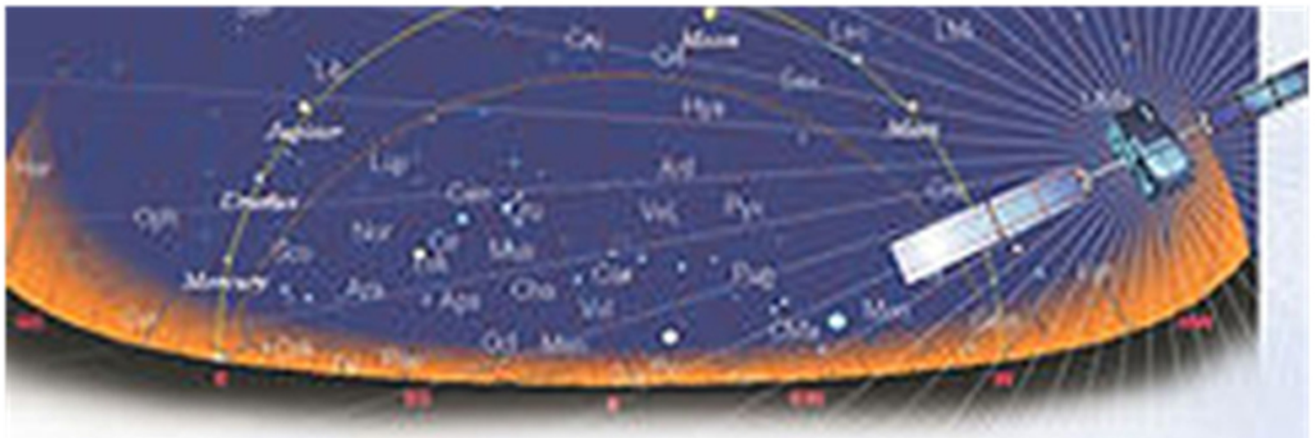
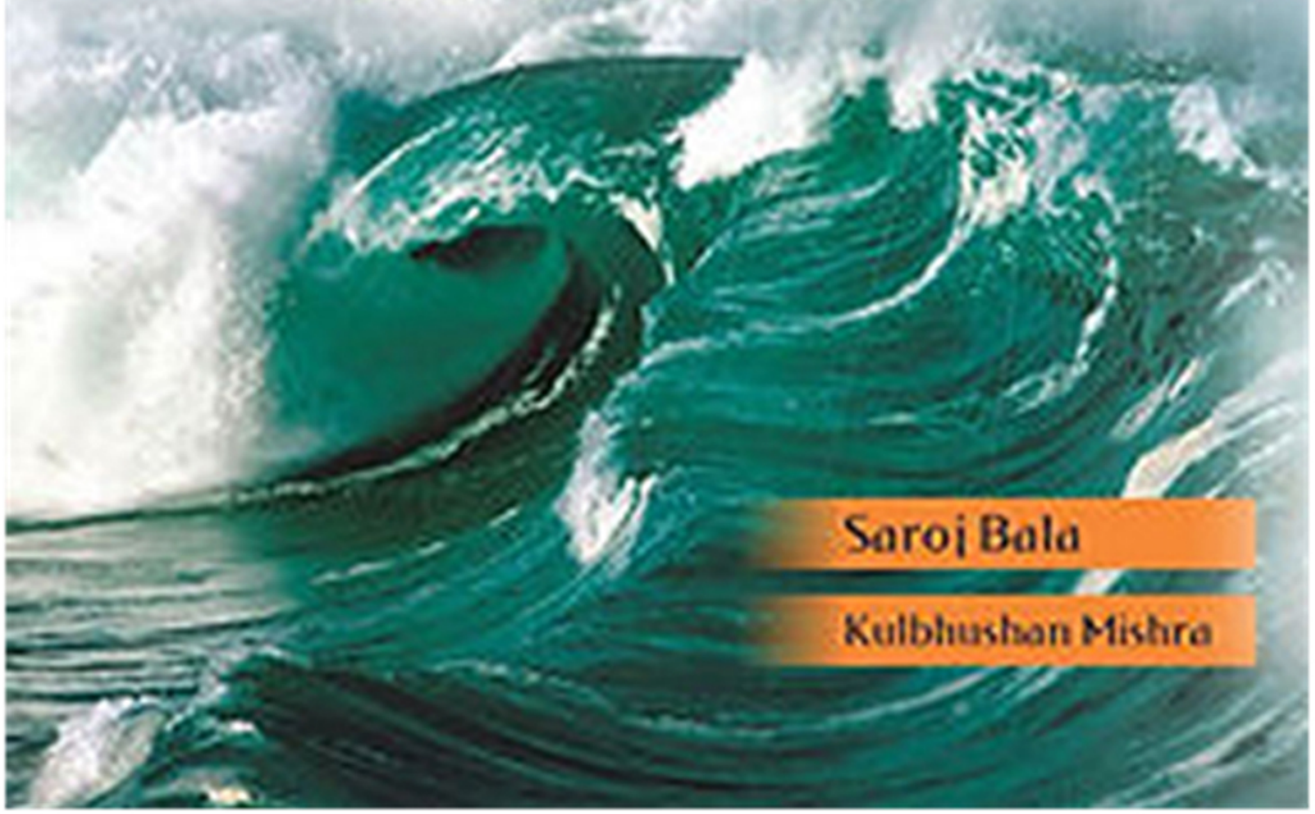


Historicity of Vedic and Ramayan Eras

Scientific Evidences from the Depths of Oceans to the Heights of Skies



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Institute of Scientific Research on Vedas
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Email: vedakavi@gmail.com Web: www.serveveda.org

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&

I-SERVE Delhi Chapter

C-II/107, Satya Marg, Chanakyapuri, New Delhi-110021

Phone : Mob: 09811343548

Email: delhichapter@serveda.org / sarojbala044@gmail.com

NATIONAL SEMINAR

on

Scientific Dating of Ancient Events before 2000 BC

Astronomical Dating of Planetary References in Ancient Sanskrit Manuscripts by making use of Planetarium software

&

Correlation of such Astronomical Dates with Corroborating Archaeological, Geological, Anthropological, Paleobotanical, Oceanographic, Ecological and Remote Sensing evidences

Organised by

I-SERVE Delhi Chapter

on

30th and 31st July, 2011 at New Delhi

(The Book includes proceedings of the Seminar and a Summary in Hindi)

Papers Presented
During the Seminar

An Overview of the Research Project:
Scientific Dating of Ancient Events before 2000 BC

Astronomical Dating of Planetary References in Rigveda
and Epics using Planetarium Software

Origin and Development of Civilization in the Indian Sub-continent
during last 8000 years: An Archaeological Perspective

Radiometric Dating of Records of Ancient Cultures in India

Archaeobotanical Evidences of Ancient Cultures in Indian Sub-continent

Genetic Profile of the People of India during Holocene: Some Inferences

Ancient Indian History is not Mythology — A Multi-media Presentation

Sea Level Fluctuations during last 15000 years and their Impact
on Human Settlements

Signatures of Paleo-Rivers Networks in North Western India:
Inputs from Remote Sensing

Geographic Evidences of Places and Rivers referred to in
Rigveda and Epics

Public Welfare and Business Opportunities
created by this Research Project

Contents

Preface

History of the world, particularly of Indian sub-continent, recorded so far is based on linguistic guesswork and religious beliefs/hearsay. However, during last 30-40 years, several new scientific tools and techniques have been developed, which are capable of determining the dates of ancient events in a scientific and precise manner. *For example:*

(a) Planetarium softwares for astronomical dating of planetary references

(b) Satellite based Remote Sensing techniques

(c) Underwater explorations and Geospatial technologies

(d) Radiocarbon dating, Thermo Luminescence dating methods

(e) Human Genome studies, Biological and Cultural Anthropology

(f) Paleobotanical, Paleozoological and Paleoclimatic studies

(g) Geographic and Geological research tools.

2. Multi-disciplinary scientific research reports, prepared during last three to four decades by making use of such scientific tools and techniques, are capable of determining the historicity and dates of ancient events with precision which lend credibility to ancient books and manuscripts. **I-SERVE Delhi Chapter** of Institute of Scientific Research on Vedas undertook research on the **Scientific Dating of Ancient Events from Rigveda to Aryabhatiam**, which had two parts:

- **To ascertain astronomical dates of planetary references in ancient Sanskrit manuscripts by making use of planetarium software.**
- **To correlate such astronomical dates with corroborating archaeological, anthropological, paleobotanical, geological, ecological, oceanographic and remote sensing evidences.**

3. The research team worked with two important objectives:

- To highlight the fact that some new scientific tools and inventions can scientifically determine the authenticity and historicity of ancient

events and as such any reliance on any religious beliefs or linguistic guesswork is not necessary. Such scientific dating is not only credible and convincing but is also likely to push back the antiquity of our civilization by 4-5 millennia, giving all Indians a shared pride in our rich cultural heritage.

- To persuade the central and state governments to incorporate such research outcomes in books meant for schools and colleges all over India so as to enable the young minds to appreciate our true history, reconstructed purely on scientific basis. These research reports are already available with the Ministries of Science & Technology, Earth Sciences, Water Resources and Culture.

4. Dr. D.S. Kothari, a highly respected nuclear physicist once said, "How can we lament lack of national pride in Indians, without first acquainting them with country's phenomenal scientific achievement in the dim distant past?" Scientific knowledge cannot be rooted in mythology; it can only be based on reality and can only be extracted from the books/manuscripts narrating the true events of the past. Therefore the Research Team of Institute of Scientific Research on Vedas aimed at determining the historicity of ancient events on purely scientific basis. This research team, consisting of Sanskrit scholars, astronomers, archaeologists, anthropologists, geologists, oceanographers and other subject experts, after carrying out research for more than three years, decided to place research outcomes before the scientists/original researchers and the public in respect of the first part *i.e.* **Scientific Dating of Ancient Events Before 2000 BC.** A two days' National Seminar on this subject was therefore held on 30th and 31st July, 2011 at Indian Institute of Mass Communication (IIMC) in New Delhi.

5. Multidisciplinary and purely scientific research reports presented at the Seminar prima facie established that the history of civilization of the world, particularly of Indian sub-continent, after the last ice age is much older than what is being taught in schools and colleges. The premise, that in 1500 BC India was civilized by the Aryan invaders from Central Asia, is based only on linguistic guesswork and has no scientific basis. Most of the scientific research reports have proved that indigenous civilization has been developing in India for last more than 10,000 years. Since these reports are neither being included in school/college books nor are normally being reported in print and electronic media,

therefore 99 % of Indians are unaware of 99 % of factual findings contained in such research reports. As the readers will go through the contents of this book, they would probably find it rather difficult to absorb some of the outcomes of scientific research reports which disprove many of their beliefs known from their school days! Their inquisitive minds will seek answers to many more questions; if even some of these questions get answered in a credible and convincing manner, the objective of publishing this book would stand achieved:

(a) The astronomical dates of planetary references in ancient Sanskrit books, calculated so far by using planetarium softwares, indicate the development of an indigenous civilization in India from dates even prior to 7000 BC. Astronomical references in Rigveda represent the sky view of dates belonging to the period 7000 BC to 4000 BC and those mentioned in Valmiki Ramayan refer to sky views seen sequentially on dates around 5100 BC. **Were these dates exclusive and did these match sequentially?**

(b) The ecological references in ancient books, especially those relating to melting of glaciers and fluctuations in water volumes of ancient rivers seem to corroborate such astronomical dates. Remote Sensing pictures taken by ISRO, corroborated by sedimentology, hydrogeology and drilling data, have revealed that a mighty river system was flowing around 6000 BC from Himalayas to Rann of Kachchh, passing through Himachal Pradesh, Punjab, Haryana and Rajasthan, exactly matching the descriptions of Saraswati in the Vedas and Epics. **What name could be given to this river system, if not Saraswati?**

(c) Recent research reports on paleoclimatic changes have revealed that, after the last ice age and in the beginning of the Holocene, the glaciers naturally first melted near the equator *i.e.* in Sri Lanka and south India, and civilization started developing on the banks of the rivers which started flowing there. When populations multiplied, these river waters became insufficient and some more adventurous people started travelling from south to north. Such northward migration continued for several centuries and finally when these people reached the banks of Himalayan Rivers, they got climatic conditions conducive to long term development of civilization on the banks of these rivers providing security of water, food and shelter. Thousands of years later, when some of these Himalayan **rivers** became non-perennial or started drying up, some of these people moved towards Central Asia, West Asia and Europe. As per ecologists**,** this ecological

cycle has been repeating itself and will get repeated after every ice age. **So did any Aryans really come from Central Asia to civilise the people of India or the dispersal probably happened the other way round?**

(d) The oceanographic reports on fluctuations of water levels in the oceans have revealed the existence of many coastal archaeological sites, either submerged or now found land locked, dated from 7500 BC onwards *e.g.* a Neolithic site near Hazira, Dholavira, Juni Kuran, Surkotda, Prabhas Patan and Dwarka in Gujarat. **Do these reports corroborate the astronomical dating of those ancient events with which these places are connected in our Epics?**

(e) The paleobotanic research reports have reported that certain cultivated varieties of plants, trees and herbs, which are mentioned in Vedas and Epics, have existed in India continuously for more than 8000-10,000 years. **Since these remained in use continuously, was there any abrupt end of ancient Indian civilization as is normally believed?**

(f) The anthropological research reports have established that DNA dating for Paleolithic continuity starts from 60,000 BC. The Genome studies during the Holocene have revealed that the genetic profile of humans settled across all parts of India, in north, south, east and west is the same and has remained the same for the last more than 11000 years and that it does not match the genetic profile of people from Central Asia or Europe. **Therefore, contrary to the popular belief, do the Dravidians, tribals, as well as the north Indians have common ancestors?**

(g) The latest archaeological excavations have revealed a large volume of data which has proved the indigenous origin and development of civilization in the Indian sub-continent since 7000 BC. Some examples are: Mehrgarh, Kot Diji and Nausharo in the northwest; Lothal and Dholavira in the west; Lahuradeva, Jhusi, Tokwa and Hetapatti in the east. **Is archaeology also supporting the astronomical, ecological and anthropological conclusions that Aryans were original inhabitants of India, who have been developing an indigenous civilization in India for last more than 10,000 years?**

6. **His Excellency Dr. A.P.J. Abdul Kalam** was an important source of inspiration for the research team and his presence to inaugurate the first seminar on the subject boosted the morale and reinforced the commitment of the research team to reconstructing the ancient history of the Indian sub-continent on purely

scientific basis so that it could become a source of shared pride for all Indians in their rich and most ancient cultural heritage.

7. This methodology of multi disciplinary scientific research was applied in some greater detail by the Director of I-SERVE Delhi Chapter for dating the era of Lord Ram. The results were outstanding, rather amazing! A summary of the conclusions arrived at reflecting credible and convincing correlation of archaeological, genealogical, anthropological, paleobotanical, geological, ecological, oceanographic and remote sensing evidences with the astronomical dating of important events in Lord Ram's life is included in the form of an article in this compilation.

8. The world has come a long way after the old Christian belief that the earth was created on 23rd October, 4004 BC and therefore events relating to the period earlier than that had to be treated as mythology. The beginnings of the Holocene are now placed around 12000 BC by pushing these back by about three thousand years. Therefore the history of the development of civilization of the world post last ice age has to start at least 11,000 years ago. Consequently not only the history of India but also the history of the whole world has to be re-constructed based on such multidisciplinary scientific evidences. As a result not only ***Ramayan*** and ***Mahabharat*** but also epics like ***Iliad and Odyssey*** are likely to shift from the realm of mythology to the realm of history. This research project and the first seminar on the subject mark the beginning of this new idea.

9. **In future, the Universities of the world may not place History as a subject under Faculty of Social Sciences or of Arts, but this subject deserves to be placed under the Faculty of Sciences**. Yes, it should be designated as a multi disciplinary science subject! The history should be scientifically reconstructed as well as taught by the scientists from different disciplines of science and doctorates on the subject should be awarded not to individuals but to multi disciplinary research groups working under teams of scientists as guides. A small beginning being made in that direction in the form of this book is placed at the feet of God Almighty with the prayer that let the people of the world be inspired to rewrite the history of the world, particularly of the Indian sub-continent, by correlating the research reports from different disciplines of science with the astronomical dating of events narrated in ancient books. Let us objectively and scientifically determine if Vedas, Upanishads, Epics, Buddhist and Jain literature etc. contain any

references to true historic events and therefore contain any worthwhile scientific knowledge, the rediscovery of which may help in improving the quality of our lives because human beings are the products of the past and live immersed in it and the future of mankind depends on true appreciation of its past!

New Delhi — **Saroj Bala**
April 13, 2012
(Baisakhi Day)

Acknowledgements

Institute of Scientific Research on Vedas is extremely grateful to **His Excellency Dr. A.P.J. Abdul Kalam** *(former President of India)* for his adorable presence as the Chief Guest and for delivering highly informative inaugural address which set the tone as well as the standard of the presentations made during the Seminar. We are indebted to **Shri Pawan Kumar Bansal**, *Hon'ble Minister for Parliamentary Affairs and Water Resources*, for delivering a befitting valedictory address emphasizing the need for coordinated multi-disciplinary scientific research which has the potential of converting much of so called mythology into history. We are indeed grateful to **Hon'ble Justice Ashok Bhan**, **Shri Jawhar Sircar**, **Shri Manbir Singh** and **Smt. Poonam Kishore Saxena** for raising the prestige of the Seminar with their graceful presence and for enriching its deliberations with their words of wisdom.

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We desire to acknowledge with gratitude the extraordinary contribution made by our session speakers who prepared and presented papers of such high standard, condensing outcomes of more than forty years of research carried out in their respective subject areas, in such a simple and convincing manner. We feel proud to have such Experts on our Panel and express our whole-hearted gratitude to them for raising the standard of deliberations during the Seminar with their presence, participation and contribution. Our experts included astronomers, archaeologists, palaeobotanists, geologists, ecologists,

anthropologists, oceanographers, space scientists, historians, Sanskrit scholars, academicians and indologists. Their names have been listed in the chapter **Seminar Details – Sessions and Panel Experts**. Further, we also take the opportunity to extend our sincere thanks to a number of other scholars and participants, who had come from all over India, to make the Seminar more enlightening as well as interesting through their active participation and involvement.

We are extremely grateful to several friends and colleagues who provided very valuable help in developing, compiling and editing of this book. Our special thanks are due to Dr. Krishnanand Sinha for giving valuable inputs and for providing Hindi translation of the "Summary and Recommendations" of the Seminar proceedings. Special thanks are due to Shri Ashok Bhatnagar for his critical suggestions and valuable inputs which helped us in modifying and improving the quality of the contents of this book. Profound thanks are also due to Smt. Vinita Surie, Smt. Divjot Kohli, Ms. Monica Bhatia, Shri Nilimesh Barua, Shri Arun Bhatnagar, Shri Rakesh Mohan, Shri Khushi Ram and Shri Nirmal Nangia for their unstinted support and all round help in making the Seminar a success. Our very special thanks are due to Shri K.N. Dikshit, *General Secretary, Indian Archaeological Society, New Delhi* and Dr. B.R. Mani, *Addl Director General, Archaeological Survey of India* for their inputs and valuable suggestions.

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— Saroj Bala

Inaugural address delivered by His Excellency Dr. A.P.J. Abdul Kalam
Former President of India on 30.7.2011

Past Meets the Present Leading to a Better Future

"The DNA of a human being is his history book ever written"

I am indeed delighted to participate in the inauguration of Seminar on Scientific Dating of Ancient Events Before 2000 BC at New Delhi. My greetings to all of you. Friends, I am happy that all of you are engaged in the mission of establishing synergy between the scientific wisdom of ancient India and modern scientific inventions in various areas such as agriculture, energy, medicine, weapon systems and metallurgy. I am sure this type of study will enable us to utilize the scientific techniques used by our ancestors and lead towards an eco-friendly planet earth for the present and future. When I am here with all of you, I would like to share my thoughts on the topic ***"Past meets the Present Leading to a Better Future"***.

Friends, when you are all working on scientific dating of epics particularly Ramayana I would like to share with you my personal experience. I was born in British India in Rameshwaram and grown there for 16 years. Every part of Rameshwaram Island is known to me in great detail, because as a young boy I used to travel to all parts of the Island to deliver the news paper daily to various houses. In my eyes Gandhamanaparvatham appears from where Rama is supposed to have seen Srilanka. In front of me appears the famous Kothanda Ramar Temple of Rameshwaram. Also I see the Ramateertham, Lakshmanateertham and Jatayuteertham and Agniteertham in different areas of Rameshwaram. The central point is the Ramanathaswamy Temple where we find the Siva linga which Lord Rama had worshiped. Today being the new moon day of Adi month, minimum 3 Lakh pilgrims from different parts of the country will be converging at Rameshwaram for sea bath. On this day, Lord Rama is

supposed to have taken the bath in the Rameshwaram Sea after returning from the war to remove the Doshas of killing Ravanan. Thousands of pilgrims visit the Island every day and enjoy its beauty and spirituality. I will be the happiest fellow, if through scientific dimensions, we establish the places from where Lord Ram, Lakshmana, Hanuman, Sugreeva and the Vanara sena created a base before launching the war on Srilanka. Really I have a profound interest in scientific dating of Ramayana.

Dating of events leads to transforming mythology into history

Vedic and post-Vedic literature has a tremendous amount of scientific knowledge which will be extremely beneficial to humanity. For creating a faith in these documents, there is a need to establish the date of creation of Vedas and Upanishads, so that they are transformed into historical events and not imaginary mythological events. I am happy that this is what the researchers in astronomy, ecology, theology, archaeology, anthropology and space science assembled here have carried out and are in the process of demonstrating it to the modern scientific world.

If we look at the study on Scientific dating of Ramayana, the important aspect about the Ramayana is that when Valmiki composed the epic, he made it with many proofs. He packed so much information about the various planetary positions of those days, the geography of the areas mentioned in the epic, the seasonal events, and about the genealogy of various kings that it is virtually a no-brainer to establish the dates on which those events occurred.

Genealogical links and archaeological findings provide clues to the dating of the Ramayana era. According to writer B.R. Haran, in no other nation and no other religion in the world, true history is so meticulously documented, supported by many evidences. Any ancient history is supported with evidences of architecture and literature. The Sangam literature is the documented evidence for the existence and rule of Tamil kings, and similarly, Ramayana and Mahabharata are the documented evidence for Rama and Krishna. Archaeological and literary methods can only provide approximate datelines. For determining the precise time of the Ramayana events, scientists use astronomical calculations. Several of India's leading astronomers and scientists have come together to establish the dates of India's ancient history.

So how is astronomical dating done? Says eminent historian Dr. P.V. Vartak:

"Sage Valmiki has recorded the dates of events in detail, albeit by describing the positions of stars and planets. To decipher the astronomical encodings has not been a trivial task, and not many have attempted to do so. It should be noted that the ancient Indians had a perfect method of time measurement. They recorded the 'tithis', days according to the nakshatra on which the moon prevailed, the months, the seasons and even the different solstices. By noting a particular arrangement of the astronomical bodies, which occurs once in many thousand years, the dates of the events can be calculated."

Dr. Vartak has taken hundreds of illustrated passages from the epic to establish dates. Valmiki records the birth of Rama as Chaitra Shuddha Navami (9th), on Punarvasu Nakshatra and five planets were exalted then; Sun in Mesha up to 10 deg., Mars in Capricorn at 28 deg., Jupiter in Cancer at 5 deg., Venus in Pisces at 27 deg. and Saturn in Libra at 20 deg. (Bala Kanda.18/Shloka 8,9). Dr. Vartak determines December 4, 7323 B.C. as the date of birth of Rama, when the four planets were in exalted position. As per above calculation based on four planets, Ramayana occurred over 9300 years ago.

Rigveda talks about an advanced civilized predominantly urban and maritime society which had used variety of ships, boats and 75 different types of houses which include hutments and palaces. Vedic literature reveals that Indians had very advanced knowledge of mathematics and were possessing extraordinary knowledge of astronomy. Takshila University was established in 700 BC where more than 10,000 students from all over the world studied more than 60 subjects. Similarly, Nalanda university was in existence in 3rd century BC which had housed more than 90 lakh books. Maharishi Atreya was the first Guru of internal medicine, Shri Dhanvantri of Surgery and Kashyapa was the first Guru of Gynaecology and pediatrics. Shushruta Samhita describes more than 40 types of surgical instruments and Ayurveda talks about holistic treatments.

Astronomical calculation making use of planetarium software have proved that events narrated in Valamiki Ramayana actually occurred around 7000 years back and they can be sequentially dated. Ramasetu is found submerged at the same location as is described in Valamiki Ramayana and the city of Dwarka has been explored by marine archaeology wing of Government of India.

As per the estimate made by the Inter-Governmental panel on Climate Change (NASA, Global Change Master Directory), the rise in the sea level during the last 7000 years has been about 2.8 meters which roughly corresponds to 9.3 feet.

The remains of Rama Sethu are found submerged nearly at a depth of 9-10 feet. Thus, obviously this bridge was capable of being used as a land route 7000 years back. This is the only existing evidence on manmade bridge a few thousand years back. It is essential that our researchers launch a mission-oriented programme in an integrated way by earth science, geological science, remote sensing and space scientists, oceanography and climate change teams and the people who are engaged in construction under the sea.

Here I request the researchers to launch research on India's epics with at least 100 Ph.Ds with the highly talented historical, geological, astronomical and space scientists to ascertain the veracity of history and date of events in our epics. Science always has multiple sources of research information to verify the conclusion. It should be true to all our research on epics and their dating.

Let me now discuss the work of Prof Tobias on human evolution.

Human Evolution

I was studying the work of Prof. Tobias on Paleo-anthropology and discovery of archaeological sites and I thought of recalling the advances made in the research on human evolution. Traditionally, there have been two distinct and different approaches in understanding human evolution. First is the archaeological evidence. The lessons that we have learnt in India from Mohen-jo-Daro and Harappa and many similar excavations the world over have been seminal and many a civilizations' way of living, its culture and its origins have become evident.

Prof. Tobias has made a significant impact in this area, particularly emanating from land, which is said to be the cradle of human evolution. The second and more recent approach is propelled by advances in our understanding of the human genome. While the major part of the human genome sequence is common between human beings and even with mice, there are small portions that differ, control and contribute to the diversity that we find in the evolution of humans.

I am happy that through such genomic studies, it has been found that Harappan civilization was not of mysterious people of unknown biological origins, or migrants from centres of high culture in western Asia, but they were descendents of population identified with pre-Harappan cultures of the North Western sector of the sub continent. Gene flow between Mesopotamia and the Indus domains,

perhaps along trade routes, accounts for the higher incidents of some phenotypic features along this east-west axis than what is apparent across north-south axis penetrating peninsular India. But migrant theory need not be invoked to explain various patterns. This makes research in genetic engineering, using human genome sequences to understand the evolution of humans, very fascinating for scientists. **The scientific dating of our epics has also to co-relate genealogies mentioned therein with human genome sequences, and the evidences that we found in the form of fossils**.

Prof. Tobias is one of the pioneers in the area of genetics. From his vast experience in genetics and Paleo-anthropology, Prof. Tobias has been able to present to the world, in an understandable capsule form, the whole process of human evolution over 600 million years. The simplicity of the outcome of his complex research has also stimulated many scientists the world over to look at the challenges posed in our understanding of human evolution. Today, the world talks about convergence of many technologies. Prof. Tobias and others have shown us that all our origins converge to a single point both in space and time. The evolution of human origins put forth by Prof Tobias should be related to events of Indian epics. After all, every Indian epic deals with human history, their conflicts and their civilization. Hence, it has to be related with the evolution of human origin.

Origins of Life

Ancient human history has been revealed beautifully by Paleoanthropology. Life originated 600 million years ago and continental drift occurred 200 million years ago creating five continents. Mammals evolved 140 million years ago, Hominids that is the human type, evolved 26 million years ago but modern man only arrived on the scene some 200,000 years ago. He migrated and colonized the world only in the last 50,000 years. The spoken language is some 10,000 years old while writing evolved only a few thousand years ago. All this phenomenal progress has been achieved only within the short span of 200 to 400 generations that is in just 10,000 to 5,000 years. **The spoken language period as per Prof. Tobias is around 10000 years old and the birth of Rama based on the 9th thithi of Chaitra month dates to 10th January in 5114 BC, that is 7117 years back. We need to establish the relationship between the birth of spoken language and the evolution of Valmiki Ramayana.**

New DNA technologies

Newer DNA technologies have given us better insight in retracing the history of man. The DNA of a human being is his history book ever written!. Nowadays, intelligence, cognizance, drug response, behavioral problems, everything, is related to genes: disease gene mapping is progressing at a faster pace with new age DNA technology. It is probably during the 30,000-50,000 years of co-existence that societies have evolved adopting newer innovations and cultures.

Thus the 'Nature - Nurture' philosophy holds good even in this Genomic Era: What we inherit from our parents is the basis; a beautiful 'building' is built over it, be it Einstein or certain unique creations, the environment plays a crucial role in shaping the destiny of the individual and leading to excellence. It is just the opportunity that makes Man. All children when they are born are equally poised to become great scholars. The nervous system, and for that matter any of our systems, should co-operate with an individual in his or her progress.

Origin of civilization in Indian sub-continent

I am happy that through the use of modern technology the perception of Indian Archaeology has changed and has facilitated researchers to prove an indigenous origin of civilization in the Indian sub-continent. This is an important factor which should work as an integrator of the entire nation since all of us have come into this land from the same ancestors and roots. While discussing this issue, I am reminded of a conversation with one of my cardio thoracic surgeon friends. He said, "When I perform an open heart surgery, on different patients, after opening I find the blood of the patient is same in colour, hence I cannot discriminate amongst patients and provide differing attention and care." This thought-process has to get embedded scientifically and culturally amongst all Indians so that we can see that nation is bigger than any individual and all of us have to contribute to the accelerated progress and development of the nation. Now, let me talk about certain application of knowledge derived from Scientific Dating of Ancient Events.

Agriculture in Ancient India

The dating studies have found that the farmers in the Vedic period used natural manures for their agriculture. They have found 12 types of soil and determined

the associated organic manure compatible to the soil types. They did not make use of pesticides or any poisonous elements in the agro sector. This has resulted in reduced environmental pollution and also provided quality food for the humankind. We have to learn a lot from this experience. Today, we have to ensure that we should use eco-friendly fertilizers, pesticides and plant systems in our overall agricultural development taking the cue from ancient civilization that will make a big contribution to green agriculture goal of 21st century. **We need to integrate our past civilizational heritage in forms of agriculture or other forms of systems which provides earning capacity with reference to modern technologies. Induction of modern technology definitely adds values to our ancestor database of civilizational heritage.**

For the mission for scientific dating of our epics, I have the following suggestions:

1. Launching research on India's epics with at least 100 Ph.Ds with the highly talented historical, geological, astronomical experts and space scientists to ascertain the veracity of history and dates of events in our epics.

2. The scientific dating of our epics has also to be related to Genealogy with human genome sequences, with the evidences that we found in the form of fossils.

3. The evolution of human origin put forth by Prof Thobias should be related to events of Indian epics. After all, every Indian epic deals with human history, their conflicts and their civilization. Hence, it has to be related with the evolution of human origin over 600 million years ago, which is scientifically proven.

4. The spoken language period as per Prof. Thobias is around 10000 years old and the birth of Rama based on the 9th thithi of Chaitra month dates to 10th January in 5114 BC, that is 7117 years back. We need to establish the relationship between the birth of spoken language and the evolution of Valmiki Ramayana.

Conclusion

I have discussed few areas which can benefit from the dating of our ancient events. I am sure the scientists and technologists assembled here will be presenting several areas in which the dating can be beneficial. To disseminate the findings of these studies to the large population will require intensive documentation

and the application potential of each one of the findings. I would suggest that the teams assembled here can work out areas which need to become the part of the learning process of our youth. This will enable the seminar to make specific recommendations on vital areas of our ancient culture in the primary, middle and secondary school text books. In addition, the seminar should attempt networking of people and ideas belonging to different specialities like agro-scientists, doctors, engineers, archaeologists, geologists and environment experts so that the benefits of lessons arising from earlier civilization and their lifestyle make a change to our thinking and lead towards the development of an eco-friendly human habitat. **The research on scientific dating may have partners, who can provide scientific, astronomical, anthropological and geological and genetic data to ascertain the veracity of the historical events**.

With these words, I inaugurate the Seminar on Scientific Dating of Ancient Events before 2000 BC. My best wishes to all the participants for success in *the mission of connecting the past to the present leading to a better future.*

May God bless you!

