

**THE TIME, THE PLACE AND THE PROCESS OF DISCOVERY OF ZERO**

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**Abstract—** *In this paper we present the time, the place and the process of discovery of zero. 3500 B.C. can be fixed up as a time, the extreme limit, when Indus Valley civilization was at its peak. With reference to the time of vedic civilization opinions of different scholars are sharply divided. The reason they produce is that according to Bible, the creation of this world was placed only 8500 years back and only during this period the whole development of human history must have happened. Today, however, archaeologists and geologists talk about crores of years.*

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Introduction

The most interesting fact regarding the time of Indus valley civilization is that there are lots of controversies and different opinions. Sampurnand in his Book *Aryon Ka Adidesa* at page 164 has quoted specialists who are of opinion that the materials found from the excavations at Mohen-jo-daro are 5500 years back which places the time of Indus Valley civilization to 3500 B.C. nearly. Radha Kumud Mukherjee in his Book *Hindu civilization* sums up different arguments and opines “----- the period of its civilization may be rightly placed between 3250 to 2750 B.C. allowing for still earlier times for its previous history and origins”. Thus, in any case, 3500 B.C. can be fixed up as a time, the extreme limit, when Indus Valley civilization was at its peak. With reference to the time of vedic civilization opinions of different scholars are sharply divided. From the Book “A History of Indian Literature” by Winternitz we lead to conclude that western scholars like Weber, Jacobi, Maxmuller are not ready to go back beyond 3000 B.C. The reason they produce is that according to Bible, the creation of this world was placed only 8500 years back and only during this period the whole development of human history must have happened. Today, however, archaeologists and geologists talk about crores of years. Even then some of the westerners do not agree that Indian civilization can be older than Sumerian or Egyptian though Weber opines “-----we are fully justified in regarding the literature of India as the most ancient literature of India as the most ancient literature”.

From Rgveda which in his opinion are 17000 years old. However, L.B.G. Tilak’s opinion is worth retaining. He writes “we can thus satisfactorily account for all the opinions and traditions current about the age of the Vedas amongst ancient and modern scholars in India and in Europe, if we place the vedic period at about 4000 B.C. in strict accordance with the astronomical references and facts recorded in the ancient literature of India”<sup>1</sup>.

In the previous section it has been concluded that zero was invented in India prior to 3000 B.C. But, then there was a need of discovery. This discovery was warranted mainly for a lack of continuity in vedic civilization. Also, Dantzig says, “The discovery of zero was an accident”. But it is not a fact. Here, certain logical and mathematical reasoning based on historical facts and inscriptions are produced which contributed to the evolution of zero and decimal place value system. This will be the answer to the question ‘How’ raised by many scholars like Dantzig, Hogben and others.

During the periods prior to 500 B.C. the use of zero and decimal place-value to a great extent are not to be found. However, after the discovery of zero, there is a flow of systematic recorded Mathematical works which exhibit the Knowledge of cypher and decimal place-value. The recorded works chronologically, in favour of the contention that zero was discovered in 500 B.C. are as follows:

(1) Lalitavistara (fifth century B.C.) :

In this work enumeration of names increasing by multiples of ten till  $10^{53}$  has been given. It is just a natural conclusion that such large numbers increasing in a Centesimal Scale could not have been enumerated without a knowledge of zero and decimal place-value system which must have been, in wide use, in India by this period. Besides, Kaccayana’s pali Grammar, *Sirsaprahelika* etc. also support our statements.

(2) Jambudvipaprajnapti (fifth century B.C.) :

It is a Jaina-Canonical work. The circumference of the earth with a diameter of 100,000 Yojanas is given as  $316,227 \frac{1}{10}$  Yojanas 3 gavyutis 128 dhanus and a little over  $132 \frac{1}{10}$  angulas. Since the value of  $\pi$  was taken to be  $\sqrt{10}$ , so a good method of extracting square roots, necessarily based on decimal place-value system, was known to Jains.

(3) Bakhshali Manuscript (200 A.D.) :

Big numbers with or without zero are present in Bakhshali Manuscript. Use of zero in calculation, representation of zero symbols as dots and small circles and use of zero as an absence of the Bakhshali Manuscript establish the fact that zero existed in all its interpretations from a very long time prior to 200 A.D. Gaurishanker Ojha in his Book "Madhyakal in Bhartiya Samskriti", P.112 comments that in the village-Bakhshali (Punjab), an old Manuscript, where numbers have been given in the Style Written on Palm leaves, was found under the ground.

