was derived from a totally independent investigational hypothesis; details are given in appendix C.

Conclusion

This chapter was an investigation of astronomical passages in the Paris Codex and inscriptions from Tikal, Yaxchilan, and Copan. The primary objective was to obtain hieroglyphic passages of unambiguous astronomical significance for testing against the various correlations. Three test cases were applied and it was concluded that the Thompson correlation yielded the only appropriate answers.

The first two test cases were taken from the pages of the Paris Codex. In order to investigate an astronomical passage among the hieroglyphic records of a particular *katun*, it was first necessary to locate the thirteen-*katun* sequence in the long count. There can be no doubt that contemporaneous (as opposed to mythological or apocalyptic) events must be referred to a *katun* sequence which spans the Late Classic and the early post-Classic periods. Post-Classic documents, like the Paris and Dresden codices, have their roots in the Classic period and thus, in this case, grant but one choice in assigning long count chronology.

The groundwork for the reading of Paris excerpts concerning eclipses (test cases 1 and 2) was laid in chapter 1 with the elucidation of the "winged" *kin* and moon glyphs. In test case 1 the Thompson correlation yielded the only significant result, a date within three days of the eclipse date at Santa Elena Poco Uinic. The analysis of chapter 3 suggests a satisfactory answer to this seeming anomaly. This is of extreme importance because it has often been observed with dismay that the Thompson correlation scores a bull's-eye on one eclipse date but misses another by several days.

Test case 2 yielded what can rightly be called an unqualified success for the Thompson correlation. The specificity of this result is due to the presence of what I have termed the *haab* distance number. The interpretation of the *haab* distance number and its connection to important positions of the year within the current *katun*, has proved to be no fluke. All eight of these numbers in the Paris Codex constructed with double coefficients are shown to behave in like manner (see appendix A).

In the light of these results favorable to the Thompson correlation, the bases for other correlations were examined. It was decided that the so-called astronomical correlations were grounded on the denial of the one principle which was most holy to the Maya, the continuity of time. With the elimination of the Spinden correlation in chapter 3, only one really viable choice remained, but judgment was reserved until the last test case was evaluated.

Test case 3, extracted from the Tikal lintels, was a further demonstration of the Maya system of zodiacal coordinates as first propounded in part I; it was not only a test of the Thompson correlation but of the predictive power of this entire hypothesis. The exact results of retrograding Venus, and Jupiter, in the Turtle constellation, as demanded by the double hypothesis were, to this author, absolute proof for the Thompson correlation. Along with the previous test cases and further readings on the Tikal lintels, I feel it is eminently justified to draw this conclusion.

The last section of this chapter considered astronomical conjunctions. It was pointed out that the Maya concept of "conjunction" and, of course, its importance, does not in all cases correspond to our own. The first example, from Yaxchilan Lintel 41, was an exposition of the newly found Jupiter glyph in conjunction (excuse the pun) with the *mol* glyph. It is noteworthy that the Maya could calculate with precision the day of a planet's conjunction with the sun during its period of invisibility, even though, for ex-

[10] This *red star* reading raises another very serious question: do all our glyphic references to *chac ek* really pertain to the planet Venus, or do some of them pertain to Mars? This could explain some of the confusion about the Thompson correlation yielding insignificant positions of Venus on dates associated with the "Venus" glyph.

ample, the actual days of inferior and superior conjunctions of Venus were not highlighted in the Dresden Venus table.

The next two conjunctions indicated by the *mol* glyph stem from Altar R at Copan. Here again we found a double reference similar to the one at Tikal; on one date the moon and Mars, on the other, the moon and Antares, both planet and star referred to as *red star*. It is gratifying to corroborate the reading of this passage with the introduction of a glyph for Mars derived by Barthel from an entirely different line of reasoning (see appendix C).

This chapter was the culmination of the astronomical hypothesis developed in parts I and II. I believe that all hypotheses regarding the Maya zodiac, the precession of the equinoxes, the Paris ephemeris, and the Thompson correlation have been adequately tested and confirmed. In the following part we will consider a problem of paramount importance, not only to mayanists but to all students of civilization as well. The problem, whose ultimate solution, I believe, stems from the Paris Codex, is the cause of the collapse of Classic Maya civilization.

PART III. FURTHER IMPLICATIONS: THE CLASSIC MAYA COLLAPSE

5. THE CONCEPT OF WORLD AGES

We come now to consider several problems which have a bearing upon 3,000 years of Mesoamerican history. A foray will be made into the realm of iconography with the objective of elucidating various concepts related to the Mesoamerican tradition of world ages. A large part of this discussion will center upon the iconography of the jaguar, who plays a key role in the hypothesis about to unfold.

Considerable discussion in chapter 1 was devoted to the identity of the destroyed constellation-being adjacent to the rattlesnake on Paris 24. I consider it not open to further question that the fire drill/Jaguar constellation was a pan-Mesoamerican concept.[1] Befitting the dualistic nature of Maya religion the jaguar had both heavenly and earthly roles; he was associated with the underworld or the center of the earth (i.e., *Tepeyollotl*, a causer of earthquakes) as well as with darkness and the night sun (i.e., *Yoaltecutli*). We will be concerned here mainly with his role as a constellation, but this requires a look at some salient features of jaguar iconography in general.

A concept to which we will frequently refer is the melding of jaguar features with those of other beings. One patent example appears on Paris 23 where the constellation-being I have named the "Canine" bears prominent jaguar markings.[2] The question of why we find a "dog in jaguar's clothing" will be discussed in the next chapter; here, however, it is of interest to focus on the identity of this canine who appears to possess the ears and spots of the jaguar, but is also appended with a rather long and bushy tail, a feature never seen on the jaguar. In order to realize this goal, it is first necessary to demonstrate that the bushy tail is one of a constellation of attributes characteristic of the black spotted dog.

Prominent round or ovoid black spots and the cleft ear have long been considered the characteristic features of the black spotted dog; the bushy tail as another attribute belonging within this classificatory scheme is now submitted to analysis. Table 14 lists all occurrences of animals in the codices which can be classified as dogs; the presence of spots, the cleft ear and the bushy tail, as well as any of the known glyphs of the dog are indicated.

In examining table 14 we note that the black spots have the highest frequency among the diagnostic features. One example (Dresden 7a) has no spots, but rather a crescent-shaped marking behind the eye which is not diagnostic of any particular animal (also seen on the jaguar and the deer). However, due to the presence of the cleft ear and an accepted glyph of the dog in the third glyph block, I consider this a member, although aberrant, of this category. The number and size of the spots is not standardized, but fifteen of the sixteen examples (94%) possess this feature. Twelve of the sixteen examples (75%) have the cleft ear, which seems to live up to its role as a diagnostic feature although its frequency is not as high as the spots. In four of these examples the tails are not depicted at all, but in nine of the twelve examples (75%), the tail is indicated with hair. I consider this trait one of the diagnostic features of the black spotted dog which enjoys the same frequency as the cleft ear.[3]

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[1] If any doubters remain who do not concur with my demonstration that the Jaguar and the fire drill were formed of the same group of ecliptic stars, I suggest a look at page 31 of Codex Nuttall (Nuttall 1902). On this page appears a deity wearing a jaguar head as a headdress, and one quadrant of the profile face, above and behind the eye, is black. I consider him the Mixtec version of *Yoaltecutli*, the jaguar god, lord of the night (compare Dresden 48e). Before the god stands a jaguar boring fire with a fire drill; two star symbols appear to either side of the sparks flying from the tip of the drill, and another upon the back of the jaguar. Three spots or stars symbolize both the fire drill and the jaguar pelt in the respective glyphs.

[2] In chapter 1 (p. 12) it was stated that I consider this constellation-being to be the black spotted dog.

[3] Often in the codices, the body form of the dog appears similar to that of the deer (or even the peccary or rabbit) which is also depicted with a bushy tail that is, however, usually quite short. The presence of cloven hooves naturally precludes the canine, but in their absence the determination can be made on the basis delineated above. The black spots are evidently the primary diagnostic feature, the dog on Dresden 7a being the exception which proves the rule; the cleft ear and bushy tail are secondary features whose presence are confirmatory, especially when accompanied by other canine attributes or a glyph.

TABLE 14

ATTRIBUTES OF THE BLACK SPOTTED DOG

Provenience		Spots	Cleft ear	Bushy tail	Glyph present
Dresden	7a	–	+	?[1]	T559.568
	13c	+[2]	+	+[3]	T559.568
	21b	+	+ (one ear only?)	?[1]	T559.568
	29a	+	+	+	?
	30a–31a	+	+	–	?
	39a	+ (over eye)	+	+[3]	T568.559?[4] (reversed)
	40b	+[2]	+	?[1]	T559.568.561
Madrid	13a	+ (over eye)	+	+	?
	27c	+[2]	–	?[1]	–
	30b	+[2]	+	+	–
	36b (right)	+[2]	+	+	–
	36b (middle)[5]	+ (over eye)	–	–	–
	37a[5]	+ (over eye)	–	–	T168:559.130?[4]
	37b	+[2]	–	+	–
	88c	+[2]	+	+	–
	91d	+[2]	+	+	T801 (head variant)
Paris:	due to obliteration, two or three possible dogs cannot be classified according to this scheme.				
Frequency	16 (total)	15/16 (94%)	12/16 (75%)	9/12 (4 examples without tails) (75%)	

[1] Tail hidden or not drawn (Dr. 21b: short tail(?); hair indicated on back).
[2] One or more spots aureolated or encircled.
[3] Hair indicated, but not strongly.
[4] Discussed further on.
[5] Prominent skeletal ribs, rare but diagnostic.

If the presence of a long bushy tail on the being on Paris 23 is supportive to his identification as the black spotted dog, then the picture on Dresden 40b is confirmatory: here, the black spotted dog hangs from a celestial band; above, in the second glyph block, appears the glyph of the dog (T559.568) suffixed with the sky glyph (T561), a compound undoubtedly to be read "dog of the sky."[4] I have found that this representation provides proof for the whereabouts of the Black Spotted Dog (Canine) constellation (see appendix D). The establishment of the zodiacal sequence Black Spotted Dog/Jaguar/Rattlesnake/Turtle is crucial to the following argument.

The above-named beings of the Maya zodiac are of such importance because they are the constellations through which the vernal equinox has been moving for the past 5,000 years. Early on, the boundaries of the Maya constellations were set according to the position of the vernal equinox in 3113 B.C. between the Rattlesnake and the Turtle constellations. The correctness of this assumption has been borne out by the demonstration of the preeminence of the vernal equinox (see chapter 1), and the ability to predict the positions of Maya constellations using astronomical references in the codices and the inscriptions.[5] Another concept is also part of the original assumption, to wit: the movement of the vernal equinox through the zodiacal constellations was the basis for a series of world ages. "All the people of Middle America believe that the present order was preceded by other worlds, each of which was destroyed by some cataclysm" (Tozzer 1941: p. 136). We turn now to the Mesoamerican concept of world ages.

As seen in chapter 2, the Maya calculated the residence of the vernal equinox in each constellation as 101 *katuns*. Thus, counting from 4 Ahau 8 Cumku we may assume that world ages came to a close at succeeding 101-*katun* intervals. To make this more precise, since the Paris table begins 2,592 days before 4 Ahau 8 Cumku, we will use the Paris *lub* as our starting point. Thus, in line with our assignment of constellation boundaries, the opening dates of the Maya world ages are as follows:

1) 12.19.12.14.8 Turtle/Rattlesnake transition
3120 B.C. beginning of the Rattlesnake age

2) 5.0.12.14.8 Rattlesnake/Jaguar transition
1129 B.C. beginning of the Jaguar age

[4] I accept Thompson's (1972: p. 101) reading *pek caan*, "dog sky," while maintaining that "sky" is to be read with the implication of "constellation."

[5] The identities and positions of the Maya constellations as delineated in chapter 1 have been documented with evidence ranging from proof to strong support.

3) 10.1.12.14.8 Jaguar/Black Spotted Dog transition
862 A.D. beginning of the Black Spotted Dog age

Aside from this record derived from the Paris Codex, Mesoamerican accounts of the system of world ages have come down to us in rather incomplete and confused form. However, let us scrutinize this record and determine if there is anything of value to be salvaged.

In the *Leyenda de los Soles* (Velásquez 1945) the world ages, called "suns," and their characteristics are discussed as follows:

1. *Nahui Ocellotl* (4 Jaguar)—this first age is said to have begun 2,513 years before the date of writing, May 22, 1558, which would place its commencement at 956 B.C. This age lasted 676 years and came to a close in the year 1 Reed when the sun disappeared and the people were devoured in one day.
2. *Nauhecatl* (4 Wind)—this age lasted 364 years and terminated when the people turned into monkeys and everything, including the sun, was swept away by the wind.
3. *Nahui Quiyahuitl* (4 Rain)—this age lasted 312 years and ended when everything, including the sun, was destroyed in one single day that rained fire.
4. *Nahui Atl* (4 Water)—this age lasted 676 years and was brought to a close in one day, by a flood; the people turned into fish and the sky collapsed; this age was named "because there was water for 52 years" (. . . *porque hubo agua cincuenta y dos años*; Velásquez 1945: p. 120).
5. *Naollin* (4 Movement)—this age is described as "the sun of we who live today" and commenced in the fire of the divine furnace at Teotihuacan.

This account is quite confused but there are some interesting points worthy of discussion. The beginning of the jaguar sun is placed not far from the date derived from the Paris Codex. However, several ages intervene between the jaguar sun and the present sun, and here we find some interesting remarks. The second sun, wind sun, is said to have lasted 364 years. This number seems not to be derived literally, but rather allegorically. I consider this an allusion by the author to the zodiacal year, and is by extension, a concept which binds this account to the zodiac.

Another seeming anomaly in the text relates to the fourth sun, water sun, which is accorded the same length as the jaguar sun (676 years) but then a curious reference to 52 years of water is made. This, as we shall see, is related to a Mexican concept that destruction of the world at the close of an age could occur at the end of any 52-year calendar round.

Seler (1902: p. 185) lists the same five suns (from the *Anales de Cauahtitlán*) but in different order:

1. *Atonatiuh* (water sun)
2. *Ocelotonatiuh* (jaguar sun)
3. *Quiauhtonatiuh* (fire-rain sun)
4. *Ecatonatiuh* (wind sun)
5. *Olintonatiuh* (earthquake sun)

Here, the duration of each age is not given, but the jaguar sun is, as in the Maya record, the second sun. As Seler (1904: p. 379) relates:

> The second age of the world, in which the giants lived, and in which *Tezcatlipoca* shone as the sun is called in the *Anales de Quauahtitlan ocelotonatiuh*, "jaguar sun." According to the *Historia de los Mexicanos por sus Pinturas Tezcatlipoca* changed himself into a jaguar and devoured the giants.

In the *Historia de Colhuacán y de México*, the world ages are allotted uniform lengths of 2,028 years each (Thompson 1950: p. 10), the total of the first four ages, multiples of 52 years, depicted in the *Leyenda de los Soles*; this compares rather well with the Maya record of 1,991 years (101 *katuns*). The lengths of the world ages are listed in Codex Vaticanus A as 18,028 years plus a few years for interegna (Thompson 1950: p. 10). This estimate is far out of line unless the full cycle of world ages (26,000 years) is implied, but has been incorrectly transcribed.

As we have surmised from the account of the water sun in the *Leyenda de los Soles*, the Mexican concept of world ages was tied to multiples of the 52-year calendar round. Sahagún (1950–1969) has left an account of ceremonies attending the close of a calendar round. This account is best summarized according to chapters in Sahagún's manuscript:

Bk.7, Ch. 9—All fires were put out; idols were cast into water; the priests bored new fire on the chest of a well-born sacrificial victim at midnight, and fed the fire with the heart of the victim.
Ch. 10—The people were frightened and filled with dread; if new fire could not be drawn, the sun would be destroyed forever, all would be ended, it would be night evermore, and the *tzizimimi* would descend to wreak destruction; pregnant women were locked up for fear of their becoming man-eating beasts if new fire could not be drawn; the people drew their own blood as an offering, and spattered it into the fire.
Ch. 11—The new fire was distributed from the temple and hurriedly brought to the homes of the surrounding community.
Ch. 12—Household goods and clothes were renewed; captives and ceremonially bathed persons were sacrificed at noon.
Bk.4, App.—When the Pleiades crossed the zenith the priests assured the people that the world had been granted another 52-year extension.

We note with interest that the completion of each 52-year calendar round was viewed as the possible end of a world age, eliciting great fear among the populace and rituals to avert disaster. Curiously, Landa makes no mention of the 52-year cycle among the Maya but there seems to be evidence that temples and other ceremonial structures were furbished at 52-year intervals (Tozzer 1941: p. 151).

Early in this research I came to the conclusion that the end of a world age must leave traces in the iconography of the people who recorded it. According to our hypothesis, the end of a world age is coeval with the passage of the vernal equinox from one zodiacal constellation to the next. Thus, we might expect to find iconographic representations of the two constellation-beings involved in the zodiacal transition and, more specifically, a melding of their respective features. In the Maya account gleaned from the Paris Codex, the first transition was that of the Rattlesnake/Jaguar. Since there is no evidence that the long count was in use at this time, we will merely be concerned with iconographic representations originating around 1129 B.C. This brings us to the time of diffusion of the Olmec were-jaguar cult.[6]

The several hundred years prior to the rise of the Olmec cult appear to have been a period of unrest throughout Mesoamerica, a time of migration and displacement of various peoples. Swadesh (1953) estimates the divergence of the Huastec language from other branches of the Maya linguistic tree to about 1200 B.C.[7] I suspect the Maya migrated into the Peten from an original homeland to the south at around this time, or shortly thereafter.[8] This inference is supported by the archaeological record which indicates that occupational levels, even at such ancient centers as Uaxactun, cannot be securely dated any earlier than about 800 B.C.; underlying levels appear to be sterile.

As an iconographic symbol the Olmec were-jaguar has been quite baffling. Its practically universal presence throughout Mesoamerica has been interpreted as signifying the existence of an Olmec empire, trade network, or proselytizing religious cult.[9] We will merely be concerned here with two features of Olmec iconography agreed upon by most authorities: 1) through time, Olmec sculpture exhibits an abiding preoccupation with the jaguar; 2) the were-jaguar bears several decidedly ophidian attributes; the forked tongue, cleft forehead and toothless gums are all characteristic of snakes not jaguars.

In viewing the array of Olmec sculpture, one receives the impression that the were-jaguar is a depiction of the outcome of some diabolical experiment aimed at producing a transitional form between the snake and the jaguar. Most germane to this discussion, when an identification can be made, it is the rattlesnake whose features combine with those of the jaguar. These rattlesnake features are so pronounced that it has been suggested (Luckert 1976) that the famous La Venta "jaguar masks" do not even represent a jaguar but rather the green rattlesnake, *Crotalis durissus durissus* to be specific. In this view, the La Venta masks were published upside down; they are held to be fairly accurate portraits of the green rattlesnake, with typical attributes including the diamond-backed skin pattern which had been called a "crown."

