tem into or out of either mode. These facts reinforce the impression, gathered by watching solitary waves collide and vanish rather than pass through each other, that these phenomena are essentially nonlinear. They could not have been discovered [although the periodicity and symmetries of wave trains can be described (*8*)] by linear mathematical models. In (*11*) an analysis is offered (together with experimental details) which attempts to rationalize these nonlinear features in terms of modification of a nonoscillatory and fundamentally nonlinear excitable kinetics by diffusion.

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2 April 1973; revised 29 June 1973

Origin of the Mesoamerican 260-Day Calendar

Abstract. *The sacred 260-day Mesoamerican calendar probably originated near a latitude of 15°N, where there is a 260-day interval between transits of the zenithal sun. Archeological and faunal evidence favors an origin in the Pacific lowlands rather than in the highlands near Copán, Honduras, although Copán, which is located at the 15th parallel of latitude, later became the principal Mayan astronomical center.*

Although civilized peoples in all parts of the world, including Mesoamerica, developed calendars based on the length of the tropical year (365 days), in Mesoamerica a second calendar 260 days in length came into being. Variously known as the *tzolkin* or *tonalámatl*, this 260-day count served as a sacred almanac or ritual calendar for all peoples of Mesoamerica and has continued in use in some of the more isolated regions of southern Mexico and Guatemala to the present day (*1*, p. 55). The 260-day cycle was the most important measure of time among all Mesoamerican civilizations, for not only did it guide the daily rituals of the people but it also formed the basis for other measures of time of great astronomical and religious significance (*2*, p. 265). For example, a double *tzolkin* (520 days) equates almost exactly with three eclipse half-years (519.93 days) and therefore provided a means for predicting solar eclipses (*3*, p. 149). Furthermore, because each day had its own name and number, a period of 52 years would elapse before the 260-day almanac would come back into phase with the 365-day calendar. This period of 52 years has been called the calendar round, or "Aztec century" (*tonalpohualli*), and was responsible for the fatalistic belief among Mesoamerican peoples that history repeated itself on a cyclical basis.

Despite the central importance of the 260-day calendar in the life, art, and science of pre-Columbian Mesoamerica, no satisfactory explanation has yet been advanced as to how and where this original contribution to time-keeping began. In 1966, Coe (*1*, p. 55) stated: "How such a period of time ever came into being remains an enigma. . . ." Other investigators have debated the locational origins of this unique Mesoamerican calendar. Kidder (*4*) favors a highland origin, but Thompson (*5*) cites an observation by Gadow that "several of the fauna which serve as day-names and day-glyphs . . . are foreign to the Mexican plateau and, one might add, to the highlands of Guatemala." Satterthwaite (*6*) writes that Caso finds the earliest evidence of the sacred round count at Monte Albán in Oaxaca, whereas Vaillant (*7*) states that the 52-year cycle seemingly stems from the Mixteca Puebla area. Robertson (*8*) likewise sees no reason to question colonial accounts of Mixtec origins for the 260-day calendar. Moreno (*9*), on the other hand, assumes the calendar to be of Mayan origin but concedes that an Olmec origin "may turn out to be more feasible"; yet he concludes by suggesting the Yucatan Peninsula as its birthplace. Coe (*1*, p. 60) disagrees, arguing that the "Mayan" calendar had reached pretty much its final form "by the first century B.C. among peoples who were under powerful Olmec influence and who may not even have been Maya. From them, writing and the calendar were spread along the Pacific coast of Guatemala and into the Maya highlands, eventually reaching the developing states of the Petén forests." It is thus apparent that there is little agreement as to when, where, or how the sacred almanac came into being or which people was responsible for its creation.

