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A Note on The Decimal Numeral System

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The present numeral system is unique, even though it is still not the best as discussed by Vuillemin (1987). It has ten symbols; each corresponds to a whole number: one, two, three, four, five, six, seven, eight, nine or, to the most important number, zero. Other numbers are written using these symbols and by juxtaposition of the symbols. In a string of symbols, each individual symbol (digit) represents a whole number one to nine or zero, or a multiple of a ten, a hundred, a thousand, etc., depending on the position of the symbol place further to the left of a point, but represents a multiple of one-tenth, one-hundredth, one-thousandth, and so on as it is placed further to the right of the point. In short, and more precisely, a decimal numeral is of the form

$$b(n)b(n-1)...b(2)b(1)b(0) \cdot p(1)p(2)...p(m)...$$

which represents a number which is equal to

$$b(n)(10 \text{ to the power of } n) + \dots + b(2)(100) + b(1)10 + b(0) + p(1)(1/10) + \dots + p(m)(1/10 \text{ to the power of } m) + \dots$$

where $b(j)$ and $p(j)$ are 0, 1, 2, 3, 4, 5, 6, 7, 8, or 9.

Such a numeral system is known as the positional numeral system, and, with the base ten, the decimal numeral system. There has been no other such numeral

systems, but there were other positional numeral systems without a numeral which represents zero [see for example Eves (1969)]. The origin of the present well-known numeral system (associated with Western civilization by most third world countries) is very controversial. Thus, it is known by many names depending on the school of thought on the subject. It is known as the Hindu numeral system, the Hindu-Arabic or Hindu-Muslim numeral system, the Arabic numeral system, or the Muslim numeral system. The author prefers the name Muslim numeral system since most of the important figures in inventing or promoting these numbers were not the Arabs but the Muslims as elaborated in his books (1999, 1985). The de-

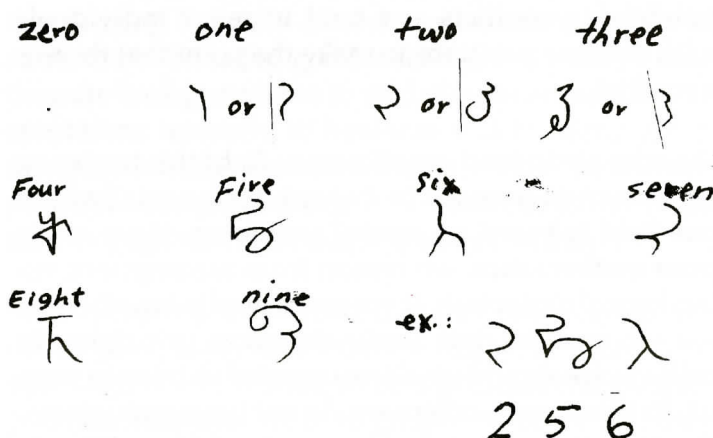


Figure 2: Hindu/Sanskrit Numerals (~400 A.D.)

Source: Midonick (1965). *The Treasury of Mathematics*. Vol. 1. Pelican.

Time	sifar (Zero)	satu (One)	dua (Two)	tiga (Three)	empat (Four)	lima (Five)	enam (Six)	tujuh (Seven)	lapan (Eight)	sembilan (Nine)
al-Khwarizmi	.	1	2	3	4	5	6	7	8	9
12 th Century A.D.	0	1	2	3	4	5	6	7	8	9
14 th Century A.D.		1	2	3	4	5	6	7	8	9
15 th Century A.D.		1	2	3	4	5	6	7	8	9

Figure 1: The Development of Muslim Numerals (al-atqam al-ghubariyah)

Source: Smith (1923). *History of Mathematics*. New York: Ginn Co.

development of this numeral system is depicted in Fig. 1, whereas the original Hindu numerals are in Fig. 2. The other known decimal numeral system found so far is the Mayan numeral system from the 5th century B.C., even though it is not completely a decimal system since a number bigger than twenty is written with the base twenty (Fig. 3). The controversy about the Hindu-Muslim numbers is based on the work of Abu Abdullah Muhammad Ibnu Musa al-Khwarizmi

