INDUS SCRIPT

Its Nature and Structure

B.V. Subbarayappa

The author, a historian of science, has presented in this monograph a new approach towards an understanding of the still enigmatic Indus script specially in its context of animal and other motifs. His main hypothesis is that the Indus script is in the nature of numerical forms and the numeration is of decimal, additive-multiplicative system. The numerical values for all the forms which have appeared on the seals, sealings and other inscribed objects have been given. The archaeological finds of barley, wheat, cotton, sesame, peas and dates have been correlated with the related animal motifs on the Indus seals, and plausible explanations offered. Besides throwing some light on the inscribed objects without field symbols as well as on a few other aspects, the monograph points out that (i) the majority of the Indus seals are quantitative records of agricultural production and management in relation to the administration of large granaries of Mohenjo-daro and Harappa; (ii) the Indus script does not represent the language of Harappans who had *ipso facto* fostered an oral tradition; and (iii) the *Rgvedic* mythology could be attributed to Harappans and the Vedic *rsis* might have been the descendents of the Harappan priestly class.

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INDUS SCRIPT:
Its Nature And Structure

B.V.SUBBARAYAPPA

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Dedicated to
Lalitha, Sheshu, Sathyu and Sarvamangala

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FOREWORD

Ever since its discovery in the twenties of the present century, the Indus Civilization has attracted the attention of scholars, both Indian and foreign. The continuing research during the last seven decades has meanwhile added new dimensions to the subject of study. While the form and content of this Civilization are now fairly well known from the extensive excavations of Mohenjo-daro, Harappa, Kalibangan, Lothal, Surkotada and Dholavira, its dynamism still remains elusive to some of its elements. One of such elements, and perhaps a significant one, is the script, which apparently pictographic, seems to be unrelated to any contemporary script. The script as is widely known, is found chiefly on seals, but is also seen on pottery, ivory sticks, copper objects and tablets. While over 450 characters or symbols in this script have been recognised, the numbers represented in an inscription may vary from one to twenty-six, the average length of a text being five. Continuing research on the subject has so far shown no difference in the script from site to site, nor any definitive evidence of evolution. The only aspect on which there seems to be a consensus is the direction of writing , *viz.* from right to left.

Many claims have been made for the decipherment of the script (including development from syllabic to phonetic with signs reduced to a bare 20) but none of these has received universal acceptance. All these attempts, it may may be recalled, base their investigations on language of which there are two known main approaches, one advocating the proto-Dravidian affinity and the other, Indo-Aryan, related to Vedic Sanskrit. Recently John Newberry of Victoria B.C., Canada has postulated that 'the Indus Valley signs are the oldest surviving written records of Austro-Asiatic language from *c.* 2500-1800, thus adding another dimension to the language issue.

Dr. B.V. Subbarayappa in his monograph departs completely from the language approach and presents an altogether new interpretation. He asserts that in a far flung civilization as the Indus, language cannot be uniform while the script can remain so. According to him, the language of the Indus people was an oral tradition while the script constituted a numerical system, expressed artistically and used largely for administrative and commercial purposes. About the total number of characters or symbols in which the script is represented, he raises a question: If each character represents a word, was the Harappan vocabulary confined to only 450words? An ancillary question: why have the Harappans not left us with long inscriptions, if the seals were intended as means of complex communication in terms of language like the Egyptian and Mesopotamian texts?

These questions have remained unanswered so far by the earlier scholars and have with some measure of conviction provided a new line of investigation to Dr. Subbarayappa.

Dr. Subbarayappa, in his own convincing manner, shows how by combining certain characters the desired numbers can be achieved. He also has worked the interlink between script form and the motifs going to the extent of correlating cereals like barley and wheat, cotton, etc. which may appear to be subjective. According to him, the most-commonly used symbol – the so-called fish – represents the number 10 and the so-called human figure the number 1000. He professes that the Indus numeration is decimal and additive – multiplicative.

A new approach to the decipherment of the Indus script has thus been proposed, which does stir imagination, acceptance or otherwise notwithstanding. Knowing that the numerical forms of the contemporary civilization of Egypt and Mesopotamia were different we still have to find out a definitive explanation for the inspirational source of expressing such numerical forms. Admittedly, trade is the driving motive for developing a system of numerals, but to adopt and perfect a complex numerical system one either reasonably looks for a source from whcih it has been derived under any stimulus-generated inspiration or shows an evolution in the whole system. In the present case the author presents us with a fully developed system without its antecedent stage.

Such issues will no doubt engage the attention of future workers. Meanwhile, in Dr. B.V. Subbarayappa's own words 'This monograph has attempted to understand the Indus script in its context of animal and other motifs ... further studies, both scientific and historical, are needed for elucidating the enchanting endeavours of the Harappans'. It is hoped that the readers will find the monograph thought–provoking. The author deserves our praise for bringing into focus another line of investigation for deciphering the so far mute Indus script.

B.K. Thapar
Former Director-General
Archaeological Survey of India

PREFACE

This monograph attempts to examine the Indus seals, sealings and other inscribed objects with a two-in-one hypothesis, namely, that (i) the script forms are numerals, additive-multiplicative, on what the historians of mathematics call the ciphered system; and (ii) the majority of the seals which have one animal motif, generally with an object-structure in front, are in the nature of account-tablets denoting agricultural production and utilisation. In addition, the significance of the seals without animal motifs, their holes and some related aspects have been discussed. In view of the numerical nature of the Indus script, it is pointed out that the Harappans had a strong oral tradition, like the Vedic people, and that the Vedic *rsis* were probably the descendants of the Harappan priestly class.

I am indebted to Professor William Shea, Hydro-Quebec Chair, McGill University, Montreal, Canada, for his unfailing encouragement which sustained my efforts in this field. I am beholden to Shri. M.C. Joshi (former Director-General of the Archaeological Survey of India, New Delhi) for his constant support throughout my studies on the Indus script. I thank specially Shri I. Mahadevan for his valuable suggestions after going through the manuscript critically. Thanks are due to Professor B.B. Lal and Shri M.N. Deshpande (former Directors-General of Archaeological Survey of India), who encouraged me to have the monograph published. I am thankful to Shri L.K.Srinivasan, former Director, ASI and Professor K.V. Raman, Head of the Department of Ancient History and Archaeology, University of Madras, for their encouraging words about my work. But none of them is responsible for the new approach which has been presented in this monograph, its commission and omission.

I offer my grateful thanks to Dr.B.K.Thapar, former Director-General of A.S.I. and distinguished archaeologist, for writing an excellent, objective Foreword to this monograph. Professor C.V.Sundaram of the National Institute for Advanced Studies and Professor R.K.Kochhar of the Indian Institute of Astrophysics, both at Bangalore, read the manuscript and gave me the benefit of their views. I thank them.

My studies in Indus script were undertaken at the Centre for History and Philosophy of Science of the Indian Institute of World Culture. I am indeed grateful to the authorities of the Institute for their constant support which enabled me to pursue my work with full academic freedom for which this Institute is noted.

I am grateful to Jawaharlal Nehru Centre for Advanced Scientific Research, Bangalore and specially to its efficient Administrative Officer, Shri L.R. Rao,for their help in many ways.

I thank Dr. S. Srinivasan of New Era Publications, Madras, for publishing this monograph. I am deeply appreciative of his devoted efforts for bringing out the monograph elegantly and expeditiously. His concern for the consistency and quality of the publication is exemplary.

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[The author is grateful to Shri M.K. Sunkad for the elegant presentation of photographs and tables]

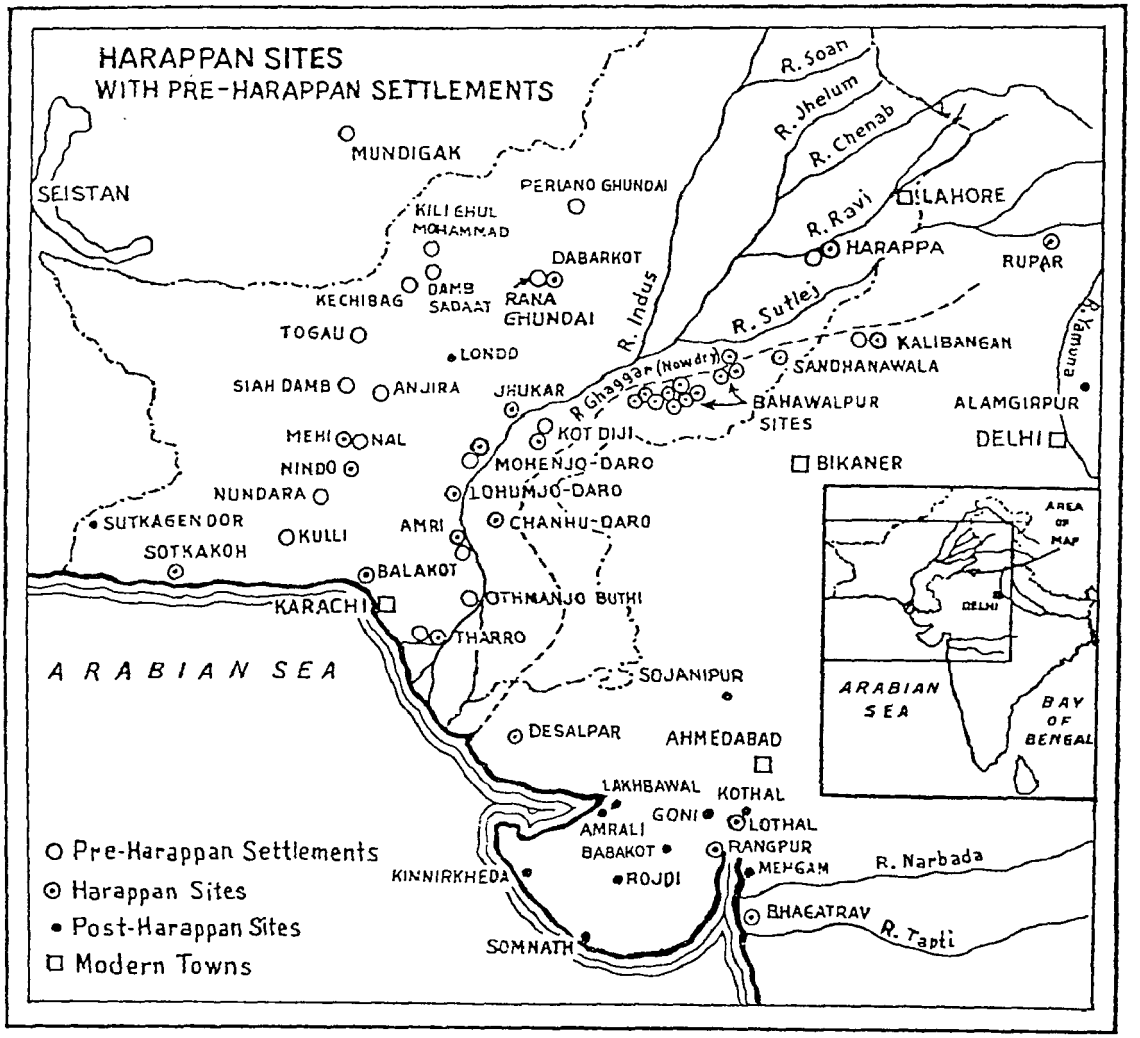


FIG. 1. Map showing principal pre-Harappan settlements, and Harappan and post-Harappan sites.

(Reproduced with permission from *A Concise History of Science in India*, INSA, New Delhi, 1971, p.7)

SECTION 1

INTRODUCTION

In the history of mankind, three ancient civilisations - the Egyptian, the Mesopotamian and the Indus Valley (Harappan) - played a pivotal role in the perceptible emergence of *Homo sapiens* (Man the Thinker) and *Homo faber* (Man the Maker) in his intellectual and material pursuits. Of the three civilisations, the Indus Valley Civilisation, also called by archeologists the Harappa Culture, was the youngest but by far the largest. It has been estimated that this civilisation embraced an area of nearly 1.3 million sq. km. extending far beyond the confines of the Indus Valley in all directions (Fig.1). It had hundreds of settlements, both rural and urban, including the two metropolitan cities, Mohenjo-daro and Harappa.

1.1 The Discovery

The discovery of Harappa (upstream Ravi, a tributary to the river Indus) and Mohenjo-daro (*lit:* Mound of the Dead; situated downstream Indus) is indeed a fascinating story. In 1856 two British engineering contractors, who were engaged in laying a railway from Karachi to Lahore and also quarrying large quantities of bricks from the ancient mounds at Harappa in the Montgomery District of the Panjab, and Mohenjo-daro in Sind stumbled upon a number of varied antiquities. These included some steatite seals bearing what they thought to be 'pictographic symbols'. Sir Alexander Cunningham, who was then heading the Archaeological Survey of India, visited Harappa in 1875, collected some more seals and revealed their remote antiquity. In 1886 and 1912 a few more seals came to light. Later (around 1920), an Indian, Dayaram Sahni, began his excavations at Harappa, and two years later, R.D. Banerjee took up excavation at Mohenjo-daro. John Marshall, the then Director-General of the Archaeological Survey of India, published in 1924 an account of the Indus seals in the *Illustrated London News*, thus announcing for the first time the discovery of an ancient civilisation in the Indus Valley. The subsequent decades, both before and after Independence, brought to light many other urban and rural settlements of this civilisation. The history of the ancient world thus took on a new dimension with a well-delineated 'Fertile Crescent' encompassing the Nile as well as the Euphrates and the Tigris on the one hand and, on the other, the Indus riverine basins.

1.2 Sources

For the details of the multi-level accomplishments of Indus Valley Civilisation or the Harappa Culture, the reader is referred to the works of John Marshall, E.J.H. Mackay, M.S. Vats, S.R. Rao, Mortimer Wheeler, and articles of B.B. Lal, B.K. Thapar and others (see Bibliography). Nevertheless, some salient aspects of Harappa Culture are briefly recounted here, specially with reference to the highly advanced settlements at Mohenjo-daro, Harappa, Chanhu-daro, Lothal and Kalibangan, the excavations of which have unearthed a great majority of seals and other objects, the inscriptions on which are called by archaeologists the Indus script. These verily constitute a viable data-base for a meaningful understanding of the nature and structure of Indus script.

1.3 Mohenjo-daro

The ancient mounds of Mohenjo-daro, situated in the Larkana District of Sind, now in Pakistan, comprise a high mound, called the 'Stupa Mound' (since a Buddhist stupa of the 2nd century B.C. was built over it) and a lower one, called the 'Lower City'. The former mound is represented by a 'citadel' which measured 365 x 183 metres. This citadel was in the nature of a huge platform of mud-bricks, over which were constructed (what is designated by archaeologists as the Great Bath, the granary and the 'College of Priests'. The citadel had fortification walls with rectangular towers at vantage points. The Great Bath (Fig.4), situated in the centre of the courtyard, was rectangular in shape, measuring 11.89 metres (north to south) and 7.01 metres (east to west), its depth being 2.44 metres. It had effective functional arrangements for the supply of water, with several bath-rooms. As Wheeler says (p.43): '... it is a fair supposition that the whole complex related to the religious life of the city or its rulers. In modern Hinduism, and indeed in other religious systems, ceremonial cleansings are an important feature, and the elaboration and prominent position of the bathing establishments on the Mohenjo-daro citadel proclaim their official use'.

To the west of the Great Bath was a large granary (Figs.5 & 6). The original granary, it has been estimated, measured about 46 x 23 metres, but was soon enlarged by additions on the southern side. Wheeler, who brought to light the details of the large granary, writes (Wheeler, pp. 43-44): 'As the plan indicates, it (granary) originally comprised twenty-seven blocks of brickwork of varying but regulated size... The criss-cross layout-passages between the blocks ensured the circulation of air beneath the main body of the Granary overhead. This superstructure had consisted of massive timber-work, and the vertical chases in the eastern and southern blocks had presumably been intended to carry a timber stair or ramp. The external walls of the podium are battered or sloped and give the structure a grim, fortress-like aspect which befits its exposed position on the periphery of the citadel-mound. Along its northern side is a brick platform, integral with the main building, with a brick-floored alcove near its western end' (Fig.6) .

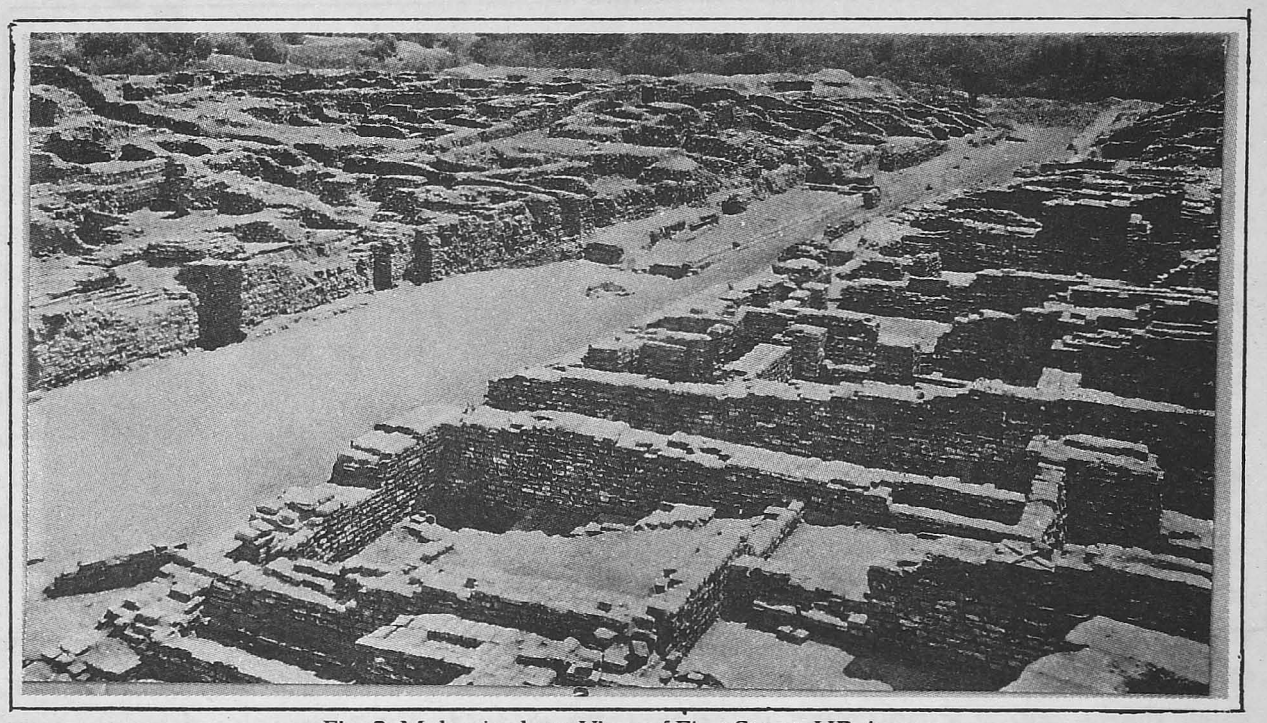


Fig. 2. Mohenjo-daro: View of First Street, HR Area
(Marshall, III, Pl.XLVII)

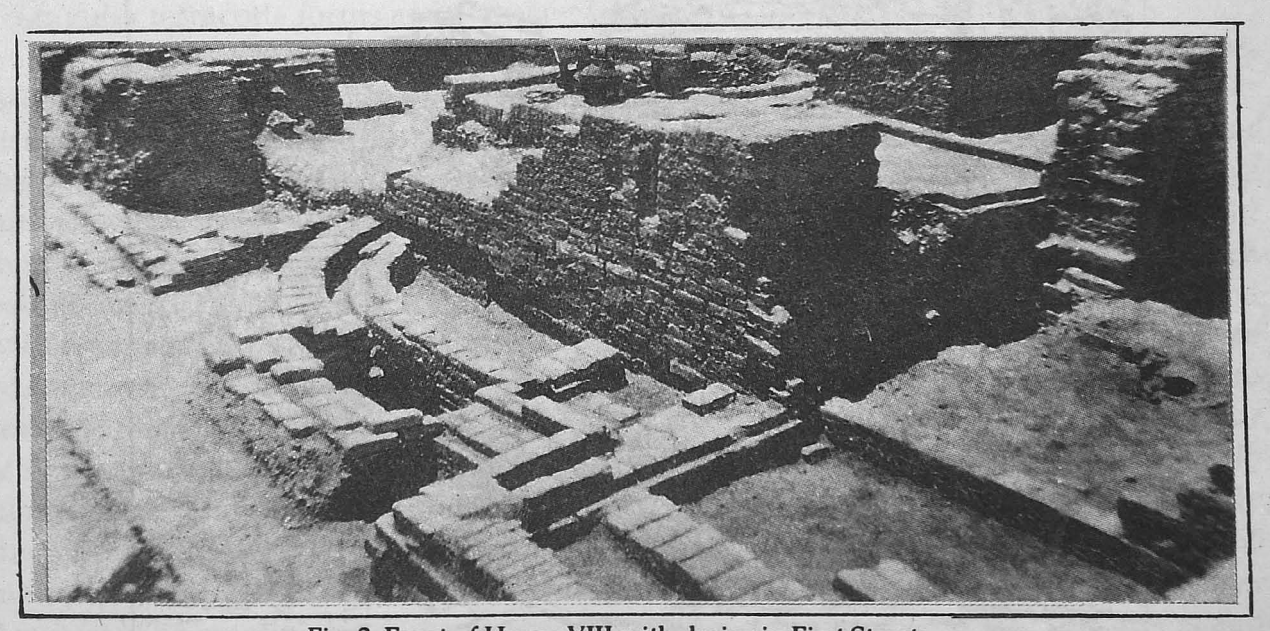


Fig. 3. Front of House VIII with drains in First Street:
(Marshall, III, Pl.LVI (a))

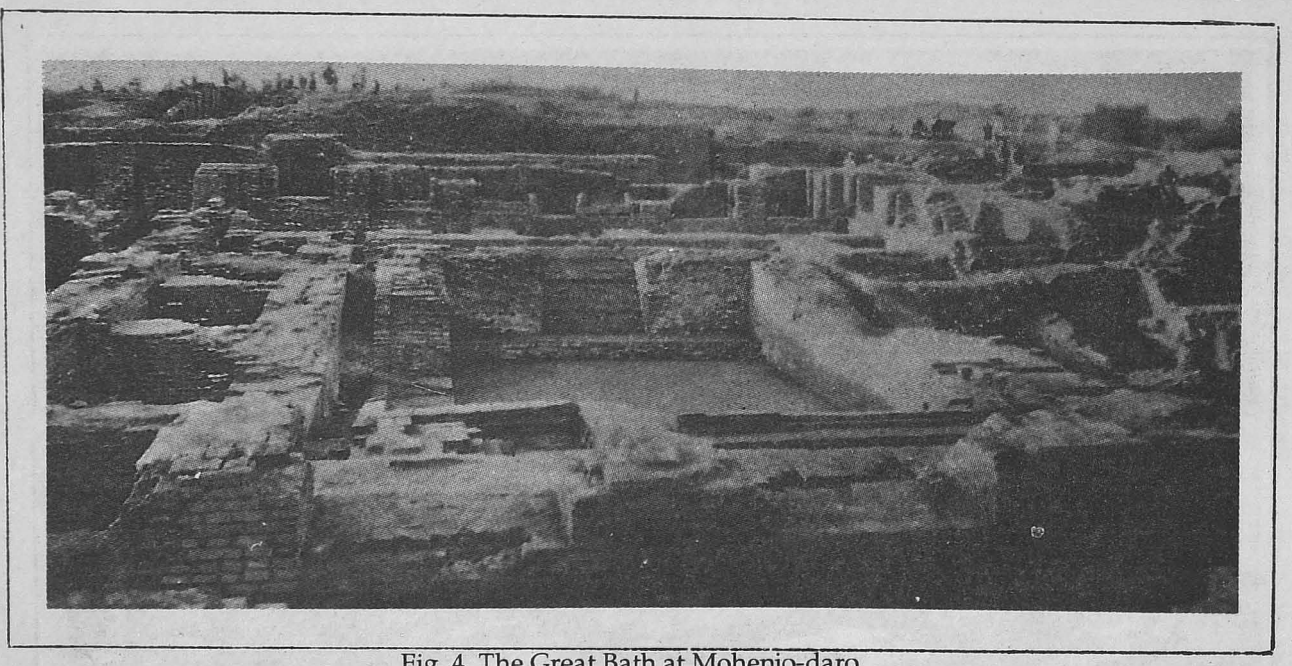


Fig. 4. The Great Bath at Mohenjo-daro
[Marshall, III, Pl.XXI (b)]

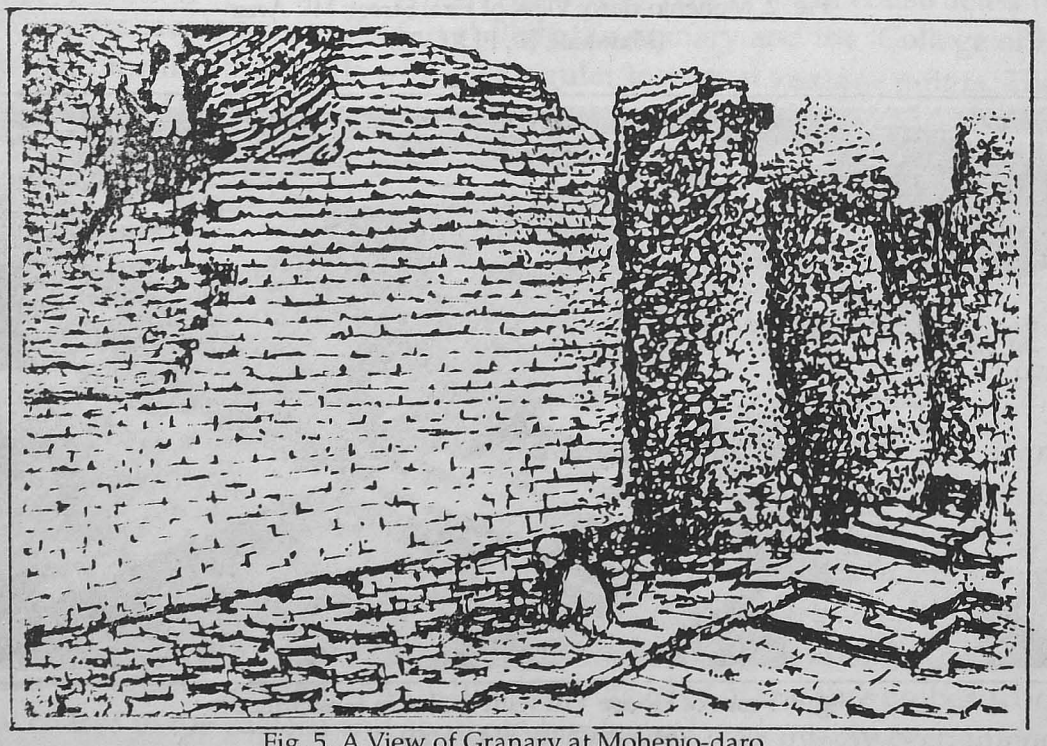


Fig. 5. A View of Granary at Mohenjo-daro

(Figs. 5 & 6 after Wheeler, Illustrations, pp. 44 - 46)

'The granary, with its outstanding massive construction, its careful ventilation, and its vivid provision of loading facilities from outside the citadel, is a significant element in the citadel plan: It will be recalled that at Harappa a regimented group of six granaries stood within the shadow of the citadel whether supplemented by a granary in the citadel itself we do not know. It may be mere chance that the combined floor-space of the Harappa group is computable with that of the single Mohenjo-daro granary...' To the north-east of the Great Bath lay the 'College of Priests' which consisted of a courtyard, about ten metres square and a series of rooms paved with bricks as well as verandahs on three sides. Towards the southern sector of the citadel was a large building, nearly 27.5 metre square and divided into five aisles, which had its main entrance from the northern side. There was also a small building on the western side which too had a hall with aisles. The citadel, presumably the seat of power, however, appeared to have had no structure for religious purposes.

The area of the 'Lower City' was quite extensive. Like the citadel, this city could well have had a fortification, though no actual remains of such an enclosure have been noticed. A notable feature was that the houses in 'Lower City' were built on higher platforms with reinforcement of either mud-bricks or baked-brick walls, which were erected from time to time, evidently to counter the onslaught of riverine floods. Triangular terracotta forms and alabaster lattice were used for ventilation.

There was a large building (over 76 metres long) in the southern sector of the 'DK Area' which has been regarded as a palace by the excavator. Apart from its other structural arrangements, this building had two wells, two courtyards and two circular mud-lined pits constructed out of wedge-shaped bricks; possibly, these two pits were furnaces. In addition, there was a bread-oven (1.12 metres in diameter and 0.92 metre high) in the south-eastern corner of the smaller courtyard. Another significant building, which was about 26.5 metres in length and 19.6 metres in width, had five conical pits, also lined with wedge-shaped bricks, possibly for keeping in position the pointed bottoms of storage jars as surmised by some archaeologists. In addition to the two large buildings, there were several other structures for different purposes – premises for workers, quarters for attendants and others. A striking feature was the drainage system which was carefully planned for sanitary purposes (Fig.3). The supply of potable water was from elegantly dug and brick-paved wells. The streets (Fig.2) had an average dimension of about 365 metres (north to south) and 244 metres (east to west), with an average width of a little over 9 metres. The crossing lanes were about two and a quarter metre wide. The streets and lanes were well laid in a gridiron pattern. 'The city was perhaps square on plan measuring 1.61 kms. from end to end' (Rao, 1, p.21). The excavations at Mohenjo-daro have unearthed seals and other inscribed objects, numbering about 1540.

