COMMENTS

MORE ON MESOAMERICAN COSMOLOGY AND CITY PLANS

Ivan Šprajc

In a recent comment Michael Smith argues that the cosmological interpretations of Maya urban layouts proposed in an article by Ashmore and Sabloff are vague and unconvincing. He also summarizes some other comparable studies in order to show that arguments for the cosmological significance of archaeologically recovered urban patterns are, in general, subjective and lack methodological rigor. I argue that his view is an unwarranted generalization and that his references to some archaeoastronomical interpretations do not adequately reflect the advances in this field of research and its relevance for the understanding of ancient city plans. I summarize the results of several studies in Mesoamerica, focusing on Teotihuacan and the Templo Mayor of Tenochtitlan discussed by Smith, to show that rigorous methods not only have been applied in archaeoastronomical research but also have resulted in explicit conclusions about specific aspects of worldview and political ideology underlying Mesoamerican architecture and urbanism.

En un comentario reciente Michael Smith argumenta que las interpretaciones cosmológicas de las trazas urbanas mayas, propuestas en un artículo publicado anteriormente por Ashmore y Sabloff, son vagas y poco convincentes. También resume otros estudios comparables, para mostrar que los argumentos respecto al significado cosmológico de los patrones urbanos arqueológicamente recuperados son, en general, subjetivos y carecen de rigor metodológico. Trato de demostrar que la opinión de Smith es una generalización infundada y que sus referencias a algunas interpretaciones arqueoastronómicas no reflejan de manera adecuada los avances en este campo de investigación y su relevancia para la comprensión de las trazas urbanas antiguas. Al resumir los resultados de varios estudios en Mesoamérica, y enfocándome en Teotihuacan y el Templo Mayor de Tenochtitlan discutidos por Smith, hago patente que los métodos rigurosos no sólo han sido aplicados en la investigación arqueoastronómica sino que han resultado en conclusiones explícitas acerca de aspectos específicos de cosmovisión e ideología política involucrados en la arquitectura y el urbanismo mesoamericanos.

In a comment published in a former issue of this journal, Michael Smith (2003) challenges the cosmological interpretations of Maya urban layouts proposed by Wendy Ashmore and Jeremy Sabloff (2002). He argues that their hypotheses are weak, vague, and unconvincing and emphasizes the need for rigorous methods in this kind of research. In his subsequent essay, Smith (this volume) extends his criticism to recent applications of the "cosmogram" concept to Maya architectural layouts. It is not my purpose to comment on his critique of the ideas expressed by Ashmore and Sabloff; their own reply (2003) eliminates many doubts and makes their procedures much more explicit than they had been before. Neither will I debate Smith's contribution published in this issue: even if one would prefer to see a better-founded case-by-case discussion, rather than a sweeping rejection, I agree that many recent interpretations in terms of cosmograms seem to be the result more of a kind of fashion trend than of serious research supported by evidence.

Instead, and following Ashmore and Sabloff's (2003:233–234) invitation to continue the dialogue and discussion, I would like to focus on the more general part of Smith's (2003) argument in his earlier article, in which he discusses the difficulties involved in cosmological interpretations of archaeologically recovered urban layouts. Nobody seriously engaged in any scientific endeavor will question his contention that "research in this area requires rigorous and explicit methods if it is to have credibility within the archaeological community" (2003:221–222). However, when he admits that "site maps often suggest that some sort of spatial order existed in ancient cities" but adds that "schol-

Ivan Šprajc ■ Scientific Research Center of the Slovenian Academy of Sciences and Arts, Novi trg 2, SI-1000 Ljubljana, Slovenia (sprajc@zrc-sazu.si)

Latin American Antiquity, 16(2), 2005, pp. 209–216
Copyright© 2005 by the Society for American Archaeology

ars have yet to develop systematic approaches to the study of the nature and origin of that order" (2003:221), he makes a subjective and unbalanced generalization, neglecting many recent advances and reliable methodological procedures applied in this field of research.