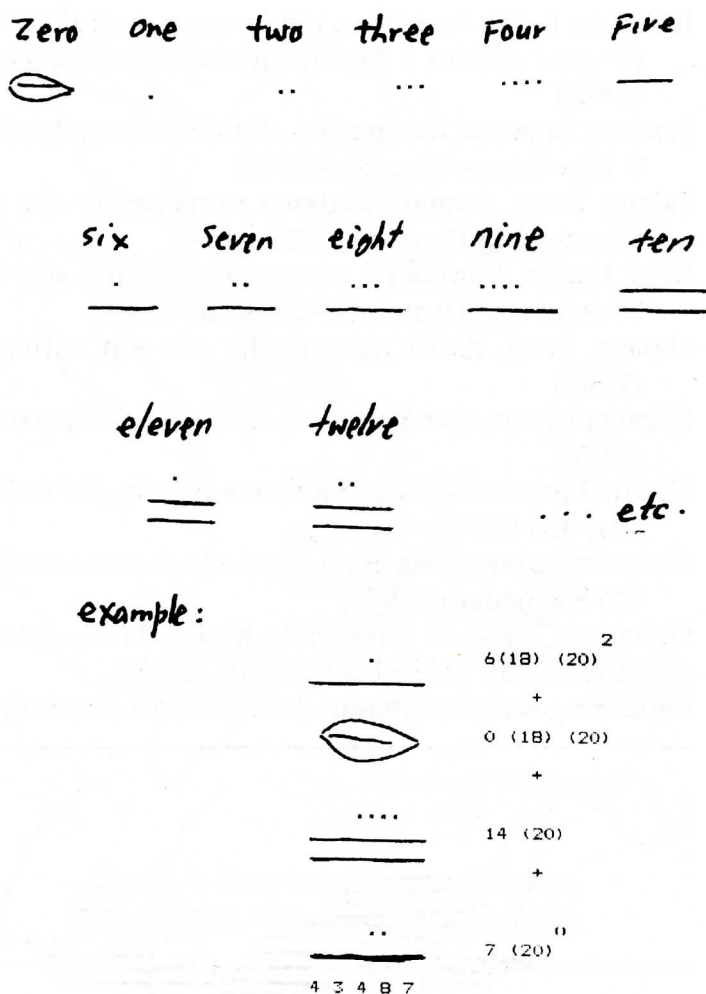


Figure 3: Mayan Numerals (400 B.C.)
Source: Midonick (1965).

(780-850 A.D., from Khwarizam in Uzbekistan), the Muslim founder of the decimal numeral system in the 9th century, in which his explanation of the numeral system contains an Arabic script which can be read as *Hind* or *Hindi* (which means Hindu or the East), and *handasi* or *handasah* (which means practical measurement, geometry, vocation or engineering). One of the well known French scholars in the history of Islamic/Arabic science, Carra de Vaux, has the opinion that one should read it as *handasi* or *handasah*. This controversy is discussed in the book of Ali Abdullah al-Daffa (1977). The controversy also rests on identifying the earliest writing of the numeral in Arabic and in Hindu. For example, even though it is believed that Hindu numerals were in existence since the 4th century B.C. (Midonick, 1965), the oldest Hindu writings (not the inscriptions) that contain such numerals are found at a much later date. In fact, according to Abdel Salam

Said (1959), the earliest Hindu writings which contain the same numerals as the Muslim numerals were dated 876 A.D., whereas the book of al-Khwarizmi "*al-Kitab al-Mukhtasar fi Hisab al-Jabr wal Muqabbala*," which contains the numerals (known in Arabic as *al-arqam al-Ghubariyah*, which we refer to as the Muslim numerals) for the first time was dated 837.