— Dr. A.P.J. Abdul Kalam

Background, Theme and Summary of the Seminar Proceedings

Institute of Scientific Research on Vedas (I-SERVE) was established on 21st June, 2004 under the chairmanship of Dr. K. V. Krishna Murthy and Shri. R Venkataraman, former President of India, as its Patron-in-chief, with the noble mission of establishing synergy between the scientific wisdom of ancient India and modern scientific inventions. It is recognized as Scientific and Industrial Research Organisation (SIRO) by Department of Scientific and Industrial Research (DSIR) and approved under section 35(i) (ii) of the Income Tax Act. The main objectives of I-SERVE are:

- To identify, collect and study Vedic and Post Vedic Indian Literature with the object of deciphering scientific theories, techniques and knowledge contained therein.
- To correlate the ancient scientific wisdom with modern sciences with the objective of developing nature-friendly and pollution-free technologies particularly in the fields of agriculture, energy, metallurgy and medicine.
- To carry out research into the authenticity and historicity of events narrated in ancient books by making use of modern scientific tools, which could provide common memories to different communities in India for developing a sense of shared pride in our rich heritage.

2. In pursuit of the 3rd objective, I-SERVE Delhi Chapter undertook research on the Scientific Dating of Ancient Events from Rigveda to Aryabhatiyam, which had two parts:

- **To ascertain astronomical dating of planetary references in ancient Sanskrit manuscripts by making use of planetarium software and**
- **To correlate such astronomical dates with corroborating archaeological, anthropological, paleobotanical, geological, ecological, oceanographic and remote sensing evidences.**

3. This research project, conceptualized by Saroj Bala, was approved and part funded by Rashtriya Sanskrit Sansthan, Ministry of Human Resource Development, Government of India. The research team proceeded with the premise that historic events are what actually happened during last thousands of years; their evidences are hidden under land and sea waters, therefore our knowledge so far is very limited. Reliance was placed on use of some new scientific inventions and tools for undertaking the scientific dating of ancient events through investigation of evidences. These evidences are not only those that lie buried under the land and the sea, but also those that are contained in our ancient books in the shape of planetary references**.**

4. The subject was very vast and our research has been very meticulous and thorough. The research team, consisting of Sanskrit scholars, astronomers, archaeologists, anthropologist, geologist and other subject experts, after carrying out research for more than two years, decided to place research outcomes before the scientists/original researchers and the public in respect of the first part *i.e.* **Scientific Dating of Ancient Events Before 2000 BC,** especially because the results of our research so far were very credible and convincing. Two-day National Seminar on this subject was therefore held on 30th and 31st July, 2011 in the auditorium of Indian Institute of Mass Communication (IIMC) at Aruna Asaf Ali Marg, New JNU Campus, New Delhi.

5. The National Seminar also proposed to bridge the gap between the information contained in research reports of our eminent modern scientists, available with the Ministry of Science and Technology and Earth Sciences on the one hand and the contents of our school and college books on the other. The history has to be looked at as history of events which occurred sequentially on our land during last thousands of years. This only can lead to shared national pride amongst all Indians in our ancient cultural heritage and scientific achievements of the dim distant past.

6. The Seminar was also supported by Ministry of Earth Sciences, Government of India. Nearly four hundred delegates from a variety of subject backgrounds such as Sanskrit scholars, astronomers, archaeologists, anthropologists, historians, geologists, ecologists, space scientists, oceanographers, bureaucrats, professionals, professors and students of various universities and academicians as well as other persons from the public and media, have participated. Presentations were made by many subject experts who have remained involved in the research and their

research papers have been published in journals of repute. These presentations were made before the subject experts, who enriched the deliberations with their presence and contribution.

7. **His Excellency Dr. A.P.J. Abdul Kalam** *(former President of India)* blessed the occasion with his venerated presence as the Chief Guest and delivered the inaugural address on 30th July. The text of this address is also available at *www.abdulkalam.com.* **Hon'ble Justice Sh. Ashok Bhan** *Chairman of National Consumer Disputes Redressal Commission (NCDRC)* and **Sh. J. Sircar** *Secretary to Govt. of India (Ministry of Culture)* were the Guests of Honor. While delivering the welcome address, **Sh. K. V. Krishna Murthy** *Chairman of I-SERVE* very appropriately pointed out that unfortunately, the world history particularly that of India so far is segmented and fragmented by the Eurocentric approach of the West and the mythological approach of the East. It is for the first time that the Delhi Chapter of I-SERVE has envisaged a totally scientific approach, which utilizes almost all available branches of sciences as its tools, to rediscover the real history not only of the Indian sub-continent, but of the whole world. Welcoming H.E. Dr. Kalam wholeheartedly he said, "this son of a fisherman from Rameswaram with his sheer wisdom, hard work and sincerity rose to become the President of India. This "ignited mind" hidden in a small pebble in the sands of Rameswaram, evolved into a venerated Bharat Ratna in 1997 and the President of Bharat in 2002." He is the people's president and lives in the hearts of all Indians.

8. **Mrs. Saroj Bala,** *Research Project Coordinator* gave a brief introduction of the subject of the seminar informing that astronomical, archaeological, anthropological, oceanographic and ecological research reports have revealed that the Aryan Invasion Theory was a myth based entirely on linguistic guesswork and religious hearsay. Multi-disciplinary scientific research has revealed that indigenous civilization has been continuously developing in India for more than 10,000 years and dispersal probably happened the other way round.

9. **Dr. A.P.J. Abdul Kalam** endorsed the scientific methods of dating of ancient events and emphasized that a mechanism needs to be built to disseminate the knowledge and information generated during the seminar amongst school and college children to generate a shared pride in our rich and most ancient heritage. His speech acted as a big motivating factor and as a morale booster for the research team of I-SERVE. He made many important recommendations, which included:

- *Launching research on India's epics with at least 100 Ph.Ds with highly talented historical, geological, astronomical and space scientists to ascertain the veracity of history and dates of events in our epics.*
- *The scientific dating of our epics has also to be related to Genealogy and with human genome sequences.*
- *The origin and human evolution put forward by Prof. Tobias should be related to events of Indian epics. After all, every Indian epic deals with human history, their conflicts and their civilization.*
- *The spoken language period as per Prof. Tobias is around 10,000 years old and the birth of Rama based on the 9th tithi of Chaitra month and sky view of planetary configurations at the time of birth dates to 10th January in 5114 BC, that is 7125 years back. We need to establish the relationship between the birth of spoken language and the evolution of Valmiki Ramayana.*

10. **The highlight of the program was the release of Seminar Memento, a Wall Clock depicting the sky view on 10th January, 5114 BC at 12:25 PM, the date of birth of Lord Ram, which also happened to be the Shukla Paksha Navami of Chaitra month. This sky view matched exactly the planetary configurations given in Valimiki Ramayan (1/18/8,9). The memento was dedicated to the memory of late Sh. Pushkar Bhatnagar, the original investigator. It was released by Dr. A.P.J. Abdul Kalam and the first clock was handed over to the mother of late Shri Pushkar Bhatnagar**.

11. The first speaker, **Shri Ashok Bhatnagar,** *Former Additional DG, India Meteorological Department and a founder Member of Astronomical Society of India,* presented a paper on **Astronomical Dating of Planetary References in Rigveda and Epics using Planetarium Software**. He elucidated the astronomical dates of planetary references in ancient books calculated by making use of planetarium software, indicating that Vedic astronomy was rather advanced and dates of many of the events mentioned in ancient books can actually be calculated by making use of such modern softwares.

(a) He further displayed that astronomical references in Rigveda represent the sky views of dates belonging to the period from 7000 BC to 4000 BC indicating evolution of calendric astronomy over millenia. Astronomical phenomena mentioned in Ramayan refer to sky views seen sequentially on dates around 5100 BC. He gave a live presentation on planetarium software and

generated pictures of sky view depicting planetary configurations narrated in Rigveda and Valmiki Ramayan.

(b) Shri Bhatnagar correlated the *richas* extracted from Rigveda with the sky views displaying the location of winter solistice in 7000 BC and in 6000 BC. He displayed the sky view generated by software to show that star Canopus, named after sage Agastya, became visible from Vindhyas only around 5100 BC. This confirmed the Pauranic legend and also correlated the references to sage Agastya in Rigveda as well as in Ramayan.

(c) He explained that Valmiki in Bal Kaand, Sarga 18, Shloka 8 & 9 (1/18/8, 9) has given the location of planets and stars on the date of birth of Lord Ram, which can be interpreted as follows:

(i) Sun in Aries
(ii) Saturn in Libra
(iii) Jupiter in Cancer
(iv) Venus in Pisces
(v) Mars in Capricorn
(vi) Lunar month of Chaitra
(vii) Moon near Punarvasu

All these configurations as seen from Ayodhya match only with the sky view of one date *i.e.* 10th January 5114 BC, which also happened to be lunar date of *Navami* of *Shukla Paksha* of *Chaitra* month, the date on which we all celebrate *Ram Navami*. These planetary configurations were not seen on any other date earlier than 5114 BC.

(d) The sky views on several other dates right from the start of *Putra Kameshthi Yajna* (15th January, 5115 BC) to start of journey to Lanka (*Uttara Phalguni Nakshtra* on 19 September 5076 BC) matched exactly the descriptions in Ramayan and that also sequentially. The sky view depicted in Ayodhya Kaand (2/4/18) was seen on the 5th January, 5089 BC when Ram was 25 years old and he had left Ayodhya for *van-gaman*.

(e) This presentation established in an extremely scientific manner that many of the events mentioned in Vedas and epics are real and these reflect continuous and indigenous development of civilization in India for the last 10,000 years and it is possible to ascertain their dates in a purely scientific manner.

12. **Shri Kulbhushan Mishra,** *Research Associate, Indian Archaeological Society, New Delhi,* spoke on the **Origin and Development of Civilization in Indian Sub-continent during last 8000 years: An Archaeological Perspective** and discussed

that the archaeological investigations carried out in the post-independence period in the Indian sub-continent have shed light on the origin and development of civilization from the northwest frontier on the west through Kashmir and the dried-up river beds of Saraswati–Drishadvati divide to the Ganga plain on the east.

(a) Various theories about the origin of civilization have been formulated by a number of scholars right from its discovery in 1921-22. During the last three-four decades or so, with the application of new methods and technology, the perception of Indian archaeology has changed significantly. As a result of these revised researches, we have an incredibly large volume of new data to prove the indigenous origin of civilization in Indian sub-continent. Foreign origin theories have taken a backseat now and the indigenous development theory is getting more and more support in the form of archaeological evidences.

(b) He elaborated that the latest archaeological excavations have revealed a large volume of new data that have proved the indigenous origin and development of civilization in the Indian sub-continent since 7000 BC. In this regard, he cited some examples such as Mehrgarh, Kot Diji and Nausharo in Indus valley in the north-west; Lothal and Dholavira in the west; Lahuradeva, Jhusi, Tokwa and Hetapatti in Ganga Valley in the east.

(c) He further described two major regions (east and north-western part) of Indian sub-continent wherein different phases from the beginning to the culmination of the civilization were attested, while elucidating the north-western region where the origin of village life was first documented at Kile Ghul Mohammad in 1956 and beginning was dated to 4th millennium BC. Thereafter, in 1974, excavations at Mehrgarh have pushed back the antiquity of settled village life to 7th millennium BC. Excavations have revealed seven occupational levels, giving striking evidence of continuous occupation and cultural development from 7th to 2nd millennium BC. Mehrgarh has also provided excellent evidence of technology, economy, material culture and social organization of pioneering farmers of South Asia.

(d) In the eastern region, the Mid Gangetic plain has a significant position in the history and archaeology of India which extends from the Himalayas in the north and Vindhyas in the south, Ganga-Yamuna confluence in the west and Bihar-Bengal border in the east. It includes eastern Uttar Pradesh and plains of Bihar. Archaeologically, this region has significantly enriched our knowledge and understanding about Neolithic/ Chalcolithic sites, material remains and

chronological sequence. In this region, excavations at Lahuradeva, Jhusi, Tokwa and Hettapatti have provided remarkable evidence about settled human occupation from 6th-7th millennium BC. At Lahuradeva and Jhusi, the earliest evidence of rice agriculture has also been found.

(e) While speaking on Harappan civilization, he elaborated that this civilization is mainly confined to the plains of Indus and Saraswati Valley. The regions covered by this civilization are Punjab in Pakistan and India; Haryana and Ganga-Yamuna Doab in western Uttar Pradesh; the northern and western tracts of Thar Desert in Rajasthan and the plains of north Gujarat including Kutch and Saurashtra. The excavations at many sites, particularly at Harappa, Mohenjo-daro, Kot Diji, Amri, Kalibangan, Dholavira and Bhirana have revealed that by 4th millennium BC the settled village societies started developing into urban settlements and this story of indigenous development of civilization continued thereafter.

(f) The major architectural characteristics of this civilization were planned cities having a citadel for the upper class and a lower town for the common people, with roads and streets running at right angles, private and public drainage system, generally covered with stones or bricks. The city is enclosed by a fortification with impressive gateways; public buildings like the Great Bath at Mohenjo-daro, dockyard at Lothal and granaries at several cities. The people of the Indus–Saraswati civilization had an excellent well-planned drainage system comprising public and private drains, further proving that the Indus–Saraswati people paid great attention to sanitation and cleanliness. The planning and management of the city indicates the existence of an active and efficient law to administrating the activities of the city and ensuring maintenance of cleanliness. The streets were paved with baked bricks and houses were provided with paved baths.

(g) The other characteristic features are sturdy wheel made pottery abundantly decorated by painted geometric and naturalistic motifs; pottery forms like goblets with pointed base, cylindrical pots with multiple perforations, jars with S-profile and dishes-on-stand; uniform chert weights and measures of metal and ivory; triangular terracotta cakes; uniform script depicted on steatite and other seals and tablets; fine Jewellery made of gold, silver, copper, ivory, shell, semi-precious stones, steatite, faience and terracotta; typical shapes of copper artifacts like bent-bladed knives, double-edged razors, barbed triangular arrowheads with holes etc.

(h) Consequently, the material testimonies of these excavations have shown gradual cultural developments from the 7th-6th millennium BC in the entire region of Indus-Saraswati-Ganga system for a period of more than eight thousand years. Contrary to the general belief, the civilization of the Indian sub-continent is deeply rooted in the cultures that existed since 8000 years ago and flourished in the 3rd millennium BC.

(i) While concluding the presentation, he furnished remarkable evidence from human biology and DNA against the supposed 'immigration' of the Vedic Aryans from Central Asia. He went on to explain that after an intensive research of a large number of human skeletons from various ancient sites in India, B.E. Hemphil and his colleagues have clearly shown that there was no immigration of any alien people between 4500 BC and 800 BC. Thus, archaeology is also supporting this conclusion that Aryans were originals of India, they have been creating and nurturing a continuously developing civilization for the last 10,000 years and dispersal probably happened the other way round.

13. **Dr. C.M. Nautiyal,** *Scientist-in-charge of the Radiocarbon Dating Laboratory at Birbal Sahni Institute of Palaeobotany, Lucknow,* spoke on the **Radiometric Dating of Records of Ancient Cultures in India.** He explained in detail the theoretical basis, principles and methods of radiometric dating techniques. To understand the origin and development of any civilization, time is among the most important parameter. The development of radiocarbon dating by W.F. Libby in 1950s was a landmark discovery which enabled an archaeologist to scientifically estimate the dates of excavated settlements. He further elucidated that during the last 60 years, the methods of radiocarbon dating have also undergone several modifications. Some new methods, including Thermo Luminescence (TL), Optically Stimulated Luminescence (OSL) and Accelerator Mass Spectrometry (AMS) for radiocarbon dating have also been developed. By making use of such methods, many Indian laboratories, such as Physical Research Laboratory (Ahmadabad) and Birbal Sahni Institute of Palaeobotany (Lucknow) have ascertained the dates of thousands of archaeological samples. This has played a very crucial role in understanding the origin and development of civilization in India during last more than 8000 years. He also gave some very interesting examples:

(a) The existence of custard apple (*sharifa*) in India goes back to 3500 BP (1500 BC), thus proving that it existed in India much before Portuguese arrived in India.

(b) The cultivation of rice in Gujarat region was introduced much earlier than what is normally believed and double cropping was practiced as early as about 2000 to 3000 BC.

(c) The dates for samples of rice from Lahuradeva and Jhusi in Middle Ganga Plain have been found to be about 7000/6000 BC by independent researchers.

Dr. Nautiyal further explained that there have been many recent examples where radiocarbon dates turned out to be older than the prevailing archaeological belief. While concluding the presentation, he significantly emphasized that the records of civilization in India are much older than what has so far been believed. There is definite need to date more samples, cover more sites and also to adopt other methods like TL, OSL and AMS to ascertain the true dates of a wider variety of samples. Data presented by him scientifically explained and corroborated the conclusions arrived at by Shri Kulbhushan Mishra.

14. **Dr. Chanchala Srivastava,** *Scientist-in-charge of the Archaeobotany Unit at Birbal Sahni Institute of Palaeobotany, Lucknow*, spoke on **Archaeobotanical Evidences of Ancient Cultures in Indian Sub-continent**. She explained at length the archaeobotanical research reports which have revealed that certain cultivated varieties of plants, trees and herbs, which are mentioned in Vedas and epics, have existed in India continuously for more than 8000- 9000 years.

(a) She elaborated that wheat and barley based cultivation has been traced back to 7000 BC at Mehrgarh. In this phase, cereal grains of einkorn wheat, emmer wheat, hard wheat, wild two-row barley and the hulled and naked six-row barley with the date fruits of cultivated date-palm have been found. In the subsequent phase (5500-5000 BC), further development in the crop husbandry is seen by the appearance of highly evolved hexaploid forms of bread wheat, club wheat and dwarf wheat with continuation of earlier variety. These data have suggested the indigenous development of process of cultivation of crops within the region of Indian sub-continent. Interestingly, the remains of dwarf-wheat, bread-wheat, club-wheat, barley, lentil and field-pea have also been reported from the earlier phases of Neolithic deposits at Gufkral and Burzahom. Fruit remains of date, almonds, and grape have also been recorded in 4th millennium BC from Kanishkpur in Kashmir Valley.

(b) Recently, the evidence of rice cultivation in 7th millennium BC has

been reported from Lahuradeva in Middle Ganga Plain. Besides this, the other plant remains which have been reported from Ganga Plain and Vindhyan region include barley, wheat, lentil, field-pea, grass and millets like ragi-millet, jowar-millet, Italian-millet from 3rd to 2nd millennium BC.

(c) However, systematic studies on Harappan civilization have brought to light convincing evidence of vast array of data to suggest the cultivation of 29 types of crops of indigenous origin. Amazingly, Harappan plant economy was supported by highly developed horticultural practices of crops such as grapes (*Vitis vinifera*), green-legume of sem-bean (*Lablab purpureus*), *Henna* (*Lawsonia inermis*), *Parijat* or *Harsingar* (*Nyctanthes arbortristis*), jasmine (*Jasminum* sp.), *Karonda* (*Carissa carandas*), lemon (*Citrus limon*) and pomegranate (*Punica granatum*), in their gardens. Their acquaintance with the possible use of opium-poppy (*Papaver somniferum* ssp. *setigerum*) can be surmised by the finds of poppy seeds in medicines and as a narcotic of great antiquity.

(d) A remarkable evidence of carbonized sample of herbal shampoo has been found at Banawali, Hissar district, Haryana from an early Harappan level (2800-2500 BC). This sample includes evidence of *soapnut* or *Reetha* (*Sapindus* cf. *emarginatus*), *Anwala* (*Emblica officinalis*) and *Shikakai* (*Acacia rugata*), which is universally used even today for shampooing hair. This denotes that high standard of hygiene have remained rooted in the minds of Indian society for more than 5000 years. The evidence is unique in its own right, even in the World Archaeobotanical context.

(e) The remains of cultivated rice, wheat and barley have been found from 7000 BC; melon seeds, lemon leaf, pomegranate, coconut and date palm, etc., from 4000 BC; lentils, millets and peas, etc., from 3000 BC; use of *Reetha, Anwala* and *Shikakai* for making shampoo since 2800 BC. The conclusion is thus inevitable that these plants have remained in use continuously for thousands of years indicating that there was not any abrupt end of ancient Indian civilization. Rather indigenous civilization has been growing constantly for last nearly 9000 years in the Indian sub-continent.

15. On 31st July, **Dr. J.R. Sharma,** *Group Director at National Remote Sensing Centre, ISRO***,** jointly with **Dr. B.K. Bhadra,** presented a paper on **Signatures of Palaeo Rivers Network in Northwest India using Satellite Remote Sensing.** He elaborated that the northwestern region of Indian sub-continent witnessed a mighty flowing river system in the past. Like present day Indus river system,

a sub-parallel river system known as **'Vedic Saraswati River'** was flowing with full majesty around 6000 BC.

(a) Based on satellite pictures, he explained that river Sarasvati originated in higher Himalayas and flowed through the western part of Indo-Gangetic alluvial plains along with several tributaries like Satluj, Yamuna, Chautang and Drishadwati. The Saraswati river system passed through the states of Himachal Pradesh, Punjab, Haryana and Rajasthan and finally discharged into Rann of Kachchh in Gujarat. The river dried up during 2500-1500 BC due to tectonic and palaeo-climatic changes in Himalayan region.

(b) He further highlighted that for delineating the 'paleo-river system', several scientific methods such as Optical Satellite data, Microwave data and Remote Sensing have been used. The mapped courses have been validated with a variety of ground information like geology, sedimentology, hydrogeology and drilling data. The satellite image interpretation shows the obscured signature of the lost river and its relics are still found in the above mentioned states.

(c) He explained in detail that Remote Sensing data fully supports the references to Saraswati in ancient Indian literature. The river is described in the Rig Veda as *'Ambitame Naditame Devitame'* that is the best of mothers, best of rivers and the best of goddesses. It was a life-giving mighty river system for the people of ancient India. Its different phases have been further described in the later Vedic literature; in Yajurveda it is left with 5 tributaries minus Yamuna; from a mighty river in Ramayan period, Saraswati flows as a non-perennial river in Mahabharat era. More than 1200 ancient archaeological sites have been excavated on the banks of the Saraswati river.

(d) Dr. Sharma concluded by saying that remote sensing imagery, archaeological findings, other synthesized scientific evidences and references in ancient literature have established three connections of Vedic Saraswati with the Himalayan sources viz. (i) with Sutlej River, (ii) with Yamuna through Bata/ Markanda, and (iii) with Yamuna through Drishadvati. The age of trapped ground water in paleochannels of Saraswati in Rajasthan varies from 18800 BP (16800 BC) to 1340 BP (660 AD).

16. The next paper was by **Dr. Rajiv Nigam,** *Scientist-G and Head of Palaeoclimate Project, Geological Oceanography Division, National Institute of Oceanography, Goa,* on **Sea level Fluctuations during last 15000 years and their Impact on Human Settlements.** He explained that the oceanographic reports on fluctuations of water

levels in the oceans have revealed the existence of many coastal archaeological sites, either submerged or now found land locked, dated from 7500 BC onwards, *e.g.* a Neolithic settlement near Hazira, Dholavira, Juni Kuran, Surkotda, Prabhas Patan and Dwarka etc.

(a) While elaborating the Lothal dockyard theory, he furnished evidence in favor of this theory. He explained that Foraminifera are exclusively marine organisms which were found at the surface of the Lothal dockyard in abundance. This micro-organism cannot be found in a fresh water body. Thus the study has concluded that Lothal water body was not a fresh water lake but a dockyard which was probably the oldest dockyard of the world.

(b) He also explained the historical details of sea level fluctuations by showing a sea level curve for the west coast of India. The curve indicated that in 4500 years BP (2500 BC), Lothal was at sea Level. The curve of the sea level fluctuation makes it clear that 4500 years back sea level was high. This also indicates that no one should doubt the Lothal Dockyard theory and that at Lothal we have a dockyard which is the oldest in the world. After that the sea level had started going down which corroborates many facts relating to the submerged city of Dwarka, which has been explored by Dr. S.R. Rao. He referred to the facts stated in Mahabharat, that Lord Krishna had reclaimed the land from the sea to build the city of Dwarka. Obviously land can be reclaimed only when the sea level is going down. The curve clearly reveals that after 4500 BP water level was going down. Consequently Lothal did not remain a port town anymore and slowly became land locked. Since the sea level had come down by more than 4-5 meters in next 1000 years, it became possible to reclaim the land and build the city of Dwarka around 3500 BP (1500 BC). Subsequently the sea level started rising and there was some event like Tsunami, as a result of which the city of Dwarka submerged.

(c) Dr. Nigam further explained that the sea level curve makes it clear that between 7000 - 7200 BP the water level was about three meters below the present level. Incidentally, the astronomical dating of the Ram era has been placed around 7100 BP and Ram Sethu is found submerged at about three meters depth at present, implying thereby that in 5100 BC this sethu was above the sea level and could be used as a land route between Rameshwaram and Sri Lanka.

(d) He also emphasized that these studies suggest a need for more concentrated efforts to compile historic and archaeological records through the

fluctuations of the sea levels and correlation of fluctuations in sea level curve with the other scientific evidences to arrive at the scientific dating of ancient events and occurrences. The need for collaborative interdisciplinary studies is even more important for Indians because it is likely to make them proud of their most ancient rich cultural heritage.

17. **Prof. V.R. Rao,** *Department of Anthropology, Delhi University*, presented a paper on **Genetic Profile of the People of India during Holocene: Some Inferences** and elaborated the anthropological researches which have established that DNA dating for Paleolithic continuity starts from 60000 BC. He explained that genomic evidences in terms of haploid (mt DNA, Y) and high density DNA studies in India have revealed that:

- Palaeolithic continuity and Tribe-Caste continuum, as DNA markers are shared; and the Tribe, Caste divisions are not reflected in the biology.
- Ancient genetic substratum across India cuts across linguistic boundaries, as this substratum is dated much earlier *i.e.* 60-70 thousand years before present.
- There is no substantial proof for Indo-Aryan invasion from Central Asia/ Europe as the DNA lineages have in situ development signatures. Even Eurasian lineages have founder nodes (roots) in Indian lineages, indicating that dispersal probably happened the other way round.

Dr. Rao concluded his presentation by stating that the Genome studies during the Holocene have revealed that the genetic profile of humans settled in north, south, east and west of India is a result of extensive sharing of ancient substratum which is reflected since Holocene (11000 years BP) to the present. It is also significant to note that the inhabitants of the Harappan civilization were not a mysterious people of unknown biological origins, or migrants from Western/ Central Asia, but they were the indigenous people identified with the pre/ early Harappan cultures of north-western region of the Indian sub-continent. Therefore, contrary to the popular belief, the Dravidians as well as north Indians have common ancestors and both are originals of India, have common genetic profile and had common ancestors.

18. **Dr. D.K. Hari,** *Director of Bharath Gyan Foundation*, made a multi-media presentation on **Ancient Indian History—not mythology.** He explained that ancient Indian history was called mythology based on four pillars which have

all been knocked down by modern scientific research:

(a) Aryan Invasion theory which was based on linguistic guesswork was inspired by the superiority complex of English rulers but was disowned by Max Muller himself. No scientific evidence whatsoever has been found in support of this so called invasion in 1500 BC of Aryans from Central Asia; rather, there is plethora of evidence of indigenous growth of civilization in India during the last 10000 years and of dispersal happening the other way round.

(b) Myth of Alexander defeating Porus in 327 BC and claim that recorded history began thereafter designating the entire earlier history as mythology.

(c) Treating genealogies of Puranas as mythology because of some inconsistencies even though such genealogies of other civilizations suffer from greater inconsistencies. In fact genealogies of Puranas have reflected true development of civilization during the Holocene as is proved by the latest scientific research.

(d) In 18th and 19th century, Christians believed that God created earth on 23rd Oct., 4004 BC, therefore, history of India referring to much earlier times was described as mythology.

Shri Hari concluded by saying that if Vedas, Puranas and epics are all treated as mythology, we will be facing a serious unresolved problem of history without literature and literature without history. In order to build its future, a nation has to squarely face its past. Therefore, it is time that India discards the myth of Aryan invasion theory and rewrites its history based on scientific evidences for God does not change the past and does not excuse the nations which fail to determine their true historical events.

19. **Dr. Baldevanand Sagar,** *Sanskrit Scholar and Broadcaster of Sanskrit News on All India Radio,* spoke on **Geographic Evidence of Places and Rivers referred to in Rig Veda and Epics.** He explained about the geographical regions of Vedic and later Vedic period. Through display of maps, he proved that excavated archaeological sites in north western Indian sub-continent have mostly been found in the places referred to in Vedic literature.

(a) He also highlighted the importance and existence of river Saraswati since several millennia by citing examples from ancient texts and correlated these references with archaeological reports and space imagery.

(b) He explained that several geographic locations referred to in Ramayan are found today having similar location, features, flora and fauna. He recited relevant slokas from Ramayan containing description of places like Chitrakoot, Dandak Van etc. and established their picture perfect correlation with these places, as are existing today.

20. **Shri Y.K. Gaiha,** *IRS (Member, Board for Industrial & Financial Reconstruction)* briefed the participants about the **Public Welfare and Business Opportunities** created by this kind of research and particularly by this National Seminar:

(a) The presentations during the Seminar have the potential of uniting all Indians by bridging the North-South divide which is based on only linguistic guesswork, having no scientific basis. These also raise their self esteem.

(b) Focus on harnessing drinkable water underground trapped below dry paleochannels of ancient rivers like Saraswati and Drishadwati can help resolve some of the water-scarcity problems in selected areas of water scarcity.

(c) Seminar creates huge potential for promoting tourism *e.g.* if a transparent tube and an underwater museum are created at the site of submerged Dwarka city, the entire cost can presumably be recovered during the first one year and tourism in India will enter the next generation facilities.

21. In the valedictory function on 31st July, Shri. K.V. Krishna Murthy, Chairman I-SERVE, while delivering the welcome address, said that it was quite amazing to know that a score of scientific branches could be so useful in determining the true dates of events in the remote past. He thanked the scientists, who had presented the papers, for sharing their extraordinary wealth of knowledge with the audience and beseeched them to carry forward their research to further logical conclusions. Smt. Saroj Bala presented the summation of the proceedings. She clarified that till now we have been told that prior to 1500 BC, India was uncivilized and that the Aryans, who came from Central Asia, pushed the uncivilized inhabitants towards the south and were later known as Dravidians. These invaders were the ones who set up the first civilized society in North India. Multidisciplinary and purely scientific research has shown that this premise, which was based on linguistic guesswork, is not correct. She reiterated that the premise on which this seminar was organized is that 99% of the research outcomes being presented are not known to 99% of Indians. Therefore, many questions raised during the deliberations at the seminar were answered as under by the experts/scientists:

(a) The astronomical dates, calculated so far, indicate the development of an indigenous civilization in India from dates even prior to 7000 B.C. Astronomical references in Rigveda represent the sky view of dates belonging to the period 7000 BC to 4000 BC and those mentioned in Ramayan refer to sky views seen sequentially on dates around 5100 BC. **These dates were exclusive and matched sequentially**.

(b) The ecological references in ancient books, especially those relating to melting of glaciers and fluctuations in water volumes of ancient rivers seem to corroborate such astronomical dates. **Recent research reports on paleoclimatic changes also corroborate these conclusions.**

(c) Remote Sensing pictures taken by ISRO, corroborated by geological reports, have revealed that a mighty river system, referred to in Vedas and **epics** as ***Saraswati***, was flowing with full majesty around 6000 BC. The river slowly dried up and almost disappeared around 2000 BC. **These conclusions have been supported by sedimentology, hydrogeology and drilling data**.

(d) The oceanographic reports on fluctuations of water levels in the oceans have revealed the existence of many coastal archaeological sites, either submerged or now found land locked, dated from 7500 BC onwards *e.g.* a Neolithic settlement near Hazira, Dholavira, Juni Kuran, Surkotda, Prabhas Patan and Dwarka etc. **It is important to note these included Dwarka and Prabhas**.

(e) The paleobotanical research reports have reported that certain cultivated varieties of plants, trees and herbs, which are mentioned in Vedas and Epics, have existed in India continuously for more than 8000-10000 years. **Since these remained in use continuously, there was not any abrupt end of ancient Indian civilization as is believed**.

(f) The anthropological research reports have established that DNA dating for Paleolithic continuity starts from 60,000 BC. The Genome studies during the Holocene have revealed that the genetic profile of humans settled in north, south, east and west of India is the same and has remained the same for the last more than 11000 years. **Therefore, contrary to the popular belief, the Dravidians as well as north Indians have common ancestors and both are originals of India**.

(g) The latest archaeological excavations have revealed large volume of new data which has proved the indigenous origin and development of civilization in the Indian sub-continent since 7000 BC. Some examples are: Mehrgarh, Kot Diji

and Nausharo in the northwest; Lothal and Dholavira in the west; Lahuradeva, Jhusi, Tokwa and Hetapatti in the east. **Thus, Archaeology is also supporting the astronomical, ecological and anthropological conclusions that Aryans were originals of India, they have been creating and nurturing a very advanced civilization for last 10,000 years and dispersal probably happened the other way round?**

Smt. Saroj Bala concluded by stating that the key findings of the Seminar have the potential of uniting all Indians and raising their self esteem by giving them shared pride in their ancient most rich cultural heritage when they know, based on scientific evidences, that indigenous civilization have been developing and flourishing in India for last 10000 years and that some of our ancestors moved out to civilise others.