I accept this identification with the qualification that it bespeaks an Olmec crypticism similar in spirit to the double references elucidated on Maya stelae (see chapter 4): viewed from one direction, the La Venta masks are a rattlesnake; from the other, a jaguar. These mosaic masks are composed of thousands of blocks of green serpentine, very fitting for a green rattlesnake. However, as determined in chapter 1, green is the color of the fifth world direction, the center of the earth, and is associated with the vernal equinox.[10] Quite mysteriously, these masks appear to have been buried from the light of day immediately after being laid in place (Drucker, Heizer, and Squier 1959).

Furthering the association of the jaguar and the rattlesnake, Monument 30 at San Lorenzo (fig. 18) shows a typical were-jaguar head attached to the body of a snake[11]; in place of the eye appear crossed bands, which turn up later as part of the Maya sky glyph. Monument 19 at La Venta (fig. 19) depicts a seated human figure wearing a "jaguar mask" surrounded by a crested rattlesnake (Drucker, Heizer, and Squier 1959); the rattles on the tail are unmistakable, and crossed bands appear in a "banner" above and before the face of the seated figure, who holds a small pouch which may represent an offering or symbol of power.

I submit that this aspect of Olmec iconography celebrated the passage of the vernal equinox from the Rattlesnake into the Jaguar constellation,[12] bringing with it the beginning of a new world age.[13]

Departing from iconography for a time, we note that the archaeological record brings to light evidence for an event which has so far eluded explanation. Without a trace of cultural discontinuity or foreign conquest, the entire sculptural repertoire at San Lorenzo Tenochtitlán was abruptly and purposefully destroyed. What makes this all the more mysterious is that it seems to have been done with great ceremonial

[6] In reviewing the cultural sequence in the Olmec area, Bernal (1969: p. 107) states that the modest beginnings of a distinctive style emerged after 1500 B.C. which was later to flower at the major Olmec centers subsequent to 1200 B.C.

[7] The Huastec of Veracruz are at present separated from other speakers of the Maya stock by a block of Nahuat speakers extending from southern Veracruz through Tabasco.

[8] Strong evidence indicates the settlement of the Peten from the Guatemalan highlands (see Willey and Smith 1963; Girard 1969).

[9] Political and religious ramifications, as well as an analysis of all aspects of Olmec iconography are beyond the scope of this work.

[10] Also connected with this symbolism are the green cords represented by the unique glyph T725 on Paris 23 (see chapter 1). Representations of cords appear on several Olmec monuments, for example, Altar 4 at La Venta (see Bernal 1969: plate 14).

[11] The thirteen incised circles on the body of the snake are also suggestive.

[12] The existence of the Jaguar constellation was actually postulated on the basis of Olmec iconography.

[13] The celestial aspects of this iconography are, I believe, reflected most poignantly in those were-jaguars whose faces are tilted up to the sky, as seen in the museums of Mexico City and Villahermosa. The astronomical realization of this transition could have come about by using the heliacal rising of a particular star or constellation (the Pleiades, for example) as the herald of the vernal equinox; through time, the advancing date of heliacal rising would betray the movement of the vernal equinox even if exact knowledge of the cycle were lacking.

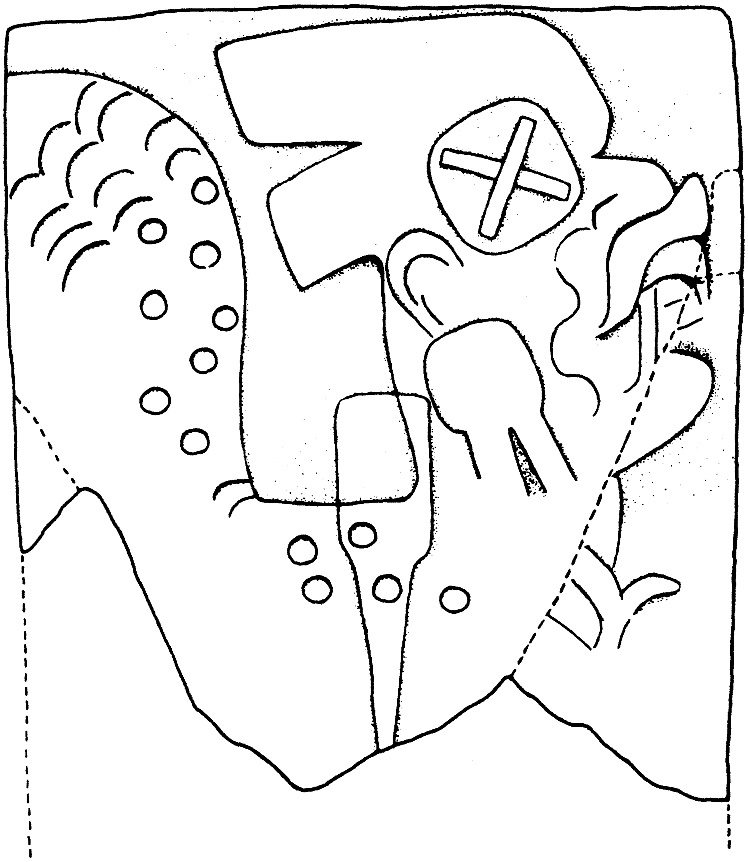

FIG. 18—Monument 30, San Lorenzo (after M. Coe 1968)

flair by the inhabitants of San Lorenzo itself (M. Coe 1968: p. 48). The sculptured monuments were smashed into pieces and buried with rich ceremonial offerings. Following this, new monuments were erected and the cultural sequence, insofar as archaeological investigation can determine, continued with unabated vigor. Evidence of similar upheavals at other sites in the Olmec heartland is not lacking. Among others at La Venta, it was remarked of Monument 23: "It is worth noting that this figure was in all probability deliberately smashed" (Drucker, Heizer, and Squier 1959: p. 204).

The ceremonial destruction of San Lorenzo has been dated by the radiocarbon method to around 950 B.C. Due to C^{14} fluctuations, these dates at San Lorenzo are probably older than 950 B.C. (M. Coe 1968: p. 62); considering the range of reliability of radiocarbon dates brings these events into practical contemporaneity with our zodiacal transition. I suggest that these ceremonial destructions were an exaggerated example of the ritual complex referred to by Sahagún as "renewal." However, judging by the extent of this "housecleaning," events surrounding the close of a 52-year calendar round do not seem to be able to provide a direct analogy; but this is the type of behavior we might expect at the end of a world age and, indeed, the occupants of San Lorenzo built a new world upon the ashes of the old.[14]

The second zodiacal transition, as we have inferred, occurred at 10.1.12.14.8 (A.D. 862) near the end of the Maya Classic period. The *Popol Vuh* gives an account of the migrations of the Quiché Maya of Guatemala, which can be ascribed to the century following this date. Several other Maya groups, among them the Itzá, also appear to have been on the move at this time. The Itzá were homeless for about forty years between being forced to leave Chakanputun in *katun* 8 Ahau (A.D. 928–948) and their occupation of Chichen Itzá (along with the legendary *Kukulkan*) in *katun* 4 Ahau (A.D. 968–988; see Roys 1967). Recinos (1950: pp. 67–68) cites evidence that the Guatemalan tribes fought with the Itzá near the Laguna de Terminos.

[14] A comment in the notes of the *Dumbarton Oaks Conference on the Olmec* (Benson 1968: p. 73) compares the Olmec upheaval to the "rebirth of the world."

FIG. 19—Monument 19, La Venta (photograph by author)

The migration account of the *Popol Vuh* is interesting from our perspective due to its mixture of historical authenticity with mythological hyperbole. The account begins with the creation of the forefathers of the Quiché tribe from "corn meal dough":

Only by a miracle, by means of incantations were they created and made by the Creator, the Maker, the Forefathers, *Tepeu* and *Gucumátz* (Recinos 1950: p. 168).

After the creation they multiplied "in the east" at a place identified as a region in Tabasco near the Laguna de Terminos (Recinos 1950: p. 165); all the tribes[15] were gathered together to await the rising of the sun:

Many men were made and in the darkness they multiplied. All lived together, they existed in great number and walked there in the East (Recinos 1950: p. 172).

Subsequently, during their wanderings, they watched for the rising of the morning star as a sign of the approaching dawn: "They took turns watching the Great Star called *Icoquih* (Venus), which rises first before the sun . . ." (Recinos 1950: p. 180). The tribes apparently wandered around in the "darkness" awaiting the sunrise for at least two generations, for during this time they begat children who grew to maturity. They encountered many hardships on their journey to the south, one of which was most unusual: "There was much hail, *black rain* and mist, and indescribable cold" (Recinos 1950: p. 178; italics mine).

The "black rain" is most probably related to the "heavy resin" which fell from the sky in another creation account of the *Popol Vuh* (Recinos 1950: p. 90): on Dresden 74 this black rain or resin is represented by the dark background and bluish-black markings on the water pouring from the mouth of the sky serpent, the two *sun at the vernal equinox* glyphs,[16] and the inverted jug held by Goddess O, an opinion also ad-

[15] These tribes were identified by name, including among others, the Cakchiquel, a Guatemalan group related to the Quiché (Recinos 1950: pp. 170–171).

[16] This is precisely the glyph to be expected on a picture dealing with the end of a world age.

vanced by Thompson (1972: pp. 88–89). Above the illustration, both the sky glyph (T561; *caan*) and the earth glyph (T526:251; *cab*) are prefixed with the glyph of the color black (T95; *ek*). Thompson identifies the squatting black deity, menacingly carrying spears, as *Hozanek*, the black *Bacab* who, along with his brothers, was actively involved in the destruction of the world by flood (as related by Landa and the *Chumayel*).

Purely mythological data pertaining to the creation or destruction of the world included in a quasi-historical migration account is potentially instructive. While no mention of a flood is made in the *Popol Vuh*, it is related: "damp and muddy was the surface of the earth, before the sun came up . . ."; and at the long-awaited sunrise, "instantly the surface of the earth was dried by the sun" (Recinos 1950: pp. 187–188).[17] I thus believe that these migration accounts can doubtless be ascribed to a time which engendered many myths surrounding the destruction and subsequent recreation of the world or, most apropos, the transition of world ages. The concept that at the beginning of each world age a new "sun" appears in the sky is corroborated in the following statement:

> . . . then the sun rose . . . It showed itself when *it was born* and remained fixed [in the sky] like a mirror. Certainly, *it was not the same sun* which we see, it is said in their old tales (Recinos 1950: p. 188; italics mine).

The similarity to Mexican concepts pertaining to the end of a world age is striking.

In looking for iconographic evidence related to the close of a later world age, we might expect to see the repetition of certain concepts developed on the earlier horizon, namely, the melding of features of the zodiacal beings involved.[18] Here again, the jaguar is the key figure whose features meld with those of the black spotted dog. A few pages back the diagnostic features of the black spotted dog were delineated; here we follow suit with those of the jaguar[19]:

1. Spots: the body of the jaguar is more or less covered with spots from head to tail; most often those running along the tail, the back, and the top of the head are indicated by rectangular, black brush strokes; the remainder are indicated by smaller dots or circles; the jaguar on Dresden 8a is a very artistic rendering in which the major spots are ovoid but conform to the head to tail arrangement which I consider characteristic.
2. Ears: rounded, usually with pointed tip (corresponding to the tuft of hair on the ear), and often including a spiral element at the base.
3. Tail: always with *smooth* outline and, as delineated above, carrying a line of spots.
4. Mouth: prominent fangs often depicted, occasionally with a tongue lolling from the corner of the mouth.

Comparing the scheme above (jaguar) to that of table 14 (black spotted dog) we find the respective attributes of both animals in striking juxtaposition on Madrid 30b. Although not exhibiting the artistic refinement of the Dresden Codex, I consider the jaguar and the black spotted dog on Madrid 30b the archetypes of their respective species (fig. 20).

However, there are several examples of animals which could be either canine or feline but whose characteristics seem to cross the line between the respective classifications "jaguar" and "black spotted dog." Following Thompson's terminology, I will refer to these as possible members of the "jog" family:

1. Madrid 12b: the trussed animal on this page appears to be a jaguar at first glance; the ears are not pointed (a feature more often omitted in the Madrid Codex), but neither are they cleft; the tail is smooth and prominent fangs are indicated; however, the two major spots (on the shoulder and lower back) are round and surrounded by an aureole of smaller black spots[20] exactly like our archetypal black spotted dog.
2. Madrid 25d: the ears of this creature seem to be jaguar; there is a fang at the front of the mouth, and a tongue lolls from the corner; the spots, however, are round and instead of an aureole, are surrounded by a thin black line[21]; parallel strokes on the body seem more indicative of hair than additional spots; unfortunately, the tail was not drawn.
3. Madrid 35b: the ears of this beast are definitely cleft; the front teeth (fangs ?) are very prominent and the tongue hangs from the corner of the mouth; only the head bears black markings which appear to be a mixture; the eye is surrounded by a u-shaped mark; the tip of the nose is black; on the forehead and back of the head are black spots with aureoles; and behind the corner of the mouth is a vertical rectangular black stroke; the rest of the body is covered with short parallel strokes which seem to indicate hair (see above).
4. Madrid 36a: this quadruped hangs from a celestial band carrying a torch in each paw and another in a smooth, seemingly prehensile tail draped over the band; the ears may be cleft but this is indicated by a line of dots, not

[17] I believe that several elements in the migration account of the *Popol Vuh* were borrowed from (or confused with) those stemming from the myths of destruction at the close of a prior world age. *Gucumatz* (*Quetzalcoatl*, the feathered serpent, the god of Venus as the morning star), who plays a prominent role as the creator, is described as covered with "green and blue feathers" and is associated with the rattlesnake: as Kelley (1976: p. 47) notes, the rattlesnake on Paris 24 has "two heads facing in opposite directions, which is immediately reminiscent of the so-called Venus monster"; this in turn is reminiscent of the Rattlesnake age discussed earlier. Significantly, *Quetzalcoatl* the creator (*Gucumatz*) is not confused with the historical figure *Kukulcan* (lord *Nacxit*, lord of the east from whom the Quiché later received the "investiture of the kingdom"); the names are kept scrupulously separate in the *Popol Vuh*.

[18] The Olmec exerted a profound influence on Formative cultures throughout Mesoamerica, particularly the Izapan and pre-Classic Maya.

[19] The proveniences of all unquestionable jaguars in the codices are as follows: Dresden 8a, 26a; Madrid 28a, 28b, 30b, 40c, 41a, 43b; Paris 11, 19, 20.

[20] Half the examples in table 14 have this feature.

[21] This rare feature appears also on Madrid 27c, 88c, and 91d; on Madrid 91d it complements the aureole, and thus appears to be a variant; it has been lumped accordingly in table 14.

Note: with the exception of the pointed ears of the jaguar, absent in four of six examples from the Madrid Codex, both creatures display all the respective attributes delineated above and in table 14.

FIG. 20. Archetypal Jaguar and Black Spotted Dog.

the usual method; the head bears an Akbal infix above the eye but the body is devoid of spots.

I think this last example is a dog based on comparison to a definite dog on Dresden 39a, part of the same almanac. Here the dog also carries torches, and the elements of the dog glyph appear, although in reversed order, in the second glyph block (T568.559; see table 14); and both animals appear to be drawn with genitals. Also, the Akbal infix of our example on Dresden 36a may well represent the black spot above the eye (four examples from table 14 have but one black spot, at the eye). Most interestingly, however, the glyph of the jog (T757), also with Akbal infix (T224), appears in the third glyph block on Dresden 36a, a combination read "affliction of war" by Thompson (1972: p. 95). This is, however, the role of the jaguar: the spreading of the jaguar skin in the marketplace was symbolic of war or disaster (Roys 1967: pp. 111, 154). Thus, we have here a *dog* who seems to be cast in the role of the *jaguar* and represented by the *jog* glyph.

Another concept which may relate to the jog appears in the Dresden Venus table. On Dresden 47f appears what Thompson (1972: p. 68) calls a jaguar or puma with a spear traversing his body. The glyph of the jaguar (T800) does not appear in the glyph blocks directly above the picture in section f; it has always been assumed that the jaguar glyph above section e, the picture of *Lahun Chan*, pertains to the "jaguar" below. The passage in which the jaguar glyph appears (section e, glyph blocks 3–6) can be read: "*Lahun Chan*, great star (Venus), great jaguar, his victim." Anomalously, the "jaguar" in section f bears no spots, but the fourth glyph block (T172.168:559) is read by Thompson (1972: p. 68) "woe to *ah*:559, the jaguar man, the warrior ??." However, the main element of this glyph block (T559) is also the main element in the glyph of the dog, representing the skeletal ribs appearing on the dogs on Madrid 36b and 37a: on Madrid 37a the dog compound, with T130 affixed (T168:**559**.130), is seen in the last glyph block; the "ribs" in the glyph and on the dog are seemingly identical.[22] The following observation may clarify the situation on Dresden 47f.

Thompson (1972: pp. 15–16) estimates the compilation of the Dresden Codex between A.D. 1200 and 1250. For about ninety years prior to the latter date the Eb group of Venus heliacal risings (see fig. 8, p. 32) had occupied the Jaguar, but immediately thereafter took up residence in the Black Spotted Dog constellation. For example, the VHR of 11.1.4.2.12 1 Eb 0 Yax[23] (Mar. 26, 1248; J.D. 2,176,975) lay within 0.5 degree of the Black Spotted Dog/Jaguar boundary. This was the last of the Eb series to inhabit the Jaguar constellation, but it is the Kan series which is associated with the "jaguar" on Dresden 47f. However, the Kan series was the previous occupant of the Jaguar constellation having moved on into the Black Spotted Dog at around A.D. 1040 leaving the Jaguar vacant for about 120 years; the Kan series occupied the Jaguar roughly between A.D. 950 and 1040. Thus, if the spearing of the jaguar was determined by the occurrence of a VHR in the Jaguar constellation,[24] the spearing data in the Venus table are only valid for the time between A.D. 950 and 1040.[25] The existing

[22] I think a good case can be made that T168:559 is associated with the dog rather than the jaguar. The main element appears also in the glyph of the turkey (T528.559), and Kelley (1976: p. 171) provides evidence that this, as well as the dog glyph (T559.568) are to be read phonetically, *cutz* and *tzul*, respectively. The sacrifice glyph (T568), whether phonetic or indicative of the dog's frequent role as a sacrifice, does not damage the argument that T559 alone is associated with the dog: T559 is the symbolic form of the month Kankin which is undoubtedly associated with the dog (Thompson 1950: pp. 113–114). In the inscriptions Kankin has a circular cross-hatched infix (a black spot) rather than the "ribs" seen in the codices. Thompson (1972: p. 64, footnote), with tortuous logic, bases his tentative translation of T168:559 as "jaguar man" mainly on a rare form of Kankin in the inscriptions. Despite the probable continuity of concepts related to Kankin, I think the post-Classic version of the codices should take precedence when reading a passage in the Dresden Codex.