Meanwhile, notwithstanding the controversy about Hindu and Muslim numerals, many historians believe that the Hindu-Muslim numeral system is not the oldest (as far as the decimal system is concerned). In 1975, for example, it was reported in *Asasains* (1975), the bulletin of the Islamic Academy of Science Malaysia, that Zakov, a paper presenter at the European Seminar on the History of Science, 1975, claimed that the zero numeral in the Malay Archipelago is older than the zero in the Hindu-Muslim numeral system. Unfortunately, details of this claim are not available to us. In 1979 Swetz, then a professor of the History of Mathematics at Pennsylvania State University, U.S.A., and a visiting professor at the Universiti Kebangsaan Malaysia, also claimed that the Malay in Sumatera (Indonesia) inherit a numeral system that has the zero numeral which is older than the one in the Hindu-Muslim numerals. Once again, details are not available to us. There have been no further studies on this subject.

In an endeavor to settle these claims, recently we examined almost all writings (the inscriptions) in the Malay World, based on the work of scholars in the field of the ancient Malays such as de Casparis, Coedes, Damais (European scholars), Sastri, Chatterji and Majumdar (Indian scholars), and Malay-Indonesian scholars referred to later, to look for the ancient Malay numeral system. The Malay World, as defined by historians, anthropologists and linguisticians, is not just the Malay Archipelego (Indonesia, Malaysia, Brunei, Singapore, Philippines, Southern Thailand and Pacific Islands, including the Easter Islands), but also Kampuchea and Vietnam, and perhaps less importantly, Madagascar and Taiwan (Fig. 4). This is much wider than the Malay Archipelego as defined by the famous natural scientist, Wallace (1863) (Fig. 5). The ancient Malay kingdom in Kampuchea (Kambujadesa) was the Funan Empire (unfortunately not shown in Fig. 4) with her golden period in the 6th century A.D., whereas the ancient Malay kingdom in Vietnam was the Kingdom of Champa (Champe) with her

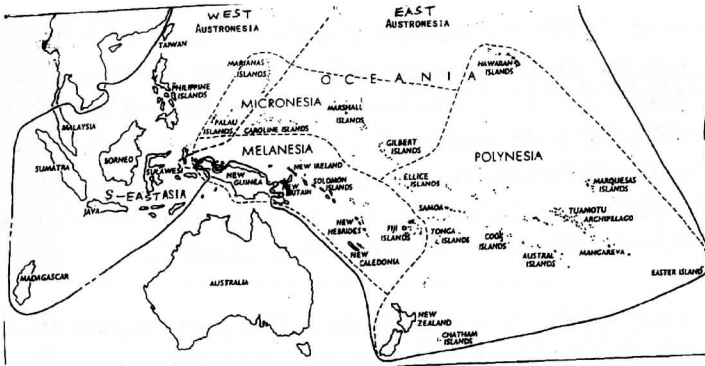


Figure 4: Alam Melayu (Malay World)

Source: Peter Belwood (1978). *Man's Conquest of the Pacific*, 118.