Presenting some cosmological interpretations of particular city plans from different cultures, Smith argues that they are unconvincing and that alternative hypotheses, unrelated to cosmology or worldview, could be substituted. One of the examples he discusses to support his opinion that the cosmological meanings of Mesoamerican urban layouts have not been recovered with confidence and rigor is the Templo Mayor of Tenochtitlan. He affirms that the large body of scholarship on the role of cosmology in the design of this structure "relies almost exclusively on subjective interpretations of Aztec myths and rituals" (2003:222), and he doubts that the results of these studies can be extended to the whole city of Tenochtitlan. The main temple of the Aztec capital is supposed to illustrate "the difficulty of inferring the ideas and intentions of rulers and builders from the material remains of urban sites, even when there is a corpus of written documentation" (Smith 2003:223). Smith presents some historical data and archaeoastronomical hypotheses about the meaning of the Templo Mayor and suggests that the urban pattern of Tenochtitlan might be an imitation of the Teotihuacan grid, but in doing so he fails to take into account all the relevant evidence and ignores recent advances both in Mesoamerican archaeoastronomy in general and in the understanding of Teotihuacan and the Templo Mayor of Tenochtitlan in particular.

Because the astronomically derived concepts were an important part of ancient cosmologies or worldviews, it is obvious that archaeoastronomy, specialized in the study of diverse manifestations of these concepts, including architectural orientations, has a prominent role in the search for the cosmological templates of the ancient urban plans. Smith's marginal references to some archaeoastronomical works do not reflect the fact that this field of research—in spite of examples of bad scholarship—has made significant progress precisely in the direction he demands: toward the application of rigorous methods and techniques that yield reliable and testable results. To support this statement I will summarize a few archaeoastronomical studies that have contributed to the understanding of Mesoamerican urban planning, with a special emphasis on two cases discussed by Smith: Teotihuacan and the Templo Mayor of Tenochtitlan.

Archaeoastronomy and Mesoamerican Urban Layouts

The shortest way of summarizing the methodological guidelines for any serious archaeoastronomical study of orientations might be the following: to conclude, with a reasonable degree of confidence, that an architectural orientation, or any alignment recognized in the archaeological record or ancient cultural landscape, had an intentionally chosen astronomical target, we need either a statistically significant number of comparable alignments, incorporated in a coherent set of archaeological features (i.e., of the same type and pertaining to the same cultural complex) and referring to the same position (declination) on the celestial sphere; or independent contextual evidence suggesting an astronomical motive for the alignment in question (iconography, written sources, etc.); or both. On the other hand, the meaning of an alignment, or a homogenous set of alignments with the same astronomical referent, can be properly understood only if we manage to find reasons for which the postulated astronomical phenomenon could have been significant to the society that produced the alignment(s). The viability of archaeoastronomical hypotheses is directly proportional to the degree of significance that can be assigned to the astronomical phenomena involved. Such significance is to be sought in the relationship of the astronomical phenomena with specific environmental and cultural facts (e.g., seasonal climatic changes, subsistence strategies, religion, political ideology, etc.; cf. Aveni 2003; Iwaniszewski 1989; Ruggles 1999).

The application of these general methodological principles in Mesoamerican archaeoastronomy can be illustrated by a number of studies, which have led to the recognition of particular concepts involved in prehispanic architectural and urban planning. Systematic research carried out during the last few decades has revealed that the orientations in civic and ceremonial architecture exhibit a clearly nonrandom distribution, which indicates that the buildings were mostly oriented on the basis

of astronomical considerations, particularly to the Sun's positions on the horizon on certain dates of the tropical year (Aveni 2001; Aveni and Gibbs 1976; Aveni and Hartung 1986; Tichy 1991). Any skeptic wanting to challenge this conclusion should offer an alternative explanation for the widespread orientation groups (the azimuths clustering around certain values occur at a number of sites in different Mesoamerican regions, some of them over long time spans), as well as for the fact that most of the east–west azimuths lie within the angle of annual movement of the Sun along the horizon.[1]