[23] This date lies exactly thirteen Venus rounds (13 × **584** = 7,592 days) forward of the 1 Ahau 13 Mac *lub* (11.0.3.1.0) which plays a large role in the proposed Venus table corrective scheme (see Thompson 1972: p. 63).

[24] I previously stated (chapter 2, p. 33) that the zodiacal position of a Venus heliacal rising may determine who was to be speared in each of the five "spearing episodes" on Dresden 46–50.

[25] This time span agrees well with the Toltec presence in Yucatan and the concomitant Mexican influences on a codex using *lubs* of Classic origin: the Dresden Codex is most probably of central Yucatan provenience (Thompson 1972: p. 16), and the Toltec conquest of Chichen Itzá occurred in *katun* 8 Ahau, A.D. 928–948 (see chapter 4 for early post-Classic chronology).

edition of the Dresden Codex must then have been copied from an earlier manuscript with the following implications: 1) the table was not adjusted to make the Eb series (rather than the Kan series) accord with the spearing of the jaguar; 2) the omission of the jaguar's spots was intentional and designed to hedge upon the issue of Venus heliacal risings near the Black Spotted Dog/Jaguar boundary.[26] The latter inference is, of course, the most germane to the present argument.

I have documented the above examples to show that the "dog in jaguar's clothing" on Paris 23 is not an isolated example. Even disregarding the Olmec evidence, the only other Maya representation of the melding of jaguar features occurs with the snake: on Madrid 54a appears the head of a jaguar attached to the body of a snake bearing Caban symbols (compare fig. 18); and the rare glyph T762, confined to Palenque, appears to combine the ear and spots of the jaguar with the mouth and serrated teeth seen on the glyph of the Chicchan snake (T764). In my view, melding is an iconographic manifestation of the grand arcanum attending the passage of world ages.

Conclusion

This chapter dealt with the Mesoamerican concept of world ages and some aspects of the iconography to which I believe it is bound. By examining Mexican accounts in the *Leyenda de los Soles,* the *Anales de Cauahtitlán,* and other sources, it was shown that a strong tradition of world ages, each ending in general destruction, existed, which has come down to us, unfortunately, in seriously distorted form. Using data derived from the Paris Codex, I have attempted to bring aspects of the Maya tradition of world ages into proper focus. The discussion centered on the jaguar, who plays the key role.

As derived from the Paris table, the vernal equinox passed from the Rattlesnake into the Jaguar constellation in the late twelfth century B.C., heralding the end of a world age. In looking for evidence of the recording of this event, it was postulated that the iconography of the time would exhibit melding of features of the constellation-beings who took part in this zodiacal transition. Arguments were advanced that the Olmec were-jaguar exhibits this combinatory iconography and is thus related to the recording of the end of a world age.

In a sense, the hypothesis being advanced in part III has already passed one critical test: the missing being on Paris 24 adjacent to the rattlesnake was postulated to be the jaguar on the basis of Olmec iconography, and proved in arguments in no way connected to the Olmec (see chapter 1); in other words, combinatory iconography involving two constellation-beings was the initial hypothetical premise and, since but one of these beings appears in the Paris zodiac, a Jaguar constellation was predicted. In this regard, the hypothesis has acted as a double-edged sword.

A second zodiacal transition in the latter half of the ninth century A.D. was postulated. Elements from the migration accounts of the *Popol Vuh* provided evidence that this period and the succeeding century were connected to a mythical creation and the birth of a new "sun" in the collective mind of the Quiché Maya. The inclusion of mythological elements in a quasi-historical record was enlightening in terms of this hypothesis; most significantly, the mythological and historical roles of *Quetzalcoatl* were delivered from confusion by the use of definitive names, *Gucumatz* and lord *Nacxit*, respectively.

Discussion of the iconography on this horizon centered upon what I have termed "the dog in jaguar's clothing," representing the zodiacal transition between the Jaguar and the Black Spotted Dog. The bushy tail proved to be a useful attribute, enabling us to distinguish the black spotted dog; full discussion of the Black Spotted Dog constellation was referred to appendix D. In order to determine that the "dog in jaguar's clothing" is not an isolated example, the concept of the jog was developed. Several animals depicted in the codices were discussed which could not be placed exclusively within one of the classificatory schemes developed for the jaguar and the black spotted dog, and indeed present a mixture of features.

The jaguar on Dresden 47f in association with the "rib" element of the dog glyph is a patent example: the proposed deliberate deletion of jaguar attributes is seen as a response to ambiguous celestial context; that is, a position between two constellations, the Jaguar and the Black Spotted Dog. Thus, the presence of jaguar attributes on the canine being on Paris 23 acquires meaning when seen in the light of combinatory iconography attending celestial transition, in this case, that of a world age. Moving the discussion to the inscriptions, the iconography of the Jaguar/Black Spotted Dog transition will be expanded in the next chapter.

6. THE COLLAPSE: RHYME AND REASON

In this chapter we continue our discussion of iconography, in particular, evidence for the celebration of the end of the Jaguar age. Since this age came to a close during the Terminal Classic period, our discussion will center upon some examples of the Maya inscriptions. The argument will proceed primarily through analysis of the iconography and hieroglyphics. This is not to deny the role of archaeological investigation in providing information on the Terminal Classic period and the collapse of Classic Maya civilization. It is archaeological reconnaissance which has supplied the bulk of the data and shown that depopulation of the central area followed close upon the

[26] This also implies that the compilation of the Dresden Codex occurred immediately subsequent to the penultimate *lub*, 11.0.3.1.0 1 Ahau 13 Mac, and that the *lub* at 11.5.2.0.0 1 Ahau 3 Xul was a projected *lub*, possibly the base of the next Venus great cycle.

heels of the demise of the stela cult. Analogously however, the reasons for the decline of Rome were not turned up under the archaeologist's spade but in the pages of historical account.

Due to conflicting interpretations of the same data, and the difficulties of distinguishing between cause and effect, the evaluation of archaeological data pertaining to the Maya collapse must be subjugated to an organizing principle which is not wholly dependent upon archaeological theory. This principle, it is hoped, can be extracted from the corpus of writing of Maya civilization which, though not so extensive nor readily decipherable, is where I believe the answer is to be found. Our incomplete understanding of Maya hieroglyphic writing[1] necessitates a theoretical approach based heavily on iconography, the traditional mainstay of glyphic research. In line with these precepts I will discuss only one example from the archaeological record which, although not "typical" of the course of events, does illustrate some general trends related to the collapse.

Tikal, in the heart of the central area, was one of the greatest Maya centers. The last stela erected at Tikal, Stela 11, was dedicated at 10.2.0.0.0 (W. Coe 1962). Before the erection of this monument, the stela cult had gone into decline at Tikal, and most other major Maya centers, at around 10.0.0.0.0.[2] The decline of the stela cult seems to go hand-in-hand with degeneration of the Classic polychrome tradition, a major pottery ware for elite and ceremonial use (Rands 1973: p. 57). At Tikal, the Late Classic Imix complex began to be replaced around 10.0.0.0.0 by the Eznab complex which appears to be an impoverished stylistic continuation of Imix (Culbert 1973: p. 63). The Eznab occupants themselves seem to have been culturally impoverished, and show population diminution by as much as ninety per cent (Culbert 1973: pp. 69–70). Also of note, elite class activity seems to have gone into slow decline rather than showing an abrupt end.[3]

The archaeological record at Tikal, although by no means identical in detail to that of other sites, appears to exhibit several general trends: 1) decline of craftsmanship (stela cult, polychrome pottery, etc.) related to high status activities; 2) rapid and progressive population decline. We may infer from these data that within a period of some fifty to sixty years, between 10.0.0.0.0 and 10.3.0.0.0, the abandonment of Tikal, and the central area in general, was well under way.

Returning to the concept of world ages, we note that the cast of the Maya mentality is inextricably involved. The Maya were obsessed with cycles, and everything from astronomy to history was conceived of in these terms. If a certain *katun* had been the time of a great misfortune or catastrophe, a repetition of the same type of event might be expected when a *katun* bearing the same coefficient came round again. This philosophy is poignantly displayed in the *katun* prophecies of the *Chumayel*. For example, *katun* 8 Ahau always seemed to spell trouble for the Itzá; in the chronicles (Roys 1967) this group met with similar hardships at thirteen-*katun* intervals:

Katun 8 Ahau, A.D. 672–692:	forced to abandon Chichen Itzá; subsequently settled at Chakanputun.
Katun 8 Ahau, A.D. 928–948:	forced to abandon Chakanputun; subsequently reentered Chichen Itzá.
Katun 8 Ahau, A.D. 1184–1204:	Chichen Itzá conquered by Hunac Ceel; subsequently seized Mayapan.
Katun 8 Ahau, A.D. 1441–1461:	Mayapan destroyed.

The ultimate irony, as noted by Roys (1967: p.136), is that the Itzá were finally conquered in their last retreat, the island stronghold of Tayasal in Lake Peten Itzá, at the close of the seventeenth century, again in a *katun* 8 Ahau.

We have inferred the end of the Jaguar age at 10.1.12.14.8 in the middle of a *katun* 3 Ahau. In the *Chumayel* are suggestive references to events occurring in a *katun* 3 Ahau; In chapter X, "The Creation of the World," it is related:

> The face of the sun was snatched away, taken from earth . . . At that time there was the riddle for the rulers . . . Then there came great misery, when it came about that the sun in *katun* 3 Ahau was moved from its place for three months. After three (heaps of) years[4] it will come back into place in *katun* 3 Ahau (Roys 1967: p. 103).[5]

[1] We will not be directly concerned here with the extent of phoneticism in the Maya script. As an analogy, Egyptian writing developed from a pictographic system at its earliest inception, the hieroglyphics proper, proscribed for profane use in the Old Kingdom, into a more eclectic script (hieratic) in which phonetic elements coupled with determinitives (pictographs used in rebus or ideographic fashion), to the final cursive script (demotic) in which the individual characters lost all resemblance to the original hieroglyphics. It must also be remembered that all three forms coexisted at the close of the New Kingdom. I think we are viewing the middle stage of such a progression in the Maya script from its earliest sporadic appearance in the pre-Classic down to the Spanish conquest. I am thus more inclined to accept well-documented cases of apparent phoneticism in the codices but would have reservations regarding the inscriptions, the earlier the stronger.

[2] Only five Maya centers commemorated the *katun* ending on 10.3.0.0.0: Uaxactun, Xultun, Xamantun (La Muñeca), Seibal and Jimbal; a text from Toniná, in the far west of Maya territory, lists 10.4.0.0.0 (see Marcus 1976).

[3] These data seem capable of supporting any number of hypotheses; the reader is referred to the literature on the subject, particularly Culbert (1973).

[4] Roys, who translates the phrase *ox tuc ti hab* literally as "three heaps of years," admits to difficulties in the translation of this sentence.

[5] It seems obvious from the construction of the text that *katun* 3 Ahau was not related to the initial creation (see Roys 1967: pp. 101–103); *katun* 4 Ahau (ending on 13.0.0.0.0 4 Ahau 8 Cumku)

"Three heaps of years" is probably an indefinitely long period of time and may have something in common with the phrase *oxlahun pic u katunil* translated by Roys (1967: p. 114) "thirteen orders of *katuns*" or alternatively "thirteen times eight thousand *katuns*."[6] Here is a possible reference to time measured in thirteen-*katun* cycles, as in the Maya reckoning of the precession.

Also in the preceding excerpt, the sentence "at that time there was the riddle for the rulers" refers to chapter IX, "The Interrogation of the Chiefs" (Roys 1967: p. 103, footnote). The "riddle" is also concerned with *katun* 3 Ahau:

> This *katun* today is *katun* 3 Ahau. The time has come for the end of its rule and reign. . . . This is the examination which takes place in the *katun* which ends today. The time has arrived for examining the knowledge of the chiefs of the towns. . . . This is the first question which will be asked of them: he shall ask them for his food "Bring the sun." This is the word of the head-chief to them; thus it is said to the chiefs. "Bring the sun, ⟨my⟩ son, bear it on the palm of your hand to my plate." A lance is planted, a lofty cross, in the middle of its heart. A green jaguar is seated over the sun to drink its blood[7] (Roys 1967: p. 89).

The "green jaguar" is reminiscent of the jaguar grasping the *sun at the vernal equinox* with which the color green is strongly associated (see chapter 1). It is also reminiscent of the Mexican concept that an eclipse was caused by a jaguar eating the sun (Seler 1902: p. 172).

Christian symbolism has left its mark on this ancient rite,[8] and mingles with allegorical elements of the sacrificial meal: the sun is described as "a very large fried egg"; the "lance" and the "lofty cross" planted in its heart are the Christian benediction; and the "green jaguar"[9] is a "green chili-pepper" (Roys 1967: pp. 89–90). However, the Maya may have been forced to resort to pious panjandrum in order to outwit the Spanish clergy, ever watchful for signs of an heretical lapse back to the old ways. That the Maya were capable deceivers in religious matters is reflected in the almost paranoid statement of Padre Avendaño, who proselytized the Itzá in 1696:

> . . . I have made a treatise on these old accounts (*katun* prophecies) . . . so that they may be evident to all . . . for if we do not know them, I affirm that the Indians can betray us face to face (Roys 1967: p. 184).

All in all, the fact that the chiefs were questioned on the anniversary of a *katun* 3 Ahau which is cross-referenced to a creation occurring in a *katun* 3 Ahau is highly suggestive.

We come now to examine one of the stelae dated to the *katun* 3 Ahau to which I believe the above narrative is related. Before beginning, I would like to mention a few of the limitations imposed upon the following analysis. In the midst of decline the stela cult produced very few stelae; those dated to the *katun* 3 Ahau ending on 10.2.0.0.0 are rare, as are those of the preceding *katun* and, especially, the following *katun*, whose terminal date was the last ever recorded in the central area. Exacerbating the difficulties is the fact that the full initial series went out of style in inscriptions of the Late Classic. Furthermore, some Terminal Classic stelae are so badly eroded that the only recognizable glyphs to be found are, if one is lucky, a calendar round date. Thus, weathering and the possibility of misinterpreted calendar round dates may have further reduced our repertoire of Terminal Classic stelae.

Stela 10 at Xultun bears a recognizable full initial series of 10.3.0.0.0 1 Ahau 3 Yaxkin on its right side. The front of Stela 10 (fig. 21) bears a calendar round date 6 Caban 10 Zip followed by the distance number 1.6.10.3. The long count position of this calendar round date is reconstructed through the distance number leading to the dedicatory date of this stela:

(10.1.13. 7.17)	6 Caban 10 Zip
+ 1. 6.10. 3	
10.3. 0. 0. 0	1 Ahau 3 Yaxkin (dedicatory date)

On Stela 10 is a large *en face* human figure, with head turned to the right, standing upon six Caban glyphs which probably represent the earth as well as the date 6 Caban 10 Zip. The figure wears an elaborate headdress and paraphernalia, including a collar with three Ahau(?) glyphs surrounded by dotted circles, reminiscent of a glyph on Lintel 3 of Temple IV at Tikal.[10] In his outstretched right hand sits an almost kittenlike jaguar and in the crook of his left arm

is logically connected with this creation (see Thompson 1950: pp. 63–64). However, a curious reference to *katun* 11 Ahau is made at the beginning of *Chumayel* chapter X: "This was after the creation of the world had been completed, but they did not know it was about to occur" (Roys 1967: p. 99). On Paris 23 the green *modifying coefficient* 11 standing above the column containing the day 4 Ahau may relate to a symbolic connection between *katuns* 4 Ahau and 11 Ahau.

[6] The chapter in which this appears, "The Song of the Itzá," also begins with a creation account, including Adam and Eve, and is unfortunately infiltrated (patronizingly ?) with Christian concepts.

[7] Last sentence: *ti ix culan yax balam yokol kin ukic u kikile.*

[8] That the chiefs were questioned on some extremely important ancient ritual knowledge is borne out by the extreme penalties for ignorance in these matters (Roys 1967: p. 92). These examinations were part of a firmly established tradition: occult knowledge was known as the "language of Zuyua" (Roys 1967: p. 192).

[9] Despite the obvious but patronizing references to Christian doctrine, the original color symbolism appears to have been retained throughout the *Chumayel*. Roys (1967: p. 171) notes that in modern ceremonies the red, white, and black wind-spirits (*Pauahtuns*) are identified with St. Dominic, St. Gabriel, and St. James, respectively; only the yellow *Pauahtun* bears a Maya name. In the *Chumayel* itself ("Ritual of the Angels"), other names are given, and the yellow *Pauahtun* is identified with Moses (Roys 1967: p. 113).

[10] The Ahau glyph at Tikal, with dotted circle (*mol*) and star superfix, is nested in the headdress of an elaborate rendition of the Moan Bird, the constellation in which an eclipse of the sun recorded on Lintel 3 occurred (see chapter 4, pp. 58–59).