22. **Hon'ble Justice Shri Ashok Bhan**, **Shri Manbir Singh**, *Secretary*, *Ministry of External Affairs* and **Smt. Poonam Kishore Saxena**, *Member, Central Board of Direct Taxes*, graced the occasion as Guests of Honour and enriched the deliberations of the Seminar with their informed and encouraging addresses. They emphasized that these multidisciplinary scientific research reports, presented during the Seminar, prima facie establish that indigenous civilization has been developing in India for last 10000 years and that all Indians share their genetic profile, therefore, it is time to move away from the linguistic theory of Aryan invasion and raise our heads with pride as nurturers of the oldest civilization in the world.

23. **Shri Pawan Kumar Bansal,** *Hon'ble Minister, Ministry of Parliamentary Affairs and Water Resources*, delivered the valedictory address on 31st July, 2011. He said that this National Seminar has highlighted many new scientific inventions and tools which may help us expand the frontiers of Indian history by undertaking the scientific dating of events through investigation of evidences. These evidences are not only those that lie buried under the land and the sea, but also those that are contained in our ancient scriptures in the form of planetary references. If a systematic and coordinated investigation is made through all the various tools and techniques which are available today, a lot of what is treated as mythology for want of evidence may actually become history.

(a) He further appreciated the initiative of scientific determination of the dates of ancient events, especially the genetic profiling which has the potential of uniting all Indians for having common ancestors. This study deserves to be carried forward as it can help bridge the divisions which got created between

north Indians and Dravidians due to distortions in our history, which was written during the colonial days, based on linguistic guesswork.

(b) He also appreciated the scientific researches done by the scientists and recommended that such types of research activities deserve to be encouraged and a mechanism needs to be built to disseminate this knowledge amongst school and college students. The information about the palaeochannels of ancient rivers, like Sarasvati, can help in harnessing much needed underground water resources.

24. Based on presentations made during the seminar, some very valuable recommendations were made for taking certain steps/ follow-up action by the Government departments, universities and autonomous/statutory bodies like Archaeological Survey of India, Geological Survey of India and Anthropological Survey of India. Most important of these were: the ancient history of India and of the World should be reconstructed based on multi-disciplinary scientific research; Indian Council of Historical Research (ICHR) should be reconstituted to include in it the Sanskrit scholars, Astronomers, Oceanographers, Space scientists, Palaeobotanists and Ecologists; setting up of an underground museum on the site of submerged Dwarka connected through a transparent tube; package tours to cover places excavated around ancient Saraswati river; developing sites at important places visited by Lord Ram to promote tourism; results of Genome studies should be widely publicized informing the people that Aryan invasion theory has now proved untrue and that Dravidians and North Indians had common indigenous ancestors; Ministry of HRD should incorporate research outcomes from several scientific researches in books meant for schools and colleges all over India. Such recommendations, made during seminar, have been dealt with in detail in a separate chapter.

The Seminar concluded with a vote of thanks by Smt. Vinita Surie, who expressed special gratitude to the experts and scientists who had presented and discussed the papers having contents of extraordinary high standards. The support provided by Rashtriya Sanskrit Sansthan and Ministry of Earth Sciences was acknowledged with thanks. While expressing sincere gratitude to the Chief Guest and the Guests of Honor, she did not fail to thank the IIMC, Event Managers, Computer service providers, Caterers and above all the audience.

— Saroj Bala
Kulbhushan Mishra

संगोष्ठी की कार्यवाही की पृष्ठभूमि एवं सारांश

वेदों पर वैज्ञानिक शोध संस्थान (आई-सर्व) की स्थापना 21 जून, 2004 को हुई थी तथा इसके मुख्य संरक्षक माननीय श्री आर वैंकटरमन (भारत के पूर्व राष्ट्रपति) थे। श्री के. वी. कृष्णमूर्ति इसके अध्यक्ष व मुख्य न्यासी हैं। आई-सर्व, भारत सरकार के वैज्ञानिक और औद्योगिक अनुसन्धान विभाग द्वारा वैज्ञानिक एवं औद्योगिक अनुसन्धान संगठन के रुप में मान्यता प्राप्त और आयकर अधिनियम की धारा 35(i) (ii) के अधीन अधिसूचित है। इस संस्थान के मुख्य उद्देश्य निम्नलिखित हैं–

(i) वेदों, उपनिषदों, महाकाव्यों आदि में निहित वैज्ञानिक गूढ़ रहस्यों, सिद्धांतों व तकनीकों की खोज।

(ii) प्राचीन वैज्ञानिक परिज्ञान को आधुनिक विज्ञान के साथ जोड़ना ताकि कृषि, ऊर्जा, धातु तथा दवा आदि के क्षेत्रों में प्रदूषण मुक्त तथा प्रकृति-अनुकूल प्रौद्योगिकियों को विकसित किया जा सके।

(iii) प्राचीन पुस्तकों व पाण्डुलिपियों में वर्णित घटनाओं का वैज्ञानिक संसाधनों के माध्यम से तिथि निर्धारण ताकि सभी भारतीय अपनी महान विरासत में सामूहिक राष्ट्रीय गर्व का अनुभव कर सकें।

2. तीसरे उद्देश्य की परिपूर्ति के लिए आई-सर्व दिल्ली शाखा ने 'ऋग्वेद से आर्यभटीयम् तक वर्णित घटनाओं का वैज्ञानिक ढंग से तिथि निर्धारण' अनुसंधान परियोजना पर कार्य प्रारंभ किया जिसके दो मुख्य भाग थे–

- प्लैनेटेरियम सॉफ्टवेअर के उपयोग से प्राचीन संस्कृत पुस्तकों व पांडुलिपियों में ग्रहों तथा नक्षत्रों के संदर्भों का खगोलीय समय निर्धारण
- इन क्रमिक तिथियों का पुरातत्त्व, भूविज्ञान, मानवविज्ञान, समुद्र विज्ञान, भौगोलिक अनुसंधान व उपग्रह चित्रों से परस्पर सम्बन्ध।

3. **इस अनुसंधान परियोजना की परिकल्पना श्रीमती सरोजबाला ने की थी तथा वो इस विषय पर पिछले ५-६ वर्षों** से शोध कर रही थीं। भारत सरकार के मानव संसाधन विकास मंत्रालय के अधीन राष्ट्रीय संस्कृत संस्थान ने सितंबर 2010 में इस अनुसंधान परियोजना को मंजूरी दी तथा आई-सर्व को आंशिक अनुदान की स्वीकृति भी प्रदान की। शोधकर्त्ता इस विश्वास के साथ खोज करने लगे कि वास्तविक एतिहासिक घटनाएँ तो वही हैं जो पिछले हजारों वर्षों में घटित हुई होंगी परंतु उनके बारे में हमारी जानकारी अत्यंत सीमित हैं क्योंकि उनके प्रमाण भूमि के नीचे तथा समुद्र की गहराईयों में छिपे हैं। इन प्रमाणों की खोज के लिए नए वैज्ञानिक संसाधनों व आविष्कारों का इस्तेमाल किया गया। ये सबूत भूमि तथा समुद्र के नीचे दबे होने के साथ-साथ ऐसे भी हैं जो किसी घटना के समय आकाश में ग्रहों व नक्षत्रों के विवरण के रूप में प्राचीन साहित्य में वर्णित हैं और प्लैनेटेरियम साफ्टवेयर के माध्यम से उनका तिथि निर्धारण संभव है।

4. विषय बहुत विशाल था और शोध अत्यन्त गहन तथा पूर्णतः वैज्ञानिक! संस्कृत के विद्वानों, खगोलविदों, पुरातत्त्वविदों, मानव-विज्ञानियों, भू-वैज्ञानिकों और अन्य सम्बद्ध विषयों के विशेषज्ञों के शोध-कर्त्ताओं ने दो से अधिक वर्षों के शोध के बाद, पहले भाग के बारे में अपने निष्कर्षों को वैज्ञानिकों, मूल शोधकर्त्ताओं और सामान्य जन के सामने रखने का फैसला विशेषरूप से इसलिये किया क्योंकि हमारे शोध के परिणाम अभी तक विश्वसनीय और ठोस थे। इस प्रथम भाग में 2000 ई०पू० से पहले की घटनाओं के वैज्ञानिक काल-निर्धारण पर शोध किया गया था। इस विषय पर दो दिन की राष्ट्रीय संगोष्ठी का आयोजन 30 और 31 जुलाई 2011 को भारतीय जनसंचार संस्थान, अरुणा आसफ अली मार्ग, नया जे.एन.यू. परिसर, नई दिल्ली में किया गया।

5. इस राष्ट्रीय संगोष्ठी के माध्यम से आई-सर्व यह भी प्रदर्शित करना चाहता था कि भारत के स्कूलों व कालेजों में पढ़ाया जा रहा प्राचीन इतिहास आमतौर पर भाषायी अनुमानों व धार्मिक मान्यताओं पर आधारित है जिसकी पुष्टि बहुआयामी वैज्ञानिक अनुसंधान रिपोर्टों के आधारपर लगभग असंभव है। इन दोनों के बीच के अंतर को कम करना अत्यावश्यक है। वैज्ञानिक प्रमाणों तथा अनुसंधान निष्कर्षों के आधार पर लिखा गया इतिहास ही सभी वर्गों व धर्मों के लोगों को स्वीकार्य हो सकता है और वही इतिहास सभी भारतीयों के हृदयों में अपनी बहुमूल्य प्राचीन धरोहर में गर्व का संचार कर सकता है।

6. इस संगोष्ठी के आयोजन में, भारत सरकार के पृथ्वी विज्ञान मंत्रालय ने भी योगदान किया। संस्कृत विद्वानों, खगोलविदों, पुरातत्त्वविदों, मानवविज्ञानियों, इतिहासकारों, भू-वैज्ञानिकों, पारिस्थितिकी वैज्ञानिकों, समुद्र विज्ञानियों, अंतरिक्ष वैज्ञानिकों, नौकरशाहों, पेशेवरों, प्रोफेसरों, शिक्षाविदों और विभिन्न विश्वविद्यालयों के छात्रों तथा जनसाधारण ने बढ़-चढ़ कर भाग लिया।

देशभर से बड़ी संख्या में शोधकर्त्ता भी इसमें शामिल हुए। संगोष्ठी में लेख प्रस्तुत करने वाले बहुत से वैज्ञानिक अपने विषय के जाने-माने शोधकर्त्ता थे। देश के कोने-कोने से आए वैज्ञानिकों तथा विशेषज्ञों ने विचार-विमर्श में भाग लेकर संगोष्ठी के स्तर को बहुत ऊँचा उठा दिया।

7. भारत के पूर्व राष्ट्रपति महामहिम डॉ० ए.पी.जे. अब्दुल कलाम ने मुख्य अतिथि के रूप में अपनी गरिमामय उपस्थिति से इस अवसर की शोभा बढ़ायी और 30 जुलाई को उद्घाटन भाषण दिया। उनका यह भाषण www.abdulkalam.com पर भी उपलब्ध है। एन.सी.डी.आर.सी. के अध्यक्ष, न्यायमूर्ति श्री अशोक भान और संस्कृति विभाग के सचिव श्री जे.सरकार, माननीय अतिथि थे। आई सर्व के अध्यक्ष श्री के.वी. कृष्णामूर्ति ने स्वागत भाषण दिया। उन्होंने कहा कि भारतवर्ष का इतिहास पाश्चात्य दृष्टिकोण व पूर्व की पौराणिक कल्पनाओं के बीच में फसकर बहुत विकृत हो चुका है। आई-सर्व दिल्ली शाखा द्वारा की गई इस नई पहल के चलते शुद्ध वैज्ञानिक ढंग से प्राचीन घटनाओं का क्रमिक निर्धारण संभव हो पाएगा। परम आदरणीय श्री कलाम जी का स्वागत करते हुए उन्होंने कहा कि रामेश्वर के मछुआरे का यह होनहार पुत्र अपनी समझ, सूझबूझ तथा कठिन परिश्रम के आधार पर वर्ष, 2002 में भारत के राष्ट्रपति पद पर आसीन हुआ तथा आजतक सभी भारतवासियों के दिलों का बादशाह बना हुआ है।

8. शोध परियोजना संयोजक, श्रीमती सरोज बाला ने संगोष्ठी व शोध विषय का संक्षिप्त परिचय दिया। उन्होंने स्पष्ट रूप से बताया कि खगोलीय, पुरातात्त्विक, मानववैज्ञानिक और पारिस्थितिकी में किये गये शोध की रिपोर्टों से पता चलता है कि 'मध्य एशिया से आर्यों का भारत में अतिक्रमण' केवल एक कल्पना है जिसका कोई वैज्ञानिक आधार नहीं है। उनका कहना था कि यह सिद्धांत पूरी तरह से भाषागत अनुमानों व सुनी-सुनायी बातों पर आधारित था। वास्तव में भारतीय सभ्यता पिछले दस हजार से अधिक वर्षों से लगातार स्वदेश में ही विकसित होती रही है। उन्होंने कहा कि कई वर्षों की वैज्ञानिक खोजबीन के बाद आई-सर्व इस निष्कर्ष पर पहुँचा है कि भारत का वास्तविक इतिहास अबतक मान्य तिथियों से कहीं अधिक पुराना है। साक्ष्य के अभाव में अभी तक जिन घटनाओं को पौराणिक कल्पनाएँ माना जाता रहा है, वर्तमान में उपलब्ध वैज्ञानिक संसाधनों एवं तकनीकों के उपयोग से किए गए अनुसंधान के फलस्वरूप वही वास्तविक व ऐतिहासिक सिद्ध होती चली जा रही है।

9. महामहिम डॉ० ए.पी.जे. अब्दुल कलाम ने प्राचीन घटनाओं के काल निर्धारण के वैज्ञानिक तरीकों का समर्थन किया और जोर दिया कि सेमिनार के दौरान उभरकर आयी जानकारी और ज्ञान का स्कूलों तथा कॉलेजों के छात्रों में प्रसार करने के लिए एक व्यवस्था बनायी जानी चाहिए, ताकि वे अपनी समृद्ध और सबसे प्राचीन विरासत पर गर्व कर सकें। उनके भाषण ने आई-सर्व के शोध

कर्त्ताओं का मनोबल बढ़ाया। उन्होंने कई महत्त्वपूर्ण सुझाव दिए इनमें कुछ इस प्रकार हैं :

- भारत के महाकाव्यों में वर्णित घटनाओं की तिथियों और इतिहास की सच्चाइयों का पता लगाने के लिए इतिहास, भू-विज्ञान, खगोलशास्त्र और अंतरिक्ष विज्ञान आदि के क्षेत्रों में काम करने वाले कम से कम सौ प्रतिभाशाली लोग इन विषयों पर शोधकर पी.एच.डी. करें।
- वैज्ञानिक काल निर्धारण के लिए हमारे महाकाव्यों में वर्णित वंशावलियों को मानव जीनोमअनुक्रमणक अध्ययनों के साथ भी जोड़ा जाये।
- प्रोफेसर टोबिआस द्वारा वर्णित मानव उत्पत्ति के क्रमिक विकास को भारतीय महाकाव्यों की घटनाओं से जोड़ा जाना चाहिये, क्योंकि अंतत: हर भारतीय महाकाव्य का सम्बन्ध मानव के इतिहास, उसके संघर्ष और उसकी सभ्यता से है।
- प्रो. टोबिआस के अनुसार बोली जाने वाली भाषा लगभग दस हजार वर्ष पुरानी है। जन्म के समय ग्रहों के विन्यास के आधार पर श्रीराम का जन्म 7125 वर्ष पूर्व (10 जनवरी 5114 ई०पू० को) हुआ था। बोली जाने वाली भाषा और वाल्मीकि रामायण के क्रमिक विकास के बीच हमें सम्बन्ध स्थापित करने की जरूरत है।

10. इस कार्यक्रम का मुख्य आकर्षण सेमिनार का स्मृति चिन्ह जारी किया जाना था। यह स्मृति चिन्ह एक दीवार पर लगाये जाने वाली घड़ी के रूप में था जिसमें 10 जनवरी 5114 ई०पू० को दिन के 12 बजकर 25 मिनट पर आकाश के दृश्य का चित्रण था। उस दिन चैत्र माह की शुक्ल पक्ष की नवमी थी जब भगवान राम का जन्म हुआ था। आकाश का यह दृश्य वास्तव में वाल्मीकि रामायण (1/18/89) में वर्णित ग्रहों की स्थिति से बिल्कुल मिलता है। यह चिन्ह, मूल अनुसंधानकर्त्ता स्वर्गीय पुष्कर भटनागर की स्मृति को अर्पित किया गया। इसे पुष्कर भटनागर जी के पूरे परिवार की उपस्थिति में महामहिम डॉ० ए.पी.जे. अब्दुल कलाम जी ने जारी किया।

11. पहले वक्ता, पूर्व अपर महानिदेशक (आई.एम.डी.) श्री अशोक भटनागर ने 'ऋग्वेद और महाकाव्य में वर्णित ग्रहों व नक्षत्रों के सन्दर्भों का तारामण्डल सॉफ्टवेयर के माध्यम से खगोलीय काल निर्धारण' पर प्रस्तुति की। उन्होंने स्पष्ट किया कि तारामण्डल सॉफ्टवेयर की मदद से प्राचीन पुस्तकों में ग्रहों के संदर्भों की खगोलीय तिथियों का निर्धारण किया जा सकता है। वैदिक काल में खगोल विज्ञान निश्चय ही अति-उन्नत था और प्राचीन ग्रन्थों में वर्णित घटनाओं की तारीखों का निर्धारण वास्तव में ऐसे आधुनिक सॉफ्टवेयर की मदद से किया जा सकता है।

(i) उन्होंने आगे बताया कि ऋग्वेद में कई खगोलीय प्रसंग 7000 ई०पू० से 4000 ई०पू० तक की तिथियों के आकाशीय दृश्य से संबधित हैं और रामायण में उल्लिखित खगोलीय प्रसंग, 5100 ई०पू० के आसपास की तिथियों पर क्रमिक रूप से देखे जाने वाले दृश्यों के बारे में हैं।

उन्होंने तारामण्डल सॉफ्टवेयर पर सजीव प्रस्तुति दी और दर्शाया कि वाल्मीकि रामायण में वर्णित ग्रहों व नक्षत्रों की स्थितियाँ सॉफ्टवेयर द्वारा प्रस्तुत आकाश के क्रमिक दृश्यों से हूबहू मिलती हैं।

(ii) श्री अशोक भटनागर ने ऋग्वेद से लिए गए कई मंत्रों का संबंध 7000 ई०पू० और 6000 ई०पू० में शरद् अयनांत (विन्टर सॉल्सटिस) के स्थान को प्रदर्शित करने वाले आकाश दृश्य से बताया। उन्होंने सॉफ्टवेयर के माध्यम से प्रकट किये गये आकाश के दृश्य को दिखाया जिसमें दर्शाया गया था कि अगस्त्य ऋषि के नाम से ज्ञात अगस्त्य नक्षत्र विंध्य से सर्वप्रथम 5100 ई०पू० के आसपास ही दिखायी दिया था। इससे रामायण और ऋग्वेद में वर्णित अगस्त्य ऋषि के सन्दर्भों का सहसम्बन्ध स्थापित होता है और इस दन्तकथा की पुष्टि होती है।

(iii) उन्होंने बताया कि वाल्मीकि ने बालकाण्ड के 18वें सर्ग के 8वें और 9वें श्लोक (1/18/8, 9) में भगवान राम के जन्म दिवस पर नक्षत्रों और ग्रहों की स्थिति का वर्णन किया है जिसके अनुसार (क) सूर्य मेष में (ख) शनि तुला में (ग) बृहस्पति एवं चन्द्रमा कर्क में (घ) शुक्र मीन में (च) मंगल मकर राशि में (छ) चैत्र माह व शुक्ल पक्ष (ज) चन्द्रमा पुनर्वसु के निकट अयोध्या से देखे गये। ये सभी विन्यास केवल एक और एक तिथि–10 जनवरी 5114 ई०पू० के आकाश दृश्य से हूबहू मेल खातें हैं। यह चैत्र महीने की शुक्ल पक्ष की नवमी भी थी। इसी दिन हम रामनवमी मनाते हैं। पिछले हजारों वर्षों के दौरान किसी और दिन ऐसा ग्रह–विन्यास नहीं देखा गया।

(iv) पुत्र कामेष्टि यज्ञ के आरम्भ (15 जनवरी 5115 ई०पू०) से लंका की यात्रा की शुरुआत (19 सितम्बर, 5076 ई०पू०) तक कई अन्य तिथियों पर आकाश का दृश्य, रामायण में किये गये वर्णन से बिल्कुल मिलता है। अयोध्या काण्ड (2/4/18) में वर्णित आकाश का दृश्य 5 जनवरी, 5089 ई०पू० को देखा गया। उस समय भगवान राम 25 वर्ष के थे और उन्हें अयोध्या छोड़कर वन गमन के लिये प्रस्थान करना था। खर–दूषण के साथ युद्ध के दौरान (3/23/1–3) वर्णित सूर्य ग्रहण 7 अक्टूबर, 5077 ई०पू० को नासिक से देखा जा सकता था।

(v) इस प्रस्तुति में विशुद्ध वैज्ञानिक तरीके से सिद्ध किया गया कि वेदों और महाकाव्यों में वर्णित बहुत सी घटनायें वास्तविक हैं और ये दर्शाती हैं कि भारतीय सभ्यता, पिछले दस हजार वर्षों से लगातार विकसित होती रही है। प्लैनेटेरियम सॉफ्टवेयर के माध्यम से इनकी तिथियों का पूरी तरह वैज्ञानिक तरीके से पता लगाना सम्भव है।

12. भारतीय पुरातत्त्व परिषद, नई दिल्ली में रिसर्च एसोसिएट श्री कुलभूषण मिश्रा ने पिछले आठ हजार वर्षों के दौरान, ''भारतीय उपमहाद्वीप में सभ्यता की उत्पत्ति और विकास : पुरातात्त्विक परिप्रेक्ष्य'' पर अपने विचार रखे। उन्होंने बताया कि भारतीय उपमहाद्वीप में स्वतंत्रता प्राप्ति के बाद

की गयी पुरातात्विक छानबीन ने उत्तर–पश्चिम से लेकर, उत्तर में कश्मीर, पूर्व में गंगा के मैदानी इलाकों तथा सरस्वती दृशद्वती द्वारा सिंचित विशाल मैदानी क्षेत्रों में विकसित होती हुयी सभ्यता के अनेकों प्रमाण मिलते हैं।

(i) 1921–22 में सभ्यता की उत्पत्ति के रहस्यों से पहला पर्दा उठने के बाद से ही अनेक विद्वानों द्वारा इस सम्बन्ध में विभिन्न सिद्धान्तों को पेश किया गया है। पिछले लगभग तीस–चालीस वर्षों के दौरान नयी रीतियों और नूतन प्रौद्योगिकी की मदद से भारतीय पुरातत्व की अवधारणा में काफी बदलाव आया है। हाल के इन शोधों के परिणामस्वरूप हमें भारतीय उपमहाद्वीप में सभ्यता के स्वदेशी मूल को साबित करने के लिए अत्यधिक विश्वसनीय रूप से नई सामग्री का भण्डार मिला है। विदेशी मूल का होने के सिद्धांत अब गौण हो गये हैं और पुरातात्विक प्रमाणों के रूप में स्वदेशी मूल के सिद्धान्त को पर्याप्त समर्थन मिल रहा है।

(ii) उन्होंने विस्तार से बताया कि नवीन पुरातात्त्विक खोजों से बहुत सी ऐसी सामग्री मिली है जिससे 7000 ई०पू० से भारतीय उपमहाद्वीप में ही भारत की सभ्यता की उत्पत्ति और विकास के प्रमाण मिले हैं। इस सन्दर्भ में उन्होंने ऐसे कुछ उदाहरण भी दिये हैं, जैसे पूर्व में गंगा घाटी में लहुरादेवा, झूसी, टोकवा तथा हेटापट्टी, पश्चिमोत्तर में सिन्धु घाटी में मेहरगढ़, कोट डिज़ी तथा नौषेरो और पश्चिम में लोथल तथा धोलावीरा।

(iii) उन्होंने भारतीय उपमहाद्वीप के दो प्रमुख क्षेत्रों, पूर्वी और उत्तर–पश्चिमी, के बारे में विशेष जानकारी दी जिसमें सभ्यता के चरम तक पहुँचने के विभिन्न चरणों का ब्यौरा दिया। उत्तर–पश्चिम क्षेत्र के बारे में उन्होंने बताया कि 1956 में किले गुल मोहम्मद में पहली बार ग्रामीण जीवन की उत्पत्ति के ऐसे प्रमाण मिले थे जिनकी शुरुआत चार हजार वर्ष ई०पू० आँकी गयी। इसके बाद 1974 में मेहरगढ़ में खुदाई से पता चला कि उन्नत ग्रामीण जीवन विद्यमान होने के प्रमाण 7,000 वर्ष ई०पू० के हैं। खुदाई में लगातार सात आवासीय स्तरों के प्रमाण मिले हैं जिन के आधार पर भारतवर्ष में 7,000 वर्ष ई०पू० से 2000 वर्ष ई०पू० तक निरन्तर सभ्यता व संस्कृति के विकास के विस्मयकारी साक्ष्यों का खुलासा हुआ है। मेहरगढ़, दक्षिण एशिया के अग्रणी किसानों के सामाजिक जीवन, प्रौद्योगिकी, अर्थव्यवस्था तथा भौतिक संस्कृति के उत्कृष्ट प्रमाण के रूप में उभरा है।

(iv) भारत के इतिहास में महत्वपूर्ण स्थान रखने वाला मध्य गंगा का मैदान, उत्तर में हिमालय, दक्षिण में विंध्य, पश्चिम में गंगा–यमुना संगम और पूर्व में बिहार–बंगाल सीमा तक फैला है। इसमें आधुनिक पूर्वी उत्तरप्रदेश और बिहार के मैदानी इलाके शामिल हैं। पुरातात्विक दृष्टि से इस क्षेत्र में नवप्रस्तर/ताम्र पाषाणकालीन स्थलों, अवशेषों और काल अनुक्रम के बारे में पता चलता

है। इस क्षेत्र में लहुरादेवा, झूसी, टोकवा और हेटापट्टी में खुदाई से छः व सात हजार ई०पू० में मध्य गंगा के मैदानों में इंसानों के प्रारम्भिक ग्रामीण सन्निवेष के बारे में महत्वपूर्ण सबूत मिले हैं। लहुरादेवा में चावल की खेती के बारे में भी शुरुआती प्रमाण मिले हैं।

(v) हड़प्पा सभ्यता पर बोलते हुए उन्होंने कहा कि यह सभ्यता मुख्य रूप से सरस्वती और सिन्धु घाटी के मैदानी इलाकों में फैली थी और पाकिस्तान तथा भारत में पंजाब, हरियाणा तथा पश्चिमी उत्तरप्रदेश में गंगा-यमुना दोआब, राजस्थान में थार मरुस्थल के उत्तरी तथा पश्चिमी भू-भाग और कच्छ तथा सौराष्ट्र सहित उत्तरी गुजरात के मैदानी इलाके इसमें शामिल थे। कई जगह विशेषकर हड़प्पा, मोहनजोदाड़ो, कोट दिजि, आमरी, कालीबंगन, धोलावीरा और भिराना में खुदाई से पता चला है कि चौथी सहस्त्राब्दी ई०पू० तक बसी ग्रामीण बस्तियाँ, शहरी बस्तियों के रूप में विकसित होनी शुरू हो चुकी थीं और सभ्यता के विकास की यह कहानी इसके बाद भी जारी रही।

(vi) इस सभ्यता की प्रमुख विशेषतायें यह थीं कि वहाँ योजनानुसार शहरों में अभिजात (उच्च) वर्ग के लिए दुर्ग व आम लोगों के लिए छोटे शहरों का निर्माण किया गया था, साथ ही सड़कें व गलियाँ सीधी दिशा में बनी थी। शहर आकर्षक प्रवेश द्वारों के साथ दुर्ग द्वारा घिरे हुए थे। लोथल में बन्दरगाह, मोहनजोदाड़ों में विशाल स्नानागार एवं अनाज भण्डार की व्यवस्था थी। घरों में विस्तृत जल निकासी की प्रणाली में सार्वजनिक व निजी नालियाँ शामिल हैं तथा नगर निगम के सार्वजनिक क्षेत्रों पर सफाई के अभाव व अतिक्रमण से बचाव को सुनिश्चित करने के लिये कानून लागू था। भवनों एवं अन्य निर्माणों में पकी ईंटों एवं धूप में सूखी ईंटों का प्रयोग होता था तथा चाक पर निर्मित मिट्टी के बर्तन जिन्हें प्राकृतिक एवं ज्यामितीय चित्रों से सजाया गया है। अन्य वस्तुओं में मानव एवं जानवरों की धातु और प्रस्तर की मूर्तियाँ, नापतौल की वस्तुयें, मिलती है। सोने, चाँदी, ताँबा, हाथी दाँत, सीप, अर्द्ध कीमती पत्थर तथा स्टीयेटाइट आदि के आभूषण प्राप्त होते हैं।

(vii) अतः खुदाई में मिले इन प्रमाणों से सिद्ध होता है कि सिन्धु-सरस्वती-गंगा नदियों के समूचे क्षेत्र में सातवीं से छठी सहस्त्राब्दी ई०पू० से निरन्तर सभ्यता व संस्कृति का विकास होता रहा। आम धारणा के विपरीत भारतीय उपमहाद्वीप की सभ्यता की जड़ें बहुत प्राचीन व बहुत गहरी हैं, जो 8000 वर्ष ई०पू० पहले से अस्तित्व में हैं और तीसरी सहस्त्राब्दी ई०पू० में भी फल फूल रही थीं।

(viii) अपनी प्रस्तुति का समापन करते हुए उन्होंने डी.एन.ए. और मानव जीव विज्ञान से महत्वपूर्ण प्रमाण प्रस्तुत करके, वैदिक आर्यों के मध्य एशिया से आगमन की मान्यता को नकारा। उन्होंने स्पष्ट किया कि बी.ई. हैम्फिल और उनके साथियों ने भारत के विभिन्न प्राचीन स्थलों से

बड़ी संख्या में मानव कंकालों पर गहन शोध के बाद निष्कर्ष निकाला कि यह बिल्कुल स्पष्ट है कि 4500 वर्ष ई०पू० और 800 वर्ष ई०पू० के बीच किसी भी विदेशी का देशान्तरण नहीं हुआ, इसलिए पुरातत्व विज्ञान भी इस निष्कर्ष का समर्थन कर रहा है कि आर्य मूल रूप से भारत के थे और वे पिछले दस हजार वर्षों से लगातार भारत में सभ्यता का विकास व पोषण करते रहे हैं।

13. बीरबल साहनी पुरावनस्पति संस्थान लखनऊ में रेडियोकार्बन काल निर्धारण प्रयोगशाला के प्रभारी वैज्ञानिक, डॉ० सी. एम. नौटियाल ने भारत में प्राचीन संस्कृतियों के रिकार्ड के रेडियोमीट्रिक काल-निर्धारण पर अपने विचार रखे। उन्होंने सैद्धांतिक मुद्दों, मतों और रेडियोमीट्रिक काल-निर्धारण तकनीकों के बारे में विस्तार से चर्चा करते हुये बताया कि किसी भी सभ्यता के उद्भव और विकास को समझने में समय सबसे महत्त्वपूर्ण मापदण्ड है। 1950 के दशक में डब्ल्यू. एफ. लिबी द्वारा रेडियोकार्बन काल निर्धारण विधि का विकास एक महत्त्वपूर्ण खोज थी। इससे पुरातत्त्वविदों द्वारा जिन स्थलों की खुदाई की गई, उनका काल निर्धारण वैज्ञानिक तरीके से करने में मदद मिली। उन्होंने स्पष्ट किया कि पिछले 60 वर्षों के दौरान रेडियोकार्बन काल निर्धारण के तरीकों में भी कई बदलाव आये हैं। इन नई पद्धतियों में थर्मोल्यूमिनिसैंस (टी.एल.), ऑप्टिकली स्टिमुलेटेड ल्यूमिनिसैंस (ओ.एस.एल.) और एक्सैलेरेटर मास स्पैक्ट्रोमेट्री (ए.एम.एस.) शामिल हैं। इन पद्धतियों का इस्तेमाल कर भौतिक अनुसंधान प्रयोगशाला, अहमदाबाद और बीरबल साहनी पुरावनस्पति संस्थान, लखनऊ जैसी कई भारतीय प्रयोगशालाओं ने हजारों पुरातात्त्विक नमूनों का वैज्ञानिक ढंग से काल-निर्धारण किया। भारत में पिछले आठ हजार से भी अधिक वर्षों के दौरान सभ्यता के उद्भव और विकास को समझने में इसकी महत्वपूर्ण भूमिका रही। उन्होंने कुछ बहुत दिलचस्प उदाहरण भी प्रस्तुत किये :

