

Zero in the pre-Columbian Americas

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Abstract

The purpose of this presentation is to provide a concise survey of the Maya zero, its creation, significance, usages and a comparative timeline to its conception in India and Babylonia. Iconographic and hieroglyphic representations of the number together with their interpretations will be discussed. Finally, a connection between the Inca and the Maya concepts of zero will be presented.

Key Words

Inca, Maya, Olmec, Pre-Columbian, Zero

1. INTRODUCTION

The number zero was independently created in Babylonia, India, and Mesoamerica. In Mesoamerica, zero was used as a true placeholder in a positional system. The Maya used this symbol for computational purposes in their calendric and astronomical calculations. Some of the earliest examples of the Mesoamerican zero appear around 300-400 BC, making it one of the worlds earliest systems that employed the number as a positional holder. For the Inca of South America, there is evidence that zero was represented by the absence of a knot in their *quipus*, a unique form of record keeping.

2. CONTENT

In Western cultures zero has two meanings: (1) Absence of a quantity, nothing, when placed independently, and (2) Fullness when used as a placeholder—102 and 120 denote two distinct values. The number zero used in the Western cultures originated in India in the second century AD, and in Sanskrit the word for zero is *sūnya*, empty, void or *kha*, which means place. *Cipher* in English, and *chiffre* in French are derived from the Arabic word *sifr*, naught, empty. The Hindu number system was transported to other countries by Arabian voyagers, and, thanks to the Moorish invasion of Spain, the number system made it to Europe. Moreover, in the 13th century the Italian mathematician Leonardo de Fibonacci, who frequently traveled to North Africa, learned about the “Arabic mathematics” and made it popular among European merchants and bankers. Hence the *Hindu-Arabic* name for the Western number system (Gheverghese 1990).



Figure 1. The Khmer number 605, Cœdès 1931

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The oldest written inscription we have of zero in 683AD is a stone inscription denoting the Khmer number 605 at Sambor, Cambodia (fig. 1).

The Babylonians used zero, denoted by two triangles, in their base 60–sexagesimal number system—as early as in 500BC but only internally—between the digits—and not externally. For example to write the number $3604 = 1 \times 60^2 + 0 \times 60 + 4$, they would use the sequence 1, 0, 4, and to write the number $3840 = 1 \times 60^2 + 4 \times 60$, they used the sequence 1, 4, and not 1, 4, 0, which seems to be 64 (fig. 2). The ambiguity caused them a lot of problems (Neugebauer 1957).



Figure 2. The Babylonian numbers 3,604 left and 3,840 (or 64?) right

The number system that the ancient Maya civilization utilized for calendric and computing purposes had its origins in earlier civilizations such as the Olmec that inhabited the Gulf coast of Mexico and the Isthmus of Tehuantepec. The Olmec's origins have been traced to pre-Olmec cultures as far as 2500BC. Considered by many the Mother Culture of Mesoamerica, they left a rich cultural legacy, one of its most important being a counting system.

In Mesoamerica we find hieroglyphic date inscriptions in the form of *Long Count* dates that cannot be possible without the use of zero. A Long Count date is a sequence of numbers used by the Maya to mark events that occurred over long periods of time. The earliest Long Count date is found in a monument in Tres Zapotes, Mexico. This monument depicts a combination of calendrics, astronomy and writing, and has the inscribed Long Count date corresponding to the Gregorian date of September 5, 31BC. Moreover, a stone slab at Chiapa de Corzo has a reconstructed Long Count date that corresponds to December 8, 36 BC. While the Tres Zapotes monument falls within Olmec territory, the Chiapa de Corzo monument is clearly Maya—a strong evidence that the Maya knew about zero at least by 36BC (Diehl 2004).

What later developed into the elegant Classic Maya systems are: (1) A vigesimal system or *base 20* that employed only 3 symbols, a *dot* representing units, a *bar* representing 5 units and a *shell*, *flower*, *hand*, *head variants*, or *full body* glyphs, to represent *completion* of a unit of 20 (zero) or higher multiples of 20 (figure 3), and, (2) A quasi-vigesimal or *chronological system* used to represent calendrical information.



Figure 3. Maya symbols for zero

The Maya vigesimal system was born from the belief that a complete human is formed of 20 digits counting fingers and toes. Twenty became their first higher unit because twenty finished a person (Kroeber 1948). As a system that is expressed in a vertical way rather than a horizontal one, its positional hierarchy has the lowest cycles at the bottom and highest at the top.

We know that the symbols that represented zero to the Maya were also used in a written and artistic language to represent ideas relating to mythical places as well as association to the cult and commemoration of ancestors. It is possible that a human life was also seen a count of years that completed itself at one's death. We find evidence of commemorative sculptures that celebrated 5-year and 20-year periods. These cycles were watched carefully and served as landmarks in a person's life (Catepillán & Méndez).

Zero has not been present in calendars worldwide; in our Gregorian calendar we do not have day 0, or month 0, not even year 0, we go from 1BC to 1AD. The Maya, however, were conscious of its use as a starting point, and used zero in their *Haab* calendar, *Round Calendar* and Long Count dates. In the case of the *Haab* or "solar" calendar, the last day of a month was followed by the first day of the next month or day 0. This was conceived as the "seating" (*Chum*) of the next month (Stuart 2011). In this vigesimal month system, we count the days to reach 19 then we have completion and the need to move over a place value. The action of "seating" which was related to the act of accession of rulership, was the completion of one sovereignty, and the beginning of the successor's rule. See figure 4 for completion symbols.



Figure 4. Left-to-right. Palenque, Méndez, 2016, Yaxunah, Catepillán, 2016, Maya completion glyph, Olmec glyph.

In addition, in the 16th century the Nahua of Mesoamerica, counted the days of the week beginning with zero, which means that zero for them was the first number, and the number that generated the rest (Chamoux 2003).

As opposed to the Hindu-Arabic zero, the Mesoamerican zero is tangible, a shell for the Maya, maize for the Aztecs (Nahua), and an unknotted string for the Inca. In Quechua, the Inca language, the word *quilla* means moon, and the moon was the goddess of zero, the word was also used for “the pendant without a knot” when referring to the number zero on the *quipus* (Laurencich-Minelli 2004). A quipu–knot in Quechua–is a recording device consisting of cords containing information in the form of knots, in which the knot’s placement represented units of 1; 10; 100, and so on, and the type of knot signified a number. Even today farmers in the Andean regions count lunar months and when the moon is not visible it is considered absent or zero (Hocquenghem 1987).

3. CONCLUSION

Although the earliest forms of the number appear to be from Mesopotamia. The use of zero in Babylonia was only internal–within numbers–and not external, compared with the Hindu and Maya. Zero is the key to an efficient number system, without it positional number systems are only successful when writing large numbers and performing arithmetical operations. In a non-positional system the biggest hurdle is the large amount of symbols required to represent big quantities, e.g. the Roman and the Greek number systems. As in the Old World versions of the concept, it is clear that New World versions of zero also considered its philosophical and religious implications. Forming the basis of computational mathematics its presence in Mesoamerican calendrical and astronomical calculations zero was essential in understanding complex relationships between humans and the vastness of the sky. In showing relationships between astronomical cycles and human activity, mathematics yielded profound statements of cosmology origin. One such statement is the number given as the creation date on Stela 1 from Cobá, Mexico, which in its long count form reaches far into the primordial past about 41,943,040,000,000,000,000,000,000,000 years! (Stuart 2011). The ability to find relationships between human actions and the actions of the gods necessitated a language of numbers. Zero became the tool with which to close the great chasm between the heavenly gods and mortals (Méndez).

4. REFERENCES

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