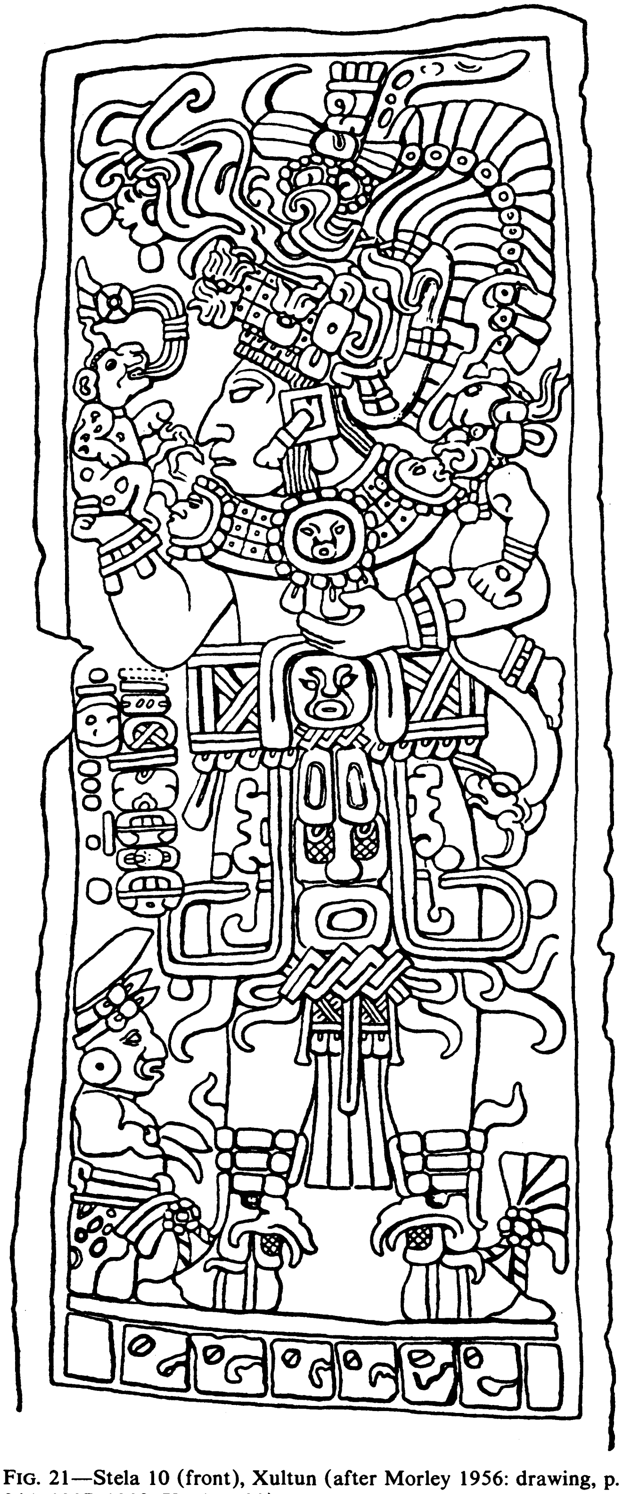

FIG. 21—Stela 10 (front), Xultun (after Morley 1956: drawing, p. 346; 1937–1938: V, plate 80).

he holds what Morley (1937–1938) terms a "manikin figure." At the right foot of the figure, beneath the distance number, stands a dwarf. The iconographic details will be discussed one at a time further on, but for the present, we should note one important feature: there is absolutely nothing in the details of this sculpture to suggest a political or military theme.[11] To the contrary, it is an astronomical event on 6 Caban 10 Zip which is of immediate importance.

On 10.1.13.7.17 6 Caban 10 Zip occurred the solar eclipse of Feb. 21, 863 (J.D. 2,036,320). The recording of a solar eclipse date is quite impressive but there are two factors which appear to make the actual eclipse subordinate to a grander scheme: 1) the eclipse occurred 23 days before the vernal equinox; 2) the path of totality of this annular-total[12] eclipse actually crossed the bulge of South America far to the south of Maya territory.

At midday the path of totality lay at longitude 89°W, latitude 34°S (Oppolzer 1887); we may thus infer that the northern limits of this eclipse (+50° latitude from path of totality) lay around 16°N latitude. Allowing for slight errors in Oppolzer's remarkably accurate data, this figure is merely an approximation. However, we can assuredly conclude that the eclipse was visible in at least the southern part of Maya territory (environs of Copan and Quirigua), but it is doubtful whether this eclipse was visible at Xultun (lat. 17°30:5N; long.89°24:5W).[13] The most poignant observation is that this eclipse, in any part of Maya territory, was hardly spectacular and no more than a grazing of the sun of very short duration.

The question is then: why did the rulers of Xultun undertake the erection of a stela to commemorate "the eclipse that never was"? It is significant that the day of this eclipse was connected to the date 10.3.0.0.0, the very last date commemorated in the central area. However, in looking at, for example, the data from Santa Elena Poco Uinic and Tikal (see chapter 4), we note that the Maya chose to expend the energy and funds for recording eclipses only if they were major eclipses[14]; and this at a time when the fabric of Maya society was whole, not in the throes of coming apart at the seams.

[11] Although in a subordinate position on this stela, the dwarf does not appear to be a captive (usually kneeling or prostrate) of, nor doing obeisance to the main figure, who seems rather to be directing his gaze at the jaguar.

[12] This type of eclipse occurs when the apex of the moon's shadow reaches the earth at a point not far above sea level; it is thus "annular" in lowland areas, but may be "total" in highland areas, assuming, of course, that the position of the observer lies along the path of totality.

[13] Barring direct observation we may undoubtedly assume that the priests of Xultun received word of the eclipse from their southern neighbors.

[14] We should not underestimate the effort involved in erecting stelae: some of the smaller sites were only able to divert enough finances or manpower to commemorate the end of a *katun*; larger sites could often afford the luxury of commemorating the *lahuntun* or *hotun* (half and quarter *katun*, respectively). The Maya had good reason to predict all possible eclipse dates as in the Dresden eclipse table, and to record each and every eclipse at the time of occurrence, but erecting a commemorative stela is another matter.

Santa Elena Poco Uinic was not a large site but the local ruler obviously considered the total eclipse of sufficient importance to erect a stela. At Tikal, the date of the near-total eclipse was inscribed on lintels concerned with the dedication of an entire temple, which doubtless had political overtones.[15] The erection of a magnificent stela commemorating a nonexistent or, at best, insignificant eclipse in the absence of political motifs is inexplicable unless the event is tied to an even greater event in which the significance of the eclipse itself is merely symbolic. This brings us to the iconography of Stela 10.

The dwarf appearing on this stela is of unusual interest. That he is not a child or an adult drawn small is indicated by his disproportionately short limbs and relatively large head. He is either presenting both hands before him palms up or is holding some object in his right hand, and wears a conical cap (or coiffure), a large round earplug, and what may be a jaguar skin, judging by the presence of spots. Quoting from Juan de Córdova's *Arte del Idioma Zapoteca*, Seler provides a connection between dwarfs and solar eclipses:

> When a solar eclipse occurred so they said, that the world may come to an end, and that the Sun God would demand war, and that they would kill each other, he, who would be able to do this first. Of the same they said, that the dwarfs were created by the sun, and that at the time (of the solar eclipse) the Sun God would demand the dwarfs as his property. And that is why, wherever there were dwarfs or midgets in a house, they were seized and killed, and they hid themselves in order not to be killed, so that at this time a few of them escaped their fate (Seler 1902: p. 183).

The concept of dwarfs in connection with the sun is immediately reminiscent of the *Bacabs*. The *Bacabs*, bearers of the sky, appear to be represented by the small atlantean figures on several bas-reliefs at Chichen Itzá (Tozzer 1941: p. 137; Roys 1967: p. 171).[16] In *The Ritual of the Bacabs* (Roys 1965: p. 143) one of the diseases referred to, *ac uinik ik*, can be translated "dwarf wind" or "turtle-man wind"; Roys relates this to the Turtle constellation[17] and the *Bacab* who wears a turtle shell (i.e., on Dresden 37a).[18] The attributes of the *Bacabs* seem to merge with those of several other deities including the *Chacs* (rain gods),[19] the *Pauahs* (primarily wind gods; Roys 1967: p. 137) and the *Ah Muzencabs* (bee gods; Thompson 1970a: p. 281; 1950: p. 85).[20] These connections are of interest here because it is related in "The Creation of the World" (chapter x of the *Chumayel*) that the *Bacabs* brought about the destruction of the world by flood (Roys 1967: pp. 99–100).

As a final link to our stela, the *Bacab* on Dresden 12c (probably an impersonator here; the *Bacab* glyph appears in the third glyph block) holds a *kin* glyph with dotted outline (to be discussed), and wears a large circular earplug and a forward-tilted conical cap or coiffeur. The cap of the dwarf is thicker and not as long but, considering spacial limitations, bears a distinct resemblance; the earplug is evidently identical. The round, nonornate earplug is prevalent in representations of the *Bacabs* in the Dresden Codex; and this particular headpiece is extremely rare, if not unique in the codices.[21]

Tying the preceding arguments together, I would not hesitate to designate the dwarf on Stela 10 as one of the *Bacabs*. The connection of a *Bacab* with a solar eclipse at the vernal equinox makes excellent sense here (see chapter 1).

The jaguar on Stela 10 which Morley (1937–1938: **I**, p. 417) terms "a small cat, a flower emerging from its mouth," has obvious spots, and a rather immature appearance. It is my contention that the jaguar on Stela 10 exhibits the combined attributes of birth and death. The "flower" emerging from the jaguar's mouth is actually composed of two elements which will be discussed separately before being brought together; in order to eliminate certain concepts with which the "flower" is not associated necessitates an investigation of things which issue from the mouth.

In the Mexican codices a small coil is placed before the mouth to indicate "speech" or "ruler" (Clark 1938: **I**, p. 6).[22] These are undoubtedly cognates of the

[15] Part of the inscription on Lintel 3 is undoubtedly of a political nature (Brack-Bernson 1975). Connecting an individual (or dynasty) to a fearful event implies some degree of control over it, and by extension, worthiness as a ruler in the eyes of his awe-inspired subjects.

[16] The concept of the *Bacabs* as dwarfs may go back to the Olmec: on an altar from Potrero Nuevo two dwarfs (atlantean figures) appear to support a representation of the sky (Bernal 1969: plate 15).

[17] Many of the "winds" (diseases) referred to in the incantations of *The Ritual of the Bacabs* are said to originate in constellations; for example, "traveller's seizure" was supposedly "born" in the *tzab*, the tail of the Rattlesnake (Roys 1965: p. 104). The word *tancaz*, "seizure," is also the name of the Milky Way.

[18] In a Mopan Maya creation myth, the sun turns into a turtle to protect himself from a thunderbolt hurled by *Chac* (Thompson 1970a: p. 346). This may be a reference to the primordial world age, Turtle sun, to paraphrase the Mexican legend.

[19] *Noho Chac Yum* (Great Father Chac), head of the Lacandón pantheon, was one of four brothers associated with the cardinal points who was imagined to be sick at the time of solar eclipses (Tozzer 1941: p. 138); Landa relates that the *Bacabs* were four brothers created by God when he created the world, who were placed at its four corners to hold up the sky so that it should not fall (Tozzer 1941). The father of *Noho Chac Yum* was called *Chac Nicté; nicté* is the Maya name of the plumeria flower, particularly associated with the sun (to be discussed).

[20] The *Bacabs* were closely associated with bees, and were the patrons of beekeepers; the root *cab* can mean "honey," "earth," or "beehive" (Roys 1967: pp. 64, 171), and the name of one of the *Bacabs*, *Hobnil*, is probably derived from *hobonil*, "of the beehive" (Thompson 1970a: p. 277).

[21] The goddess on Dresden 36b has a similar headpiece which, however, terminates in the head of a bird with a fish in its beak.

[22] For example, in Codex Mendoza (Clark 1938) this speech scroll (coil) is most often blue, and in Codex Magliabecchi (Nuttall 1903) also appears in red, green, and yellow.

question-mark-shaped scrolls issuing from the mouth of the black spotted dog on Dresden 13c and 21b[23]; these same scrolls also appear issuing from the mouths of head glyphs of animals or personages on Dresden 57b, 68b, and Paris 5.

Another variety of object (a line with feathered edges) issues from the mouth of a jaguar on Madrid 40c; it is not a tongue since this organ lolls from the corner of the mouth. This object appears in revealing context elsewhere in the Madrid Codex: on Madrid 28c three examples appear between two wooden poles, all of which rests upon a Caban glyph; also present is what appears to be a worm whose head glyph is in the fourth glyph block; on Madrid 75 (bottom right, inverted) one example appears between two wooden poles emerging from a Kan glyph; on Madrid 86b one example appears beside a wooden pole above an unidentifiable glyph held by God E (corn god).[24] The emergence of this object from the Caban glyph (the earth), and the Kan glyph (corn) infer an association with plants of the milpa; the "worm" on Madrid 28c, whose glyph is preceded by a death glyph, may indicate a parasite which damages the crops. The appearance of these objects between two wooden poles may be indicative of beans, which were often interplanted among the corn stalks around which they wound themselves.[25] I am thus inclined to identify this as a sprout of corn or beans, which together grow in the milpa.[26]

The "flower" issuing from the mouth of the jaguar on Stela 10 has no demonstrable connection with any of the above objects. The "stem" of this "flower" appears rather to share the same derivation as the wavy lines used to depict water or wind in the codices. On Madrid 32b, lines issuing from the mouth of a goddess brush across the body of a human figure suspended upside down. The goddess bears the characteristic mouth of the Mexican wind god *Eecatl* (an aspect of *Quetzalcoatl*), and raises aloft an Ik glyph in her right hand. Aside from its function as a day name, *ik* has several homonyms in the Maya language including "wind," "life," "soul" and "spirit."[27] The goddess is evidently in the act of breathing life into (or extracting it from) the inverted dead figure; the figure is obviously dead, indicated by its limp posture, closed eye and the presence of a death glyph[28] below, at the right knee of the goddess (opposite a second Ik glyph at her left foot). The closed eye appears to be a good indicator of death in this context (see footnote 28), and we note that the eye of the jaguar on Stela 10 is closing. Thus, I submit that we are witnessing the departure of the spirit or soul, the *ik*, from the jaguar's mouth in the form of the "breath of life."[29]

The preceding argument has concentrated on the "stem," but we may now draw the "flower" itself into the argument; Ik has a strong association with one particular flower: "In the *Kaua* divinatory list the winds are associated with Ik, and the tree connected with the day is the frangipani (the plumeria)" (Thompson 1950: p. 73). This relationship is especially significant because the sun is particularly associated with the plumeria, and flowers in general: *kin*, the symbol of the sun, is normally depicted as a four-petaled flower. However, as Thompson (1950: p. 142) suggests, an original association of the sun with the five-petaled plumeria was later changed to one with a four-petaled flower because four is the number of the sun god; evidence for the association of the sun with the flower and the plumeria is myriad.[30] Thus,

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[23] These scrolls probably convey the same meaning, "speech" (and "singing"?), as the small circles connected by dotted lines to the mouth and nose of the dog on Madrid 37a: this dog has his head tilted back (as the example above), and is playing a drum; these same marks are seen coming from the nose of the death god on Madrid 83c, 111c, 110b and 23d. Another object which issues only from the mouth of the death god is a "death eye" (like a balloon on a string) appearing on Dresden 10a, 11a, 12b, 15a and 15c.

[24] This object also appears in similar or noncontradictory context on Madrid 36b, 81c, 82c, 83c, 91c and 110c.

[25] Beans are members of the Leguminosae family which replenishes nitrogen absorbed from the soil by corn and other cultigens. Without being aware of the biochemistry involved, the Maya undoubtedly exploited the symbiotic relationship of corn and beans; in the diet also, corn and beans had adaptive advantages: beans are rich in the amino acid lysine in which corn is deficient.

[26] We may speculate that the glyph compound Caban:T156 represents the plant depicted on Madrid 28c being attacked by the death-dealing worm. T156 is the element appearing above the Kan glyph in the month sign Cumku, and on Madrid 75 the Kan glyph from which the plants grow is supported by an interlocking element which bears a strong resemblance to T156; as Thompson (1950: p. 117) notes, the name *Cumku* may signify the "god of the corn bin." Thus, a reading of "corn," "beans," or "milpa" may be appropriate here.

[27] Proskouriakoff (1963) has identified a compound which may denote death (of a ruler) in the inscriptions: the combination Ik (T503) with *al* (T23) subfix is proposed to read *ikal*, "spirit," signifying the departure of the spirit or soul.

[28] This glyph (T15.1047) undoubtedly functions in the capacity of a death glyph (perhaps the stylized head of a death god). The combination T15.736 (with or without additional affixes) accounts for 208 of 265 examples of T736 (death) listed by Thompson (1962: pp. 314–315), including countless occurrences as the "day Cimi in codices" lumped together in example 1. A characteristic feature of the variants of T736 is the "percentage" death symbol in place of the eye, or a closed eye with conspicuous downcast lashes. The latter is identical to the eye of the hanging figure on Madrid 32b, which therefore must be indicative of death. The juxtaposition of Ik and T15.1047 must be symbolic of the life and death dichotomy.

[29] In the strongly traditional burial rites of the Chorti Maya the corpse is placed upon a bier with the face upward to permit unobstructed exit of the soul (Girard 1969: p. 280). The mouth is obviously the portal of the soul at death, a concept shared by many cultures.

[30] The flower appended to the jaguar appears to be four-petaled, those above the instep of the main figure (one of which appears to merge with an object stemming from the waistband of the dwarfish *Bacab*) may have four or more petals. Whatever the number of petals, the flower is assuredly the symbol of the sun. *Xochitl*, "flower," was the day of the sun god among the Mexicans (Thompson 1950: p. 88); and in Codex Magliabecchi (Nuttall 1903: p. 9),

the solar significance of the flower appended to what I have termed the *ik*, the "breath of life," issuing from the jaguar's mouth on Stela 10 seems unquestionable; and solar symbolism on an eclipse date is highly appropriate here.

The death attributes of the jaguar appear to be unusually counterbalanced by a cordlike appendage issuing from the vicinity of the navel and terminating in an amorphous object. Judging by the rather immature appearance of the jaguar, it seems obvious that this appendage represents the umbilicus and the placenta. In the *Chumayel* (Roys 1967: p. 94) mention is made of the "smooth green thing . . . the placenta of the sky . . . shaped into thirteen layers." This immediately recalls the green cords on Paris 22 and the symbolic union of heaven and earth (see chapter 1). The jaguar as a constellation deity, and his associations with the earth, the sun, the vernal equinox, and eclipses, comes into sharp focus on this stela.

The birth attributes of the jaguar bring us to the "manikin figure" held in the crook of the left arm of the main figure on Stela 10. Birth as well as death are related to transition, being the major "transitions" in the life of an individual. Depiction of the newborn is traceable to the Olmec: "A favorite theme is that of a personage seated in a niche with a child in his arms . . . the larger figure always looks masculine" (Bernal 1969: p. 58). Here, the "child" is the baby were-jaguar with typical grotesque face; he is most often supported in the crook of the arm as displayed on Altar 5 at La Venta (see Bernal 1969: plate 13). The grotesque face of the "manikin figure" on Stela 10 and his position in the crook of the arm are at once reminiscent of the Olmec were-jaguar; it is now our task to determine what type of were-animal may be represented on this Terminal Classic stela.

The "manikin figure"[31] on Stela 10 bears circular crosshatched areas (indicating the color black) at the top of the head, the shoulder, and the back of the hand; his ear is rather large and divided by a horizontal cleft. Certainly our discussion of the attributes of the black spotted dog (see chapter 5) can serve us here to advantage. Thus, I propose that the "manikin figure" is actually an anthropomorphized Black Spotted Dog, the constellation in which the eclipse of the sun occurred.