Although structures assumed to have been observatories have been identified at such sites as Monte Albán and Chichén Itzá, the Mayan center at Copán, Honduras (Fig. 1), is generally recognized as having been of paramount importance in pre-Columbian astronomical studies (*1*, p. 161; *2*, pp. 323 and 325; *3*, p. 70; *10*). It is my contention that Copán attained its distinction as the single most important center for astronomical studies in the New World because it was the only place within the Classic (lowland) Mayan realm where the sacred 260-day calendar could be calibrated. Because of Copán's preeminence in astronomy, there is a strong temptation to ascribe the origins of the *tzolkin* to this place—a temptation which I feel impelled to resist on historical grounds. On the contrary, rather than arguing in favor of Copán as the birthplace of the calendar round, I would propose just the reverse, namely, that the calendar round was responsible for the founding of Copán.

Inasmuch as the Mesoamerican cultural hearth lies entirely within the tropics, the most critical fixed points of the solar year are less likely to have been the solstices and equinoxes (*11*) (as they are in higher latitudes) than the 2 days of the year when the sun is vertically overhead at a given place. The interval between such positions could be calibrated simply by taking note of the number of days which elapsed between the times that a given pillar or post failed to cast a shadow. Obviously, because the Mesoamerican area lies in the Northern Hemisphere, a 260-day span of time between zenithal sun positions could only be measured in the winter half-year, because the sun would complete the shorter 105-day part of its cycle during the Northern Hemisphere summer. Thus, if we accept the thesis that the critical fixed points of the *tzolkin* must be the zenithal sun positions, the only question that remains is to determine where such an interval could be measured. This is found to be slightly south of the 15th parallel of latitude, a line which intersects only the southeastern corner of Mexico but runs through the entire width of Guatemala and Honduras. Because the sun's declination changes about 18′ of arc per day at this stage in its annual circuit, it is more accurate to speak of a band within which, rather than a line along which, such a calibration is possible. Thus, any site between 14°42′N and 15°N will experience a 260-day interval between zenithal sun positions. Within this band, the sun reaches the zenith each year on or about 12–13 August on its apparent journey into the Southern Hemisphere and again on or about 30 April–1 May as it "moves northward." The former date is in perfect accord with the month and day of the zero starting point of the Mayan long count calendar as calculated by both the Goodman-Martínez-Thompson and Spinden correlations, although the year in which the count began remains an open question (*12*). [Although the beginning of the *tzolkin* postulated here does not favor one of the above correlations over the other, since they are exactly 260 years apart, it does render unlikely any other correlation which does not arrive at a zero point of 12–13 August. For example, the Kreichgauer correlation (*11*) is 164 days out of phase with it.]

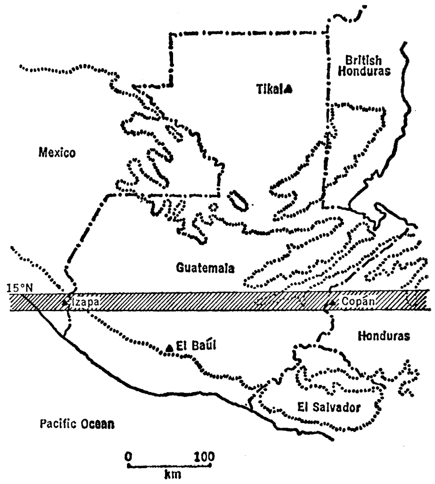

Fig. 1. Map showing a portion of Mesoamerica near 15°N. The dotted lines denote elevations over 300 m; the hatched horizontal band represents the area in which the 260-day zenithal interval is found.

