

Numerations in the Sinhala Language

by
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Abstract

This paper covers the findings of recent research into archaic numerals in Sinhala language by the authors. Sinhala language in the present day uses numerals which were introduced by Portuguese, Dutch and English after 1505 AD and these numerals are known in Europe as Arabic numerals. The paper will also cover briefly of numerations and numerals existed in the recent past in Sinhala before 1815 AD of British occupation of Kandyan kingdom and it will also provide some of the findings of evolution of some of archaic Sinhala numerals into the form found at the time of British occupation of Kandy.

1. Introduction

Sinhala belongs to the Indo-European Language family with its roots deeply associated with Indo-Aryan sub family to which the languages such as Persian and Hindi belong [Histroy1]. Although it is not very clear whether people in Sri Lanka spoke a dialect of Prakrit at the time of arrival of Buddhism in Sri Lanka, there is enough evidence that Sinhala evolved from mixing of Sanskrit, Magadi (the language which was spoken in Magada Province of India where Lord Buddha was born) and the local language which was spoken by people of Sri Lanka prior to the arrival of Vijaya in Sri Lanka, the founder of Sinhala Kingdom [Dissa06:11]. It is also surmised that Sinhala had evolved from ancient variant of Apabramsa (middle Indic) which is known as 'Elu'. Some scholars believe that 'Elu' is a type of Prakrit which was from India but others argue that it was native to Sri Lanka. When tracing history of Elu, it was preceded by Hela or Pali Sihala [Histroy1].

Sinhala though has close relationships with Indo Aryan languages which are spoken primarily in the north, north eastern and central India, and was very much influenced by Dravidian language families of South India especially by Tamil. Sinhala has borrowed many Tamil words which have become part of Sinhala vernacular. Though Sinhala is related closely to Indic languages, it also has its own unique characteristics: Sinhala has symbols for two vowels which are not found in any other Indic languages in India: 'Ae' (අෛ) and 'Ae:' (අෛ:).

The Sinhala script had evolved from Southern Brahmi script from which all most all of the Southern Indic Scripts such as Telagu and Oriya had evolved. Later Sinhala was influenced by Grantha writing of Southern India. Since 1250 AD, the Sinhala script had remained the same with few changes. Although some scholars are of the view that Brahmi Script arrived with Buddhism, Mahavamsa (Great Chronicle) speaks of written language even right after the arrival of Vijaya. Archeologists had found pottery fragments in Anuradhapura Sri Lanka with old Brahmi script inscriptions, which had been carbon dated to 5th century BC. Earliest Brahmi Script found in India had been dated to 6th Century BC in Tamil Nadu though most of Brahmi writing found in India had been attributed to emperor Ashoka in the 3rd century BC[Brahmi02].

Sinhala letters are round-shaped and are written from left to right and they are the most circular-shaped script found in the Indic scripts. The evolution of the script to the present shapes may have taken place due to writing on Ola leaves. Unlike chiseling on a rock, writing on palm leaves requires to be more round-shaped to avoid the stylus ripping the Palm leaf while writing on it. Drawing vertical or horizontal straight lines on Ola would have ripped the leaf and this also may have influenced Sinhala not to have a period or full stop, but instead a stylistic stop which was known as 'Kundaliya' was used. Period and commas were later introduced into Sinhala script after the introduction of paper due to the influence of the Western languages.

In modern Sinhala, Arabic numerals, which were introduced by Portuguese, Dutch and English are used for writing numbers and carrying out calculations. Roman numerals are used for writing dates and for listing items or words in Sinhala though at present, Roman numerals are not commonly used and they were also introduced by western powers who occupied Sri Lanka. It is accepted that Arabic numerals had evolved from Brahmi numerals. It had also been discovered by Sri Lankan archeologists that Brahmi numerals were used in ancient Sri Lanka and it may have evolved into a set of numerals which were known as archaic Sinhala numerals which were found in the Kandyan period. This paper will mainly cover archaic numerals and numerations in Sri Lanka at the time of British occupation of Kandyan Kingdom and their evolution to the forms which were found at the time of British occupation of whole of Sri Lanka. This paper will also touch upon Brahmi numerals, which was found in Sri Lanka.

2. Approach and Methodology of research into Sinhala numerals

The authors carried out research into Sinhala numerals from the both linguistic and mathematical perspectives. In their research, the authors had looked specifically for the existence of zero in any form of numerations in Sinhala which were found in their research since the invention of zero had been a major demarcation point in mathematics and advancement in modern pure mathematics would have not been possible without having the concept of zero. Although zero had been discovered and re-discovered independently by various civilizations in the world, it is now accepted that zero as an independent number was discovered and used for the first time by the Indian mathematicians and it had been taken to the west by the Arabs with the rest of numerals which were developed in India from Brahmi numerals. E.T. Bell in his book, the development of Mathematics, describes of the development of zero by Indian mathematicians in the following manner:

"The problem of numeration was finally solved by Hindus at some controversial date before A.D. 800. The introduction of zero as a symbol denoting the absence of units or of certain powers of ten in a number represented by the Hindu numerals has been rated as one of the greatest practical inventions of all time"

[Bell40:51]

In their research into Sinhala numerals or numerations, the authors had looked into the following:

- i. Papers or publications on Sinhala numerals,
- ii. Original documents which had some of form of numerals or numerations,
- iii. Rock inscriptions,
- iv. Ola leaf page numbering,
- v. Any evidence for zero in Sinhala numerals or numerations,
- vi. Numismatics

Shapes of several numeral sets which belong to Indic languages were compared with of the numerals sets which were identified as numerals or numerations in Sinhala language. The Indic numerals sets which were studied extensively were Thai, Lao, Burmese, and Malayalam numerals.

The museums in Colombo and Kandy were visited many instances to study Ola leaf pagination by the authors. The Colombo museum library hosts an Ola leaf collection which is known as W. A. De Silva Collection and this sizable collection amounts to be 5000. Some of the original and older Ola leaf collections were found to be outside of Sri Lanka. A major collection is located in Britain and is known as Hugh Neville collection and the catalogue of this collection is available in Sri Lanka. Museums in other countries that are reputed to host Sinhala Ola leaf collections are in Arizona, US, Brussels, Belgium and Netherlands.

3. Numerals or numerations found immediately before the fall of Kandyan Kingdom

It had been found by the authors that five different types of numerations were used in Sinhala language at the time of occupation of Kandyan kingdom by the British. Out of the five types of numerations, two sets of numerations were in use in the twentieth century mainly for astrological calculations and to express traditional year and dates in ephemerides. The five types or sets of numerals or numerations are listed below.

i. Sinhala Numerals or Sinhala Illakkam

In “A Comprehensive Grammar of the Sinhalese Language”, Abraham Mendis Gunasekera, the author of the book describes a set of archaic numerals which had not been in use even at the time of the publication of his book in 1891. According to Mr. Gunasekera, these numerals were used for ordinary calculations and to express simple numbers. These numerals had separate symbols for 10, 40, 50, 100, 1000[Guna1891:144]. These numerals were also regarded as Lith Lakunu or ephemeris numbers by W. A. De Silva in his “Catalogue of Palm leaf manuscripts in the library of Colombo Museum”. This set of numerals was known as Sinhala illakkam or Sinhala archaic numerals.

The following is an excerpt from “A Comprehensive Grammar of Sinhalese Language”, by Abraham Mendis Gunasekera describing Sinhala Archaic numerals:

“Sinhalese had symbols of its own to represent the different numerals which were in use until the beginning of the present century. Arabic Figures are now universally used”

The old numerals are given in Figure 1 (No. iii.).