Let us now summarize the iconographic manifestations of Stela 10 at Xultun; in the preceding discussion I have proposed the following:

1. The recording of a very minor solar eclipse (probably not even visible at Xultun) 23 days before the vernal equinox.
2. A *Bacab* appearing as a dwarf and having demonstrable connections with the sun, eclipses, and the vernal equinox.
3. A jaguar suffering symbolic death, and concurrently exhibiting birth attributes.
4. The *were-black spotted dog.*

Let us also summarize the data surrounding the zodiacal transition extracted from the Paris Codex:

1. The zodiacal transition fell "officially" on 10.1.12.14.8 11 Lamat 6 Yax, July 5–6, A.D. 862 (J.D. 2,036,091).
2. The vernal equinox immediately prior to the zodiacal transition was the *last* in which the sun resided in the Jaguar constellation.
3. The vernal equinox immediately following the zodiacal transition, arriving 23 days after the date on Stela 10, was the *first* in which the sun resided in the Black Spotted Dog constellation.

In the light of the zodiacal transition inferred from the Paris Codex, the connection between the iconography of Stela 10 and the end of a world age begins to take meaningful form. We have seen that eclipses were greatly feared, and that an eclipse might bring about or signal the end of the world. Considering such beliefs, I propose that the reason the priests of Xultun chose to glorify this particular eclipse was two-fold: it was the only visible eclipse in Maya territory for several years before or after the zodiacal transition (see Oppolzer, 1887); and it was just 23 days before the sun at the vernal equinox resided in the Black Spotted Dog constellation for the very first time. Thus, the symbolic value of an eclipse with the above properties would, in our scheme, far outweigh the actual magnitude of the eclipse. I now offer an interpretation of each of the iconographic elements related to the zodiacal transition.

The *Bacab* extends his hands before him palms up-

the *manta del sol* is an eight-petaled flower whose diagonally opposite petals are of the same color, four colors in all. Kelley (1976: p. 126) reviews evidence that the *kin* glyph with dotted outline and *te* (T87) subfix is the glyph of the plumeria; on Dresden 12c this glyph is held by *Kinich Ahau*, the sun god (right), and, as previously discussed, by the *Bacab* with the conical cap or coiffeur (middle); on Madrid 69a a long-stemmed flower appears to grow from it. The plumeria, besides having a close association with the sun and moon, also represents the concept of carnal sin (Thompson 1950: p. 88; Roys 1967: p. 105), which evidently relates to the Mopan Maya myth that the sun and moon had "the first sexual intercourse in the world" (Thompson 1970a: p. 364). The day Ahau, with which the number four is strongly associated, represents the sun god. In highland Guatemala, Ahau is associated with "he of the blowgun" (Thompson 1950: p. 89), probably a reference to the myth in which the young sun god, renowned for his prowess at hunting with the blowgun, turns himself into a hummingbird in order to court the moon (Thompson 1970a: p. 345). The association of the hummingbird with the sun is evident in the name of the Mexican god *Huitzilopochtli*, "hummingbird on the left" (Thompson 1970a: p. 371). Associations of the sun, the hummingbird, and the plumeria are found in *The Ritual of the Bacabs* (Roys 1965) and the *Chumayel* (Roys 1967). As Roys (1967: p. 104) notes, the Maya word *nicté* means flower in general, particularly the plumeria, and always the plumeria in *The Ritual of the Bacabs*. We find a reference to *dzunin-nicté*, "hummingbird-plumeria," in *The Ritual of the Bacabs*, and in the *Chumayel* the hummingbird is taken as a husband by the five-petaled plumeria.

[31] The "manikin figure" should not be confused with the "manikin scepter" surmounted by the head (or full figure) of God K with characteristic ornate nose.

ward; in his role as a sky bearer the *Bacab's* hands are usually palms upward but above the head, in the act of supporting the sky. This may be indicative of the reaching of a resting place or, in Maya parlance, a *lub* in which the celestial burden of a new world age is transferred. This may also signify the proclivity of the *Bacab* to let go and allow the sky to fall in: the role of the *Bacabs* in the catastrophic destruction at the close of a prior world age has been recorded by Landa and the anonymous author of the *Chumayel.*

The closed eye and issuance of the *ik*/flower from the mouth of the jaguar represents his symbolic death[32]: the lines issuing from the mouth indicate *ik* as the soul or spirit departing from the body; the flower denotes the jaguar's loss of power over the sun, in particular, the sun at the vernal equinox. Conversely, on Paris 23–24, the constellation-beings hold the symbol of the *sun at the vernal equinox* between the teeth, which symbolizes the 101-*katun* period of power over the vernal equinox exercised by each of the constellations in turn during the 26,000-year cycle of the precession.

The *were-black spotted dog* represents the constellation-being newly born to power over the vernal equinox; he is portrayed in much the same way as the infant were-jaguar born to power at the beginning of the Jaguar age. Iconographic elements pertaining to the kittenlike appearance, umbilicus and placenta, represent the concept of "rebirth." *Balam* did not only signify "jaguar" but was also a title of office: the jaguar held "office" for almost 2,000 years and may not have been so easily dissociated from his role in the mind of the Maya. Thus, the jaguar may have been "reborn" in the form of the black spotted dog[33] who from then on bore his title and insignia. This explains why the black spotted dog on Paris 23 bears the markings of the jaguar; his jaguar spots are the insignia of the new *balam*, who assumed one of the jaguar's roles but never replaced him.

This analysis appears to indicate that events surrounding a zodiacal transition heralding the end of a world age were engraved on Stela 10 at Xultun.[34] This has been a theoretical discourse, but strongly supported, I believe, by the iconographic evidence. I will attempt now to further support the validity of this interpretation.

At a small site along the banks of the Río de la Pasión is an unusual and magnificent stela which, I believe, also records the zodiacal transition. Stela 1 at La Amelia (fig. 22) depicts a human figure with elaborate headdress and paraphernalia; on a lower panel divided from the main panel by a plain band is a "reclining jaguar with lolling tongue" (Morley 1937–1938: **II**, p. 307). The glyphs of the inscription (not included in Morley's drawing) are divided among three panels of glyph blocks. Uniquely, each panel of glyphs begins with the same calendar round date, 2 Ben 6 Zac (Morley 1937–1938: **II**, p. 307). On stylistic grounds Morley opts for a date "well advanced in the Great Period" (Late Classic), and lists three occurrences of 2 Ben 6 Zac as possible long count positions:

9.16. 4.6.13	2 Ben 6 Zac
9.18.17.1.13	2 Ben 6 Zac
10.1.9.14.13	2 Ben 6 Zac

He then summarily dismisses the last date as "probably too late on the grounds of chronological probability" (Morley 1937–1938: **II**, p. 308), and chooses the middle date, although not without two interrogation points of reservation. On the basis of astronomical and glyphic evidence, I consider the later date preferable.[35] Let us then consider the glyphs of Stela 1, especially their astronomical significance.[36]

Stela 1 does not seem to contain anything of a political nature, and the star glyph almost hidden in the feathers at the back of the headdress points to an

[32] There is independent evidence that flowers issuing from the mouth are associated with death: on one of the murals from Teotihuacan in the Museo Nacional de Antropología e Historia in Mexico City, several of the dead people in Tlalocan (the paradise of the rain god) chase butterflies while flowers issue from their mouths; on the Santa Rita mural (Gann 1900: plate 31) is seen a skull with floral motifs issuing from the mouth.

[33] *Xolotl*, the god of twins and deformities, is pictured in Codex Vaticanus B as a hairy dog; Seler (1902: pp. 182–183) calls attention to the myth in Sahagún book 7: *Xolotl* did not want to be sacrificed with the rest of the gods to allow the sun to rise; *Nanauatzin*, a small syphilitic god, sprang into the fire and was "reborn" as the sun. Thompson (1950: p. 79) thinks *Nanauatzin* is merely a variant of *Xolotl* and that syphilis was the cause of the dog's ragged ears. This may have a bearing on the beginning of the Black Spotted Dog age.

[34] The stelae at Xultun display unusual concern for the jaguar (see Morley 1937–1938: **II**) but the iconography, except on Stela 3, is quite different from that of Stela 10. The "manikin figure" (attributed to the black spotted dog) appears only on Stela 10, and Stela 3 (Morley 1937–1938: **V**, plate 79) dedicated on 10.1.10.0.0 4 Ahau 13 Kankin. This stela is extremely eroded, making comparison difficult, but two points can be made from a cursory examination: the "manikin figure" is very similar, if not identical to the one on Stela 10; and the "flower" issuing from the mouth of the jaguar also appears to be identical (other details are too difficult to be discerned in the published photograph). Coming less than three years before the zodiacal transition, this iconography could easily be accommodated to our hypothesis. Indeed, it supports the inference that the iconography of Stela 10 is not merely symbolic of an eclipse; it is not investigated nor discussed here due to the condition of the stela. Stela 19 (Morley 1937–1938: **V**, plate 78d) is dated to early *baktun* 9. Here the jaguar is mature and the "flower" is apparently identical to the object issuing from the mouth of the jaguar on Madrid 40c, or the mouth of the black spotted dog (T801) on Madrid 91a. This object we have defined as a sprout of either corn or beans growing in the milpa. Stela 5 at 9.12.0.0.0 and Stela 1 at 10.1.0.0.0(???) are too eroded to discern more than the presence of the jaguar (Morley 1937–1938: **V**, plates 76e, 78e).

[35] As seen in the discussion of Yaxchilan Lintel 41 in chapter 4, Morley's penetrating analysis has occasionally placed calendar round dates one cycle too early in the long count.

[36] Photographs from the negative files of the Carnegie Institute of Washington now at the Peabody Museum of Harvard University, courtesy of Ian Graham.

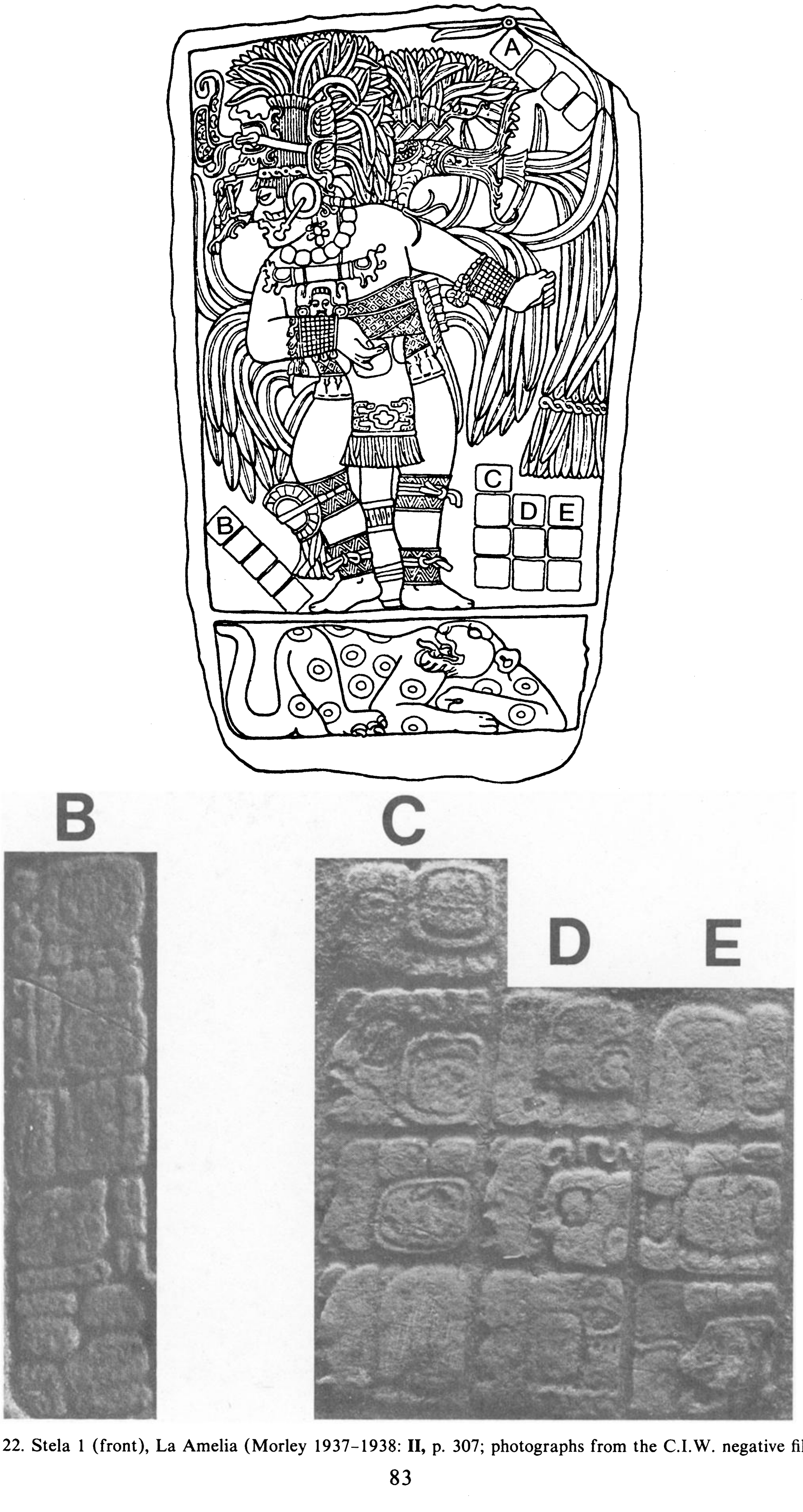

FIG. 22. Stela 1 (front), La Amelia (Morley 1937–1938: **II,** p. 307; photographs from the C.I.W. negative files).

astronomical significance.[37] Turning to the glyphs, we see that glyph block D3 contains the familiar turtle glyph (T743) with the "elbow" glyph (T187) affixed in the upper right-hand corner; Thompson's (1962: p. 325) notation of this glyph block is T229.187:**743**:12. The "elbow" glyph is one of the standard parts of Glyph B of the lunar series. It is thus not unreasonable to assume that glyph block D3 contains a reference to "the moon in the Turtle." Plotting the heavens on my preferred date, 10.1.9.14.13, shows that the moon was indeed in the Turtle constellation (fig. 23), and it is reassuring to note that on the other two dates considered by Morley the moon was nowhere near the Turtle constellation.

The configuration of the planets is also interesting

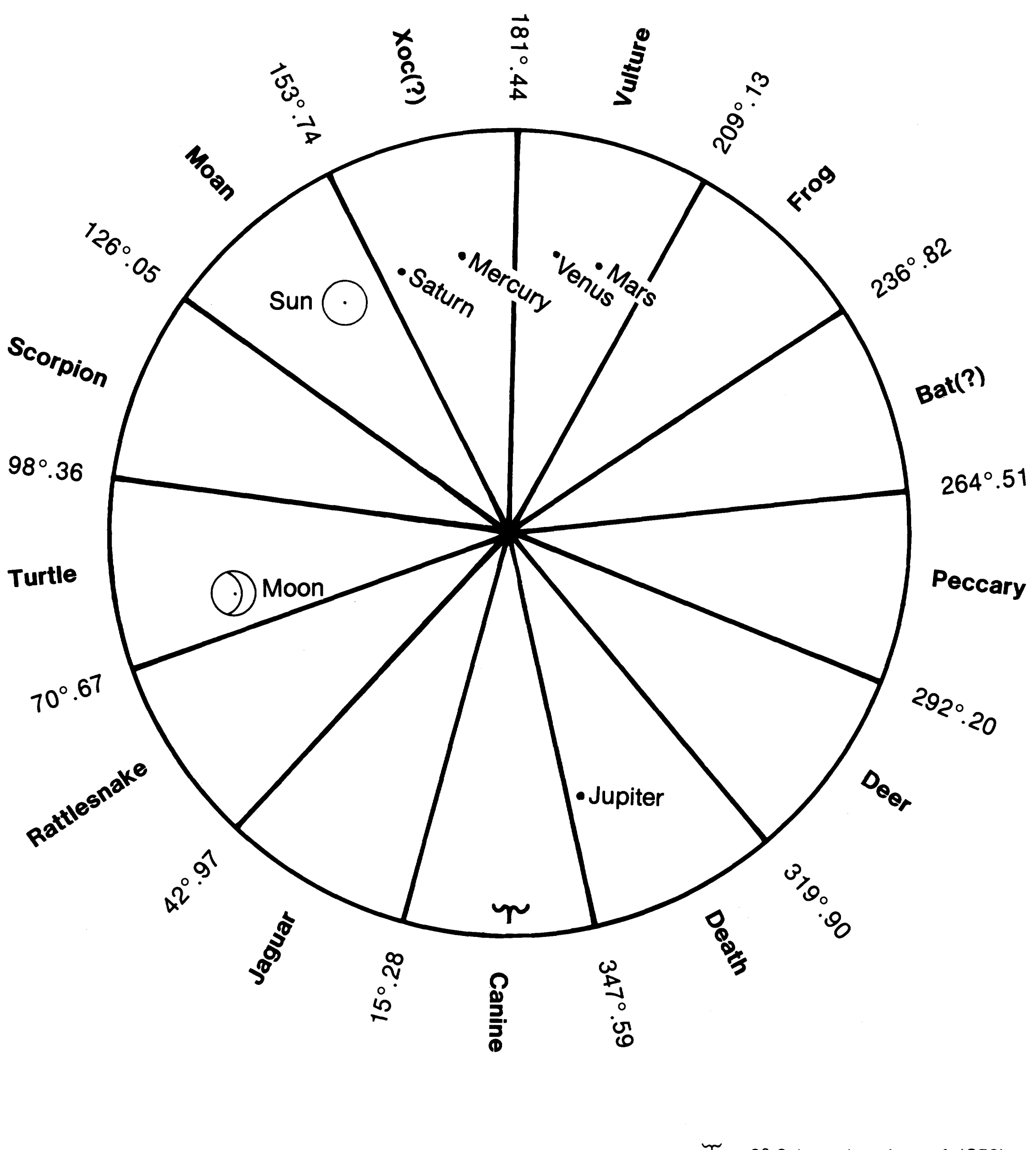

FIG. 23. The Sky on 10.1.9.14.13.

Maya date: 10.1.9.14.13 2 Ben 6 Zac
Julian day: 2,035,016
Date: July 28–29, 859

[37] Also, the design on the breachcloth appears to be derived from the Venus glyph, and the pectoral may bear an Ahau face.

on this date: four of the five visible planets lie in a train following the sun at sundown. Such a configuration would not last more than a few days and could not be expected to occur very often, but its significance to the Maya is at present a matter of speculation. There are, however, other astronomical indications which may support my proposed reassignment of long count chronology. Glyph block D2 appears to contain a head variant of a number (1?) prefixed to T588[38]; above the head of T588 (actually a compound here) appears a variant of the torch affix, a part of Barthel's Mars glyph (see appendix C). Glyph T588 is always associated with the 819-day count (Thompson 1962: p. 217), which appears to be a good working estimate of successive conjunctions of Mars and Jupiter (see appendix D). Preceding T588, glyph block C3 contains the head of the vulture (T747b) as an affix; in Thompson's (1962: p. 369) notation **T747b**.168?:769. It is admittedly speculative that T588 is a personified Mars glyph, and that the vulture functions here as a constellation coordinate, but we note that both Mars and Venus were in the Vulture constellation on my preferred date, 10.1.9.14.13.