Now, as regards fixing up the time when zero came into use the following points are to be considered:

- (i) The time of Atharvaveda is definitely before 500 B.C. Zero has been used as a dot or small circle in Kashmirian Atharvaveda not only in Marginal notes but also in the text.
- (ii) There was a conception of Brahma during the time of the Vedas. Concentration or Meditation or Brahma led to short symbols like dot or small circle for zero.
- (iii) The astronomical observations of planets in the Vedanga Jyotisa (1200 B.C.) and in Jainese works (400 B.C.) also contributed to the short symbols for zero. Datta and Singh fix up the time of Vedanga Jyotisa as 1200 B.C. while Shukla gives the period of composition of Vedas and Vedanga Jyotisa from 2500 B.C. to 500 B.C. from the Book "History of Indian Literature, Vol. I", Calcutta 1959, P. 271. We see that Winternitz also is of the latter opinion.
- (iv) The use of very big numbers in decimal system of notations in Lalitavistara and Jainese works in the vicinity of 500 B.C. needed short symbol for zero.
- (v) Sunya-Bindu in Amarkasa refers to Vedic literature.
- (vi) There is a direct reference to zero in Pingala's Chandahsutra, prior to 200 B.C.
- (vii) The use of dot and a small circle for the symbol zero occurs in Bakhshali Manuscript (200 A.D.)

All these factors lead to the conclusion that prior to 500 B.C., the short symbols dot (.) and small circle (o) must have been in use. Very briefly, we have the following points in support of discoverer of zero and place of discovery of zero.

#### **DISCOVERER**

Munjalacarya begins his Book belonging to the Bharadwaja Kula, the best among the Brahmanas, famous as the sun in Prakasa, State another, Langhumanasa, giving brief and unprecedented methods of determining the true places of planets.

This shows that the author does not wish to mention his name rather he refers to the cultural heritage to which he belongs to. It has been the Indian tradition that individuals never mattered here. What mattered was a particular school of thought. The name of persons who created the Vedas or who wrote down the Upanisads are not found. Only very recently it has been supposed that Vyas Muni wrote down Mahabharata and Gita although there are no historical evidences of it. The Hindu culture and courtesy did not want to show off. Professor V.S. Agrawala in his book "Hindu Savyata" at page 272 has shown that Budha did not allow his disciples to exhibit their performance. Hindu sages who wanted to remain aloof from society were also rather shy in exhibiting their inventions. Hence, any discovery in the vicinity of 500 B.C. with the help of Buddhist Mathematicians and Hindu sages must have had its retardation as regards exhibition was concerned. Thus, the discovery of zero had been made either independently or by joint efforts of Buddhist monks and Hindu sages who wanted to remain aloof from the society and were rather shy in advertising their names. Hence, the name or names of the person or persons who discovered zero are not known to us.

#### **PLACE OF DISCOVERY OF ZERO**

- (i) Just preceding the Christian era is the time in Babylon when zero was used to represent the absence. India had a conception of zero as an absence and decimal place-value before this time.
- (ii) The conception of zero for absence has been carried from India to Greece by some itinerant and Alexander.
- (iii) The Vedanga Jyotisa (1200 B.C.) has been composed in India and there is a symbol for zero as 0 which is a contribution in giving the observation of planets.
- (iv) The use of zero and decimal place-value system is found in the Indian Mathematical works from 500 B.C. to 600 A.D. There is no such use in the Mathematical works of other countries during the above period.
- (v) The concentration or meditation on Brahma during the time of the Vedas also contributed to the symbol 0 for zero. The direct use of Sunya or zero in calculation has been given in Pingala's Chandahsutra, prior to 200 B.C.
- (vi) In Epigraphic records the earlier evidences are found in 595 A.D. (346 has been given in decimal figures) in 672 A.D. (60 written in decimal figures with zero) and in 683 A.D. (605 written in place-value with zero) in India. In no other country there is any Epigraphic record of zero during the time. The Arabs adopted zero from India in 750 A.D.
- (vii) A Sicilian Coin with the date 1134 Anno Domini is the first example, found in the book "Mathematics for the Million" at page 288 written by L.Hogben, of the decimal place-value in Christendom of the official use of the so called Gobar numerals, the Hindu number system as modified by the western Arabs.

Thus, it is a certainty that zero and decimal place-value system had their origin in India. Now, let us see how the discovery of zero occurred.

