

# New zeros and old Khmer

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André-G.Haudricourt, in his stimulating study of the development of botanical nomenclature, has called attention to an important nexus: vernacular language, classical language and the codification of scientific and technical communication. The purpose of this note is to look again at the language/science nexus elucidated by Professor Haudricourt in order to suggest how these interacting categories might offer insights in another area: a stage in the development of decimal place notation, with special attention to the Old Khmer evidence of numeration. The main suggestion here follows from little-appreciated observations of Coedès (1931) regarding the relatively early appearance of decimal place notation in Southeast Asia. I propose that a set of "new" numerical writing practices involving local reconfigurations of Indic classical/vernacular norms may have contributed to the comparatively early Khmero-Sanskrit inscriptional indications of decimal numeration in general and evidence of the figure zero in particular. In line with this proposal, there is a further suggestion that a published date for an inscriptional source (the Non Sang Inscription) be slightly corrected.

## The first extant material zero?

In the history of the decimal place system of numerical notation now in universal use, the arising of a place-holding figure representing zero is widely seen as the crucial conceptual breakthrough—so much so, that it now seems gratuitous to sing the praises of zero. As Rotman (1987) suggests, by now zero has become one of the crucial givens forming the background of everyday modern life and mentality.

Although the later Cuneiform cultures, and perhaps even the earlier Sumerians, may have operated with an empty space somewhat like zero in certain mathematical functions, in form as an explicit numeral intended for practical use it is widely acknowledged that this invention is to be attributed to Hindu India (von Soden 1994; Flegg 1989). To judge from surviving evidence, Hindu learning in linguistics and logic had made systematic use of null operators for several centuries before zero appeared as an arithmetic numeral (Allen 1955). These traditions, along with more commercial interests associated with the Indic 'sand abacus', may have combined to produce a context for zero's use in decimal place notation. In form, the Hindu zero was either a dot or a small circle, the former the direct progenitor of the way zero is now written in Arabic and the latter, of the way it is generally written elsewhere. Literary evidence is convincing that zero, as a concept if not as a

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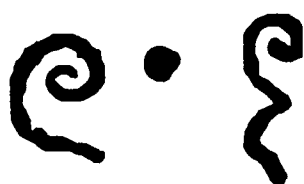
physical figure, was known to Indic mathematician-astronomers such as Varaha-Mihira somewhat before AD 600.

What is less widely appreciated is that the first extant material—as distinct from literary—evidence of zero as a numerical figure currently known is from 7th-century Southeast Asian sources (Coedès 1931; Flegg 1989:110; George 1991:241). It is not attested on firmly dated inscriptions in India until some two centuries later, although other decimal expressions in dates that do not happen to show zero are perhaps to be recognized as authentic. For explicit materially-attested zero in its place-holding dot form, available published evidence indicates that the mixed Old Khmer and Sanskrit inscription of Sambor (Figure 1), dated to the equivalent of AD 683, currently holds the record as the earliest zero exemplar. Further, the numeral figures in this inscription are clearly embedded in a calendrical passage of text (Coedès 1942, II:89):

**çaka parigraha 605 pañcami roc...**

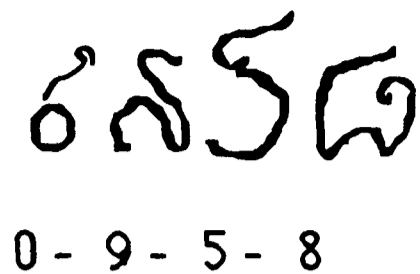
'The Çaka era has reached 605 the fifth day of the waning moon...'

This context renders it improbable that the figures were a later addition, unlike the situation with certain Indic inscribed copper plates, where numeral dates occur marginal to main text, raising the possibility of later additions (Kaye 1914).



**Figure 1.** The figures 6 0 5 on the Old Khmer Inscription of Sambor (Trapang Prei), K 127, a Çaka date equivalent to 683 AD. (Coedès 1931.)