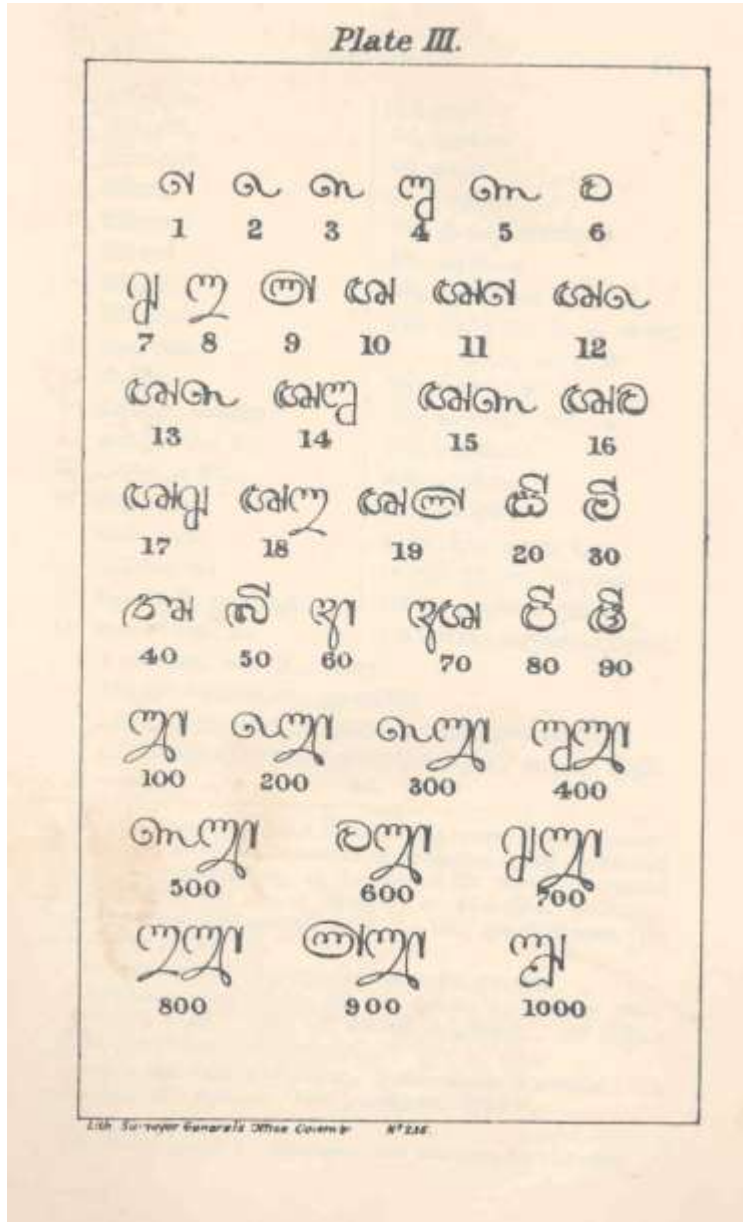


Figure 1: Archaic Sinhala Numerals from Plate III of Abraham Mendis Gunasekera's book 'A Comprehensive Grammar of Sinhalese Language'. These numerals did not have a zero and they also did not have zero concept holder.

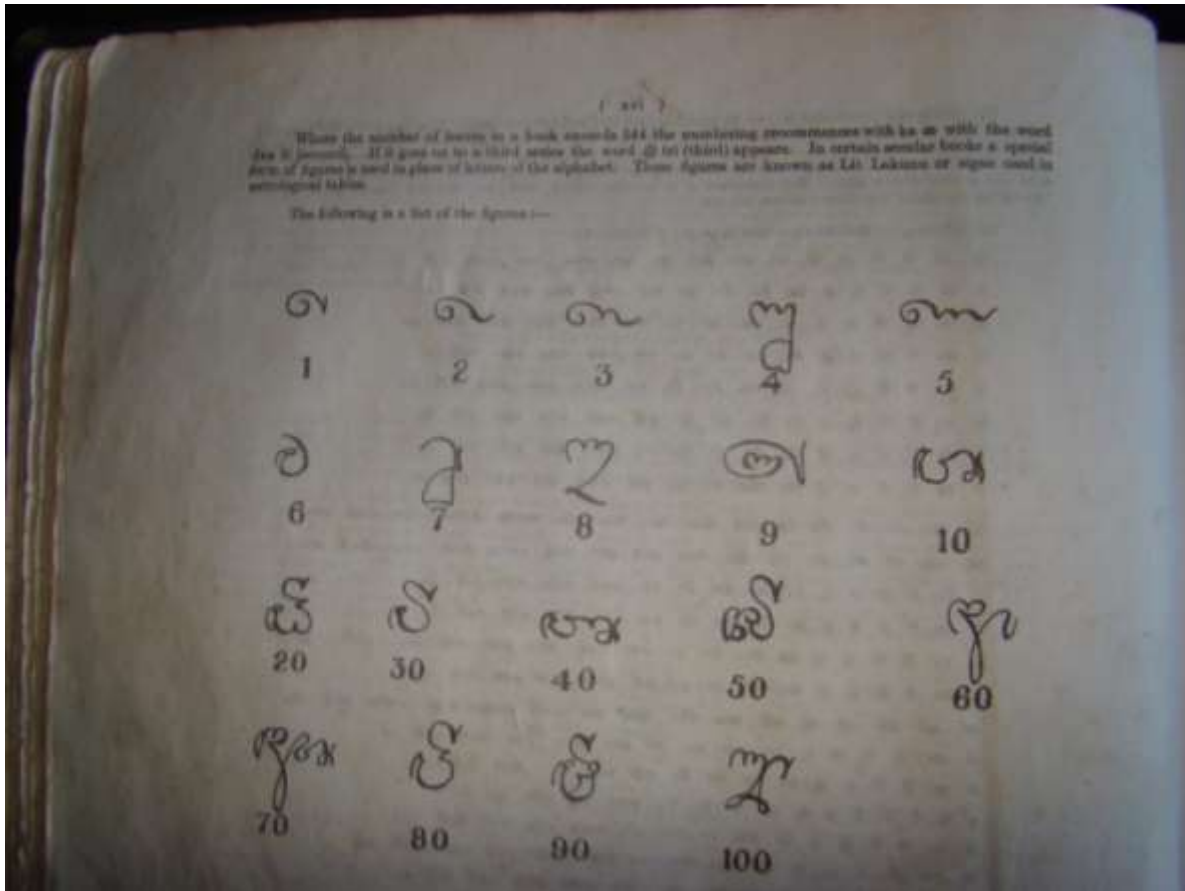


Figure 2: Archaic numerals from 'Catalogue of Palm leaf manuscripts in the library of Colombo Museum', Volume I, compiled by W.A. De Silva, published by the Government Printer in 1938

One of the major findings had been the discovery of Sinhala numerals or Sinhala illakkam in the Kandyan convention which was signed between Kandyan chieftains and the British governor in 1815. Eleven clauses had been numbered in Arabic numerals in the English section of the agreement and the parallel Sinhala clauses were numbered in Sinhala Archaic numerals.