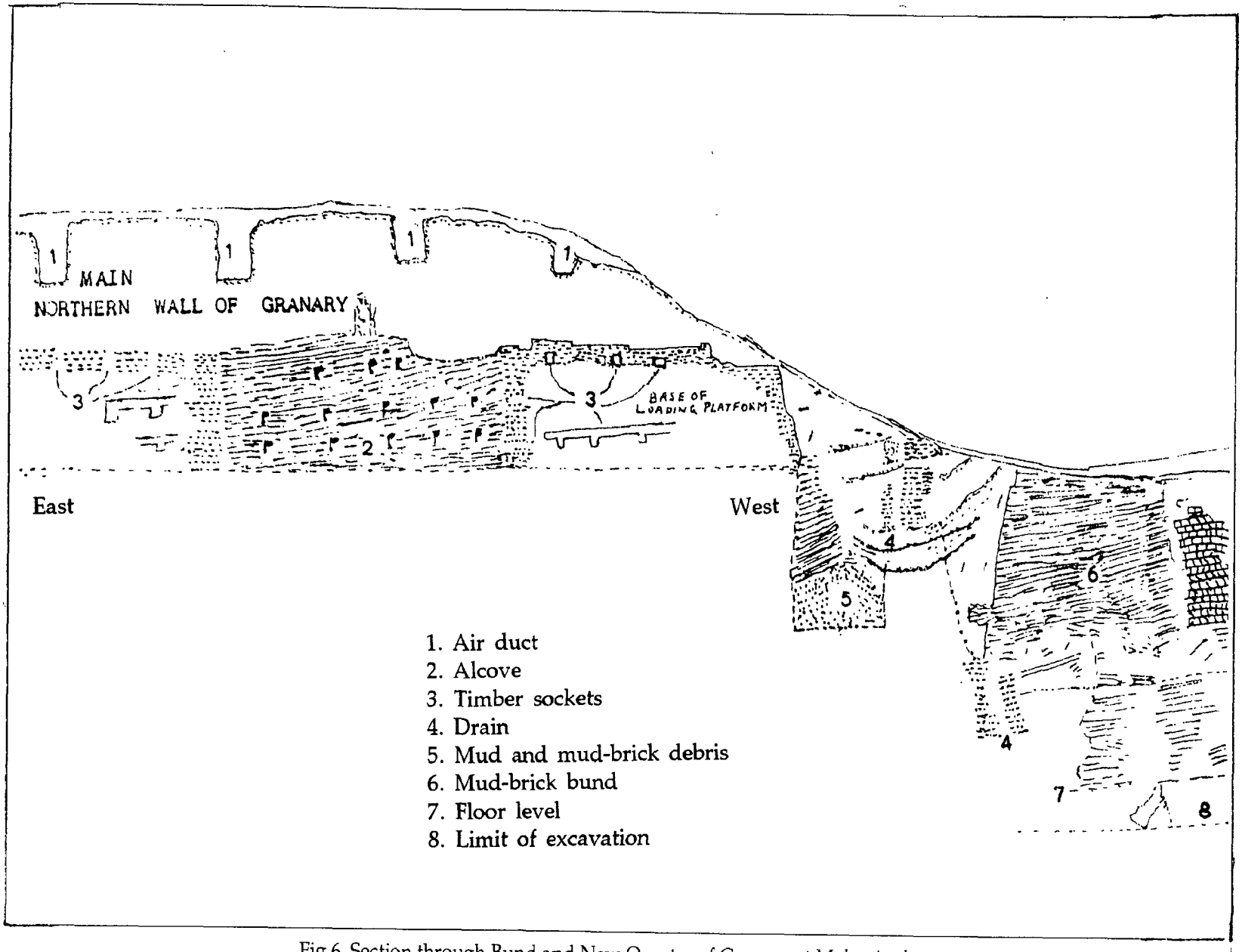


Fig.6. Section through Bund and New Quarter of Granary at Mohenjo-daro

1.4 Harappa

The city of Harappa was nearly five kilometres in circuit and was as well planned as Mohenjo-daro. It had also neatly built fortifications and a citadel. To the west of the Citadel lay the 'Lower City'. Like Mohenjo-daro, Harappa had a well-knit drainage system, streets and lanes. The citadel, which was rather in the shape of a parallelogram, was 415 metres north to south and 193 metres east to west. It had a huge platform which was constructed out of mud-bricks as well as mud, with an enclosure in the form of a 14 metre thick wall of mud bricks on three sides (east, south and north) and of baked-bricks (west). The main entrance to the citadel lay on the northern side with devices for re-entry from other sides by using a flight of steps.

The 'Lower City' had many structures – two ranges of barrack-like buildings; five rows of circular platforms erected out of baked bricks; and platforms of bricks for the dehusking of grains (Fig.8A); two rows of houses (18 m x 8 m), each having two rooms, a courtyard with partially brick-paved flooring; and a compound. Alongside, there were as many as sixteen furnaces (probably for copper-bronze working) and eighteen circular brick platforms, each created in the form of five concentric rings of bricks with a hole at the centre, obviously for pounding grains. Significantly, these platforms were laid in the vicinity of the granary. And evidently the grains were ground on a massive scale under the control of a central administration as at Mohenjo-daro.

The granaries (Figs. 7 & 8) were located not far away from the river-bed and each unit measured about 15 1/4 metres in length and six metres in width. They were built symmetrically in two rows of six units with a central passage of about seven metres. They had by and large wooden sleepers and functional contrivances for storing agricultural produce in an effective manner. S.R. Rao writes (1, p.16):

'They [the granaries] must have acted as state banks collecting taxes and paying wages in kind as in Ur and other Sumerian cities. In this connection it is interesting to find the clay tablets from Ur mentioning even the quantity stocked and wages paid. One of them contains a reference to the commandant of the granary asking him to make payment for 10,930 man-days to workers who included scribes, overseers, shepherds, irrigators etc. Attention may be drawn here to the fact that the treasury of Upper Egypt (White House) had granary as one of the departments for collecting taxes. Despite these references to the clay tablets no building which can be identified as a granary has been found in Egypt or Mesopotamia. On the other hand, the identification of granaries at Harappa and Mohenjo-daro and of a warehouse at Lothal is highly significant; *but no records regarding collection of taxes, payment of wages and maintenance of accounts are available from the Indus Cities'*.

The last observation (italicized for emphasis) of S.R.Rao needs a reconsideration as will be noticed later. But, so far no attempt has been made by archaeologists and others

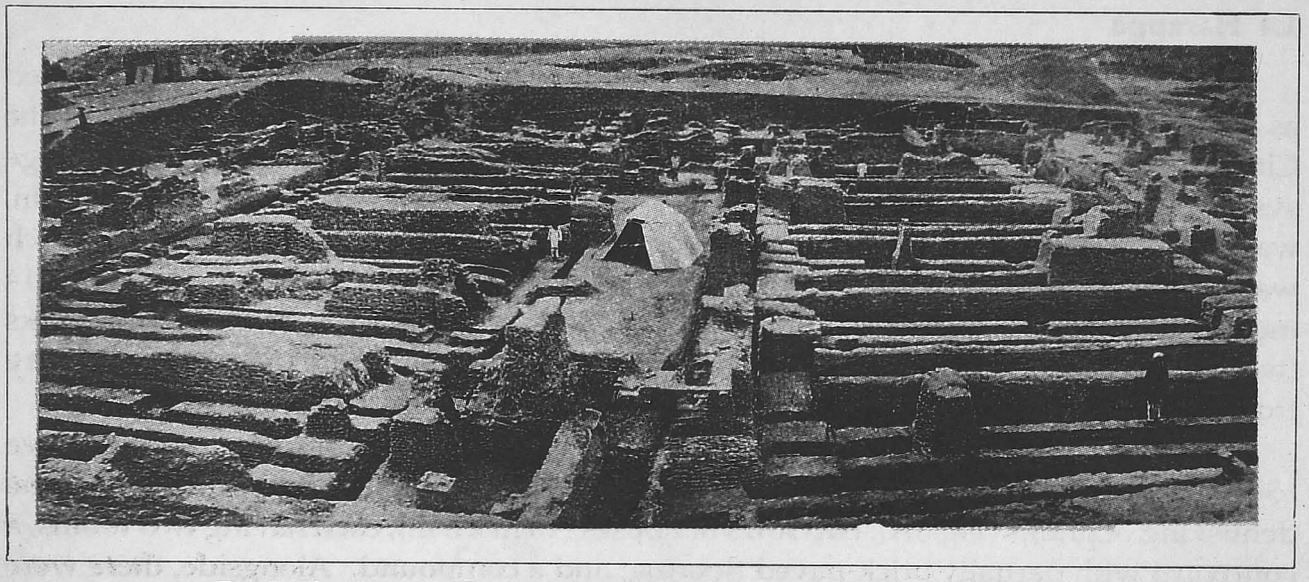


Fig. 7. The Granary: Panaromic View; looking south, Mound F, Harappa
(Vats, II, Pl.IV)

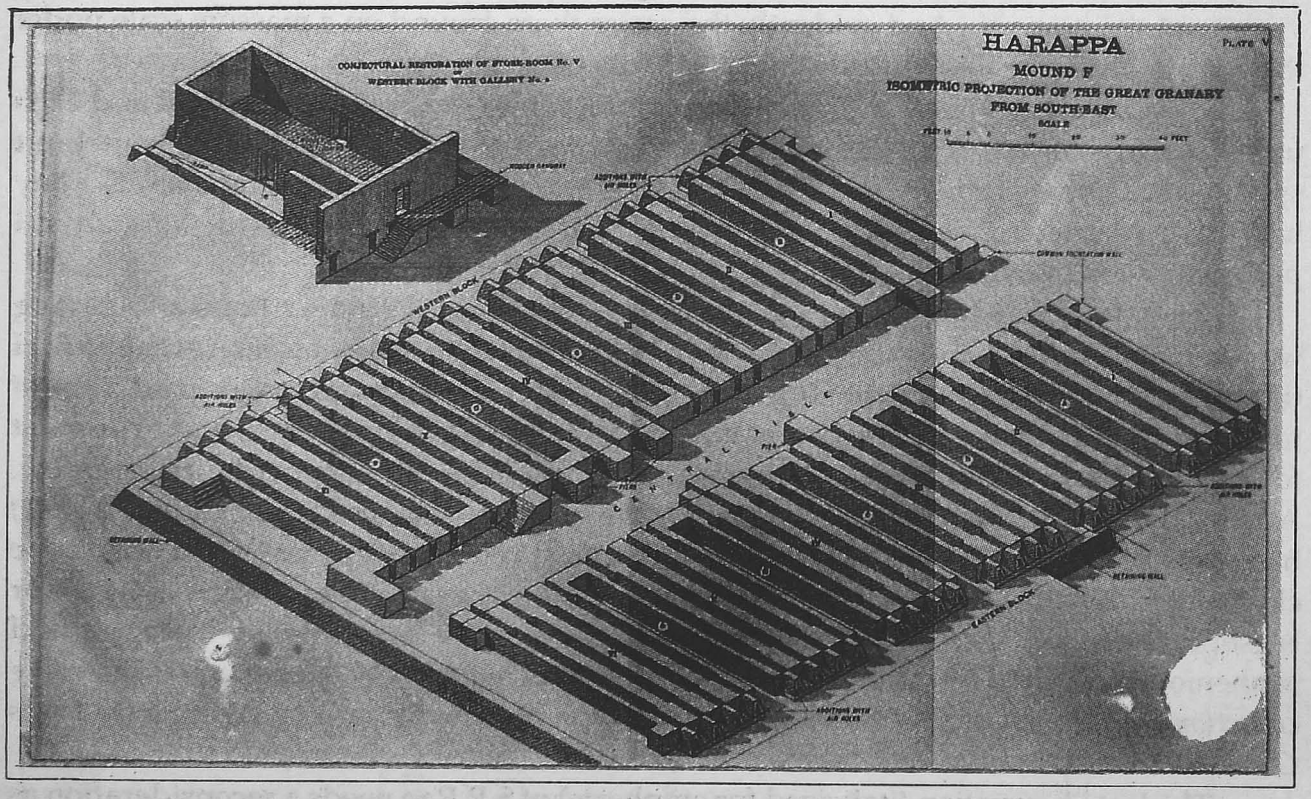


Fig. 8. Isometric projection of the Granary Front,South-East, Mound F
(Vats II, Pl.VI)

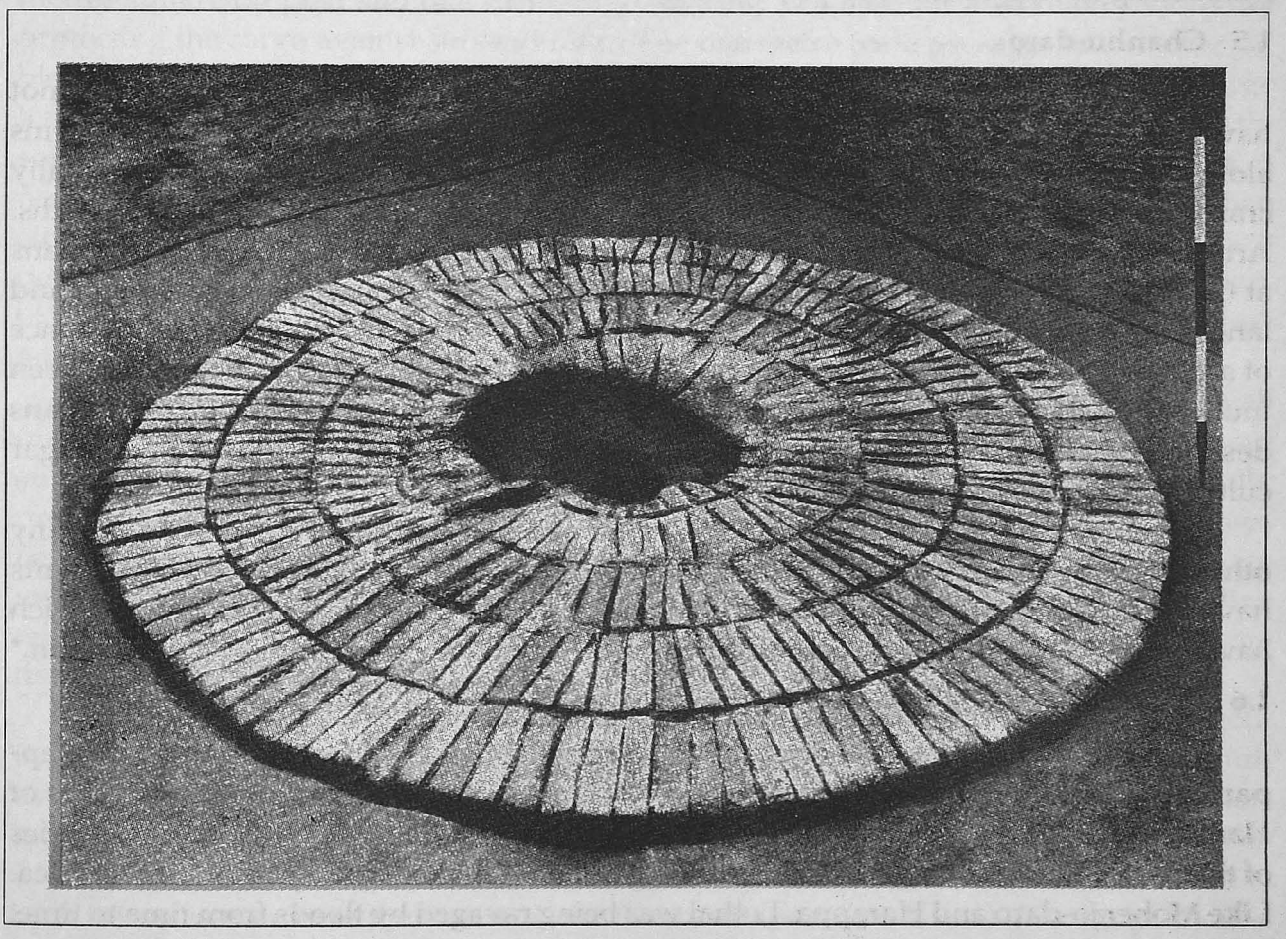


Fig.8A. Harappa: Dehusking Platform
(Source: S.R. Rao (1), Pl. 1B)

to understand the possible relation between the script forms on the Indus seals and the maintenance of accounts. Their tacit assumption has been that the script indicated the name of the consigner or owner of goods for commercial transactions. Could many of the seals have been in the nature of 'accounting tablets'? This question will be examined later (see Section 6). The site of Harappa has yielded seals, sealings and other inscribed objects, numbering about 985.

1.5 Chanhu-daro

Chanhu-daro lay about 129 kilometres south of Mohenjo-daro. This town did not have a citadel. It had, nevertheless, a well laid surface drainage system and platforms along with rows of mud-brick houses. The residents were believed to be essentially craftsmen. The craftsmen comprised bead-makers, shell-workers and coppersmiths. Archaeologists are of the opinion that there were three phases of occupation by Harappans at Chanhu-daro and the third phase was noted for houses, drainage system, streets and lanes and other amenities. Differing views have been expressed regarding the existence of a granary at Chanhu-daro. In any case, 66 seals, sealings and related objects have been found in the site at this place. It is surmised that, in the second millenium B.C., Harappans deserted this town and people of what are called by archaeologists, the Jhukar and Jhangar cultures, occupied it successively.

It may be noted that Mohenjo-daro, Harappa and Chanhu-daro as well as many other sites are now in Pakistan. On the Indian side also, a number of Harappan settlements have been found and among them Lothal (Gujarat) and Kalibangan (Rajasthan), which have yielded 213 and 99 seals and allied objects respectively, merit our special attention.*

1.6 Lothal

Lothal, it would appear, was already a commercially active village before Harappans appeared on the scene and, in the succeeding centuries, it had a distinct impress of Harappa Culture. The town of Lothal was connected, at that time, with navigable estuaries of the Sabarmati and Bhogowa rivers flowing into the Gulf of Cambay of the Arabian Sea. Like Mohenjo-daro and Harappa, Lothal was being ravaged by floods from time to time; but it withstood these onslaughts and emerged as a notable port-town of commercial importance.

The Acropolis of Lothal – 117 metres (east to west), 136 metres (north) and 111 metres (south) was in the shape of a trapezoid, and had within it several constructions. On a platform of about 3.5 metres height stood (what is designated as) the residence of the ruler, which measured 126 x 30 metres. Like Mohenja-daro and Harappa, Lothal town too had well-knit streets and lanes, blocks of houses, efficient drainage system and wells

* Dholavira and Banawali were the other important settlements; but their accounts are not included here. Seven inscribed objects have been found at Banawali and one large inscribed object, at Dholavira.

for the supply of potable water. The town was known for the production of beads (as evidenced by the remains of furnaces which were built for this purpose) and copper objects. These apart, it had a distinct warehouse erected on a four metre high platform with a floor-area of about 1,930 square metres. According to S.R. Rao (the excavator of Lothal): The warehouse 'originally supported 64 cubical blocks of mud-bricks, each 3.6 metres square on plan and one metre high, serving as a base for a wooden canopy for protecting the cargo against sun and rain... The one metre wide passages interlacing the blocks were brick-paved to facilitate easy movement of labour and inspection of cargo by customs authorities. The brick-built groove at the northern extremity of the north-south passage suggests that a wooden door could be inserted to close the air-vent, if necessary ... It (the warehouse) is the largest structure of its kind covering more area than either of the granaries at Harappa and Mohenjo-daro. Lothal was obviously the busiest port of the Indus Empire, and must have handled the largest volume of trade' (Rao, 1, p. 66). Besides the warehouse, the Acropolis had some impressive buildings, also erected on high platforms.

The 'Lower Town', which was in area thrice that of Acropolis was equally well planned with a bazaar on the northern side, a place for arts and crafts on the western and an ensemble of private houses on the north-western sides. All of them were skilfully protected against the frequent fury of floods. There were also relatively large buildings, besides workshops and a bead-production unit, which covered an area of about 500 square metres. The 'Lower Town' did not lag behind in sanitary arrangements and was in line with those of Acropolis. The streets were functionally wide, some of them being more than thirteen metres in width.

According to the excavator of Lothal, there existed a dockyard (there are divergent interpretations of this structure) which was 'the largest structure (as dockyard) ever built by the Harappans or any other Bronze Age Community for handling cargo'. It had water-locking devices and water-regulatory mechanism. The dockyard was built across a *nullah* (canal) which then connected the basin of the dockyard with the river 'which swelled at high tide as is even now the case with the Bhogowa river near Lothal' (Rao, 1, p.70). The dockyard was trapezoid in shape and the lengths of the embankment walls were 212.4 metres (west), 209.3 metres (east), 34.7 metres (south) and 36.4 metres (north), and the walls were built with well burnt-bricks. There is a view that the Lothal dock was big enough even by modern standards, for harbouring sail-borne ships of considerable size. It would thus seem that there was an appreciably voluminous sea-borne trade through Lothal. From this site 213 seals, sealings and other engraved objects have been unearthed.

1.7 Kalibangan

Kalibangan, which was situated on the left bank of the river Ghaggar (now dried up) in Hanumangarh Tehsil of the present Ganganagar District of Rajasthan, lay about

160 km. south-east of Harappa. Like Lothal and Chanhu-daro, Kalibangan had some settlements before the Harappa Culture made its inroads there. The town, which was much smaller than Mohenjo-daro, Harappa or Lothal, was well planned like them. Besides its possible fortification walls, Kalibangan had streets and small lanes. The drainage system, however, left much to be desired. The furrowed field which came to light during excavations has revealed the type of agricultural operations practised there about 4,500 years ago. The residential houses were built in oblong blocks, and ornamental (geometric patterns) baked-tiles were used for flooring. Some houses had private baths, soakage jars and drains. The overall civic standard at Kalibangan, however, appeared to be at a low level when compared with that at Mohenjo-daro, Harappa or Lothal. There is archaeological evidence to show that certain ritualistic practices were in vogue at Kalibangan as also the performance of sacrifice in fire-altars. 99:seals, sealings and other inscribed objects have been found at this site.

1.8 Agriculture and other Accomplishments

The Harappa Culture was noted for its efficient agrarian system, and its economy was agriculture-based. The fertile lands of the riverine beds and the climate were conducive to raising several types of crops. Although no agricultural implements of any significance have been unearthed in any part of this Culture, the use of a type of plough can be assumed and operations like threshing and pounding inferred. The excavations have revealed that bread wheat (*Triticum compactum* and *Triticum sphaerococcum*), varieties of barley (*Hordeum vulgare*) and cotton (*Gossypium arboreum*) were being grown extensively. Barley was the most important food grain, followed by wheat. There is evidence to indicate that rice was being grown to some extent in the region of Saurashtra at a later time. Sesame, melon and peas were cultivated at Harappa, and dates at Mohenjo-daro, as indicated by their charred remnants in these places. *Rai* (*Brassica* variety) was also grown at several places.

Sheep, humped and humpless cattle, buffalo, dogs and pigs were among the domesticated animals. It would appear that horse, though known to the Harappans at a later stage in Saurashtra, was not as useful an animal for them as it was from the *Rgvedic* times. As to the other animals, Harappans were familiar with elephant, bison, tiger (possi- bly lion), spotted deer, sambhar, and rhinoceros, besides monkeys and various types of birds and fish.

Apart from the pottery and associated techniques of glazing and paintings on it, Harappan artisans were skilled in several crafts – statuaries; terracotta art; spinning and weaving; boat-building; bead-making; production of standardized bricks (1:2:4) and the like. They seemed to have a working knowledge of a large number of minerals and their uses – Lapis Lazuli, turquoise, limestone, alabaster, soapstone and steatite, haematite,

amethyst, agate, jasper, chalcedony, onyx, bitumen, lollingite, arsenical pyrites, galena, cerrusite and others. The Harappan metal-smiths possessed appreciable experience in copper-bronze working, coiling and riveting, and above all, in metal-casting. The bronze statuette of a dancing girl found at Mohenjo-daro was understandably cast by the lost-wax *(cire perdue)* process.

One of the most important civilisational components is a system of weights and measures, which are so essential for ensuring an acceptable and recognisable distribution mechanism for agricultural produce as well as the other types of production. The Harappa Culture had indeed developed an elaborate system of weights, both small and medium, as confirmed by a wide but graded variety of standard objects found at Mohenjo-daro and Harappa. The nearly integral ratios of one weight to another reveal the extreme care bestowed by Harappans on the system of weights.

SECTION 2

INSCRIPTION AND THE PROBLEM

2.1 Seals and Other Inscribed Objects

The most fascinating skill of Harappan artisans was their elegant technique of making seals and other inscribed objects, with or without animal and other motifs but with a noticeable variety of script forms. As noted before, the three distinctive seals which were found at Harappa in 1857, 1886 and 1912 were in the nature of a front door, as it were, to archaeologists for gaining entry into an enchanting civilisation that lay buried there. The explorations that followed in subsequent decades at Harappa, Mohenjo-daro, Chanhu-daro, Lothal, Kalibangan and other sites, numbering 30, have yielded about 3,000 seals and other inscribed artefacts as shown in Table 1. While the accomplishments of Harappa Culture in ceramics, metal-working and other arts and crafts have been understood and even evaluated in the perspective of similar achievements of Egyptian and the Mesopotamian cultures, the Indus seals and inscriptions have remained an enigma, defying so far their meaningful interpretation to the satisfaction of the world of scholars.