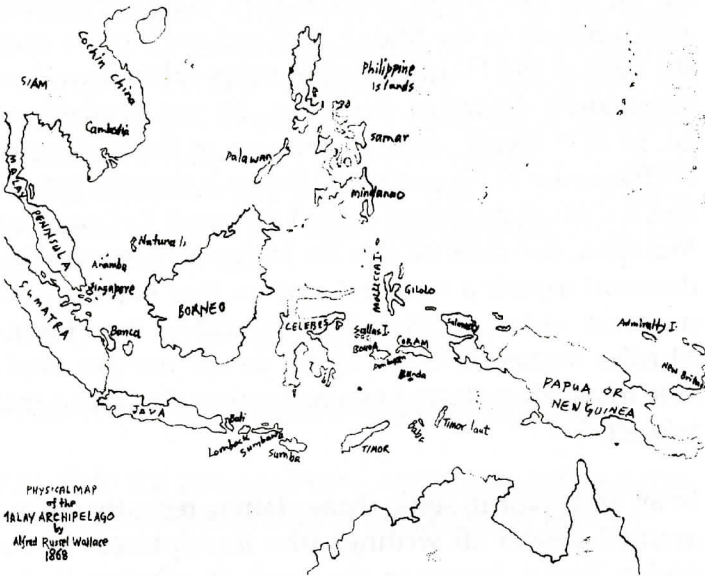
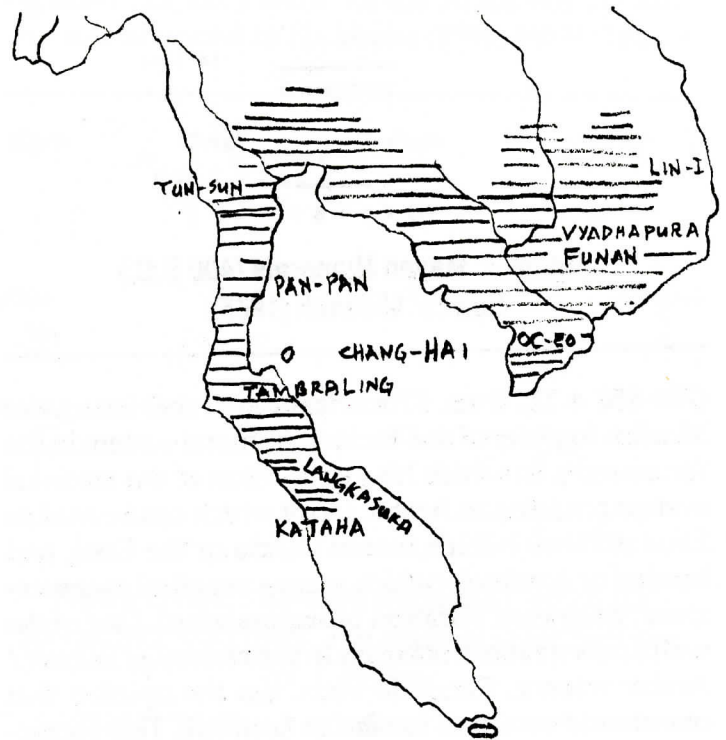


Figure 5: Physical Map of the Malay Archipelago

Source: Wallace, A.R. (1868). *The Malay Archipelago*.

golden era in the 9th century A.D. but completely collapsed at the end of 15th century (Fig. 6 and 7). The other well-known Malay Kingdoms before Islam came to the Malay World were the Kingdom of Srivijaya in the 7th to 13th century A.D. centered in Central Sumatra, and the Kingdom of Majapahit in the 12th to 14th century A.D. centered in the West Java (Java) (Fig. 8 and 9). We found that there are a total of twenty-two (22) Malay inscriptions from Sumatra, Jawa, Southern Thailand and Kampuchea that contain ancient Malay numerals dated from the 8th century A.D. to the 14th century A.D. The inscriptions are as follows:

- Kedukan Bukit, Sumatera, dated numerically 605 S (S= year of Saka = 78 A.D.) [Coedes and Damais (1992)]
- Sambar/Sambaur, Kampuchea, dated numerically 605 S [Coedes and Damais (1992)]
- Talang Tuwo, Sumatera, dated numerically 606 S [Coedes and Damais (1992)]
- Kota Kapur, Sumatera, dated numerically 608 S [Coedes and Damais (1992), Sastri (1949)]
- Dinaya, Jawa, dated numerically 682 S [Chatterji (1967)]
- Polengan, Jawa, dated numerically 797 S [de Casparis (1975)]
- Plate of Randusari, Jawa, dated numerically 827 S [de Casparis (1975)]
- Statue at Gunung Tua, Sumatera, dated numerically 946 S [Chatterji (1967)]
- Statue of Ganesa at Karangrejo Kediri, Jawa, dated numerically 1056 S [de Casparis (1975)]
- Candi Singosari/Sanghasari, Jawa, dated numerically



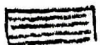
 FUNAN EMPIRE

Figure 6: Funan Empire at its Height (in the 6th Century A.D.)

Source: Intan (1991).