Also of interest is the elapsed time between 10.1.9.14.13 and 12.19.12.14.8 12 Lamat 11 Pax, the *lub* of the Paris table:

Elapsed time: 1,453,325 days = 3,979 sid. yrs. − 30 days
= 3,979 syn. yrs. + 26 days

At this point the cumulative difference between the sidereal and synodical years is equal to 56 days, exactly two I units: as a measure of distance, two I units represent the progress of the sun in traversing two Maya constellations on its yearly *eastward* course (see chapter 2) as well as that of the vernal equinox in crossing two Maya constellations on its *westward* course since the *lub* of the Paris table. The date of Stela 1 may thus represent a measure of precessional motion: the excess or deficiency of days in the number of synodical and sidereal years, respectively, would be ideal at 28 days, but is nonetheless suggestive with a two-day discrepancy; two days later the astronomical configuration, including the moon in the Turtle, no longer existed.

Let us now consider the jaguar in the lower panel. His reclining posture is in itself quite unusual; the jaguar is rarely portrayed in other than upright position, often seated, as on Dresden 8a, Madrid 30b, Paris 19 and, of course, Stela 10 at Xultun.[39] But there is one notable place where he is also reclining, Dresden 47f, where a spear thrown by *Lahun Chan* (the god of Venus as morning star) is piercing his side (fig. 24).[40] Comparing the two representations, one perceives that the jaguar on Stela 1 is also not his usual virile self; he is crouching in a subordinate position below the standing figure. This may thus be another way of representing the symbolic death of the jaguar.

Turning to the diagonally placed column of glyphs at the right foot of the standing figure, we find mention of the jaguar. Glyph blocks B1–B2 are occupied by the calendar round date 2 Ben 6 Zac; B3–B4 form a phrase which concerns the jaguar; and B5 is a complex compound consisting of at least four elements, which is unfortunately too eroded to read with certainty:

B3: 61.**756**.1[41] (bat)

B4: **751**.145:188? (jaguar)

The bat glyph (T756) with prefix T61 is an interesting combination; Thompson, in his discussion of the bat glyph states:

With Prefix 61 and often with 568, the sacrificial glyph, infixed, the bat glyph commonly stands at the beginning of a subsidiary text . . . (Thompson 1962: p. 349, see also discussion of sacrifice glyph, p. 194).

The bat glyph does indeed stand at the beginning of a phrase of three glyph blocks, but most importantly, the presence of T61 and the possessive *u* (T1) as a postfix eliminates consideration of the bat as a constellation coordinate (see footnote 41). Eliminating minor affixes, the major elements of this phrase can be reduced to T756.1.751; the possessive *u* indicates possession by the bat. I thus suggest translation of this phrase *zotz' u balam*, "bat, his jaguar."

A search of the literature, commencing with bat and jaguar glyphs in the Thompson catalog, suggests that phrases involving the bat and the jaguar are rare, and that this particular combination (T756.1.751) is unique. In order to establish a significance for this reading, we must refer to the iconography of the bat. The bat is well known as a nocturnal creature, and several species habitually obtain nourishment by sucking the blood of their victims. It is thus not surprising to find the bat associated with darkness, the underworld, death and sacrifice, and it is the bat god who accepts the blood and heart of sacrificial victims in both Maya and Mexican mythology (see Thompson

[38] This glyph is not listed anywhere in Thompson's catalog; he may have thus considered it a member of the portrait group (T1000–T1087) with a "brilliance" or torch affix (T42 or T122), which does not deny its seeming identity with T588. The only difference is that the torch affix sits upon the head rather than stemming from the eye.

[39] Note also the round encircled spots.

[40] The spots of the jaguar on Dresden 47f may have been intentionally excluded; see discussion in chapter 5, pp. 74–75.

[41] Thompson (1962: p. 344) annotates T1 with an interrogation point, presumably because the compound T61.756.1 is unique. In my photograph the affix is quite clearly T1; the only other possibility is that it functions as the star glyph. However, the star glyph as defined by Kelley (1976: p. 38) when in the postfix position always seems to have the circles turned outward, facing away from the compound, not inward as in our example on Stela 1 at La Amelia. Thus, the possessive *u* seems the exclusive reading here.

FIG. 24. Speared Jaguar (excerpt from Dresden 47).

1962: pp. 348–349 for a summary of this aspect of bat iconography): the bat glyph (T756) is often infixed with the sacrifice glyph (T568); and Dieseldorff (1894: p. 576) notes that the bat god depicted on a vase from Chamá wears the collar of the death god. It is thus in keeping with his iconography to conclude that the bat, as a god of death and sacrifice, has taken possession of the jaguar. The symbolic death of the jaguar is a concept appropriate to the close of the Jaguar age as we have seen on Stela 10 at Xultun: in other words, to paraphrase the *Anales de Cauahtitlán*, the jaguar will no longer shine as the sun.

In this section we have reviewed two examples whose interpretation at this stage is hypothetical. There may be other stelae of similar character whose elucidation is hindered by three factors: 1) problems attending the reassignment of calendar round dates; 2) possible predominance of political motifs; 3) erosion and/or purposeful mutilation of Terminal Classic monuments. In the interpretation of glyph passages on Terminal Classic monuments, as well as in the inscriptions in general, it is obvious that we are pushing against the frontiers of our knowledge of the Maya hieroglyphics. However, I believe a good case can be made for the recording of the end of a world age around the middle of the *katun* ending on 10.2.0.0.0.

It is certainly suggestive that the period within about thirty years on either side of the zodiacal transition, between 10.0.0.0.0 and 10.3.0.0.0, encompasses the collapse of the stela cult and the beginning of, and most probably the height of, the abandonment of the central area. In postulating a connection between transition and collapse, I will exercise the caution stemming from our rather incomplete knowledge of the time. I am proposing not one but three possible models for events surrounding the collapse of Classic Maya civilization; following Einstein, I shall name these field equations:

Field Equation 1: the Maya became increasingly uneasy at the approaching end of a world age according to prophecy; panic spread among sections of the priesthood and aristocracy, and groups of them with their retainers began to leave the major sites, leaving the government to a depleted aristocracy and/or the lower classes; those left in control could not maintain the *status quo* creating a political vacuum into which non-Classic or Mexicanized Maya began to penetrate; eventually the spread of anarchy made it impossible to maintain a trade network capable of supplying basic raw materials not extant within the central area; the result, total abandonment.

Field Equation 2: the Maya elite, beset with many deep-seated societal problems, were dealt a crushing blow to their psychological resiliency by prophecies of the catastrophic end of a world age; the prophecies of doom engendered a defeatist attitude in coping with cultural stress, tipping the scales in favor of emigration; as capable leadership was lost, the effects of emigration fed back into defeatism creating a vicious cycle; downward spiraling effectiveness of the elite power structure resulted in anarchy, economic collapse, and abandonment.

Field Equation 3: the Maya commemorated the close of a world age, drew a sigh of relief that the sky did not fall in, and went about their business of collapsing for totally unrelated reasons.

Let us review some of the implications of the field equations. Field equation 1 would inculpate prophecies of doom as the sole reason for the Classic collapse. This, I believe, would be an oversimplification of what has come to light as a very complex situation in the archaeological record. Field equation 3, the other extreme of this spectrum, denies any relationship of the end of a world age to the Classic collapse. I am personally inclined to view field equation 2 as a closer approach to the truth. If my data on the recording of the end of the Jaguar age are acceptable, its very presence in the heart of the collapse and abandonment speaks persuasively for the existence of some causative or exacerbating involvement.

In field equation 2 I have alluded to the very powerful role of prophesy in Maya culture. Let us then follow this to its logical conclusion. In the life of the Maya, prophecies did indeed play an important role and "occupied a prominent position in their literature"

(Roys 1967: p. 182). Furthermore, "foretelling the future was the profession of a special branch of the priesthood" whose highly esteemed practitioners were known as *chilans* (Roys 1967: p. 182); the *chilan* (*Chilam Balam*) who supposedly foretold the coming of the Spaniards to Yucatan was honored as the greatest of the Maya prophets (Roys 1967: p. 3). And further comment from the man who made the study of the Maya prophecies his life's work:

The events recorded in the Maya Chronicles found in the *Mani, Tizimin* and *Chumayel* manuscripts offer excellent grounds for believing that this belief (in prophesy) was so strong at times as to actually *influence the course of history*. A surprisingly large proportion of the important upheavals in Maya history appear to have occurred in some *katun* named either 4 Ahau or 8 Ahau (Roys 1967, p. 184; italics mine).[42]

That a prophecy can actually "influence the course of history" is also supported by data from the Aztec. An old Aztec prophecy of the return of *Quetzalcoatl* played a role in the Spanish conquest of Mexico. Moctezuma is reported to have greeted Cortés with the following words: "My royal ancestors have told that you would come to visit your city and that you would sit upon your mat and chair when you return" (Seler 1902–1923: **IV**, p. 447). The "mat and chair" are the symbols of royal authority which Moctezuma implicitly, and almost resignedly, cedes to Cortés. The chronicles of the Spanish conquest bear out the fact that this prophecy was known and exploited by Cortés, the conquistador (see Díaz del Castillo 1908–1916; MacNutt 1908).

Further support comes from a Quiché chronicle related in the *Recordación Florida* of Fuentes y Guzmán:

My forefathers of the house Tanub founded the great city of Tula . . . from which their descendants withdrew *upon the command of an oracle*, and with many delays and long detours migrated more than 700 miles (Fuentes y Guzmán 1932–1933: **III**, p. 387; italics mine).

Whether or not the Quiché were the fabled lords of Tula (see Girard 1969), the implications of this account are enormous.

Returning to the Maya proper we note that a *katun* prophecy probably raised the hopes of the plotters who overthrew the Cocoms and destroyed Mayapan in the *katun* 8 Ahau beginning in 1441. Thompson (1950: p. 182) states that ". . . waverers would have shown more inclination to join the revolt in a *katun* 8 Ahau because they would have taken into consideration its bellicose aspect." Just before the dawn of the next *katun* 8 Ahau the yet independent Itzá at Tayasal were visited by a group of proselytizers headed by Padre Avendaño in 1696. The missionaries were told that neither the god nor the government of the Spaniards could be accepted at that time. However, they should return in two years for then *katun* 8 Ahau, the traditional *katun* of political change, will have begun and the Itzá might be more amenable to accept conversion. Two years later the Itzá were indeed conquered and we can but speculate that the *katun* 8 prophecies had no salutary effect on their fighting spirit.

Born of an obsession with time, the effect of prophesy on Maya history should not be underestimated. For what is prophesy but a manifestation of the desire of men to know their fate, no matter what it may be. In the extreme, when fate is meted out by a clockwork universe, a concept of predestination is engendered whereby free will is transformed into illusion, for mortals and even the gods themselves. And the prophecies of men compelled by this inveterate fatalism tend to become self-fulfilling.

Strong points have been made in the preceding argument but the ultimate strength of the hypothesis advanced in these pages is, I believe, its testability. Glyph readings based mainly on iconographic interpretation can be tested again and again as our knowledge of the Maya hieroglyphics increases; this pertains to all aspects of this work from the codices to the inscriptions. In closing I would like to extend the reach of this hypothesis to include some archaeological predictions of a general nature.

I expect the archaeological record to provide evidence for the entrance of the Maya into the Peten at around 1200–1000 B.C., and that they were probably its first inhabitants. This would support the inference that the Peten was occupied for the span of one world age, which would bring motivations for abandonment of the ancestral homeland into sharper focus; that the Maya were never replaced by other groups, particularly of high culture, argues for the unusual circumstances of both their coming and going.

I also expect the archaeological record to provide further evidence that the elite of Maya society were the vanguard of the abandonment. This may create problems since it would be hard to distinguish archaeologically whether occupations of the elite class were continuous or if their structures and trappings had been taken over by members of a *nouveau riche* group rising to fill the upper class vacuum. Opportunists may well have been at work claiming elite status along with goods characterizing high status dwellings and burials. We might thus find that the "elite" at a Maya site showed an actual increase in the last stages of the Terminal Classic. That this was not the traditional elite, however, would be indicated by a case of "too many chiefs, not enough Indians." The situation at Tikal, where culturally impoverished Eznab inhabitants occupied previous elite class structures in the central precincts of the city but "distributed their

[42] I have already discussed the Itzá's misfortunes in *katuns* 8 Ahau stretching over a period of 1,000 years.

refuse in courtyards, down stairways and even within rooms" (Culbert 1973a: p. 59), may be applicable here.[43]

In support of the above inferences, much stratigraphic and demographic data are needed. I also believe a thorough survey and reconsideration of Terminal Classic monuments would be in order. If any advances in our knowledge have been made in the preceding pages, they will continue to be supported by each new accretion of archaeological and epigraphic evidence.

Conclusion

This chapter was primarily a search for evidence that the Maya recorded the zodiacal transition accompanying the end of the Jaguar age around the middle of the *katun* 3 Ahau ending on 10.2.0.0.0. My methodology has continued to rely heavily on the interpretation of iconography and its extension into the hieroglyphic writing system. Two Terminal Classic monuments which I believe commemorate this zodiacal transition were discussed. Both these stelae appear to be thoroughly nonpolitical and to treat of astronomical events which are far overshadowed by the greater event.

Stela 10 at Xultun was shown to have commemorated an eclipse of the sun which in all probability had not been seen from that city. However, the iconography supports the conclusion that this eclipse was merely symbolic: the eclipse, possible presage to the end of the world, was recorded 23 days before, according to the Paris Codex, the sun at the vernal equinox entered the Black Spotted Dog constellation for the first time. I consider this strong, if not conclusive evidence that the Maya recorded a zodiacal transition. It should be noted here that any hypothesis which purports to explain the significance of Stela 10 at Xultun in terms other than those I have suggested, will have to answer one "monumental" question: why did the Maya erect a monument to an "eclipse that never was"?

In investigating Stela 1 at La Amelia we were on more theoretical grounds. However, the reference to the moon in the Turtle constellation was of great support to my reassignment of long count chronology. The interpretation of other astronomical glyphs, although hypothetical, have not been "pulled from a hat" as it were, but are logical extensions of the data. If the proposed long count position proves acceptable, my reading *zotz' u balam*, "bat, his jaguar," provides strong support for the symbolic death of the jaguar as an aspect of the zodiacal transition.

My assessment of Maya psychology, with its penchant for fatalism, is supported by the work of the late Ralph Roys, events surrounding the Spanish conquest of Mexico, and other sources. The idea that an autogenous belief in the catastrophic end of a world age could "influence the course of history" is, to this author, inescapable, and implicates doomsday prophesy in the Classic Maya collapse.[44] The late J. Eric Thompson (1972: p. 113) eloquently sums up the apocalyptic aspect of the Maya character when he states ". . . I think the Maya had evolved a theory of predestination from which the gods themselves were not free." Given doctrines of predestination and astrological world ages, it is no great leap of the imagination to admit of a self-destruct system *sui generis*; the instinct for self-destruction of our supposedly sapient species is seen as a relic of our phylogenesis by a host of authors (see Koestler 1967). I am convinced that the demise of the Classic civilization was in essence a *self-fulfilling prophecy*.

Due to the complexity of the facts, three models for the Classic collapse, termed field equations, were proposed. I am inclined to the view that doomsday prophecy played at least an exacerbating role in the Classic collapse (field equation 2). While not going into the archaeological record in great detail, I have endeavored to include two key predictions which I believe ongoing archaeological research will eventually confirm:

1. Formative through Classic Maya culture occupied the Peten from circa 1100 B.C. to A.D. 900, the span of one world age.
2. The Maya elite were the first to abandon, leaving a vacuum filled for a time by "carpetbaggers" and opportunists, making up a pseudo-elite.

It is hoped that these ideas will influence archaeological research design in the central area. In the last analysis, it is only by concerted effort among archaeologists, epigraphers and culture historians that we can hope to solve the problem of the collapse of Classic Maya civilization.

In summarizing this chapter, I am also summing up this monograph. In closing I would like to leave the reader with a question. In viewing the last products of the Classic Maya intellect, one is overcome with awe and a sense of sadness: did this brilliant civilization contain within it, from the very outset, the seeds of destruction destined to leave it decaying in the vast greenness of the tropical rainforest?

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[43] At Tikal, evidence for looting of burials and caches, resetting of stelae and redepositing of offerings are indicative of "abnormal" practices "when viewed in the light of the rigidly standardized patterns of Classic times" (Culbert 1973: pp. 74–80). A proponent of invasion hypothesis concludes "there was at least a partial, if not complete, changeover in the ruling elite at Seibal by the beginning of the Tenth Cycle in the Maya calendar" (Sabloff 1973: p. 129). Quite clearly, invasion can be interpreted as a cause or effect of the departure of the traditional Seibal elite, especially along the Usumacinta, a heavily traveled trade route to the gulf coast.

[44] As discussed in chapter 5, there is a strong tradition of world ages and their catastrophic ends throughout Mesoamerica.

APPENDIX A

THE *HAAB* DISTANCE NUMBER

Paris 2–11 contain many examples of the Cauac glyph with affixed coefficients; we are concerned here only with those glyphs bearing two coefficients, not with those bearing one, which may or may not carry another affix. Besides the examples discussed in the text, there are seven others located on Paris 3, 5, 6, 7, 8, 9 and 11. They serve as distance numbers to connect an important position of the year (particularly one of the stations of the year) with the end of a *katun*, the *katun* which is the subject of the page on which it appears.[1]

As discussed in the text, the *haab* distance number is read as follows: the coefficient to the left refers to the number of *haab* (vague years of 365 days); the coefficient above, to the number of *kin*; the total being χ *haab* + *y kin*. All examples discussed below will be interpreted in this way.

The first three examples connect very closely to one of the stations of the year:

Paris 5: (lower left) — 6 *haab* 5 *kin* (2,195 days) before 9.19.0.0.0 (J.D. 2,017,083)[2]
2,017,083 − 2,195 = J.D. 2,014,888
June 18, 804
Position: summer solstice + 2 days[3]

Paris 6: — 12 *haab* 3 *kin* (4,383 days) before 10.0.0.0.0 (J.D. 2,024,283)
2,024,283 − 4,383 = J.D. 2,019,900
Mar. 9, 818
Position: vernal equinox − 7 days; Venus at heliacal rising: the "official" day of VHR may have been three days later on 8 Ahau(?) which appears below the *haab* distance number (immediately preceding glyph destroyed).