2.2 Seal-making

The preparation of seals was a skilful operation. According to Marshall (Vol.2, pp.377-79), steatite stone was first cut into shape by means of a thin saw and 'if it was to have a boss, this was roughly cut into shape with the saw; a horizontal cut was made from each side of the seal towards the centre and four vertical cuts were then made downwards to meet the horizontal ones. A rough square projection, the size of the boss, was thus left at the back of the seal. The boss was then carefully rounded off after the groove that always runs across its centre had been roughly made by a V-shaped cut. The rounding off of the boss was apparently done with a knife and finished off with an abrasive, after which a hole was bored through it from opposite sides to take a cord. The hole for the cord was sometimes bored horizontally but more generally it dips slightly from the two ends towards the centre. As steatite has a tendency to split along the cleavage planes, the probable idea of these converging holes, which are too common to be accidental, was to carry the hole into the substance of the seal itself rather than to rely on the

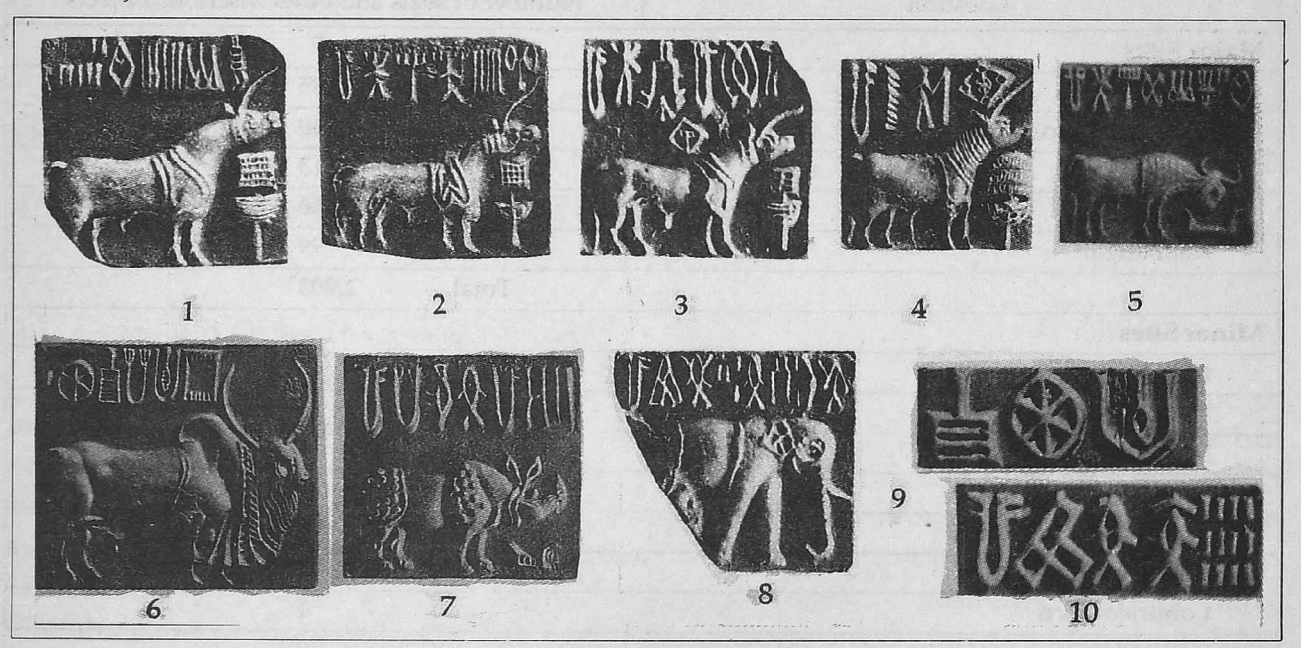
Table 1

Location	Number of seals and other inscribed objects
Major Sites	
Harappa	985
Mohenjo-daro	1,540
Lothal	213
Chanhu-daro	66
Kalibangan	99
Total	2,903
Minor Sites	
Kot-diji	1
Nindowari	3
Jhukar	1
Amri	2
Balakot	2
Desalpur	2
Lohumjo-daro	1
Surkotda	3
Alamgirpur	3
Rupar	2
Mitathal	1
Rakhi Shapur	1
Banawali	7
Chandigarh	4
Dholavira	1
Total	34
West Asian Sites	
Ur	10
Kish	2
Umma	1
Girsu	3
Tell Asmar	2
Tepe Gowra	1
Susa	2
Bahrain	2
Failaka	1
Hama	1
Total	25

Source : S.R. Rao, *The Decipherment of Indus Script*, p.5

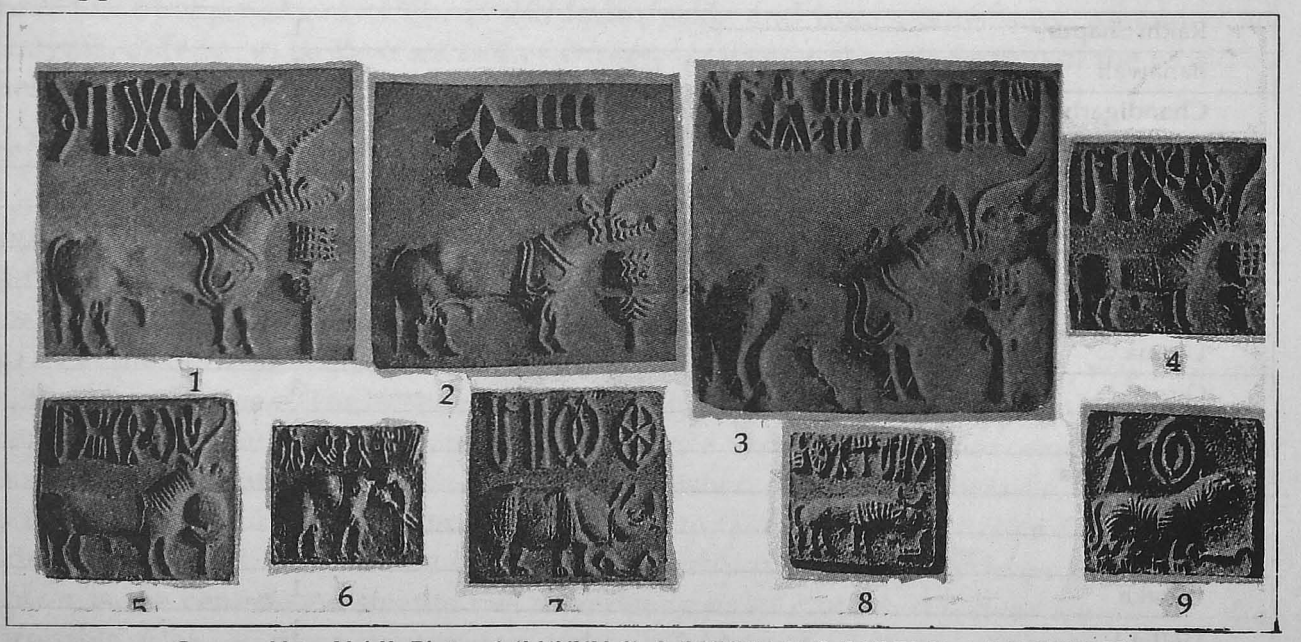
Fig.9 Seals (examples)

Mohenjo-daro



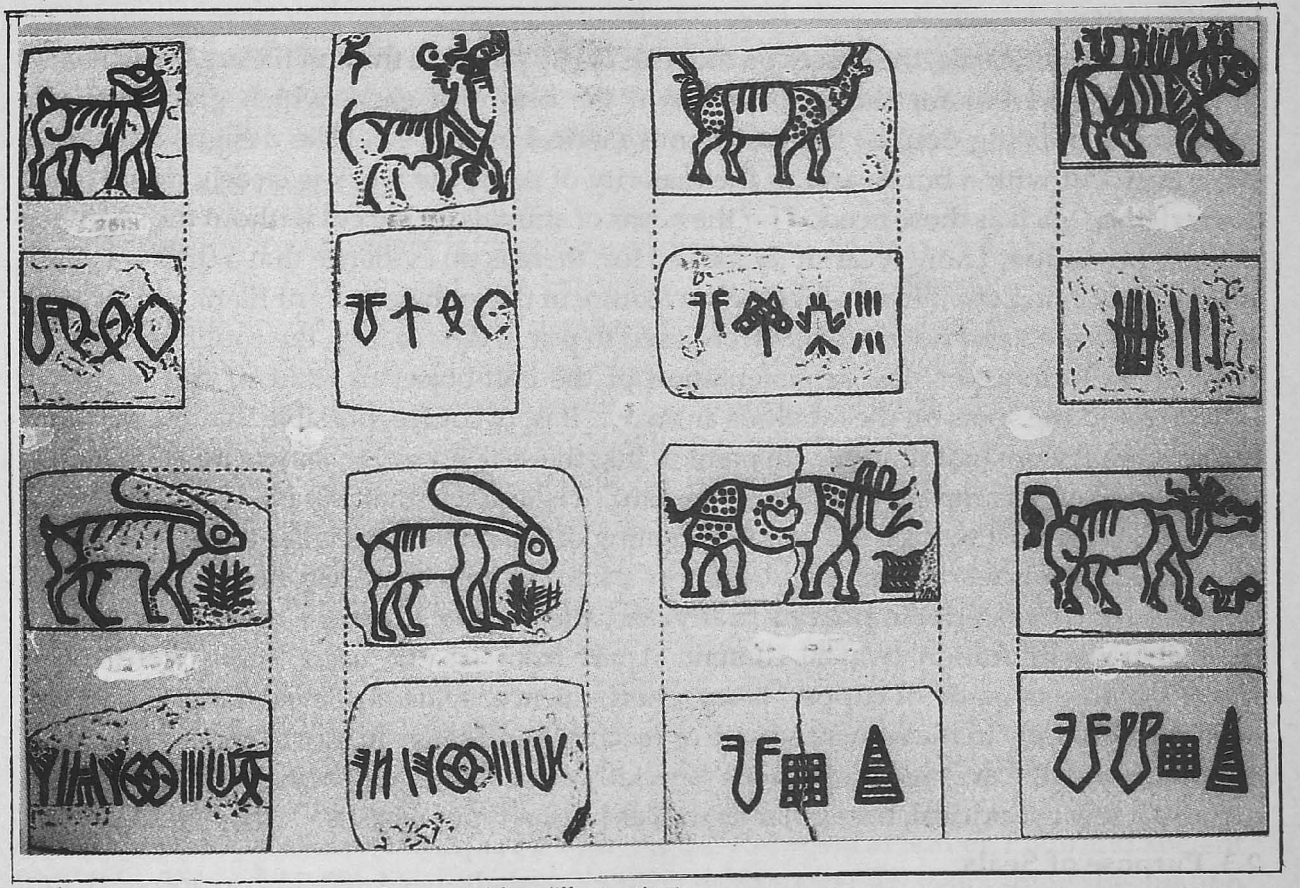
Source: Marshall, Vol III, Plates: 1 (CV, 54); 2 (CV, 50); 3 (CVI, 99); 4 (CVII, 118); 5 (CX, 322); 6 (CXI , 337); 7 (CXI, 342); 8 (CXII, 373); 9 (CXIII, 463); 10 (CXIII, 470)

Harappa

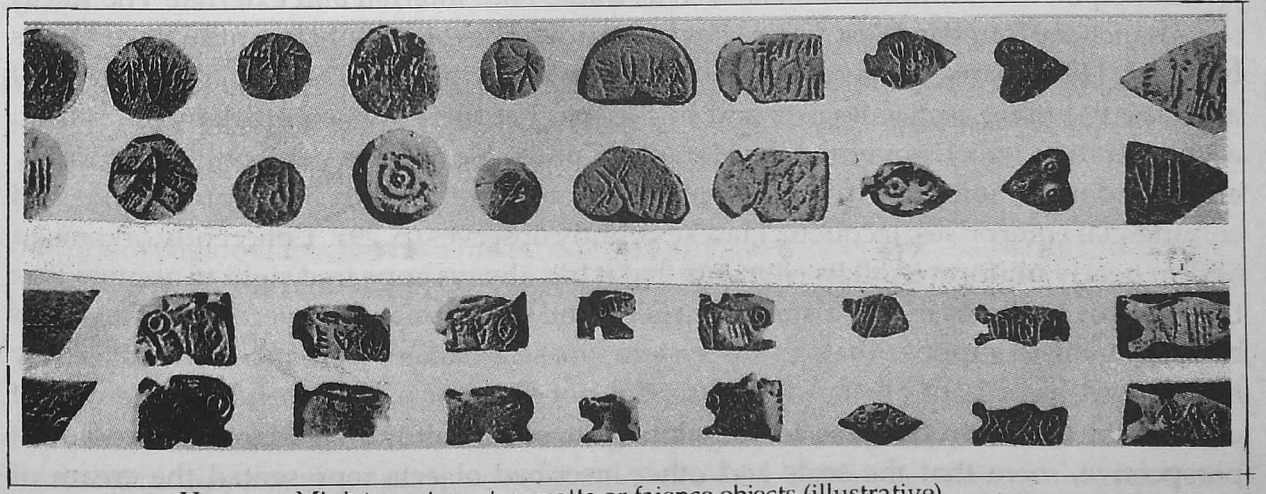


Source: Vats, Vol II, Plates: 1 (LXXXV. 8); 2 (LXXXV, 9); 3 (LXXV, 2); 4 (LXXVIII, 78);
5(LXXXVII, 87) 6(XCI,229);7(XCI,253);8(XCI,245);9(XCI,246)

Fig. 9A



Mohenjo-daro: Copper tablets (illustrative)
Source: Marshall, Vol III, Plate CXVII, 1-8



Harappa: Miniature stone, terracotta or faience objects (illustrative)
Source: Vats, Vol II, Plate XCV, 410-428

boss which, owing to its prominence and the nature of the stone, was always liable to be knocked off ...'

'As a general rule, the bosses on the seals occupy about a third of the area of the back of the seal, and but for the grooves down the centre of each, which give them an appearance of being double, they are hemispherical in shape ... The designs appear to have been cut with a burin, and in the majority of seals, the work is clearly done, even curved lines, such as those needed for the horns of animals, being cut without the slightest trace of hesitation. Though carefully looked for, there is no evidence that a drill was first used for outlining the figures – a common feature of the archaic seals of Elam and Sumer. But both pointed and hollow drills were used to put in details, e.g., the roughness of the hide of the rhinoceros, the ornamentation of the cult-object in front of the so-called unicorn, and the spots on the fabulous animal ... It is, of course, possible that the outlines of the animal were first drawn with paint or ink; the seal, however, shows no evidence of this, though on a damp site like Mohenjo-daro, it is unlikely that any paint or ink would remain ...' The seal was given a smooth-coating of the same material as that of seal itself to conceal blemishes. It was then baked in a kiln by which process the seal would be whitened and its exterior improved. In any case, after heating, steatite would get hardened by losing its hydration (water) content. Apart from steatite seals, there were other inscribed objects made of copper, ivory, chert, faience, agate and even clay. The Indus seals are generally in the form of square or rectangle and range in size from 1.25 x 1 cm to 5.5 cm square, the average dimensions (specially of a steatite seal) being 3 x 2 cms. There are also a few cylindrical, triangular as well as button types of seals.

2.3 Purpose of Seals

It is generally accepted that the Indus seals served as recordings or instruments which helped the administration as well as trade, both internal and external. The Indus seals which are found in West Asian sites have proved beyond doubt the intimate relations between Harappans, Sumerians, Elamites as well as others. There is also a general agreement among archaeologists and historians that there was an efficient centralised administration which governed the Harappa Culture, ensuring a perceptible uniformity and standardisation – be it in town-planning, arts, crafts or in other productive and commercial enterprises. Jacquetta Hawkes rightly observes (p. 29): 'Coherently organised and so nearly uniform in all its elements that it has always appeared right to assume that the area covered was in fact a state controlled one by centralised government'. It would be reasonable to suppose that, in this system, the seal-makers were pre-eminent as they maintained records of all that was essential not only for a purposeful functioning of centralised authority but also for regulating its socio-cultural standards. It would, in perspective, seem that the seals and other inscribed objects represented the cream of

Harappan accomplishments in one form or the other. Unfortunately, however, the script forms on the seals and several types of other engraved objects of chert, faience, copper, pottery, ivory and the like, it may be reiterated, remain enigmatic despite the devoted efforts of many scholars towards their interpretation. What is more, not much is known with authenticity about Harappan people, their origin and evolution.

2.4 Divergent Views

The following summary is largely based on a review on this subject by Mahalingam (pp.87-95): H. de Terra opined that Harappans could have possibly evolved from an indigenous culture. Stewart Piggot also thought that the origin of Harappans outside India was improbable. Mortimer Wheeler stressed that 'this civilisation was the result of environmental opportunity offered to a people of a creative genius which would account for its rapid development'. Gordon Childe, who paid a tribute to the sustained creativity of Harappans, had no solution to offer to the puzzling problem of their origin. D.H. Gordon, on the other hand, thought that Harappans were immigrants, although he did not specify clearly the location from which they entered India. In his view, they 'brought with them the knowledge of those things which form the basis of civilised living and, by exploiting and adapting this knowledge to suit their new environment, were able by their drive and vision to establish within the matter of a hundred years or so, the pattern of culture which was to endure for a thousand (years)'. He even chose to state categorically: 'No further search is going to bring to light either in India or some adjacent country a Harappan city site where the constituents of this culture can be shown to have evolved over millennia, parallel to, but separate from the development of Sumer, Elam and ancient Iran' (Gordon, pp. 57-58). Nevertheless, there have been over the years some speculation that Harappans were either Aryans, similar to the later Vedic people or Dravidians like Tamils.

The anthropological data concerning the people of Harappa Culture is but scanty. The only available evidence about them is a few human skeletons and skulls which have been excavated so far. It is indeed hard to arrive at any rational generalisation, leave alone definitive conclusion, on the basis of the analysis of such scanty craniological evidence. The general opinion among archaeologists and anthropologists is that the population of Harappan cities and towns was a mixed one and probably comprised the racial types now recognised as proto-Australoid, Mediterranean, Alpinoid and Mongoloid.

2.5 Indus Script: Varied Opinions

If the origin and nature of the Harappans are still enigmatic, so too are the language, script forms, animals as well as other motifs engraved by their craftsmen on seals and other objects. Several attempts have been made over the last six decades to unravel their mystery and bring to light their significance. One of the earliest scholars, L.A. Waddell,

compared the signs of Sumerian and Indus scripts and tried to read the latter as if it was all Sumerian – a simplistic approach which could not meet with the desired success. Langdon endeavoured to show the connection between Indus and the later Brāhmī scripts. Holding a similar view, C.J. Gadd thought that the language depicted by the Indus script was Indo-Aryan. Pran Nath even gave alphabetical values to a number of signs of Indus script by comparing them with those of the Brāhmī script and suggesting that the Indus language was some form of Prākṛt or pre-Vedic language. S.K. Ray was another scholar who thought of the alphabetical character of the Indus script.

There were other views too. The noted Egyptologist, W.M. Flinders Petrie, interpreted Indus script in terms of ideographic presentations of the Egyptian hieroglyphs and even made a suggestion that the scripts on the seals connote the titles of officials. There was also a comparison made by M.G. de Hevesy between a number of Indus signs and those of the Easter Islands which lie about 4,000 km away in the Pacific Ocean. G.R. Hunter examined the Indus and the Elamite scripts and concluded that the Indus script was a borrowed mix of the Mesopotamian and Egyptian ones. Yet another view of foreign inspiration was expressed by the well known scholar, B. Hronzy, who related the Indus script to the Hittite hieroglyphics. P. Merggi brushed aside the Indo-Aryan or Sanskritic nuances of the Indus script and thought, like Hronzy, that not only the Hittite hieroglyphics bear some resemblance to the Indus script but even stressed that the seals were meant for administrative purposes.

Heras viewed the Harappans and Indus script in a different light with the supposition that the Harappans were Dravidians, their script was picto–phonographic and that they spoke a proto-Dravidian language (old Tamil). This was criticised by Deringer, who opined that 'the attempts of Heras, to equate the most up-to-date linguistic forms with the undeciphered seals belonging to the third millennium B.C. might put the unwary on the wrong track' (Mahalingam, pp. 90-94). About 15 years ago, Walter A.Fairservis Jr. came forth with the idea that the Harappan language is a form of Dravidian (Tamil–Kannada).

That the language of the Indus seals could well be proto-Dravidian, specially Tamil, has found, exponents in the Russian V.I. Knorozov, Finnish Asko Parpola and, to some extent, Indian Iravatham Mahadevan. They have used the potentialities of computer, each with his own programming methods wherever necessary. In contradistinction to this approach, S.R. Rao, unaided by computer, has attempted to decipher the Indus script as well as the language conveyed by it. Adducing his own arguments, he has drawn the conclusion that the Harappan language was old Indo-Aryan akin to the *Ṛgvedic* (Sanskritic) language and that the script is syllabic to alphabetic.

It is not intended here, nor is it possible, to discuss the merits or demerits of all the dedicated efforts made so far by various scholars in and outside India with or without the

aid of computer. Suffice it to say that the core of the assumption or hypothesis adopted so far relates to the so called linguistic nature of the Indus script. Though there are numerical signs which are in the form of vertical strokes on seals and other objects, they too have been interpreted by these scholars as words of a presumed language, and do not appear to have been recognised by these scholars as notations or forms of numbers of one, two, three etc. Alan S.C. Ross, while examining the numerical signs, even emphasised that they do not, in general, represent actual numbers.

Two other views, in this respect, need specific mention. Mahadevan (2, p. 14) states: '... Numbers precede the objects enumerated. The system appears to be decimal. The units are represented by short strokes and the tens by the inverted semicircles, both as in the Egyptian. Numerals from 1 to 4 are also found written with two–tiered strokes. The long strokes do not seem to represent ordinary numbers (except probably on the miniature tablets from Harappa). The short superscript suffixes are certainly not numbers. The sign with 12 strokes arranged in three tiers does not function as a numeral as the number of strokes is found to be variable and the occasional zig-zag arrangement of the tiers and doubling of the sign are features not shared by the numeral signs. Numerals also appear to be used in ideographic (non-numeral) function especially when they appear as fixed numbers in set combinations (e.g.) VII - City, III - FENCE. The largest numbers identified so far are 35 and 76 occurring on two bronze axes (6,306, 2,925). Signs for higher numbers, especially for 100 and 1,000 may exist as still unidentified word-signs'.

Kinnier-Wilson, in his 'New approach to the problems of the Indus script', began from a relatively safe basis, the numerals' (Zvelebil, p. 92). Supporting his identifications with Sumerian parallels, he considered 'the language of at least some strata of the Indus people as a type of Sumerian' and thought that 'the two scripts, Indus and Sumerian, branched out from a single stem at some early period and that the original features are preserved in both'. He endeavoured to show that the Indus seals had economic undertones, denoting weights, measures, etc.

2.6 The Emergent Picture

What then is the emergent picture of the endeavours of many a savant towards the decipherment of Indus script? It is abundantly clear that, over the decades, it is only the script forms that have engaged the attention of scholars. Such efforts have not encompassed in any meaningful manner the significance and relationship of what are generally referred to as 'field symbols' and other constituents of the seals. Even so, the position in respect of the decoding of the script forms themselves is far from being rationally meaningful.

In 1967, T.V. Mahalingam wrote: 'In spite of all that has been written on the subject, the Indus script will have to remain a mystery till such time as a key of an unimpeachable

character or a bilingual inscription and a known language or a long inscription with significant recurrent features, is found' (p.96). In 1987, Asko Parpola wrote in his Introduction to *Corpus of Indus Seals and Inscriptions* (pp, XVII-XVIII):

'The Indus script has been considered genetically connected with the Brāhmī script of early historical India. Other hypotheses have connected the Indus script with the scripts of the ancient Sumerians, Proto-Elamites, Egyptian, Hittites and Chinese, and even with Etruscan pot-marks and script-like carvings on wooden tablets found in the Easter Island, in the middle of the Pacific Ocean. The language underlying the Indus script has been supposed to be Sumerian, Proto-Dravidian, Proto-Indo-European, Proto-Indo-Iranian, Sanskrit, Prākṛt and so on'.

'But no unanimity has been reached even on the basic issues and most literature on the Indus script requires a lot of sifting in order to pick up useful ideas. The main reason for this unfortunate state of affairs is the fact that all keys that opened other unknown scripts are unavailable here. There are no bi- or multi- lingual inscriptions giving the same text in both Indus script and some readable characters ...'

In 1988, I. Mahadevan titled his Presidential Address to Section V of the Indian History Congress : 'What Do We Know About the Indus Script? *Neti Neti* (Not This Nor That)!' The decipherment of Indus script, based on the assumption that it represents the language of the Harappans, seems to have reached a position : 'thus far and no further'. In 1990, Zvelebil wrote: 'A major negative conclusion which must be unfortunately stressed is (that) none of the published claims of the decipherment of the Indus script (and language) is valid' (p. 97).

If the linguistic approach has not met with the desired success so far, is it possible to think of a scientific approach? In other words, are there on the seals and other inscribed objects certain scientific ideas presented in an integrated manner encompassing the script forms, animal motifs and others? Is an entirely new approach possible? Such a new approach has been discussed in Section 4. In order to appreciate the significance of this approach, the ancient number systems have been dealt with in Section 3.

SECTION 3

NUMBER SYSTEMS

The most crucial strands of human progress have been the communicable language and number-reckoning systems. Together with agricultural operations, arts and crafts and the use of minerals and metals, these two strands, more than any other, have purposefully shaped diverse human settlements in different parts of the world right from the neo-lithic times. Between the two, the concept and formulation of numbers are a triumph of the innovative human mind, since numbers as such do not exist in nature. Number-reckoning is an entirely human ingenuity and, over the millennia, man has acquired such a mastery over it that man and numbers, in one form or the other, have become inseparable. Numbers are both an art and science – art in the sense of their notational forms, and science as they have rationally engendered both theoretical and quantitative intellection.

The story of number-reckoning is truly a fascinating one and its origins can be traced to remote antiquity, to the activities of man as food-gatherer who perhaps intuitively was able to identify 'one', 'two' and the several, as 'many' by pointing out to the objects before him. Some experiments with birds like crow have revealed that they do possess a number-sense, albeit to a limited extent. In course of time, as daily necessities arose, man developed an easily communicable method of denoting numbers first by using his fingers, and later also by toes in addition. But his efforts were still circumscribed by the act of correspondence between the objects before him and the numbers he had in his mind.

3. 1 Tallying

From this state of mental and physical correspondence to that of some type of recording* was doubtless a big step in early human ingenuity. An early endeavour in this direction, known as tallying, was to record a mark (generally a vertical line) for each object, like vertical scratches on mud or stone. And this was possibly followed by tying the desired number of knots in a string of rope, by assemblage of pebbles, sticks or notches in bone or wood. The oldest tallying device is exemplified by a tally stick found in Moravia, which dates back to paleolithic times. Alongside, appropriate vocal sounds began to manifest themselves as words-tally. The human mind has strong inductive and deductive dimensions. As a result, there appeared one of the most significant developments in number-reckoning, namely, the grouping of numbers and identification of and inference

* Finger counting and the tying of knots using a rope such as the Peruvian Quipu are not indicated here because they stand on a different footing.

from such grouped numbers. It is surmised that initially the first grouping was in sets of 'four', probably because of four fingers of human hand. Later, the thumb was included to identify a group of five. In any case, the grouping of numbers was an important landmark in the history of number-reckoning. It was not long before such an effort encompassed 'five', 'ten' and 'twenty', admittedly based on four fingers and the thumb of one hand, those of both the hands, and the latter along with toes respectively.

3.2 Adoption of a Base

At that stage, perhaps some simple words to connote 'one' and 'two' were used and subsequent numbers were expressed in terms of 'two one', 'two two' and the like, thus extending the ability to name other numbers by an additive approach. The next step was to establish a base for counting system and this differed from one culture-area to another. The first choice of a base could well have been 'two' (primitive), followed by 'three' (Australian tribes), i.e. the binary and the tertiary systems. Since the fingers and toes could be used for counting, one would expect that 'five', 'ten' and 'twenty' would be the bases and such bases have been noticed not only among some primitive communities but even in fairly advanced ones. Known by the names of 'quinary', 'decimal' and 'vigesimal' respectively, one of these was adopted by them, although the base 'four' (quaternary) was also in use initially, as denoted by the counting system of the Luli of Paraguay. It is significant to note that, in some of the cultures, the word for the number 'five' is the same as that for 'hand'. It would seem that the Sanskrit word *'Panca'* (five) is related to the Indo-Iranian term *'Pentcha'* meaning 'hand'. The Russian word *'Piat'* (five) is probably a derivative of *'Piast'*, which means the out-stretched hand. And the word for 'ten' likewise is the same as that for 'two hands'. Several studies on counting systems of the extant tribal communities like that of Greenland Eskimos, have revealed the gradual adoption of 'five', 'ten' or 'twenty' as bases. Possibly, twenty was the limit of a definite number at one time. The English word 'score' for twenty also means a large number or a total ('score of a game'). It is derived from the Anglo-Saxon word 'skar' which meant 'scratch' or 'tally' (for details see the publications of Boyer, Cajouri and Crozer).

The ingenuity of number-reckoning attained new dimensions with the emergence of specific numerical forms or notations in several advanced human settlements which heralded the dawn of early civilisations. The urbanisation which was steadily coming to the fore had its own social, economic and bureaucratic compulsions – the maintenance of records of agricultural production and distribution, adoption of standards for weights and measures, payment of wages, trade accounts and the like – all of which needed for precise communication a viable system of numbers and their numerical forms. The quantitative records suited to the genius of each civilisation were in the nature of an index of the quality of life of its people, then as now.

Let us now consider the number systems and associated numerical forms of two ancient civilisations – the Egyptian and the Mesopotamian – which were almost contemporaneous with each other, the former having arisen perhaps a little earlier than the latter.

3.3. Egyptian Numbers

With the chance discovery of the trilingual Rosetta Stone (found at Rosetta, an old harbour which lay near Alexandria) during Napoleonic expedition in 1799, the decipherment of Egyptian hieroglyphics became an acceptable reality. This large tablet had inscriptions in three languages, Greek, the old Hieroglyphic (sacred language) and the much later Demotic or popular language. [There was also an intermediary called 'hieratic' (priestly language)]. Champollion in France, Thomas Young in England and Adolf Hermann in Germany were able to decipher the Hieroglyphic and the Demotic on the basis of the accompanying Greek language, thus paving the way for the readings of several other Egyptian texts which were either on stone tablets or on papyrus. Several Egyptian papyri in particular disclosed in no uncertain way among others, the Egyptian numeration, its system and notations, many of which can be dated to about the fourth millennium B.C.

Egyptians, in general, adopted the decimal scale and used distinctive symbols for each of the six powers of ten: a vertical stroke | (one); a heel bone form ∩ (ten); a snake or a coil form,  ($100=10^2$); a lotus,  ($1{,}000=10^3$); a bent finger or a pointer, ($10{,}000=10^4$); a burbot fish resembling a polywog,  ($1{,}00{,}000=10^5$); and a man in astonishment!  ($10{,}00{,}000=10^6$). Through simple iterative (repetition of the desired symbols) operations, Egyptians were able to record very high numbers on stone, wood or papyrus along with other hieroglyphics of their intent. A close examination of such numerical presentation reveals that the symbols were arranged vertically or horizontally, sometimes even in reverse positions. And the order was not necessarily followed in relation to the ascending values of numbers. Small numbers (which were normally placed on the right) were also sometimes placed on the left following the higher numbers. An Egyptian royal mace which is more than 5,000 years old (now in a museum at Oxford) has on it a record of 1,20,000 prisoners and 1,42,200 captive goats – all in an additive way of juxtaposed symbols. Some of the Papyri have writings of mathematical nature involving notations of lower numbers and their derivatives. It is now recognised that Egyptians intelligently employed the decimal scale, adopted an additive-multiplicative principle and probably were the first to evolve the ciphered system as early as the third millennium B.C. The general Egyptian numerals are given in Table 2.