- भारत में शरीफा, अब से 3500 वर्ष (1500 ई०पू०) पूर्व पाया जाता था। इससे सिद्ध होता है कि यह फल, भारत में पुर्तगालियों के आगमन से काफी पहले पाया जाता था।
- गुजरात क्षेत्र में धान की खेती शुरू होने का समय जो आमतौर पर माना जाता है वह वास्तव में उससे काफी पहले शुरू हो गया था।
- मध्य गंगा के मैदानी इलाकों में झूसी और लहुरादेवा से चावल के नमूनों से इसकी खेती का काल लगभग 7000/6000 ई०पू० होने का पता चलता है।

डॉ० नौटियाल ने आगे बताया कि हाल में ऐसे बहुत से उदाहरण सामने आये जिनसे पता चला है कि रेडियोकार्बन की तिथियाँ प्रचलित पुरातात्त्विक मान्यताओं के मुकाबले काफी पुरानी हैं, इसीलिए और स्थलों से नमूने लेने तथा उनके काल का अनुमान लगाने के प्रयास तेज़ करने की जरूरत है। ऐसा करने में परम्परागत और आधुनिक दोनों पद्धतियों का इस्तेमाल किया जाना चाहिये। अपनी

प्रस्तुति का समापन करते हुए उन्होंने इस बात पर जोर दिया कि भारत में सभ्यता के रिकार्डों के बारे में अब तक जो मान्यता रही है वे वस्तुतः उससे कहीं अधिक पुराने हैं। यह बहुत जरूरी है कि और नमूनों का काल निर्धारण किया जाये तथा कुछ और स्थलों से जानकारी हासिल की जाये तथा टी. एल., ओ. एस. एल., तथा ए. एम. एस. जैसी आधुनिक पद्धतियाँ अपनाई जाये ताकि इन नमूनों का सही काल निर्धारण किया जा सके। डॉ० नौटियाल द्वारा दी गई जानकारी से श्री कुलभूषण मिश्रा द्वारा निकाले गए निष्कर्षों की वैज्ञानिक रूप से पुष्टि भी हुई।

14. प्राचीन भारत में पुरातात्विक स्थलों से वन्य पेड़-पौधों के अवशेषों की पुरावनस्पति शास्त्रीय और प्राचीन परिस्थितिकीय जांच-पड़ताल पर पी.एच.डी. और बीरबल साहनी पुरावनस्पति संस्थान की प्राचीन वानस्पतिक इकाई की प्रमुख डॉ० चंचला श्रीवास्तव ने भारतीय उपमहाद्वीप में प्राचीन सभ्यता के पुरातात्विक प्रमाण' विषय पर अपने विचार रखे। उन्होंने उन पुरातात्विक शोध रिपोर्टों के बारे में विस्तार से बताया जिनसे यह खुलासा हुआ है कि वेदों और महाकाव्यों में उल्लिखित कुछ पेड़-पौधे और जड़ी बूटियाँ भारत में लगातार आठ-दस हजार वर्षों से अधिक समय तक निरन्तर पाये/उगाये जाते रहे हैं।

(i) उन्होंने बताया कि गेहूँ और जौ की खेती 7000 वर्ष ई०पू० से पहले मेहरगढ़ में किये जाने का पता चला है। इस चरण में-इन्कॉर्न गेहूँ, एम्मर गेहूँ, हार्ड गेहूँ, दो बालियों वाला जौं, छिलके वाला तथा बिना छिलके वाला छह बालियों वाला जौं और खजूर की खेती का पता चला है। बाद के चरण (5500-5000 ई०पू०) में पहले की किस्मों के साथ-साथ क्लब गेहूं और ड्वार्फ गेहूं की अत्यधिक गुणकारी किस्मों के पाये जाने से कृषि में और विकास का पता चलता है। इससे भारतीय उपमहाद्वीप में फसल उगाने की स्वदेशी प्रक्रिया के विकास की बात उजागर होती है। दिलचस्प बात यह है कि कश्मीर घाटी में स्थित गुफकराल तथा बुर्जाहोम में नवपाषाण काल के प्रथम चरणों से बौना गेहूँ, क्लब गेहूँ, जौ, मसूर और मटर की खेती किए जाने के प्रमाण मिले हैं। कश्मीर घाटी में कनिष्कपुर में चौथी सहस्त्राब्दी ई. पूर्व में खजूर, बादाम और अंगूर उगाए जाने के भी प्रमाण मिले हैं।

(ii) हाल में मध्य गंगा के मैदानी इलाकों में लहुरादेवा में 7वीं सहस्त्राब्दी ई०पू० में चावल की खेती के साक्ष्य मिले हैं। गंगा के मैदानी इलाकों और विन्ध्य क्षेत्र में तीसरी से दूसरी सहस्त्राब्दी ई०पू० से लगातार जौं, गेहूँ, मसूर, मटर, घास और रागी बाजरा, ज्वार बाजरा तथा इतालवी बाजरा की खेती किए जाने के भी सबूत मिले हैं।

(iii) हड़प्पा सभ्यता पर किये गये सिलसिलेवार शोध से स्वदेशी मूल की 29 किस्म की फसलों की खेती के बारे में पुख्ता सबूत के तौर पर अपार सामग्री मिली है। अँगूर, सेम की हरी फली, मेहंदी, पारिजात या हारसिंगार, चमेली, करौंदा, नींबू और अनार की बागवानी की उन्नत पद्धतियों के बारे में दस्तावेजी सबूतों से हड़प्पा सभ्यता की कृषि सम्बंधी जानकारी हासिल होती

है। बहुत प्राचीन औषधियों में पोस्त के बीजों के इस्तेमाल की जानकारी मिलने से, अफीम और पोस्त के इस्तेमाल का अनुमान लगाया जा सकता है।

(iv) हड़प्पा सभ्यता के प्राथमिक स्तर पर 2800–2500 ई०पू० हरियाणा में हिसार जिले के बनावाली में हर्बल शैम्पू के कार्बनीकृत नमूनों के पुख्ता प्रमाण मिले हैं। आज भी भारत में बालों को शैम्पू करने के लिए इस्तेमाल किया जाने वाले रीठा, आँवला और शिकाकाई के मिश्रण का उपयोग इस बात का सबूत है कि भारतीय सभ्यता लगातार विकसित होती रही है। इससे यह भी पता चलता है कि भारतीय समाज 5000 वर्ष पहले भी स्वास्थ्य विज्ञान पर पूरा ध्यान देता था।

(v) 7000 ई०पू० से चावल, गेहूँ और जौ की खेती के सबूत मिले हैं। 4000 ई०पू० से खरबूजे के बीज, नींबू की पत्तियों, अनार, नारियल तथा खजूर की बागवानी किए जाने के प्रमाण मिले हैं। 3000 ई०पू० से मटर आदि और 2800 ई०पू० से, शैम्पू बनाने में रीठा, आंवला और शिकाकाई के इस्तेमाल के सबूत मिले हैं। इससे यह निष्कर्ष निकलता है कि ये पेड़–पौधे हजारों वर्षों से निरन्तर उपयोग किए जाते रहे हैं। यह इस बात का सूचक है कि आमतौर पर स्कूलों और कॉलेजों में दी जाने वाली शिक्षा के विपरीत, भारत की प्राचीन सभ्यता का अनायास अन्त नहीं हुआ था, बल्कि वह पिछले दस हजार वर्षों से भारतीय उपमहाद्वीप में लगातार फलती–फूलती रही है।

15. डॉ० जे.आर. शर्मा, जो नेशनल रिमोट सेंसिंग सेन्टर, इसरो, हैदराबाद में ग्रुप डाइरेक्टर, इसरो–जोधपुर में क्षेत्रीय रिमोट सेंसिंग सेन्टर के महाप्रबंधक और वेब इनेबल्ड वाटर रिसोर्स इन्फॉर्मेशन सिस्टम ऑफ इंडिया परियोजना के निदेशक हैं, ने 31 जुलाई को ''उत्तर–पश्चिम भारत में प्राचीन नदियों और उनके नेटवर्क के साक्ष्य : रिमोट सेंसिंग पर आधारित तथ्य'' विषय पर अपनी प्रस्तुति दी।

उन्होंने बताया कि भारतीय उपमहाद्वीप के पश्चिमोत्तर क्षेत्र में हिमालय से अरबसागर तक बहने वाले विशाल नदी समूह के सूखे हुए प्राचीन जलमार्गों का जाल बिछा है। प्रमाणों के आधार पर सिद्ध होता है कि, 6000 ई०पू० के आसपास वैदिक सरस्वती नाम से जाना जाने वाला एक सिन्धुनदी के समानान्तर, नदी समूह पूरी तेजस्विता पर था।

(i) उपग्रह से प्राप्त चित्रों के आधार पर उन्होंने बताया कि सरस्वती नदी हिमालय की ऊँचाई से निकलकर और सतलज, यमुना, चौतांग तथा दृशद्वती जैसी कई सहायक नदियों के साथ सिंधु के मैदान के पश्चिमी भाग में बहती थी। सरस्वती नदी समूह, हिमालय प्रदेश, पंजाब, हरियाणा तथा राजस्थान से गुजरते हुये अन्त में गुजरात में कच्छ के रन में समा जाता था। यह नदी, हिमालयी क्षेत्र में भूगर्भीय हलचल तथा पुरापर्यावरण बदलावों के कारण 2500–1500 ई०पू० के दौरान सूख गयी।

(ii) उन्होंने आगे बताया कि प्राचीन नदी समूह के चित्रण के लिए आप्टिकल सेटेलाइट डाटा, माइक्रोवेव डाटा और रिमोट सेंसिंग जैसे कई वैज्ञानिक तरीकों का इस्तेमाल किया गया है।

भूविज्ञान, सेडिमेंटोलोजी, हाइड्रोज्योलोजी और ड्रिलिंग डाटा जैसी जानकारी से मानचित्रित मार्गों की पुष्टि की गयी है। उपग्रह चित्रों में विलुप्त नदी के स्पष्ट निशान मिलते हैं और इसके अवशेष अब भी उपरोक्त राज्यों में देखे जा सकते हैं।

(iii) डॉ० शर्मा ने विस्तार से बताया कि रिमोट सेंसिंग डाटा, प्राचीन भारतीय साहित्य में वर्णित सरस्वती के सन्दर्भो की पूरी तरह पुष्टि करते हैं। ऋग्वेद में इस नदी का वर्णन अम्बीतमे, नदीतमें, देवीतमें के रूप में किया गया है। इसका अर्थ है- माताओं में सर्वश्रेष्ठ, नदियों में सर्वश्रेष्ठ और देवियों में सर्वश्रेष्ठ। यह प्राचीन भारत के लोगों के लिये जीवनदायी महान नदी समूह था। उत्तरवर्त्ती वैदिक साहित्य में इसके विभिन्न चरणों का और वर्णन किया गया है। यजुर्वेद में यमुना को छोड़कर पाँच सहायक नदियों के साथ इसका वर्णन है। सरस्वती नदी के किनारों पर बारह सौ से अधिक प्राचीन पुरातात्विक स्थलों की खुदाई की गयी है।

(iv) डॉ० शर्मा ने अपनी प्रस्तुति का समापन करते हुए कहा कि उपग्रह चित्रों, पुरातात्त्विक खोजों, अन्य वैज्ञानिक प्रमाणों और प्राचीन साहित्यिक सन्दर्भों से, वैदिक सरस्वती और हिमालयी क्षेत्रों के बीच तीन प्रकार का सम्बन्ध स्थापित होता है :

(क) सतलुज नदी के साथ

(ख) बाटा/मारकंडा के जरिए यमुना के साथ और

(ग) दृशद्वती के जरिए यमुना के साथ। राजस्थान में सरस्वती के प्राचीन जलमार्गों में भू-जल की समय सीमा 16800 ई०पू० से 660 ई० तक की आँकी गयी है।

16. अगली प्रस्तुति गोवा के राष्ट्रीय समुद्र विज्ञान संस्थान (एन.आई.ओ.), में भू-वैज्ञानिक समुद्र विज्ञान विभाग की प्राचीन जलवायु परियोजना के अध्यक्ष और वरिष्ठ वैज्ञानिक डॉ० राजीव निगम की थी। उन्होंने पिछले 'पंद्रह हजार वर्षों के दौरान समुद्र की सतह में आये उतार-चढ़ाव और इसके किनारे बसी मानव बस्तियों पर इनके प्रभाव' पर प्रकाश डाला। उन्होंने विस्तार से बताया कि समुद्र में जलस्तर के उतार-चढ़ाव के बारे में समुद्र विज्ञान की रिपोर्टों से 7500 ई०पू० और उसके बाद से जलमग्न हुए या तत्पश्चात् भूमि से घिरे कई तटवर्त्ती पुरातात्त्विक स्थलों के अस्तित्व का पता चलता है। इनमें शामिल हैं - हज़ीरा, धोलावीरा, जुनी कुरन, सुरकोट्डा, प्रभास पाटन और द्वारका इत्यादि। लोथल बन्दरगाह के बारे में विस्तार से चर्चा करते हुए उन्होंने यहाँ पर डॉकयार्ड होने के पक्ष में अनेक साक्ष्य पेश किये। उन्होंने बताया कि फोरामिनिफेरा केवल समुद्री जीव है तथा ये इस बन्दरगाह की सतह पर बड़ी संख्या में पाये गये हैं। इन सूक्ष्म जीवों को ताज़े पानी के स्रोतों में नहीं देखा जा सकता। इससे यह निष्कर्ष निकाला गया कि लोथल की यह संरचना ताज़े पानी की झील नहीं थी, बल्कि एक बन्दरगाह था, जो सम्भवत: दुनिया का सबसे पुराना समुद्री डॉकयार्ड है।

(i) उन्होंने भारत के पश्चिमी तट के लिए समुद्री सतह के उतार चढ़ाव को प्रदर्शित करते हुए इनका ऐतिहासिक विवरण दिया। इससे यह पता चला कि 4500 वर्ष पूर्व (2500 ई०पू०) लोथल समुद्र के स्तर से ऊपर था लेकिन बाद में लगभग 1500 ई०पू० तक इसमें गिरावट आती गयी। अत: डॉ० एस. आर. राव द्वारा खोजी गयी जलमग्न द्वारका नगरी 1500 ई०पू० समुद्र तल से ऊपर थी। उन्होंने यह भी बताया कि महाभारत में वर्णित तथ्य से इसकी पुष्टि होती है कि भगवान कृष्ण ने समुद्र से कुछ भूमि लेकर द्वारका नगरी बसायी थी क्योंकि 1400/1500 ई०पू० तक समुद्र का जल स्तर गिरते जाने के कारण, भूमि का यह भाग समुद्र से ऊपर हो गया था। डॉ० निगम ने आगे बताया कि इसके बाद समुद्र का स्तर लगातार बढ़ता गया।

(ii) डॉ० निगम ने पूर्वी तट पर समुद्र के उतार-चढ़ाव पर प्रकाश डालते हुए एक बहुत महत्वपूर्ण तथ्य का जिक्र किया और बताया कि समुद्र का स्तर 7000-7200 वर्ष पूर्व (5000-5200 ई०पू०) के आसपास मौजूदा स्तर से लगभग 3 मीटर नीचे था। संयोग से वर्तमान में रामसेतु लगभग 3 मीटर नीचे पानी में डूबा है। इसका अर्थ हुआ कि 5000 ई०पू० में यह सेतु समुद्र की सतह से ऊपर था और इसका इस्तेमाल रामेश्वरम् तथा श्रीलंका के बीच भू-मार्ग के रूप में किया जा सकता था। इस प्रकार समुद्र के उतार-चढ़ाव पर किए गए इस अध्ययन से रामायण युग के खगोलीय काल-निर्धारण की पुष्टि हुई है।

(iii) उन्होंने सुझाव दिया कि समुद्र के उतार चढ़ाव पर आधारित पुरातात्त्विक प्रमाणों का विविध वैज्ञानिक अनुसंधानों से सहसंबंध प्राचीनतम घटनाओं की एतिहासिकता जानने में अत्यंत सहायक हो सकता है।

17. प्रो० वी. आर. राव (दिल्ली विश्वविद्यालय) ने नूतन युग के दौरान 'भारत के लोगों का आनुवांशिक प्रोफाइल : कुछ प्रसंग' विषय पर अपने विचार रखे। उन्होंने उन मानवशास्त्रीय शोधों के बारे में विस्तार से बताया, जिनसे यह प्रमाणित हुआ कि पुरापाषाण युग से डी.एन.ए. की निरन्तरता पिछले 60,000 वर्षों से चली आ रही है। उन्होंने बताया कि भारत में अगुणित एमटी. डी. एन. ए. और उच्च घनत्व डी.एन.ए. के अध्ययनों के संदर्भ में जीनोम प्रमाणों से निम्न तथ्य प्रकाश में आने के खुलासे हुए हैं :

- डी. एन. ए. अध्ययन के आधार पर भारत में पुरापाषाण युग से अब तक रहने वाली जातियों, जनजातियों एवं अनुसूचित जातियों का किसी प्रकार का विभाजन जीव विज्ञान के आधार पर परिलक्षित नहीं होता।
- पूरे भारत में प्राचीन आनुवांशिक तत्व, भाषा की सीमाओं से परे हैं क्योंकि ये अब से 60-70 हजार वर्ष से भी काफी पहले के हैं।

- भारत में बाहर से आर्यों के अतिक्रमण के प्रमाण नहीं मिलते क्योंकि डी.एन.ए. वंशावलियों का स्वदेशी विकास हुआ है। यहाँ तक कि यूरेशियन वंशावलियों की जड़ें भी भारतीय वंश परम्परा में कुछ सीमा तक समाहित हैं जिससे यह संकेत मिलता है कि सम्भवत: भारत उपमहाद्वीप से लोग उस ओर गये।

डॉ० राव ने अपनी प्रस्तुति का समापन करते हुए कहा कि नूतन युग के दौरान जीनोम अध्ययन में पता चला है कि भारत के उत्तर, दक्षिण, पूर्व और पश्चिम में बसे मानवों के आनुवांशिक प्रोफाइल, एक जैसे हैं तथा वे पिछले 11000 वर्षों से एक जैसे हैं। इससे यह सिद्ध होता है कि हड़प्पा सभ्यता के निवासी पश्चिमी/मध्य एशिया से प्रवासी या अज्ञात मूल के रहस्यमय लोग नहीं थे, बल्कि वे भारतीय उपमहाद्वीप के स्वदेशी लोग थे। इसलिए प्रचलित मान्यता के विपरीत, द्रविड़ों और उत्तर भारतीयों के पूर्वज एक ही थे। ये दोनों भारतीय मूल के हैं और इनका आनुवांशिक प्रोफाइल भी एक जैसा है इसलिये इनके पूर्वज भी एकसमान हैं।

18. भारत ज्ञान फाउण्डेशन के डॉ० डी. के. हरि ने ''प्राचीन भारतीय इतिहास–वास्तविक है न कि काल्पनिक'' विषय पर मल्टीमीडिया प्रस्तुति दी। उन्होंने कहा कि प्राचीन भारतीय इतिहास को चार मान्यताओं के आधार पर काल्पनिक कथायें कहा जाता था लेकिन आधुनिक वैज्ञानिक अनुसन्धान ने इन मान्यताओं को गलत सिद्ध कर दिया है:–

(i) भारत में मध्य एशिया से आर्यों का अतिक्रमण भाषायी आधार की कोरी कल्पना है जिसकी वास्तविकता का एक भी वैज्ञानिक प्रमाण नहीं है। इसके विपरीत पिछले 10 हजार वर्षों के दौरान भारत में ही भारतीय सभ्यता के विकास के अनेकों वैज्ञानिक प्रमाण मिले हैं।

(ii) 327 ई.पू. में सिकन्दर द्वारा पोरस को हराने की कथा को ही इतिहास मानकर उसके पहले के समूचे इतिहास को काल्पनिक अथवा पौराणिक बताना फैशन मात्र था जिसका मूल अंग्रेजी लोगों का सुपीरिआरिटी कॉम्पलैक्स था।

(iii) कुछ विसंगतियों के कारण पुराणों की वंशावली को पौराणिक कथा के रूप में पेश किया गया हालांकि अन्य सभ्यताओं की ऐसी वंशावली में और भी अधिक विसंगतियाँ थी। नवीनतम वैज्ञानिक अनुसन्धान के प्रमाणों के अनुसार पिछले हिमयुग के पश्चात् वास्तव में पुराणों की वंशावलियों से सभ्यता का वास्तविक विकास परिलक्षित होता है।

(iv) 18वीं और 19वीं शताब्दी में ईसाइयों की मान्यता के अनुसार पृथ्वी की रचना 23 अक्टूबर 4004 ई०पू० में हुई थी, इसलिये इसे इससे काफी पहले बताने वाले भारत के इतिहास को पौराणिक कथा बताया गया था।

श्री हरि ने अपनी प्रस्तुति का समापन करते हुए कहा कि पुराण, वेद और महाकाव्य सभी काल्पनिक कथाओं की श्रेणी में डाल दिये जाते हैं, परिणामस्वरूप बिना साहित्य के इतिहास और

इतिहास के बिना साहित्य की अनसुलझी गंभीर समस्या खड़ी हो गयी है। किसी भी राष्ट्र को अपने भविष्य के निर्माण के लिए अपने बीते समय से सामंजस्य स्थापित करना होगा, इसलिये अब समय आ गया है कि भारत, आर्यों के आक्रमण के मिथ्या विश्वास को छोड़कर, वैज्ञानिक प्रमाणों पर आधारित इतिहास की पुनर्रचना करें, क्योंकि भगवान भूतकाल को नहीं बदलते और न ही उन देशों को माफ करते हैं जो अपने इतिहास की सच्ची घटनाओं का निर्धारण करने में विफल होते हैं।

19. डॉ० बलदेवानंद सागर ने 'ऋग्वेद और महाकाव्यों में वर्णित स्थानों और नदियों के भौगोलिक साक्ष्यों पर अपने विचार रखे। उन्होंने वैदिक काल और उसके बाद के भौगोलिक क्षेत्रों के बारे में बताया। उन्होंने मानचित्र के माध्यम से बताया कि उत्तर-पश्चिमी भारतीय उपमहाद्वीप में खुदाई से जिन पुरातात्विक स्थलों का पता चला है, उनमें से अधिकतर का वैदिक साहित्य तथा वाल्मीकि रामायण में वर्णन किया गया है।

(i) उन्होंने, प्राचीन ग्रंथों से उदाहरण पेश करते हुए कई सहस्त्राब्दियों से सरस्वती नदी के अस्तित्व और महत्व पर प्रकाश डाला। उन्होंने पुरातात्त्विक रिपोर्टों और उपग्रह चित्रों के साथ इन संदर्भों के सम्बन्ध के बारे में बताते हुए इनकी वास्तविकता की पुष्टि की। उन्होंने वेदों से अनेक मंत्रों का उच्चारण करने के साथ-साथ बताया कि ऋग्वेद-काल में सरस्वती नदी तीन स्रोतों से निकली हुई, सात सहयोगियों वाली, पर्वत से समुद्र तक बहने वाली महान नदी थी। परंतु यजुर्वेद की रचना के समय इसकी केवल पाँच सहायक नदियाँ थीं और उनमें यमुना शामिल नहीं थी।

(ii) उन्होंने बताया कि रामायण में वर्णित कई ऐसे भौगोलिक स्थल आज भी मौजूद हैं जहाँ उसी प्रकार की स्थितियाँ, चित्रण, पेड़-पौधे तथा जीव-जन्तु पाये गये हैं। डा० रामावतार जी द्वारा किए गए श्रीराम वनगमन स्थलों के अनुसंधान के आधार पर श्री सागर ने बताया कि वाल्मीकि रामायण में वर्णित स्थलों में से अयोध्या से रामेश्वरम् तक भारत में 290 से अधिक स्थल ऐसे हैं जिनमें अभी भी ऐसे तालाब, नदियाँ, पर्वत, वन, जड़ी-बूटियाँ तथा ऋषि-आश्रम आदि हैं जिनका वर्णन रामायण में किया गया है। महाभारत युग के भौगोलिक साक्ष्यों का उल्लेख करते हुए उन्होंने समुद्र के भीतर डूबी हुई द्वारका नगरी का उदाहरण भी पेश किया।

20. श्री वाई. के. गैहा, आई.आर.एस., सदस्य, (बी.आई.एफ.आर.) ने इस प्रकार के शोध, तथा इस प्रकार के राष्ट्रीय सेमिनार के माध्यम से उभरकर आये कारोबारी अवसरों और जन-कल्याण के बारे में जानकारी दी।

(i) सेमिनार के दौरान पेश की गई प्रस्तुतियों से सिद्ध होता है कि उत्तर, दक्षिण, पूर्व तथा पश्चिम भारत में रहने वाले सभी भारतीयों का जैनेटिक प्रोफाइल एक है और उत्तर भारतीयों तथा द्रविड़ लोगों के पूर्वज एक ही थे। इसीलिये ये सभी भारतीयों को एकता के सूत्र में बाँधकर उनके आत्म सम्मान व राष्ट्रीय गर्व में वृद्धि करता है।

(ii) सरस्वती और दृशद्वती जैसी प्राचीन नदियों की सूखी धारा के नीचे भूमिगत जल के इस्तेमाल पर जोर देने से कुछ चुने हुए इलाकों में पानी की कमी की समस्या का समाधान किया जा सकता है।

(iii) सेमिनार में पर्यटन को बढ़ावा देने के लिये कई संभावनाओं की चर्चा की गयी, जैसे कि अगर जलमग्न द्वारका नगरी के स्थल पर एक संग्रहालय जो पारदर्शी ट्यूब के माध्यम से जुड़ा हो स्थापित किया जाए तो इससे होने वाली आय से इसकी स्थापना के पहले वर्ष में ही इसकी लागत वसूल की जा सकती है और इससे भारत में पर्यटन को भी बढ़ावा मिलेगा।

21. आई-सर्व के अध्यक्ष श्री के. वी. कृष्णमूर्ति ने समापन समारोह में स्वागत भाषण दिया। श्रीमती सरोज बाला ने सेमिनार में की गई प्रस्तुतियों का संक्षिप्त विवरण दिया। उन्होंने स्पष्ट किया कि अब तक हमें बताया जाता रहा है कि 1500 ई०पू० से पहले भारत असभ्य था और आर्य, लोगों ने मध्य एशिया से आकर असभ्य उत्तर भारतीयों को दक्षिण की ओर ढकेल दिया जिन्हें बाद में द्रविड़ कहा गया। इन हमलावरों ने उत्तर भारत में पहला सभ्य समाज स्थापित किया। वर्तमान में वैज्ञानिक संसाधनों तथा तकनीकों के क्रमबद्ध उपयोग से किये गये क्रमबद्ध वैज्ञानिक अनुसन्धानों से यह सिद्ध होता है कि यह केवल एक भाषागत अनुमान था और वास्तव में पिछले दस हजार वर्षों से विकसित होती हुयी भारतीय सभ्यता वेदों, तथा महाकाव्यों में वर्णित है और हमारा प्राचीन इतिहास कल्पना नहीं बल्कि वास्तविकता है। उन्होंने यह भी कहा कि इस सेमिनार में प्रस्तुत अनुसन्धान रिपोर्टों/शोध से अधिकांश भारतीय अनभिज्ञ हैं। इसलिए विचार-विमर्श के दौरान उठाये गये कई प्रश्नों के उत्तर विशेषज्ञों/वैज्ञानिकों ने इस प्रकार दिये:

(i) अब तक जिन खगोलीय तिथियों की गणना की गयी है उनसे भारत में भारतीय सभ्यता का विकास 7000 वर्ष ई०पू० से भी पहले होने के बारे में पता चलता है। ऋग्वेद में खगोलीय संदर्भ, 7000 वर्ष ई०पू० से 4000 वर्ष ई०पू० तक की तिथियों के आकाशीय दृश्यों और रामायण में वर्णित खगोलीय संदर्भ, 5100 वर्ष ई०पू० के आसपास की तिथियों को क्रमबद्ध रूप से देखे जाने वाले आकाश दृश्यों का प्रतिनिधित्व करते हैं। ये तिथियाँ अनन्य हैं और क्रमिक रूप से भी मिलती हैं।

(ii) प्राचीन ग्रन्थों में विशेषकर ग्लेशियरों के पिघलने और प्राचीन नदियों के जलस्तर में उतार-चढ़ाव के सम्बन्ध में पारिस्थितिकीय सन्दर्भों की पुष्टि ऐसी खगोलीय तिथियों से होती है। जलवायु सम्बन्धी बदलावों के बारे में हाल की रिपोर्टों से भी ऐसे ही निष्कर्ष सामने आये हैं।

(iii) उपग्रह चित्र व भूगर्भीय अनुसन्धान इस तथ्य की पुष्टि करते हैं कि वेदों और महाकाव्यों में वर्णित सरस्वती नदी समूह 6000 वर्ष ई०पू० के आसपास पूरे यौवन पर था। यह नदी

धीरे-धीरे सूखती गयी और 2000 ई०पू० के आसपास लगभग विलुप्त हो गयी। तलछटी शास्त्र, जल भू-विज्ञान और ड्रिलिंग डाटा से भी इन निष्कर्षों की पुष्टि हुयी है।

(iv) समुद्र के स्तर में उतार-चढ़ाव पर समुद्र विज्ञान की रिपोर्टों से 7500 वर्ष ई०पू० से जलमग्न हुये या वर्तमान में भू-भाग से घिरे पाये गये कई तटीय पुरातात्विक स्थलों के अस्तित्व का पता चलता है उदाहरणार्थ हज़ीरा, धोलावीरा, जुनी कुरन, सुरकोट्डा, प्रभास पाटन और द्वारका इत्यादि। इनमें द्वारका और प्रभास का शामिल होना काफी महत्त्वपूर्ण है।

(v) पुरावनस्पति-वैज्ञानिकों के अनुसार वेदों और महाकाव्यों में वर्णित बहुत से पौधों, पेड़ों और जड़ी-बूटियों की उपस्थिति पिछले 8000-10000 वर्षों से लगातार भारत में बनी हुई है। चूँकि इनका इस्तेमाल निरन्तर होता रहा है, यह सिद्ध होता है कि मान्यता के विपरीत प्राचीन भारतीय सभ्यता का अन्त नहीं हुआ था बल्कि वही सभ्यता वर्त्तमान में फलफूल रही है।

(vi) ताजा, पुरातात्विक खोजों से ऐसी काफी सामग्री मिली है जिससे यह प्रमाणित होता है कि भारतीय उपमहाद्वीप में भारतीय सभ्यता का उद्भव और विकास 7000 ई०पू० से हुआ था। इसके कुछ उदाहरण है- पूर्व में लहुरादेवा, झूसी, टोकवा तथा हेटापट्टी, पश्चिमोत्तर में मेहरगढ़ कोट डिजी तथा नौशारो और पश्चिम में लोथल तथा धोलावीरा। इस प्रकार पुरातात्त्विक प्रमाणों ने भी इन खगोलीय, पारिस्थितिकीय और मानव वैज्ञानिक निष्कर्षों की पुष्टि की है कि आर्य मूलरूप से भारतीय थे तथा वे पिछले दस हजार वर्षों से एक बहुत प्रगतिशील सभ्यता का उद्भव और पोषण करते चले आ रहे हैं और उन्हीं में से कुछ लोग मध्य एशिया तथा यूरोप की तरफ भी गये।

(vii) मानवशास्त्रीय शोधों से पता चला है कि भारत में प्रतिनूतन युग से डी.एन.ए. की निरन्तरता पिछले 60,000 वर्षों से चली आ रही है। नूतन युग के दौरान जीनोम के अध्ययन से यह स्पष्ट हुआ है कि भारत के उत्तर, दक्षिण, पूर्व और पश्चिम में बसे लोगों के आनुवांशिक प्रोफाइल एकसमान हैं और पिछले ग्यारह हजार से अधिक वर्षों से एकसमान रहे हैं। अतः प्रचलित मान्यता के विपरीत उत्तर भारतीय और द्रविड़ों के पूर्वज एक ही थे और वे दोनों मूलरूप से भारतीय थे।

श्रीमती सरोज बाला ने अपनी प्रस्तुति का समापन करते हुए कहा कि संगोष्ठी के प्रमुख निष्कर्षों से भारतीयों में उनकी प्राचीनतम समृद्ध सांस्कृतिक विरासत के प्रति गर्व पैदा करके उनमें एकजुटता और आत्म सम्मान की भावना पैदा की जा सकती है। वैज्ञानिक अनुसंधानों से यह भी प्रमाणित हुआ है कि भारतीय सभ्यता, पिछले दस हजार वर्षों से लगातार भारत में विकसित हो रही है और फल-फूल रही है और हमारे कुछ पूर्वज अन्यों को सभ्य बनाने के लिए यहाँ से बाहर गए थे।