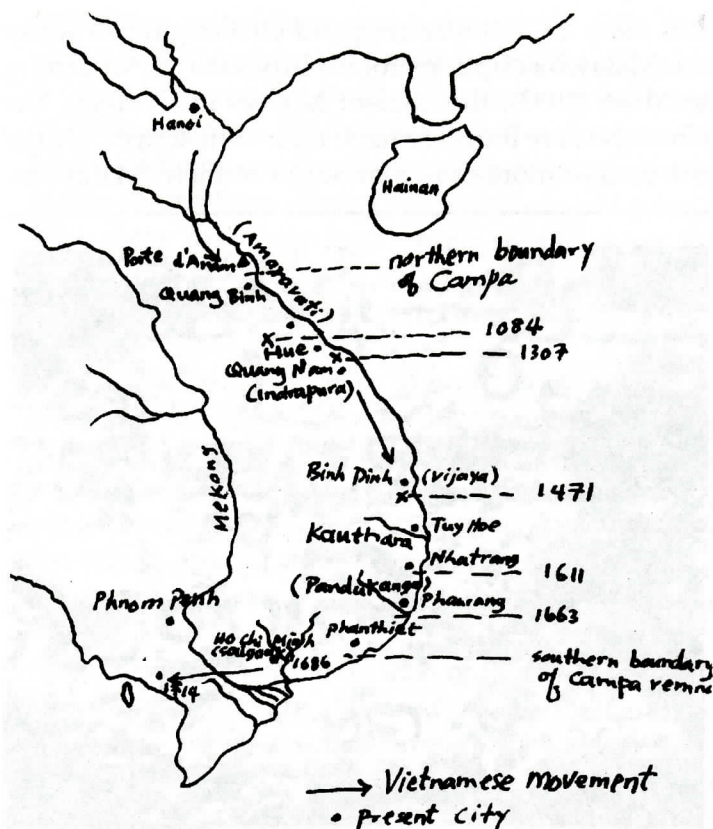


Figure 7: Kingdom of Campa/Champe
Source: Abdul Rahman al-Ahmadi (1988).

1214 S [de Casparis (1975)]

Plate of Penaggungnan/Penang-Gungen, Jawa, dated numerically 1218 S [de Casparis (1975), Chatterji (1967)]

Candi Penataran, Jawa, dated numerically 1291 S and 1301 S [de Casparis (1978)]

Cemetery Stones at Tralaya, Jawa, dated numerically 1298 S, 1389 S and 1397 S [de Casparis (1978)]

Renek, Jawa, dated 1301 S [de Casparis (1975)]

Ngadoman, Jawa, dated 1371 S [de Casparis (1975)]

Cemetery Stone of Ahmad Majanu, Port Dickson, Peninsular Malaysia, dated numerically 1385 S [Othman and Nasir (1990)]

From the dates of these inscriptions and the numerals contained in the inscriptions, we deduce that the Malays in the 7th century already have their own numeral decimal system; development of the numerals is depicted in Fig. 10. This confirms the claim made by Zakov and Swetz mentioned earlier in in this paper. It is also interesting that the oldest Malay inscriptions found so far which contain the numerals are dated 605 S = 683 A.D. This is older (by 150 years)

than the oldest inscription or writing of Hindu-Muslim numerals (since al-Khwarizmi). Since the ancient Malay scripts during this period are known as Palawi (Fig. 11), which is believed to be a modification of the Pallavi scripts in Southern India, then it is possible also that the ancient Malay numerals are also a modification of the Hindu (Pallavi) numerals. But, comparing with the Hindu numerals in Fig 2., perhaps this hypothesis is as controversial as the polemics among scholars on the Hindu and Muslim numeral systems. On the other hand, Majumdar (1953) already claimed that the Funan (ancient Khmer or Kembujadesa) inscriptions dated around the 7th century A.D. (the oldest dated 531 S = 609 A.D. and reported in the *Bulletin de l'Ecole Francais d'Extreme-Ori-*