3.4 Ciphered System

In the history of numbers and their purposeful exploitation for socio-economic betterment, the ciphered system has a distinct place. It was this system that had a very

long innings spanning almost 3,500 years till the adoption of the decimal place-value system in about the fourth century A.D., probably first in India, whence it spread to the other parts of the world. In the ciphered* system, different symbols are created for representing each of the desired numerical value by using a base like ten or twenty, and, if necessary, a multiplication of numbers whenever needed. This system had the advantage of expressing numbers in a manner that would accurately represent their nature – either addition or multiplication, and was capable of denoting even large numbers. The Egyptian Hieratic numbers which were evolved from the Hieroglyphic ones (Table 2), the early Babylonian numbers (Table 3), Attic Greek system of numeration (Table 4) as well as the early Brāhmī numerals (Table 9) are examples of the ciphered system. The Mayas had also developed a ciphered system (Table 6) with base twenty (vigesimal) superimposed on base five (quinary). Such superimpositions were not uncommon in ancient cultures. The Romans had also developed a number system and the Roman numerals are given in Table 5.

3.5 Positional System : Babylonian

The ciphered system of notations, no doubt, served the purpose of recording even large numbers. But, of necessity, it gave birth to a plethora of notations for expressing different numbers and it became rather difficult to memorize or learn all of them. Thus arose a need for computation in a simplified manner by using only a few digits. To meet this necessity, a positional numeral system was evolved in which the position or the place occupied by a numerical symbol would determine the value of that notation. In this system, which is now familiar to us, the same symbol could have different values in accordance with its place or position in the system of enumeration, say ten, hundred, thousand and so on. The ancient Babylonians were probably the first to think along these lines and evolve a positional numeral system, but with base sixty (sexagesimal) for higher numbers and base ten for numbers one to fiftynine. In other words, the Babylonian sexagesimal system was superimposed on a simple grouping decimal system.

It is generally believed that the choice of sixty as a base by Babylonians was influenced by the necessity of unifying their system of weights and measures as well as by the fact that sixty has as many as ten integral divisibles or factors – two, three, four, five, six, ten, twelve, fifteen, twenty and thirty – which would make the desired computations easier. It may be noted that the division of hour into sixty minutes, and minute into sixty seconds as well as of the circle into 360 degrees, each of sixty minutes and sixty seconds of arc, dates back to Babylonians. Nevertheless, their sexagesimal

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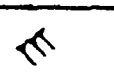
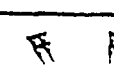
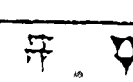
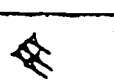
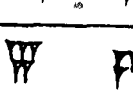
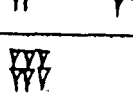
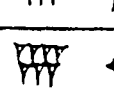
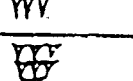
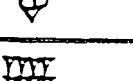
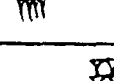
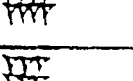
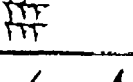
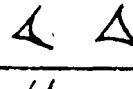
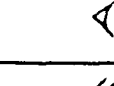
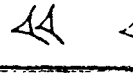
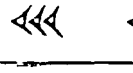
* The word 'Cipher' is not be confused with the modern word meaning Zero. In ancient times it was associated with the calculation involving forms of numbers (perhaps in secret manner) to connote a group or sum of numbers.

Table 2. Egyptian Numerals

Number	Hieroglyphic	Hieratic
ONE	𓏺	𓏺
TWO	𓏺𓏺	𓏺𓏺
THREE	𓏺𓏺𓏺	𓏺𓏺𓏺
FOUR	𓏺𓏺𓏺𓏺	𓏺𓏺𓏺𓏺
FIVE	𓏺𓏺𓏺𓏺𓏺	𓏻
SIX	𓏺𓏺𓏺 𓏺𓏺𓏺	𓏼
SEVEN	𓏺𓏺𓏺𓏺 𓏺𓏺𓏺	𓏽
EIGHT	𓏺𓏺𓏺𓏺 𓏺𓏺𓏺𓏺	𓏾
NINE	𓏺𓏺𓏺𓏺𓏺 𓏺𓏺𓏺𓏺	𓏿
TEN	𓎆	𓍢
TWENTY	𓎆𓎆	𓍣
THIRTY	𓎆𓎆 𓎆	𓍤
FORTY	𓎆𓎆𓎆𓎆	𓍥
FIFTY	𓎆𓎆𓎆 𓎆𓎆	𓍦
SIXTY	𓎆𓎆𓎆 𓎆𓎆𓎆	𓍧
SEVENTY	𓎆𓎆𓎆𓎆 𓎆𓎆𓎆	𓍨
EIGHTY	𓎆𓎆𓎆𓎆 𓎆𓎆𓎆𓎆	𓍩
NINETY	𓎆𓎆𓎆𓎆𓎆 𓎆𓎆𓎆𓎆	𓍪
HUNDRED	𓍢	𓍢
TWO HUNDRED	𓍢𓍢	𓍢𓍢
THREE HUNDRED	𓍢𓍢𓍢	𓍢𓍢𓍢
FOUR HUNDRED	𓍢𓍢𓍢𓍢	𓍢𓍢𓍢𓍢
EIGHT HUNDRED	𓍢𓍢𓍢𓍢 𓍢𓍢𓍢𓍢	𓍢𓍢
NINE HUNDRED	𓍢𓍢𓍢 𓍢𓍢𓍢 𓍢𓍢𓍢	𓍢𓍢
THOUSAND	𓆼	𓆼
TWO THOUSAND	𓆼𓆼	𓆼
NINE THOUSAND	𓆼𓆼𓆼 𓆼𓆼𓆼 𓆼𓆼𓆼	𓆼

Source: Cajouri, p.12

Table 3. Mesopotamian Numerals

	Classical Sumerian	Assyrian-Babylonian or Akkadien
One		
Two		
Three		
Four		
Five		
Six		
Seven		
Eight		
Nine		
Ten		
Twenty		
Thirty		
Forty		
Fifty		
Sixty		

Source: René Labat pp. 188, 189, 210-13 and 242-247

Table 4. Greek Numerals

Numbers	1	5	10	50	100	500	1,000	5,000	10,000
Old Celtic (1500 B.C.)	) or I	))))) or IIIII	• or —		\or/		◇		
Attic Greeks (600 B.C.) and Herodionic	I	⌐	Δ	⌐Δ	H	⌐H	X	⌐X	M

Source: (a) Cajouri, p. 21; (b) Crozer, p. 40

Table 5. Early Roman Numerals

Modern	1	2	3	4	5	6	7	8	9	10	50	100	500	1,000	5,000
Roman	I	II	III	IIII	V	VI	VII	VIII	IX	X	L	C	D	M	ↁ

Source: Crozer, p. 41

Table 6. Maya Numerals

Modern	1	2	3	4	5	6	7	10	11	15	16	19	20
Maya	•	••	•••	••••	—	•—	••—	=	•=	≡	•≡	••••≡	

Source: Cajouri, p. 41; Crozer, p. 51

Table 7. Chinese Numerals

	Shang Oracle-(14th-11th Cent. B.C)	Bronze and Coin forms (10th-3rd Cent. B.C.)	Other forms on Coins (6th-3rd Cent. B.C.)
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			
11			
12			
13			
14	Analogous; but not found in inscriptions		

	Shang Orade-(14th-11th Cent. B.C.)	Bronze and Coin forms (10th-3rd Cent. B.C.)	Other forms on Coins (6th-3rd Cent. B.C.)
15			
20			
30			
40			
50			
60			
100			
200			
300			
500			
1,000			
3,000			
4,000			
5,000			

Source: Needham, III, Tables 22 and 23

positional numeral system was not adopted by others, possibly because it did not have a symbol for zero like the later decimal place-value system, although Babylonians used, rather inconsistently, a symbol similar to a punctuation mark to serve as a place determinant.

Be that as it may, the Babylonians were able to express all their numerals generally in combinations of two cuneiform (wedge-shaped) symbols. A vertical wedge (which was produced by pressing a prism-shaped stylus or rod into wet clay) represented one, and the wedge in a horizontal position represented ten. The vertical one was also used for denoting sixty (see Table 3). The Babylonian style of numeration needed extraordinary care to determine and to record numbers. Even so, the Babylonians have left behind their knowledge of astronomy and mathematics in terms of this type of number presentation on clay tablets.

3.6 Chinese Numbers

In the Far East, the Chinese had developed a decimal system of numeration by about 1400 B.C., as revealed by the notations on oracle-bones of the Shang Dynasty, the first Bronze Age culture of China. Such numerical notations also appeared on bronzes and coins (Table 7). The notations were in the nature of a grouping ciphered system. In a treatise on arithmetic *(Sun-Tsŭsuan-Chi)* probably belonging to the first century A.D., there is a description of the use of calculating rods, generally made of bamboo, for denoting numbers. This treatise also has a decimal place-value concept as follows: 'In making calculations we must first know the position of numbers. Unity is vertical and ten, horizontal; the hundred stands, while the thousand lies; and the thousand and the ten look equal and so also ten-thousand and the hundred' (Needham, III, p.90).

3.7 Indian Numeration

In the Indian sub-continent, the earliest numerical signs (vertical strokes) for one to twelve are found on Indus seals. (That all the script forms on the seals and other inscribed objects represent only numbers, i.e. they are all numerical notations, which is the main theme of this monograph, will be discussed in the next section). From the vertical strokes on the seals to some definitive numerical forms which appear in the Asokan Brahmi and Kharosti inscriptions, there was a very long time-gap of 16-18 centuries. During this long interregnum, however, the number system found expression in the form of words in the Vedic literature. The Vedic Indians adopted ten as the base and evolved appropriate terminology for expressing large numbers on the ascending decimal scale *(daśaguṇottara)*. The *Taittirīya* and *Vājasaneyi Saṃhitās (Yajurveda)* have enumerations as follows: *eka* (one), *daśa* (ten), *śata* (hundred = 10^2), *sahasra* (thousand = 10^3); *ayuta* (ten thousand = 10^4); *niyuta* (hundred thousand = 10^5); *prayuta* (ten hundred thousand = 10^6, *arbuda* (hundred hundred thousand = 10^7); *nyarbuda* (ten hundred hundred thousand = 10^8); *samudra* (hundred

Table 8
Kharoṣṭi Numerals

ONE	𐨑
TWO	𐨑𐨑
THREE	𐨑𐨑𐨑
FOUR	𐨑𐨑𐨑𐨑 or 𐨒
FIVE	𐨒𐨑 or 𐨒𐨑𐨑
SIX	𐨒𐨑𐨑
SEVEN	𐨒𐨑𐨑𐨑
EIGHT	𐨒𐨒
NINE	𐨒𐨒𐨑
TEN	𐨓
TWENTY	𐨔
FORTY	𐨔𐨔
SIXTY	𐨔𐨔𐨔
EIGHTY	𐨔𐨔𐨔𐨔
HUNDRED	𐨕 or 𐨖𐨑
TWO HUNDRED	𐨖𐨑𐨑

Source: Corpus Inscriptionum Indicarum, Vols.

Ojha, Tables Meninger, p.62

Table 9. BRAHMI NUMERALS
(3rd cent. B.C. to 9th cent. A.D.)

Number	Aśokan	Nānāghāt	Nāsik	Āndhra, Kuśān Mathura	Gupta	Pallava	Place-value Notations copper plates and Gwalior
ONE	1	—	—	—			
TWO	11	=	=	=			2
THREE		≡	≡	≡			3
FOUR	+						
FIVE							
SIX							
SEVEN							
EIGHT							
NINE							
TEN							10
TWENTY							20
THIRTY							30
FORTY							40
FIFTY							50
SIXTY							60
SEVENTY							70
EIGHTY							80
NINETY							90
HUNDRED							100
TWO HUNDRED							200
FOUR HUNDRED							400
THOUSAND							1000
FOUR THOUSAND							4000
TWENTY THOUSAND							20000

Source : Georges Ifrah, *From One to Zero : A Universal History of Numbers*, New York, 1985, pp. 454-5.

Table 10. A Comparison of the Indus, Chinese, Kharoṣṭi and Brāhmī Numerals.

Number	Indus Forms	CHINESE			In Kharoṣṭi Inscriptions	IN BRĀHMĪ INSCRIPTIONS		
		Forms on, Shang Oracle-Bones	Forms on Bronze	Forms on Coins and Others		Ashokan	Nānāghāt	Nasik and Others
1								
2								
3								
4								
5								
6								
7								
8								
9								
10								
20								
30								
40								
50								
100								
1000								

hundred hundred thousand = 10^9); *madhya* (ten hundred hundred hundred thousand = 10^{10}); *anta* (hundred hundred hundred hundred thousand = 10^{11}); and *parārdha* (ten hundred hundred hundred hundred thousand = 10^{12}).

Another Vedic text, the *Kāṭhaka* lists the same, but with the exchange of places for *niyuta* and *ayuta*. The *Pañcaviṃśa Brāhmaṇa* follows this enumeration up to *nyarbuda*, then introduces the words *nikharavaka, bhadra, akṣita* and *go*. Using this system, this text has number-reckoning from four digits (e.g. 6144) to six digits (e.g. 393216). The Vedic word-numbers are in the nature of a ciphered system in the expression of numbers between *daśa* and *śata*, between *śata* and *sahasra*, and so on. A multiplicative system was also adopted by the combination of word-numerals. Likewise the additive principle: *eka-daśa* (11); *aṣṭa-triṃsat* (38) and ṣaṣṭim - sahasranavātim nava (60,099). Even fractions were expressed in words - *ardha* (1/2); *tripāda* (3/4); *śapha* (1/8); *dvādasa-bhāga* (1/12); *kalā* (1/16); *dvi-saptama* (2/7); *tri-aṣṭama* or *tryaṣṭa* (3/8); *pancamasya caturviṃśa* (1/24 of 1/5) and the like.

From about the fifth century A.D., specific words *(bhūta-sankhyā)* also began to be used for numbers in the decimal place-value system in astronomical-cum-mathematical texts in Sanskrit with a view to facilitating oral transmission and also to be in conformity with metrical necessities of verses in which these texts, by and large, were written. Alongside, Āryabhaṭa I (5th cent. A.D.) developed an alphabetical system in his own way for expressing numbers too in the decimal place-value system. There was also another alphabetical system called the *Katapayādi* used by Indian astronomers in addition to the word-numerals.

As to the archaeological or epigraphical evidence, we are still in the dark up to about the period of the Asokan (Brāhmi) inscriptions. Thereafter, happily, there is considerable inscriptional numerical forms either in Kharoṣṭi or in Brāhmī and its evolved forms, found in Saka, Parthian, Kusan, Andhra, Mathura, Kṣatrap and Gupta inscriptions up to about the sixth century A.D., These are of value to us for understanding the ancient Indian numerical forms, the ciphered ones as well as those of the decimal place-value system in its formative stage.

By the ninth century A.D., the Brāhmī numerical forms and associated decimal place-value system had found adherents in the then new Islamic centres of learning, specially in the Caliphate at Baghdad. Al-Khwarizmi was the noted exponent of the Indian numerical system and forms. In the twelfth century A.D., When his work in Arabic was translated into Latin in medieval Europe, the Indian numerals and the decimal place-value system began to spread in Europe. In the next four to five centuries, they spread both in the West and in the East. The numerical forms one to nine underwent some modifications from the original Brāhmī numerical forms, and by the fifteenth century A.D., assumed the forms that we now use.

But the origin of the ciphered numerical forms which are found in the Brāhmi and Kharoṣṭi inscriptions is still obscure like that of the Brāhmī script itself. Nevertheless it would appear that the still enigmatic Indus script forms hold the key to solve this problem. Since none of the linguistic attempts made so far for deciphering the Indus script has met with success, it is desirable – indeed necessary – to understand the Indus script from a different standpoint, namely, that the entire Indus script represents numbers. This has been discussed in the next Section.

SECTION 4

DECIPHERMENT : A NEW APPROACH

There is no denying the fact that the Harappa Culture had evolved its own language. But it will be very difficult to assume that the language was the same throughout the length and breadth of this culture. Even the Mesopotamian Civilization, which was much smaller in area than that of the Harappa Culture, had regional variations in language. Such variations have been noticed practically in all the advanced civilizations in all periods of history. India has been a multilingual culture-area even from ancient times. There have been marked variations in not only the spoken languages but also the scripts of such languages, though the scripts have been derived from the same source, namely, the Brahmi script. One may even be inclined to the view that it would be swimming against the historical currents that have shaped human progress, if it is tacitly postulated that any of the ancient civilizations had one and the only one language throughout its length and breadth. As to a common script, whatever was the situation in the other ancient civilisations, the picture is different in the Indian sub-continent. Even when the script began to be used by about the fifth century B.C., there were two scripts – Kharosti and Brahmi - as vehicles of the same language.

4.1 Numerical Forms : Their Pervasiveness

A pertinent question is: Are we right in assuming that the Harappan language was the same everywhere – Mohenjo-daro, Harappa, Chanhu-daro, Lothal, Kalibangan, Kot-diji, Surkotda, Banawali, Dholavira – in northern, eastern and southern, urban as well as rural settlements? There could well have been a multiplicity of languages and dialects in that vast area without any type of uniform script for expressing the different languages. Even granting that one script could have been used for expressing different languages of the vast Harappa Culture, it would be it difficult to accept the basic premise of the attempts made so far in terms of one Harappan language. Further, several script forms are repeated side by side twice, thrice and even four times on a particular seal. Could such a presentation be compatible with that of a language? However, all the seals and other inscribed objects found in different parts of the Harappa Culture, even separated by long distances, have practically similar forms executed in similar style with a noticeable standard of their own. Such a standardised continuity was possible only in the case of

numerical notations of a particular culture which adopted a viable system of numerical forms. Indeed, such numerical forms were in the nature of a distinct mark of identification, as it were, of that culture. The numerical forms have the potentiality of being presented in similar way as well as of pervasiveness even in a vast culture. For, the number-reckoning and notations have cut across linguistic and allied barriers, then as now. If there is one human invention which has found universal adherents, both in the orient and in the occident, it is the number system and associated notations.

4.2 Language and Script

Yet another aspect merits our consideration. There is ample evidence to show, both in India and elsewhere, that several languages have been in vogue which do not have scripts of their own. A critical question is: Did the Vedic language, other than which there was no powerful and sublime language in the ancient period, have a script for over a thousand years till about the fourth century B.C.? There is a general agreement that it did not, although some scholars have attempted to show, on unconvincing grounds, that the Vedic people knew writing. There is, however, no archaeological evidence to this effect. A cognate question is : Has not a systematic oral communication of traditional knowledge been a dominant gene in India from ancient times till very recently? Yet another question is: If, as some archaeologists and Indologists suggest, there was some sort of a linkage between Harappa Culture and Vedic people (whether they were immigrants or indigenous) and if there was a strong writing tradition among Harappans, why did not the Vedic people continue with such writing tradition of Harappans? The most crucial question, however, is: If the Harappans had fostered a writing tradition for their language, how was it that they did not leave behind sufficiently long texts on clay or any other material like those which have shown up in large numbers in the Mesopotamian civilisation with which the Harappans had established contacts? Moreover, in the Indian tradition, the writing of numbers is from right to left (see p. 63). Is not the general direction of writing the Harappan script (which according to some scholars, is from right to left), in consonance with that of writing the numbers?

If the foregoing and related questions are examined dispassionately, we are compelled to conclude that the Indus script represents numerical forms and that the Harappans had preferred an oral language tradition. In the Indian sub-continent, such a tradition was also followed by the succeeding cultures – the Banas or Ahar, the Vedic as well as the post-Vedic and the Megalithic 2m besides the authors of copper-hoards and other chalcolithic settlements. Significantly, so far no written language records have been found concerning these cultures.

Language and number system, each being articulate and communicative in its own way, are the warp and weft of any civilisational fabric, the socio-economic dimensions

being the hues and designs of that fabric, in which numbers and numerical forms have a major share. If one looks at the three ancient civilisations, one would discover that Harappa Culture did not lag behind the Egyptian or the Mesopotamian civilisations, its two senior contemporaries, in evolving its own numerical forms and a system of number-reckoning. Its central administration, agricultural production and management, arts and crafts, weights and measures, and commercial practices, both internal and external – all of these doubtless needed a viable system of numbers and their forms. The Harappans developed such a system and spared no efforts in expressing the associated numerical forms artistically. More importantly, such numerical forms would have found their way on to the Indus seals and other objects which admittedly were used mainly for administrative and commercial purposes.

4.3 New Approach

A careful examination of the forms inscribed on Indus seals does not fail to indicate, as noted already, that often some forms occur side by side in twos, sometimes in threes and fours. One of the fascinating characteristics of numbers is that they could be repeated even side by side and could still have validity. If, on the other hand, words are used in such a repetitive manner, they would have an odd effect. If there are about 450 script forms which, by permutation and combination, have appeared on seals and other objects, sometimes in a repetitive manner, naturally a question arises: If these forms connote words, was the vocabulary of Harappans limited to these? On the other hand, in the ciphered system of numeration, by using as many as 450 forms, a wide variety of numbers both small and large, can be recorded in the desired way. These considerations lead to the conclusion that the script on Indus seals and other objects cannot but be numerical forms. One may even say that the seals are an exclusive repository of numerical forms, unparalleled elsewhere. This is the point of departure from the attempts made so far for deciphering the Indus script. Our new approach, therefore, consists in treating all the Indus script forms as those of numbers, which are expressed in an ingenious manner. Besides, the inter-links among the script forms, the animal motifs and the concerned object-structure in front of them, will also be examined as an integral part of this new approach.

4.4 Evidence

The main question which needs to be answered in relation to this approach is: If the Indus script is in the nature of numerical forms, how can it be substantiated with plausible evidence, either direct or indirect? It would appear that any direct evidence is well nigh impossible, since the numerical forms of the Egyptian and Mesopotamian have no general resemblance (except in a very few cases) to those used by the Harappans. Nevertheless, certain historical situations are of great value in this respect. As the Harappa Culture was

atrophying around 1600 B.C., there were two significant appearances which shaped two culture-areas, each in its own way. One was the emergence, all of a sudden, of a bronze culture about that time in the northern part of China, called by Sinologists the culture of Shang Dynasty. Another was the appearance of a thoughtful people, also about the same time, in India, the Vedic people (the controversial term, Aryan, is deliberately not used here). Even at the time of their appearance, both Shang and Vedic people were quite familiar with numerical enumeration as evidenced by the archaeological finds (oracle-bones) in the case of Shang Culture, and literary sources in respect of Vedic people. The number-reckoning and the forms or words of these two cultures are valuable for understanding the Harappan numerical forms with the assumption that they might have been familiar with the Indus numeration. In addition, all the forms which have been understood as representing numbers in the inscriptions in Kharosti and Brahmi which have been found in different parts of the Indian sub-continent are equally valuable, even though they are of a much later date. For, it would not be inappropriate to assume that the Indus numbers, because of their practical nature, should have had a continuity in some way or the other in the geographically contiguous areas, despite the fact that so far there has been no discernible archaeological or epigraphical evidence relating to this long period between 1600 B.C. and 400 B.C., and long before they appeared in Kharosti and Brahmi inscriptions. B.B. Lal has, however, shown some Indus forms on the Megalithic pottery and one can infer from such forms a possible continuity of the former in India even during this long period.

4.5 Shang Culture and Indus Numerical Forms

While we can assume the continuity of the Indus numerical system in the Indian subcontinent without much of contradiction, the flow of the Indus numeral forms into the remote Chinese Shang Dynasty area needs some consideration. The only internal evidence of some value in this context is the one skeletal form of Mangoloid features found at the metropolis of Mohenjo-daro (Jacquetta Hawkes and Leonard Wooley, p.396). Wooley has interpreted this find as a foreign one and remarks that 'One would expect to find a few immigrants from the north-eastern hill countries.' It is generally agreed that in the cities of Mohenjo-daro and Harappa in particular, and in the other towns in general, there lived different ethnic groups possibly for trading purposes. One of them belonged to the Mangoloid type similar to the ethnicity of the Chinese. There were trade contacts between India and Mesopotamia (Bridget and Raymond Allchin, pp. 188-89) and the trading groups conceivably were moving from one place to another not only in the Harappan Culture-area but even beyond into Mesopotamia, thus carrying their knowledge of Indus numerical forms from one place to another. Possibly, these reached even the southern

parts of Chinese culture-area whence it might have seeped into the northern parts of China, where lay the Shang Culture.

According to Sinologists, the Shang Culture owed its inspiration to the southern parts of China and their inhabitants. Further, the Shang Culture appeared to have had some interaction with the West Asian region. For, certain ceramic forms, including the tripod ones which are found earlier in the Western Asian region, made their appearance in the Shang Culture. Several Indologists like B.N. Mukherjee are of the view that, even in very ancient times, Indian contacts with China were possible through West Asian points of mutual contact. It may be noted that there was a Harappan community in the Sumerian region and Shang traders could well have been in touch with them. Thus the Indus numeration and notations were known to the Shang Culture through this mediation. Conceivably, the Shang traders and craftsmen might have become familiar even with the Babylonian number-system during their contacts with West Asia. But the Babylonian number-reckoning, just using one vertical and one horizontal wedge shapes for enumeration on the sexagesimal system, had its complexities of presentation. Obviously, such a system did not appeal to the people of the Shang Culture; nor was it attractive to the other culture-areas. It is interesting to note that the nearby Greeks, who were heirs to Babylonian astronomy and mathematics, did not prefer (Table 4) the Babylonian number forms.

In any case, the Shang Culture chose the decimal system (and not the sexagesimal system of the Babylonians) and evolved its own numerical forms (Table 7), which were totally at variance with those of the Babylonians. On the other hand, not a few of the Shang forms are practically identical with those of the Harappans. It was not unlikely that the Indus numerical forms had their imprint on the Shang Culture. It should, however, be emphasised at this stage that in the early history of numerical systems, no culture borrowed totally from another culture and that, along with an exogenous influence and assimilation, the endogenous developments took place. The Shang Culture was no exception.

Even in a single culture-area, for example, in the Indian sub-continent, the numerical forms have shown assimilation and variations to some extent from one region to another, like the Kharosti and Brahmi, and within a region, from one tradition to another. The numerical forms of Shang oracle-bone inscriptions as well as those on bronzes and coins up to about the 3rd century B.C. also showed some variations along with assimilations. Thus even the variations of Chinese numerical forms and those of Kharosti and Brahmi are veritable sources for a proper appreciation of the Indus numbers and notations. Since the Harappa Culture had contacts with the Sumerian Culture, the Sumerian numerical forms could also throw light on Indus notations, which totally characterise the Indus script on all the seals and other inscribed objects.

A question may be asked : Did the seals of any other civilisation which were contemporaneous with Harappa Culture depict only numbers as the Indus ones did? An answer to this question lies in reflecting upon two aspects: one, no other known civilisation had large granaries of the types of Mohenjo-daro and Harappa; and second, no other civilisation had evolved such an exquisite town-planning and standardisation as Harappa Culture. The administrative efficiency of Harappa Culture lay in its social goals, in the production and management of various commodities which perforce needed a viable number system and recording as the hall-mark of such an administration.

4.6 Table 10 illustrates the correspondence and variations among the important numerical forms – Harappan, Chinese, Babylonian, Brāhmī and Kharoṣṭi.

SECTION 5

INDUS NUMERATION

A detailed examination of a wide variety of numerical symbols which have been inscribed on the seals and others reveals that these represent the ciphered system involving additive-multiplicative approach to arrive at and express the desired numbers. In this ciphered system, as in the others, the base (b) employed is ten and hence the Indus numeration is decimal in its conceptual matrix. There are different symbols concerning simple grouping for one to nine (b-1); multiples of ten (2b, 3b --- 9b); a symbol for one hundred, which is the square of the base (b^2); multiples of hundred ($2b^2$, $3b^2$, --- $9b^2$) and a symbol for one thousand, the cube of the base (b^3) followed by its multiples. To connote multiplication, Indus seal makers adopted ingenious methods, as will be observed later.

5.1 Simple Grouping

Number Four: In the history of numbers the first attempt at simple grouping related to the number four. The earliest step in this direction was to cross four vertical strokes like  with a view to facilitating the counting of easily recognisable units of four and thus to maintain an account or a reckoning based on such units.

On the Indus seals there are three types of notations of simple grouping for connoting number four, namely  or  or  It may be observed that each of these three forms is composed of four lines. The Indus seal makers used each of them depending not only upon the availability of space on a seal but also upon the artistic compulsions. The form and its derivatives were in use mostly in Mohenjo-daro and Harappa, while and its derivatives, whose number is very large, were used in all the places. The form was not used as such, but in the form of its derivatives, mostly in Mohenjo-daro and Harappa. Notably, when one of these notations is employed, neither of the other two generally appears on the same seal. The form has survived in the Kharosti inscriptions for the numerical value four.

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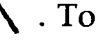
* The old Celtics used the symbol (Table 4)for denoting one thousand. But the manner in which the Indus seal makers formulated its derivatives indicates that this symbol represents four.

Number Five: The notation for five was derived from by the addition of one vertical stroke, i.e.  and this form has been found on Indus seals.

Number Six: Likewise, by the addition of one more stroke to the form for five, i.e.  the notation to represent number six was obtained . In course of time, this form was changed into  . To arrive at this notation, six strokes  or  which were earlier employed, could well have been presented as  (six lines) or simply to denote six, which was not only easier to inscribe but also would occupy less space than the other one. These two forms were used by the Chinese (Table 7). The form  could also be written as  (this is also found on the seals) which could undergo transformation into  showing again six strokes, which, in course of time, could have become  The latter form has survived in Aśokan Brāhmī inscriptions for denoting six (Table 9).