22. माननीय न्यायमूर्त्ति अशोक भान, विदेश मंत्रालय में सचिव श्री मनबीर सिंह और केन्द्रीय प्रत्यक्ष कर बोर्ड की सदस्य श्रीमती पूनम किशोर सक्सेना ने सम्माननीय अतिथियों के रूप में

उपस्थित होकर इस अवसर की शोभा बढ़ायी। उन्होंने अपने ज्ञान एवं उत्साह वर्धक सम्बोधन से सेमिनार का स्तर ऊँचा उठाया। उन्होंने इस बात पर ज़ोर दिया कि सेमिनार में प्रस्तुत इन बहुव्यवस्थित वैज्ञानिक अनुसंधान रिपोर्टों से प्रथम दृष्ट्या साबित होता है कि भारतीय सभ्यता पिछले दस हजार वर्षों से विकसित होती रही है और सभी भारतीयों का डी एन ए प्रोफाइल एकसमान है, इसलिए अब 'आर्यों के अतिक्रमण' की भाषागत अवधारणा को बदलने और विश्व के सामने गर्व से अपना मस्तक ऊँचा कर घोषणा करने का समय आ गया है कि भारत ही विश्व की प्राचीनतम् सभ्यता का सृजक व पोषक है।

23. संसदीय कार्य और जल संसाधन मंत्री श्री पवन कुमार बंसल ने 31 जुलाई 2011 को समापन भाषण दिया। उन्होंने कहा कि इस राष्ट्रीय सेमिनार में कई नए वैज्ञानिक शोधों और स्रोतों की जानकारी मिली है। प्रमाणों की छानबीन के जरिए घटनाओं के वैज्ञानिक काल-निर्धारण से भारतीय इतिहास की सीमाओं का विस्तार करने में इनसे मदद मिल सकती है। उन्होंने बताया कि ये केवल वही प्रमाण नहीं है जो समुद्र या भूमि के नीचे दबे पड़े हैं, बल्कि इनमें ऐसे साक्ष्य भी शामिल हैं जो नक्षत्रीय संदर्भों के रूप में मिलते हैं। यदि सभी उपलब्ध तकनीकों का प्रयोग कर विभिन्न स्रोतों की व्यवस्थित और समन्वित छानबीन की जाए तो ऐसी बहुत सी सामग्री उपलब्ध होगी जिससे साक्ष्यों के अभाव में पौराणिक कथाएँ लिये जाने वाले प्राचीन तथ्य वास्तव में ऐतिहासिक सिद्ध हो सकते हैं।

(i) उन्होंने इस सेमिनार के इस निष्कर्ष पर प्रसन्नता व्यक्त की कि चूँकि सभी भारतीयों के पूर्वज एक हैं, इसलिए प्राचीन घटनाओं के विशेषकर आनुवंशिक प्रोफाइलिंग से, वैज्ञानिक काल-निर्धारण की कोशिशों से उन्हें एकजुट किया जा सकता है। इससे औपनिवेशिक काल के दौरान, भाषायी अनुमानों के आधार पर लिखित हमारे इतिहास के कारण उत्तर भारतीयों और द्रविड़ों के बीच किए गए विभाजन को खत्म करने में मदद मिल सकती है।

(ii) उन्होंने इस बारे में किए गए वैज्ञानिक शोधों की भी सराहना की। उन्होंने सुझाव दिया कि इन्हें बढ़ावा दिया जाना चाहिये और इस ज्ञान का प्रसार स्कूलों तथा कालेजों में किया जाना चाहिये। सरस्वती जैसी नदियों के प्राचीन जलमार्गों के बारे में जानकारी से भूमिगत जल संसाधानों के दोहन में मदद मिल सकती है।

24. सेमिनार में पेश प्रस्तुतियों के आधार पर कुछ महत्त्वपूर्ण सुझाव सम्बन्धित सरकारी विभागों, विश्वविद्यालयों, स्वायत्तशासी एवं सांविधिक निकायों जैसे भारतीय पुरातत्व सर्वेक्षण, भारतीय भूवैज्ञानिक सर्वेक्षण एवं भारतीय मानवविज्ञान सर्वेक्षण को दिये गये। संक्षिप्त रूप से इनमें से कुछ निम्नलिखित है: प्राचीन भारतीय इतिहास एवं विश्व के इतिहास की पुनर्रचना बहुआयामी वैज्ञानिक

अनुसन्धानों के आधार पर की जानी चाहिये; भारतीय इतिहास अनुसन्धान परिषद का पुनर्गठन कर इसमें संस्कृत विद्वानों, खगोल शास्त्रियों, समुद्र विज्ञानियों, अन्तरिक्ष विज्ञानियों, पुरावनस्पति शास्त्रियों और पारिस्थितिकीविदों को शामिल करना चाहिये; जलमग्न द्वारका को पारदर्शी ट्यूब से जोड़कर भूमिगत संग्रहालय का निर्माण; प्राचीन सरस्वती नदी के आसपास के उत्खनित स्थल एवं भगवान श्री राम द्वारा भ्रमण किये गये महत्त्वपूर्ण स्थानों के लिये पर्यटन पैकेज देना; जीनोम अध्ययन के निष्कर्षों का व्यापक प्रचार प्रसार करना चाहिये कि आर्यों के आक्रमण का सिद्धान्त अब गलत साबित हो चुका है और उत्तर भारतीयों तथा द्रविड़ों के पूर्वज एक ही थे; मानव संसाधन विकास मंत्रालय को इन विभिन्न वैज्ञानिक शोध के निष्कर्षों को समस्त भारत के स्कूल एवं कालेजो की पुस्तकों में शामिल किया जाना चाहिये। सेमिनार के दौरान की गयी उपर्युक्त अनुशंसायें विस्त्रित रूप में एक अलग अध्याय में की गयी है।

सेमिनार का समापन श्रीमती विनीता सूरी के धन्यवाद ज्ञापन के साथ सम्पन्न हुआ। उन्होंने विशेषज्ञों एवं वैज्ञानिकों को विशेष आभार व्यक्त किया जिन्होंने उच्च स्तर के शोध पत्र प्रस्तुत किये। राष्ट्रीय संस्कृत संस्थान और पृथ्वी विज्ञान मंत्रालय द्वारा प्रदत्त सहायता के लिये धन्यवाद दिया। उन्होंने मुख्य अतिथि महोदय, सम्मानित अतिथियों एवं श्रोताओं को विशेष आभार व्यक्त किया और साथ में जन संचार संस्थान, इवेन्ट मैनेजर, कैटरर एवं अन्य सहयोगियों को भी धन्यवाद ज्ञापित किया।

विशेषः विश्वस्तरीय प्रख्यात परमाणु वैज्ञानिक डॉ० डी. एस. कोठारी ने भारतीय विज्ञान अकादमी में एक भाषण में कहा था, 'भारतीयों में राष्ट्रीय गर्व के अभाव के बारे में हम अफसोस कैसे कर सकते हैं जबकि उन्हें हमने देश के अत्यन्त प्राचीन अतीत की महान वैज्ञानिक उपलब्धियों से अवगत नहीं कराया ?'

इस राष्ट्रीय वैज्ञानिक संगोष्ठी के माध्यम से अपने देशवासियों को इन्हीं वैज्ञानिक उपलब्धियों से सुपरिचित कराने की महत्वाकांक्षा से विज्ञान एवं प्रौद्योगिकी मंत्रालय तथा भू-वैज्ञानिक मंत्रालय से अनुरोध किया गया कि उनके पास प्राप्त वैज्ञानिक अनुसंधान रिपोर्टों को मानव संसाधन विकास मंत्रालय के पास भेजें ताकि इन्हें स्कूलों एवं कॉलेजों के पाठ्यक्रम/पुस्तकों इत्यादि में सम्मिलित किया जाये और भविष्य में भी इनका समय-समय पर ऐसे ही समावेश होता रहे।

हिन्दी रूपान्तर

कृष्णानन्द सिन्हा **सरोज बाला**

वैज्ञानिक (सेवानिवृत्त) **कुलभूषण मिश्र**

आर्यभट प्रेक्षण विज्ञान शोध संस्थान, नैनीताल

Seminar Details – Sessions and Panel Experts

of

National Seminar on Scientific Dating of Ancient Events before 2000 BC

(30th and 31st July, 2011)

30th July, 2011

9:00 am onwards	Registration of participants and invitees
10:00 am - 10:45 am	Introduction of experts on the panels

Inaugural Session

10:45 am -	Arrival of the Chief Guest **His Excellency Dr. A.P.J. Abdul Kalam**
11:00 am - 11:05 am	Welcome address by **Sh. K. V. Krishna Murthy** – *Chairman, I-SERVE*
11:05 am - 11:10 am	Introduction to the Seminar by **Smt. Saroj Bala** – *Director, I-SERVE Delhi Chapter*
11:10 am - 11:15 am	Address by **Sh. Jawhar Sircar** – *Secretary, Ministry of Culture*
11:15 am - 11:20 am	Address by **Hon'ble Justice Ashok Bhan** – *Chairman, National Consumer Disputes Redressal Commission (NCDRC)*
11:20 am - 11:50 am	Inaugural address by **His Excellency Dr. A.P.J. Abdul Kalam**
11:50 am - 12 noon	Release of **Seminar Memento**: Wall Clock depicting the Sky View on January 10, 5114 BC (Date of Birth of Lord Ram) - Dedicated to the memory of Late Sh. Pushkar Bhatnagar
12 noon - 12:30 pm	Vote of thanks followed by Tea.

Seminar Sessions

12:30 pm - 1:00 pm	An overview of the research project '**Scientific Dating of Ancient Events before 2000 BC**' presented by **Smt. Saroj Bala**
1:00 pm - 1:40 pm	**Astronomical Dating of Planetary References in Rigveda & Epics** using Planetarium Software Presented by **Sh. Ashok Bhatnagar**

PANEL OF EXPERTS:

Dr. Amba Kulkarni – *Professor & Head, Deptt. of Sanskrit, University of Hyderabad*

Prof. K. Ramasubramanian – *Deptt. of Humanities & Social Sciences, IIT, Mumbai*

Dr. (Ms.) Rathnasree – *Director, Nehru Planetarium, New Delhi*

Dr. Ranjan Gupta – *Prof. of Astronomy, Inter-University Centre for Astronomy and Astrophysics, Pune*

2:30 pm - 3:45 pm **Origin and Development of Civilization in the Indian Sub-continent during last 8000 years: An Archaeological Perspective** Presented by **Shri Kulbhushan Mishra**

PANEL OF EXPERTS:

Dr. B. R. Mani – *Addl. Director General, Archaeological Survey of India*

Dr. Shanti Pappu *– Secretary, Sharma Centre for Heritage Education, Pune*

Sh. K. N. Dikshit *– General Secretary, Indian Archaeological Society, New Delhi*

Prof. V. H. Sonawane*– Former Prof., Deptt. of Archaeology & Ancient History, M.S. University of Baroda*

Sh. D.V.N. Sharma

3:45 pm - 4:30 pm **Radiometric Dating of Records of Ancient Cultures in India** Presented by **Dr. C.M. Nautiyal**

PANEL OF EXPERTS:

Dr. B. R. Mani – *Addl. Director General, Archaeological Survey of India*

Dr. Shanti Pappu – *Secretary, Sharma Centre for Heritage Education, Pune*

Sh. K. N. Dikshit – *General Secretary, Indian Archaeological Society, New Delhi*

Prof. V. H. Sonawane – *Former Prof., Deptt. of Archaeology & Ancient History, M.S. University of Baroda*

5:00 pm - 6:30 pm **Archaeobotanical Evidences of Ancient Cultures in Indian Subcontinent** Presented by **Dr. Chanchala Srivastava**

PANEL OF EXPERTS:

Dr. R.K. Ganjoo – *Director & Professor, Himalayan Institute of Glaciology, Deptt. of Geology, University of Jammu*

Dr. Ranvir Singh – *Director, Institute of Sanskrit & Indological Studies, Kurukshetra University*

Dr. Krishnanand Sinha – *Scientist E (Retd.), Aryabhata Research Institute of Observational Sciences (ARIES), Nainital*

Dr. M.D.N. Sahi – *Former Professor, Deptt. of AIH & Archaeology, Aligarh Muslim University*

31st July, 2011
Seminar Sessions

10:00 am - 11:00 am — **Signatures of Paleo-Rivers and their networks in North Western India: Inputs from Remote Sensing**
Presented by **Dr. J.R. Sharma**

PANEL OF EXPERTS:

Dr. A.R. Chaudhri – *Professor, Deptt. of Geology, Kurukshetra University*

Dr. B.K. Bhadra – *Scientist, Regional Remote Sensing Centre, ISRO, Jodhpur*

Dr. G.S. Srivastava – *Former ADG, Geological Survey of India, Lucknow*

Shri Darshan Lal jain – *Saraswati Nadi Shodh Sansthan, Yamuna Nagar*

11:00 am - 12:15 pm — **Sea Level Fluctuations during last 15000 years and their Impact on Human Settlements** Presented by **Dr. Rajiv Nigam**

PANEL OF EXPERTS:

Dr. K. H. Vora – *National Institute of Oceanography, Goa*

Dr. Rajeev Sarasvat – *National Institute of Oceanography, Goa*

Prof. V.H. Sonawane – *Former Prof., Deptt. of Archaeology & Ancient History, M.S. University of Baroda*

Dr. R.K. Ganjoo – *Director & Professor, Himalayan Institute of Glaciology, Deptt. of Geology, University of Jammu*

12:30 pm - 1:00 — **Ancient Indian History is not mythology**
— A multi-media presentation Presented by **Dr. D.K. Hari**, *Founder, Bharath Gyan*

1:00 pm - 2:00 pm	**Genetic Profile of the people of India during Holocene: Some Inferences** Presented by **Dr. V.R. Rao**
	PANEL OF EXPERTS:
	Dr. Murari Ratnam – *Director, Central Soil and Material Research Station, New Delhi*
	Prof. D. P. Tiwari – *Deptt. of AIHC & Archaeology, Lucknow University*
	Prof. Anup K. Kapoor – *Deptt. of Anthropology, Delhi University*
	Prof. Jai Krishna – *Deptt. of Geology, Banaras Hindu University, Varanasi*
2:45 pm - 3:30 pm	**Geographic Evidences of Places and Rivers Referred to in Rigveda and Epics** Presented by **Dr. Baldevanand Sagar**, *Incharge, Sanskrit News, All India Redio, New Delhi*
	PANEL OF EXPERTS:
	Dr. Ram Autar Sharma – *Researcher in Places referred to in Ramayana*
	Gen. Rookmangud Katawal – *Former Chief of Army, Nepal*
	Ms. Leena Mehndale – *Chief Patron of Kaushlam Trust, Bangalore*
3:30pm - 4:00 pm	**Public Welfare and Business Opportunities Created by this Research Project** Presented by **Sh. Y.K. Gaiha**

Valedictory Session

4:00 pm	Arrival of Chief Guest **Sh. Pawan Kumar Bansal**, *Honourable Minister for Parliamentary Affairs and for Water Resources*
4:00 pm - 4:05 pm	Welcome address by **Sh. K. V. Krishna Murty**, *Chairman, I–SERVE*
4:05 pm - 4:15 pm	Summation of the National Seminar by **Smt. Saroj Bala**
4:15 pm - 4:20 pm	Address by **Smt. Poonam Kishore Saxena**, *Member, Central Board of Direct Taxes*
4:20 pm - 4:25 pm	Address by **Sh. Manbir Singh**, *Secretary (ER), Ministry of External Affairs*

4:25 pm - 4:30 pm	Address by **Hon'ble Justice Ashok Bhan**, *Chairman, National Consumer Disputes Redressal Commission (NCDRC), New Delhi*
4:30 pm - 5:00 pm	Valedictory address by the **Honorable Minister Shri Pawan Kumar Bansal**
5:00 pm - 6:00 pm	Vote of thanks by **Mrs. Vinita Surie** *IRS (Retd.)*, followed by Tea

(From 6 pm to 7:30 pm, informal discussions were held with scientists and experts, who had come from all over India, to have the feedback on the seminar as well as on the methodology of the Research Project, to take suggestions for making improvements and to determine the future course of action)

National Seminar on Scientific Dating of Ancient Events Before 2000 BC

(30th & 31st July, 2011)

Profiles of Speakers

1. Ms. Saroj Bala

Ms. Saroj Bala belongs to 1972 batch of Indian Revenue Service. She did her post-graduation in Political Science from Punjab University and L.L.B. from Punjabi University. She was the first lady officer in the history of Income-tax Service to be adjudged the 'Best All Round Officer' at National Academy of Direct Taxes. As Member of Central Board of Direct Taxes (CBDT), she conceived and implemented the idea of bringing out an annual publication titled "Let us Share – A compilation of Best Orders and Best Practices" which has instilled a spirit of competition for improving the quality of work in Income Tax Department.

She has been deeply involved, for more than last ten years, in scientific research into the historicity and dating of ancient events. She has conceptualized the research project titled **Extraction, translation and sequential dating of astronomical references in Sanskrit manuscripts from Rigveda to Aryabhatiya and correlation of such dates with other scientific evidences** and has been constantly working on it. The research results in respect of Vedic and Ramayan eras were so encouraging that she and her team members decided to present these before the Nation by organizing a two-day National Seminar on **Scientific Dating of Ancient Events before 2000 BC.** The research into scientific dating of Mahabharat and Bauddh eras is currently going on.

2. Shri A.K. Bhatnagar

Shri A.K. Bhatnagar obtained M.Sc. degree in Astronomy and Astrophysics from Centre of Advanced Study in Astronomy, Osmania University, Hyderabad in 1970 and worked for 26 years as professional astronomer during his career of 39 years.

He began his career at the U.P. State Observatory, Nainital (now ARIES under DST), worked as Director of Positional Astronomy Centre, Kolkata and retired as Additional Director General from India Meteorological Department (IMD) in 2010. He has more than 100 departmental books/publications to his credit and has published 19 research papers in various scientific journals. He is a founder member of the Astronomical Society of India.

3. Shri Kulbhushan Mishra

Shri Kulbhushan Mishra has been working in Indian Archaeological Society, New Delhi as a Research Associate since July, 2007. He did his M.A. from Banaras Hindu University (BHU) in 'Ancient Indian History Culture and Archaeology' in 2003 followed by Post Graduate Diploma (2004-2006) in Archaeology from Institute of Archaeology, Archaeological Survey of India. He has actively participated in the various excavations such as Lahuradeva (UP), Baror (Rajasthan) and Sisupalgarh (Orissa). He has participated and presented papers in national/international conferences. He has authored a book jointly with late Dr. S.P. Gupta (in press) and published several research papers in reputed archaeological journals. He is a life member of the Indian Archaeological Society. Currently he is engaged in a project on "Atlas of Indus – Saraswati Civilization". It involves preparation of maps using Geographical Information System Software`.

4. Dr. C.M. Nautiyal

Dr. Chandra Mohan Nautiyal is the scientist-in-charge of the Radiocarbon Dating Laboratory at Birbal Sahni Institute of Palaeobotany, Lucknow. He obtained Masters Degree from UOR (IIT-Roorkee) and carried out Doctoral and Post-Doctoral research at Physical Research Laboratory, Ahmadabad. In addition to five Scholarships and Fellowships as a student, he received INSA- DFG Fellowship to work in Germany. He specializes in isotope measurements and their use for chronology. His present academic interests include Radiocarbon Dating and application to Palaeoclimate and Archaeology and he has published on them in various prestigious journals. He is a recipient of INSA Medal for Young Scientists and recognition from ISMAS and Meteoritical Society, USA. He received the title of '*Vigyan Vachaspati*' from *Vigyan Parishad*, BSIP Medal for Highest Consultancy and also several recognitions for science popularization. He is a Fellow of the Geological Society of India (Bengaluru), NCSTC-Network

(New Delhi) and the Society of Earth Scientists (Lucknow). He is in the National Committee for Archaeological Sciences and also in the Society of the Earth Scientists of India. He is also a well known science communicator through print and audio- visual media.

5. Dr. Chanchala Srivastava

After completing M.Sc. (Botany) from University of Lucknow, Dr. Chanchala Srivastava joined the department of Quaternary Biogeography and Archaeobotany at Birbal Sahni Institute of Palaeobotany, Lucknow in 1980 and completed Ph.D. on Palaeobotanical and Palaeoecological investigation of wild plant remains from the archaeological sites in ancient India. Her expertise as well as published work is on investigation of botanical remains (seeds, fruits, wood remains, etc.) from archaeological sites of different cultural chronology in north-western parts of India. She is a Fellow of 'The Palaeobotanical Society, Lucknow' and life member of 'Indian Society for Pre-Historic and Quaternary Studies', Pune. At present, she heads the Archaeobotany Unit at Birbal Sahni Institute of Palaeobotany, Lucknow.

6. Prof. V.R. Rao

Prof. V.R. Rao is a B.Sc. with Botany, Zoology and Chemistry, M.Sc in Physical Anthropology and Ph.D. in Applied Biology. At present he is professor in Department of Anthropology, University of Delhi. He has been the Director of Anthropological Survey of India, Kolkata for more than 6 years *i.e.* between 2003- 2009. He has won many awards like 'Young Scientist Award' of Indian Society of Human genetics; Presidential award for production of best non-feature Ethnographic film and Dr. Panchanan Mitra Memorial Lecturership award by the Asiatic Society. He has vast research experience in the field of anthropology at Delhi, Kolkata, Hyderabad and Nagpur. He has organized many national and international conferences/workshops on topics like 'DNA Methods for the Diagnosis of Haemoglobinopathies' and 'Genetic Structure of Indian Population'. He has also supervised and participated in many programs of the Survey, conducted or being conducted, on various aspects of genetic studies.

7. Dr. Rajiv Nigam

Dr. Rajiv Nigam is Ph. D. (Geology) and is working as a Scientist–G and Head of Palaeoclimate Project, Geological Oceanography Division, National Institute of

Oceanography, Goa. His areas of interest are: Palaeoclimate, Geology, Sea Level Changes, Palaeomonsoon, Archaeology, Pollution Studies and Palaeofisheries. He has 112 scientific research papers/publications to his credit. He is a recipient of many Awards/Recognitions *e.g.* CSIR Young Scientist Award, Outstanding Young Person Award, National Mineral Award, Vigyan Prabha Award, Krishnan Gold Medal and also the Ministry of Earth Sciences Award for his book on Monsoon (2007). He is a Visiting Professor for Chinese Academy of Sciences.

8. Dr. J.R. Sharma

Dr. J.R. Sharma joined ISRO in 1987 after eight years of teaching at University of Rajasthan, Jaipur. He is currently Scientist 'G' and Group Director at National Remote Sensing Centre, ISRO, Department of Space, Hyderabad with multiple scientific, technical and administrative responsibilities. He is General Manager of Regional Remote Sensing Centre of ISRO, Jodhpur for the past 21 years. Applying the remote sensing and GIS methods, he has directed nearly 200 important studies related to natural resource management, in general, and water resources, in particular. He was given Leadership Award 2003 and Veer Durgadas Rathore Award - 2008. Currently, as the Project Director of India - WRIS Web GIS, he is leading a team of 80 scientists across eight ISRO centres to develop Web-enabled water resource information system of the country.

9. Shri D.K. Hari

He is a well known and eminent scholar of ancient Indian knowledge and wisdom. He has authored several books on the historicity and antiquity of Ramayan era. He is one of the conceptualizers of Bharath Gyan, Bangalore, which has been collating specific scientific knowledge of India using ancient knowledge sources and modern scientific tools. Bharat Gyan has entered into an alliance with the Art of Living for compilation and dissemination of wisdom of ancient India to the community at large.

10. Shri Baldevanand Sagar

An authority in Sanskrit language, Shri Baldevanand Sagar has a doctorate in Sanskrit and has 37 years of experience in broadcasting Sanskrit News on All India Radio and in Doordarshan. He has been teaching diction and soft skills as

visiting faculty at National School of Drama, New Delhi and at Asian Academy of Films and Television, Noida. At present, he is in-charge of Sanskrit News, All India Radio.

11. Shri Y.K. Gaiha

He belongs to 1975 batch of Indian Revenue Service (IRS). He has a degree in law (LLB) and also M.Sc. in Statistics. A very bright and outstanding officer of Income Tax Department, he is known for his extraordinary administrative and managerial capabilities. At present posted as Member of Board for Industrial & Financial Reconstruction (BIFR), Mr. Gaiha is a regular Tennis player and an excellent singer. He has organized many sports events, conferences and music programs. He has deep interest in learning about the ancient Indian wisdom and culture.

Astronomical Dating of Planetary References in *Ṛgveda* and Epics using Planetarium Software

A. K. Bhatnagar
Former Additional Director General,
India Meteorological Department
Email : bhatnagar.ashok@gmail.com

ABSTRACT

A vast store of ancient Sanskrit literature exists in India. The most ancient among them, the four revered *Vedas*, the *Vedāṅgajyotiṣa* and the great epics of *Rāmāyaṇa* and *Mahābhārata,* contain numerous references to astronomical phenomena and observations. Several scholars have, in the past, attempted determination of the dates of these texts by applying modern astronomical knowledge to the celestial phenomena described therein.

Sky simulation software for use on small computers have become available during the past decade to generate views of the sky over a given place for any time in the past or future up to a few thousand years with sufficient accuracy. We find that these can be used to simulate the phenomena described in *Ṛgveda*, *Rāmāyaṇa* and a few other texts in order to determine the date of these texts. We show that astronomical references in *Ṛgveda* represent the sky views of dates belonging to the period from 7000 BC to 2000 BC and those mentioned in *Rāmāyaṇa* refer to sky views seen sequentially on dates around 5100 BC.

1. Introduction

All civilizations from very remote antiquity showed keen interest in astronomical phenomena as evident from vide ranging references to them in ancient scriptures

(Saha 1955). The natural cycles that affected the conditions of human life most were the alternation of daylight and night, recurrence of the phases of the Moon and recurrence of the seasons. Even prehistoric man could not help noticing these cycles, but found it difficult to establish simple and accurate relations among them, as their periods are not commensurate with each other. Thus began a tradition of keeping long records of astronomical observations in some form or the other, initially for time reckoning.

The earliest organized societies founded themselves on agriculture; and agricultural practices depend on seasonal weather conditions. With these agricultural practices also grew social and religious festivals over a course of time. Prediction of the seasons and the phases of the Moon thus became the most urgent need of the earliest organized societies in order to devise a reliable calendar to regulate the civic, social and agricultural activities.

Shukla (1987) has reviewed the astronomical content found in the ancient Sanskrit literature. Numerous references to astronomical phenomena and observations are found in the *Vedas*, the *Vedāṅgajyotiṣa* and the great epics of *Rāmāyaṇa* and *Mahābhārata*. Several scholars have attempted in the past determination of the dates of these texts by applying modern astronomical knowledge to the celestial phenomena mentioned therein. Dikshit (1896) has done pioneering work on this subject. Abhyankar (1998, 2005) has carried the work forward and traced the antiquity of earliest Vedic calendar to 7000 BC based on the reference to solstices and equinoxes. Achar (2003) has determined the date of *Mahābhārata* war as 3067 BC by using astronomical references in it.

In recent years, computer software has become available to simulate the sky accurately over a given place for any time in the past or future up to a few thousand years. We have examined a few such softwares and used them to generate the view or the phenomena described in *Ṛgveda*, *Rāmāyaṇa* and a few other texts in order to determine the date of these texts. We have used English translation of *Ṛgveda Saṁhita* by Wilson edited and revised by Arya and Joshi (2001) and its translation in Hindi by Shriram Sharma Acharya (2002). We used *Śrīmadvālmīki Rāmāyaṇa* of Gita Press Gorakhpur (25th edition), referred to in this paper as *Valmiki Rāmāyaṇa*.

2. Ancient observations, general precession and simulation of sky

Before we proceed further, let us briefly discuss the observations of the Sun,

the Moon and the stars made by the early man, the phenomenon of precession of equinoxes (now called general precession) and how these can be used to determine the time when these were made.

The commonest observation was the daily shift in the point of sunrise on the horizon. The early man noticed its oscillation from south to north and back, identified the four cardinal points (solstices and equinoxes) and could relate them to the cycle of seasons. Correspondingly, the height of the Sun at noon above the horizon became another indicator of the season. With sufficient observations lasting over at least several decades, the practice of beginning the year at the Winter Solstice was introduced very early in India. The observations of solstices and equinoxes provided the basis for determining the length of tropical or seasonal year. The year consisted of two halves, *Uttarāyaṇa,* beginning with Winter Solstice and *Dakṣiṇāyaṇa,* beginning with the Summer Solstice. At the same time, the ancient Indians observed the stars and the movement of the Moon and the Sun among them. While it was easy to see the waxing and waning Moon move through stars in a narrow belt in the sky, they noticed the motion of the Sun among stars by watching stars on the eastern horizon near the sunrise point or on the western horizon just after sunset. The path of the Moon among stars latter gave rise to the concept of *Nakṣatra* divisions and that of the Sun to the ecliptic and zodiacal *Rāśi.* The ancients picked up a few bright stars on the eastern horizon as they emerged on the western side of the Sun (heliacal rising) just before sunrise, as indicators of the year beginning. This provides the basis for determining the length of the sidereal year- i.e. the interval between two successive returns of the Sun to the same star. The sidereal year, as we know today, is longer than the year of seasons by about 20 minutes due to the phenomenon of general precession.

The Greek astronomer Hipparchus (190-120 BC) drew attention to the phenomenon of precession of equinoxes. He concluded that the autumnal point and hence the vernal point was moving westward at the rate of 51½ seconds of arc per year. Newton, in Book III of his *Principia,* provided the mathematical explanation of the precession as we find in modern textbooks on dynamical astronomy. He explained that the earth not only rotates once in a day around its axis but the axis of rotation itself precesses slowly in a conical motion in space much in the same way as that of a spinning top. The axis cuts a circle in the sky once nearly in 26,000 years keeping the pole of ecliptic at its centre. The

phenomenon called General Precession occurs due to the combined gravitational effect of the Sun, the Moon and planets on the Earth. As a result, the equinoxes move westward along the ecliptic relative to fixed stars at the rate of about 50.3 seconds of arc per year. The vernal equinox slowly regresses 360 degrees completing a full circle through the ecliptic constellations in about 26,000 years at the rate of about 1 degree every 71.6 years on an average.

In India, we find various references in the ancient texts to the solstices or equinoxes occurring in proximity of certain star or star groups, according to the prevalent convention. Since the rate of precession is known, such references can serve as important clues to determine the time of the particular epoch.

Rapid advances in computing technology and online availability of vast amount of high precision data on positions of stars (such as HIPPARCOS Catalogue), and solar system ephemeris (such as DE200/HORIZONS of JPL, NASA, USA and VSOP87 of France) have helped in development of sky simulation softwares, commonly known as planetarium softwares, for public use on computers. Some of the easily available softwares are: Planetarium Gold, Stellarium, Starry Night, Celestia, SkyMap Pro, Cartes du Ciel, Voyager, Digital Universe Atlas, RedShift, TheSky, Universe Sandbox, XEphem etc. The time simulated by most of these softwares can be set at any point in the future or past to generate views of the sky. Although planetary orbits are only accurate (0.1–1 arcsec) within a few thousand years of the present day (3000 BC – 3000 AD), they are sufficient to match the naked eye observations of the remote past as attempted in this paper. As a part of a project undertaken by I-SERVE to date the earliest periods of Indian civilization, the author has used some of these softwares to simulate the astronomical phenomena mentioned in the *Vedas* and *Rāmāyaṇa*. A comparison was made between the softwares – Planetarium Gold and Stellarium to generate common phenomena. Planetarium appears to use the tropical length of the year throughout for the calendar dates, whereas Stellarium has attempted to incorporate Julian calendar before 1582, the date of Gregorian reform, resulting in longer year. While the date of Vernal Equinox remains nearly fixed around 21–23 March in Planetarium over millenia, it keeps drifting in Stellarium from 21 March during 2011–1582 to 2 May in 5000 BC and so on.

In the present study, we have used 'Plantearium Gold' software to verify the events mentioned from *Ṛgveda* to *Rāmāyaṇa*. We present below some result of the above study.

3. *Ṛgvedic* References

3.1 The earliest Vedic calendar

The following references from *Ṛgveda* clearly indicate the understanding of the astronomical cycles of the day and night (360 each occurring in pairs making a total 720), the month and the year and the attempts by Vedic people to devise an intercalary or thirteenth month to frame a reliable calendar.

वेद मासो धृतव्रतो द्वादश प्रजावतः। वेदा य उपजायते॥ ऋ-सं. १-२५-८॥

नियमधारक वरुणदेव प्रजा के उपयोगी बारह महीनों को जानते हैं और तेरहवें माह (अधिक मास) को भी जानते हैं।

"He, who accepting the rites (dedicated to him) knows the twelve months and their productions and that which is supplementarily engendered."

