achieved when no material resources are available, equivalent to the constant losses by respiration and mortality. Making these rates functions of the levels of space and material resources complicates the equations but does not alter the conclusions.
6. An ecologically possible solution requires positive values for x_1, x_2, and x_3. No such solution is possible for either $f_{12} = f_{22} = 0$ or $f_{13} = f_{33} = 0$.
7. M. L. Rosenzweig, *Science* **171**, 385 (1971); C. D. McAllister, R. J. LeBrasseur, T. R. Parsons, *ibid.* **175**, 562 (1972); M. L. Rosenzweig, *ibid.*, p. 564.
8. R. G. Wiegert, in preparation.
9. The development of the ideas in this report has been aided by NSF grants GB-21255 and GB-7683. I am indebted to many students and colleagues for helping shape these ideas. Some comments by W. Anderson prompted the direct comparison with the logistic.

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Origin of the 260-Day Cycle in Mesoamerica

Malmstrom (*1*) has recently attempted to account for the origins of the Mesoamerican 260-day cycle, or sacred almanac, in terms of the interval between zenithal transits of the sun. His hypothesis is that the 260-day cycle originated in the narrow latitudinal band (14°42′N to 15°N) in which the sun is vertically overhead about 12–13 August and again 260 days later about 30 April–1 May. Although this is one of the more stimulating hypotheses on the origins of the sacred almanac, there are serious objections which ought to be raised. It is not a new explanation; Malmstrom was anticipated by several earlier investigators (*2*).

The most serious objection to explaining the origin of the sacred almanac in terms of the interval between zenithal sun positions has been forcefully expressed by Thompson (*3*, pp. 98–99). Although there is a 260-day interval between the autumn and spring zenithal transits of the sun (within the critical latitudinal band), there is a complementary 105-day interval between the spring and autumn positions. The sacred almanac, on the other hand, ran continuously; the spring position would fall on or near the same day in the sacred almanac as the preceding autumn position, but the subsequent autumn position would not correspond. One of the most striking aspects of Mayan calendrics is the importance of reconciling cycles; the Venus table in the Dresden Codex is perhaps the best example of this pervasive concern with the days on which the beginning points of cycles of varying length, all running simultaneously, would coincide (*3*, pp. 208–229). It is extremely unlikely that the 260-day cycle could have been based upon any natural phenomenon that was not continuously repetitive and that was not observable in the greater part of the area in which the sacred almanac was in use.

The nature of the 260-day cycle does not force the conclusion that it was based upon a natural phenomenon. It could simply have resulted from the permutation of its subcycles (13 and 20, both important numbers in Mesoamerican thought), in the same way that the 52-year cycle resulted from the permutation of the 260-day cycle against the solar year (*4*). Thus, any argument for a correspondence with some natural phenomenon must be not merely plausible but compelling.

Malmstrom calls attention to the fact that the lowland site of Izapa is located within the critical latitudinal band, and to the fact that much of the earliest evidence for the use of the Long Count occurs in Late Preclassic contexts which are in some sense Izapan (at least stylistically). As he notes, however, this evidence occurs outside the critical zone, not at Izapa itself; moreover, it is by no means certain that Izapa was the center of this "culture." Malmstrom mentions but does not deal with the fact that the earliest presently known Mesoamerican calendar system—probably (but not unequivocally) involving a typical 260-day cycle—is that of Monte Albán I and II of highland Oaxaca, which is considerably earlier than the Izapan evidence (*5*).

Malmstrom, citing Thompson's (*6*) observations about the distribution of the fauna which lend their names to days in the sacred almanac, rejects the possibility of a highland origin. Although a strong case can be made for a lowland origin, the question is complex and cannot be resolved on the basis of this category of evidence alone. Thompson (*7*) has in fact recently reversed himself, arguing for a highland origin precisely on the basis of the day names.

Although it does not affect his arguments, Malmstrom's misuse of native terms is likely to add confusion to Mesoamerican calendrical studies and should be corrected. He refers to the 260-day cycle as the *tzolkin* or *tonalámatl*, and to the 52-year cycle as the *tonalpohualli*. Actually, *tonalpohualli* ("count of the days") refers to the 260-day cycle, and *tonalámatl* ("book of the days") refers to the books in which it was depicted; *xiuhmolpilli* ("binding of the years") was the Náhuatl word for the 52-year cycle (*8*). The term used by the Maya for the 260-day cycle is unknown; *tzolkin*, which would mean "count of the days" in Yucatec Maya, is a creation of modern Mayanists (*3*, p. 97).