Paris 11: — 9 *haab* 19 *kin* (3,304 days) before 10.5.0.0.0 (J.D. 2,060,283)
2,060,283 − 3,304 = J.D. 2,056,979
Sept. 14, 919
Position: autumnal equinox − 1 day

Thus, these three examples and the one in the text lead to positions near each of the stations of the year, and in two cases directly to astronomical events of obvious significance; i.e., total lunar eclipse, Paris 10 (discussed in text), and VHR, Paris 6 (see above).

The next two examples are about equally spaced around the winter solstice:

Paris 3: — 17 *haab* 12 *kin* (6,217 days) before 9.17.0.0.0 (J.D. 2,002,683)
2,002,683 − 6,217 = J.D. 1,996,466
Jan. 10, 754
Position: winter solstice + 24 days

Paris 7: — 13 *haab* 7 *kin* (4,752 days) before 10.1.0.0.0 (J.D. 2,031,483)
2,031,483 − 4,752 = J.D. 2,026,731
Nov. 20, 836
Position: winter solstice − 26 days

The example on Paris 3 is preceded by a *uinal* glyph which may bring the count back to the winter solstice; the condition of the glyphs on Paris 7 does not allow comparison. There may be some significance for dates about 25 days before or after the winter solstice of which we are not yet aware.

The last two examples seem rather to deal with zenith passage of the sun which occurs in late April and early August (about 50 to 52 days before and after the summer solstice, respectively) at the latitude of the Maya[4]:

Paris 8: — 13 *haab* 13 *kin* (4,758 days) before 10.2.0.0.0 (J.D. 2,038,683)
2,038,683 − 4,758 = J.D. 2,033,925
Aug. 1, 856
Position: summer solstice + 47 days (zenith passage − 3 to 5 days)

Paris 9: — 13 *haab* 10 *kin* (4,755 days) before 10.3.0.0.0 (J.D. 2,045,883)
2,045,883 − 4,755 = J.D. 2,041,128
Apr. 21, 876
Position: summer solstice − 54 days (zenith passage − 2 to 4 days)

Both examples are about three days before first and second zenith passage of the sun, respectively. The condition of the accompanying glyphs leaves much to be desired.

This exhausts the examples of *haab* with two coefficients in the Paris Codex. There are several other glyphs of this type bearing but one coefficient which probably function in a similar manner. In this rather limited study it was my intention only to support the reading of the example in the text. No attempt to interpret the hieroglyphics will be made at this time because, unlike the lunar eclipse reading, none of the glyphs in other passages accompanying the *haab* distance number refers to "obvious" astronomical events. However, I am certain that some glyph readings will ensue from a complete investigation. The *haab* distance numbers are of decidedly limited applicability,

[1] The long count positions of the *katuns* on Paris 1–13 were delineated in the first section of chapter 4 (see footnote 2, p. 49).

[2] According to the Thompson correlation (Ahau equation 584,283) as determined in chapter 4.

[3] Dates in the Julian calendar do not correspond to dates since the Gregorian reform of 1582 (i.e., summer solstice Julian calendar is not on June 21/22 as in the Gregorian calendar). The stations of the year fall around the fifteenth to the seventeenth of the month Julian in the Late Classic/early post-Classic periods.

[4] First zenith passage corresponds roughly to the beginning of the rainy season. Girard (1969) discusses the importance of the zenith passages in Maya mythology and ritual.

but their rather generous sprinkling over these pages in the Paris Codex is potentially enlightening.

APPENDIX B

THE CALCULATION OF PLANETARY POSITIONS

For most purposes, the determination of ecliptic longitude (λ) suffices; the planets do not wander more than a few degrees from the ecliptic, making the ecliptic latitude (β) for the most part unnecessary. There are convenient reference works for λ at ten-day intervals (Stahlman and Gingerich 1963) and both λ and β at five- and ten-day intervals (Tuckerman 1964), the latter encompassing the moon as well. The positions on days not included in these tables are obtained by extrapolation. However, in the case of planetary or lunar conjunctions, more precise coordinates are required.

The calculation of ecliptic coordinates can be accomplished on a daily basis for the sun and planets, or on an hourly basis for the rapidly moving moon (Ahnert 1960), with an accuracy of about ± 0.1 degree. These determinations can be done by hand in a few minutes, or can be programmed into a small calculator. However, the results must be applied with great care when the position in relation to the fixed stars is desired.

The longitudes reached by all the above methods refer to the first point of Aries as zero degrees longitude. However, this is the first point of Aries *of date*, not of March 21, 1950, the standard reference point of most star charts for current use.

Due to the precession of the equinoxes, the first point of Aries, along with the official boundaries of our zodiacal signs, is itself wandering along the ecliptic about one degree westward every 72 years; the actual constellations remain in place but the signs with which they originally coincided (i.e., Aries, Scorpio, Libra, etc.) do not. Thus, the preceding methods are fine for calculating the sign of our twelve-constellation zodiac in which a heavenly body resides, but do not tell us anything about its position in relation to the fixed stars.

In the historical references of Western civilization, planetary positions are often given in this movable system of zodiacal signs. However, in dealing with Maya zodiacal references, none of the familiar relationships hold: the Maya zodiac must be assigned to the only appropriate reference, the background of fixed stars. Thus, to find positions in the Maya zodiac, one must calculate from a fixed point in the sky: the first point of Aries of 1950.

In order to find the positions of the sun, moon and planets in relation to the fixed stars, a simply calculated correction for the precession of the equinoxes must be added to the longitudes reached by all the methods outlined above. Without this correction an error of fifteen degrees or more is incurred in calculating back to the Classic period. The correction is applied only to longitude (latitude remains the same), and is merely the distance in degrees the first point of Aries has moved since the date of interest to 1950.

The correction (C_λ) is found by multiplying the number of elapsed years (between the date obtained through the Thompson correlation and 1950), by the precessional constant (*American Ephemeris and Nautical Almanac*):

$$C_\lambda = (1950 - \text{date}^1) \times 0.013960111.$$

The correction is then added to the longitudes derived from the method of choice:

$$\lambda + C_\lambda = \lambda' \text{ (corrected } \lambda).$$

The transformation of ecliptic coordinates to equatorial coordinates (right ascension and declination) can be found in any text on spherical astronomy (i.e., Roy and Clarke 1977). These transformations are sometimes necessary because the coordinates of the fixed stars (i.e., Antares) are most often given in right ascension and declination, as in the *American Ephemeris and Nautical Almanac*. Routine transformations can be performed by the method of Bertiau and Fierens (1977) using program cards for the Hewlett Packard HP-97 calculator.

[1] Since there is no year 0, dates B.C. are decreased by one and given a negative sign (i.e., 1200 B.C. becomes −1199 for purposes of astronomical calculation).

APPENDIX C

BARTHEL'S MARS GLYPH

Barthel (meeting of April, 1979; and personal letter of July 4, 1979) has brought to my attention a glyph in the text of Copan Altar R which he identifies as that of the planet Mars. Full discussion is given in his article *Weiteres zur Frage der altmexikanischen Nachtherren* (Barthel 1975), but I think it of value to present the pith of his argument, which provides such strong corroboration of my own argument, in English.

In the text I discussed glyph blocks 13–16[1] associated with the dates 9.15.9.13.0 7 Ahau 3 Zip (glyph blocks 20–21) and 9.16.12.5.17 6 Caban 10 Mol (glyph blocks 1–2). Barthel's glyph appears on the upper half of glyph block 22:

[1] Following Maudslay's (1889–1902: plate 94) numbering.

(After Maudslay 1889–1902: plate 94)

The main element is a member of the "burden" group (including T512, T515, and T532); the prefix is a representation of a torch. Barthel reads this *Fakelträger*, "*torchbearer*."

The connection to the planet Mars is made on the basis of an illustration on Codex Laud 10 which gives all indication of correspondence to the Sanskrit *gaganolmuka*, "the torch of the sky," a name for Mars in ancient India. This is one of those tantalizing cases of parallelism, if not outright diffusion, from the Old World.

The *torchbearer* carries a lunar postfix (T181; possibly *ah*, or of dual significance?); the lower half of glyph block 22 may be a defaced *mol* glyph, as in glyph block 14, and carries a lunar prefix. The upper part of the following glyph block (23) is read by Barthel *yax hatz' kin*, "sunrise."[2] Taken together there can be little doubt that we have a reference to "*torchbearer* (Mars) and the moon at sunrise." These glyph blocks at the end of the inscription directly follow the date 7 Ahau 3 Zip (9.15.9.13.0) which, as I have demonstrated in the text, was the occasion of a conjunction of the moon and Mars at sunrise of the vernal equinox (see figs. 14 and 15).

It is of acute significance that these glyph blocks are cut off from the rest of the inscription by the date 7 Ahau 3 Zip and thus pertain *only* to this date; the glyph blocks discussed in the text lie *between* both dates, which bears out my assumption that they pertain to both dates and that *red star* is a generalization which refers to both Mars and Antares.[3]

Thus, approaching the inscription on Copan Altar R from two different hypothetical directions, the readings derived are in exact concordance. Due to his personal involvement in this reading Barthel reaffirms the verity of the Thompson correlation.

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[2] The entire glyph block may even indicate a particular sunrise, the one on the morning of the vernal equinox; the name of the postulated Copan ruler New-Sun-at-Horizon is derived from this source.

[3] The last glyph block (24) contains the glyph of the leaf-nosed bat (T756). Two spiral superfixes surrounded by dotted circles appear, but no star glyph or lunar glyph is present. Thus, I do not think a "conjunction" is depicted. However, this may indicate some relationship between Mars and Antares, which is the most prominent star in the constellation I have designated the Bat(?). The entire inscription on Altar R may be connected symbolically to the mythological origin of the city of Copan, or its ruling dynasty: the major element of the emblem glyph of Copan is the leaf-nosed bat (T36.168:**756**; see Berlin, 1958). This may provide strong connections between the destructive torch-bearing Mars god and the bloodthirsty bat god, and explain why their conjunctions with the moon were especially revered at Copan.

APPENDIX D

THE BLACK SPOTTED DOG AND THE SERPENT NUMBERS

The black spotted dog was first proposed in chapter 1 (see p. 12) as the identity of being #13 of the Paris zodiac. The identity of this constellation is essential to the argument in part III (especially chapter 6) and will be considered here. Since the bushy tail on the being on Paris 23 is not in itself diagnostic, and the glyph of the black spotted dog (T801) on Paris 24 is not in direct association with the being, the identity of this constellation-being will have to be confirmed by other means; that is, an examination of the serpent numbers and one of the almanacs of the Dresden Codex.

The serpent numbers appearing on Dresden 61–62 and 69 all begin from a date 9 Kan 12 Kayab some 30,000 years in the remote past. Most of these are long reckonings leading to calendar round dates in the Classic period. Although there are several mistakes in these numbers, all (including long count dates to which they lead) have been reconstructed to the satisfaction of most authorities (Thompson 1972: pp. 80, 85).

It has been noted that several of these derived long count dates, for example, 10.6.10.6.3 13 Akbal 1 Kankin, contain a day name (in this case 13 Akbal) which is the *lub* of one or more almanacs on succeeding pages. If the *lub* of an almanac listed with the day name alone corresponds to the long count date reached by one of the serpent numbers, this yields an unusual opportunity to place the entire almanac within the long count. Unfortunately, most of the following almanacs do not connect to any of the serpent numbers in this way.[1] It is my contention, however, that the serpent numbers are the organizing factor which may eventually enable us to place all of these almanacs (or at least part thereof) within the long count, even though they do not connect to the serpent numbers in any as yet obvious manner.

Most of the serpent numbers do not seem to lead directly to dates of interpretable astronomical events. However, in investigating the intervals between the derived long count dates, I have uncovered several of astronomical significance. At present it would be premature to offer a complete report on these findings, but I will illustrate with one pertinent example. On Dresden 61 the black long reckoning 4.6.10.9.10.1 (in the coils of the serpent with the rabbit seated in open jaws) leads to the long count date 10.7.4.3.5 3 Chicchan 13 Yaxkin. Another black long reckoning, 4.6.0.13.15.1 (blue serpent with *Chac* kneeling in open

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[1] Even the full calendar round dates in the inscriptions listing month positions cannot be assigned to the long count with security unless other dating controls are present.

Day	Long count	Julian day	Date
13 Akbal (*indirect lub*) + 136 days↓	10.6.10. 6. 3*	2,071,206	Aug. 27, 958
6 Cauac (*lub*) + 87 days↓	10.6.10.12.19†	2,071,342	Jan. 10, 959
2 Cimi (*t'ol* 9)	10.6.10.17. 6‡	2,071,429	Apr. 7, 959

* derived from the serpent number on Dresden 62 and ring numbers on Dresden 63 and 31a.
† inferred from first hypothetical assumption.
‡ inferred from second hypothetical assumption.

FIG. 25. Derivation from *indirect lub.*

jaws), leads to the long count date 9.17.8.8.5 3 Chicchan 18 Xul. On both of these long count dates the moon was just over one day old, which corresponds to the first day of a count from new moon in *system A* (first appearance after conjunction; see chapter 3). The interval between the two long count dates is none other than Thompson's (1950) suggested lunar formula: 70,460 days = 2,386 lunations.[2] The odds of this not being a lunar calculation are reduced to almost null by the fact that the two long count dates which it connects are both at new moon.

Diverting our attention from the serpent numbers for a moment, we return to the issue of the Black Spotted Dog constellation. Stretching across Dresden 38b–41b is an almanac of 11 *t'ols*.[3] In *t'ol* 9 of this almanac, on Dresden 40b, is what I deem the representation of an unambiguous astronomical event. Here, the black spotted dog, bearing a torch, hangs inverted from a celestial band. In the first glyph block appears a glyph which signifies torch or fire preceded by the possessive *u*; in the second, the glyph of the dog suffixed with the sky glyph (T559.568.561); these are assuredly to be read together as "his fire, dog of the sky," which must be a reference to the Black Spotted Dog constellation. The celestial band from which the creature hangs is composed of two units: on the left is the well-known Venus symbol; on the right, the equally well-known symbol of the moon. I have interpreted the meaning of this *t'ol* "conjunction of the moon and Venus in the Black Spotted Dog constellation." Let this be a hypothesis which, in order to be empirically tested, brings us back to the serpent numbers, and to several assumptions concerning their connection to succeeding almanacs in the Dresden Codex.

The *lub* of our almanac is 6 Cauac (listed on Dresden 38b), a day which does not appear in any derivative of the serpent series or ring numbers. Several pages back, on Dresden 31a, appear several ring numbers, one of which leads to the long count date 10.6.10.6.3 13 Akbal 1 Kankin. This long count date is derived from the black serpent number on Dresden 62, 4.6.9.15.12.19 (blue serpent with blue peccary seated in open jaws), as well as from a ring number on Dresden 63. Due to the derivation of 10.6.10.6.3 13 Akbal 1 Kankin from the above numbers, and again from another ring number on Dresden 31a, a full eighteen pages later, I was given to assume that the day name 13 Akbal was not only the *direct lub* of several almanacs but an *indirect lub* as well. What I mean here is that an almanac may begin on the first occurrence in the *tzolkin* of its *lub* day immediately following the 13 Akbal of the long count date. Let us call this our first hypothetical assumption.

A day 6 Cauac follows a day 13 Akbal after an interval of 136 days in the *tzolkin.* 6 Cauac, the *lub* of our almanac beginning on Dresden 38b, lies seven pages beyond the third derivation of 10.6.10.6.3 13 Akbal 1 Kankin, and *t'ol* 9 lies an additional two pages forward. Counting the black distance numbers across the almanac brings us to the day 2 Cimi in *t'ol* 9, 87 days after the *lub,* 6 Cauac. I had to further assume here that an important astronomical event depicted in *t'ol* 9 would have occurred on the day reached by the first run through the black distance numbers starting from the *lub.* This is my second hypothetical assumption, and it may indeed seem as though I am piling assumption upon assumption. Nonetheless, figure 25 illustrates the long count position and the Julian day reached by this manipulation.

Before testing this hypothesis, I would like to apprise the reader of the odds of finding a specific astronomical event within a specific constellation on one day of the long count during at least one thousand years of Maya observation and recording. Conjunctions of the moon and Venus are not all that rare, but conjunctions with a planet such as Venus (a planet which follows the sun and does not reside long in any one constellation) within a particular constellation do not occur more than once every several years. Thus, with all my assumptions duly noted, the chance of

[2] As demonstrated, this lunar calculation fits neatly into the Maya estimate of the precession with a remainder equal to the length of the Dresden eclipse table (see chapter 2): 9,453,600 ÷ 70,460 = 134 + **11,960** days.

[3] I have already discussed the first *t'ol* of this almanac in relation to the "winged" glyphs (see chapter 1).

picking, "out of a hat" as it were, the day of such a conjunction, is astronomical.

Figure 26 shows the celestial picture on 10.6.10.17.6 2 Cimi 19 Xul, the date derived above. As readily seen, the moon and Venus are in conjunction (closest visible approach about 3°β) almost exactly in the middle of what I have called the Canine constellation. This is indeed noteworthy but is by no means the end of this story. I also made the assumption that this was not merely an isolated event but one of a cyclical nature which may repeat after an interval found among the serpent numbers. This assumption is based on the interval of 70,460 days between new moons separated by 2,386 lunations, which brings us back to the serpent numbers.