Furthermore, interpretations based on contextual evidence have been proposed concerning both the practical and the symbolic significance of architectural orientations. Aveni and Hartung (1986), for example, have analyzed a number of alignments in Maya architecture and conclude that they allowed the use of observational calendars based on solar zenith passages and other dates separated by multiples of 20 days, that is, basic periods of the Mesoamerican calendrical system; these observational calendars, they (1986:56–57) argue, must have served agricultural needs. The existence of similar observational schemes, composed of calendrically significant and, therefore, easily manageable intervals, is disclosed by a recent study (Šprajc 2001) based on 37 archaeological sites with monumental architecture in central Mexico: the intervals separating the sunrise and sunset dates recorded by the alignments tend to be multiples of 13 and 20 days. Because the dates included in these patterns are found to correspond to sunrises and sunsets both along architectural orientations and above prominent hilltops on the local horizon, it has been argued that important ceremonial structures were not only oriented but also located on astronomical grounds. The correspondence between the most frequently recorded dates and the crucial moments of the cultivation cycle suggests that the reconstructed observational schemes facilitated a proper scheduling of agricultural and associated ritual activities (Sprajc 2001).

Aveni et al. (2003) recently studied alignments involved in a special type of Maya architectural assemblage located in the Petén area and resembling Group E at Uaxactún, Guatemala. Their analysis, based on a statistically significant and typologically homogenous sample of alignments, led them to abandon a previous hypothesis, which interpreted the greater part of these assemblages as nonfunctional imitations of the (astronomically functional) Group E of Uaxactún (Aveni and Hartung 1989). They then conclude that the alignments reflect the use of observational schemes composed of calendrically significant intervals. They also note that the most frequently recorded dates suggest the importance of anticipatory Sun sightings during the dry half of the year leading up to the planting season (Aveni 2003:161–162; Aveni et al. 2003:163).

Even if the observational function of architectural orientations indicates their relationship with practical needs, which is in accordance with what we know about the adaptive value of astronomical knowledge and its consequent importance in archaic civilizations (Aveni and Hartung 1986:56; Iwaniszewski 1989:28–29; Šprajc 1996a:20–22), the alignments cannot be understood in purely utilitarian terms. As the repeatedly occurring directions are most consistently incorporated in the monumental architecture of civic and ceremonial urban cores, entailing considerable effort, they must have had an important place in the worldview and even in the cosmologically substantiated political ideology. This can be understood if we consider that the apparently immutable and perfect order observed in the sky, obviously superior to the one reigning on the earth, must have been the primary source of the deification of heavenly bodies, whose cyclic behavior thus was not viewed as being simply correlated with seasonal transformations in the natural environment but, rather, as provoking them. Assuming that also the proper annual movement of the Sun was, therefore, believed to be responsible for timely occurrences of these changes, the directions to the points of sunrise and sunset on crucial dates of the agricultural cycle must have acquired a sacred dimension. Because the beliefs composing the worldview were incorporated into the political ideology of rulers, who as man-gods pretended to be responsible for the proper functioning of the universe (cf. López Austin 1973), the alignments reproducing significant astronomical directions in civic and ceremonial architecture can be interpreted not only as a sanctified materialization of the union of space and time (whose importance in the Mesoamerican worldview is attested in different sources) but also as a manifestation of attempts of the governing class to legitimate its

power by re-creating and perpetuating the cosmic order in the earthly environment (Aveni 2001:148–152, 217–222; Šprajc 1996a:21–22).

The ability to determine specific dates, whose importance was vital for subsistence, and to lay out accurate alignments to the corresponding solar events was obviously not a public domain based on a commonly shared worldview but, rather, part of the esoteric knowledge reserved for the elite. If these phenomena, which in certain architectural configurations produced light and shadow effects that may have been conceived as solar hierophanies, were observed on predicted dates, they sanctioned the ideology of the ruling class, reinforced social cohesion, and thereby contributed to the preservation of the existing political order (Broda 1982:99–105, 1991:462–463, 491; Iwaniszewski 1989:30–31; Šprajc 2001:121–122, 154–155, 411–415).

Although these are rather general conclusions, the studies summarized above, as well as many others, offer quite specific answers about a significant part of the regularities detected in the spatial ordering of Mesoamerican cities. Beyond merely identifying the astronomical phenomena implicated, they attempt to explain the reasons for their importance in terms of what we know about the economy, worldview, and political organization of the societies involved. However, although "perhaps more often than we have yet recognized, the sky provides the cues to spatial order on the terrestrial plane" (Knapp and Ashmore 1999:3), the following example illustrates archaeoastronomers' awareness of the fact that an objective and comprehensive understanding of this order can only be achieved by exploring both its astronomical and other possible foundations and by placing these efforts within a broader context of landscape archaeology (cf. Aveni 2001:217–222; Ruggles 1999:112–124).