Proclamation දැන්වීමේ ප්‍රකාශනය

The Convention නිකුත්වීයේ කැටුම්බාදොර ප්‍රදේශයේ
held on the 21st day of March පහලොහනැවැනි වසරේ මාර්තු 21 වන දින
in the year of our Lord 1815 දෙවන වසරේ මාර්තු 21 වන දින
the Congales year 1781 කැටුම්බාදොර ප්‍රදේශයේ කැටුම්බාදොර
the Palace in the City of කැටුම්බාදොර නුවර ප්‍රදේශයේ
St. George's සිංහල නුවර ප්‍රදේශයේ
between His එකීනි වසරේ පුනරුත්ථාපනයේ
Majesty's Government ප්‍රතිසංස්කරණ ප්‍රදේශයේ
General Robert Brownrigg ජෙනරාල් බ්‍රවුන්රිග්
Governor and Commander පාලකයා සහ ප්‍රධානියා
in Chief in and over the ප්‍රධානියා සහ ප්‍රධානියා
British Settlements බ්‍රිතාන්‍ය ප්‍රදේශයේ
situated in the Island ප්‍රදේශයේ ප්‍රදේශයේ
of Ceylon, acting in the ප්‍රදේශයේ ප්‍රදේශයේ
name and on behalf of ප්‍රදේශයේ ප්‍රදේශයේ
His Majesty George the එකීනි වසරේ පුනරුත්ථාපනයේ
Third King, and His ප්‍රදේශයේ ප්‍රදේශයේ
Royal Highness George එකීනි වසරේ පුනරුත්ථාපනයේ
Prince of Wales Regent, එකීනි වසරේ පුනරුත්ථාපනයේ
of the United Kingdom එකීනි වසරේ පුනරුත්ථාපනයේ
of Great Britain and එකීනි වසරේ පුනරුත්ථාපනයේ
Ireland in the name එකීනි වසරේ පුනරුත්ථාපනයේ
of His Majesty එකීනි වසරේ පුනරුත්ථාපනයේ
George the Third එකීනි වසරේ පුනරුත්ථාපනයේ
King, and other එකීනි වසරේ පුනරුත්ථාපනයේ
Principal Chiefs of එකීනි වසරේ පුනරුත්ථාපනයේ
the එකීනි වසරේ පුනරුත්ථාපනයේ

Figure 3: First page of the Kandyan Convention, 1815.

<p>The King and Queen, in behalf of the Inhabitants, and in presence of the Mahattas Corraes, Vidcons and other Sub- ordinate Magistrates from the several Provinces, and of the People then and there assembled on the other part, it is agreed and established as follows.</p> <p>1st That the Cruelties and oppressions of the Malabar Ruler, in the Arbitrary and unjust infliction of Bodily Torments and the pains of Death, in their Trial and Execution without an accusation or the possibility of a Crime; and in the general Cru- elty and Contumacious of all Civil Rights, have become flagrant, un- pardonable and intolerable;</p>	<p>අනුබලයෙන් විකල්පයක් විවේචනය වීමට තීරණය කරන බව පෙනේ. - එවන් අයක් නොකරවන සේ වලදි පවතින අයුතු ක්ව නොනොතිව. ඉදහ රනේ වටු චායාවක් පවති වන්නොලදි නොකරන චායාවක් පවතින අයුතු වන නොව සලකන බව වන නොව සලකන බව නිසා වන බව පෙනේ. මෙහි අයුතු ක්ව නො කරන බව පෙනේ. මෙහි අයුතු ක්ව නො කරන බව පෙනේ. මෙහි අයුතු ක්ව නො කරන බව පෙනේ. මෙහි අයුතු ක්ව නො කරන බව පෙනේ. මෙහි අයුතු ක්ව නො කරන බව පෙනේ. මෙහි අයුතු ක්ව නො කරන බව පෙනේ.</p>
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Figure 4: Second page with clear number one in Sinhala numerals

The acts and measures of
 the Government being
 equally and entirely
 aware of that Justice
 which should govern
 the state of the subjects;
 and of that good faith
 which might obtain
 a beneficial intercourse
 with the neighbouring
 States.
 And that the Spirit
 of the Roman Religion
 should, by the habitual
 dictates of the Chief
 & most sacred Duties
 of a Sovereign, have per-
 suaded all Nations to
 that little or the Liberty
 annexed to the Crown,
 and as declared further
 and defended from the
 Oppress of being all in
 Community and Liberty
 whether in the manner
 any Government or
 Collateral

සහ අන්යෝන්ය ජාතිකයන්
 විශ්වාසයෙන් සහයෝජනය
 වන නිසා සුදුසු නිසා -
 ආදායම් වැඩි කිරීමට පියවර
 ගැනීමට කැපවීමෙන් සහ
 එහි ප්ලාසටික් සුදුසු නිසා
 සහ ආයතනවලට වෙන් වෙන්
 වශයෙන් වැඩි කිරීමට පියවර
 ගැනීමට කැපවීමෙන් සහ
 එහි ප්ලාසටික් සුදුසු නිසා
 ආදායම් වැඩි කිරීමට පියවර
 ගැනීමට කැපවීමෙන් සහ
 එහි ප්ලාසටික් සුදුසු නිසා
 සහ අන්යෝන්ය ජාතිකයන්
 විශ්වාසයෙන් සහයෝජනය
 වන නිසා සුදුසු නිසා -
 ආදායම් වැඩි කිරීමට පියවර
 ගැනීමට කැපවීමෙන් සහ
 එහි ප්ලාසටික් සුදුසු නිසා
 සහ ආයතනවලට වෙන් වෙන්
 වශයෙන් වැඩි කිරීමට පියවර
 ගැනීමට කැපවීමෙන් සහ
 එහි ප්ලාසටික් සුදුසු නිසා

Figure 5: 2 and 3 in Sinhala numerals in the Kandyan Convention

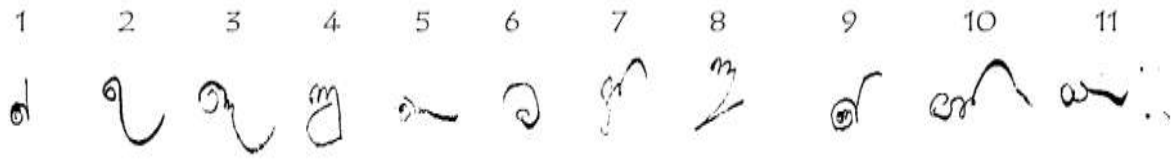


Figure 6: Sinhala numbers of the Kandyan Convention, 1815.

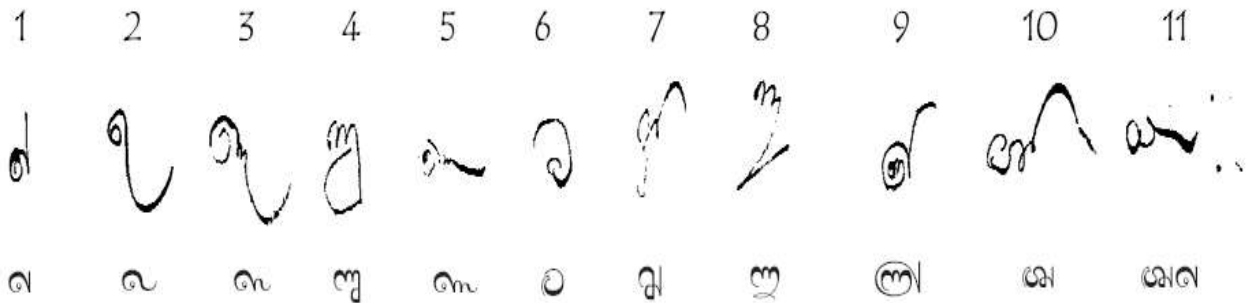


Figure 7: Sinhala archaic numerals with Sinhala numerals of Mendis Gunasekera.

The set of numerals found in the Kandyan convention has been given above with the numerals with Mendis Gunasekera's depiction of the same numerals .It is noteworthy to mention that number 2 and 3 of Sinhala numerals found in the Kandyan convention differ from the manner Mendis Gunasekera had depicted of the same set of numerals. The above set has been taken as the most accurate set when the shapes of the numerals are considered by the authors. The above assumption has been proven by examining the pocket watch of Sri Wickrama Rajasinghe, the last king of Kandy.