Number Seven : An addition of one more stroke to the simplified notation of six,  , would make it represent number seven. Gradually it would have been simplified into and these notations are found on Indus seals. The form, , has been used in (Brāhmī) Nanaghat, Nasik and other inscriptions (Table 9).

Number Eight : In order to indicate a number which immediately follows seven, a form similar to seven but distinct from it would have been thought of by adding one more stroke or to represent eight. This might give rise to a definite form like (in which the stroke is added at the bottom) to denote eight. In the Brāhmī inscriptions, has been used for number eight (Table 9).

Number Nine : It would appear that nine strokes in an artistic but a condensed way were employed to denote nine as follows : which would have undergone a modification into . Indus seal makers used a simplified and elegant form, for denoting number nine. The Chinese employed for nine.

5.2 Number Ten

In the history of numbers, ten is indeed a landmark for which ten fingers of two hands provided the first imagery. According to the noted historian of mathematical notations, F.Cajouri, the earliest form for indicating number ten as a means of communication, was a picture of two hands held in prayer, the fingers close to one another, the palms pressed to each other and the two thumbs thrusting out (quoted by Crozer, p. 39).

Expressed graphically, the original symbol for ten would have been  . In course of time, possibly this sign had undergone a transformation specially among Sumerians and Assyrian-Babylonians, into horizontal* form,  . (Table 3).

The Indus seal-makers adopted this form in a vertical position, i.e.,  for denoting ten (see also p.55). But they also used this symbol in an artistic way, namely  , to connote ten. It is significant to observe that it is this form, with some minor variations, that has survived in the Brâhmī inscriptions (Table 9) for the numerical value of ten. Thus, it would seem that the inspirational source for Harappans in respect of this symbol was Sumerian or Assyrian-Babylonian.

At the same time, the Indus seal-makers did not lose sight of the folded hand sign as noted above. They used it adding two more strokes at the bottom, i.e.,  for denoting ten plus two, i.e., twelve, thus arriving at a simple grouping for number twelve, which appeared to be as important as the symbol for ten. It is worthy to note that the symbol  is used as many as 381 times on Indus inscribed objects. It may be pointed out that in ancient times twelve was also regarded as one of the basic units for counting, understandably because of the set of three horizontal folding marks on each of the four fingers which are capable of being counted by the opposing thumb. Even now, such a practice is not uncommon, specially among rural people, to count number twelve. Has not dozen been a recognised counting unit over the ages?

There was yet another way, then as now, of counting ten as a unit, by using fingers. When ten fingers are counted, a finger on the left hand would be raised to denote that one counting of ten was over; two fingers raised to indicate that two countings of ten were over, and so on. In other words, a vertical stroke  (on the analogy of a raised finger) could also denote ten. The Chinese adopted the dual role of a vertical stroke for denoting one as well as ten. On the other hand, the Sumerians used a vertical  wedge (with a cuneiform wedge-shaped contrivance) for denoting one and the same form in a horizontal position  for connoting ten. But the Indus seal-makers even thought of a device, namely, either placing a small filled circle at the centre or at the end of the vertical stroke like  or presenting the vertical stroke in a slanting position like  or in a slightly

* In ancient times, there was no difference between the same or nearly the same horizontal and vertical forms. The form was more important then than its horizontal or vertical representation.

curved fashion like a bracket, i.e.) or (The slanting stroke was also used by Greeks for denoting ten (Table 4). The form, ϕ , was used by the Chinese (Table 7) and the form,) was used in the Kharoṣṭi inscriptions for ten (Table 8).

The Sumerian form ≺ for ten (Table 3) which was used by Indus seal-makers in a vertical position, i.e., A gradually underwent change into simplified forms in course of time. The form A was thus transformed into 𒌋, 𒌋, 𒌋 and 𒌋 . Likewise, the Sumerian notation o (small oval) or small D was also employed by Indus seal-makers for ten, though sparingly.

Thus number ten has been represented on the Indus seals by any one of the following symbols: ✕, A, 𒌋, 𒌋, 𒌋, 𒌋, ϕ, ϕ, /,), o, D (variants). It may be noted that old Sumerians as well as Greeks also adopted the symbol Δ for denoting ten, in addition to the other symbols for ten (Tables 3 and 4). Alternative symbols were employed to denote the same number because each seal-maker or a group of seal makers had his or its own preference not only for depicting this important number artistically but also for utilising effectively the availability of space on a seal. Moreover, in the long span of about eight hundred years of Harappa Culture, one should expect an evolution of such alternatives. Of these alternatives, A Δ𒌋 and ⊙ were used mostly in Mohenjo-daro and Harappa, while ✕ was used in almost all the Harappan places.

5.3 Number Twenty

Just as number ten was determined by counting the number of fingers of both hands, the number twenty was also capable of being arrived at by counting in terms of ten fingers and ten toes. Known as the vigesimal system, it was in vogue, as a recognised basic unit, among the Mayas (Table 6). However, the decimal system of counting in units of ten could also be an antecedent for units of twenty. It would appear that Harappans had super-imposed the vigesimal system on the otherwise decimal system of theirs, since the forms for twenty and its derivatives are much larger in number (about 2,300) on the seals than those of ten (about 1,400). As to the numerical form for twenty, the astute seal-makers represented it by the nail form, U , which is common to fingers and toes alike. Significantly, in the *Rgveda, nakha* (nail) is used as a word-numeral for expressing number twenty. In course of time, this nail form underwent a slight change inasmuch as the open

top ends became closed, resulting in a comparatively bigger oval shape,  , than that for ten. This closed form was used in Brāhmī inscriptions for denoting twenty (Table 9).

5.4 Number Thirty

Generally, the Indus symbol for thirty is a direct descendant of that for twenty; for, this has been derived from  by introducing a vertical stroke in its middle, which, as stated before, also has the value of ten, i.e., 20 + 10 = 30. The symbol so derived, i.e.,  represents thirty and such a symbol was used by the Chinese also (Table 7) for thirty.

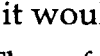
5.5 Number Forty

As a logical step, the symbol for number forty should have two vertical strokes each connoting ten, added on to the symbol for twenty, i.e.,  Indeed this is the case with the Chinese symbol for forty (Table 7). On the Indus seals, however, this has been modified into a horizontal form:  . If this is the case, one would expect that the symbol  might have been in vogue for thirty. In fact it does appear in the form or  (Seals Nos. Lothal 7029 and FEM 2269; See Mahadevan (1), Variants). In any case, a similar form was used for denoting thirty in the Kuśan and other inscriptions (Table 9).

5.6 Number Fifty

The symbol  or  could represent fifty in view of the fact that a similar form, namely  or has been used in a vertical position for denoting fifty in the Aśokan Brāhmī inscriptions (Table 9). As noted before, the horizontal or vertical form was a case of convenience.

5.7 Number Sixty

Viewed from the manner in which the symbol for forty has been derived, namely,  , from the symbol for twenty, it would be reasonable to think that the symbol  or could connote number sixty. These forms have been found on the Indus seals.

5.8 Number Seventy

Understandably, the notation for seventy should be derived from that of twenty, as in the previous cases, by a suggestive graphic presentation, and this would be indicative if a form which connotes the value of seven is added on to the form of twenty. Such a notation on the Indus seal would be  , the form  being denotative of seven. There is a similar form on some Indus seals, which, though it does not appear as such, is in association with the symbol for ten, 

5.9 Number Eighty

Possibly, the two other forms on the Indus seals, namely  or  could be connotative of eighty, since these are in the nature of derivatives from the form for twenty.

5.10 Number Ninety

The notation  of the Indus seals represents the value ninety, because it could be derived from the notation for twenty,  with the symbol for nine,  , affixed on to it in a suggestive manner.

5.11 Notations for Hundred

It has been stated already that a vertical stroke was also used for denoting ten (p.45). If two such vertical strokes are fused horizontally so as to form the figure  , such a form would mean ten into ten or one hundred. A few Indus seals do have this basic form and several of them, its derivatives. This form in fact was used by Attic Greeks to denote 100 (Table 4). A simplified but suggestive version of this form, namely,  (fusion of two slanting strokes, each denoting ten) was used in Kharoṣṭi inscriptions (Table 8) for denoting hundred, while more or less the same  was employed in some Brāhmī inscriptions for denoting hundred (Table 9). Thus and  on the Indus seals denote one hundred. It is rather difficult to determine as to which of the two forms was used first or whether both of them were in use at the same time depending upon the availability of space on the seals.

5.12 Notation for one Thousand

The notation  which portrays human form in a simple graphic manner, represents one thousand for two principal reasons: (i) a somewhat similar form (which picto- graphically stands for 'man' in the Chinese) is noticeable on the Shang-oracle bone inscriptions for number one thousand (Table 7); (ii) in the *Ṛgveda* the word-numeral *sahasra* (one thousand) is associated with *Puruṣa* in the *Puruṣa Sūkta* (*Rv.* X 90), although this word-numeral has been interpreted by some commentators as meaning infinite or countless. But it may be observed that in the Vedic literature, there are, as stated before (p. 35), words for expressing much larger numbers. The word *ananta* has the connotation of infinity and could well have been used by the authors of the *Ṛgveda* to denote the countless attributes of *Puruṣa*. None of these, save *sahasra* (one thousand), has been used

for delineating *Puruṣa*. It stands to reason that one thousand is the number which is related to *Purusa* or the human form of cosmic significance in the *Ṛgveda*.

The form  is also used in the Shang oracle-bone inscriptions and is stated to mean big or very large. No derivative, however, of this form is noticeable in these inscriptions. On the other hand, the Chinese pictograph for man,  which is used for expressing the number one thousand, has also its derivatives (Table 7) as indicated by the multiples of one thousand. The form  on the Indus seals has a large number of derivatives and hence this form could have the numerical value of one thousand.

A summary of the foregoing discussions is presented in Table 11.

5.13 Mechanism for Obtaining Desired Derivatives (Numbers)

The Indus seal-makers had undoubtedly developed a viable mechanism for indicating a plethora of numbers through the media of varied notations which were rationally derived from the basic symbols as follows:

(i) *Repeating or iterating side by side a symbol, two, three or four times to denote twice, thrice, four times etc.:*

Examples : = 1000 + 1000;  = 20+20+20;  = 9+9+9+9; *or sandwiching a symbol between two vertical strokes or placing two small vertical strokes at the top corner of a symbol to connote twice :*

Examples :  = 2 x 1000;  = 2(4x4); [= 4; = 4x4] ;

 (10x3+10x3) 2 [=10; =10x3; = [10x3+10x3] : two times.

(ii) *Addition of one, two, three or more strokes to a basic symbol:*

Examples :  = Ten; = Eleven; = Fourteen; = Forty;  = Forty – three;  = Twelve; = Sixteen

(iii) *Addition of one basic symbol to another:*

Examples :  = 70 + 10 or 70 x 10 ? [ = 10; = 70]

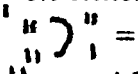
(iv) *Use of*  *on top of a symbol to indicate thrice :*

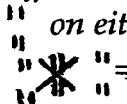
Example: = 4x3;  = 9x3

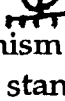
(v) *Use of*  *or* *on either side of a symbol to indicate four times*

Example :  = 13x4 ; = 5x4. Likewise, five small strokes for five times, although no such form is noticed on the available inscribed objects.

(vi) *Use of the symbol for six on top of another symbol to denote six times:*
Examples:  = 12 x 6;  =9 x 6

(vii) *Use of " " on either side of symbol to connote seven times:*
Example:  = 10 x 7

(viii) *Use of " " on either side of a symbol to denote eight times:*
Example:  = (4 x 4) 8 [= 4; = 4 x 4]

(ix) *Fusion of one symbol with another to denote multiplication :*
Examples:  = 1000 x 20;  = 20 x 20
 = 300 x 7;  = 9 x 15

A notable aspect of the mechanism adopted by Indus seal-makers is its extremely suggestive character as well as its standardisation, which enabled them to maintair uniformity in the depiction of the desired numbers so that their counterparts in other places of Harappa Culture could easily and unambiguously understand the value of the concerned notation.

5.14 Table 11 gives the basic Indus numerical forms. Table 12 presents not only these forms but also their variants/evolved ones (as the case may be) and their derivatives as exhaustively as possible in terms of either additive or multiplicative units.

5.15 Table 13 gives the values for such forms as are in the nature of embellishments which appear like bird, insect, dog and leg. The value for the composite has also been indicated. It is not improbable that Indus seal-makers, artistically oriented as they were, sometimes resorted to embellish certain numerical forms.

5.16 Frequency of Pairwise Combinations

Mahadevan has tabulated the frequency of different pairwise combinations (1,pp. 724-745) which occur on the inscribed objects, the total number of the former being 2758. Out of them, 1598 occur only once and, by the definition of the word, frequency, they should be really outside the purview of the tabulation. As to the other pairs, the maximum frequency, according to his table, is 291 for the pair  ; the frequency of the pairwise combination  is 184, followed by 126 for the combination  . There is one pair which has a frequency of 114,a few others more than 50 times, some between 10 and 50 times, and many others between 2 and 10. It would appear that the number of similar pairs in the copies of inscribed objects have also been included in the computation, eg. the frequency of the pair  is computed as 31 times, but this number includes 18 copies. It is desirable to work out the frequency of pairs keeping in view their occurrence on the copies and also the possible continuation of recording such pairs as noticed in some inscribed objects. However, it is likely that some known aggregates of four, five, ten, twenty, hundred or thousand or easily recognisable units were first separated and kept

Table: 11 Basic Numerical Forms on Indus Seals and other Inscribed Objects.

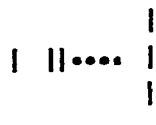
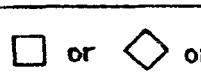
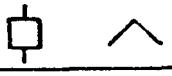
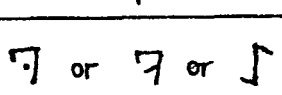
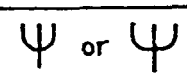
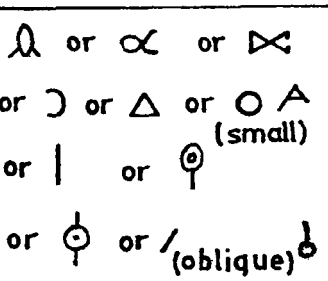
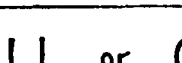
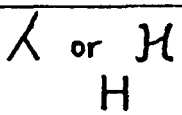
Indus Form	Value	Remarks
	1 to 12	
	4	X form used in Kharoṣṭi inscriptions
	5	Derived from 
	6	 used by Chinese
	7	 used by the Chinese in Brāhmī inscriptions
	8	 used in Brāhmī inscriptions
	9	 used in Chinese Oracle bone forms
	10	 in Brāhmī inscriptions in Kharoṣṭi inscriptions  used by Sumerians  used by Attic Greeks  used by the Chinese
	20	 used by the Chinese  used in Brāhmī inscriptions
	100	 used in Kharoṣṭi inscriptions  used in Brāhmī inscriptions  used by Attic Greeks
	1000	 used in Chinese Oracle-bone inscriptions  used in Brāhmī inscriptions

Table 12

Indus Numerals and their derivatives

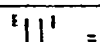
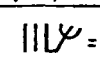
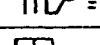
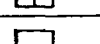
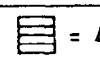
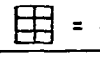
Indus Form	Value	Variants	Evolved Form	Derivatives (and their numerical units) as found on inscribed objects
I	ONE			
II	TWO			 = 2 x 4
III	THREE			 = 3 x 9
IIII	FOUR			 or  = 4 x 4 ;  = 4x4
				 = 4 + 4 ;  or  = 4 x 2
				 = 4 x 4 ;  = 4 x 4 x 1
				 or  = 4 x 3 ;  = 4 x 4 x 4 x 4
				 = 4 x 4 ;  or  = 4 x 6
				 = 4 x 6 ;  = 4 x 6 x 2 ;  = 4 x 8
				 = 4 x 6 x 4 ,  = 4 x 9 x 1
				 = 4 x 4 x 4 x 20
				 = 4 x 2 ; = 4 x 2 x 2 x 2 x 2
				 = 4 x 4
	Four			or  = 4 x 4 x 9
				 = 4 x 4 x ? Scribal error?
				 = 4 x 4 x 2 x 2 ;  = 4 x 4 x 3
				 or  = 4 x 4 (13 + 13)
				 = 4 x 4 x 7 ;  = 4 x 4 x 7 x 4
				 = 4 x 4 x 4 x 13 ; = 4 x 4 x 13
				or = 4 x 4 x 4 x 4 x 4
				= 4 x 4 x 4 x 4 x 4 x 4
				= 4 x 4 x 4 x 4 x 4 x 90
				= 4 x 4 x 4 x 4 x 4 x 10

Table 12 (contd.)

Indus Form	Value	Variants	Evolved Form	Derivatives (and their numerical units) as found on inscribed objects
	Four	X		X = 4×3
			X	X or X or X or X or X or X or
			X	X or X = 4×4
				X or X = 4×4×3
				= 4×4×8
				= 4×4×14
				= 4×4×9
				= 4×4×(10+10+10)
				= 4×10
IIIII	Five			= 5×2
		or III / II		= 5×3×4
				= 5(10×10×10)
				= 5×4
				= 5×5
IIIIII	Six			= 6×2×4
		III / III		or = 6×2
				= 6×3 = 6×2; = 6×3
				= 6×6

Table 12 (contd.)

Indus Form	Value	Variants	Evolved Form	Derivatives (and their numericals units) as found on inscribed objects
				= 6+6+1
				= 6×6 ; = (6+6+1)2
				= 6×6+6
				= 6×6+4
|||||||	SEVEN		7 or	(|||||||) = 7 (10+10)
				= 7 (10+10)
				= 7×2
				= 7×4
				= 7×9
				= 7×9×6
				= 7×2×(10×2)
||||||||	EIGHT			
|||||||||	NINE	|||||||||		= 9×3 ; =9×6 ;
				= 9×8 ; = 9×2
				= 9+15 ; = 9×3
				= 9×15 ; = 9×4
				= 9×7
				= 9+2 ; = 9+3

Table 12 (contd.)

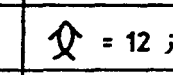
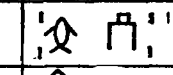
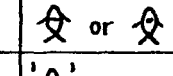
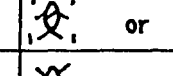
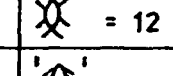
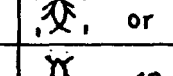
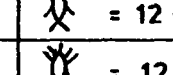
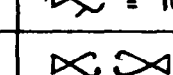
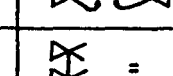
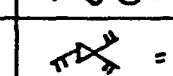
Indus Form	Value	Variants	Evolved Form	Derivatives (and their numerical units) as found on inscribed objects
	TEN			 = 12 ;  = 12 × 4
				 = [12 + (4 × 3)] × 4
				 = 12 × 6
				 = 12 × 6 × 4
				 = 12 + 1 = 13
				 = (12 × 2) 4
				 = 12 + 2 ;  = 12 + 4
				 = (12 + 2) 4
				 = 12 + 3 ;  = 12 + 4
				 = 12 + 5
	TEN			 = 10 × 1 ;  = 10 × 2
				 = 10 + 10
				 = 10 × 10
				 = 10 × 10 × 10
				 = (10 × 10 × 10) 4
				 = 10 + 20 + 10
				 = 10 (12 + 12 + 12)
				 = 10 × 13
				 = 10 (13 + 13)
				= 10 (13 + 13 + 13)

Table 12 (contd.)

Indus Form	Value	Variants	Evolved Form	Derivatives (and their numerical units) as found on inscribed objects
	TEN	or		)) or ((or = 10+10 ; = 10+10+10 ;
				)))) = 10 + 10 + 10 + 10
				)))))= 10+10+10+10+10 ; =10+4 ; =(10+4)4
				= (10+6) 4 ; = 14 x 4
				= 10 x 7 ; =(10+6) 2 ; =10x10
				= (10x10) 5 ; = (10x10) 7
				)(= 10 +10 = 10 x 10
	TEN			= 10x4 ; = 10 x 6
				= 10 x 8
				= 10 x 10 ; = 10 x 2
				or △△△ = 30 ; = 60 ;
				= 30 x 9 ; = 30x3
			△	or = 10 x 3 ; =10x6 ; = 10 x 2
				= 10 x 5 ; = 10 x 14 ; = 10x3 x3x3
				= (10x2) 3 ; = 10 x 3
				= (10x3) 2 ; = 10 x 4
		/		||/ = 2 + 10 ; /// = 1 +10+10
				= 10x3 x 7 ; = 10 x 3x3 x4
				=10x10 ; =10x10x2
		o		18 or 8 = 20 ; = 20x3 ; = 20 x 6 ;
				= 30 ; = 30x2 ; = 20x2 ; = 10 x 3x2 ; = 10 x 4 x 2 = (10+10+10+10)2

Table 12 (contd.)

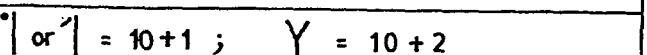
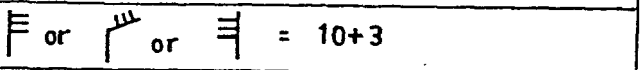
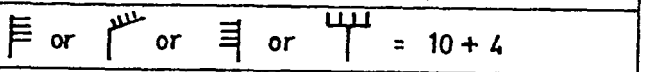
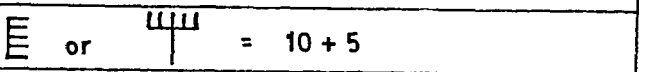
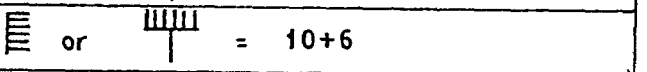
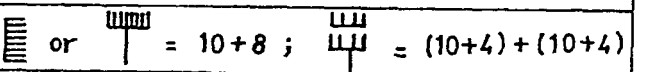
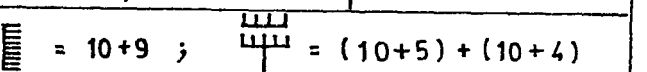
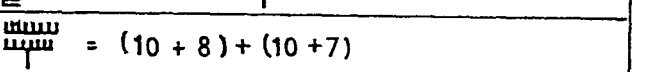
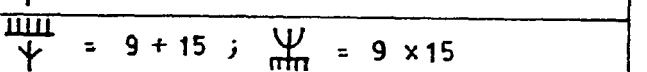
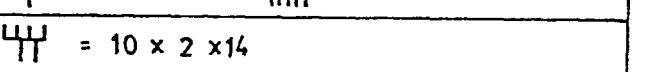
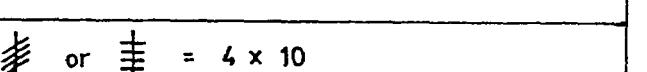
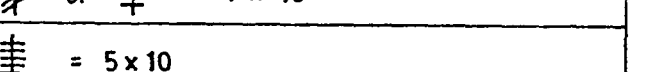
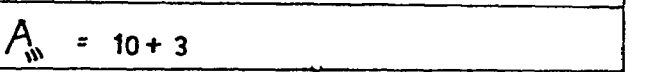
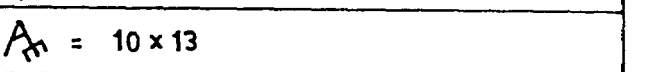
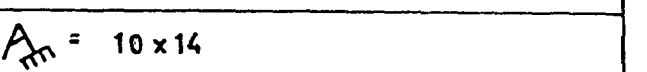
Indus Form	Value	Variants	Evolved Form	Derivatives (and their numerical units) as found on inscribed objects
	TEN	|		
	(See Table 7)			
				
				
				
				
				
				
				
				
				
				
				
				
	TEN		A	
				
				
				
				

Table 12 (contd.)

Indus Form	Value	Variants	Evolved Form	Derivatives (and their numerical units) as found on inscribed objects
	TWENTY			= 22 ; = 23 ; = 24
				= 25 ; = 20 x 13 ; = 20 x 12
				or = 20 x 3 ; = (20 + 3) 3
				or or = 20 x 2 ; = 20 x 4 ; = 20 x 5
	THIRTY			= 30 + 3 ; = 30 + 2 ; = 30 + 5
				= 30 x 6 = 32 x 6
				= 30 x 7 ; = 30 x 7 x 7
	FORTY			= 41 ; = 42 ; or = 40 + 3
				= 43 ; = (40 + 6) (12 + 12)
or	FIFTY			= 51 ; = 50 x 12 ;
	SIXTY			= 60 x 13
	SEVENTY			= 70 x 10 ; = 70 x 7 x 10
				= (70 + 3 + 3) 10
	EIGHTY			= 81 ; = 81 x 6 ; = 81 x (14 + 15)
	NINETY			= 90 x 4 ; = 90 x 6 x 6 ;
				= 90 x 90 ; = 90 (14 + 14) ;
				= 90 (14 + 16)

Table 12 (contd.)

Indus Form	Value	Variants	Evolved Form	Derivatives (and their numerical units) as found on inscribed objects
	TWENTY			= 20+1 ; = (20+1) 10
		Closed form of U		= (10+21)4 ; = 20×3
				= 20×2 ; or = 20+10
				= 20 × 8
				= 20 × 3 × 3 ; = 20 × (14 + 14) ;
				= 20 (15+10) ; = 20 × 7 ;
				= 20×9 ; = 20×9×4 ; = 20×12
				= 20×13 ; = 20 × 13 × 4
				= 20 × 14 ; = 20×12
				= 20 × 4 + 10
				= 20 × (4×8 + 10)
				= [20 × 4 + 10 + 2] 4
				or or = 20 × 20
				= 20×20×4 ; = 20×20×13
				or = (20×20) 3
H	Hundred			= 100 ; = 200 ; = 300 ;
				or = 400 ; = 500 ;
				= 600 ; = 700 ;
				= 300×7 ; = 400 + 400
				or = 400 (13×7)
				600 (12 × 17) ;
				= 500 (13×20) ; = 500 (13×7)
	Hundred			= 200
				or or = 300
				= 400 ; = 400×10

Table 12 (contd.)