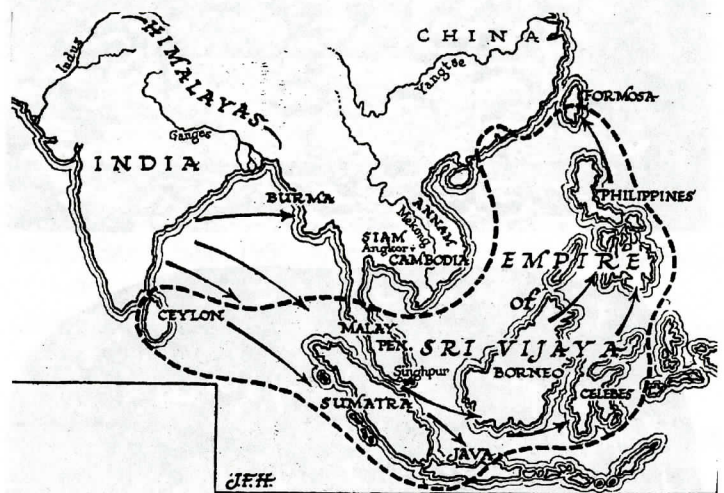


Figure 8: Empire of Sri Vijaya
Source: Nehru, J. (1963). *Jawaharlal Nehru Quest*. London: Asia Pub. House.



Figure 9: Majapahit Empire at its Height in the 13th Century
Source: Lee Sin & Nambar bin Yunus (1994). *Sejarah KBSM*. Kuala Lumpur: Pelangi.

Century A.D.	Zero	one	two	three	Four	Five	six	Seven	Eight	Nine
7 th -8 th	o	o	3	2	4	5 or 6	6	7	8	9
13 th	o	o	7	2	3			U		
14 th	o	o	o	o	o	o	o	o	o	o
Currently (Java)	o	o	o	o	o	o	o	o	o	o

Figure 10: The Development of the Ancient Malay Numerals

it is even more interesting and challenging to study the Malay inscriptions found in Vietnam. According to Intan (1992), the ancient Malays in Vietnam, the Champas, are found to have their own scripts. Out of the total of more than a hundred of their (Malay) in-

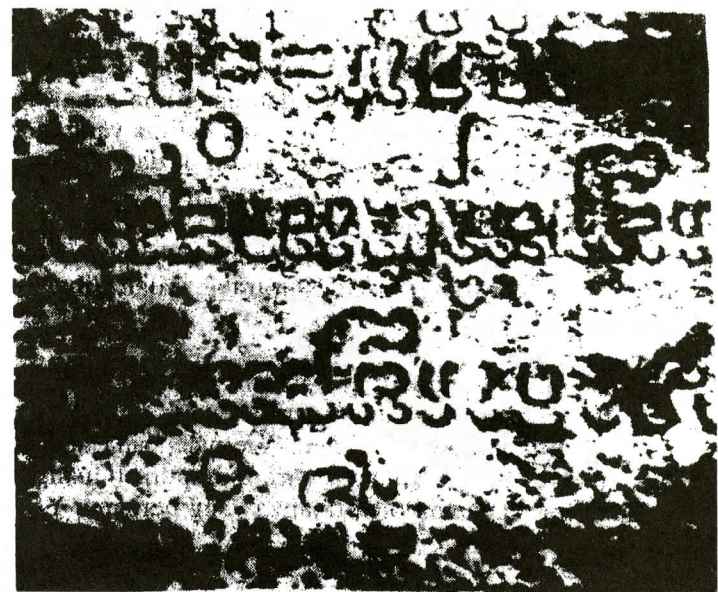


Figure 12a: The Oldest Malay Inscription (found in Vietnam during the Campa Empire)
Source: Intan (1991).