The watch gives considerable information as to how time was expressed in Sinhala. Sinhala day is made of Sixty Sinhala hours. Therefore the watch has thirty Sinhala hours for a half day.



Figure 8: the pocket watch of Sri Wickrama Rajasinghe the last king of Kandy.

The authors found an article in the Sinhala Encyclopedia on Sinhala numeration and numerals by Dr. P. D. S Kularatne former educationist and Principal of Ananda College of Sri Lanka who had given the shapes and description of the above numerals [Kula67]. In addition, the authors had found first Bible in Sinhala which was written at the time of the Dutch occupation where the year of compilation of the Bible was given using the above set.

ii. Lith Illakam or ephemeris numerals

Although this numeral set was commonly used for casting horoscopes and to carry out astrological calculations, the authors had found that this set had been used for numbering pages of Ola palm leaf books which covered primarily of non Buddhist topics. Dr. P. D. Kularatne in his article on Numerals and numerations in Sinhala language to Sinhala Encyclopedia claims that this set was used only for Astrological calculations [Kula67].



Figure 9: Number 1 in Lith Illakam

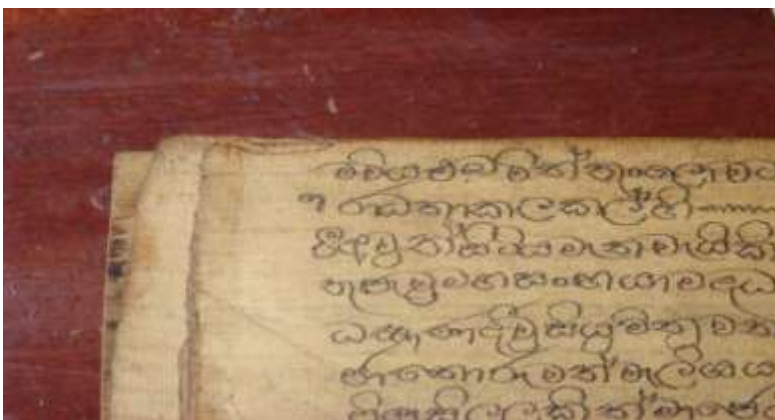


Figure 10: Number 2

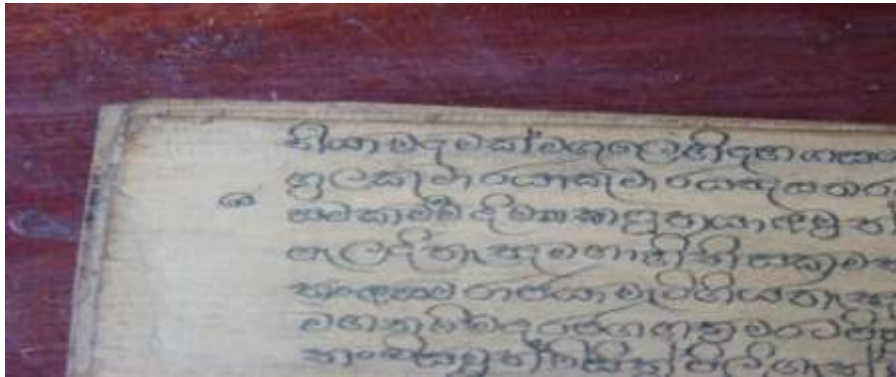


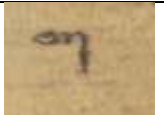



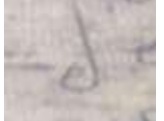
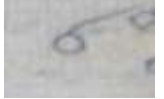
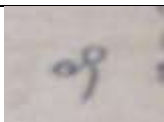
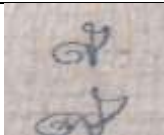
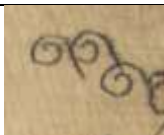
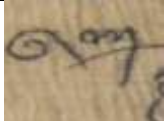


Figure 11: number 6 or akma

	Number 1 or kombuwa
	Number 2 or letter Na from 8 th Century
	Number 3 or Naa from 8 th Century
	Number 4 or letter Ja
	Number 5 or letter Da
	Number 6 or Akma
	Number 7 or letter OO
	Number 8 or Letter Ra
	Number 9 or letter Ni
	Number 10 or Combination of Kombuwa and Halant
	Number 11 or two kombuwas
	Number 13

Numbers of lith illakkam are depicted by Sinhala letters and vowel modifiers. The authors had discovered that there are mainly two versions of these illakkam according to the way numbers 2, 3 and 9 are written. The number six is known as ‘akma’ in the Lith Illakkam. These numerals were in use continuously for writing horoscopes on Ola leaf, the tradition of which continued till the beginning of the twentieth century. Both versions of Lith illakkam have a zero and the zero is the Halantha or Hal lakuna (kodiya) in the Sinhala language. Although it is not understood whether Sinhala mathematicians treated zero as a number, it was quite possible they had known the concept of zero. In Lith Illakum, numbers greater than zero were written the same way as the Arabic numbers with the zero and the value of the number in the left was increased by ten. In other words, Lith Illakkam had a zero and a zero place holder concept. Lith Illakkam version 1 had for 2, 3 and 9, Sinhala letter ‘Murthda Na’ in 6 to 8th century. In the second version of Lith Illakkam as W. A. De Silva had depicted in his book, 2,3 and 9, Sinhala letter, ‘Na’ (න) with vowel modifiers.

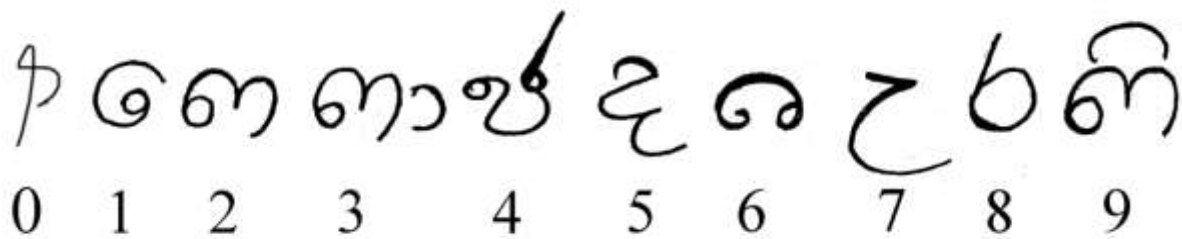


Figure 12: Lith illakkam version 1

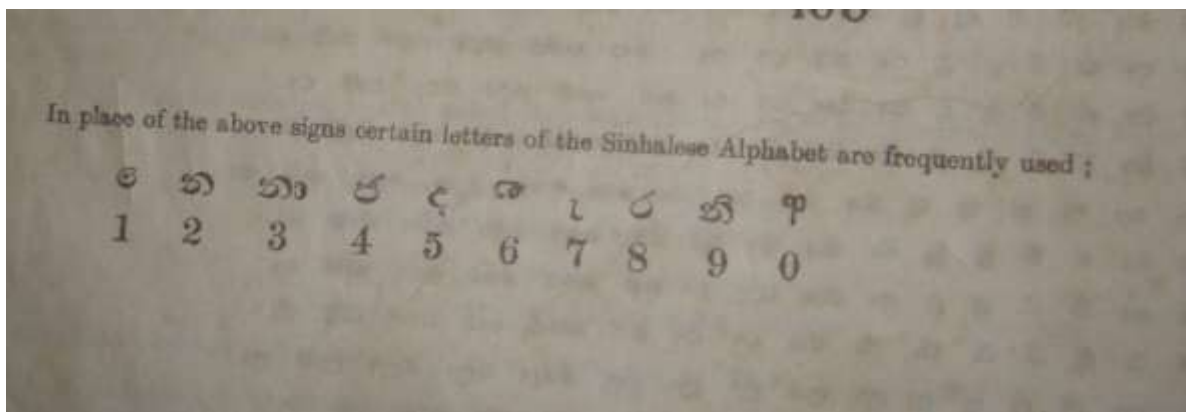


Figure 13: second version of Lith Illakkam. W.A. De Silva describes Lith Illakkam; he had placed a vowel modifier for number 7 which has to be Letter OO