The earliest zeros in more familiar circular form are found at almost exactly the same time—a year or two after the date of the Sambor Inscription—in Çrivijayan sites in the Palembang region of Sumatra (Coedès 1931). It is not impossible that the dot and circle forms of early zero were virtually stylistic alternates. (Compare modern versions of the figure seven with and without a crossed stem, or modern fours with and without upper closure.) Khmer punctuation practices may have affected this issue, especially in later centuries, since what looks like a familiar zero was regularly used as a mark beginning a new discourse unit. (Compare the so-called 'hen's eye' or *taa-kày* mark in traditional Thai texts). Good examples are the Phnom Cisor Inscription of AD 1019, in which the sign 0 is repeatedly used as a punctuation sign, sometimes directly preceding numerical expressions (Coedès 1942:29). Similarly, the Phimai Inscription of AD 1046; see Figure 2.



**Figure 2.** Zero-like punctuation sign followed by figures 9 5 8 on the Old Khmer/Sanskrit Inscription of Phimai, No. 59, with Çaka date equivalent to AD 1046 (National Library 1986, vol. 3, p. 177).

Further issues that we must leave aside here concern the specific phonological form of the Old Khmer numeral system (Vickery 1992) and what could be called an occasional "non-decimal" use of decimal notation, perhaps related to the Khmer partially five-based system, where certain departures from the strictly defined place value system are found in some Old Khmer sources (and also in later Thai ones).

### Word-symbol notation

Another part of the zero story involves the function and distribution of the so-called word-symbol method of numerical representation. In this system, well-known to epigraphists dealing with Old Khmer and other Southeast and South Asian texts in Sanskrit, numerical values are indicated obliquely through a conventionalised system of chronograms or symbolic representations. Standardised items are taken to stand for numerical digits, e.g. "moon" stands for *one*, "eyes" stand for *two*. Furthermore, for reasons to do with Sanskrit versification noted below, a given digit might be represented by several symbolic alternates. Thus *two* could equally well be represented by "wings" or "hands". For similar reasons, sometimes normal number names were mixed into these expressions as well.

A well-preserved early example is found in the dating of the Khao Rang Inscription from a site now in the Thai-Khmer border area and presently held in the Bangkok National Library. The date of this inscription is given as "in the Çaka year of senses-tastes-moon". By convention there were five senses, six tastes and a single Moon, giving the figure 5-6-1. As the Çaka era begins in AD 78, the inscription's date is equivalent to  $561 + 78$ , or AD 639. Also, the normal order of citation was from units to tens to hundreds, so the literal form of the text above was "moon-tastes-senses". Coedès has called attention to the earliest date he found in this method in Southeast Asia, a stele with a date corresponding to AD 604. (National Library 1986, vol. 1:35; previously published by Coedès in *Inscriptions du Cambodge*, K 505, 1953, vol. 5). See Faraut (1909:45) for a similar dating corresponding to AD 633. The distributional evidence thus indicates a general acceptance of this system of dating in the Khmer area by the first half of the 7th century.

Word-symbol notation was in use in India but the antiquity of the system there is far from clear. In their *History of Indian Mathematics*, Datta and Singh

(1935:60), who normally emphasize the antiquity of Indic material, in this case admit that Southeast Asian sources such as those cited above provide the first material inscriptional evidence of word-symbol numerical expressions used as dates. They observe that "in India proper, although they were in use amongst the astronomers and mathematicians from the third or fourth centuries AD onwards, it did not become the fashion to use them in inscriptions until a much later date." We return to the issue of differential and shifting fashions below.

Another significant aspect of literary fashion: Sanskrit inscriptional texts are almost invariably in verse, and it is generally agreed that the rationale for the word-symbol numerical system was in part dictated by poetic constraints of Sanskrit verse forms. When dates or other numerical values were mentioned, those who composed the inscriptional texts needed to have available a stock set of alternates to fit differing metrical constraints. Datta and Singh imply that poetry mainly accounts for why the use of direct numbers in their own right was not favoured. Of course other factors, such as esthetic feelings or even intentional obscurantism on the part of the Brahman litterati cannot be discounted.