In the Palaeolithic age Aboriginal people with the help of two hands and two feet could count only up to four. When the improvement in man's civilization grew more and when men began to have herds and flocks the necessity for counting large numbers arose. It was necessary for them to count the numbers of the sheep and cows to verify that none was missing. Before men learned to live in Cities they knew how to count objects in groups. With the help of ten fingers in both hands they began to count things in terms of tens. According to L.Hogben, there were a tribe of Paraguayan aborigines who had names corresponding to the numbers one to four, Five (one hand) ten (two hands) fifteen (two hands and a foot) and twenty (both hands and feet). The ancient Maya Calendar numerals include Separate signs for the units, one to four, five and for twenty.

Even now, in our village, in India, we find people counting things taking twenty as the base. An old lady when asked about her age would at once say that she is just equal to four twenties. Hence, it is an evolutionary and social fact ten, fingers in two hands, is the base of our counting while in Syria they had taken two<sup>2</sup>, in Central America (Maya) twenty, in Babylon<sup>3</sup> sixty as respective bases in their counting of numbers. From the time of the Vedas Indian sages had dealt with very large numbers in multiples of ten. Numbers at least  $10^5$  have been used in the Rgveda (I-64-15). Numbers up to  $10^{12}$  are found in the Yajurveda (xvii.2). Numbers till  $10^{53}$  are present in the Lalitavistara (PP 168-169). Thus, as discussed previously, zero which was invented prior to 3000 B.C., suffered a gap.

In spite of the gap one can safely assume that prior to the discovery of zero in the vicinity of 500 B.C., Indian people had a basic knowledge of ten as a base and a knowledge of zero in its spiritual form<sup>4</sup>, in its physical representation<sup>5</sup> and as a dot or small circle as noticed in the Kashmirian Atharvaveda. Romans, Egyptians and Greeks did the counting on the counting board with bead. It would seem that the first time anyone wanted to record a number obtained on the counting board, he would automatically have put down a symbol of some sort, a dash, a dot or a circle, for that empty column-which we today represent by zero. But, in thousands of years, nobody did, not Pythagoras, not Euclid, not Archimedes, for the great mystery of zero is that it escaped even the Greeks. We note that the dot Sunya which the Hindus invented was not the number zero. It was merely a mechanical device to indicate an empty space and that was what the world itself meant empty. The dot Sunya which the Hindus invented paved way for the discovery of number zero. The extent to which primitive people carried their number systems was, of course determined by their needs. The native Australians, for example, were little given to trade and so they left the need of number names only to two, three or four and for the Hottentots five was a sufficient limit. Among the Papuan people, those of paraido count to ten while those of Pauwi living farther inland find five sufficiently large for their similar needs. The Kafirs, however, possessing herds of cattle, count to a hundred or more while the Nubians and Abyssinians representing a higher civilization, often use numbers to a thousand or even to a million without apparent European influence. The Hindus, having need for large numbers in a semi religious way, as appears from Vedic writings, early developed a numeral system that is practically unlimited. Here, we see how the numerals known as Hindu figures slowly marched to the west through Egypt and northern Arabia.

As India had flourishing trade with Arab Nations of the present day Middle East in due course the knowledge of integers was carried by traders and scholars to those lands. It is no surprise that in the Arab world the integers are even today known as Hind-sa meaning that which came from Hind i.e. from Hindustan (India). Further, to the west in Europe the digits are called Arabian digits. Mathematicians, the world over, have acknowledged the fact of digits being an Indian invention. But, the present day Arab scholars claim it to be an invention of the Arab Mathematicians of the past. There is hardly any need to contradict these false claims. Doesn't the utility of the these days' TV serials. The Ramayana and Mahabharata would pervade people's consciousness and influence their conduct? If it is so, one would rightly say that some of the messages conveyed in these two epics and depicted on the small screen give wrong signals about our democratic constitution which guarantees equal rights to all. Let us, for example, take a look on the story of Ram and Kaikeyee in the Ramayana. The real heir is sent to the forest and the younger one is crowned. Also, we notice the story of Ekalavya in the Mahabharata. Dronacarya asked Eklavya to give his right thumb as gurudakshina because he had committed himself to make Arjuna a matchless master of archery. Eklavya did not hesitate even for a moment. He cut off his thumb and offered it to Dronacarya. These are beautiful stories. But, what message it conveys in today's context? The false claims have been in use from very beginning. The point being made here is that our Mathematicians and students of Mathematics should be proud of their heritage and rich legacy. The country has great talent and a vast reservoir of competent Mathematicians. Some of our finest and brainiest Mathematicians have migrated to the Western countries and there at the numerous Universities and Research centers have proved their mettle. In 1984 Narendra Kumar Karmarkar, a twenty-year old scientist while working in U.S.A., invented Linear Programming Algorithm which is finding wide application in computer programming. We have no doubt that our young Mathematicians can bring the lost glory, provided they take to Mathematics seriously and are taught Mathematical logic from young age. Hindu Numerals from the time 500 to 1000 A.D. learning seems to have made little progress in the Northern India. The above of Mathematics now moved Northward and is found for two or three centuries in Persia and in other lands. In southern India, however, there must have been some encouragement of Mathematics. Hindu Numerals reached Europe through the medium of the Arabic civilization so that in Arabian Mathematics we find both Greek and Hindu elements. The Arabic Trigonometry is Indian also in its use of the sine and the arithmetic form rather than of the Hipparchan chord and geometric representation.