ලිත් ඉලක්කම්

෧ 1	෨ 2	෩ 3	෪ 4	෫ 5
෬ 6	෭ 7	෮ 8	෯ 9	෧෦ 10
෧෧ 11	෧෨ 12	෧෩ 13	෧෪ 14	෧෫ 15
෧෬ 16	෧෭ 17	෧෮ 18	෧෯ 19	෨෦ 20
෨෧ 21	෨෨ 22	෨෩ 23	෨෪ 24	෨෫ 25

Figure 14: Dr. P. S. Kularatne on Lith Illakkam (20 is incorrectly depicted)

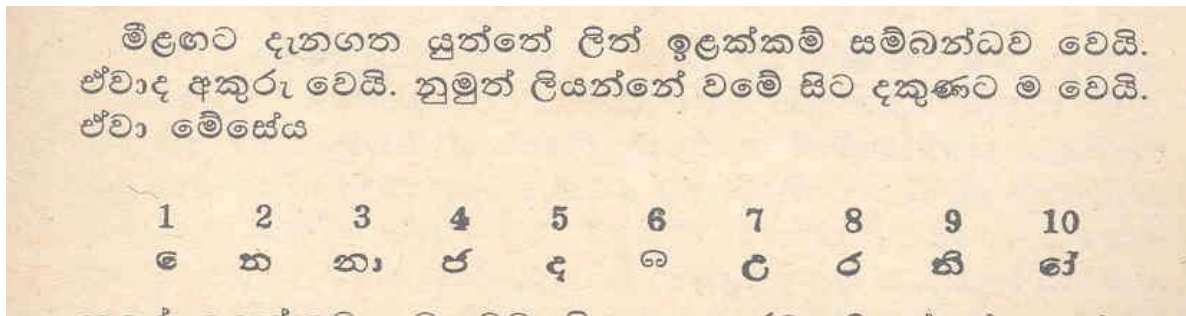


Figure 15: (ලිත් අංක) or Ephemeris numbers from Hendirk De Silva Hettigoda's Astrology book

Figure 15 provides third version of Lith Illakkam but the authors had not observed this version in general except in this particular book. The difference of this version is the zero, instead of hal lakuna, this version has a 'Pilla' with hal lakuna[Hetti87].

One of the most interesting articles which the authors had come across is an article on numerals and numerations in Sinhala language, by Abraham Mendis Gunasekera. In this article, he refers to Lith Illakum as well as to Sinhala Illakkam. For Sinhala Illakkam, he produces the same shapes which had been given in his book written in English. Abraham Mendis Gunasekera uses modern Sinhala letters and vowel modifiers which is Version 2 of Lith Illakkam. In this article, he clearly mentions that Hal lakuna or 'Kodiya' is the zero. In other words, 'Sunayathana' is filled with a kodiya will multiply by ten, the number on the left side of Sunayasthana. Abraham Mendis Gunasekera clearly states that instead of Hal lakuna of Sinhala language, a 'Shunaya binduawa' (zero place holder) can be used to fill the 'Shunayasthana'. In other words, Lith Illakkam uses duality of zero to write numbers greater than 9[Guna-Article1891]. This article counters that lith illakum may have been used up to 60 by P. D. S Kularatne[Kula67].

පිළිබඳ ගණන් කීමට භාවිතාකරණ ලැබෙන්නේ,
 ඒවා මෙසේය :—

ඉලක්කම්.	කම.	සමාන අරාභි අවකාශ.
අ	කොම්බුටු	1
ආ	භයන්ත	2
ඇ	තායන්ත	3
ඈ	ජයන්ත	4
ඉ	දයන්ත	5
ඊ	ආක්ම	6
උ	ඊයන්ත	7
ඌ	රයන්ත	8
ඍ	නස්තියන්ත	9

මේ ඉලක්කම්වලට අල් ලකුණ යෙදුනල එහි
 විධිනාකම් දැනට රැස් වැඩේ. එබැවින් 0 * යනු
 10 යි; 01 යනු 20 යි; 02 යනු 30 යි; මේආදී මෙකී.
 ඉහත සීමට බිත්ලුව (0) ද යොදත්. ගණන්
 දැක්වීමට මේ ඉලක්කම්වල යෙදීම අරාභි ඉලක්
 කම් ඉයාදන පිළිවෙලට වේ : එනම් 84 යනු රජ;
 102 යනු 0 න් හෝ හො; 1547 යනු දෙපල; 1807
 යනු රෙතිල.

Figure 16: Abraham Mendis Gunasekera on Lith Illakkam. In his examples, he had used zero to write 102 instead hal lakuna

According to the above article, the following combinations given in figure 17 are possibilities.