### Zero in word-symbol notation

Of particular interest for the question raised here is the following set of terms:

<i>çūnya</i>	'void'	<i>vyoma</i>	'wind; sky'
<i>ambara</i>	'atmosphere'	<i>kha</i>	'emptiness; sky'
<i>ākāça</i>	'air'	<i>dyu</i>	'firmament'
		<i>gagana</i>	'sky'

These terms were used regularly to stand for zero, e.g.

<i>gagana</i>	Bakong stele of 8 0 3 Çaka = AD 881 (Coedès 1937, I: 34)
<i>kha</i>	Prasat Komphu's Inscription of 8 9 0 Çaka = AD 968 (ibid, p. 165)
<i>dyu</i>	Prah Kô Inscription of 8 5 0 Çaka (?) = AD 928 (ibid, 191)

The connection between "the void", and hence air-sky, and zero as a place holder in a decimal system of notation has been plausibly related to a mechanical, or at least graphical, method of reckoning by a number of scholars since the last century: Taylor, Woepcke, Bayley, Burnell and others, as cited by S.R. Das (1927: 104). Although material evidence for the early use of the abacus in its familiar Chinese form is problematic in early India, there are good indications of the use of equivalent systems, e.g. of temporary markings on, or the piling of counters on, a dedicated plank (called *pati*) covered with dust or sand. It is not unlikely that in the Indian reckoning powers of ten were distinguished by their grid placements and "the void" in this situation would refer to the fact that a given power of ten had a zero value: that its place in the grid was empty. It is further probable that, if necessary or convenient, this place-holding "void" could be symbolically represented by a dot, an alternate symbol being a small circle. In texts of the period

the dot was sometimes referred to as *çūnyabindu* "dot of emptiness" (Datta and Singh 1935:81; Flegg 1989:111).

In any case, the earliest material—that is, physically inscribed—evidence of zero in this form is again not in India but in Southeast Asia: the Mi-son Stele inscription of Champa, dated 609 Çaka (equivalent to AD 687), with the central zero represented by *amvara* 'atmosphere', an alternate of *ambara* (Coedès 1931).

Two centuries later, zero continues to be represented by items in this set, e.g. through *vyoma* 'wind, air'. It is instructive to compare two calendrical expressions using this form in contemporary Old Khmer - Sanskrit inscriptions.

(i) Prah Kô of AD 879 (Coedès 1937:21; K713, text from A:27)

**candravyomavasūpalakṣitaçaka**

candra-vyoma-vasu-upalakṣita-çaka

moon - wind - Vasus - expressed - Çaka (era)

I.e. 1 - 0 - 8 = 801 Çaka (= AD 879)

(The Vasus are a conventional group of eight Vedic deities, hence appropriate to represent the numeral 8.)

(ii) Non Sang, Yasothorn, dated by the Fine Arts Department BE 1432 (= AD 889); (National Library 1986, vol. 3:30-35; text from line 1.)

**murttivyomaṣṭabhūtaçaka**

murtti-vyoma-aṣṭa-bhūta-çaka

image - wind - eight - having been - Çaka (era)

(a) 1 - 1 - 8 = 811 Çaka (= AD 889)

(b) 3 - 0 - 8 = 803 Çaka (= AD 881)

As the chronogram system was in use for at least five centuries, Faraut (1909) has shown that it was not without its interpretive ambiguities in different times and places. (ii) above appears to be subject to such quandaries, with an eight-year discrepancy in interpretations (a) and (b). In (a), the published Fine Arts Department account, both "image" and "wind" are taken as symbolic analogues of one and this interpretation is explicitly mentioned in the notes (1986:35). In (b), I propose instead to follow the noted Sanskrit epigraphist D.C. Sircar (1965) and interpret "image" as representing three and "wind" as representing zero, as in (i). Although the first number, "image" (i.e., actually the units-place digit) may perhaps remain problematic, it seems to me that interpretation (b) is clearly to be preferred for "wind", especially since (i) attests to the same item used at about the same time in the Old Khmer area with a value that Coedès, Sircar and other authorities consistently assign as zero. In fact, I am unable to find any evidence for this item representing one as in interpretation (a), or for that matter, any value other than zero.