There are Fibonacci numbers, named after the great Mathematician who is also known as Leonardo of Pisa. His father made Leonardo learn the use of the abacus when a small boy and Leonardo developed an insatiable taste for Mathematics. In his travels through Egypt, Syria and Greece he collected an abundance of material on Arabic Numerals and in 1202 published his great work Liber Abaci which was responsible for the adoption of the Arabic notation into western civilization. From that time arithmetic and algebra flourished and expanded and paved the way for such geniuses as Descartes, Fermat, Pascal, Galileo, Newton, Euler, Maxwell and hundreds of others who are immortalized by their enormous contributions to modern science and Mathematics. But, the perfecting of the so-called Arabic notations was due almost entirely to the Hindus who were among the greatest thinkers and philosophers of their day. The nine numbers that we use today were born away back in the third century B.C. although in appearance they were entirely different then from what they are now. Much later in the tenth century, the processes of addition and subtraction began to take on more of their present day appearance. The idea of the Carry-over was invented and combined with the place-value system. Regarding Egyptian Numerals Swami Shankaranand opines the Mathematicians who used the number-symbols during Mohen-jo-daro civilization went away altogether towards the west as far as Egypt and that is the reason why these number-symbols are not found again in India during succeeding 3200 years<sup>6</sup>.

“Traders who carried the customs and manners from country to country”<sup>7</sup> were also responsible for this movement. We have some proofs that Mathematicians also moved from one country to another. Pythagoras (540 B.C.) lived at the time in Greece when Greece had enjoyed two centuries of commercial activity<sup>8</sup>. Thus, the number symbols had moved from India to other countries with the help of traders, Scholars, Mathematicians and other people. As far as the return of the numerals to India is concerned, there are two possibilities. We know that numerals returned to India in the form of Kharosthi Scripts. The first possibility is that it might have come back to India at the time of Greek Invasion during Maurya period and had its manifestations in the inscriptions of Ashoka who belongs to 300 B.C. period. The other alternative which seems more probable is that the Number-Script which evolved in a picture script in Indus Valley Civilization prior to 3500 B.C. had remained dormant in India during the period 3500 B.C. to 500 B.C. as the priests during the Vedic age taught in their Schools orally<sup>9</sup> and spoken word not writing had mainly been the basis of the whole of the literacy and Scientific activity during the period Succeeding the periods of Indus Valley civilization. Moreover, as we have already discussed there have been very few excavations in India and if further excavations in India and possible other places are made there may be found some proofs of continuity of Indus-Valley Numerals during the Vedic period. Aryans who were the oldest representatives of the Indo German Race<sup>10</sup> and who lived in the northern part of India between the Himalayas and the Vindhya mountains<sup>11</sup> must have left some evidences somewhere of their Numeral-Symbols in the form of inscriptions which are yet to be dug out and brought to light. In any case the Vertical strokes in Kharosthi numerals not only resemble Greek Numerals but also have a strong resemblance with Mohen-jo-daro numerals. Thanks to the genius of the ancient Hindus due to whom we have been able through elementary arithmetic to built up Mathematics and discover the Universe of science unlocking thousands of nature’s secrets.

#### References

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- [9.] Winternitz, M, “History of India Literature -1 “, P. 35
- [10.] Opinion of Langden, quoted by V.S. Agrawal, i.c., PP. 47-48 and also opinion of Maxmuller in Sampurnānand’s “Āryon Kā Ādidesa”, P. 16.
- [11.] Indian Scholars opine that Āryans lived in India from time immemorial and did not come from outside vide Sampurnanānd, i.c., and P. 17.