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References

1. V. H. Malmstrom, *Science* **181**, 939 (1973).
2. Z. Nuttall, *Atti 22nd Congr. Int. Am.* **1**, 119 (1928); O. Apenes, *Ethnos* **1**, 5 (1936); H. Larsen, *ibid.*, p. 9; R. H. Merrill, *Am. Antiq.* **10**, 307 (1945). For a brief summary and critique of theories on the origin of the 260-day cycle, see Thompson (*3*, pp. 98–99) and J. Broda de Casas [*The Mexican Calendar as Compared to Other Mesoamerican Systems* (No. 15, Acta Ethnologica et Linguistica, Vienna, 1969), pp. 15–16].
3. J. E. S. Thompson, *Maya Hieroglyphic Writing: An Introduction* (Univ. of Oklahoma Press, Norman, ed. 2, 1960).
4. The same suggestion has been made by Thompson (*3*, pp. 98–99), Broda de Casas (*2*), and Prem (*5*, p. 115).
5. A. Caso, in *Handbook of Middle American Indians*, R. Wauchope, Ed. (Univ. of Texas Press, Austin, 1965), vol. 3, pp. 931–947; H. J. Prem, *Contrib. Univ. Calif. Archaeol. Res. Fac.* **11**, 112 (1971).
6. J. E. S. Thompson, in *Handbook of Middle American Indians*, R. Wauchope, Ed. (Univ. of Texas Press, Austin, 1965), vol. 3, p. 65.
7. ———, *Maya Hieroglyphs without Tears* (British Museum, London, 1972), pp. 21–23.
8. A. Caso, in *Handbook of Middle American Indians*, R. Wauchope, Ed. (Univ. of Texas Press, Austin, 1971), vol. 10, pp. 333–348.

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Perhaps Malmstrom (*1*) can resolve what seems to be a conflict regarding the precedence of the hypothesis describing the correlation of the Mayan *tzolkin* 260-day calendar with zenithal transits of the sun near latitude 15°N. I refer to a theory apparently overlooked by Coe (*2*, p. 55) and others in the field and cited by Peterson (*3*, pp. 186–187) in a discussion on the origin of the *tonalpohualli* or Aztecan version of the *tzolkin*. The pertinent comment is quoted here in its entirety:

> We do not know why a 260-day religious period was chosen, nor what 260 is intended to count. It may have been based on some important astronomical observation of the ancient Mexicans which we have not taken into account, or it may refer to certain cycles of the sun, moon, Venus, or the solstices. Ola Apenes explained it by certain observations made in the Maya region, in the following manner: the difference between the 260-day religious cycle and the 365-day solar cycle

is 105 days. Between the tropics of Capricorn and Cancer, there is a zone in which the sun passes through the zenith twice each year at 260- and 105-day intervals. Near the old Maya city of Copán, in Honduras, the fall and spring passages of the sun through zenith take place on August 13 and April 30, respectively. Soon after the sun passes the zenith on its northern passage the rainy season starts. Then there is a lapse of 105 days until the sun again passes the zenith on its way south. Thus the year is divided into a planting and growing period of 105 days and a harvesting and devotional period of 260 days, which may be the origin of the Tonalpohualli.

Regarding Apenes' nomination of Copán as a logical site for the origin of the 260-day calendar, it may be noted that, prior to the early 1960's, the significance of the Izapa, El Baúl, Miraflores, and Esperanza horizons as vehicles for cultural transferral between Olmec and Maya had yet to be realized, and therefore Copán (already the subject of considerable investigation) probably amounted to an "only choice." No doubt we may expect further enlightenment on what surely is one on the world's more intriguing cultures.

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References

1. V. H. Malmstrom, *Science* **181**, 939 (1973).
2. M. D. Coe, *The Maya* (Praeger, New York, 1966).
3. F. A. Peterson, *Ancient Mexico* (Capricorn, New York, ed. 2, 1962).

25 September 1973

The hypothesis that I advanced for the origin of the 260-day Mesoamerican calendar (*1*) was predicated on two geographic (that is, locational) arguments: (i) that the length of the calendar represents the time interval between zenithal sun positions near the 15th parallel of latitude and (ii) that the choice of faunal symbols used on the calendar strongly suggests a tropical lowland place of origin. I was led to conclude that both of these conditions could only be met by the Late Preclassic site of Izapa in southeastern Mexico.