Aveni (1991:63) has observed that in a number of cases in Mesoamerica, a prominent mountain is found to the north of a civic or ceremonial center. Furthermore, in central Mexico there are a large number of structures accurately oriented to mountaintops on the local horizon. Though there is no clear preference for the east- or west-lying mountains, the number of buildings aligned to a peak to the north is nearly twice as large as the number of those oriented to a hill to the south (Šprajc 2001:57). Even if the prominent summits on the eastern and western horizon could have served as precise markers of the Sun's positions and thereby facilitated observations, the relationship of architectural orientations with mountains, in general, may be accounted for by the latter's aquatic and fertility symbolism, an important aspect of the Mesoamerican worldview (Broda 1991), whereas the prevalence of the north-lying mountains probably reflects beliefs connecting not only mountains but also the northern part of the universe with water and fertility (Šprajc 1996b:41–43, 58–61). The discovery of this pattern, which reveals that not all of the evidently intentional alignments were based on astronomical motives, adds another element to our understanding of the complex set of rules that dictated architectural and urban planning in Mesoamerica, in which astronomical considerations were intertwined with beliefs about the symbolic meanings of landscape features and sides of the world.

In some cases, if there is a sufficient amount of supportive contextual data, a plausible interpretation can be proposed even for a single orientation. An illustrative example is the Palace of the Governor at Uxmal, Yucatán, Mexico. The plastic decoration of the façade includes nearly 400 Venus glyphs. The correspondence between five synodic periods of Venus and eight years was well known to the Maya; therefore, the fact that the masks of the rain god Chac adorning the façade are arranged in groups of five as well as the occurrence of eight bicephalic serpent bars above the main entrance and of a numeral eight on a Chac mask at the palace's northeast corner also suggest some relationship of the building with Venus. Aveni (1975:183–186; Aveni and Hartung 1986:22–34) long ago related the orientation of this structure to the southernmost rising point of Venus as the morning star, and my own interpretation links the alignment to the great northerly extremes of the evening star (Šprajc 1996a:173–178, 1996b:75–77). My argument is based on a better agreement of the orientation with the evening star extremes, as well as on the fact that Venus glyphs are placed in the cheeks of the rain god masks, probably alluding to the coincidence of these phenomena, always occurring in late April or early May, with the onset of the rainy season. Aveni (2001:286), on the other hand, attributes less importance to precision; apart from the fact that the building faces east, he mentions other data that, he

believes, more strongly support an eastward-directed orientation scheme.

Here it is important to stress that the difference between Aveni's and my own interpretations by no means reflects inconsistencies in the methodology applied or a lack of credibility of archaeoastronomical hypotheses. Our disagreement, which concerns only the final details of our proposals and derives from giving different weights and interpretations to particular types of contextual evidence, may eventually be solved by the application of the very same methodology we have been employing. What we need is more comparative data. If more orientations that can be associated with Venus extremes are detected, it will be possible to find out how closely they match the morning/evening star extreme rising/setting points; by evaluating the degree of precision involved, it should become easier to identify the phenomena targeted in particular cases. For the moment only a few other structures probably referring to Venus extremes are known (e.g., El Circular at Huexotla, in the Valley of Mexico, and the Caracol at Chichén Itzá, Yucatán [Aveni 2001:273–276; Šprajc 1996a:178–184, 1996b:72–85]), constituting too small a sample to allow any reliable conclusion.

Teotihuacan and the Templo Mayor of Tenochtitlan

To support his overall skepticism concerning the reliability of cosmological interpretations of Mesoamerican urban plans, Smith discusses two examples from central Mexico. If properly viewed in the light of the evidence available, however, they constitute perhaps the most illustrative cases that refute his opinion.