	Thousand			or = 2 x 1,000
				or or = 3 x 1,000
				or or or = 4 x 1,000
				= 6 x 1,000 ; or = 9 x 1,000
				= {9,000 + (10 + 10)}
				= (10 + 10) 3 x 1,000 ;
				= 10 x 1,000 ; = 10 x 10 x 4) x 1,000
				or or = 10 (1,000)
				or or = 10 + 10 (1,000)
				or = 11 (1,000) =
				= 13 (1000) ; or = 14 (1,000)
				or = 15 (1,000)
				= 10 x 5 (1,000) ; = 10 x 1000
				= 16 (1,000)
				= 20 (1,000) ; = 2 x 1,000 x 5 x 10
				= 30 (1,000) ; = 30 x 1,000
				= 60 (1,000) ; = (10 + 20) x 1000
				= 60 + 60 (1,000)
				= [(10 + 10) 3 x 40] 1,000
				= 30 x 1,000 ; = 60 x 1,000 ↓ (30 + 30)

Table 13. Other Forms

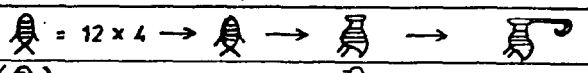
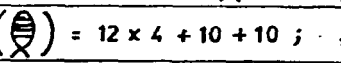
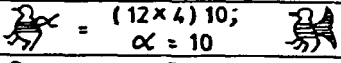
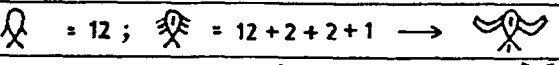
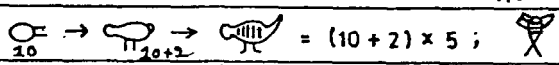
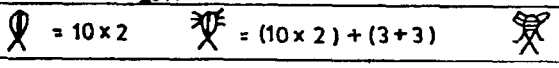
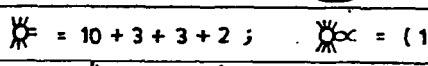
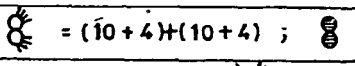
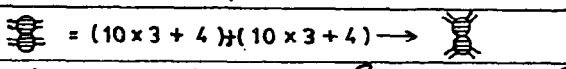
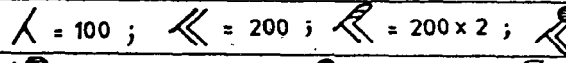
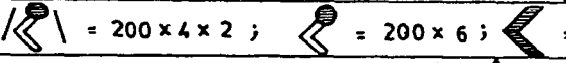
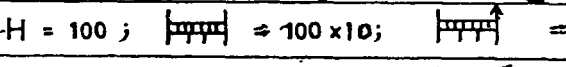
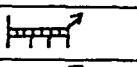
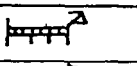
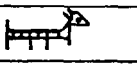
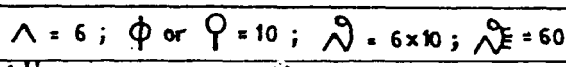
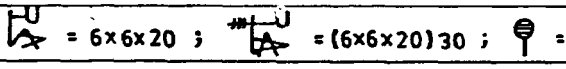
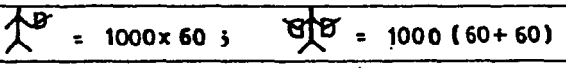
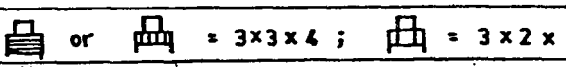
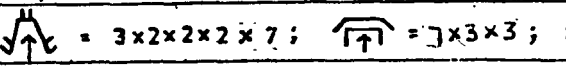
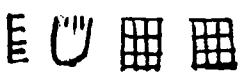
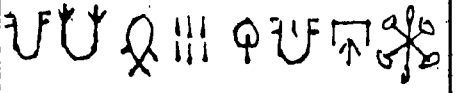
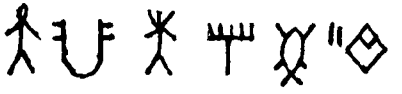
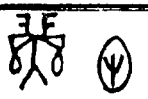
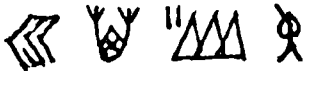
FORM	EVOLUTION EMBELLISHMENT VALUE
BIRD	 = 12 x 4 → → → (EMBELLISHMENT)
	 = 12 x 4 + 10 + 10 ; = 12 x 3
	 = (12×4) 10; α = 10 = (12 x 4) (10×8)
	 = 12 ; = 12 + 2 + 2 + 1 →
	 → → = (10 + 2) x 5 ; = 10×3×8×10
	 = 10×2 = (10×2) + (3+3) = 12 x 3 x 8 x 10
	O or ○ = 20 ;  = 20×20 →
INSECT	O = 10 ;  = 10 + 3 + 3 + 2 ; = (10 + 4+4) 10
	8 = 10 + 10 ;  = (10+4)+(10+4) ; = (10 x 3)+(10 x 3)
	 = (10×3 + 4)+(10×3+4) →
LEG	 = 100 ; = 200 ; = 200 x 2 ; = 200 x 4 ;
	 = 200 x 4 x 2 ; = 200 x 6 ; = 200 x 17 ; = 200 x 16
DOG	 = 100 ; = 100 x 10 ; = 100 x 10 x 7 [↑=7]
	
	
	
COMPOSITE	 = 6 ; or = 10 ; = 6×10 ; = 60+4 ; = 60+5 ; = 6×6 ;
	 = 6×6×20 ; = (6×6×20) 30 ; = 10 x 3 → (Embellishment)
D FORM	D or = 60 (early Sumerian form, Table 3 ; = 60+4 ; = 64 x 3
	 = 1000 x 60 ; = 1000 (60+60) ; = 60 x 8
	D (small) = 10 (Early Sumerian form, Table 3 ; or = 10×10 (Embellishment)
BELL FORM	 = 3 ; = 4 ; = 3 x 4 ; = 3×2 ; = 3×2×2
	 or = 3×3×4 ; = 3 x 2 x 4 x 2
	 = 3×2×2×2×7 ; = 3×3×3 ; = 3×7 ; = 3×14

Table 14. Indus Script on some seals and their Numerical Value
(Illustrative)

SITE	SEAL No.	INSCRIPTION	VALUE/QUANTITY RECORDED
MOHENJO-DARO	1248		15+23+(4x9)+(4x9)
	2099		40+90+12+6+10+41+(7x3)+4x10
	2307		(12x6)x4+14+3+30+10+(90x2)
	2338		1000+40+(9x1000)+15+14+(4x4)2
HARAPPA	4029		(10+10+40)x1000+(20x9)
	4107		14+4+(4x4)2+(1000x60)
CHANHU-DARO	6224		40+64+2+(4x4)2
LOTHAL	7049		(2x10)x1000+5+9
KALIBANGAN	8040		(3x100)+(90x6x6)+(10+10+10)2 + + 1000+10
UR	9832		11000+(700x13x7)+(10x10x5)+16+ + (6x2)

The seal numbers correspond to those of Mahadevan (1)

aside as pairwise combination. Thereafter, the remaining units were suitably categorised. Such an exercise is not uncommon even at present. Its advantage lies in the ease with which a purposeful and realistic recording can be accomplished.

5.17 Direction of Writing

There is a general agreement among the scholars who have studied the Indus Script that the direction of writing is, by and large, from right to left, barring some exceptions. It is interesting to note that the principle followed in the writing of numerical forms and their computation, in Indian astronomical and other texts is ankanam vamato gatih (numbers move to left, i.e., the writing of numbers is from *right* to *left* to determine their place-value. One wonders whether the origin of this concept can be traced to the Harappan practices !

In the history of numerical notations and the process of enumeration, it would appear that, in all probability, ancient accountants did not know the actual counting beyond twenty (ten fingers and ten toes). But they were able to maintain accounts in terms of easily recognisable groups or units, both small and big, based on the ciphered system. They were also able to differentiate between, say, ten into five and one unit of fifty by this method. In fact, even from the modern point of view, 10 x 5, which is equal to 50, is not, in reality, the same as 50 x 1. For example, a fifty rupee note is not materially the same as five notes of ten rupees each. The reckoning process is different although the value is the same, and in terms of number of units, both the entities are apart. Even till recently, it was not uncommon in rural areas of this part of the world that vegetables and grains were being accounted for and sold in calculable heaps and cumulative groups. In ancient times, the barter transaction was carried out by resorting to such methods. In Table 12, therefore, the concerned numerical forms are given their values in the form of additives or multiplicatives, without a total value as we understand them today. The modern numbers are indicative of the units or groups which were intended by the scribes through specific notations to indicate the quantities of goods and other things which were produced and stored in jars or pots in the granary, and distributed for consumption or used in some other way in cities and towns of Harappa Culture. Such accounting methods were in vogue among the Sumerians, Minoans and Mycenaeans. The Sumerian tablets contain inventories of goods, yields of royal and priestly lands and of workshops as well as the distribution of rations and materials to craftsmen (Oppenheim, pp. 230-35). The Minoan and Mycenaeans have left behind records, which are a repository of economic data of their regions, Crete and Pylos respectively (Samuel, pp. 75 ff; Ventris and Chadwick, pp. 84-103). But the Indus seals and the related inscribed objects are a class by themselves. They are exclusively quantitative records with no words or ideograms interposed in between. The quantities are reckoned in terms of small units as well as huge aggregates,

the basic quantitative units being small, as evidenced by a number of small weights found at Mohenjo-daro, and their ratios; possibly the measures used were also small. A scientific study of Harappan weights and measures is necessary for a definitive understanding of the units and their multiples which have been fascinatingly expressed in a wide variety of numerical forms on Indus seals and other objects.

More importantly, many of the seals are executed with a scientific symbolism which is inexorably linked with the quantities denoted. The symbolism speaks volumes specially about the botanical knowledge of the seal-makers, as will be seen in the next Section.

SECTION 6

FIELD SYMBOLS

The broad spectrum of impressive motifs engraved on the seals and others are designated by archaeologists as Field Symbols. The total number of such motifs is about 2030, of which the motif of unicorn occupies a place of distinction, as it has been represented on as many as 1,164 seals, sealings and other inscribed artefacts. Table 15 illustrates the general nature of the field symbols and the number of inscribed objects which depict them.

Meticulous documentation of the varied field symbols apart, certain it is that no serious attention has been bestowed by any of the decipherers so far on the possible relationship between such symbols, specially the animal motifs, and the inscriptions. An extreme view has even been expressed by S.R. Rao. Adducing his own arguments based on his 'linguistic' interpretation, Rao opines, '... it is therefore reasonable to conclude that in most cases the animal motif is in no way related to the inscriptions, but it cannot be denied that the animals had some significance so far as the owner of the seal was concerned' (Rao 2, p.263). He has not, however, thrown any light on the possibility or otherwise of private ownership of seals in the context of the centralised administration that Harappa Culture had evolved, as postulated by archaeologists. Like the other decipherers, Rao too has not explained meaningfully certain object-structures which are inscribed in front of animals on a large number of seals.

Asko Parpola has brought to light 'the important role played by the Proto-Elamite civilisation in the formation of the Harappa Culture by drawing attention to some new and telling correspondences in art motifs'. He has examined the 'contest motifs', a 'hero' grasping a tiger, the 'bull-man', water buffalo and others, and shown the parallels among the Proto-Elamite, Sumerian and the Harappan inscribed motifs. Here again, the associated script forms on the Indus seals and sealings remain unexplained by him in relation to the assumed mythological and other scenes (Parpola 3, pp. 176-195). There is no gainsaying that a decipherment of Indus script attains the realm of meaningful reality only if it were to integrate all the elements (the script, the animal and the object-structure in front of the animal as the case may be) which the seal-makers so diligently inscribed, obviously with a purpose.

Table 15

Field Symbol	No. of inscribed objects portraying the field symbols	Remarks
Unicorn	1,164	Includes two with a bull having two horns, but otherwise resembling unicorn
Humped Bull	54	Includes two showing the bulls standing face to face
Short Horned Bull	95	
Buffalo	14	
Elephant	56	Includes a horned one
Tiger	21	Includes 5 horneed ones
Rhinoceros	40	Includes one with two rhinoceros at either end
Goat-antelope	37	Includes the one depicting two goats flanking a tree
Ox-antelope	26	
Hare	15	Includes 5 objects in the shape of a hare
Groups of animals, including fabulous and composite ones	109	A wide variety of presentation
Reptiles, fish, birds, etc.	80	
Trees and leaves	38	
Anthropomorphic forms and scenes with various figures	60	
Symbols and other motifs	218	

Source: Mahadevan, pp. 793-798.

6.1 Copper Tablets and Miniature Objects

It would appear that the early recordings were made on copper tablets at [Fig. 9A (top)] Mohenjo-daro, and on miniature stone, terracotta or faience objects [Fig 9A (bottom)] at Harappa. The former, numbering 135, have been found only at Mohenjo-daro and the latter, 272 in number, only at Harappa.

The flat inscribed copper tablets are generally rectangular and their sizes range from 3 cm x 1.3 cm to 3.8 cm x 2.5 cm. There are, however, a few square shaped ones which

measure on an average, 2.3 cm x 2.3 cm. Their thickness varies from 1.75 mm to 3 mm. A striking feature of these tablets is that there is generally an inscription on one side, and a field symbol on the reverse. In two cases there is also an inscription above the animal figure, and in four, an additional line is engraved above the inscription. One tablet does not have any inscription but only a field symbol. Another notable characteristic of these tablets is that the engraving of the inscription is positive, and such engravings are not appreciably deep, thus indicating that the copper-tablets were not used for stamping purposes (Marshall, pp. 398-401; Pandey, p.268). But to meet the administrative necessities, replicates were often made. For example, eight copies of identical inscription with hare facing a bush as the symbol (*1705, 1706, 3304, 3312, 3331, 3355, 3381 and 3384); three of one and the same inscription with elephant as the field symbol (1711, 3356 and 3392); three more of the same inscription with elephant, but with a single vertical line added on to the same inscription (3328, 3336 and 3368); three identical inscriptions with a fabulous animal having a head on either side (2920 (?), 3344 and 3347).

The replication of engravings at Mohenjo-daro on the surface of copper tablets was indeed a difficult operation. The situation at Harappa could have been no better with the miniature objects of clay, terracotta or faience. For example, making five copies of the miniature with gharial as the symbol (4430, 4431, 4433, 4434 and 4435) and three copies (4421, 4422 and 4423) as well as two other copies (4424 and 4425) in the shape of hare itself. The origin of seal-making can be traced to the felt-need of overcoming such difficulties of replication. For, one seal would be enough to produce the required number of its copies. But the material for carving the inscription easily had to be soft. And steatite, a soft metamorphic rock, was the obvious choice for the preparation of seals. Thus ensued a purposeful step towards easy recordings in the form of seals, mostly made of steatite which, in addition, offered a manoeuvrability for the full expression of the artistic capabilities of Indus seal-makers.

6.2 Recordings of Agricultural Production

The early inscriptions, it would seem, were intended to maintain an account of the quantities of grains and others used for edible purposes on the one hand and, of cotton, on the other, which were actually made available for use by people under centralised dispensation. In the early phase of Harappa Culture, conceivably even Mohenjo-daro and Harappa were sparsely populated and the storage of farm produce as such perhaps needed no separate recordings. But as the population grew, and to be in tune with it, the farm produce was registering a substantial growth; likewise, the other types of production. The administrative compulsions naturally led to the maintenance of accurate records of not only the farm produce and their storage, but also the other products like

* Numbers in brackets correspond to those given in Mahadevan (1)

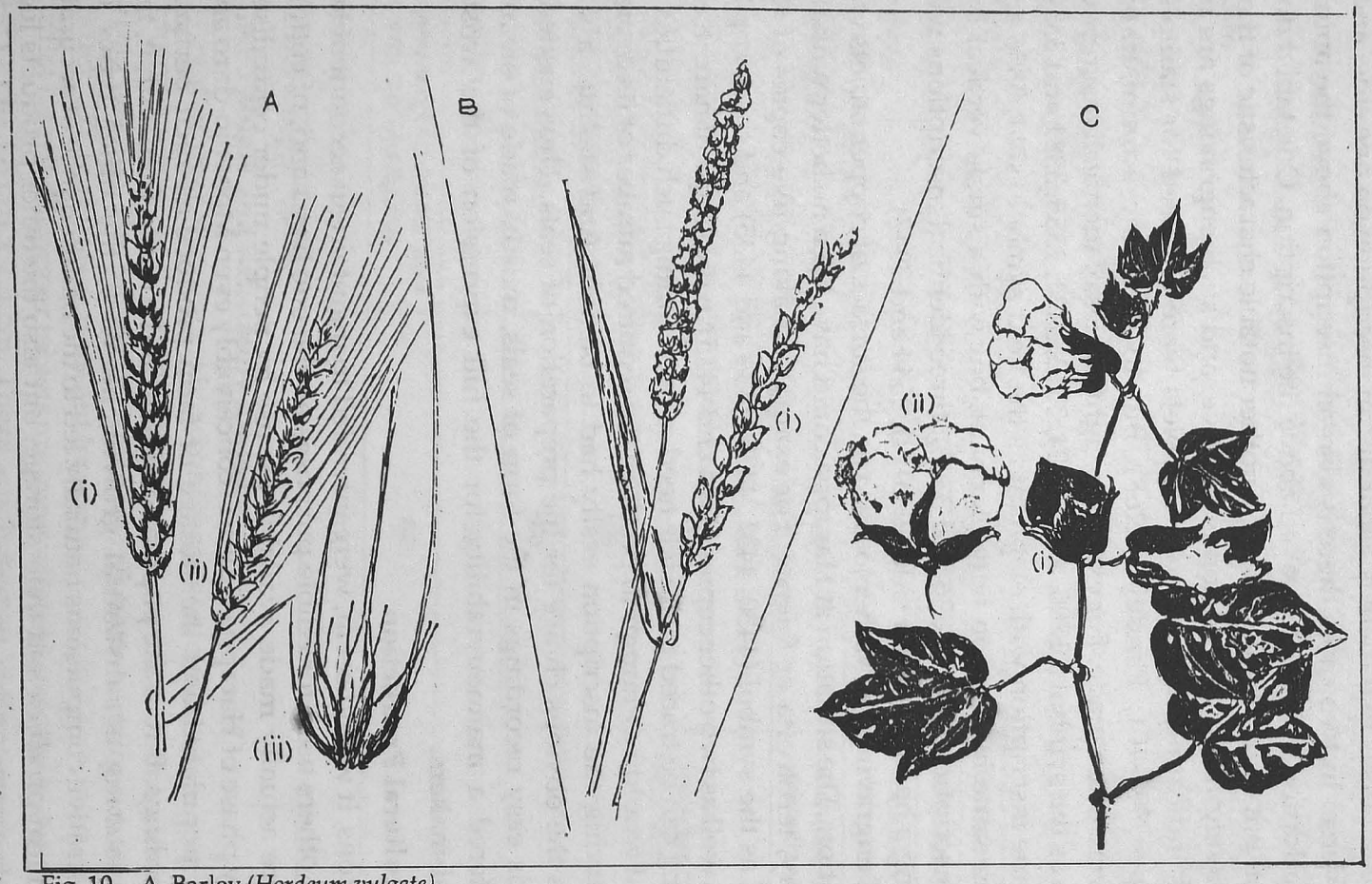


Fig. 10 A. Barley (*Hordeum vulgate)*

(i) Six-rowed; (ii) Two-rowed; (iii) Spikelets

B. Wheat *(Triticum aestivum)*

(i) Shows the zig-zag central axis

Source : Hubbard, *Grasses,* Hiddlessex, 1954.

C. Cotton *(Gossypium arboreum)*

Part of the plant with (i) closed; and (ii) open boll

Source : *The Wealth of India,* CSIR, New Delhi, Vol.iv, 1958.

pottery, bronze as well as ivory objects. Viewed from this angle and the enormous care bestowed by Harappan authorities on production and distribution, the administration of Harappa Culture had established strict control as well as evolved methods of verification for the agricultural production and management, besides the standardisation of crafts.

There were two aspects of agricultural production and management which needed an efficient accounting : (i) the actual production of grains and their storage in granaries, as well as other food articles; and (ii) the quantities of grains released either for making flours and bread or for their use in some other form. In the initial stages, the latter received immediate attention with novel attempts at their proper identification and recording. The representation of animal and other motifs on copper tablets for identification purposes was truly an innovation of Harappans, unparalleled elsewhere. A manger or a trough in front of an animal motif was clearly indicative of the food-grains and other food articles being utilised and accounted for. Thus, as will be seen later, the representation of animals (generally with a trough in its front) like ox-antelope (representing the utilisation of two rowed barley); goat-antelope (four-rowed barley); short horned bull (six-rowed barley); elephant (wheat); the fabulous animal with a head on either side (peas); buffalo (sesame); tiger (date-palm) and gharial (rape seed), portrayed the intent and purpose of the central authority. As to cotton, the motif of hare (generally associated with a bush) on copper tablets at Mohenjo-daro and the inscribed object in the form of hare at Harappa, connoted the production of cotton (for detailed explanation and significance of these motifs see pp. 79-84). In the early stages of Harappa Culture, recordings such as these were in the nature of accounts of foodstuffs being released for consumption and served the general purpose of administration.

But as the cultivation of grain crops and cotton expanded to meet the needs of growing population, the administration and seal-makers rose to the occasion through an innovation of a high order engendered by an extraordinary perspicacious endeavour, in which a composite animal, the so called Unicorn, found an extensive representation on the versatile seals, adding a veneer of excellence to the stylistic art of seal-makers. More importantly, they developed a concept and evolved a technique *par excellence* for denoting scientifically three types of barley, wheat and cotton, using only the motif of Unicorn, but with different and suggestive object-structures in front of it.

6.3 The Unicorn

The most favourite animal motif with one rather curvilinear elongated horn, some stripes on the neck as well as saddle-like markings on the body and resembling perhaps an ox otherwise, is designated as 'Unicorn'. Marshall questions the idea that this apparently one horned animal is mythical (Vol. 1, p. 68) and refers to the two seals depicting the animal with two horns. Mackay, terming it as 'Urus-bull' (p.326), has pointed

out that 'it is not yet certain that this animal was purposely represented as having a single horn; in all probability owing to the difficulty of drawing in perspective, one horn is supposed to be behind the other. This method of portraying horns is well known on archaic Sumerian seals, the same animal being indifferently portrayed with two horns or one'. In any case, Seal Nos.234 and 359 (Mackay : Pl LXXXVII and LXXXIX) distinctly show an animal which is definitely of the type 'that is usually portrayed with one horn but possessed of two horns, though of a rather different shape'. There are, however, in all 5 seals (Mahadevan, p. 793) depicting a 'Bull' with two rather upright horns, otherwise resembling the so-called 'Unicorn', and also facing objects similar to those depicted in front of the unicorn. This animal has been identified by Friedrichs as either *Bos primigenius* or *Bos namadicus*, Falc. characterized by the difference in the shape of the horns as well as that of the body on the seals (Mackay, p. 326).

Caroline Grigson has examined in detail the presentation of unicorn on the seals as well as the others, and states: 'the form of the horn (of the unicorn) is typical of *B. primigenius* and *B.namadicus*, but many illustrations show that *Bos primigenius* in the Middle East had only moderately long horns... The unicorn's horn is too long for *primigenius*. Cattle *sensu sticto* (i.e. the various *Bos* species) have smooth, not ridged horns, and in this respect the unicorn looks closer to a buffalo, gazelle or even an Arabic oryx. The attachment of the horn to the head is not clearly illustrated, but the horn does not stand out from a prominent intercornual ridge as it does in *B. primigenius* ...' Grigson has also thrown light on the ears, head, neck, withers, hindquarters, legs and decorations w.f. this animal motif. In Grigson's view, one possibility is that the unicorn is a composite animal – some of its parts resembling those of cattle and others looking like those of antelopes, heartebees or nilgai (pp. 167-168). Mackay also thought that 'perhaps we have here a fabulous animal which is a composite of the ox and the antelope' (p. 382).

The second possibility, according to Grigson, is that 'while being based on *Bos primigenius*, these seals have been copied again and again in the absence of the original animal. And in the process of being copied, either from a depiction of the actual animal or from a remembered animal, many of its features have become distorted or perhaps been replaced with those of the other species. Some of the unicorn features may have been over-emphasised to suggest a contrast with those of the familiar humped bull' (p. 168). The second possibility, as Grigson points out, appears to be the most likely. In any case, the unicorn motif does not seem to be mythical either in its conception or execution by the Indus seal–makers. They thought of an animal form with its several facets as that would serve their purpose of recording the production of barley of three varieties, wheat and cotton, using one composite animal motif as that of Unicorn on the concerned seals by varying the front object-structures.

6.3 The Front Object-Structures

There is a general view among archaeologists and others that the inscribed object in front of this animal represents an incense burner, following perhaps the interpretation of Marshall (Vol.1, p.69) and Vats (Vol.1, p.321). Another view is that it connotes a special cult object. A careful examination of the ob ject-structure in front of the unicorn, however, does not fail to reveal that there are noticeably *five* variations: *three* of the variations are structured in such a way that they depict six, four or two rows either in the form of vertical lines (Fig.12) or with crossed vertical and horizontal lines (Figs.13,14,16-19); the *fourth* one structured with zig-zag lines (Figs.20-21); and the *fifth* with more tiered horizontal and vertical strokes, having either a curvature above (Fig.22), or suggestive of curvature (Fig.23) or even without it (Fig.24) depending upon the availability of space below the neck of the animal. In any case, all of the structures are shown on what some archaeologists call the 'upper vessel'. Below this is a bowl-like form which, in turn, is depicted as the upper part of a stalk-like vertical. Some minor variations in this style of presentation could be attributed to scribal preference and artistic sense. Some of the lower bowl-like forms carry a number of small circles with central dots, or small round projections, etc., embedded in the front and sideways too (see p. 79).

On a detailed examination of the five types of object-structures and for the reasons given below (see 6.4), one would be convinced that they were intended by the seal-makers to convey the message that they represent respectively (i) six-rowed (Figs. 12-15), (ii) four-rowed (Figs. 16 & 17), and (iii) two- rowed barley (Figs. 18 & 19); (iv) wheat (Figs. 20 & 21); and (v) cotton (Figs. 22,23 & 24). The varieties of barley *were depicted in terms of their definite number of seeds on the axis of barley plant; wheat, in the form of its zig-zag jointed central axis; and cotton boll in relation to many seeds often with a boll form. It was the ingenuity of seal-makers to represent the number of seeds as rows generally through intersections of horizontal and vertical strokes. It is significant indeed to note that the samples of charred barley and wheat have been recovered from the sites of Mohenjo-daro and Harappa and that there is enough archaeological evidence in respect of the use of cotton in these places.

A clue to the idea that the object-structure in front of the 'unicorn' might well represent the seeds, has been provided by Seal No. 704 (Mackay, P1. LXXXII, Fig. 11 of this monograph) on which a plant stalk and the symbolic indication of a row of seeds have been portrayed. Since it would be difficult every time to carve out on the steatite exactly the seed-forms, specially of barley and wheat because of their likeness, as well as delicate

* In the two-rowed variety, two barley grains, one of each side at each node (Figs.18 & 19), appear in a row vertically. Likewise in the four–rowed one, two grains, and in the six-rowed one, three grains (Fig.15) on each side of the node grow, thus giving rise to sets of two, four and six grains in a row (see also 6.4).

Abbreviations

MIC : *Mohenjo-daro and The Indus Civilisation* by Marshall
FEM : *Further Excavations at Mohenjo-daro* by E.J.H. Mackay
EH : *Excavations at Harappa* by M.S. Vats

Fig 11. FEM, Pl LXXXII, 704

Note the depiction of seeds, the glume (middle) and the stalk (lower); The middle and the lower depictions are similar in respect of objectstructures in front of Unicorn as the motif on all other seals; Only the upper depiction is different

Seals with Unicorn as field symbol and associated front object-structure

Examples

Fig 12. MIC Pl.CV, 51

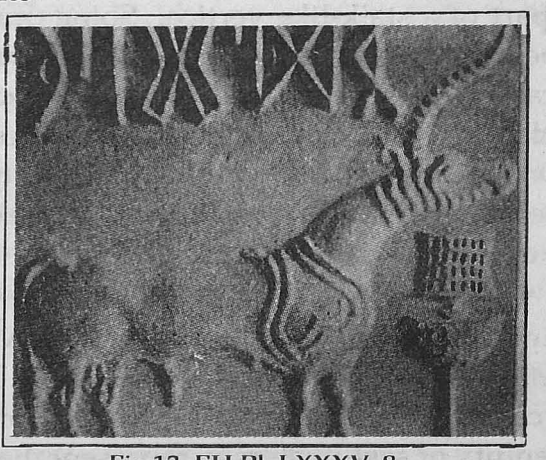


Fig 13. EH Pl. LXXXV, 8

Fig 14. MIC, Pl. CVIII, 182

Fig 15. MIC, Pl. CIV 21

See foot-note on next page

Seals depicting six-rowed barley

Seals depicting four-rowed barley

Fig 16. MIC, Pl. CIII, 8

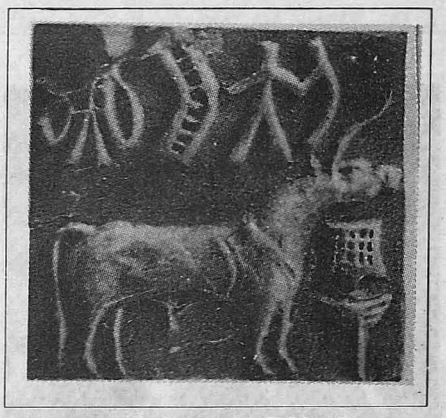


Fig 17. MIC, Pl.C V, 43

Seals depicting two-rowed barley

Fig 18, MIC, Pl. CVI, 99

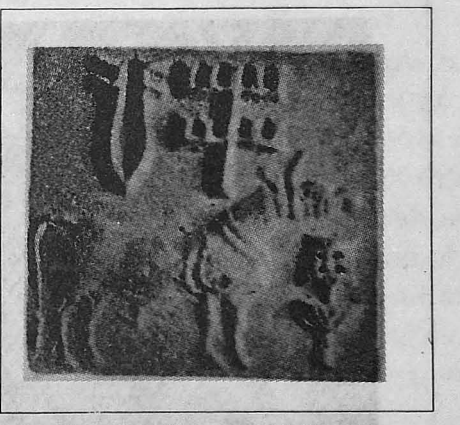


Fig 19, FEM, Pl. LXXV, 154

Note: Two-rowed barley and the six-rowed one appear to have been initially depicted as shown in Fig.19 and Fig.15 respectively. Perhaps, later, as the four-rowed barley had also to be recorded, there was an innovation in terms of four-and six-rows, for the depiction of four-rowed and six-rowed barley.

Seals depicting Wheat
(Examples)

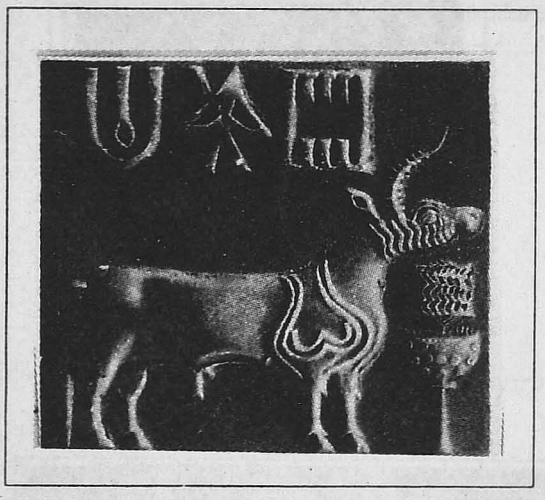


Fig 20. MIC, Pl. CIV, 38

Fig 21. EH, Pl. LXXV, 12

Seals depicting Cotton
(Examples)

Fig 22. MIC, Pl. CIV, 36

Fig 23. MIC, Pl. CIII, 17

Fig 24. FEM, XCVII, 585

labour and time involved in the process, Indus seal-makers had to resort to easily identifiable structures. As to cotton, they made a suggestive innovation in relation to its boll form as well as the large number of seeds which the boll contains inside. In addition, they depicted the horn of the animal on a considerable number of seals, in a way that would resemble a longitudinal spikelet of barley or wheat plant or twig of cotton plant.