It is now abundantly clear (from the comments of Henderson and Fitchett) that I was "anticipated" in the first of my arguments by at least four other researchers, beginning with Nuttall in 1928 (*2*). However, it is just as clear that several Mesoamerican scholars [including Thompson (*3*) and Coe (*4*), as well as Henderson] have remained unconvinced of the validity of that argument; for them, the questions of how and where the 260-day calendar originated continue to be—in Coe's words—"an enigma" (*4*, p. 55). Henderson contends that an "argument for a correspondence with some natural phenomenon must be not merely plausible but compelling" (*5*). Yet, nowhere in his own argument does he make any attempt to explain two "coincidences" which lend great support to the astronomical origin of the calendar. The first coincidence is that the zero starting point of the Mayan calendar as calculated by the Goodman-Martinez-Thompson correlation is 12–13 August—the very date on which the 260-day interval between zenithal sun positions begins near the 15th parallel of latitude. The second coincidence is that, of all the places the Mayas could have erected their principal center of astronomical studies, they chose Copán near the 15th parallel of latitude, despite the fact that it lay more than 300 km away from the center of their civilization in Petén. What more compelling arguments does one need to demonstrate the importance of the zenithal sun to Mayan calendrics?

The second of my arguments regarding the faunal symbols used on the calendar is based on an observation of Gadow (*6*), not of Thompson. The fact that Thompson has "recently reversed himself" (*5*) is hardly a cause for discrediting Gadow; it merely suggests that Thompson is now willing to ignore the faunal "evidence" as well as the astronomical and geographic coincidences I mentioned above. Fitchett seems to imply that, if only Apenes had known what we now know about the cultural significance of such places as Izapa, he would probably have "anticipated" me in this argument as well (*7*). However, this misses the point, for the thrust of my argument is that lowland Izapa is situated in an ecological niche that is quite distinct from all the other (highland) sites located along the 15th parallel—a clue to which Apenes presumably was as much privy as I.

Finally, Henderson's plea for greater precision in the use of terminology in Mesoamerican calendrical studies will be seconded by all researchers in the field, providing they can agree on the list of definitions he has provided to start them off.

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References

1. V. H. Malmstrom, *Science* **181**, 939 (1973).
2. Z. Nuttall, *Atti 22nd Congr. Int. Am.* **1**, 119 (1928).
3. J. E. S. Thompson, *Maya Hieroglyphic Writing: An Introduction* (Univ. of Oklahoma Press, Norman, ed. 2, 1960).
4. M. D. Coe, *The Maya* (Praeger, New York, 1966).
5. J. S. Henderson *Science* **185**, 542 (1974).
6. H. F. Gadow, *Through Southern Mexico* (Scribner's, New York, 1908), p. 303.
7. F. A. Peterson, *Ancient Mexico* (Capricorn, New York, ed. 2, 1962), pp. 186–187.

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Possible Noninhibition of Cellular-Mediated Immunity in Marihuana Smokers

Nahas *et al.* (*1*) report that the T (thymus derived) cell immunity of chronic marihuana smokers is impaired, a finding that would represent a heretofore unrecognized effect of *Cannabis* in humans. However, their results should be interpreted with caution for the following reasons.

It is unfortunate that the authors did not define in precise terms the "eighty-one healthy volunteers . . . used as controls." While it is implicit that these controls were not marihuana smokers, it is essential to know if the controls were subjects who (i) smoked tobacco cigarettes, (ii) did not smoke tobacco cigarettes, or (iii) were a mixed population of (i) and (ii) for the following reason. In an earlier study Vos-Brat and Rümke compared 60 heavy tobacco cigarette smokers with 31 nonsmokers (*2*). They found that the responsiveness of lymphocytes to phytohemagglutinin (PHA) was significantly lower in the smokers than in the nonsmokers. Hence, in the Nahas *et al.* study, if all the normal controls were in fact tobacco cigarette smokers, then the results shown [table 1 in (*1*)] may be considered unequivocal. However, in the absence of such data for the controls, it is not clear whether or not the reduced blastogenic response of the lymphocytes derived from the marihuana smokers was the exclusive result of smoking marihuana as Nahas *et al.* suggest. On the basis of the Vos-Brat and Rümke report (*2*), it would appear that smoking of tobacco as well as of marihuana decreases, in some manner, the response

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