द्वादशारं नहि तज्जराय वर्वर्ति चक्रं परि द्यामृतस्य।
आ पुत्रा अग्ने मिथुनासो अत्र सप्त शतानि विंशतिश्च तस्थुः॥ऋ-सं. १-१६४-११॥

ऋत (सूर्य अथवा सृष्टि संचालक यज्ञ) का बारह अरों (राशियों) वाला चक्र इस द्युलोक में चारों ओर घूमता रहता है। यह चक्र कभी अवरुद्ध या जीर्ण नहीं होता। हे अग्निदेव! संयुक्त रूप से रहने वाले सात सौ बीस पुत्र यहाँ (इस चक्र) में रहते हैं।

"The twelve-spoked wheel, of the true (Sun) revolves round the heavens and never (tends) to decay: seven hundred and twenty children in pairs, Agni, abide in it."

The earliest Vedic calendar had the following salient features:

- Year (*Saṁvatsara*): Seasonal – determined from observation of position of rising Sun and at noon
- Half years: *Uttarāyaṇa* begins at Winter Solstice (as also the year); *Dakṣiṇāyan* begins at Summer Solstice *(Viśvadin).*
- Year had 360 days and 720 day/night.
- 12 solar months - (*Aruṇa, Aruṇarāja* etc.), of 30 days each *(Ṛgveda 1-164-11/48)*
- Leap days (*Atirātras*) – 4, 5 or 6 days added at the end of *Samvatsarasatra*. *(Taittiriya Saṁhitā 7.1.8)*

Practice changed to having an intercalary solar month of 30 days after every 6 years.

3.2 Year Beginning-Heliacal Rising of Aśvinī Nakṣatra at Winter Solstice, 7000 BC

There are 53 references in *Ṛgveda* as prayers offered to *Aśvinī* at dawn. The description clearly points to the observation of the pair of stars in the Aries constellation (referred to as *Āśvin* or *Aśvinī*) just before sunrise as a ritual to mark the year beginning. The distinction between *Aśvinī Nakṣatra* and *Āśvin* month does not seem to have been made at that time. We give below some of these mantras that clearly establish that the ritual was followed to observe the Heliacal Rising of *Aśvinī*, i.e. the first sighting when they emerge from behind the Sun on the eastern horizon just before sunrise, apparently to mark the year beginning.

प्रातर्यावाणा प्रथमा यजध्वं पुरा गृध्रादररुषः पिबातः।
प्रातर्हि यज्ञमश्विना दधाते प्र शंसन्ति कवयः पूर्वभाजः॥ऋ-सं. ५-७७-१॥
हे ऋत्विजो! प्रातः काल में सब देवों से पहले आने वाले अश्विनीकुमारों का आप पूजन करें। वे अदानशील और लोभी (राक्षसों) से पूर्व ही आकर सोमपान करते हैं। वे प्रातः यज्ञ को सम्यक् रूप से धारण करते हैं। पूर्वकालीन ऋषिगण उनकी प्रशंसा करते हैं।

"First worship those who come early in morning. Let the twain drink soma before others. The sages of old extol that the Āśvin claim the sacrifice at daybreak."

प्रातर्यजध्वमश्विना हिनोत न सायमस्ति देवया अजुष्टम् ।
उतान्यो अस्मद्यजते वि चावः पूर्वः पूर्वो यजमानो वनीयान् ॥ऋ-सं. ५-७७-२॥
हे ऋत्विजो! अश्विनीकुमारों के लिए प्रातः काल यजन करें। उन्हें हव्यादि प्रदान करें। सायंकालीन प्रदत्त हव्य देवों को सेवनीय नहीं होता। वह देवों के पास गमन करने वाला नही होता। हमसे अन्य जो कोई पूर्व में यजन करता है, वह सब देवों को तृप्त करता है। हमसे पहले जो यजन करने वाला होता है, वह देवों के लिए विशिष्ट प्रीतिकारक होता है।

"Worship the Āśvin at early dawn; offer their oblations: the evening is not for the gods; it is unacceptable to them: and whether it be any other than ourselves who worships them or propitiates them, the worshipper who is foremost (in his devotion) is the most approved of."

अशोच्यग्निः समिधानो अस्मे उपो अदृश्रन्तमसश्चिदन्ताः।
अचेति केतुरुषसः पुरस्ताच्छ्रिये दिवो दुहितुर्जायमानः ॥ऋ-सं. ७-६७-२॥
हमारे लिए अग्निदेव प्रदीप्त हो रहे हैं, अंधकार का अन्त दिख रहा है। द्युलोक की पुत्री (उषा) के सम्मुख प्रकट होने वाले ये सूर्यदेव शोभा का बोध कराने वाले हैं।

"Kindled by us, Agni blazes, the extremities of the darkness are seen nigh at hand, the banner (of the Sun) is perceived rising with the glory on the east of the dawn the daughter of heaven."

अप स्वसुरुषसो नग्जिहीते रिणक्ति कृष्णीररुषाय पन्थाम् ।
अश्वामघा गोमघा वां हुवेम दिवा नक्तं शरुमस्मद्युयोतम् ॥ऋ-सं. ७-७१-१॥
रात्रि अपनी भगिनी उषा से अलग होकर लाल बिम्ब वाले सूर्यदेव का रास्ता खोल देती है। गोधन-वाजिधन के रूप में ऐश्वर्य देने वाले (हे देवो)! आपका हम आवाहन करते हैं। आप दिन या रात्रि के शत्रुओं को दूर करें।

"Night retires before the dawn, the sister (of the Āśvin): the dark night leaves the path clear for the radiant (Sun): upon you, who are affluent in horses, affluent in cattle, we call day and night: keep away from us the malevolent."

आ वां रथमवमस्यां व्युष्टौ सुम्नायवो वृषणो वर्तयन्तु ।
स्यूमगभस्तिमृतयुग्भिरश्वैराश्विना वसुमन्तं वहेथाम् ॥ऋ-सं. ७-७१-३॥
हे अश्विदेवो! उषाकाल होने पर बलिष्ठ और स्वेच्छा से चलने वाले अश्व आपको लेकर हमारे पास आएँ तथा हमें तेजस्विता एवं उत्तम सम्पत्ति प्रदान करें।

"May your docile and vigorous (horses) bring hither your chariot at the approaching dawn: conduct hither, Āśvin, your radiating, wealth-laden chariot, with your rain-bestowing steeds."

उदु स्तोमासो अश्विनोरबुध्रञ्जामि ब्रह्माण्युषसश्च देवीः ।
आविवासन्नोदसी धिष्ण्येमे अच्छा विप्रो नासत्या विवक्ति ॥ऋ-सं. ७-७२-३॥
अश्विनीकुमारों को (ये) स्तुतियाँ जगाती हैं। सब लोग उत्तम कर्म से उषाकाल को चैतन्य करते हैं। वसिष्ठ, द्यु और पृथ्वी लोकों की सेवा करते हुए अश्विद्वय की स्तुति करते हैं।

"Praises waken up the Āśvin, kindred adorations (arouse them) and the celestial dawns: the sage, addressing these laudations to the adorable heaven and earth glorifies the Nāsatyās in their presence."

वि चेदुच्छत्यश्विना उषासः प्र वां ब्रह्माणि कारवो भरन्ते ।
ऊर्ध्वं भानुं सविता देवो अश्रेदृहदग्नयः समिधा जरन्ते ॥ऋ-सं. ७-७२-४॥
हे अश्विद्वय! उषा के द्वारा अन्धकार हटाने पर स्तोता आपकी प्रार्थना करते हैं। सूर्यदेवता ऊर्ध्वगामी होते हुए तेजस्विता धारण कर रहे हैं। यज्ञ में समिधाओं के द्वारा अग्नि प्रज्वलित हो रही है।

"When the dawns arise, your worshippers, Āśvin, proffer you praises: the divine Savitā casts his splendours on high: the fires, with their (kindled) fuel, greatly glorify you."

अतारिष्म तमसस्पारमस्य प्रति स्तोमं देवयन्तो दधानाः।
पुरुदंसा पुरुतमा पुराजामर्त्या हवते अश्विना गीः ॥ऋ-सं. ७-७३-१॥
हे अश्विद्वय! हम देवत्व प्राप्ति की इच्छा से प्रार्थना करते हुए अज्ञानान्धकार से पार हो जायें। बहुकर्मा, पूर्वकाल से अमर कीर्ति वाले हे अश्विदेवो! स्तोतागण आपका आवाहन करते हैं।

"Devoted to the gods, and hymning their praise, we have crossed to the opposite shore of this (state of) darkness: the worshipper invokes the Āśvin, the doers of many deeds, the most mighty, the first born, the immortal."

स्वश्वा यशसा यातमर्वाग्दस्रा निधिं मधुमन्तं पिबाथः ।
वि वां रथो वध्वा यादमानोऽन्तान्दिवो बाधते वर्तनिभ्याम् ॥ऋ-सं. ७-६९-३॥
हे शत्रुहन्ता अश्विदेवो! आप श्रेष्ठ घोड़ों से जुते रथ पर बैठकर, अन्न के सहित यहाँ पधारें और मधुरस का पान करें। सूर्य के साथ गमन करने वाला आपका रथ गतिशील चक्रों से द्युलोक के अन्तिम छोर को भी आन्दोलित करता है।

"Well horsed and celebrated, come, Āśvin, to our presence: drink, Dasras, the sweet pledge: your chariot, conveying you, with your spouse, furrows with its two wheels the extremities of the sky." 'वि वां रथो वध्वा यादमानोऽन्तान्दिवो बाधते वर्तनिभ्याम्।' ***also translates as*** *"Your cart on which your spouse is wont to travel marks with its track the farthest ends of heaven"*

This shows that the *Aśvinī̄s* then represented the southernmost point of the Sun's travel- the Winter Solstice (WS). The backckward motion of the equinox due to precession at the rate of 50.3 arcseconds per year results in slow increase in longitude of the stars with time. The longitude of *Aśvinī̄s* (Aries) as on today is about 36°. One can calculate that it matched with Winter Solstice, i.e. 270°, about 9000 years ago. Using Planetarium software, we find that the Winter Solstice occurred on 19 December, 7000 BC at 0735 hrs as shown in Figure 1. This is the earliest reference to Vedic calendar with year beginning at Winter Solstice, found in *Ṛgveda* 5-77-1/2; 1-46-14; 7-69-3/2. Heliacal rising of *Aśvinī̄ Nakṣatra* (Aries) can be seen to occur on 5th January, 7000 BC, marking the year beginning (Fig. 2).

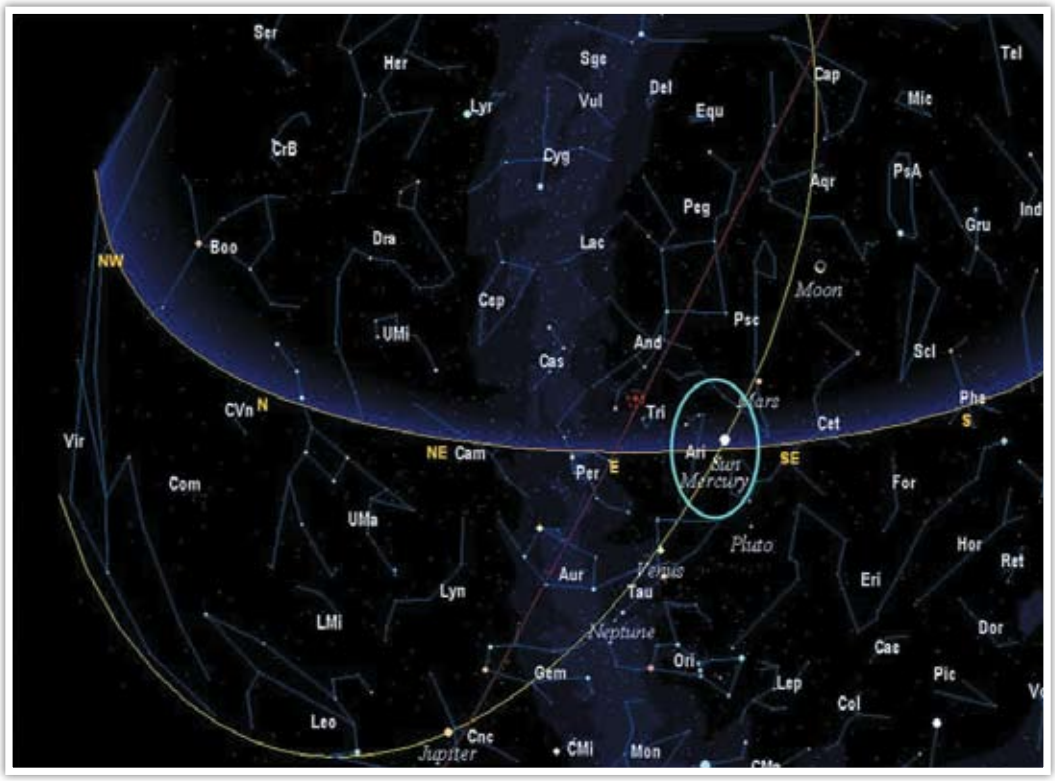

Fig. 1: Winter Solstice occurred in Aries (*Āśvinī Nakṣatra*) on 19 December, 7000 BC at 0735 h Local Time (*Ṛgveda* 1-112-13, Aitareya Brahmaṇa 18.18, 18.22)

3.3 The next stage-Year Beginning by Citra Nakṣatra opposite Winter Solstice, 6000 BC

A thousand years later, Winter Solstice no longer occurred near Aries (*Aśvinī*) due to precession. As a result, *Aśvinī* were no longer rising heliacally as before. They were still below the horizon at sunrise around Winter Solstice time as evident in the following verse. The Winter Solstice had moved to *Revati* by 6000 BC.

कूष्ठो देवावश्विनाद्या दिवो मनावसू ।
तच्छ्रवथो वृषण्वसू अत्रिर्वामा विवासति ॥ऋ-सं. ५-७४-१॥

हे उत्कृष्ट मन-सम्पन्न अश्विनीकुमारो। आप दोनों द्युलोक से आगमन कर यज्ञ-भूमि पर स्थित हों। हे धनवर्षक देवो! आप अत्रि ऋषि के उन स्तोत्रों का श्रवण करें, जो आपके निमित्त निवेदित किये गये हैं।।

"Where in the heaven are you today, Gods, Āśvin, rich in consistency? Hear this, ye

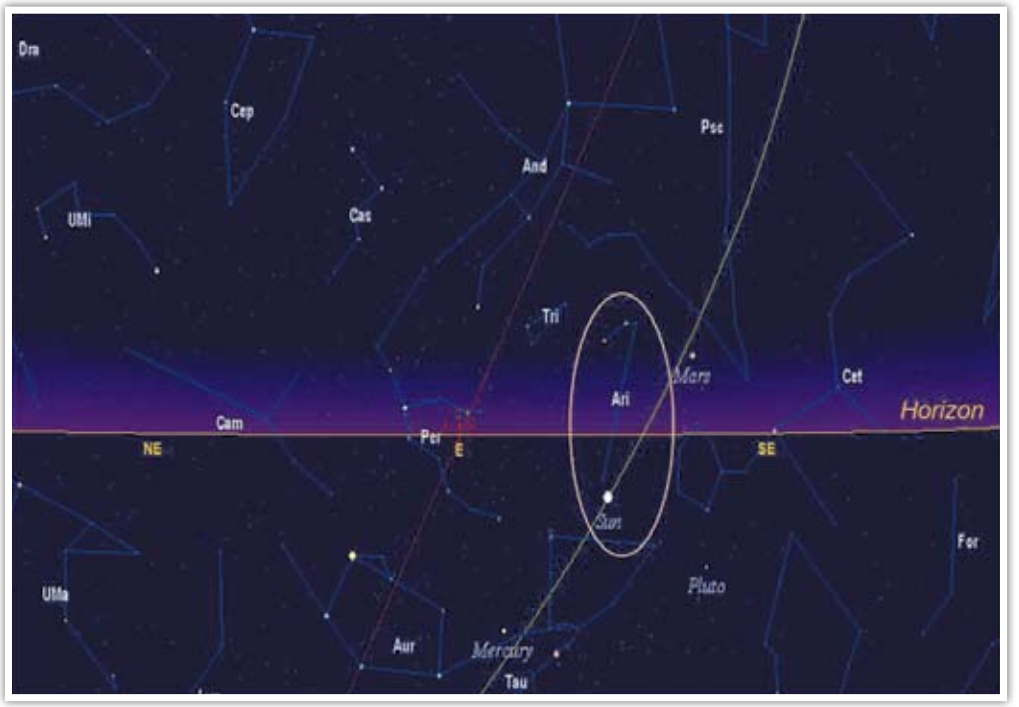

Fig. 2: Sky on Jan 05, 7000 BC, 0649 hrs shows heliacal rising of *Aśvinī Nakṣatra* after Winter Solstice, marking the year beginning (*Ṛgveda* 5-77-1/2; 1-46-14; 7-69-3/2)

excellent bestowers: Atri invites you to come. Where are they now? Where are the Twain, the famed Nāsatyā, gods in heaven"

कुह त्या कुह नु श्रुता दिवि देवा नासत्या ।
कस्मिन्ना यतथो जने को वां नदीनां सचा ॥ऋ-सं. ५-७४-२॥

हे असत्यरहित दीप्तिमान् अश्विनीकुमारो! आप दोनों कहाँ हैं? द्युलोक में किस स्थान में आप सुने जाते हैं? किस यजमान के गृह आप आगमन करते हैं? तथा किस स्तोता की स्तुतियों के साथ आप संयुक्त होते हैं?

"The divine Nāsatyā, where are they? Where are they heard if in heaven? To what worshipper do you come? Who may be the associate of your praises?"

The Sky of 19th December, 6000 BC at sunrise on the Winter Solstice day shows (Fig. 3) that *Aśvinī* gave way to bright star *Citrā* (αVir) on opposite side (Western horizon). A full Moon in *Citra Nakṣatra* provided a new time marker in the sky and heralded the lunar month naming system-*Caitra, Vaiśākha* etc.

संवत्सरस्य यत्फल्गुनीपूर्णमासो मुखत एव संवत्सरमारभ्य दीक्षन्ते तस्यैकैव निर्या यत्सांमेध्ये विषूवांत्सम्पद्यते चित्रापूर्णमासे दीक्षेरन्मुखं वा एतत्संवत्सरस्य यच्चित्रापूर्णमासो मुखत एव संवत्सरमारभ्य दीक्षन्ते तस्य न काचन निर्या भवति चतुरहे पुरस्तात् पौर्णमास्यै दीक्षेरन् तेषामेकाष्टकायां क्रयः सम्पद्यते तेनैकाष्टकां न छंबट् कुर्वन्ति तेषाम्॥तै. सं. ७-४-८॥

उसमें एक ही निर्या (दोष) है कि सामेध्य के स्थान में विषुवान् आ जाता है, इसलिए चित्रापूर्णमासी को दीक्षा लेनी चाहिए। चित्रापूर्णमास संवत्सर का मुख है (अतः उस दिन यज्ञ का आरम्भ करने वाले) मुख से ही संवत्सर का आरम्भ करके दीक्षित होते हैं। इसमें एक भी दोष नहीं है। पूर्णिमा के चार दिन पूर्व दीक्षा लेनी चाहिए। उनका एकाष्टका में (सोम का) क्रय होता है। इससे (वे) एकाष्टका को निष्फल नहीं करते।

"Citrā full Moon is the mouth of the year"

Thus, the next stage for the year beginning of Vedic calendar appears to be use of *Citrā Nakṣatra* (Alpha Virginis) opposite the Sun in Winter Solstice. This can be found to occur on 19th Dec, 6000 BC (Fig. 3).

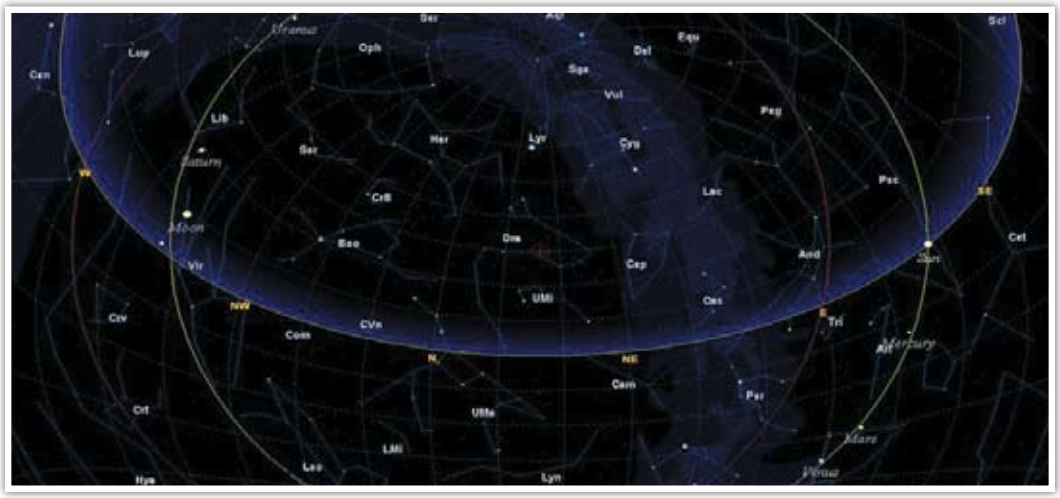

Fig. 3: Winter Solstice opposite *Citrā* - Sky of 19 Dec 6000 BC at sunrise shows that *Aśvini* gave way to bright star *Citrā* on opposite side (western horizon). It began to be used for determining the year beginning. A full Moon occurring in *Citrā* heralded the lunar month naming system-*Caitra*, *Vaiśākha* etc (Tait. Samh. 7-4-8)

3.4 The *Agastya-Rāmāyaṇa* Era, 5100 BC

In India, the star Canopus (Alpha Carina) is named after sage *Agastya*. According to a Pauranic legend, *Agastya Muni* first observed the star Canopus from *Vindhyās*.

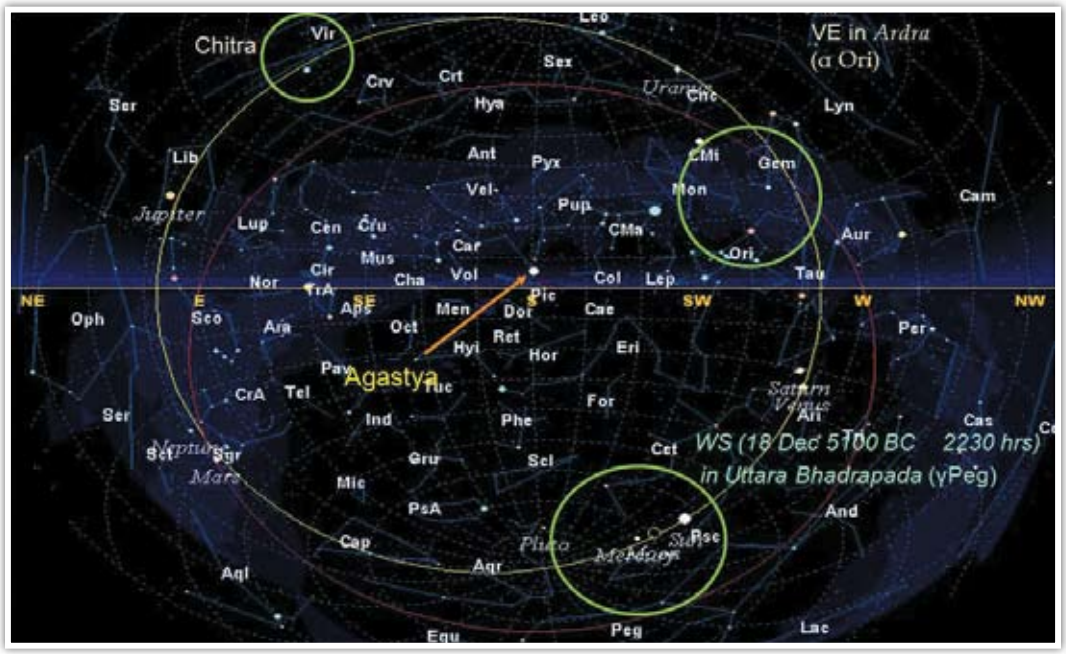

Fig. 4: Sky as seen on 18 Dec 5100 BC, 2230 hrs from *Vindhyās*. The star Canopus was first seen from *Vindhyās* low over the southern horizon by sage *Agastya* around 5100 BC

Canopus, which is the second brightest star in the sky, lies low in the southern sky due to its far south declination. Its declination was 68° South in 7200 BC and hence it was not visible from most of India. It became visible from *Vindhyās* only around 5100 BC when its declination had slowly changed to 61°.5 South due to precession. This enabled Canopus to rise more than 5° above the southern horizon at its highest (meridian transit) as seen from *Vindhyās* (Fig. 4). It is likely that it might have been first observed from *Vindhyās* by *Agastya Muni* around that time. It can also be seen that Winter Solstice at that time was in *Uttara Bhādrapada (γ Peg)* and Vernal Equinox in *Ārdrā (α Ori)*. The Year began with *Caitra Śukla 1* after Winter Solstice according to the prevalent Vedic practice. As Agastya was contemporary of Ram this would also be the time of *Rāmāyaṇa*, which matches well with other evidence in this paper.

4. References from *Rāmāyaṇa*

The following verse mentions that *Ṛṣi Valmīki* composed *Rāmāyaṇa* after return of Śri Ram from exile. It was recited by *Lav-Kuśa* as per *Valmīki Rāmāyaṇa* 1/4/1.

प्राप्तराजस्य रामस्य वाल्मीकिर्भगवानृषिः ।
चकार चरितं कृत्स्नं विचित्रपदमर्थवत् ॥ वा. रामा. १/४/१

श्री रामचन्द्रजीने जब वन से लौटकर राज्यका शासन अपने हाथ में ले लिया, उसके बाद वाल्मीकि मुनिने उनके सम्पूर्ण चरित्रके आधार पर विचित्र पद और अर्थ से युक्त रामायण काव्य का निर्माण किया।

This shows that, *Valmīki* was contemporary to Ram.

4.1 Birth of Ram, Bharat, Lakshaman and Shatrughna

The following verse relates to the time about two years before the birth of Ram, when *Rājā Daśrath* went to *Vaśiṣṭha* for initiation for conducting *Aśvamedha Yajña* for getting offsprings. Year-long preparations for *Aśvamedha Yajña* were commenced on *Caitra Śukla 1* which works out as 25th January, 5116 BC (Fig. 5).

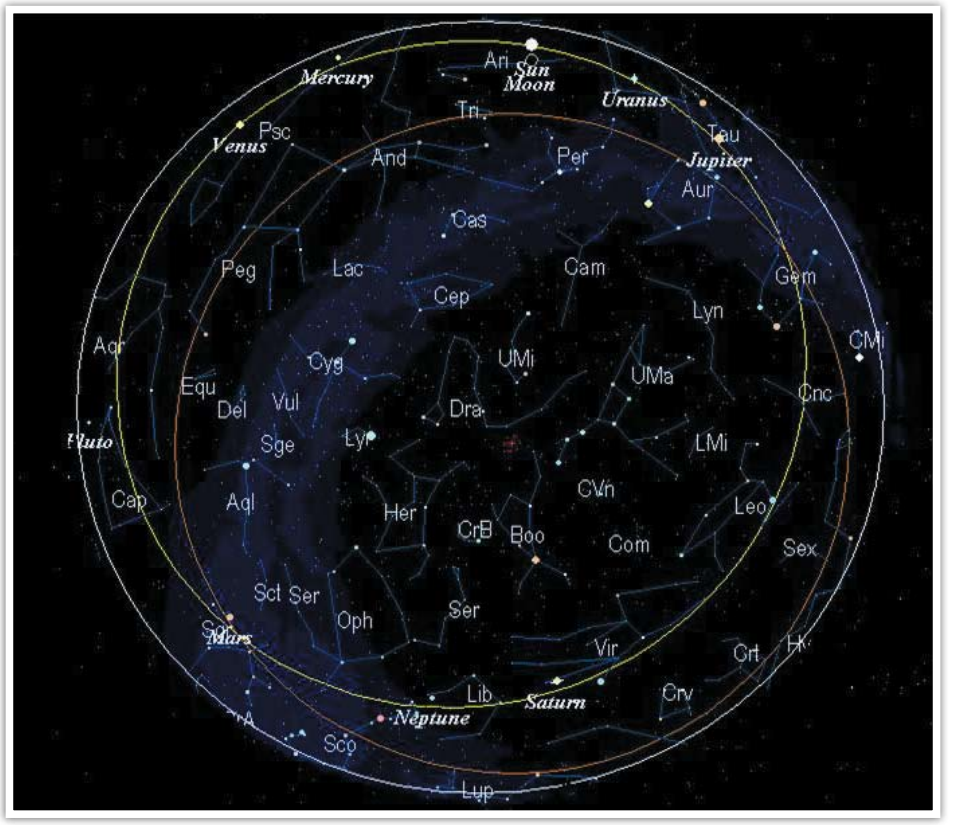

Fig. 5: The sky seen over Ayodhya on 25 Jan, 5116 BC, when *Aśvamedha Yajña* was commenced, two years before the birth of Śri Ram (tithi- *Caitra Śukla* 1) (V. R. 1/13/1)

पुनः प्राप्ते वसन्ते तु पूर्णः संवत्सरोऽभवत् ।
प्रसवार्थं गतो यष्टुं हयमेधेन वीर्यवान् ॥ वा.रामा. १/१३/१

वर्तमान वसन्त ऋतुके बीतनेपर जब पुनः दूसरा वसन्त आया, तबतक एक वर्षका समय पूरा हो गया। उस समय शक्तिशाली राजा दशरथ संतान के लिये अश्वमेध यज्ञकी दीक्षा लेने के निमित्त वसिष्ठजीके समीप गये।

"Spring season has returned and one year has completed."

Putra Kameṣṭhi Yajña was commenced one year before the birth, at the beginning of Lunar Year, *Caitra Śukla* 1, which works out to 15 Jan, 5115 BC (Fig. 6).

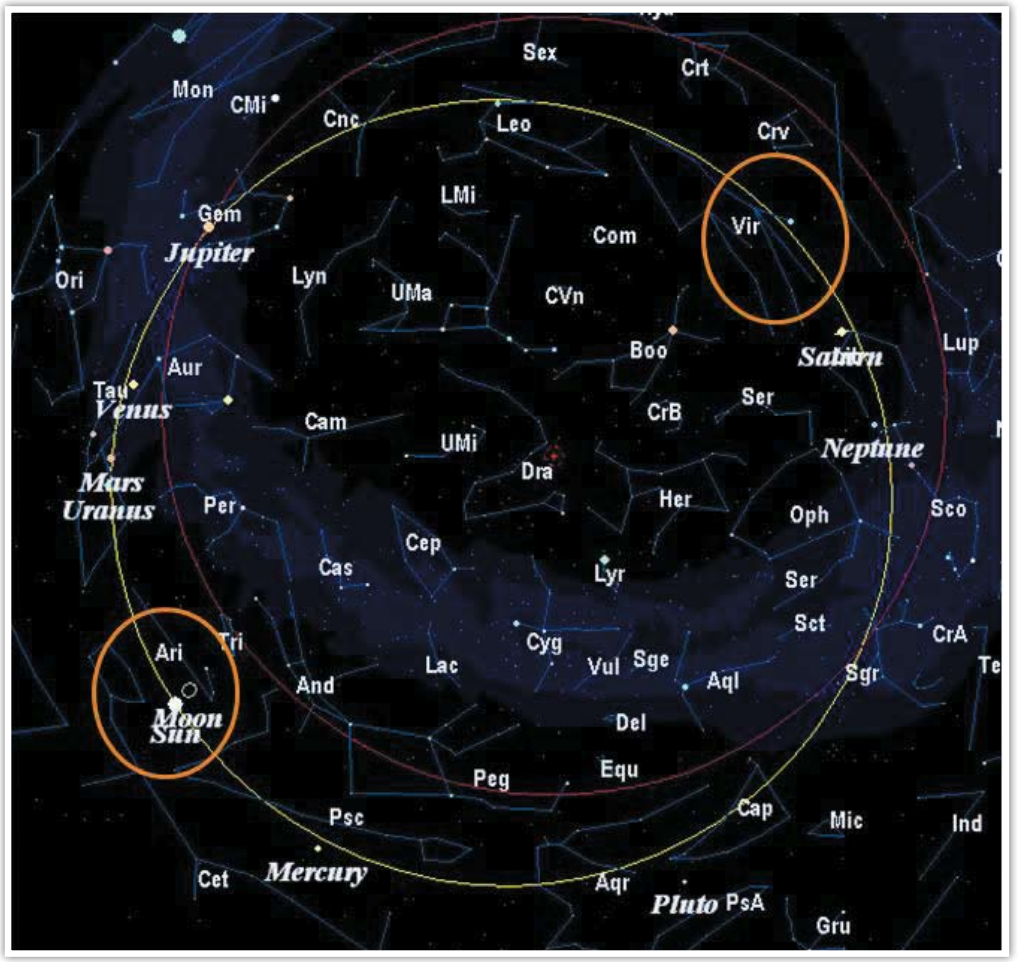

Fig. 6: Beginning of Lunar Year (15 Jan, 5115 BC) at the time of *Putra Kameṣṭhi Yajña*, a year before the birth of Śri Ram

The following verse in the *Valmīki Rāmāyaṇa* provides the key to the time of Śri Ram's birth.