Making a matrix and analyzing the intervals be-

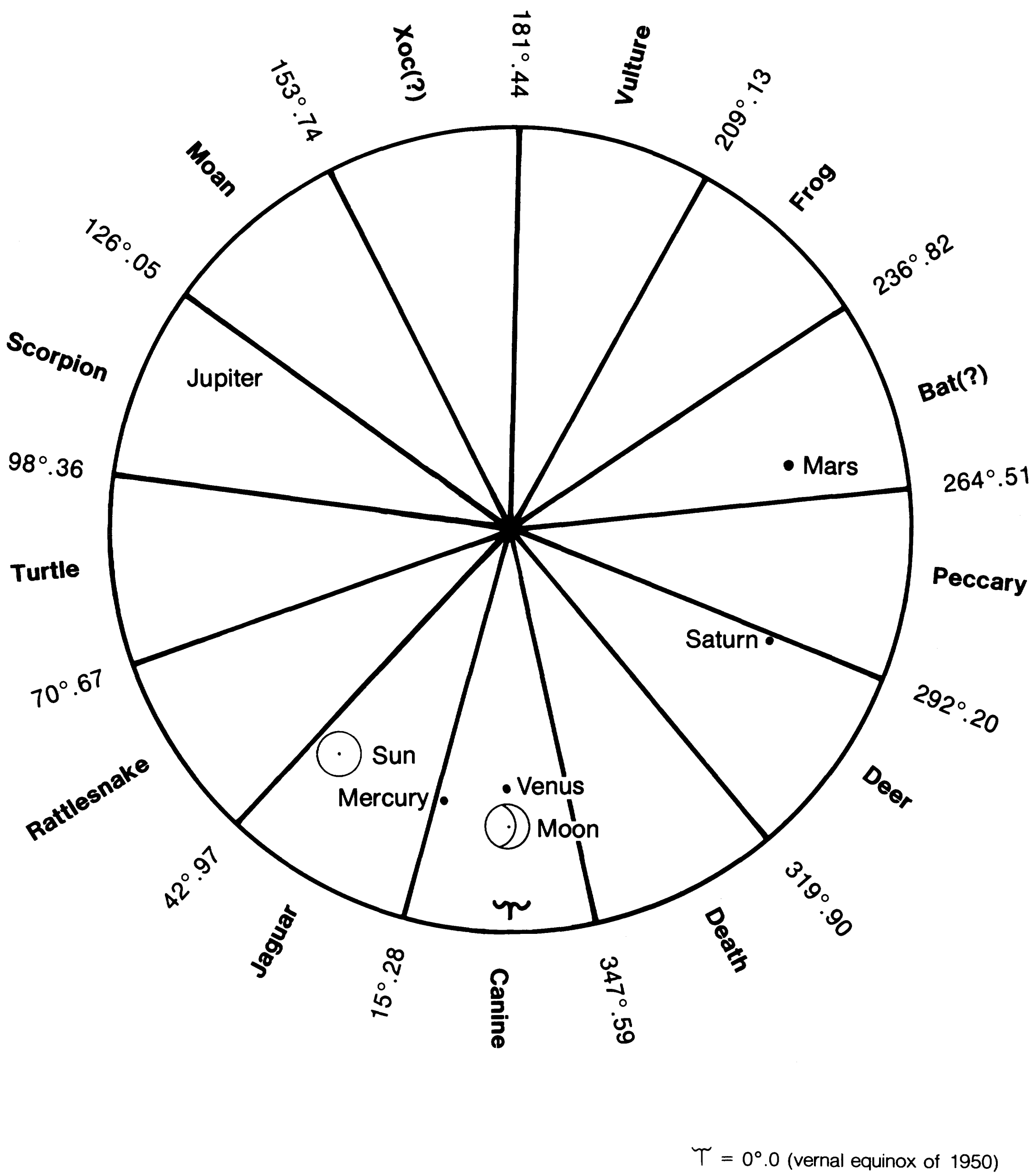

FIG 26. The Sky on 10.6.10.17.6.

Maya date:	10.6.10.17.6 2 Cimi 19 Xul
Julian day:	2,071,429
Date:	April 7, 959 (at sunrise)
Remarks:	the moon and Venus conjunction in the Black Spotted Dog (Canine).

Long count		Julian day	Date	Ecliptic longitude (λ) of conjunction*
8. 3. 8. 3. 4	9 Kan 12 Yaxkin	1,760,827	Nov. 18, 108	237
9.14.19.10. 5	12 Chicchan 8 Pax	1,916,128	Jan. 27, 534	299
10. 6.10.17. 6	2 Cimi 19 Xul	2,071,429	Apr. 7, 959	0
11. 8. 2. 6. 7	5 Manik 15 Muan	2,226,730	June 15, 1384	61

* Only the ecliptic longitude of Venus is given; the moon in each case was from 0°.5–3°.0 longitude (λ) to the west of Venus just before sunrise, the time of conjunction.

Table 15. Moon/Venus Conjunctions at 155,301-day Intervals.

tween long count derivatives of the serpent numbers, I looked for an interval which may tie together the cycles of the moon and Venus. Several intervals were tested by trial and error during this analysis until, on the third attempt, an exceedingly interesting combination was found. On Dresden 61 the red long reckoning 4.6.1.11.5.0 (serpent with rabbit) leads to the long count date 9.18.5.16.4 3 Kan 12 Yax; on Dresden 62 a long reckoning with ring number (not one of the serpent numbers but on the same page) leads to the long count date 8.16.14.9.3 13 Akbal 16 Pop; the distance between the two being 155,301 days.

Starting with the moon/Venus conjunction of *t'ol* 9 on April 7, 959 (J.D. 2,071,429), it was found that similar conjunctions of the moon and Venus occurred at intervals of 155,301 days (table 15). In table 15 I have calculated only those which go back to the late pre-Classic period and forward to the last one which the Maya would have observed.[4] Interestingly, the conjunction does not occur in the same constellation each time but moves about sixty degrees east of its previous position. This means that on the sixth repetition the conjunction would come back to practically the same point in the sky. Thus, this series, completed after 2,551.2 years (6 × 155,301 = 931,806 days), splits the zodiac into six divisions. The moon/Venus conjunction which occurred in the Black Spotted Dog constellation was the last member of this series to be recorded by the Maya before the Dresden Codex was written; the next conjunction occurred like clockwork 155,301 days later on June 15, 1384.[5]

I carried the analysis to the preceding *t'ol* in this almanac on the chance that *t'ol* 8 was also in direct sequence from the *lub* 6 Cauac, and thus preceded the moon/Venus conjunction by eleven days. *T'ol* 8 has been discussed by Thompson (1972: p.100), who reads the glyphs above the illustration as: "his flaming fire; there on high; *Kinich Kakmo*; *kintunyaab*(*il*) (drought)." What Thompson refers to as the sun-eye fire macaw (*Kinich Kakmo*, or an anthropomorphized form) stands beneath a celestial band holding two torches. The celestial band consists of two units: on the right, the *kin* or sun symbol; on the left, what appears to be the *kin* but with four circlets in the corners connected by two dotted lines crossing at the center. Seeing the two symbols together suggests that they both do not represent the sun and that the latter depicts the planet which never strays very far from it, Mercury.[6]

The representation of a fire macaw as an aspect of, or in dualistic terms, an accompanier of the sun, seems logical in this context. Checking the planetary positions eleven days prior to the moon/Venus conjunction, March 27, 959 (J.D. 2,071,418), shows that Mercury was at heliacal rising. Thus, I suggest that the planet Mercury is associated with the fire macaw, and the *kin* with crossed dotted lines, at least in the codices, is its symbol.[7]

Let us pause to recapitulate the preceding results. We have found an almanac whose *lub* day is not identical to one of the long count dates derived from the serpent numbers and/or ring numbers, but rather is the first occurrence of the *lub* day immediately following. I would like to designate this phenomenon an *indirect lub almanac* (as opposed to *direct lub almanac*).

Theoretically, if an almanac is based somewhere in the long count, an astronomical event portrayed in one of the *t'ols* must not necessarily take place on the first reading through the almanac. In reading through an almanac and reaching a red day coefficient in a particular *t'ol*, at each reading across the *t'ols* we reach the same day coefficient but not necessarily the same day name. Thus, for example, the first reading brings us to 2 Cimi in *t'ol* 9 (the day of a moon/Venus conjunction); the second, to 2 Oc; and the third, to 2 Ix,

[4] This sequence could most probably be extended far into the past and future, but the calculations are laborious, and these examples are enough to demonstrate the point.

[5] We may speculate that the Maya detected a pattern in recurring conjunctions of the moon and Venus which repeats every 155,301 days (425.2 years). I can assure the reader that this is not the only example of such conjunctions at intervals derived from the serpent numbers (or ring numbers) and recorded among the *t'ols* of succeeding almanacs. I have found, for example, that the 819-day count (over the long run) is an excellent approximation of successive conjunctions of Mars and Jupiter.

[6] Mercury remains at all times within 27 degrees of the sun, and is seen only in the fiery glow of dawn or sunset.

[7] In the inscriptions, the macaw glyph (T744), with appropriate affixes, should be tested as a possible glyph of Mercury.

etc. Our example, the moon/Venus conjunction in the Black Spotted Dog constellation, occurs in the first reading through the almanac on 2 Cimi, hence I shall term this a *first line manifestation.*[8] It is obvious that not all astronomical events referred to in almanacs of the Dresden Codex, are *first line manifestations,*[9] which raises the question of how indeed these almanacs were organized.

It is my belief that many almanacs of the Dresden Codex were organized by taking isolated (but often cyclical) astronomical events and placing them in *t'ols* not necessarily connected by the black distance numbers between them. This may be visualized as the Maya having drawn events from a day by day astronomical record covering perhaps several *tuns*: only the red day names have been extracted from the long count dates of the events and placed in an almanac where the black distance numbers reflect only the distance in the *tzolkin* to the day name of the next chosen event. The events chosen for inclusion in an almanac may reflect particular religious significance accorded to those events falling on certain days of the *tzolkin*, with priority given to the coefficient of a particular set of days. Thus, events portrayed in the *t'ols* may occur as other than *first line manifestations.*

This organizing principle is related to the one used in the I_2 mode of the Paris table and may be expressed mathematically: the distance between succeeding red day coefficients in any two *t'ols* equals the sum of the black distance numbers plus *n* times the number of days in one repetition of the almanac; in our example from the almanac on Dresden 38b–41b:

$$\text{Distance: } lub \rightarrow t'ol\ 9 = 87 + n \times 104^{10}$$

When $n = 0$, we have a *first line manifestation*; subsequent readings will yield *second* and *third line manifestations*, etc.

These concepts must, of course, be used with great caution in the investigation of the Dresden almanacs; it is, in my case at least, a matter of "feel." However, I am certain that careful application of these concepts will make it possible to place many of the Dresden almanacs within the framework of the long count and to extract the utmost of astronomical and glyphic information. For the present, I have carried the analysis only so far as necessary in elucidating the identity of the Black Spotted Dog as a member of the Maya zodiacal sequence which continues Jaguar/Rattlesnake/Turtle.

[8] This applies also to the Mercury heliacal rising in *t'ol* 8: all days reached on successive readings bear a red coefficient of 4, but the first, 4 Men, was the day of the event (10.6.10.16.15 **4 Men** 8 Xul).

[9] These may turn out to be reserved for the more important events. Conjunctions and heliacal risings are of obvious significance, and here, but not necessarily elsewhere, the Maya concept accords roughly with our own.

[10] This almanac is a double *tzolkin* (520 days); the *lub* is reached after five repetitions of the basic interval (104 days): 5 × 104 = 520. It has an *indirect lub* probably because the day 13 Akbal (the *indirect lub*) did not figure in the events organized within.

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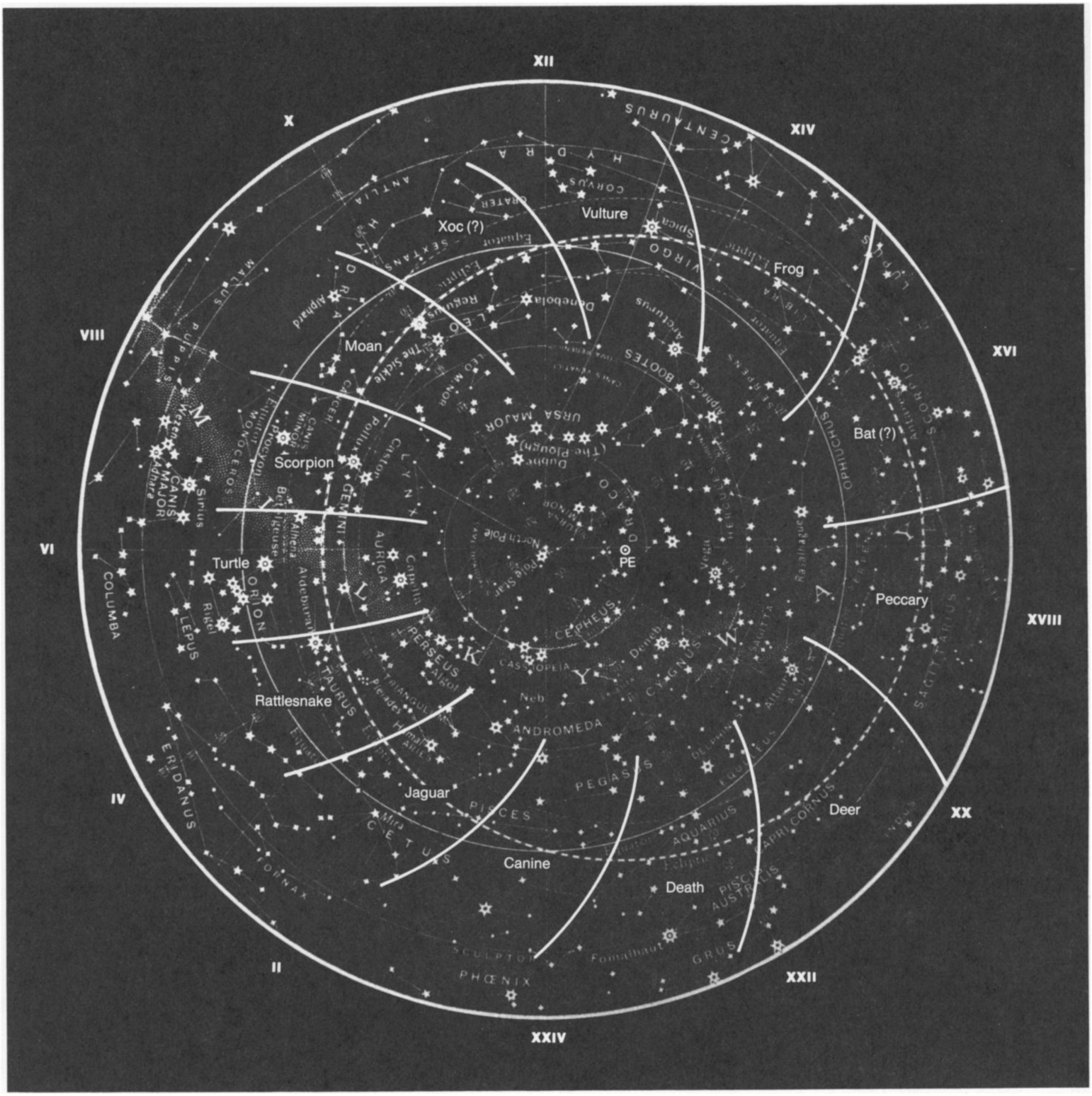

Note: the "houses" of the Maya zodiac extend arbitrarily 30° north and south of the ecliptic. This chart is an equatorial projection from the celestial north pole whereas the constellation boundaries project from the north pole of the ecliptic (PE on chart); hence the lines do not appear equally spaced and straight. See table 13, p. 55, and figure 10, p. 57, for the coordinates of the boundaries, and footnote 18, p. 20, for positions of the stations of the year.

INDEX

Chronology Table of Long Count Dates[1]

Calendar round	Long count	Page
9 Kan 12 Kayab	(*lub* serpent nos.)	91
12 Lamat 11 Pax	12.19.12.14. 8	30*
8 Ahau 18 Zec	12.19.13. 4. 0	30
1 Ahau 18 Kayab	12.19.13.16. 0	33,39
4 Ahau 8 Cumku	13. 0. 0. 0. 0	9*
12 Lamat 1 Zec	13. 0. 4. 6. 8	30*
5 Lamat 6 Zotz	5. 0.12.14. 8	68
9 Kan 12 Yaxkin	8. 3. 8. 3. 4	94
13 Akbal 16 Pop	8.16.14. 9. 3	94
1 Ahau 18 Kayab	9. 9. 9.16. 0	39
10 Ahau 8 Yaxkin	9.12. 0. 0. 0	18, 48, 82
4 Eb 10 Yax	9.12.10. 5.12	41
7 Imix 14 Zec	9.13.11. 6. 1	65
12 Chicchan 8 Pax	9.14.19.10. 5	94
7 Ahau 3 Zip	9.15. 9.13. 0	65, 90, 91
3 Ahau 3 Mol	9.15.10. 0. 0	55*
11 Ik 15 Chen	9.15.12. 2. 2	55*
12 Akbal 16 Chen	9.15.12. 2. 3	59
6 Eb 0 Pop	9.15.12.11.12	62
7 Ben 1 Pop	9.15.12.11.13	62
7 Imix 14 Zec	9.16. 4. 1. 1	65
2 Ben 6 Zac	9.16. 4. 6.13	82
12 Lamat 1 Muan	9.16. 4.10. 8	30, 50, 51
1 Akbal 16 Muan	9.16. 4.11. 3	50, 51
3 Etznab 11 Pax	9.16. 4.11.18	50
9 Cimi 14 Yaxkin	9.16. 5. 3. 6	31
6 Caban 10 Mol	9.16.12. 5.17	31, 65–66, 90
3 Chicchan 18 Xul	9.17. 8. 8. 5	92
5 Cib 14 Chen	9.17.19.13.16	50
3 Kan 12 Yax	9.18. 5.16. 4	94
3 Ahau 3 Yax	9.18.15. 0. 0	41
2 Ben 6 Zac	9.18.17. 1.13	82
9 Ahau 18 Mol	9.19. 0. 0. 0	45
7 Ahau 18 Zip	10. 0. 0. 0. 0	76, 86
5 Ahau 3 Kayab	10. 1. 0. 0. 0	82
2 Ben 6 Zac	10. 1. 9.14.13	82, 84–85
4 Ahau 13 Kankin	10. 1.10. 0. 0	82
11 Lamat 6 Yax	10. 1.12.14. 8	71, 76, 81
6 Caban 10 Zip	10. 1.13. 7.17	77*
3 Ahau 3 Ceh	10. 2. 0. 0. 0	76, 77, 86
1 Ahau 3 Yaxkin	10. 3. 0. 0. 0	49, 76, 77, 86
1 Cib 4 Pop	10. 3.14.15.16	52–53
5 Ahau 3 Uo	10. 4. 0. 0. 0	76
13 Akbal 1 Kankin	10. 6.10. 6. 3	91–92
6 Cauac 12 Uo	10. 6.10.12.19	92
4 Men 8 Xul	10. 6.10.16.15	95
2 Cimi 19 Xul	10. 6.10.17. 6	92–94
3 Chicchan 13 Yaxkin	10. 7. 4. 3. 5	91
12 Lamat 6 Mac	10.11. 3.10. 8	50
1 Ahau 13 Mac	11. 0. 3. 1. 0	75
1 Eb 0 Yax	11. 1. 4. 2.12	74
1 Ahau 3 Xul	11. 5. 2. 0. 0	75
5 Manik 15 Muan	11. 8. 2. 6. 7	94
12 Kan 1 Pop	(equiv. July 15, 1553)	54

* First appearance in text; these dates occur several times on succeeding pages.

[1] Further Maya dates are listed in table 10, pp. 42–44, and chapter 4, footnote 2, p. 49; the former encompass long count dates associated with lunar series, the latter delineate the thirteen-*katun* chronological sequence on Paris 1–13; together they form a comprehensive chronology of Maya dates discussed in the text.

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