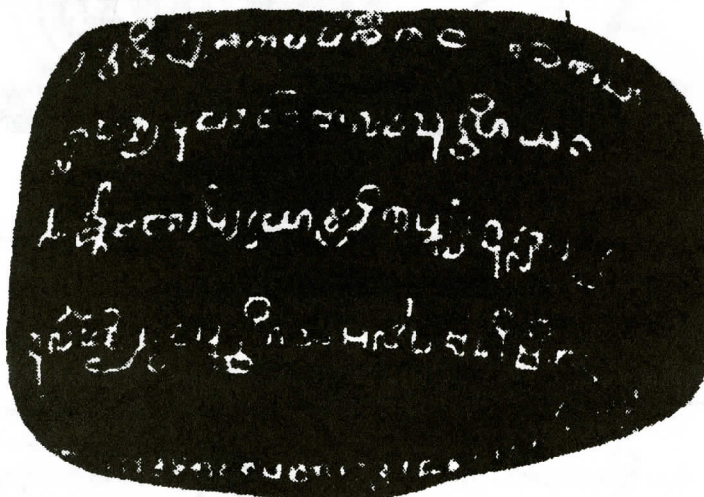
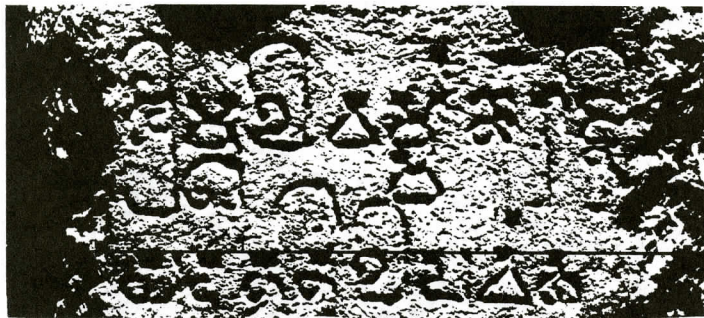


Figure 11: Samples of the Palavi Characters Found in Inscriptions Dated to the 4th Century A.D. Throughout the Malay World

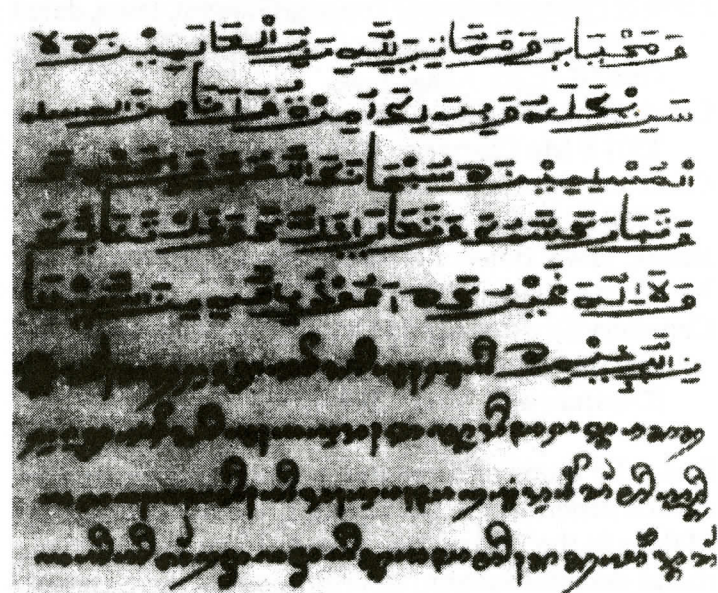


Figure 12b: A Mixture of Arabic and Campa Scripts found at Panduranga, Coast Northeast of Saigaur/ Saigon/Ho Chi Minh City
Source: Intan (1991).

ent, Hanoi, XXXIII: 530-531), contain the decimal numerical system. This is of course much older than the Malay numerals mentioned above. However, details are not available to us. Unfortunately, we are unable to obtain at least some of the relevant inscriptions that have already been transcribed into English or French. Even though this is interesting and very challenging,

scriptions, one of them dated around 400 A.D., is the oldest Malay inscription found so far (Fig. 12) which is apparently similar, but not the same, as the Hindu or Pallavi scripts. We believe that the older ancient Malay numerals can be found by examining all these Malay inscriptions during the Kingdom of Champa. We believe that these inscriptions should prove that the decimal system of the ancient Malays is as old as, if not older than, the Hindu decimal system.

Meanwhile, according to Ismail (1972) and Amat Johari (1996), the Malays in the Malay Archipelago have their own scripts before the invention (or adoption) of the Palawi scripts; the scripts are known as *huruf Rencong* (Rencong scripts) (Fig. 13). Naturally, the Malay should have a numeral system in these scripts. Unfortunately, the oldest Malay inscriptions in these characters dated sometimes in the 13th century (Hooykaas (1959)) do not contain any numerals. But, these scripts are still used by the Malays in remote areas in various places in the Malay Archipelago. Zainal Ariffin *et al.* (1979) have recorded the numeral system in the *huruf Rencong* based on their field work in Sumatera, and as shown in Fig. 14, the Malay numeral system in the *huruf Rencong* is also a decimal system.