Smith (2003:222–223) suggests that the Aztecs, designing the layout of Tenochtitlan, may have simply imitated the orthogonal grid of Teotihuacan, irrespective of any cosmological notions of their own, and also that this pattern may have nothing to do with the passage of the Sun. In view of the arguments he presents, it might be assumed that a grid layout originated for reasons not related to cosmology; however, such motives can by no means account for the *orientations* of the two urban grids.

The two main orientations embedded in the urban layout of Teotihuacan pertain to the so-called 17° family, which is one of the most widespread alignment groups in Mesoamerica (Aveni 2001:234). Numerous hypotheses have been proposed about the meaning of these orientations (Aveni 2001:223–230, 2003:156–158). Partly in agreement with these former proposals is my own interpretation, based on both contextual evidence and a large sample of comparative alignment data (Šprajc 2000a). Because the whole argument, including an exhaustive discussion of previous hypotheses, has been presented elsewhere (Sprajc 2001:107–120, 201–238), I will only summarize the most important conclusions: (a) the two similar but slightly different orientations dominating the Teotihuacan urban grid must have been dictated by those of the Sun Pyramid and the Ciudadela; (b) both orientations were related to the Sun's positions on the horizon on dates separated by calendrically significant intervals and composing a canonical agricultural cycle; and (c) the Pyramid of the Sun was deliberately located on the spot where the perpendicular to the intended east–west alignment pointed to Cerro Gordo to the north and from where sunrises on a pair of significant dates (recorded at several other sites) could be observed over a prominent mountain on the eastern horizon.

Some of these interpretations may be challenged. It is a fact, however, that architectural alignments at a number of other sites from different periods correspond to sunrises and sunsets on the very same dates as those recorded by the east–west axes of the Pyramid of the Sun and the Ciudadela at Teotihuacan, and we can thus conclude with reasonable certainty that these alignments, indeed, referred to the Sun, and also that the target dates had some practical or ritual significance, or both.[2] Therefore, if urban layouts reproduce such alignments, then they can hardly be explained only in terms of "energetic efficiency" or even "random or stochastic growth processes" (Smith 2003:223).

Although the archaeological information about the urban layout of Tenochtitlan is much poorer than in the case of Teotihuacan, we can reach a similar conclusion and even support it with historical data. It has been commonly held that the streets in the historical center of Mexico City follow the prehispanic urban configuration. This is, indeed, very likely if we consider that the orientation of the colonial grid, skewed 7–8° clockwise from cardinal directions, corresponds with the orientation of

Phase II of the Templo Mayor. As in Teotihuacan, the main temple of Tenochtitlan must have dictated the orientation of the prehispanic urban layout, which was later adopted by the colonial grid. Although the grid pattern per se may have been a tradition inherited from Teotihuacan, as Smith (2003:222) suggests, we can, again, hardly find an interpretation other than the astronomical one for its orientation, which is different from that prevailing in the Classic period metropolis but belongs to a group common in Postclassic central Mexico (Šprajc 2001: Figure 7).

However, the famous text inserted in Motolinía's work and mentioned by Smith (2003:222), saying that the feast of Tlacaxipehualiztli "fell when the sun was in the middle of Uchilobos, which was the equinox" (Motolinía 1971:51), obviously refers to the temple that was in use at the time of Spanish conquest. When Aveni and Gibbs (1976:513–516) and Aveni et al. (1988) attempted to reconcile this statement with the orientation of the Templo Mayor, suggesting that the equinox sunrises were observed in the notch between the two upper sanctuaries, they assumed that the orientation of Phase II was preserved by subsequent construction stages. This assumption was supported by the north–south alignment azimuths, which remained virtually the same throughout the temple's construction history. It is now clear, however, because of precise orientation measurements in the Templo Mayor precinct, that in its walls running east–west Phase III adopted a different orientation, which was maintained in all the following phases up to the conquest and was incorporated also in many adjacent structures. One of the two sunset dates corresponding to the east–west axis of the temple's late construction stages, including the last one, is 4 April, which in the Julian calendar of the sixteenth century corresponded to 25 March. In 1519, this was the last day of the month of Tlacaxipehualiztli, according to the day-by-day correlation of the Mexica and Julian calendars established by Caso (1967:58, Table IV) and supported by different kinds of evidence (Prem 1991; Šprajc 2000c). According to various sources (including Motolinía 1971:45), the main feast of every month was celebrated on its last day (Caso 1967:39, 51; Prem 1991:395). Furthermore, in medieval Europe, 25 March, the Feast of the Annunciation, was commonly identified with the vernal equinox (McCluskey 1993:110–111, 114; Newton 1972:22–27).[3] We can thus conclude that the author of the statement quoted above did not refer to the astronomical equinox (the date of which would have hardly been known to a nonastronomer at that time). Rather, he only made note of the correlation between the day of the Mexica festival, which in the last years before the conquest coincided with the sunset along the axis of the Templo Mayor, and the date of the Christian (Julian) calendar that corresponded to the traditional day of spring equinox (see the whole argument in Sprajc 2000b, 2001:383–410).