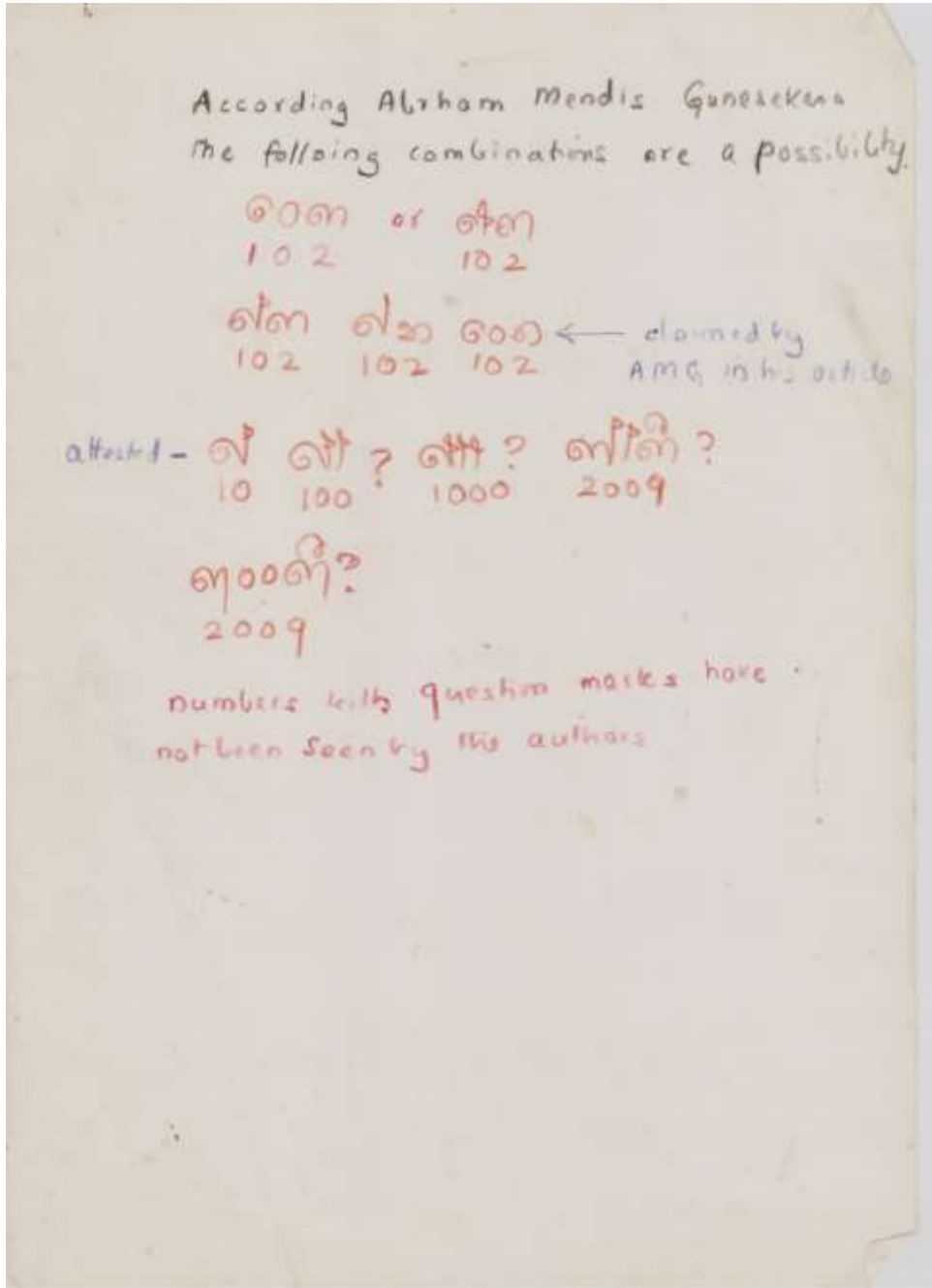


Figure 17: possible combinations using lith Illakkam



Figure 18: Ephemeris found in the Kandy Museum



Figure 19: Degrees that Planets were positioned in Nakshathra



Figure 20: Horoscope cast in October 1936



Figure 21: Same Horoscope with Lith Illakkam

The authors have found a horoscope which had been casted in 1932 in Matale using the same Lith Illakkam which has been included.

iii. Katapayadia

Even to this day, years are given in the front page of popular ephemeris in Sri Lanka, 'Panchanga Lith' using 'Katapayadia'. Katapayadia is a unique numbering scheme where numbers 1 to 9 and 0 have been depicted by consonants. The katapayadia is mainly used for writing dates.

1	2	3	4	5	6	7	8	9	0
ක	ට	ඟ	ඞ	ඞ	ඞ	ඞ	ඞ	ක	ක
ඞ	ඞ	ඞ	ඞ	ඞ	ඞ	ඞ	ඞ	ඞ	ඞ
ඞ	ඞ	ඞ	ඞ	ඞ	ඞ	ඞ	ඞ	ඞ	ඞ

Figure 22: Katapayadia (borrowed from Life and Planets, the book written by Hedrick De Silva Hettigoda).

This numeration is known as Katapayadia:⁴ so called since number one is assigned the Sinhala letters 'Ka' (ක), 'Ta' (ට), 'Pa' (ප) and 'Ya' (ය). In this tradition of writing numbers, the year 2007 can be written with for instance 'Ka' (ක) 'Na' (න) 'Na' (න) 'Sa' (ස). Traditionally, 2007 will be written from right to left: 7002. Ordinarily, using vowel modifiers, a word in Sanskrit will be created for the year 2007 (7002 right to left) with the allocated letters for 7002. When reading, one has to remove the vowel modifier.

Katapayadia was widely used by South Indian astrologers and some of Chola rock inscriptions in Sri Lanka have dates inscribed in Katapyadia.

iv. Page numbering of Ola leaves using Sinhala 'Swara (ස්වර)'

The method of page numbering of Ola using Sinhala Swara had been common tradition in the ancient and recent history of Sri Lanka. The author had found that using Sinhala Swara in place of numeration could be traced back to Aryabhata's (the great Indian Mathematician and Astronomer) numbering system where he used Sanskrit Swaras in place of numerals. Sinhala scribes had developed their own numeration based upon Sinhala characters according to the order of the position of consonants and vowels in the Sinhala Alphabet without the modern two vowels: 'Ae' (ඈ) and 'Ae:' (ඈ) in the Sinhala Alphabet (the Sinhala alphabet without the above mentioned two vowels is known as 'Pansal Hodiya' or the alphabet of the temple). The numeration method which is similar to the use of Sinhala Swara is found in Burmese Ola collection.

The tradition of Swara as numeration in page numbering in Ola had been commonly used for Buddhist manuscripts. The authors had the opportunity of examining several Ola palm leaf books in the Colombo museum¹ and the catalogues of Hugh Neville⁵ collection in the London Museum². Having investigated paging of Ola leaves, the majority of palm leaf manuscripts which are in the museum had Sinhala consonants with 'swara' (ස්වර) (combinations of sounds) for numbering. The number of combinations which can be made out of consonants is 544 and once the first 544 ends, paging begins with the second cycle of 544 with the word 'dwi:' (ද්වි) or 'second' in English. If the second cycle does not end the palm leaf book, it goes into third cycle of 544 which begins with the word 'three' (ත්‍රි) or Three in English [DeSilva38].

v. Bhootha Anka or Butha Samkaya

In Sinhala literature, certain words in the language were used to denote numbers. For instance, sky is associated with zero or 'Sunaya', and a number which was denoted by words is known as Bhuta Anka. Bhootha Anka was created by ancient Sanskrit Mathematicians and Astronomer prior to the invention of a symbol for zero. Some of the words which are associated with numbers are

Moon = one

Eye = two

Fire = three

If one were to write 130, he or she would place moon, fire, sky together to form the number. Pierre-Sylvain Filliozat in his article 'Ancient Sanskrit Mathematics: an oral tradition and a written literature', describes Bhootha Anka as object-number metronomic expressions.

As it was mentioned previously, knowledge was transferred through memory rather than writing it down. In order to make memorization easier, it is natural that the numbers are placed as words and the words are formulated sequentially that they would sound rhythmical. The Indian tradition of Bhootha anka was imported to Sri Lanka as it was used in India and the tradition continued with Sinhala words that had same meanings.

4. Brahmi numerals found in Sri Lanka

Dr. Senarath Paranavithana (first Sri Lankan Commissioner of Archaeology) and Prof. Abaya Aryasinha of the University of Kelaniya, had independently found in their research that Sinhalese had used numerals which closely resembled Brahmi numerals of India in the early days of Sinhala civilization. The evidence for use of Brahmi numerals had been discovered primarily in rock inscriptions which were inscribed in between AD 200 and 400. These numerals were used to record donations given by royals and other people who were belonged to the upper echelon of ancient Sinhala society to Buddhist temples [Abi90:90].

Brahmi numerals are ancestors of Arabic numerals which are used presently worldwide. Brahmi numerals had symbols for 10,100, and 1000. Number 1 and 10 in Brahmi have not been found in Sri Lanka up to now. Therefore shapes of these two numerals have been hypothesized without physical evidence [Menninger92:395]

Sinhala rock inscriptions suddenly become barren of numerals from A.D. 400 onwards. Tradition of writing numbers in word becomes more prevalent from the above period.