### In conclusion: the "new" representation of zeros

The preceding brief survey poses a puzzle. It indicates that material, as distinct from literary, evidence for decimal numeration and the occurrence of the figure zero in its modern place-holding function is found in Southeast Asia in the 7th century AD, some two centuries earlier than when it is materially documented in India, where, however, the decimal place system undoubtedly originated. In particular, Khmer-area evidence would seem to account both for the first known inscriptional cases of zero in its word-symbol form (as in *ambara* 'atmosphere', above) and its numerical figure form (as a place-holding dot in Figure 1). What factors might have weighted distribution of extant evidence in the Southeast Asian direction?

A possible clue: recalling the observations of Datta and Singh above, we find also that Sircar reports salient contrast in how time was emphasized and represented in the classical and local textual sources. He finds that the mentioning of specific dates by *eras*—particularly by *Çaka era*—such as times of accession, conquest, or the installation of images, was less a regular feature of inscribed Indic texts of the 7th century AD than of temporally and functionally corresponding Southeast Asian (in this case Old Khmer) sources. "Unlike Indian inscriptions of the *praçasti* type, the Cambodian eulogies of the kings often give, besides other details of historical importance, the date of accession of the reigning monarch as well as his ancestors" (1965:216). Exact dating of religious installations and other dedications often seems to furnish a ceremonial impetus for the inscriptions themselves. Occasionally even the details of calculations were explicitly displayed, as in the 10th-century Prasat Khna Inscription (Mlu Prei, see Coedès 1937, I:207; several centuries later the Thai King Lithai similarly displayed his arithmetic abilities on an inscription.)

Furthermore, Fleet (1910:823) has called attention to the correlation of *Çaka-era* dating with the astronomical-astrological profession, as well as with other Brahmanic teachings such as in linguistics, where, as noted above, zero had occurred as a quasi-mathematical operator. Fleet and Sircar note that the *Çaka era*, as used almost exclusively in the early Old Khmer sources, is hardly ever employed in contemporary Indic inscriptional texts, where other dating systems were preferred. This evidence suggests that the Southeast Asian interest in precise dating with *Çaka-era* numerical expressions, whether in numerals (when the language was Old Khmer) or in the word-symbol system (when in Sanskrit), would have represented a new sort of local norm with respect to the Indic matrix. The "new zeros", for example, would find their place as a new fashion within an innovative set of writing practices. These practices appear to point to an especially important role for court astrologers, who may have organised the writing of certain inscriptions, reinforced perhaps by local sensibilities regarding the sacral significance of auspicious timing.

This suggests progress toward a solution to the distributional puzzle may lie in the nexus of literary practices associated with the classical language Sanskrit and the vernacular Old Khmer—in particular how norms, writing practices and sensibilities regarding dates may have differed in India and Southeast Asia over time. To summarise: 7th-century inscriptions in the Khmer area quite consistently show decimal numeral values in dates and other contexts in Old Khmer prose texts,

but favour the word-symbol system in corresponding Sanskrit poetic ones, probably for metrical reasons as suggested. The same classical-vernacular poetry-prose patterns involving numeration are found in contemporary Champa. Similarly, zero in its present function, but also in its current circular form, is attested in Çrivijaya by AD 684. In India, to judge from available evidence, a similar pattern of numerical usage applied to inscribed texts became more general only some two centuries later although decimal numeration is known from literary texts. For example, the first material figure zero attested in India proper occurs on the Gwalior inscription of AD 870 (Flegg 1989:117). Until new evidence comes to light, the dot zero in Figure 1 and similar Çrivijayan material thus would have good claim to be not only "new" zeros in terms of norms of the 7th century but also arguably the oldest surviving inscribed zeros remaining for us to view today.

### Note

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