Although several important post-Classic cities fall into the latitudinal band described above, all in the highlands of west-central Guatemala, in view of the great antiquity of the *tzolkin* it seems more rational to look for a site which dates back at least into Late Formative times. [Moreover, in my opinion, Gadow's argument (*5*) is sufficiently strong to rule out any highland site for faunal reasons alone.] Copán, at an elevation of 600 m above sea level, is the only Classic site of importance which lies within the band, but a much more likely point of origin is the large Late-Preclassic ceremonial center of Izapa (Fig. 1), which lies just over the western border of Guatemala in Mexico. Located at the edge of the foothills which border the Pacific coastal plain, Izapa is situated at an elevation of about 250 m. In point of time Izapa is not only far older than Copán but it is spatially far closer to the original cradle of Mayan culture as hypothesized by Coe. Indeed, he makes the point that the Izapan civilization "occupies a middle ground in time and in space between the Middle Formative Olmec and the Early Classic Maya" (*1*, p. 60). However, Coe observes that "writing and the calendar are absent" in Izapa, but that, "as one moves along the Pacific slopes east into Guatemala, one finds sites with inscribed monuments and Baktun 7 dates." One of the latter, from El Baúl, has been equated to A.D. 36, "some 256 years prior to the first such date in the Maya lowlands" (*1*, pp. 61–62). Somewhat later in the same work (*1*, p. 76) Coe states that "the Izapan culture of the highlands must have had a good deal to do with the adoption of civilized life in the central and northern areas" of the Mayan realm and that both monuments with long count dates and writing "were present among the coeval Izapan centers of the Highlands and Pacific Coast," whereas they were either "missing or exceedingly rare" in the lowlands before the dawn of the Classic era. The oldest long count date known from the Mayan area is Stela 29 from Tikal, which bears an inscription equated to A.D. 292, whereas "the custom of erecting sculptured stone monuments probably spread to Copán as *early* as [A.D.] 465" (italics are mine) (*2*, p. 59). On the other hand, the oldest recorded long count dates appear on monuments outside the Mayan area, to the northwest (*1*, p. 59). If, as Coe states, "It is generally agreed that the Long Count must have been set in motion long after the inception of the Calendar Round" (*1*, p. 59), then the 260-day sacred almanac must date well back into the pre-Christian era. Furthermore, if the hypothesis for its origin presented here is correct, the diffusion of this idea appears to have been more rapid to the northwest—into Mexico—than it was to the northeast into the Mayan area. On the other hand, once they had adopted the concept of the *tzolkin*, the Mayas, alone among the peoples of Mesoamerica, were in a position (latitudinally) to calibrate, test, and refine the measurements based on this sacred almanac. Even though their principal economic and political centers developed in the Petén region of northern Guatemala, the Mayas saw fit (perhaps one should say, felt religiously obliged) to erect an astronomical center more than 320 km to the southeast, virtually on the frontiers of their domain, in the most accessible site which met the requirements of the 260-day interval. Thus, although the Mayas are indebted to the Izapans for the original idea of the sacred calendar (as are all other Mesoamericans as well), the credit for developing it into a highly complex and precise system for reckoning time and predicting celestial events is entirely their own.

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2 April 1973

Mouse Immunoglobulin Kappa Chain MPC 11: Extra Amino-Terminal Residues

Abstract. *The kappa chain from the immunoglobulin of myeloma tumor MPC 11 has 12 extra residues at its amino terminus, the first six of which are identical to the residues at positions 1 to 6 of typical mouse kappa chains and at positions 13 to 18 of MPC 11 itself. Two of the peptide bonds within this extra 12-residue segment are cleaved under very mild conditions.*

I have discovered two unusual features of the kappa-type light chain from the mouse myeloma tumor line MPC 11. (i) When its first 75 amino acids are aligned with other mouse kappa chains, MPC 11 is seen to contain an extra 12 amino acids at its amino terminus. (ii) Two of the peptide bonds within these 12 extra amino acids undergo facile hydrolysis under very mild conditions which do not ordinarily promote peptide bond cleavage.

A clone of cells (clone 45–6) in continuous culture derived from MPC 11 (*1*) was supplied by M. D. Scharff. These cells were injected intraperitoneally into BALB/c mice, which formed 3 to 12 ml of peritoneal fluid a few weeks later. The MPC 11 myeloma protein was isolated from the supernatant of this fluid by precipitation three times with an equal volume of 3.5*M* ammonium sulfate at 0°C. Light chains were separated from heavy chains by chromatography on Sephadex G-200 in 5*M* guanidinium chloride after cleaving all disulfide bonds in 7*M* guanidinium chloride. This cleavage was effected either by reduction with 10 m*M* dithiothreitol and alkylation with 22 m*M* iodoacetamide (*2*) or by mixed disulfide formation (*3*) with 5 m*M* dithiothreitol and 0.25*M* diethanol disulfide or diethylamine disulfide (cystamine).