6.4 Paleo-ethno-botanical Aspects

In order to understand the ingenuity of Indus seal-makers, let us now consider certain paleo-ethno-botanical aspects of barley, wheat and cotton in a brief historical perspective, since these three played a pivotal role in ancient civilizations.

Barley

It has been recognized that barley, along with wheat, was the first cereal to have been domesticated and used as food around 6500 B.C. in the region of Middle East or West Asia – in the Syrian plains, the Euphrates basin, the Iraqi Khurdistan (Jarmo), southern Jordan and Ali Kosh in Iranian Khuzistan (Helbaek, pp. 355-358). This type of barley, in the beginning, was by and large a two-rowed one, from which the six-rowed one emerged. Later, the six-rowed one began to be cultivated by the Egyptians also. According to Vavilov, there could have been two other centres of the origin of barley, viz., low-awned and hull type from Ethiopia and North Africa; the short-awned, hull-less and hooded type from China, Japan and Tibet (Chowdhury, p. 372).

Whichever might have been the place of origin of barley cultivation, there is no denying that it was probably the most important cereal of the Fertile Crescent.

As Helbaek states (p. 359): 'The species of barley *(Hordeum)* migrated towards the East into Asia and there eventually in ecological frontier zones, developed a huge group of diverse local forms. At the beginning of agriculture in Egypt, a whole series of hulled forms were grown: *Hordeum distichum* (two-rowed); *Hordeum deficiens* (rather infertile); *Hordeum tetrastichum* (four-rowed); and *Hordeum vulgare*. But in the course of a short time, the last species mentioned *(Hordeum vulgare)* gained supremacy to the exclusion of all the others'. It is now identified (Chowdhury, p.372) that the barley from Mohenjo-daro and Harappa belongs to *Hordeum vulgare*, var *nudum* and *Hordeum vulgare* var *hexastichum*. The former is a two-rowed one and the latter, a six-rowed one, of which the four-rowed one is a variant.

While this is not the place to discuss the whole taxonomy or morphological aspects of the barley plant, it may be noted that in the ear of barley (Fig. 10A) 'three single flowered spikelets are borne at each node of the rachis or the central axis. These alternate on the rachis so that the triplets of spikelets immediately above or below any one triplet is on the opposite side of the rachis or axis of the ear. This arrangement gives six rows of spikelets. In all the varieties, the median spikelet is fertile and develops a grain. In certain varieties,

the lateral spikelets are also fertile so that three rows of grain are produced on each side of the ear, giving a six-row-barley '(Cook, pp. 103 ff). Further, within the six-row there could occur yet another variety, viz., when the lateral florets are infertile, (i.e., do not produce seeds), and when only the medium floret produces a grain, it becomes a two-rowed barley.

According to Cook (p. 104), the term 'four-rowed' barley is frequently encountered. The only difference between a six-rowed one and a four-rowed one lies in what may be called the density of grains in the ear. In the 'four-row' form, the lateral florets on both sides of the rachis make two irregular lines, whereas in the denser six-row, they keep their true positions. In any case, Hubbard (p. 385) refers to the 'four-rowed' barley being produced in Britain even now and the Scottish bere (another name for barley) has its grains in four rows (*Everyman's Encyclopaedia*, II. p.89). A.K.N. Iyer (pp. 97-99) states that the cultivated varieties are six- rowed, four-rowed and two-rowed, though the six-rowed one is the most common.*

In any case, on the basis of the rows of seeds – two, four, or six – the varieties of barley could be discerned, since the number of seeds on the rachis is definite, unlike, say, in wheat or cotton. According to some botanists, the number of seeds, either definite or within a range, could be used as one of the parameters for identifying broadly a plant (Hubbard, pp. 370-381). In ancient times, understandably, the seed-range of a plant could well have been a yardstick for the latter's identification.

If we critically examine the concerned Indus seals, the representation consists of the stalk (vertical), the glume (cup-like) and the rows numbering six, four and two, which are denoted by the desired number of vertical lines (rows) as in Fig.12 or with horizontal cross lines (Figs. 13, 14,16-19). As to the representation of the six-row, there is another possibility. Since three seeds, as explained above, could be seen in the front, a form which would indicate a set of three, one above the other, would also indicate the six-rowed barley. It would thus seem that depending upon the availability of space and the associated elegance of presentation, the seal-maker had to make innovations to denote the six-rows also in terms of sets of three (see Fig.15). Possibly this type of representation of six-rowed barley was adopted in the initial stages and, when the necessity arose for differentiating the six-rowed from the four-rowed barley, six and four rows of representations were preferred in a distinct manner.

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* It has been pointed out by botanists that in the cultivated barley, Hordeum vulgare species, there is variation in the fertilization of the lateral spikelets. It should be emphasized that the spikelets occur in groups of three at each node of the rachis and it is not the single spikelet but it is each cluster of three or the triad of spikelets that would constitute the elementary unit of the ear of the barley plant. In fact, the ear of barley is really the extension of the stem of the plant (Cook, p.6)

Wheat

In the perspective of the history of field crops, it would appear that wheat and barley had been cultivated together even from the beginning of village-farming in the Middle East. According to Helbaek, the first identified grains of the domesticated wheat *(Triticum monococcum)* type are a few battered specimens from Ali Kosh (c. 6500 B.C.) and this variety is characterised by the twin grained spikelets which more or less resemble *Triticum dicoccum,* but are much smaller in size (Helbaek, 351). Helbaek has also thrown light on the possible places of origin of different species of wheat, specially in Central Anatolia. However, he inclines to the view that there was another centre of evolution in Central Asia on the basis of the archaeological remains of wheat in Indus Valley cultures.

It is now known that the charred wheat grains recovered from Mohenjo-daro belong to the species *Triticum aestivum* L. and *Triticum compactum* Host., while the ones from Harappa belong to *T. compactum* and *T. sphaerococcum* Perciv. (Chowdhury, p. 372; Marshall, p. 586, Vats, 466). *T. aestivum, T. compactum* and *T. sphaerococcum* are called by botanists the hexaploids. *T. aestivum* is the common or bread wheat while *T. compactum* is known as the club wheat. Its synonyms are *T. sativum* L. and *T. vulgare. T. aestivum L,* from which most of the modern forms of wheat have been evolved, has a wide range of morphological and physiological variation and ecological adaptation (Purseglove, pp. 290-292). There are many varieties of wheat – Emmer Wheat, Persian Wheat, Macaroni Wheat, Polish Wheat and the like, with their botanical names.

Of concern to us is the possible methodology which was diligently adopted by Indus seal-makers to represent wheat on the seals. Unlike barley, these wheat varieties do not bear an exact number of seeds in their rachis in a row. *T. aestivum* has 4 to 5 grains, and *T. compactum,* 2-5 grains (Peterson, pp. 15 ff, Pal, pp. 35 ff) with the result that it would be rather difficult to represent them by way of the exact number of linear seed-rows in the same manner as could be portrayed in respect of barley.

However, there is one special characteristic of wheat plant, namely, that whatever be the variety of wheat and whatever be the number of grains on the axis, the wheat-head or the ear consists of a zig-zag jointed central axis (Fig. 10B) with a spikelet attached at each point called the node (Peterson, p. 7; Hunter, p. 95; Pal, p.24). Thus a zig-zag form, as has been unmistakably depicted on some of the seals (Figs. 20 & 21) could be unambiguously constructed as being indicative of wheat. It is amazing that the Indus seal makers had such an uncanny insight that they were able to convey a difference between barley and wheat by their growth characteristics. Equally amazing is it that just as they have meticulously depicted the animal forms on the seals, so have they done in respect of the two cereal plants, barley and wheat, the former in linear rows, and the latter in zig-zag rows.

Cotton

Cotton belongs to the genus *Gossypium*. The origin of the cultivation of cotton is still controversial. In any case, the Indus Valley archaeological evidence confirms that cotton was in considerable use there even in the third millennium B.C., and that the lint was from *Gossypium arboreum*.

The lint, it may be noted, is formed from the cells of the epidermis (outermost layer) of seeds, and its growth is governed by several factors which need not be recounted here. Of particular importance to us is the fact that the spherical or ovoid capsules, called bolls, appear in course of time and, on maturity, split along the carpel edges into locks exposing the linted seeds (Purseglove, *Dicot.*, p. 350). Each boll may be 3-5 locular and each loculus might contain 5 to 8 or even more seeds. In a boll of cotton (Fig. 10 C), therefore, there could be about 15 to 40 seeds. In other words, unlike barley and wheat, cotton boll has many more seeds. From this point of view, if the related seals are closely evaluated, one would not fail to observe that many object-structures in front of the unicorn have horizontal and vertical strokes, indicative of more seeds. In addition, a large number of them have curvature at the top, connoting the shape of a cotton boll. Thus, the boll form or an indication of more seeds, could well denote cotton (see Figs. 22, 23 and 24).

Out of 1,164 seals, sealings and others, which have portrayed unicorn, nearly 950 are found at the two metropolitan cities – Mohenjo-daro and Harappa.

In the light of the foregoing discussions concerning barley, wheat and cotton, the seals, sealings and others of Mohenjo-daro and Harappa which have unicorn as the motif along with object-structures in front of it, have been examined and the observational results are presented in Table 16.

Table 16

Barley

No. of seals depicting →	Six rows	Four rows	Two rows	Wheat (zig – zag)	Cotton (boll form and many seeds)
Mohenjo-daro	91	95	29	19	179
Harappa	36	26	02	10	051
Total	127	121	31	29	230

Note: Out of about 950 seals and sealings with unicorn motif, the photographs of which have been reproduced in the works of Marshall, Mackay, Vats and others, the object- structures of 538 are identifiable. In respect of the others, the object-structures are either worn out or not clearly visible. Besides, a number of them show only the animal motif or a part of the object structure. The above Table gives the break-up relating to 538 seals and sealings out of 950.

A reflection on the above figures would perhaps lead to a question, namely, whether the number of the concerned seals could be proportionately or in any other way indicative of the produced quantities of grains or of cotton? A word of caution is necessary at this stage. Although the seals pertaining to wheat are not many, in contradistinction to those of barley or cotton, the number expressed on some seals connoting wheat production, if computed on the basis of the Indus numerical forms, is considerably large. Further, it is not absolutely certain whether the seals unearthed so far are the only ones; perhaps many more could have been either lost or lying underneath in the unexcavated portions.

Another question relates to the seed-like forms found either on the cup or on the sideways. A considerable number of seals have these forms. Is it likely that these were intended to connote the seeds set apart or preserved for sowing purposes? It is indeed difficult to arrive at any definite conclusion in this regard. However, Table 16 leads to the inference that barley, wheat and cotton were grown in considerably large quantities, and obviously stored in the granaries of Mohenjo-daro and Harappa.

In conclusion, it may be stated that (i) the so called 'Unicorn' symbolically represented the three important field crops and the inscribed object-structures in front of it indicate whether it was six, four or two-rowed barley, wheat or cotton; and (ii) the numerical forms on the seals were, in reality, the systematic records or accounts of the produce of these crops or the storage of their grains. It would seem that, in this respect, the Indus Valley Civilization was far more organized and methodical than either the Egyptian or the Mesopotamian. This type of maintaining records of the farm products might throw some light, if studied in more detail, on the agricultural management, production and distribution, which were obviously the sheet-anchor of Harappa Culture.

6.5 Other Animal Motifs

Hare facing a Bush : In the earlier phase of the Harappa Culture, as noted before, the recording was done at Mohenjo-daro on copper tablets, with the motif of hare facing a bush. At Harappa, it was on miniatures in the form of hare itself. The white colour of hare and its posture which are suggestive, to some extent, of the boll form of cotton, were possibly the determinants for this animal motif to indicate the production of cotton/cloth. But this motif receded to the background as the unicorn motif and the object-structure in front of it in the form of cotton boll and/or a representation of many seeds, began to be used extensively for connoting the production of cotton.

Short-horned Bull : This animal motif is represented on as many as 95 inscribed objects, the highest number for any single motif other than unicorn. The short-horned bull, depicted as it is generally with its head lowered over a trough (Fig. 25), indicates an edible entity. In view of the fact that the six-rowed barley was used much more as a staple

food than any other grain, the short-horned bull motif could be suggestive of the use of six-rowed barley being accounted for.

Goat- and Ox-Antelopes : The goat-antelope symbol is sometimes associated with a trough and, if an allowance is made for the scribal communication gap for having not shown a trough in front of this motif on all seals and others, the goat antelope motif could represent the quantities of four-rowed barley for edible purposes (Fig.26). The ox-antelope motif (Fig.27) could perhaps be suggestive of the use of two-rowed barley, although, in both the cases, there is no easily perceptible indication to this effect on the concerned seals. The motifs of goat-antelope and ox-antelope are 36 and 26 respectively in number, nearly half of them being depicted on copper tablets and the rest on seals.

Elephant : Wheat was another cereal of the Harappan Culture, perhaps less used than barley as a staple food. As noted before (p.77), the axis of the wheat grains is not straight but is zig-zag. It may not be unreasonable to suppose that, in view of the fact that the trunk of elephant is not straight, this animal, which has generally a trough in front of it (Figs.28 & 29), was adopted as the symbol for connoting the quantity of wheat being used for edible purposes.

Rhinoceros : The fabulous animal (Fig.30), with one head on each side as depicted on copper tablets at Mohenjo-daro, has on it several dots embedded above its hind and fore legs. Such dots are connotative of peas, the two heads being suggestive of the dicotyledon nature of peas (pulse). In course of time, this animal motif was replaced by rhinoceros (Fig.31) with its two ears shown prominently and the dots embedded on it more or less in the same way as in the case of the fabulous animal. Rhinoceros is represented on as many as 36 seals of Mohenjo-daro (out of a total of 40 such objects) pointing to the fact that peas were grown extensively in Mohenjo-daro.

Buffalo : Sesame was an important oil-seed of Harappa Culture as evidenced by the fossilised seeds of sesame found specially at Harappa. Significantly, there are a few inscribed objects with the sesamum plant (on the reverse) as motif (Fig.32) both at Mohenjo-daro and Harappa. While the sesamum inscribed objects depict the quantity of sesame produced, the motif of buffalo, generally with a trough in front (Fig.33), seems to have been employed for denoting the quantity of this oil–seed being used for expelling oil and obtaining the oil cake. It would seem that the oil–extracting units were concentrated in Mohenjo-daro and Harappa, since out of a total of 14 of this motif, 10 are found in Mohenjo-daro and 3 in Harappa, the remaining one being in Kalibangan.

Gharial : The dark brown colour of gharial and the circular forms embedded on its back (Fig.34) could be indicative of the colour and form of rape seed. It is, therefore, possible that this animal motif was intended to convey the quantities of rape seeds being utilised. In view of this animal motif being much more in Harappa (36 out of 49) and to a

Seals with different field symbols generally with a trough in front
(indicating quantities for consumption)
Examples

Short-horned bull (six-rowed barley)

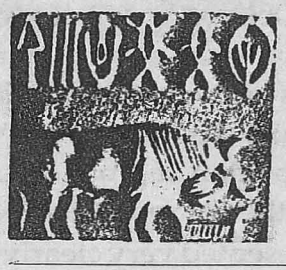


Fig 25. FEM, Pl. LXXXV, 123

Ox-antelope (four-rowed barley)

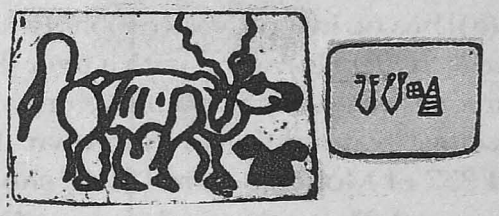


Fig 27, MIC, Pl. CXVII, 8. Copper tablet

Goat-antelope (two-rowed barley)

Fig 26 (a) FEM, Pl. XCIX, 673; (b) Pl.XCVII, 565

Elephant (wheat)

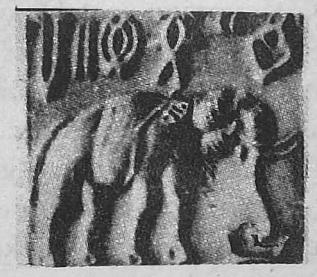


Fig 28. MIC, Pl.CXII, 369

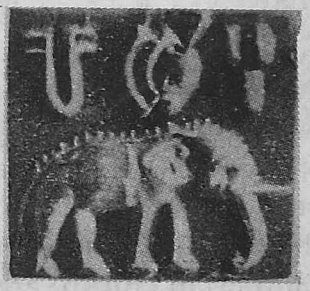


Fig 29. MIC, Pl.CXII, 366

Fabulous animal

Rhinoceros

Fig 30. MIC, Pl.CXVII, 3, Copper tablet

Fig 31. MIC, Pl.CXI, 342

considerable extent (11 out of 49) in Mohenjo-daro, it might be inferred that rape seeds were used substantially at Harappa and to a considerable extent at Mohenjo-daro.

Tiger : This motif needs a somewhat detailed explanation. Fourteen (out of a total of 16) seals at Mohenjo-daro and one at Harappa have the representation of tiger in its different aspects; the remaining one is a West Asian find. Object No. 352 of Mohenjo-daro [Fig. 35(a)] has no inscription (probably it is mutilated), but has the depiction of date-palm (*Phoenix dactylifera* L.) along with a tiger [Fig.35 (b)] with its head in the opposite direction. The trunk of the date-palm with its crown of leaves is clearly visible.

A close examination of the crown also reveals the depiction of pinane. Seal Nos. 353, 355 and 357 of Mohenjo-daro (MIC) show unmistakably the compound spike or spadix inflorescence*. The main penduncle and branches are represented very clearly [Fig. 35(b)], although the spikes are represented without any fruits.

According to Campbell Thomson (pp. 308-311), the date-palm grows abundantly from Basrah to Baghdad on the Tigris, and Anah on the Euphrates. The cultivation of date-palm demands a constant supply of water. Of the various kinds of dates mentioned in the (Babylonian) cuneiform texts, there is also one from Meluhha (which is identified as Baharian Islands or an Indus Valley city like Mohenjo-daro). Possibly, date-palms were grown largely at Mohenjo-daro where fossilised date-seeds have been found. Since the animal tiger is shown associated with date-palm and generally with a trough in front, it may be inferred that the inscribed objects having tiger as the symbol denote dates and the numerical representation, the quantities of edible dates.

There are five seals of Mohenjo-daro which depict a person seated on a date-palm's spadix inflorescence (Fig. 36) with a tiger below looking up to him. According to Campbell Thomson, there are descriptions in some Sumerian texts about a man climbing a date-palm to fertilise the inflorescence, carrying a pollen bag with him and having a rope in a loop and the tree to support him. This was also an Egyptian tradition of the fertilisation of dates. Such descriptions correspond to what is represented on the aforementioned seals. There were date-pickers who were generally peripatetic like the Sussex hop-pickers (Thomson, p.311). Dates in the Sumerian culture-area had religious undertones as well as medical applications. Harappans, who had contacts with the Sumerians, would have been familiar with these aspects of dates, perhaps holding the dates and tiger (a cult animal in ancient times) in veneration.

Humped Bull : One of the most fascinating animal motifs inscribed on the seals is humped bull. It is interesting to observe that there is a type of interlacing on the flappy portion of the neck of humped bull, indicating as it were, an intertwining of threads [Figs. 37(a) & 37(b)] which can be construed as being suggestive of cotton threads. Equally

* The author is thankful to Dr. S. Sundararajan, a competent botanist, who has examined the suggestion of the author and confirmed that the concerned plant motifs represent date-palm and spadix inflorescence.

Sesamum

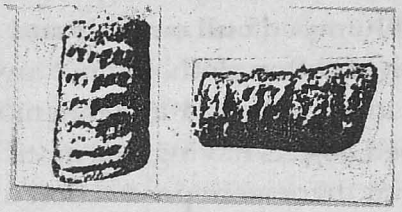


Fig. 32. EH, Pl. LXXXVIII, 331-2

Buffalo (Sesame)

Fig 33. MIC, Pl.CX, 306

Gharial
(Rape Seed)

Fig 34. MIC, Pl. CXI, 361

Tiger (dates)

Fig 35(a) MIC, Pl.CII, 353

Fig 35(b) Pl.CXI, 357

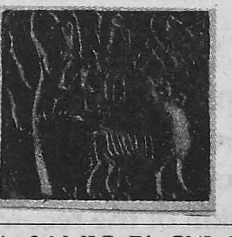


Fig 36 MIC, Pl. CXI, 355

Seal with humped bull as field symbol relating to cotton cloth
(Examples)

Fig 37(a) MIC, Pl.CXI, 337

Fig 37(b) FEM, Pl. LXXXV, 132

interesting it is to note that no humped bull symbol has before it any trough or manger. It seems, therefore, plausible that the representation of humped bull on seals and others was intended by seal-makers to connote the production of cotton cloth, but not anything edible (in the absence of a trough or manger). This motif is found at Mohenjo-daro, Harappa and Kalibangan, and, if the number of inscribed objects having this motif found in these places is any indication, it could be inferred that there were production units of cotton cloth to a great extent at Mohenjo-daro (46 out of a total 54 such objects), and to some extent at Harappa (6 out of 54), while at Kalibangan, the production was less (2 out of 54). Such a situation was in consonance with the needs of people who were much more in Mohenjo-daro, less in Harappa and still less in Kalibangan.

It should, however, be emphasised that in the other towns like Chanhu-daro and Lothal, cotton was being grown, but generally in small quantities as indicated by the numerical notations inscribed on some seals having unicorn as the motif and the boll form object-structure in front of it. Possibly, the quantities of cotton produced in these two and other minor places were used domestically and no cloth production unit such as the ones at Mohenjo-daro and Harappa was in existence at these places. It is for this reason perhaps that no other seal or other type of inscribed object having humped bull as the motif has been found in Chanhu-daro, Lothal and some minor sites.

6.6 Seals without Field Symbols

There are about 320 seals without any type of field symbol on each of them: Mohenjo-daro (195); Harappa (71); Lothal (38); Kalibangan (10); Chanhu-daro (3) and a few others of minor sites. Possibly, the numerical presentation on such seals could be an extension of the recordings on the seals which have field symbols. It is rather difficult, on the basis of the extant data, to determine exactly the particular seal without a field symbol which was attached to the one with a field symbol as a continuation of the recording on the latter. As noted before (p.14), most of the seals have converging holes. These were possibly meant for tying together the seal or seals (one, two or more as the case may be) without field symbol and the one which had the field symbol. It is possible that, initially, the continuation of recordings on a seal was effected on its other side(s). But, as the necessity arose for increasing entries, Indus seal-makers adopted the mechanism of boring a hole through the boss of the seal with the inscribed field symbol and tagging to it the ones without the same field symbol, to avoid duplication or replication of inscribing the concerned field symbol. The one which had a field symbol was placed first and the related other seals (without the field symbol) were tied together in the desired order with a string or a copper wire.

6.7 Seals with Anthropomorphic and other Forms

There are nearly 60 seals and other inscribed objects which have divine, semi-divine and human forms, including the elegant portrayals of anthropomorphic and animal figures, trees and others (Mahadevan, pp. 795-796). To cite a few examples: Fabulous animal with the body of an ox with three heads (one at Mohenjo-daro); Two heads of unicorn joined end to end under a stylised pipal tree (one at Mohenjo-daro); Fabulous animal with the body of an ox with three heads, two of antelopes and one of short-horned bull (two at Mohenjo-daro and one at Kalibangan); Horned personage (with three visible faces) seated on a pedestal and surrounded by five types of animals – rhinoceros, buffalo, antelope, tiger and elephant (one at Mohenjo-daro); Horned person seated on a pedestal (three at Mohenjo-daro); Fabulous personage with a composite body or a human being in the upper half and of a tiger in the lower half, having horns, etc. (one at Kalibangan); Person grappling with two tigers standing on either side of him and rearing on their hind legs (three at Mohenjo-daro); and a horned personage standing between the branches of a pipal tree, a row of seven figures neatly attired (one at Mohenjo-daro), etc.

Many of them could well be mythological depictions and some of them appear to echo in glyptic art the Assyrio-Sumerian-Akkadian mythological imageries. The pertinent question is: why are numerical forms associated with them? It is interesting to observe that on some of the Sumerian cylindrical seals of mythological significance, there are forms like triangles, squares, extended rectangles and others which are attractively inscribed but separated from the mythological scene. Possibly, such forms added a mystical or magical dimension to the myths depicted. It is not improbable that the numerical forms on such of the Indus seals as have anthropomorphic and other mythical depictions might have been associated with number mysticism (which held sway over human mind specially in ancient times). To Harappans, who had a mastery over the art and science of numeration, possibly the numbers might have had a mystical appeal.

SECTION 7

IN RETROSPECT

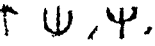
7.1 Certain historical aspects in a broad chronological spectrum merit some attention. The Egyptian civilisation had assumed perceptible dimensions around 4200 B.C. (pre-Dynastic period). The first Egyptian dynasty came up around 3400 B.C. and, in the Third Dynasty (2980-2900 B.C.), the first stone pyramid was erected. The hieroglyphics, including numerals, were in use around 3000 B.C. and a little later the hieratic forms of number-reckoning. The hieratic mathematical papyri *(Reisner Papyri)* which is now in Boston was composed between 2160 and 2130 B.C. The other papyri, viz., *Rhind Mathematical Papyrus* (now in the British Museum), *Moscow Mathematical Papyrus, Kahun Papyri* (London) and *Berlin Papyri* appeared during the next 500 years.

In Mesopotamia, Sumerians had established themselves around 4000 B.C. and by 3000 B.C. developed their own number-recording technique. Later, the Akkadians, who were city dwellers and had embarked upon trading, evolved their standards for numerals. The Hittites entered the eastern part of this region around 2000 B.C. with their commercial undertakings and the Kassites were there in the southern parts two and a half centuries later (Hammerton and Barnes, Table of Dates). Contemporaneous with the Fifth and Twelfth Dynasties in Egypt, and the Sumerian Empire under Ur-Engur at Ur as well as the Kassite rule in Babylon, the Harappa Culture flourished (c 2500-1900 B.C.) and continued as late Harappan for another three hundred years.

Jacquetta Hawkes and Leonard Wooley have suggested that from about 2300 B.C. onwards Harappan traders had their Indian agents domiciled in the cities of Mesopotamia and that 'a business aristocracy might have existed in Mohenjo-daro and Harappa' (p.454 and p.610) engaged in 'international trade and high profits'. There were Indian residents at Ur involved in trade exchanges. Bridget and Raymond Allchin have also thrown light on trade contacts between Harappan and Mesopotamia (pp.188-89).

Of 17 inscribed objects listed as West Asian finds by Mahadevan (p. 160), 16 are seals and one sealing which has no corresponding seal in any of the Harappan sites, thus pointing to the fact that its seal was probably in existence in the Mesopotamian region. Six of these objects are from Ur which had an Indian colony. Gadd (pp. 3-22) has discussed the seals of Harappan style found at Ur*. It is reasonable to suppose that the Indian

*No. 1 seal described by Gadd, which belongs to the class of 'button' seals of Indus style has short-horned bull motif, with no manger or trough in front of it. A horizontal line divides the motif from the inscription which follows in a horizontal way above the dividing line. Gadd thinks that the script is of archaic cuneiform writing. David Pingree, the noted scholar in Babylonian and Indian astronomy, says in a personal communication that these characters do not at all look Mesopotamian. They are of the type of Indus numeration.

mercantile community at Ur and other West Asian towns were maintaining records in the form of seals in the same way as the Harappans did because of the use by the former of Indus notations. It may also be inferred that these inscribed objects being seals, may not be in the nature of records of trade between Harappan cities or towns and the West Asian ones, but of the agricultural production and management of the Indian community itself there. The animal motifs of the West Asian seals are unicorn (3); short-horned bull (8); bull mating a cow (1); tiger (1); a large tablet (1) having two parts – the upper one depicting a person grappling with two animals (tigers?), a horned personage standing behind a pedestal and a plant, while the lower one portrays a bird in flight over a unicorn, an antelope, and two short-horned bulls facing each other (Mahadevan, p. 797). In any case, the Indus notations were in vogue in the south-east Sumerian region at Ur and other places. It is not improbable that the Chinese who had contacts with West Asia would have been familiar with Indus notations employed by the Harappan community settled in those places and adopted some of those notations into their own system of reckoning. It is significant that notations like  which were used on the West Asian seals of the Harappan community there, were also used by the Chinese as numerical symbols (Table 7), the first five as such and the last one with minor modifications.

7.2 The natural conditions of Indus Valley resembled those of Sumeria – extensive alluvial plains, inundation by rivers from May to August each year and riverine irrigation potentialities (Jacquetta Hawkes and Leonard Wooley, p.452). The Harappan settlements in Ur and other places in Sumeria, therefore, found a congenial environment there. These Harappans were probably the intermediaries in trade between Sumeria and Indus cities and towns, in which Mohenjo-daro and Harappa played a pivotal role. The trade was both by sea and land routes, perhaps more of the latter, via the Elamite region.