ततो यज्ञे समाप्ते तु ऋतूनां षट् समत्ययुः।
ततश्च द्वादशे मासे चैत्रे नावमिके तिथौ ॥८॥
नक्षत्रेऽदितिदैवत्ये स्वोच्चसंस्थेषु पञ्चसु ।
ग्रहेषु कर्कटे लग्ने वाक्पताविन्दुना सह ॥९॥
प्रोद्यमाने जगन्नाथं सर्वलोकनमस्कृतम् ।
कौसल्याजनयद् रामं दिव्यलक्षणसंयुतम् ॥१०॥ वा.रामा. ॥१/१८/८-१०॥

यज्ञ-समाप्ति के पश्चात् जब छः ऋतुएँ बीत गयीं, तब बारहवें मासमें चैत्र के शुक्लपक्ष की नवमी तिथि को पुनर्वसु नक्षत्र एवं कर्क लग्न में कौसल्यादेवी ने दिव्य लक्षणों से युक्त, सर्वलोकवन्दित श्रीराम को जन्म दिया। उस समय (सूर्य, मंगल, शनि, गुरु और शुक्र—ये) पाँच ग्रह अपने-अपने उच्च स्थान में विद्यमान थे तथा लग्न में चन्द्रमा के साथ बृहस्पति विराजमान थे।

The above verse does not explicitly give the position of the planets etc. at the time of Ram's birth. However, Rao (1990) has interpreted the position of Sun, Moon and bright planets in terms of the astrological content of the above verse as follows:

- Sun in Aries
- Saturn in Libra
- Jupiter in Cancer
- Venus in Pisces
- Mars in Capricorn
- Lunar Date – *Caitra Śukla* 9

There seems to be general agreement among scholars on the above planetary positions. Bhatnagar (2004) has used Planetarium software to simulate sky with the above planetary positions and arrived at the date of 10th January 5114 BC, 12:30 hrs as Śri Ram's date and time of birth. We confirm the same in the present study as shown in Figure 7. The time of Winter Solstice preceding the above date comes out to be 18th December, 5115 BC. The date of Lunar year beginning on *Caitra Śukla 1* comes out as 3rd January, 5114 BC after the Winter Solstice. *Citra* (Alpha Vir.) is found opposite the Sun in Winter Solstice as per the Vedic tradition for the year beginning. It is noteworthy that this date matches closely with the time of *Agastya Muni*, Śri Ram's contemporary, as determined above from independent observation of Canopus.

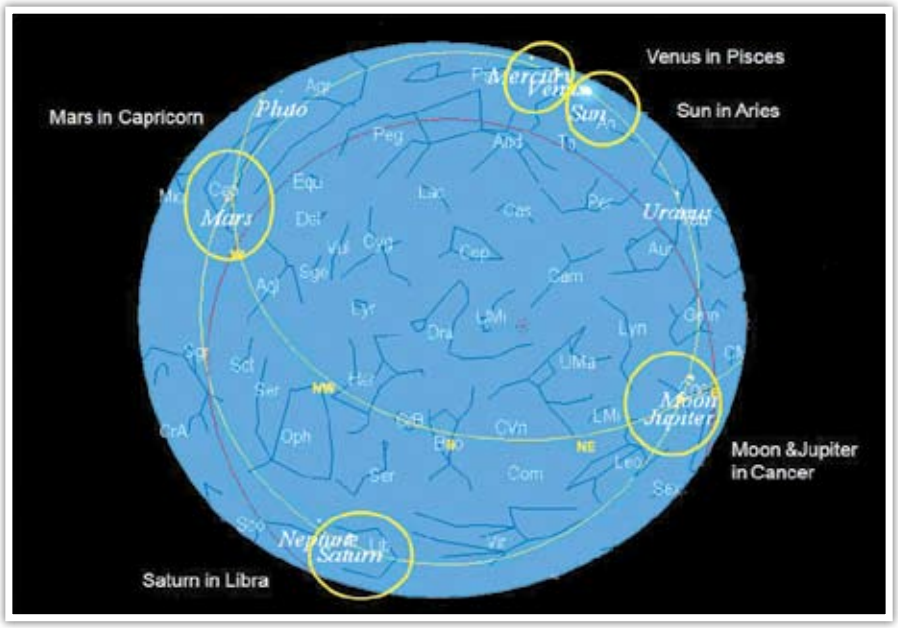

Fig. 7: Planetary Positions at Śri Ram's Birth (Caitra S 9, 10 Jan 5114 BC, 1230 hrs)

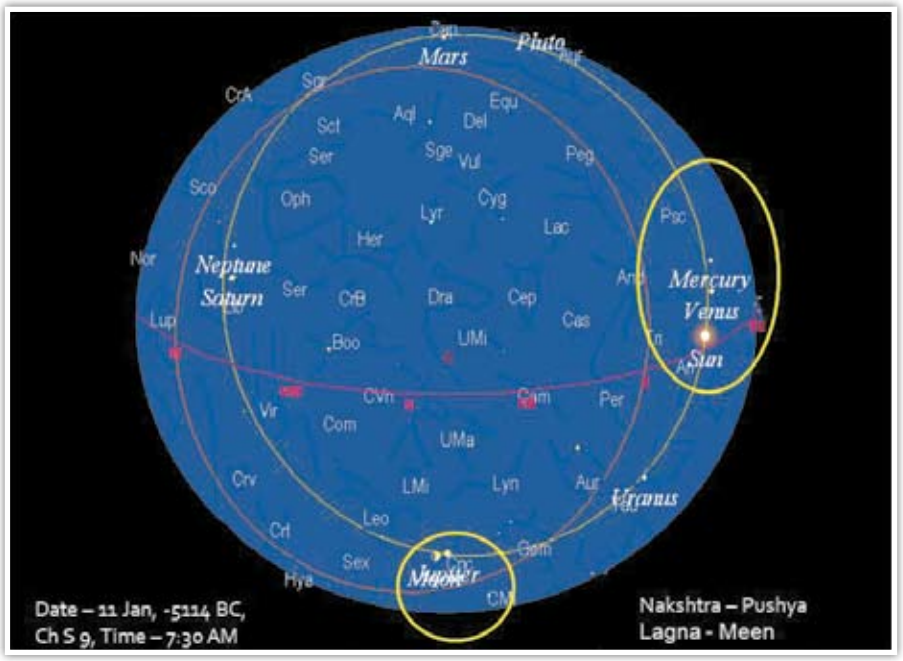

Fig. 8: Sky at the time of birth of Bharat (V.R. 1/18/13-16)

As per the following verse, Bharat was born in *Puṣya Nakṣatra* and *Mīna Lagna*. Two Sons of Sumitra (Lakshaman and Shatrughna) were born in *Āśleṣa Nakṣatra* and *Karka Lagna* with Sun in Aries. The time of Bharat's birth is determined as 11th January, 5114 BC at 07:30 hrs (Fig. 8) and that of Lakshaman and Shatrughna as *Caitra Śukla 10, 11* January, 5114 BC, 13:33 hrs (Fig. 9).

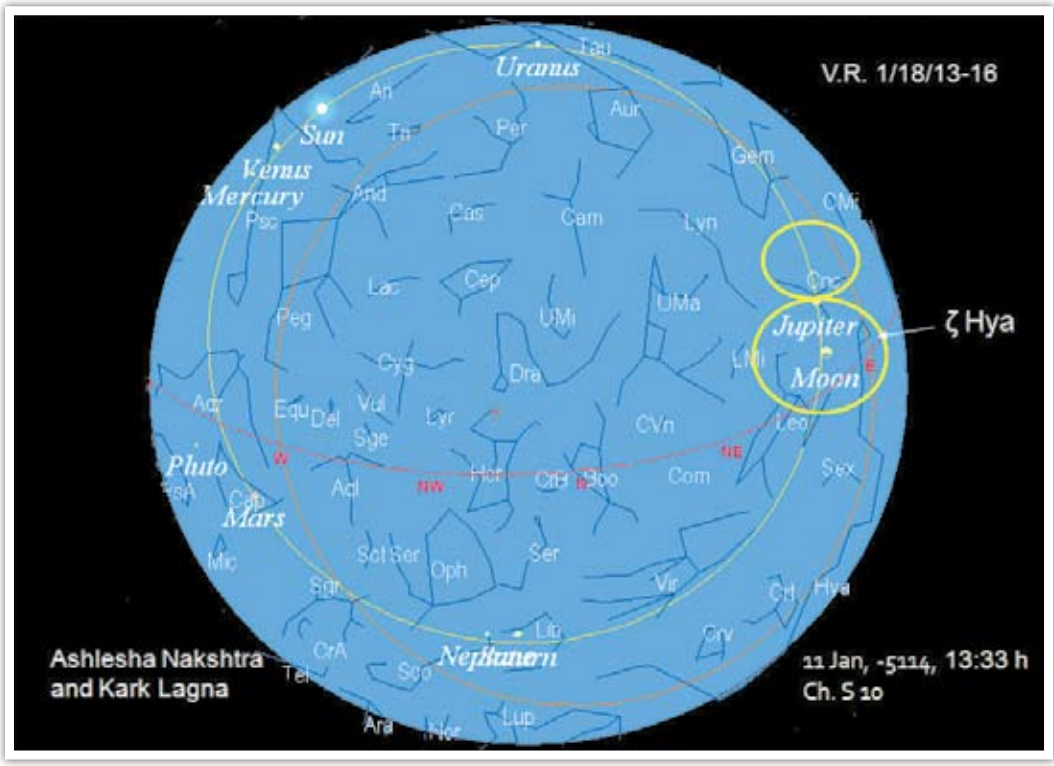

Fig. 9: Sky at birth of Lakshman and Shatrughna

पुष्ये जातस्तु भरतो मीनलग्ने प्रसन्नधीः ।
सार्पे जातौ तु सौमित्री कुलीरेऽभ्युदिते रवौ॥ १५॥ वा.रामा. ॥१/१८/१५॥

भरत सदा प्रसन्नचित्त रहते थे। उनका जन्म पुष्य नक्षत्र तथा मीन लग्न में हुआ था। सुमित्रा के दोनों पुत्र आश्लेषा नक्षत्र और कर्कलग्न में उत्पन्न हुए थे। उस समय सूर्य अपने उच्च स्थान में विराजमान थे।

4.2. Time of Exile

The following verse gives the position of Moon in *Punarvasu Nakṣatra* and mentions that it would be in *Puṣya* tomorrow. Ram was to be coronated on completion of

25 years of age, when he had to proceed for exile. The date of exile in his 25th year with the above combination comes out as 5th January, 5089 BC (Fig. 10).

अद्य चन्द्रोऽभ्युपगमत् पुष्यात् पूर्वं पुनर्वसुम् ।
श्वः पुष्ययोगं नियतं वक्ष्यन्ते दैवचिन्तकाः ॥२१॥ वा. रामा. २/४/२१

आज चन्द्रमा पुष्य से एक नक्षत्र पहले पुनर्वसुपर विराजमान हैं, अतः निश्चय ही कल वे पुष्य नक्षत्र पर रहेंगे–ऐसा ज्योतिषी कहते हैं।

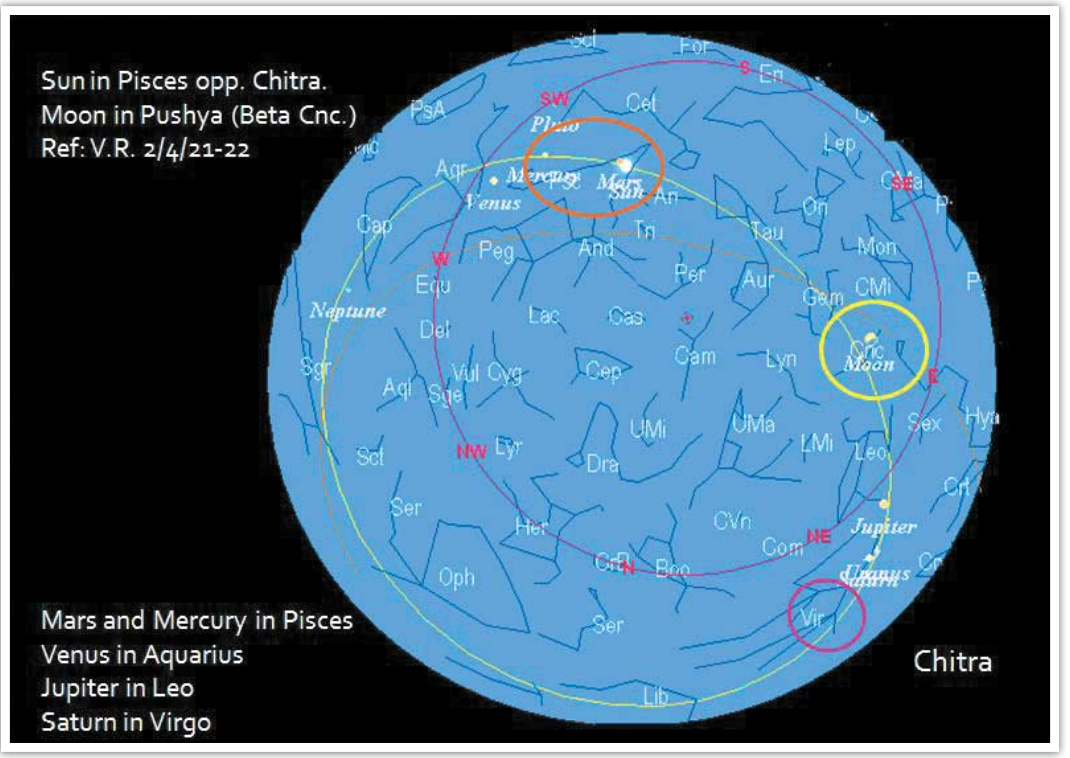

Fig. 10: The sky at the time of exile of Śri Ram – 5 January, 5089 BC, 1403 hrs

4.3. Start of journey to Lanka

In the following description, Sun in the middle implies Autumnal Equinox. The date works out as 19th September, 5076 BC, 0621 hrs (Fig. 11-14), when the *Nakṣatra* is *Uttarā Phālgunī* (β Leo).

अस्मिन् मुहूर्ते सुग्रीव प्रयाणमभिरोचय ।
युक्तो मुहूर्ते विजये प्राप्तो मध्यं दिवाकरः ॥३॥ **वा. रामा. ६/४/३**

सुग्रीव! तुम इसी मुहूर्त में प्रस्थान की तैयारी करो। सूर्यदेव मध्य भाग में जा पहुँचे हैं। इसलिये इस विजय नामक मुहूर्त में हमारी यात्रा उपयुक्त होगी।

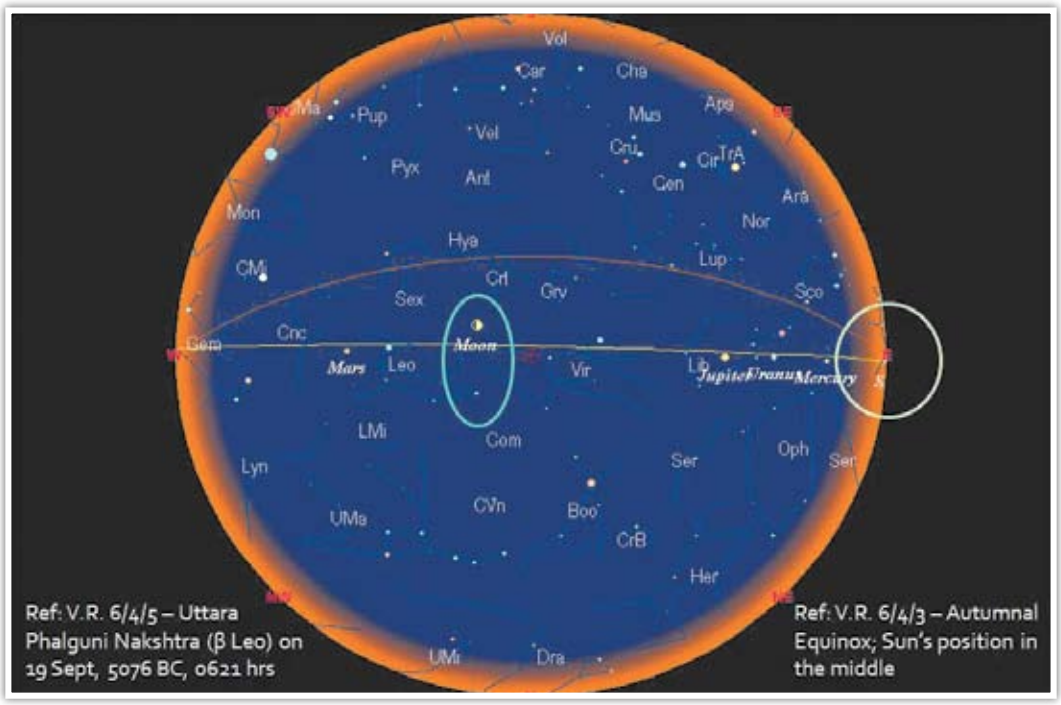

Fig. 11: Sky as seen at start of journey to Lanka

उत्तराफाल्गुनी ह्यद्य श्वस्तु हस्तेन योक्ष्यते।
अभिप्रयाम सुग्रीव सर्वानीकसमावृताः ॥ **वा. रामा. ६/४/५**

आज उत्तराफाल्गुनी नामक नक्षत्र है। कल चन्द्रमाका हस्त नक्षत्र से योग होगा। इसलिये सुग्रीव! हमलोग आज ही सारी सेनाओं के साथ यात्रा कर दें।

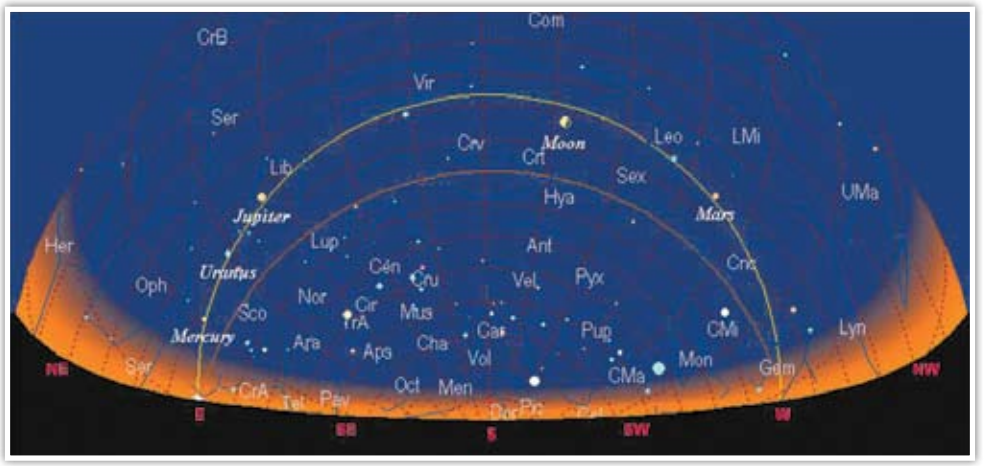

Fig. 12: Journey to Lanka on 19 Sep. 5076 BC, 0623 hrs. The description of *Saptaṛṣi* and Venus shining behind shows that they were traveling towards South. *Viśākha* (Alpha Lib) is also visible (V.R. 6/4/46-48, 6/4/50)

The simulation of sky matches the following description of *Saptaṛṣi* keeping the pole (not the present pole star) to its right.

ब्रह्मराशिर्विशुद्धश्च शुद्धाश्च परमर्षयः ।
अर्चिष्मन्तः प्रकाशन्ते ध्रुवं सर्वे प्रदक्षिणम् ॥ वा.रामा. ६/४/४८

जहाँ सप्तर्षियों का समुदाय शोभा पाता है, वह ध्रुवतारा भी निर्मल दिखायी देता है। शुद्ध और प्रकाशमान समस्त सप्तर्षिगण ध्रुवको अपने दाहिने रखकर उनकी परिक्रमा करते हैं।

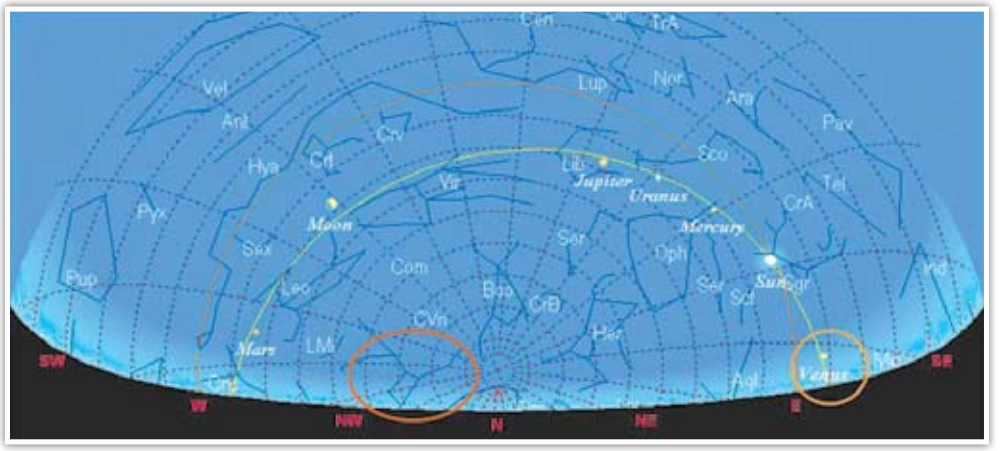

Fig. 13: Journey to Lanka on 19 Sep. 5076 BC, 0756 hrs. Description of Venus behind and *Dhruva* (not the present Polaris) to the right of *Saptaṛṣi* matches. A 5.2 mag star occupies the position of North Celestial Pole near the star Iota Draconis in that year (V.R. 6/4/46-48)

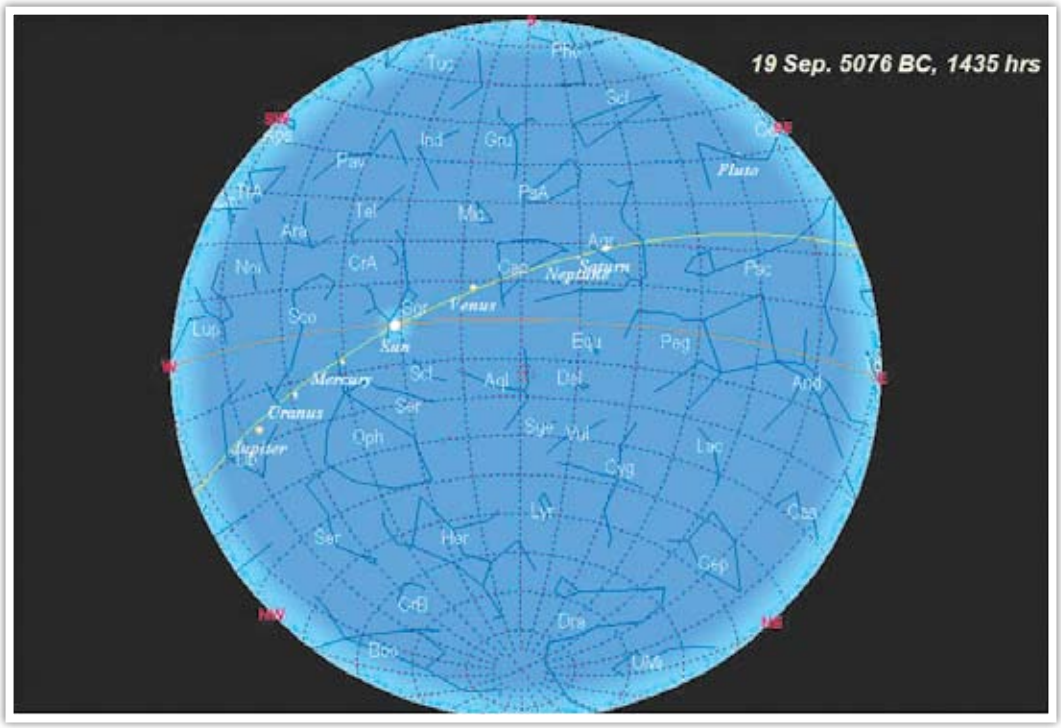

Fig. 14: Sky at the time when Hanuman Meets Ram after returning from Lanka

5. *Kaliyuga* and the legendary planetary conjunction

Kaliyuga era is widely used in Indian astronomical literature from very ancient times to the present in almanacs. It is often used to date the events including the time of *Pāndavas*. The following verse of *'Daśagītikā'* of Aryabhata tells us about the period elapsed from the commencement of *Kalpa* up to the beginning day of *Bhārata* war.

काहो मनवो ढ (१४) मनुयुगश्ख (७२) गतास्तेच (६) मनुयुगछना (२७) च ॥
कल्पादेर्युगपादा ग (३) च गुरुदिवसाच्च भारतात् पुवें ॥५॥ दशगीतिका, ५

All *Padas* of the *Yuga* are taken equal in length. Aryabhata has stated that '*Bhārata*' battle was fought at the end of *Dvāpara Yuga*. He has stated in his work that 3179 years of *Kali* had elapsed at the beginning of *Śaka* era (78 AD), which brings the date of *Kali* beginning as 3102 BC. However, many scholars in the past have tried to demonstrate that the grand conjunction of all planets in Aries

at the beginning of *Kali* era as mentioned by Aryabhata was a myth. One finds mention of *Kaliyuga* in *Mahābhārata* itself in many places:

अंतरे चैव संप्राप्ते कलिद्वापरयौरभूत्॥ समंतपंचके युद्धं कुरुपांडवसेनयोः ॥१३॥ आदिपर्व अध्याय २/१३

एतत्कलियुगं नाम अचिराद् यत्प्रवर्तते..... ॥३८॥ वनपर्व अध्याय १४९/३८

अस्मिन् कलियुगे त्वस्ति पुनः कौतुहलं मम ..... ॥३॥ वनपर्व अध्याय १८०/३

..... यदा सूर्यश्च चंद्रश्च तथा तिष्यबृहस्पति ॥९०॥ वनपर्व अध्याय १८०/८०

एकराशौ समेष्यन्ति प्रपत्स्यति तदा कृतम् ..... ॥९१॥ वनपर्व अध्याय १९०

प्राप्तं कलियुगं विद्धि प्रतिज्ञां पांडवस्य च॥

आनृण्यं। यातु वैरस्य प्रतिज्ञायाश्च पांडवः॥२५॥ शल्यपर्व अध्याय ६०/२५

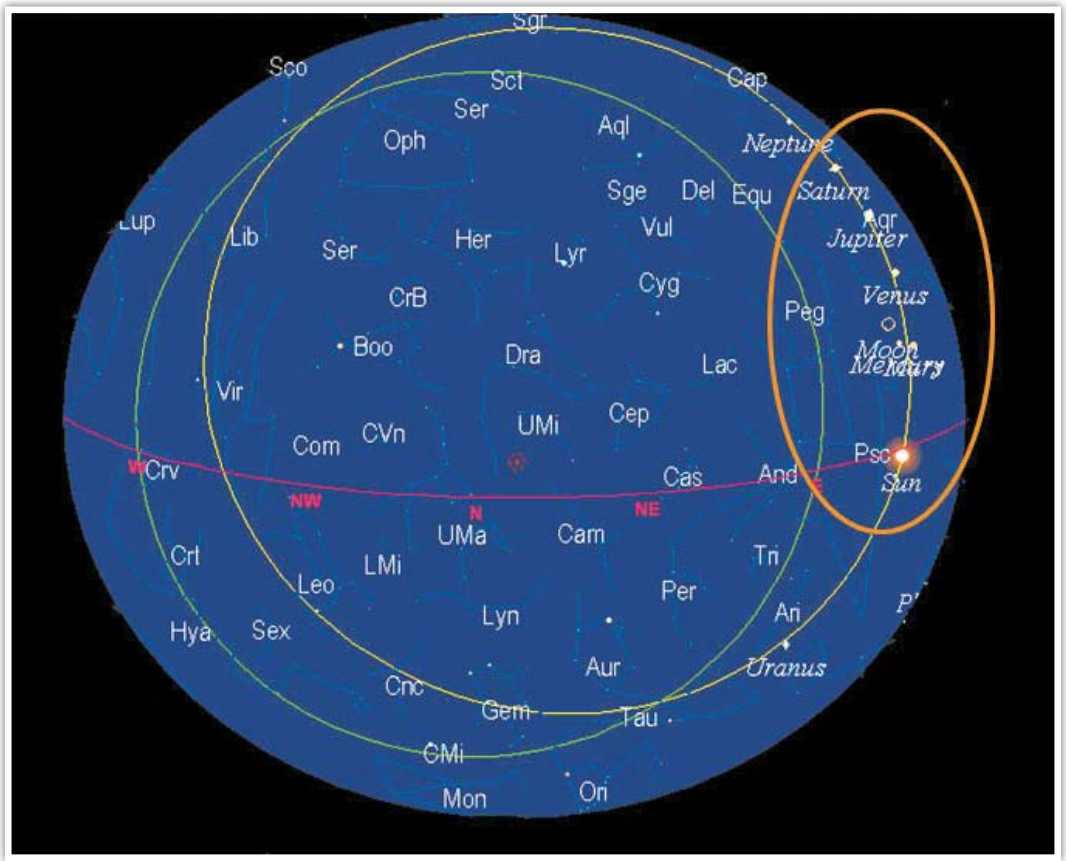

Fig. 15: The truth of Kali Era-the legendary conjunction. Five bright planets, Sun and Moon came close together above eastern horizon as a spectacular sight on 13 Jan 3103 BC, 22 days after the Winter Solstice

In keeping with the Vedic tradition of beginning the year at Winter Solstice, we tried to look for a conjunction of the Sun, the Moon and bright planets around Winter Solstice of 3102 BC using the Planetarium software. We indeed found a spectacular assemblage of Moon and five Bright planets lined up in the constellations of Capricorn and Pisces, all within a span of about 30 degrees above the rising Sun on the eastern horizon on 13th January, 3103 BC, 22 days after the Winter Solstice (Fig. 15). This sight at dawn must have been so striking that it came down as a legend to be associated with the beginning of a *Yuga*. The accuracy of less than a year in Aryabhata's calculation is remarkable, although the computed location of the conjunction in Aries was in error by one *Rāśi*.

6. *Kṛttikā* era and the time of *Śatapatha Brāhamaṇa* – 2174 BC

Verses 2.1.2.1 to 13 of *Śatapatha Brāhmaṇa* (Deshpande, 2008), refer to different *nakṣatra*s namely, *Kṛttikā, Rohiṇī, Mṛgaśirṣa, Phālguṇi, Hasta and Citrā,* for the purpose of setting up sacrificial fires.

एकं द्वे त्रीणि। चत्त्वारीति वा ऽअन्यानि नक्षत्राण्यथैता ऽएव भूयिष्ठ्ठा यत्कृत्तिकास्तभ्दूमानमेवैतदुपैति तस्मात्कृत्तिकास्वादधीत॥२॥ श. ब्रा. २-१-२-२

"Moreover, the other lunar asterisms (consist of) one, two, three or four (stars), so that the Kṛttikā are the most numerous (of asterisms): hence he thereby obtains abundance. For this reason he may set up his fires under the Kṛttikā."

This shows the well established *Nakṣatra* system at the time of *Śatapatha Brāhmaṇa.* Further, the following verse in *Taittiriya Brāhmaṇa* (1.5.2) shows that the first *Nakṣatra* of the system was *Kṛttikā*:

कृत्तिकाः प्रथमं॥ विशाखे उत्तमं॥ तानि देवनक्षत्राणि॥ अनुराधाः प्रथमं॥ अपभरणीरुत्तमं॥ तानि यमनक्षत्राणि॥ यानि देवनक्षत्राणि॥ तानि दक्षिणेन परियन्ति॥ यानि यमनक्षत्राणि॥७॥तान्युत्तरेण॥

"Kṛttikā are the first and Viśakhā the last; these constitute divine Nakṣatra: Anurādhā is the first and Apabharaṇī the last; these constitute Yama nakṣatra: The divine stars turn from south (to north) and the Yama from north (to south)."

तस्मादादित्यः षण्मासो दक्षिणेनैती षडुत्तरेण॥तै. सँ. ६-५-३

"The Sun goes by the south for six months and for six months by the north."

स यत्रोदङ्ङावर्त्तते। देवेषु तर्हि भवति देवाँस्तर्ह्यभिगोवपायत्त्यथ यत्र दक्षिणाऽऽवर्त्तते पितृषु तर्हि भवति पितॄँस्तर्ह्यभिगोपायति॥३॥श. ब्रा. २-१-३-३

"Now when he (the Sun) moves northwards, then he is among the gods, then he guards the gods; and when he moves southwards, then he is among the fathers, then he guards the fathers."