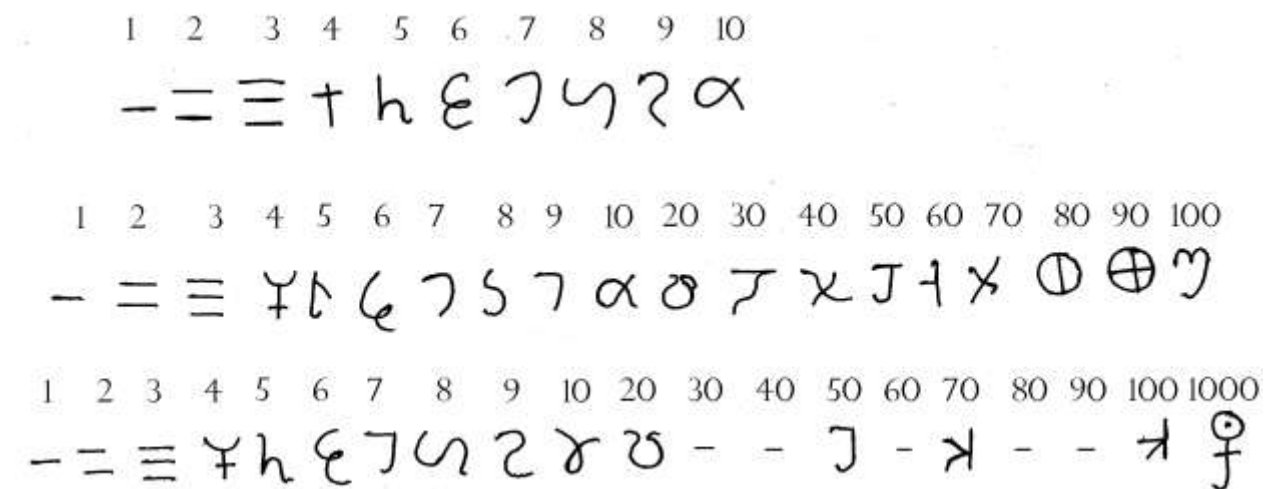


Figure 23: The first set was found during 3BC and the second was commonly found in 1AD in India and the Sri Lanka set is without 80 and 90



Figure 24: number 4 in the Kandy museum

අංක 2 දරන රූප සටහනෙන් උපුටාගත් බ්‍රාහ්මී අංකන ක්‍රමය

[- (1)] ?	ඊ (10)
= (2) /	ඊ (20)
≡ (3) /	- (30)
ූ (4) /	- (40)
ඞ (5) /	ඉ (50)
ඞ (6) /	- (60)
ඞ (7) /	ඊ (70)
ඞ (8) /	- (80)
ඞ (9)	- (90)
[ඊ (10)] ? /	ඊ (100)
	ඊ 1000 /

4 වන රූප සටහන

Figure 25 Brahmi numerals in Sri Lanka [Abi90:90]

5. Evolution of Sinhala Illakkam and Lith Illakkam

i. Sinhala Illakkam

Sinhala Illakkam had evolved from Brahmi numerals which were found in Sri Lanka. Since Brahmi number 1 and 10 had not been discovered in Sri Lanka, it is not possible to know the shapes of those two numerals in order to compare with Sinhala Illakkam. The shapes of these two numerals were surmised comparing with the Indian Brahmi numerals at the same period. In Sri Lanka Brahmi 4 had evolved parallel with the Indian Brahmi, but Sinhala Illakkam had evolved into more complex shapes than that of its Indian cousins (Arabic numerals had evolved from sets of Indian numerals) due to cursive shapes of Sinhala letters. Shapes of Brahmi number 100 and 1000 found in Sri Lanka are different from of Brahimi 100 and 1000 which are commonly found in India. The following is possible evolution of process of Brahmi into Sinhala Illakkam.

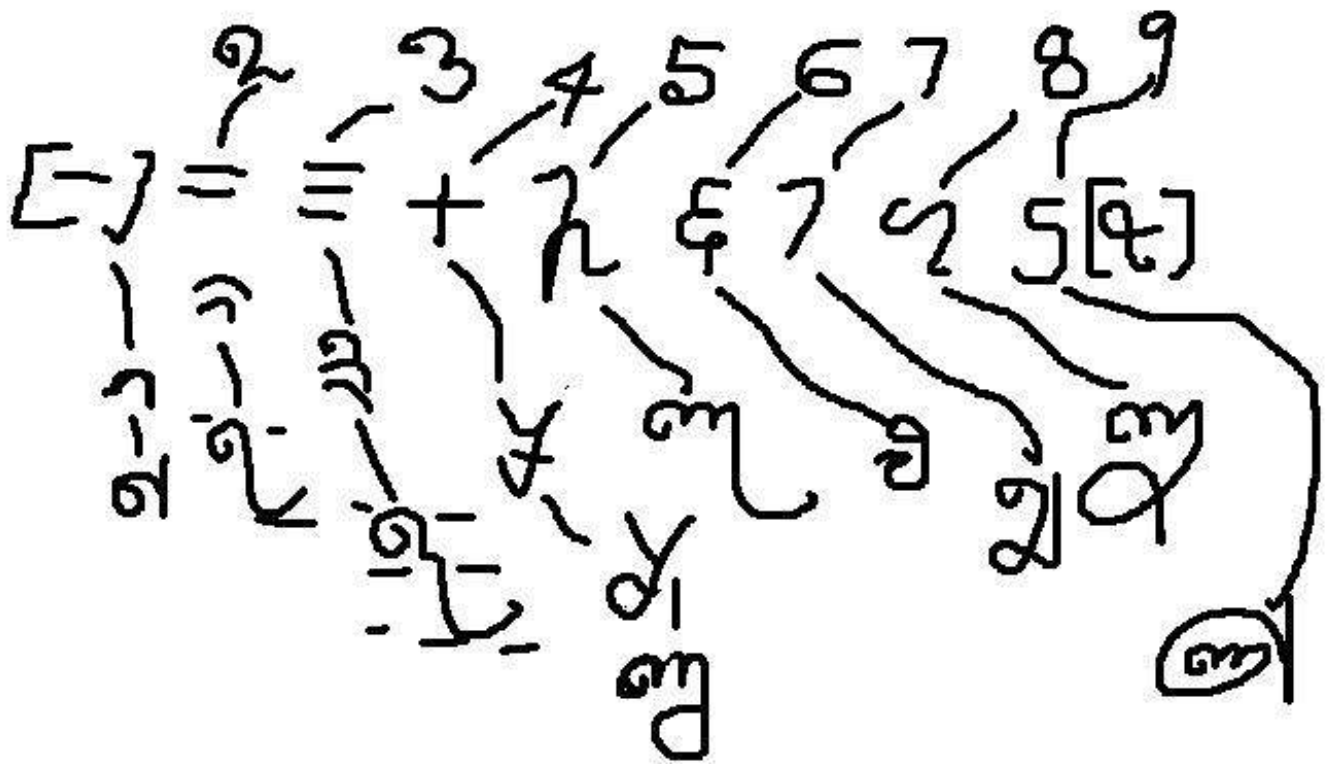


Figure 26 Evolution of Sinhala Illakkam

The authors modeled the evolution of Sinhala Illakkam using Morphing Software and modeling enables the authors to see possible stages of evolution we had not discovered physically. It can be quite easily seen the evolution of Numbers 1, 2 and 3 of Brahmi into Sinhala Illakkam comparing how Indian numerals had evolved from the Indian Brahmi.

The authors have found some evidence for Sinhala Illakkam at the Wata Da Ge in Polonnaruwa. Floor tiles of Wata Da Ge at Polonnaruwa were made from rock slabs which were quarried and were brought from a far distance from the present location. Since Wata Da Ge is a circular structure, the builders had numbered the tiles before transporting them to the present location. At the Wata Da Ge, the researchers had found three different categories of numbering systems. At the first level, rock slabs were numbered using Sinhala 'Swara' and second level , clear number 1 of Sinhala Illakkam was found.



Figure 27: Sinhala Swara KU on the ground floor of Wata Da Ge in Polonnaruwa.



Figure 28: Sinhala Illakkam number 1

The three categories of numbering found at Wata Da Ge were

1. Possible Sinhala Illakkam
2. Swara based Numbering which was found in the Ola lead paging
3. Sanskrit letter (swara) and Indian Numeral

Figure 27 provides evidence for category 1 of numbering and figure 28 is a clear indication that some of Sinhala Illakkam had been used for numbering of rock tiles. The following is the evidence for third category of numbering at Wata Da Ge. When looking at the history of Wata Da Ge, it was originally built by King Parakramabahu the first and it was again restored by Nissanka Malla. At the end of Polonnaruwa period, Wata Da Ge had been destroyed and it was again restored for the last time during the Dambadeniya period in the ancient times until the 20th century.