Within the Indus empire too there must have been trade, specially among the major cities and towns. Preliminary studies indicate that some seals and sealings provide a clue to this effect. It can be tacitly assumed that if copies of a particular seal of one place are found in another place, it could reasonably indicate the transport of goods from that place to another. For example, 9 copies (Mahadevan, p.523) of seal number 2262* at Mohenjo-daro have been found in Lothal, and none of them in Mohenjo-daro itself. This seal has unicorn as its motif and the object-structure (zig-zag) in front of it indicates that it is wheat. From the 9 copies of the same inscription of this seal found at Lothal with elephant as motif symbol for wheat consumption, could it be construed to mean that 9 bundles or packages, each of the same quantity of wheat, were sent from Mohenjo-daro to Lothal, for their utilisation?

*The numbers correspond to Mahadevan (1)

There is another interesting example. Seal No. 4128 of Harappa has the unicorn motif and the object-structure (boll form) in front of it connotes the quantities of cotton. Seal No.1339 (Mohenjo-daro) has humped bull as the field symbol, which connotes the production of cloth. Since both of them have the same inscription, could it be inferred that the quantity (represented by the numerical forms) was despatched from Harappa, and the entire quantity, was utilised for the production of cloth? A detailed analysis of seals and sealings of the major cities and towns of Harappa Culture is likely to throw more light on the quantitative transactions in goods or commodities among the different centres of Harappa Culture.

While a number of sealings of a particular seal of one place is explainable on the basis of its copies needed by the central administration, the occurrence of two seals in the same place having the same inscription needs some consideration. Such occurrences are but a few. Seal Nos.1232 and 2580 of Mohenjo-daro have the same inscription with unicorn as the field symbol. But a close examination of both of them reveals that they differ from each other in execution. The former is small and the tail of the unicorn is practically missing. Understandably, the seal maker would have discarded it and preferred a bigger seal, which the latter is, with the full tail of the animal motif neatly engraved. Seal Nos. 4033 and 4128 of Harappa are otherwise the same except for their dimensions; the latter is very small and the former, relatively bigger which the seal-maker preferred.

In the history of numbers, Indus numeration has a distinct position marked by rare originality. In no other ancient culture do we see such an extensive use of a variety of numerical forms; nor do we observe elsewhere such an accurate expression of botanical knowledge in such a symbolism as Harappans adopted. Just as they had scaled new heights in numeration and recording of agricultural products, they should also have developed ideas concerning the universe, man and nature, albeit their religio-mythological heavy undertones which were characteristic of ancient times. But, for their communinication, Harappans seemed to have preferred oral tradition to a recording one, and the literary script was noted for its absence.

Parallels

At this stage we must turn our attention towards some aspects of the glyptic art of Harappans in the absence of any written sources concerning their mythological and associated ideas. As noted before (p.65) Asko Parpola has ably shown the influence of the Proto-Elamite civilisation on the formation of Harappa Culture by pointing out the correspondences in art symbolism – 'contest motifs', a 'hero' grasping a tiger, the 'bull-man', water buffalo as well as others depicted on Indus seals. He has convincingly pointed out the parallels among the Proto-Elamite, Sumerian and Harappan engraved objects. (Asko Parpola, 3, pp.176-195). During-Caspers has provided some insight into some

Harappan art motifs which seem to have been borrowed from Mesopotamia even during 2800-2500 B.C. (During-Caspers, pp. 112 ff). In Mesopotamian art, lions, sometimes bulls, are depicted in the fighting scene. In Harappan context, tiger replaced lion in the scene so as to be in conformity with the local fauna (Mackay, I, 337). Another aspect of the tiger motif on some Indus seals has been dealt with already (pp.82-83) in relation to date-palm and the fertilisation of the spadix inflorescence similar to the descriptions in some Sumerian texts of mythological significance.

Let us now briefly examine certain mythological thought structures of the *Rgveda* in relation to the primitive Mesopotamian mythological ideas which would have been refined by Harappan priesthood. The word 'Mesopotamian' is used here in a large sense inclusive of the Sumerian, Akkadian, Assyrian, the general nomenclature the Babylonian, the Proto-Elamite which was at one time under the suzerainty of Sumerians, and the admixtures which took place during the fourth-third millenium B.C. Some minor differences apart, they had common perceptions of their gods, including the attributes and deeds of the latter.

In the Mesopotamian mythology, the Universe was divided into two parts and three regions. Each of the latter had a god-head: (i) Anu – ruler of sky or heaven; Enlil-ruler of the earth; and Ea-the governor of waters. Anu was the supreme god and the other gods regarded him as their 'father' or chief. He was all-powerful but meted out justice whenever the need arose. He created stars to destroy the wicked and the stars were known as 'the soldiers of Anu'. He never descended to the earth, but walked in an exclusively reserved portion of the sky, which was designated as Anu's way. (ii) Enlil whose domain was the earth, was the Lord of the Air too. He was the god of the hurricane and his weapon was *amaruk* (the deluge). In his anger sometimes he caused the deluge to annihilate the recalcitrant human race. (iii) Ea or Enki ruled over waters and the name means 'House of Water'. But he was not the sovereign of marine waters, but of Apsu (the stretch of fresh water that encircled the earth and on which the earth floated). Ea was invoked in incantations and was the patron of artisans. In course of time, this triad of gods was replaced by Marduk (also spelt as Merdoch) who absorbed all the other gods with supreme authority. He was supposed to be the son of Ea, having arisen from Apsu. There was thus the conception of an all-powerful god-head among gods. Such a conception is also noticeable in the *Rgveda*, but in a refined form, and this is called by the Vedic scholars the monotheism out of henotheism or kathenotheism (Dasgupta, I, p.16).

Among the Mesopotamian gods, there was also the triad of what may be called the sidereal divinities, namely, (i) Sin (not to be confused with the English word in modern sense) or the Moon-god, who was venerated specially at Ur, was a destroyer of nocturnal evil-doers by his illumination in the night. He was also a measure of time and full of wisdom; (ii) Shamash, the Sun-god who was known for his vigour and courage and who

was regarded as the god of Justice 'bore the title of Judge of the Heavens and the Earth' and no evil action escaped from his purview. Also the god of divination, Shamash was worshipped specially at Sippar; and (iii) Ishtar, the daughter of Anu, was the goddess of morning and evening. She was the personification of the planet Venus. She was voluptuous and even a war-goddess (Larousse Encyclopaedia of Mythology, pp. 49-72).

Apart from these divinities, there was Adad, the god of lightning and tempest, standing on a bull and grasping thunderbolt in each hand. He was the god of rains, inundation and fertilisation. Like Shamash, he was also the Lord of revealing future. Gibel was the fire-god and was regarded as the son of Anu. But Nusuku, another fire-god represented the sacred fire and was invoked during sacrifices as the sublime messenger carrying sacrificial fragrance to the gods.

In the Vedic ensemble, the division of the Universe into two parts *Dyava* and *Prthvi* and three regions, each with a god-head, the concepts of nature in terms of Aditi, Aryaman's way, Soma identified with the Moon, Surya and Agni (whom the Vedic sages extolled in diverse ways), are somewhat similar to, if not exactly identical with, those of the Mesopotamian gods, viz., Anu, and Anu's way, Sin, Shamash and Gibil (as well as Nusuku) respectively. But the Vedic hymns to gods are more refined and they abound in poetic imagery. Vedic Varuna and Indra, the gods of rain and thunder, air and water, occupy the pride of place and their natural attributes can also be found in one or the other Mesopotamian gods, but in a primitive form. Sacrificial rites were practised in Mesopotamia in a rather obnoxious way in contradistinction to the refined Vedic performances of sublime intent. Indra as the champion god was invoked by the Vedic bards to destroy cities, not *per se*, but of *asuras* and of demon Vala (*RV.* 6,18,5-8; 20,3). A similar concept of the destruction of cities can also be found in Mesopotamian mythology but in a different way. Neargal, the Warrior-god and his variant, Dibarra, were associated with the destruction of cities like Babylon and Erech. They were gods of war and plague by which they sought to annihilate cities on their own volition — a primitive impulse of the gods to establish their supremacy over human beings.

In the Mesopotamian *Epic of Creation,* water is the primordial element. It postulates that from the fusion of *Apsu* (sweet or fresh water) and *Tiamat* (salt water) arose all beings beginning with gods, the most powerful god, Marduk emerging later as an omnipotent god. In the *Rgvedic* cosmogony (Nāsadīya Sūkta *RV.* X. 129), one of the questions relate, to water as the primordial element as follows:

Nasadāsinno sadāsīttadānīm
nāsidrajo no vyomā paro yat
Kimāvarivah kuha kasya sarmanambhah
kimāsīd gahanam gabhīram (RV. X.129, 1)

Ther e was neither Existent nor non-Existent
The mid-World was not, nor the sky nor what is beyond
what enveloped it? and where? In whose protection?
What was the water, unfathomable and deep?

From these examples it can be inferred that Harappans were not only familiar with the mythological and related ideas of the Mesopotamian and Proto-Elamite cultures but even 'Harappanised' them to suit their socio-cultural practices. The primitive Mesopotamian mythological thoughts were refined in tune with the ethos of the Harappan priestly class, just as the Harappan administration excelled the Mesopotamian cultures in respect of an elaborate number system, functional town-planning and efficient agricultural production and management as evidenced by the excavated cities and towns, their huge granaries, seals and other inscribed objects. According to Jacquetta Hawkes, the noted archaeologist, the first-town planning in the history of civilization was in the Indus Valley. Likewise, the granaries at Mohenjo-daro and Harappa were unparalleled elsewhere in the then 'Fertile Cresent'.

Harappan Priestly Class and Vedic *ṛsis*

By the time the Harappans began to move to other parts of India (around 1600 B.C.) their priestly class might have evolved already an impressive man-spirit-cosmos view which was far more refined than, but not totally divorced from, the Mesopotamian ideas of nature and gods. What is more, they might have developed a linguistically disciplined articulation of various ideas which were a part of their man-spirit-cosmos view. It is interesting to observe that 'the Babylonian priesthood preserved the Akkadian tongue as a sacred language. Indeed the proper pronunciation of Akkadian was an absolute necessity for the successful performance of religious rituals and the Babylonian priests formulated new religious compositions in a special type of Akkadian' (Spence, p. 14) and preserved them as a sacred language. The Harappan priesthood was well aware of this tradition of Mesopotamian region and developed a sacred language of its own for religious purposes with special emphasis on the pronunciation.

It is significant to note that proper pronunciation of the *mantras* of the hymns is a notable characteristic of the *Ṛgveda- Saṃhitā* even as an advanced compilation.

In his *Vedic Mythology*, Hillebrandt wrote (p.9): 'The evolution of mythology does not follow simple rules, its life no less complicated than that of a language, and it is the end product of different external and internal laws which are not sufficiently known or appreciated. The people who moved into the land of five rivers were not without a language. Their (Vedic) gods had their origin under a different sky and under different circumstances, and had to fade out or pass through a reinterpretation under the impact of a totally different climate, as the name of Indra or Vrtra shows.'

Eighty six years later, the noted scholar S.N. Dasgupta wrote in *A History of Indian Philosophy* (I, pp.14-15): 'The hymns of the *Rgveda* are neither the productions of a single hand nor do they probably belong to any single age. They were composed probably at different periods by different sages and it is not improbable that some of them were composed before the Aryan people entered the plains of India. They were handed down from mouth to mouth and gradually swelled through the new additions that were made by the poets of succeeding generations. It was when the collection had increased to a very considerable extent that it was arranged in the present form, or in some other previous forms, to which the present arrangement owes its origin'. Apparently, on time-scale, the origins of the *Rgveda* can go back to 3000-2500 B.C., among the Harappan priestly class.

Some questions, however, arise: As the *Ṛgvedic* oral tradition preserved its religio-mythology, can it be supposed that the Vedic oral tradition was a continuation of the Harappan oral tradition? If so, can it be further supposed that the Rgvedic claśs of *rsis* owed its origin to the Harappan priestly class? Was it likely that, as Harappa Culture atrophied possibly because of ecological imbalances or floods, its priestly class specially fled into more congenial places to the safer riverine and hilly regions and became the custodians as well as exponents of Harappan oral tradition? In other words, were the Vedic *rsis* the descendants of Harappan priestly class? Could there be some concordance between the Sumerian gods like Sin (Moon), Shamash (Sun) and Gibil (Sacred Fire) and the Vedic *Soma* (Moon), *Sũrya* (Sun) and *Agni* (Sacred Fire)? Was it possible that the priestly class had evolved a language to express its religio-mythical ideas in contradistinction to, but not totally divorced from, that of the laity like the *Ṛgvedic* Sanskrit and Prākṛt? A discussion on such questions is beyond the scope of this monograph. Nevertheless, they assume relevance because the Indus script forms bespeak only numbers, thus indicating, though indirectly, that the Harappan literary tradition was essentially an oral one.

An objective study of the Proto–Elamite culture may shed some light on the origin of Harappans. The tradition of account-tablets was fostered by the Proto-Elamites for a very long time. Many (script) forms found on such tablets appear on the Indus seals and seem to suggest that the Proto-Elamites could well have continued their tradition of account-tablets, moving east and south-east, eventually ushering in what is now called the Harappa Culture. Since the Proto-Elamite script has not been deciphered yet linguistically, it would appear that their script may also be nemerical in nature and that the Proto-Elamites could have preferred an oral tradition and nurtured it as they moved along and settled in the new lands. Possibly, the origins of the Vedic mythology, which has close parallels with the Mesopotamian, could also be traced to the Proto-Elamites, the eastern neighbours of Mesopotamians for a long time (For a detailed discussion on this subject, see Subbarayappa, under publication).

This monograph has attempted to understand the numerical nature and structure of the Indus script in its context of animal and other motifs. The archaeological finds of barley, wheat, cotton, sesame, peas and dates have been correlated with the motifs on seals and plausible explanations offered, although in the case of some animal motifs with trough in front, the explanations might be in the nature of conjectures. But they are not improbable. Nevertheless, further studies, both scientific and historical, will shed more light on the enchanting endeavours of Harappans, besides revealing their plausible relationship with the Ṛgvedic people.

SELECT BIBLIOGRAPHY

Allchin, Bridget and Raymond: : *The Rise of Civilization in India and Pakistan*, New Delhi, 1989

Beaven, E.S. : *Barley*, London, 1947.

Bews, J.W. : *The World's Grasses*, London, 1929.

Bose, D.M., Sen,S.N. and Subbarayappa, B.V. (eds) : *A Concise History of Science in India*, 2nd edn., New Delhi, 1991.

Boyer, B. : *A History of Mathematics*, New York, 1968.

Buhler, G. : *Indian Paleography*, London, 1884.

Cadagoan, G. : *Places of Minoan Crete*, London, 1978.

Cajouri, F. : *A History of Mathematical Notations*, 2 Vols, Chicago, 1928.

Chalam, G.V. and Venkateswarulu, J. : *Introduction to Agricultural Botany in India*, New Delhi, 1965.

Chowdhury, K.A. : Chapter on Botany in *A Concise History of Science in India*, pp.371-374.

Cobley, L.S. : *An Introduction to the Botany of Tropical Crops*, London, 1956.

Cook, A.H. : *Barley and Malt*, New York, 1961.

Conant, L.L. : *The Number Concept: Its Origin and Development*, New York, 1896.

Constantini, L. : 'The Beginning of Agriculture in the Kochi Plain: The evidence of Mehrgarh', in *South Asian Archaeology, 1981*, (ed.) B. Allchin, Cambridge, 1984, pp. 29-33.

Contenau, Georges : *Everyday life in Babylon and Assyria*, London, 1954.

Corpus Inscriptionum Indicarum : 7 Vols, different editors, Archaeological Survey of India, Calcutta, Ootacamund and New Delhi, 1888-1978.

Corpus of Indus Seals and Inscriptions, (ed.) Joshi, J.P. and Parpola, Asko, Helsinki, 1987.

Cotton in India : A Monograph, Indian Central Cotton Committee, Bombay, 1960

Crozer, V.S. : *A Survery of Mathematics*, New York, 1968.

Dales, G.F. : 'New Investigations at Mohenjodaro', *Archaeology*, 18,2,1965; pp. 145-50 and 'The Mohenjo-daro Floods', *American Anthropologist*, 70, 5, 1968.

Dani, A.H. : *Indian Paleography*, Oxford, 1963.

Dowson, V.H.W. : *Dates and Date Cultivation of Iran*, London, 1921.

During-Campers, E.C.L. : 'Further evidence for cultural relations between India, Baluchistan and Iran and Mesopotamia in the early dynastic times' *Journal of Near Eastern Studies*, Chicago, 24, 1965, pp. 53-56.

Fairservis, W.A. Vr. : 'The Harappan Civilization according to its writing', in *South Asian Archacology, 1981*, (ed.) B.Allchin, Cambridge, 1984, pp. 154-161.

Fredbury, H.A. : *A History of Mathematics*, New York, 1961.

Gadd, C.J. : 'Seals of Ancient Indian style found at Ur', *Proceedings of the British Academy*, 1933, pp. 3-22.

Gordon, D.H. : *The Pre-historic Background of Indian Culture*, Bombay, 1958.

Gow, James : *Greek Mathematics*, New York, 1968.

Gregory, J.C. : *Nature of Number*, London, 1919.

Grigson, C. : 'Some Thoughts on Unicorn and other Cattle depicted at Mohenjo-daro and Harappa', in *South Asian Archaeology*, 1981, (ed.) B. Allchin, Cambridge, 1984, pp. 166-169.

Grilling, R.J. : *Mathematics in the time of Pharaohs*, Cambridge, Mass., 1974.

Haralan, J.R. and Zohary, D. : 'Distribution of Wild Wheats and Barleys', *Science*, 153, pp.1074-80.

Hawkes, Jacquetta : *The Great Civilisations*, Pelican Books, England, 1977.

Hawkes, Jacquetta and Wolley, Leonard : History of Mankind, Vol. 1, *Pre-History and Beginnings of Civilization*, London, 1963.

Hector, J.M. : *Introduction to the Barley*, Field Crops, Vol.1, Cereals, New York, 1936.

Helbaek, H. : 'Commentary on the Phylogenesis of Triticum and Hordeum, *Economic Botany*, 20, 1966.

Heras, H. : *Studies in Proto-Indo-Mediterranean Culture*, Bombay, 1953.

Higgins, R. : *The Archaeology of Minnoan Crete*, London, 1973.

Hillebrandt, A. : *Vedic Mythology*, 2 vols. *Tr.* S.R. Sarma, Delhi, 1990.

Hoernle, A.F.R. : 'The Bhakshali Manuscript', *Indian Antiquary*, 17, pp. 33ff, 1888.

Hoffman, J.E. : *The History of Mathematics*, New York, 1957.

Hooker, J.T. : *Mycenaean Greece*, London, 1977.

Hooper, A. : *Makers of Mathematics*, London, 1948.

Hubbard, C.E. : *Grasses*, Pelican Books, Middlesex, 1954.

Hultzch, G.R. : *Inscriptions of Ashoka*, (new ed.), New Delhi, 1969.

Hunter, G.R. : *The Script of Harappa and Mohenjo-daro and its connections with other Scripts*, London, 1934.

Hunter, H. : *Crop Varieties*, London, 1951 and *The Barley Crop*, London, 1952.

Iyer, A.K.N. : *Field Crops of India with specific reference to Mysore*, Banglore, 1972.

Kang, Shin, R. : *Sumerian Economic Texts from Drehem Archive*, Vols. 1 and 2, Chicago, 1972.

Keightly, David, N. : *Sources of Shang History*, Berkeley, 1978.

King, L.W. : *Egypt and Western Asia*, Brighton, 1907..

Kinnier-Wilson, J.V : *Indo-Sumerian: A New Approach of the Problems of the Indus Script*, Oxford, 1974..

Knorozov, Yu : 'The Formal Analysis of the Proto-Indian Texts', *Journal of Tamil Studies*, 2, 1970, pp. 13-28.

Khan, F.A. : *Preliminary Report on Kot-Diji Excavations*, 1957-58, Karachi, 1959.

Kramer, S.N. : *The Sumerians : Their History and Characters*, Pennsylvania, 1981.

Karmer, Edna, E. : *The Main Stream of Mathematics*, Oxford, 1951

Kwang-Chi Chang : *The Archaeology of Ancient China*, New Haven, 1965.

Labat, Rene : *Manuel D'Epigraphie Akkadienne* (signs,) *Sylabaire, Ideograms*, Paris, 1988.

Lal, B.B. (1) : 'Fresh Light on the Indus Civilisation', *Science and Culture*, 35, 15-16 .

Idem, (2) : 'Some Aspects of the Archaeological Evidence Relating to Indus Script', *Puratattva*, 7, 1974, pp. 20-24

Idem, (3) : 'From the Megalithic to the Harappan: Tracing back the graffiti on the Pottery', *Ancient India*, 16, 1960, pp. 4-24.

Idem, (4) : 'The Direction of Writing in the Harrapan Script', *Antiquity*, 40, 1966, pp. 52-55.

Idem, (5) : 'A Further Note on the Direction of Writing in the Harappan Script', *Puratattva*, 1, 1968, pp. 15-16.

Luckenbill, D.D. : *Ancinet Records of Assyria and Babylonia*, Vols. 1 and 2, New York, 1968.

Macdonnel, A.A. and Keith, A.B. : *Vedic Index of Names and Objects*, Varanasi, 1958.

Mackay, E.J.H. : *Further Excavations at Mohenjo-daro*, 2 Vols. New Delhi, 1938.

Mahadevan, I. (1) : *The Indus Script : Texts, Concordance and Tables*, New Delhi, 1977.

Idem, (2) : *What do we know about the Indus Script: Neti Neti ('Not This Nor That')*, Presidential Address, Section V, Indian History Congress, Dharwad, 1988.

Mahalingam, T.V. : *Early South Indian Paleography*, Madras, 1967.

Majumdar, N.G. : *Explorations in Sind*, No. 48, Memoirs of ASI, New Delhi, 1948.

Mallowan, M.E.L. : 'The Birth of Written History', in *Dawn of Civilization*, (ed.) S. Piggott, New York, 1961, pp. 65-96.

Marshall, J. (ed) : *Mohenjo-daro and the Indus Civilization*, 3 Vols., London, 1931.

Menninger, K. : *Zahlwort and Ziffer* (Ger), Gottingen, 1957/58.

Marley, S.G. : *The Ancient Maya*, Stanford, 1947.

Miller, G.A. : 'Our Common Numerals', *Science*, N.S. LXXVIII, 1933, pp. 236-37.

Moneir Williams : *A Sanskrit-English Dictionary*, New Delhi, 1970.

Needham, Joseph : *Science and Civilization in China*, Vols. 1 and 3, Cambridge, 1954.

Neugebauer, O : *The Exact Sciences in Antiquity*, 2nd ed., Berlin, 1957.

Newman, J.R. (ed) : *The World of Mathematics*, 4 Vols., New York, 1956.

Ojha, G.H. : *Bharatiya Prachina Lipimana* (Hindi), New Delhi, 1959.

Oppenheim, (1) A.L. : 'An operational Devise in Mesopotamian Bureaucracy', *Journal of Near Eastern Studies*, Vol. 17, 1958, pp. 121-128.

Idem, (2) : *Ancient Mesopotamia* (Revised edn.), Chicago, 1977.

Pal, B.P. : *Wheat*, Indian Council of Agricultural Research, New Delhi, 1960.

Pande, B.M. : 'Inscribed Copper Tablets from Mohenjo-daro : A Preliminary Analysis, in *Ancient Cities of the Indus*, (ed) Gregory Possehl, New Delhi, 1985.

Parpola, Asko (1) : 'Tasks, Methods amd Results in the Study of the Indus Script', *Journal of the Royal Asiatic Society*, 2, 1975, pp..

Idem, (2) : 'The Meluhha Village: Evidence of Acculturation of Harrapan Traders in late third Millennium Mesopotamia', *Journal of Economic and Social History of the Orient*, 20, 1977, pp. 129-65.

Idem, (3) : 'New correspondence between Harappan and Near Eastern Glyptic Art', in *South Asian Archaeology*, 1981, (ed). B.Allchin, Cambridge, 1984, pp. 176-195.

Parpola, S., Parpola, Asko and Brunswing, R.H. (Jr) : 'The Indus Script'. *Journal of the Royal Asiatic Society*, 2, 1977, pp. 178-209.

Peterson, R.F. : *Wheat* (World Crop Series), London, 1965.

Pochlman, J.M. and Dhirendranath Borthakur : *Breeding Asian Field Crops*, Calcutta, 1969.

Purseglove, J.W : *Tropical Crops, Monocotyledons and Dicotyledons, Essex*, U.K. 1981.

Puskas, Ildiko : 'Society and Religion in the Indus Valley Civilization'. in *South Asian Archaeology*, 1981, 1981, (ed). B. Allchin, Cambridge, pp. 162-165.

Rao, S.R. (1) : *Lothal and the Indus Civilization*, Bombay, 1973

Idem, (2) : *The Decipherment of the Indus Script*, Bombay, 1982.

Rawlinson, G. : *History of Egypt*, Vol. 1, London, 1908.

Ray, S. : *Indus Script Memorandum*, 1 & 2, New Delhi, 1963-65.

Ross, Alan, S.C. : *Numerical Signs of the Mohenjo-daro Script, Memoirs of ASI*, 57, New Delhi, 1938.

Saggs, H.W.F. : *The Greatness that was Babylon*, 'Mathematics, Astronomy and Medicine', London, 1962, pp. 399-428.

Samuel. A.E. : *The Mycenaeans in History*, New Jersey, 1966.

Sankaḷia, H.D. : *The Prehistory and Proto-history of India and Pakistan*, 2nd edn., Pune, 1974.

Schmandt-Besserat, D. : 'From Tokens to Tablets : A Re-evaluation of the So-called Numerical Tablets', *Visible Language*, Vol. XV, 4, 1981. pp. 321- 344.

Idem, (1) : *The Emergence of Recording*, Research Report, University of Texas, Austin, 1989.

Idem, (2) : 'The Earliest Precursor of Writing', *Scientific American*, 238, 1978, pp. 50-59.

Idem, (3) : 'The Decipherment of the Earliest Tablets', *Science*, 2, 11, 1981, pp. 283-285.

Scriba, C.J. : *The Concept of Number*, Mannheim/Zurich, 1968.

Sircar, D.C. : *Inscriptions of Ashoka*, Delhi, 1957.

Idem, : *Indian Epigraphy*, Delhi, 1957.

Smith, D.E. : *History of Mathematics*, Vol. 1, Boston, 1923.

Spence, Lewis : *The Myths of Babylonia and Assyria*, London, MCMXVI.

Stanford, Vera : *A Short History of Mathematics*, London, 1950.

Struik, J.W. : *A Concise History of Mathematics*, 2 Vols, Chicago, 1928.

Subbarayappa, B.V. : 'The Rigvedic People: A New Approach to their Identity' *(under publication in M.S.Nagaraja Rao Felicitation Volume).*

Swain, J.W. : The Ancient World, New York, 1950.

Thapar, B.K. (1) : 'Relationship of the Indian Chalcolithic Cultures with West Asia', in *Indian Prehistory*, (eds) V.N. Misra and M.S. Mate, Poona, 1965.

Idem, (2) : 'Comments on the Indus Civilisation: Its origins, authors, extent and chronology, by A. Ghosh', in *Indian Prehistory*, (eds) V.N. Misra and M.N. Mate, Poona, 1965..

Idem, (3) : 'New Traits of the Indus Civilisation of Kaliangan: An Appraisal', in *South-Asian Archaeology*, (ed.) Norman Hammond, Park Ridge, 1973, pp. 85-104.

Thapar, Romila : 'A Possible Identification of Meluha, Dilmun and Makan', *Journal of the Economic and Social History of the Orient* , 18, Pt.I, 1975, pp.1-42.

Thomson, Campbell R. : *A Dictionary of Assyrian Botany*, London, 1949.

Van der Waerden, B.L. : *Science Awakening*, 2nd edn. New York, 1961.

Vats, M.S. : *Excavations at Harappa*, 2 Vols., Calcutta, 1940.

Ventris, M. and Chandwick, J. : 'Evidence for Greek Dialect in the Mycenaean Archives', *Journal of Hellenic Studies*, Vol. 73, 1953.

Wallis Budge, E.A. : *An Egyptian Hieroglyphic Dictionary*, London, 1920.

Wheeler, M. : *The Indus Civilization*, 3rd edn., Supplement to the Cambridge History of India, Cambridge, 1968.

Zeuner, F.E. : *A History of Domesticated Animals.* London, 1963.

Zvelebil, Kamil, V., : *Dravidian Linguistics: An Introduction*, Pondicherry, 1990.

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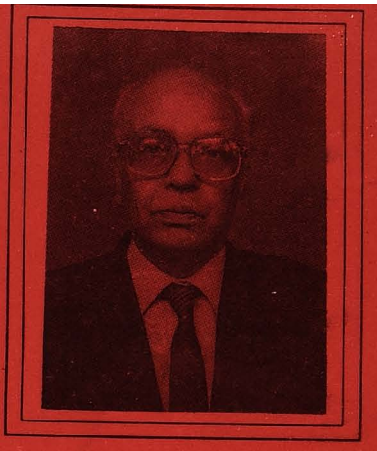

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