Both the text inserted in Motolinía and the drawing of the Templo Mayor in the map of Tenochtitlan attributed to Cortés, where the Sun disk is shown between the twin sanctuaries, have frequently been interpreted as references to the observation of *sunrises*, but the sources are far from explicit. The fact that Marquina, paraphrasing Motolinía, mentions the Sun "in front of Huichilobos" (1960:113) shows clearly that the text is ambiguous and may well refer to *sunsets* in the axis of the building. Additionally, the Templo Mayor faces west, which might be an indication of the special importance of that direction. Nonetheless, and in spite of the prevalence of west-facing temples, it has been argued that most architectural orientations in central Mexico were astronomically functional in both eastern and western directions (Šprajc 2001:69–71); because the observational scheme proposed for the late stages of the Templo Mayor and composed of calendrically significant intervals includes both sunrise and sunset dates (Šprajc 2000b:S22, 2001:399), the scene depicted in the map of Tenochtitlan may represent a general allusion to the relationship between the temple's orientation and the Sun.

Whereas the hypothesis forwarded by Aveni and Gibbs (1976) and Aveni et al. (1988) implies an oblique alignment (i.e., to a celestial target well above the horizon), the azimuth distribution patterns exhibited by Mesoamerican architectural orientations indicate that in most cases these orientations recorded astronomical phenomena on the horizon (Šprajc 2001:25). There is evidence suggesting that orientations similar to that of the late stages of the Templo Mayor of Tenochtitlan (5°36' south of east) were common in the area of Texcoco (Šprajc 2001:322, 324–325, 330). The agreement between the text in Motolinía and one

of the two sunset dates corresponding to the archaeologically attested orientation of the late phases of the Templo Mayor is hardly fortuitous and offers probably the most convincing support to the conclusion that this structure, as so many others, was intentionally oriented to the Sun's positions on the horizon.

Moreover, considering that two prominent mountain peaks on the eastern horizon of the Templo Mayor of Tenochtitlan marked sunrises on significant dates (included in observational calendars reconstructed for both orientations), it seems very likely that even the location of this building, just like that of the Sun Pyramid at Teotihuacan (Šprajc 2000a:410–412, 2001:231–238), was determined by astronomical considerations related to the surrounding topography. The idea is supported by independent evidence indicating that the site where the Templo Mayor was erected was, in practical terms, hardly appropriate for construction. Based on the results of their analyses of soil mechanics, Mazari et al. (1989) argue that no natural island had ever existed on the spot and that the temple was built upon a huge artificial platform some 11 m in height and submerged approximately 6 m below the lake surface (Šprajc 2000b:S22, 2001: 397–398).

Epilogue

The preceding examples show that archaeoastronomical studies can and do formulate explicit conclusions based on coherent data selection and rigorous methodological procedures. Though they obviously do not represent the only approach to the understanding of Mesoamerican architecture and urbanism, they do offer answers to a number of specific questions concerning the nature of the underlying concepts, their significance with respect to the natural environment and cultural context, and their consequent role in worldview and political ideology.

Some time ago Kintigh asserted that "archaeologists see archaeoastronomers as answering questions that, from a social scientific standpoint, no one is asking" (1992:1). Smith's opinion, if shared by a wider community, gives a somewhat different impression: archaeoastronomers may be viewed as giving relevant answers that, within the "mainstream" archaeological audience, no one reads. My foregoing comments represent an attempt to bridge the communication gap between the two, who are in any case closely related brands of scholars, and an invitation to combine our efforts in the pursuit of common anthropological goals.