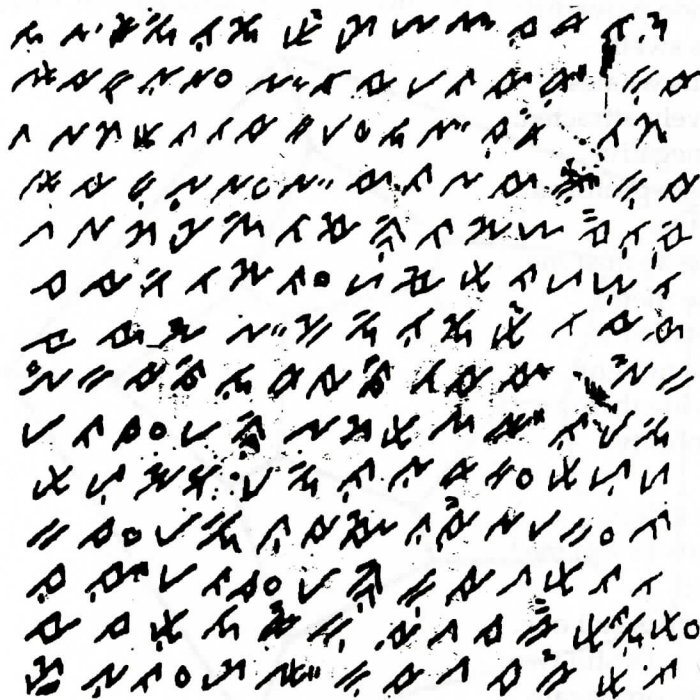


Figure 13: Huruf Rencong (Rencong Characters)
Source: C. Hooykaas (1961). *Perintis Sastera*.

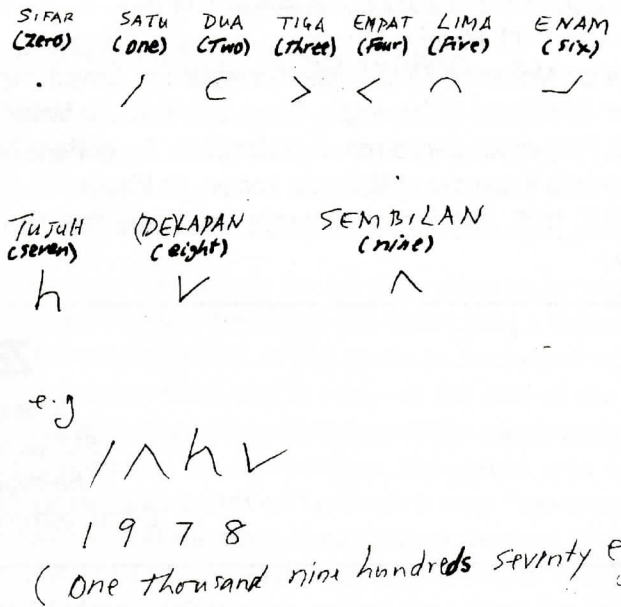


Figure 14: A Malay Numeral System Based on *huruf Rencong*
Source: Zainal Ariffin *et al.* (1979).

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ZERO

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You probably think of me as just
 a black-rimmed ellipsoidal fruit,
 a moon squashed by Jupiter's knees,
 a dot grown too big for its space,
 a nothing—void of weight,
 El Zippo.

Wrong!

I'm the 0rigin of all numbers.

Alone, I am soooo powerful
 all others swell
 like voracious whales
 when I'm positively attracted.
 When I'm negative,
 they become mere protozoa.

Multitudes come against me,
 I obliterate them.
 Dare try divide me,
 they become nought.
 Choose I divide them,
 they're infinity.

Decimate a digit
 who simply wants to join me?
 Not I!
 One more than me is still one.
 When I leave two, it's still two
 When I choose to propagate,
 that number is elevated.

Zero's the name, the real world's my game!