Figure 29: Deva nagri ltha and suspected 7

2. Evolution of Lith Illakkam or Ephemeris numbers

Unlike Sinhala Illakkam, the authors had a difficulty in tracing the evolution of Lith Illakkam. The authors had looked for any evidence in India for the origins of this set in vain. At present, almost all evidence points to very Sri Lankan origins of Lith Illakkam. Shapes of number 2, 3 and 9 of first version of Lith Illakkam are self evident. When their evolution is considered and it goes back to eighth and ninth century Sinhala Letter 'Murthda Na'. Therefore it can be surmised that the origins of this set would have been in the 8th and 9th century in Sri Lanka. The very selection of specific letters for 1 to 9 had been a puzzle for the authors from the inception of the research. The authors surmise at present, the selection of these letters had been based upon specific sounds and these sounds may have been allocated for specific nakshatra or nakath. There are 27 or 28 Nakshatra in the Indian zodiac and each Nakshatra has been allocated specific sounds. Though each letter and vowel modifier depicts a number in this set, in order to hear the sound, they have to be read together aloud. For instance number 1 and number 2 are depicted with 'Kombuwa' and letter 'Na' and they have to be sounded together. And number 5 is letter 'Da' and number 6 is 'ackma' which is a vowel modifier which is placed on top of a consonant. In this instance, one could sound these two together as 'Di'. What surprised the authors had been the beginning sound 'Ne' is fourth 'pada' and the end sound of 'Ni' is the first 'pada' of Nakshatra Anurudha or Anuradha and the others sounds are placed sequentially one after another according to Nakshatras, completing a full circle.

The authors were further surprised in the manner that the zero had been depicted in the lith Illakkam. Hal lakuna or Halantha is a nullifier of a natural vowel sound in a consonant in Sinhala. Halantha in this aspect is a nullifier and since Sinhala letter had been used for writing numbers, whoever invented this set naturally used Hallantha or Hal Lakuna for the zero. In Sinhala, there are two ways that halantha can be used. Certain letter such as 'Ma', halantha is attached to the top of the letter without standard 'Kodia'. Kodia is the only halantha which has been used for the depiction of zero. Unlike other version of Halantha, kodia can be placed without a letter, and hence the authors surmise that large numbers with many zeros could have been written using 'kodia'.

6. Conclusion

Although there is a vacuum and silence when Sinhala mathematics is concerned, it can be said without doubt that Sinhala language had several well developed numeral sets. Although numbers are depicted in words in many rock inscriptions after 400AD, the evolution of numerals may have occurred in parallel with the Sinhala letters from Brahmi numerals. Sinhala Illakkam is the older brother or sister of Arabic, and Devangri numerals. But unlike Arabic and Devanagri, it never evolved into a set with a zero. Instead Sinhala astrological mathematicians, or '*Ganithas*', developed their own numerals set which is known as Lith Illakkam which was unique to Sri Lanka and it was based upon Sinhala consonants and vowel modifiers according to sound. This set possessed a clear zero and a zero place holder unlike Sinhala Illakkam. This numeral set was used to carry out tedious calculations such as finding exact timing of the end and the beginning of year based upon traversing of sun in the zodiac or movement of earth in the solar system. Further research is required to be carried out to establish whether Sinhala mathematicians had treated zero as a number.



References

- [Bell40] Bell E.T. Development of Mathematics, Second Edition, , Mc-Grew Hill Book Company, Published 1940, 1945, page 51
- [DeSilva38] De Silva W.A., from 'Catalogue of Palm leaf manuscripts in the library of Colombo Museum', Volume I, Government Printer, 1938
- [Dissa06] Dissanayaka J. B., Sinahala Graphology, Sumitha Publication, 2006
- [Epa07] Epa Panchanga (Epa Ephemeris), Epa Printers, 2007
- [Ever07] Everson Michael, ISO/IEC JTC1/SC2/WG2 N3195R, Proposal to add archaic numbers for Sinhala to the BMP of UCS, 2007
- [Filliozat04] Filliozat Pierre-Sylvain, Ancient Sanskrit Mathematics: an oral tradition and a written literature, this article is in the book 147, History of Science, History Text by Karine Chemla, 2004
- [Guna1891] Gunasekera, Abraham Mendis A Comprehensive Grammar of Sinhalese Language, Sri Lanka Sahitya Mandalaya (Academy of Letters, 144-150, 1891.
- [Hetti87] Hettigoda, Hendrick De Silva, Life and Planets, Vishwa Lekha, Sarvodaya, 34 -36, 1987 (First print in 1967)
- [Indian98] Indian Epigraphy: A Guide to the Study of Inscriptions in Sanskrit, Prakrit, and the Other Indo-Aryan Languages,By Richard Salomon,Published by Oxford University Press US, 1998
- [Jouv95] Jouveau-Dubreuil G., The Pallavas, V. S. Swaminadha Dikshita,Published by Asian Educational Services, 1995
- [Kula67] Kularathne P.D.S, Article on Numeration, Sinhala Encyclopedia, 1967
- [Masica93] Masica, Colin P., Indo Aryan Languages, Cambridge language surveys,1993
- [Menninger92]Menninger Karl, Paul Broneer Number words and number symbols: a cultural history of Translated by Paul BroneerPublished by Courier Dover Publications, 1992.
- [Sam00] Samaranayake V. K., Nandasara S. T., Disanyake J.B., Weerasinghe A. R., Wijayawardhana, An Introduction to UNICODE for Sinala characters, H., 2000
- [Mahanama03] Mahanama Thera,The Mahavamsa, The Great Chronical of Sri Lanka, Vijith Yapa publication 2003
- [Abi90]අභිලේඛන, සමරු පොත් පෙළ, දෙවන වෙළුම, ප්‍රධාන සංස්කාරක - පණ්ඩිත ආචාර්ය නන්දදේව විජේසේකර, පුරාවිද්‍යා දෙපාර්තමේන්තුව, 1990
- [Guna-Article]1891]ගුණසේකර ඒබ්‍රහම් මෙන්දිස් ගුණථාන්වය, කතෘ - (පිටු අංක 3 සිට 10 දක්වා)
- [History1]History of Sinhala Language, accessed 29th of May 2009
http://en.wikipedia.org/wiki/Sinhalese_language/

[Brahmi2] Wikipedia on Accessed on 26th of May 2009, Brahmi Script:
http://en.wikipedia.org/wiki/Br%C4%81hm%C4%AB_script/

[Code3]Code charts, accessed 29th of May 2009, www.unicode.org

[Divehi4] Divehi Akuru, acceseed 29th of May 2009 <http://www.omniglot.com/writing/dhivesakuru.htm>

[5]http://www.unicode.org/cldr/data/charts/supplemental/languages_and_scripts.html

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Harsha Wijayawardhana.

Numerations in the Sinhala Language

by
Harsha Wijayawardhana
edited by
Aruni Goonetilleke

Every one knows that the Arabs and the Romans have their own numerals. Very few know that the Sinhalese also had their own numerals. No one knew that the Sinhalese numerals had a zero, until Harsha Wijayawardhana told us so. He spent months amidst ruins in our lost cities, museums and libraries to prove, beyond doubt, that the Sinhalese had created a zero, an event that marks a crucial turning point in the history of Sinhala mathematics, when even the Romans could not think of a zero.

Harsha's book will make you think, again and again, about a matter that has escaped our concern. It is hoped that this book will be the beginning of a long journey into the world of Sinhala mathematics and Sinhala writing.

J.B.Disanayaka

Professor Emeritus, University of Colombo
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