References Cited

Ashmore, Wendy, and Jeremy A. Sabloff
2002 Spatial Orders in Maya Civic Plans. *Latin American Antiquity* 13:201–215.
2003 Interpreting Ancient Maya Civic Plans: Reply to Smith. *Latin American Antiquity* 14:229–236.

Aveni, Anthony F.
1975 Possible Astronomical Orientations in Ancient Mesoamerican Architecture. In *Archaeoastronomy in Pre-Columbian America*, edited by Anthony F. Aveni, pp. 163–190. University of Texas Press, Austin.
1991 Mapping the Ritual Landscape: Debt Payment to Tlaloc during the Month of Atlcahualo. In *To Change Place: Aztec Ceremonial Landscapes*, edited by Davíd Carrasco, pp. 58–73. University Press of Colorado, Niwot.
2001 *Skywatchers: A Revised and Updated Version of Skywatchers of Ancient Mexico*. University of Texas Press, Austin.
2003 Archaeoastronomy in the Ancient Americas. *Journal of Archaeological Research* 11:149–191.

Aveni, Anthony F., E. E. Calnek, and H. Hartung
1988 Myth, Environment, and the Orientation of the Templo Mayor of Tenochtitlan. *American Antiquity* 53:287–309.

Aveni, Anthony F., Anne S. Dowd, and Benjamin Vining
2003 Maya Calendar Reform? Evidence from Orientations of Specialized Architectural Assemblages. *Latin American Antiquity* 14:159–178.

Aveni, Anthony F., and Sharon L. Gibbs
1976 On the Orientation of Precolumbian Buildings in Central Mexico. *American Antiquity* 41:510–517.

Aveni, Anthony F., and H. Hartung
1986 *Maya City Planning and the Calendar*. Transactions of the American Philosophical Society Vol. 76, Pt. 7. American Philosophical Society, Philadelphia.
1989 Uaxactun, Guatemala, Group E and Similar Assemblages: An Archaeoastronomical Reconsideration. In *World Archaeoastronomy*, edited by A. F. Aveni, pp. 441–461. Cambridge University Press, Cambridge.

Broda, Johanna
1982 Astronomy, Cosmovisión, and Ideology in Pre-Hispanic Mesoamerica. In *Ethnoastronomy and Archaeoastronomy in the American Tropics*, edited by Anthony F. Aveni and Gary Urton, pp. 81–110. Annals of the New York Academy of Sciences Vol. 385. New York.
1991 Cosmovisión y observación de la naturaleza: El ejemplo del culto de los cerros en Mesoamérica. In *Arqueoastronomía y etnoastronomía en Mesoamérica*, edited by Johanna Broda, Stanislaw Iwaniszewski, and Lucrecia Maupomé, pp. 461–500. Universidad Nacional Autónoma de México, Mexico City.

Caso, Alfonso
1967 *Los calendarios prehispánicos*. Universidad Nacional Autónoma de México, Mexico City.

Iwaniszewski, Stanisław
1989 Exploring Some Anthropological Theoretical Foundations for Archaeoastronomy. In *World Archaeoastron-*

omy, edited by A. F. Aveni, pp. 27–37. Cambridge University Press, Cambridge.

Kintigh, Keith W.
1992 I Wasn't Going to Say Anything, but Since You Asked: Archaeoastronomy and Archaeology. *Archaeoastronomy and Ethnoastronomy News* 5:1–4.

Knapp, A. Bernard, and Wendy Ashmore
1999 Archaeological Landscapes: Constructed, Conceptualized, Ideational. In *Archaeologies of Landscape: Contemporary Perspectives*, edited by Wendy Ashmore and A. Bernard Knapp, pp. 1–30. Blackwell, Malden, Massachusetts.

López Austin, Alfredo
1973 *Hombre-dios: Religión y política en el mundo náhuatl*. Universidad Nacional Autónoma de México, Mexico City.

Marquina, Ignacio
1960 *El Templo Mayor de México*. Instituto Nacional de Antropología e Historia, Mexico City.