A partial amino acid sequence for positions 1 to 51 of the MPC 11 light chain was determined by the methods of Smithies *et al.* (*4*) on an Edman-Begg sequenator (*5*) (Illitron division of Illinois Tool Works). The positions of the half-cystine residues were determined with [^{14}C]carboxamidomethyl-labeled light chain by counting a portion of each step from the sequenator.

In order to extend this sequence, [^{14}C]carboxamidomethyl light chain (20 mg/ml) was cleaved at its methionine residues (*6*) by CNBr (70 mg/ml) in 70 percent formic acid at room temperature for 1 hour, which was sufficient time to destroy all the methionine residues. Amino acid analysis had indicated that the light chain contains four methionine residues. Three of these had already been located at positions 4, 16, and 23 in the partial sequence of the undigested light chain. The fourth was presumed to correspond to a constant-region methionine located 39 positions from the end of mouse kappa chains (*7*). Consequently, I expected five CNBr fragments of very different sizes: a very large one (CNBr-I) extending from position 24 to the constant-region methionine; a 39-residue fragment (CNBr-II) extending from the residue following this methionine to the end of the chain; and three small peptides of 4, 7, and 12 amino acids. I tried to separate these fragments by chromatography on Sephadex G-100 in 10 percent formic acid. This procedure resolved the CNBr digest into three peaks. The first peak contained 50 percent of the radioactivity; since it was excluded from the gel, it presumably consisted of large aggregates. The second peak contained 37 percent of the radioactivity; the sequence data reported below indicate that it was an aggregate containing both CNBr-I and CNBr-II (CNBr-I/II). The third peak, containing 13 percent of the radioactivity, was not characterized.

CNBr-I/II was sequenced for 52 steps by the same methods used for the undigested light chain (as described above). Two sequences were present. One of these corresponded to the 39-residue constant-region fragment CNBr-II, which was expected to have a sequence identical to that at the corresponding positions of other mouse kappa chains [for example, positions 176 to 214 of the kappa chain of tumor MOPC 21 (*7*)]. The residues from this fragment decreased in yield as the sequenator degradation progressed, and could not be detected at all beyond step 24. Presumably this decrease in yield was due to partial loss of the short residual peptide during extraction of excess reagents at each step of the degradation. The other sequence obtained from CNBr-I/II continued for all 52 steps and corresponded to the expected fragment CNBr-I. The first 28 residues of this sequence were entirely consistent with the partial sequence that had already been determined for positions 24 to 51 of the undigested light chain.

Taken together, the data from CNBr-I/II and undigested light chain sufficed to determine the sequence of the first 75 amino acid residues of the MPC 11 light chain. In Fig. 1, this sequence is compared to the mouse kappa chain MOPC 21 (*7*) and to other sequences that will be discussed later. Residues 13 to 75 of MPC 11 align very well with residues 1 to 63 of MOPC 21. By contrast, if residues 1 to 75 of MPC 11 are aligned with residues 1 to 75 of MOPC 21 (or of any other mouse or human kappa chain) no homology is evident except at residues 1 to 6, which are similar or identical to the corresponding residues of typical mouse kappa chains and to residues 13 to 18 of MPC 11 itself (Fig. 1, underlined residues). MPC 11 therefore has 12 extra residues at its amino terminus.

These extra residues call to mind the extra residues that are found at the amino terminus of the precursor polypeptides coded by messenger RNA's (mRNA's) of mouse kappa chains. This precursor has been found by four groups of investigators using mRNA's for tumors MOPC 41 (*8*), MOPC 21 (*9*), and MOPC 321 (*10*). In the case of MOPC 41, the precursor migrated in sodium dodecyl sulfate gel electrophoresis as if it were about 20 residues longer than mature light chain. By the same criterion, the precursor for MOPC 21 seemed to be about 14 residues longer than mature light chain; it was also shown to have an altered NH_2-terminal tryptic peptide and to contain a chain-