Mazari, Marcos, Raúl J. Marsal, and Jesús Alberro
1989 Los asentamientos del Templo Mayor analizados por la mecánica de suelos. *Estudios de Cultura Náhuatl* 19:145–182.

McCluskey, Stephen C.
1993 Astronomies and Rituals at the Dawn of the Middle Ages. In *Astronomies and Cultures*, edited by Clive L. N. Ruggles and Nicholas J. Saunders, pp. 100–123. University Press of Colorado, Niwot.

Motolinía, Fray Toribio de Benavente
1971 *Memoriales o libro de las cosas de la Nueva España y de los naturales de ella*. Edited by Edmundo O'Gorman. Universidad Nacional Autónoma de México, Mexico City.

Newton, Robert R.
1972 *Medieval Chronicles and the Rotation of the Earth*. John Hopkins University Press, Baltimore.

Prem, Hanns J.
1991 Los calendarios prehispánicos y sus correlaciones: Problemas históricos y técnicos. In *Arqueoastronomía y etnoastronomía en Mesoamérica*, edited by Johanna Broda, Stanislaw Iwaniszewski, and Lucrecia Maupomé, pp. 389–411. Universidad Nacional Autónoma de México, Mexico City.

Ruggles, Clive
1999 *Astronomy in Prehistoric Britain and Ireland*. Yale University Press, New Haven.

Smith, Michael E.
2003 Can We Read Cosmology in Ancient Maya City Plans? Comment on Ashmore and Sabloff. *Latin American Antiquity* 14:221–228.

Šprajc, Ivan
1996a *La estrella de Quetzalcóatl: El planeta Venus en Mesoamérica*. Editorial Diana, Mexico City.
1996b *Venus, lluvia y maíz: Simbolismo y astronomía en la cosmovisión mesoamericana*. Colección Científica 318. Instituto Nacional de Antropología e Historia, Mexico City.
2000a Astronomical Alignments at Teotihuacan, Mexico. *Latin American Antiquity* 11:403–415.
2000b Astronomical Alignments at the Templo Mayor of Tenochtitlan, Mexico. *Archaeoastronomy* 25 (*Journal for the History of Astronomy* 31 [supplement]):S11–S40.
2000c [2001] Problema de ajustes del año calendárico mesoamericano al año trópico. *Anales de Antropología* 34:133–160.
2001 *Orientaciones astronómicas en la arquitectura prehispánica del centro de México*. Colección Científica 427. Instituto Nacional de Antropología e Historia, Mexico City.

Tichy, Franz
1991 *Die geordnete Welt indianischer Völker: Ein Bespiel von Raumordnung und Zeitordnung im vorkolumbischen Mexiko*. Das Mexiko-Projekt der Deutschen Forschungsgemeinschaft 21. Franz Steiner Verlag, Stuttgart.

Notes

1. In their study on Maya architectural alignments, Aveni and Hartung comment: "The astronomical hypothesis would seem especially worthy of consideration if we find alignments that are confined to a narrow azimuthal range in a sample of buildings spread far apart in space. In this case, there can be no conceivable way of actually laying out the chosen direction other than by the use of astronomical bodies at the horizon as reference objects" (1986:7–8).

2. A particularly illustrative example is the Acropolis of Xochicalco. Just like in the urban grid of Teotihuacan, the buildings of the Xochicalco Acropolis (including the Pyramid of the Feathered Serpents), sufficiently well preserved to allow precise measurements of orientations, incorporate two slightly different east–west alignments, which correspond to the same declinations (sunrise and sunset dates) as the orientations of the Sun Pyramid and the Ciudadela at Teotihuacan (Šprajc 2000a, 2001:201–238, 258–275). The conclusion that the orientations of the 17° family were solar derives precisely from the fact that the target declinations (dates) remained the same for many centuries: had these alignments referred to the rising or setting point of a star, the corresponding declinations would necessarily exhibit a consistent increase/decrease as a function of time, because of precessional shifts in the star's position on the celestial vault.

3. Even if the canonical date of ecclesiastical equinox established in A.D. 325 by the Council of Nicaea was 21 March, the Roman tradition associating the equinox with 25 March also survived (Newton 1972:22–27).

Received November 26, 2003; Accepted February 9, 2005; Revised March 1, 2005.