एता ह वै प्राच्यै दिशो न च्यवन्ते। सर्व्वाणि ह वा ऽअन्यानि नक्षत्राणि प्राच्यै दिशश्च्यवन्ते तत्प्राच्यामेवाऽस्येतद्दिश्याहितौ भवतस्तस्मात्कृत्तिकास्वादधीत॥३॥श. ब्रा. २-१-२-३

"And again, they do not move away from the eastern quarter, whilst the other asterisms do move from the eastern quarter. Thus his (two fires) are established in the eastern quarter; for this reason he may set up his fires under the Kṛttikā."

In order that *Kṛttikā* rise exactly at the east point, they had to be situated on the equator.

व्वसन्तो ग्रीष्मो व्वर्षाः। ते देवा ऽऋतवः शरद्धेमन्तः शिशिरस्ते पितरो य ऽएवाऽऽपूर्य्यतेऽर्द्धमासः स देवा योऽपक्षीयते स पितरोऽहरेव देवा रात्रिः पितरः पुनरह्नः पूर्व्वाह्णो देवा ऽअपराह्णः पितरः॥१॥
श. ब्रा. २-१-३-१

"The spring the summer and the rains, these seasons (represent) the gods; and the autumn the winter, and the dewy season represent the fathers. That half-moon which increases represent the gods, and that which decreases represent the fathers. The day represents the gods, and the night represents the fathers. And, further, the forenoon represents the gods and afternoon the fathers."

The above verse indicates that the first season was spring, thereby establishing that by the time of *Śatapatha Brāhmaṇa* the year beginning had been shifted to the vernal equinox.

We thus generated the sky around 2000 BC to account for the precession that has shifted *Kṛttikā* (principal star η Tau) from Vernal Equinox to their present position. Fig. 16 shows that the scenario occurs on 21 March 2174 BC.

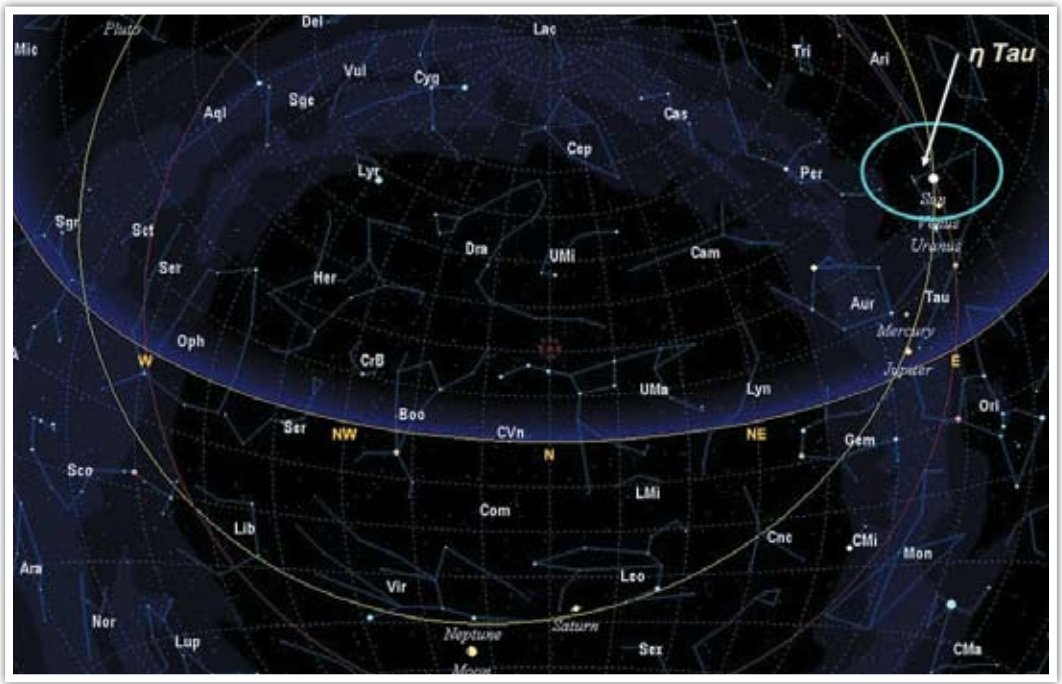

Fig. 16: VE was in *Kṛttikā* (η Tau) on 21 March, 2174 BC at the time of *Śatapatha Brāhmaṇa* 2.1.2.3

7. Conclusions

1. The earliest reference of year beginning at Winter Solstice is found in *Ṛgveda* 5-77-1/2; 1-46-14; 7-69-3/2, which corresponds to the date 19th December, 7000 BC and heliacal rising of *Aśvinī Nakṣatra* (Aries) on 5th January, 7000 BC.
2. The second stage of development for the year beginning appears to be use of *Citrā* (alpha Vir.) opposite the Sun in Winter Solstice, found on date 19th December, 6000 BC (*Taittirīya Saṃhitā* 7.4.8).
3. The next epoch, *Agastya–Rāmāyaṇa* era, relates to the discovery of star Canopus by *Agastya* around 5100 BC from *Vindhyās*. Vernal Equinox was then in *Ārdrā nakṣatra*.
4. Preparations for *Aśvamedha Yajña* commenced two years before the birth of Śri Ram (*Caitra Śukla 1*) on 25th January, 5116 BC (*Valmīki Rāmāyaṇa* 1/13/1.)
5. Beginning of Lunar year at the time of *Putra Kameṣṭhi Yajña* occurred on 15th January, 5115 BC.

6. Winter Solstice around date of birth of Śri Ram occurred on 18th December, 5115 BC.
7. Lunar year began on *Caitra Śukla* 1, 3rd January, 5114 BC, after winter solstice, before birth of Shri Ram.
8. Date of birth of Shri Ram comes out as January 10th, 5114 BC (at around 12:30 hrs) and the sky described at several major events of his life is found to match with the simulation using 'Planetarium Gold' software.
9. A spectacular assemblage occurred of Moon and five Bright planets lined up within a span of about 30 degrees above the rising Sun on the eastern horizon on 13th January, 3103 BC, 22 days after the Winter Solstice . This striking sight at dawn must have come down as a legend to be associated with the beginning of *Kali Yuga*.
10. Based on references to *Kṛttikā* , the time of *Śatapatha Brāhamaṇa* is worked out as 2174 BC.

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Origin and Development of Civilization in the Indian Sub-continent during last 8000 years: An Archaeological Perspective

Kulbhushan Mishra
Research Associate
Indian Archaeological Society, New Delhi
Email : mishra90@gmail.com

Archaeological investigations carried out during the last five or six decades in the Indian sub-continent have shed light on the origin and development of civilization from northwest frontier on the west through Kashmir and dried-up river beds of Saraswati–Drishadvati divide to the Ganga plains on the east. Various theories about the origin of the civilization have been formulated by a number of scholars right from its discovery in 1921-22. During last three to four decades, with the application of new methods and technology, the perception of Indian Archaeology has changed drastically. As a result, we have an incredibly large volume of new data to prove an indigenous origin of civilization in the Indian sub-continent. Foreign origin theories have taken backseat now and the indigenous development theory is getting more and more support in the form of archaeological evidence. The excavations at Mehrgarh, Nausharo and Kot-Diji in the Indus valley from west and Lahuradeva, Jhusi, Tokwa and Hetapatti in the Ganga valley from east provide immensely important data for the indigenous development theory. The material testimonies of these excavations have shown continuous cultural development from 7th – 6th millennium BC till its culmination into the great Harappan Civilization. This paper is an outcome of a thorough survey of the published details of various excavated sites.

While using the term 'Civilization' it is worthy to define it here as it tends to highlight a particular facet of a complex human organization. Possehl (1984) has defined that 'civilization' tends to focus on the cultural aspect of life and deals inclusively with the totality of large, long-lived human traditions. He again briefed in short that civilization can be said to relate to the cultural aspect of life and to historically long-lived cultural traditions' (Possehl 1984: 28-29).

The Earliest Village Settlements: Significant Data from Indus-Baluchistan Region

In this region various sites have illustrated the changes from a semi-nomadic pastoral life towards settled village life. The origin of village life in the Indian sub-continent was first documented at Kile Ghul Mohammad in the Quetta Velley (Fairservis 1956) and its beginning was dated to 4th millennium BC. The sites of Ghar-i-Mar and Aq Kupruk in Afghanistan shed further light on the domestication process and beginning of food production at circa 6th-7th millennium BC (Possehl 1990: 264). The data from Mehrgarh have strengthened the evidence by providing solid foundation for gradual development of settled village life since 7th millennium BC in the Indian sub-continent (Jarrige *et al.* 1995).

Mehrgarh

The site of Mehrgarh is located on the Bolan River, a tributary of Indus, at the eastern edge of Baluchistan plateau overlooking the Indus plain. The French Archaeological Mission in collaboration with Pakistan Archaeology Department has conducted excavations from 1974 to 1985, under the direction of Jean-Francois Jarrige (Jarrige 1986). Excavations have revealed seven occupational levels, giving striking evidence of continuous occupation and cultural development from 7th to 2nd millennium BC. Mehrgarh has also provided excellent evidence of technology, economy, material culture and social organization of pioneering farmers of South Asia. The salient features of cultural periods and its gradual developments are given below.

Period I (IA & IB) 7000-5500 BC

Period I and II belong to Neolithic phase, though there is a small amount of copper present. Period I is divided into two sub periods i.e. IA and IB, marked with the aceramic and ceramic respectively. The inhabitants of this period lived in houses

made of mud and handmade mud bricks (Fig. 1&2). The bricks used for house wall were of a standardized size with distinctive rounded ends and finger impressions on their upper surface. Multiple rooms without doors, divided into small units are believed to have been used for storing grains. Subsistence economy was based on a combination of plant cultivation, stock breeding and hunting. Cultivated plants comprise several varieties of wheat and barley and domesticated animals comprise cattle, sheep, goat and water buffalo. Necklaces of micro beads of steatite along with beads of turquoise, lapis lazuli and marine shell (Fig. 3, 4 & 5); stone axes and microliths have also been found. The presence of beads of several materials, which are not available in the immediate vicinity of the site, indicates long distance trade.

Fig. 1: Structures from period IA, Mehrgarh (after Jarrige *et al.* 1995: 334)

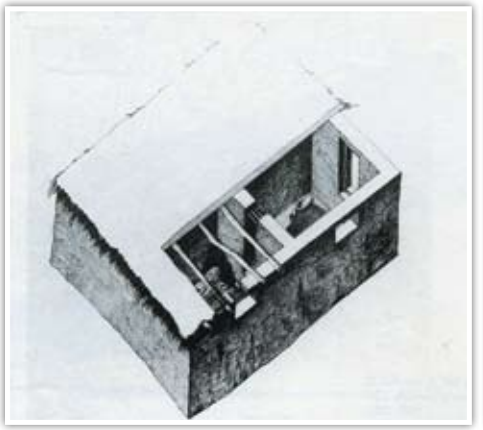

Fig. 2: Reconstructed view of House structure from period IA, Mehrgarh (after Jarrige *et al.* 1995: 335)

Fig. 3: Limestone and shell beads from period IA, Mehrgarh (after Jarrige *et al.* 1995: 330)

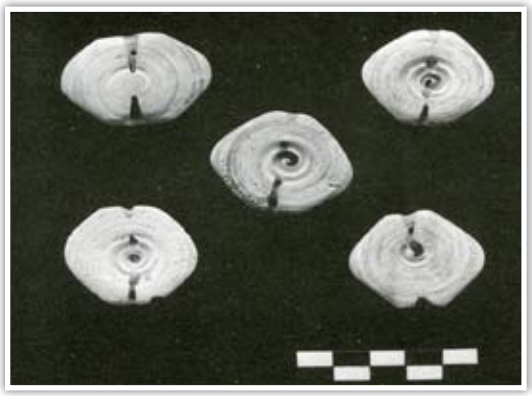

Fig. 4: Shell ornaments ground shell pendants, period IA, Mehrgarh (after Jarrige *et al.* 1995: 256)

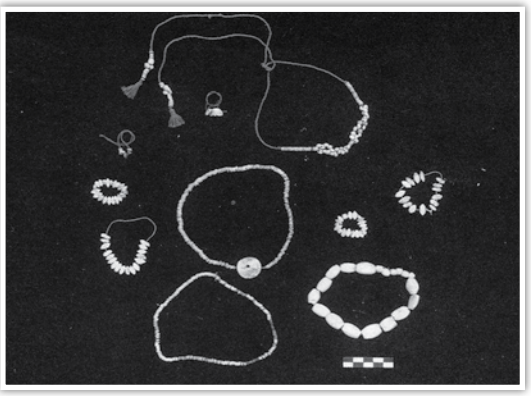

Fig. 5: Ornaments of shell, turquoise, steatite and semi precious material, period IB, Mehrgarh (after Jarrige *et al.* 1995: 298)

Period II (5500-4800 BC)

This period is further divided into three sub periods, on the basis of pottery: IIA – handmade basket impressed coarse ware, IIB –improved quality and IIC – appearance of wheel made pottery. In this period, agriculture practice was increased compared to hunting. Some sickles made of stone bladelets, set obliquely in wood handles with bitumen as the adhesive material, indicate that this may have been used for harvesting. The size of settlements also increased and several mud brick structures were divided into small cell like compartments (Fig. 6 & 7). Some of these may have been used

Fig. 6: Superimposed compartmented buildings used for storage from IIA, Mehrgarh (after Jarrige 2007-08: 150)

Fig. 7: House structures from IIA, Mehrgarh (after Jarrige 2007-08: 140)

for storage purposes. For instance, some small rooms witness with barley seeds on the floors, suggesting storage activity. The major pottery type is vessels which are buff to reddish in colour and painted in black pigment with simple straight and curved lines, rows of dots and criss crosses. Discovery of a copper ring and a bead shows the emergence of metal technology. Terracotta human figurines and bangles also appear in this phase. Appearance of new variety of barley (*Hordeum sphaerococcum)* which can be grown only in irrigated fields, suggests improvement in farming technology. The presence of cotton seeds suggests the possibility of use of this fiber in textile manufacturing.

Period III (4800-3500 BC)

This phase is marked by the increase in the size of settlement and remarkable development in craft activities, including large scale production of wheel made ceramics with painted decorations, characterized by the innovations and refinements in pottery making technique. This period has witnessed occurrence of three ovens exposed on a pottery manufacturing area where an accumulation of pottery debris has also been found. Vessels were decorated with paintings of birds and animals as well as geometric designs. In the agricultural repertoire oats and a variety of wheats were added. There is evidence of stone bead manufacturing and copper smelting at the site. The frequent occurrence of ornaments such as necklaces and bracelets made out of tiny steatite beads indicates that bead making was another important craft. There are also beads of semi precious stones such as lapis lazuli, turquoise and agate as well as of terracotta and shell. There were a few terracotta humped bulls. Terracotta crucibles with traces of copper suggest the beginning of metallurgy. Architectural remains include a large granary with multiple rectangular cells, much larger than the preceding granaries.

Period IV (3500-2400 BC)

This period is marked by the emergence of polychrome pottery with a tall goblet with wide mouth and a pedestal base as a new shape. There is evidence of extensive use of timber in the construction of houses, female terracotta figurines with pendulous breasts (Fig. 8) and stamped

Fig. 8: Terracotta figurine from period IV, Mehrgarh (after Jarrige *et al.* 1995: 174)

seals of terracotta and bone. The appearance of seal including compartmented ones in terracotta and stone indicates the emergence of commercial transactions.

Period V & VI (2500-2100 BC)

Period V was short- lived and characterized by the decline in polychrome decoration on pottery. Period VI, when similar styles of pottery start appearing in various other sites of Baluchistan, indicates an increase in interaction. A large pottery kiln was also found in this period. The appearance of Red ware decorated with *piple* leaf (Fig. 9), a well-fired Grey ware and humped bull designs on pottery which anticipate Harappan motifs, terracotta figurines also witnessed proliferation. The female terracotta figurines show elaborate hairdos, heavy breast and joined legs (Agrawal 2007:29-37).

Fig. 9: Potsherds with *pipal* and gazelle motif from Mehrgarh (after Agrawal 2007)

Period VII (2200-1700 BC)

This period is marked by richness and a wide variety of terracotta figurines (Fig. 10 & 11); some figurines have red paint in the middle partition of the hair suggesting the popular practice of using vermilion after marriage among Hindu women. Terracotta seals have design of Swastika, cruciforms and running animals. Discovery of a very large mud platform signifies the emergence of monumental architecture. The cultural history of period VI onwards at Mehrgarh is continued at the nearby site of Nausharo where the habitation

Fig. 10 & 11: Terracotta Female Figurine and Terracotta Male Figurine from period VII, Mehrgarh (after Jarrige *et al.* 1995: 175)

starts from first quarter of the 3rd millennium BC (Jarrige 1990; Misra 2001: 500-503).

In a recent paper by A. Coppa *et al.* (2006), an earliest evidence of proto dentistry at the site of Mehrgarh from 7500–9000 BC has been reported. A total of 11 drilled molar crowns from nine adults recovered from a Neolithic graveyard confirm ancient sophisticated technique of dentistry.

Apart from Mehrgarh

The Bolan Pass leads from Mehrgarh into the Queta valley, where there are a number of sites. Kile Ghul Mohammad and Damb Sadat are important excavated sites in this area and fall in between 5000-4500 BC. However the evidence from other sites of the region such as Gumla, Rehman Dheri in Gomal valley and Nausharao near Mehrgarh; Anjira and Siah Damb in Kalat plateau excavated by Beatrice de Cardi; Mundigak on the dry tributary of Argandab river in Afganistan excavated by J.M. Casal; Rana Ghundai in Loralai valley of Baluchistan excavated by Brigadier Ross; Sarai Khola in Northern part of Punjab province in Pakistan; Balakot on the Makran coast of Southern Baluchistan have not only provided a detailed picture of pre-pottery Neolithic stage going back to the 7th millennium BC (Fig. 12) followed by ceramic Neolithic and other cultures up to the 2nd millennium BC but have also corroborated the evidence with each of them (Lal 1997:32-91; Mani 2004-05:7-10; Agrawal 2007:39-53). The material testimony of these sites has proved gradual developments of early village settlements from 5th to 3rd millennium BC, when this process culminated into the form of great Harappan Civilization in the Indian sub-continent.

Origin of Harappan/Indus-Saraswati Civilization

For several decades following its discovery in 1921-22, the origin of Harappan Civilization has remained much debated. It was believed that the founders of Harappan Civilization came from West/Central Asia/Mesopotamia which had an older history of civilization. However, the origin of this civilization could not be looked at any single place and any single year. This applies to all civilizations because a civilization is a product of a long process of culture-change and evolution involving long period of time and large areas of land and not something which happens overnight (Gupta 1996: v). Gupta (1996: ix) has further suggested "the origin of Indus-Saraswati Civilization lie in this complex

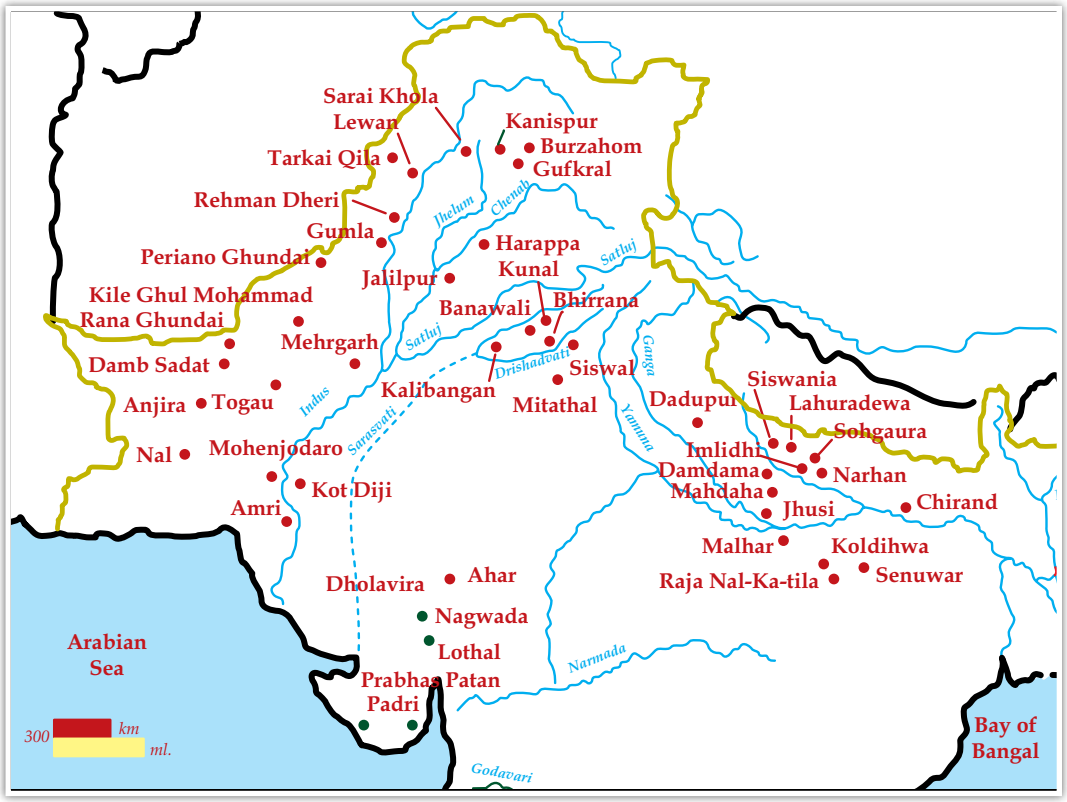

Fig. 12: Map showing the sites of northern South Asia during 9th to 4th millennium BC (after Mani 2006: 230)

process which integrated several regions with their individualistic cultures into a socioeconomic and ideational system with its own concomitant cultural elements and nothing else, neither in Mesopotamian nor Iranian nor Turanian cultures". He also suggested that "those who are accustomed to look at the history of the formation of civilizations in the framework of 'events' or else 'nuclear zone and peripheral areas' fail to appreciate the point that civilizations are not at all formed in this fashion". The introduction of various Harappan elements at different levels at the site of Mehrgarh and Nausharo culminated into the emergence of Harappan civilization (Shinde *et al.* 2006: 65). In this regard, V.N. Misra has also explained that a variety of crafts like wheel made pottery and elaborately decorated ceramics, stone bead industry, terracotta animal and human figurines, and copper-bronze metallurgy had already appeared in the early village cultures of Baluchistan in the 5th millennium BC. By the beginning of the 4th millennium

BC permanent settlements began to appear in the Indus valley as also in the valley of the presently dried-up Saraswati/Ghaggar- Hakra river which was flowing parallel to, and east of the Indus. It is in this vast and fertile alluvial plain that the first urban settlements, characteristic of the Indus/Harappan civilization appeared (Misra 2001: 502). After classification of archaeological evidence and fresh data along with scientific dates from north-western regions of South Asia, B.B. Lal has discussed the antecedents and origin of the earliest civilization into details (Lal 1997:32-91). Lal has described the origin of civilization in details, continuity of tradition from five thousand years ago, Aryan migration etc in his recent book "*How Deep are the Roots of Indian Civilization? Archaeology Answers*". While concluding the section on the supposed 'immigration' of Vadic people from central Asia, he mentioned remarkable evidence from human biology and DNA (Lal 2009:113) by quoting B.E. Hemphil and his colleagues as:

'As for question of biological continuity within the Indus Valley, two discontinuities appear to exist. The first occurs between 6000 and 4500 BC. … The second occurs at some point of after 800 BC but before 200 BC.'

'It is, therefore, absolutely clear that there was no immigration of any alien people between 4500 BC and 800 BC. Where then is the evidence of an 'invasion' or 'migration' of Vedic people, which some scholars think took place around 1500 BC (Lal 2009:114).

He again mentioned an important genetic research by quoting Sanghamitra Sahoo as:

'The sharing of some Y-chromosomal haplogroups between Indian and Central Asian populations is most parsimoniously explained by a deep, common ancestry between the two regions, with the diffusion of some Indian – specific lineages northward. The Y-chromosomal data consistently suggest a largely South Asian origin for Indian caste communities and therefore argue against any major influx, from regions north and west of India, of people associated either with the development of agriculture or the spread of the Indo-Aryan language family.'

The evidence from various excavated sites such as Mehrgarh, Harappa, Mohenjo-daro, Kot Diji, Amri, Kalibangan, Kunal, Bhirana and Dholavira now lead us to believe that the Harappan civilization emerged out of the early Harappan phase. It is also evident that the process of transformation from Early to Mature Harappan appears to have happened over the major Harappan region including

Baluchistan, Sindh, Indus-Saraswati basin and Gujarat (Shinde *et al.* 2006: 65). Thus the civilization is now seen as an indigenous development of the Indian sub-continent.

Terminology

It is worth discussing here the related terminologies of the great civilization such as 'Harappan Civilization', 'Indus Valley Civilization' and 'Indus-Saraswati Civilization'. The civilization was first identified at Harappa in 1920-21 by Daya Ram Sahni, and hence named as 'Harappan Civilization' after the name of the site. Sir Mortimer Wheeler first used the term 'Harappa Culture' in his excavation report of Harappa in 1946. The site Harappa is located on the Ravi river in Sihawal district of Punjab, Pakistan and Mohenjo-daro on the Sindhu river in district of Sindh, Pakistan. Since Ravi is a tributary of the Indus or the Sindhu, Sir John Marshall called it 'Indus Valley civilization' in his site-report entitled '*Mohenjo-daro and the Indus Civilization'* (1931). However, from 1942, when Sir Aurel Stein, started exploring the banks of dried up river Saraswati in Rajasthan he found many more sites of the Harappan civilization. After partition, archaeologist from both the countries (India and Pakistan) started exploring for many more sites on the Indus and Saraswati river systems. As a result of this, a substantial number of Harappan sites were located in India and Pakistan. There are more sites located on the Saraswati and its tributaries in India and Pakistan than the Indus and its tributaries. Hence, it is not surprising that S.P. Gupta (1996) renamed this civilization as 'Indus-Saraswati Civilization'. However, there are other terminologies used by some scholar such as Jim Shaffer (1992) who used the term 'Indus Valley Tradition' for the long series of human adaptations starting from the Neolithic/Chalcolithic stage to the decline of the Harappan civilization. Within this bracket, he applied the term 'regionalization era', 'integration era' and 'localization era' for the early Harappan, mature Harappan and late Harappan respectively. In this paper we use the term 'Indus-Saraswati Civilization'.

The Indus-Saraswati Civilization was a long cultural process having three stages viz. the early Indus-Saraswati, mature Indus-Saraswati and late Indus-Saraswati. These three stages represent the gradual cultural process from origin, growth, culmination and degeneration of this civilization.

Early Indus-Saraswati Period

In 1980, M.R. Mughal published an article entitled 'New research on the origin of Indus Civilization', and used the term 'Early Harappan Period' for the first time. The term 'Early' shows the transition or continuity or formative stage of the Indus-Saraswati civilization. It was the first large scale study of the archaeological assemblages dated to *circa* 3200-2500 BC in the Indus Region (Possehl 2002:112). Possehl (2002) has further suggested that the material found in stratified context below the 'mature' Indus-Saraswati phase at Kot Diji, Amri, Kalibangan and the pre-defense level of Harappa belongs to an Early Indus-Saraswati period assignable to the first half of the 3rd millennium BC. But the story has been developed over 4000 years, across a vast and varied geographical area. All over the Hakra-plain right up to Baluchistan, the Gomal valley, Bannu, and the Potwar plateau there are abundant remains of the Early Indus-Saraswati sites (Fig. 13) (Chakrabarti 2004:23,26). This early phase is characterized by a unique pottery tradition i.e. a short-necked ovoid jar painted at the neck with black, and designs including horned motif in black on the body and emergence of several urban features like town planning; developed metal technology; craft specialization in a variety of materials such as stone, terracotta, incipient Harappan script and miscellaneous objects of shell and bone which are represented at several sites like Harappa, Kot Diji, Sothi, Siswal, Kalibangan, Kunal, Bhirana and Dholavira etc (Gupta 1996: 56; Rao *et al.* 2004-5).

The Early phase of the Indus-Saraswati civilization incorporates some significant features of succeeding Mature Indus-Saraswati civilization phase (see table 1). Therefore mature phase is supposed to be the integral development within the early phases of civilization. In the Sindh-Baluchistan region, the elements of the Amri and Kot Diji phase dominated the assemblages of the Mature Indus-Saraswati phase, whereas in the Saraswati basin, the elements of the early Sothi-Siswal continued to be dominating in the Mature Indus-Saraswati phase and in Gujarat region, the mature phase has also been evolved out of the Padri early phase (Shinde *et al.* 2006: 66). In the entire Indus-Saraswati region, there are regional variations in ceramics and material culture, thus Possehl (2002) has identified more than seven domains on the basis of geography and settlement pattern. Besides these regional variations, there are many common traits present in ceramics, stone tools and technology, terracotta objects and architecture which also occur in mature Indus-Saraswati period.

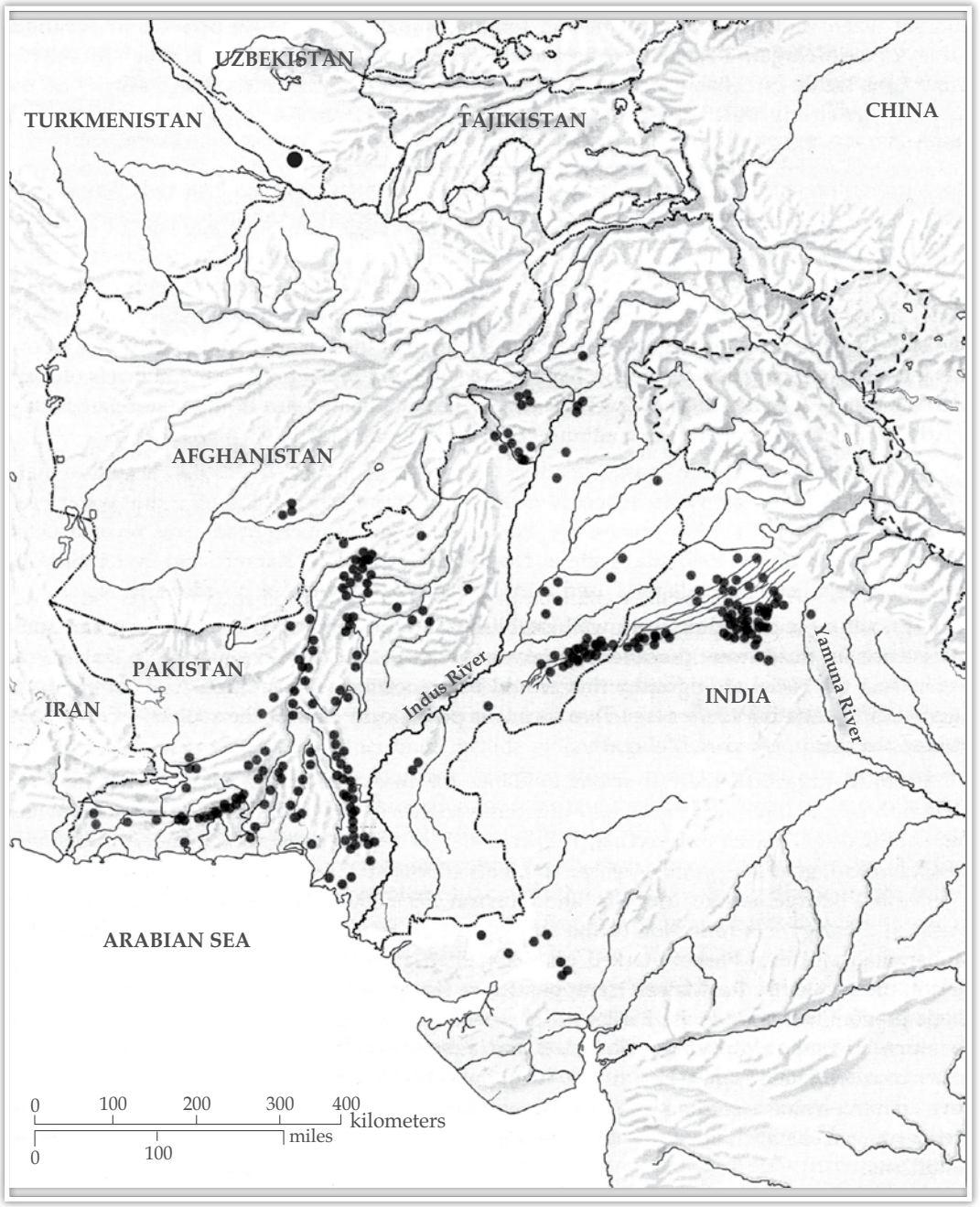

Fig. 13: Map showing the sites of Early Indus-Saraswati civilization marked by the black circles (after Possehl 2002)

Table 1: Continuity and change from Early to Mature Indus-Saraswati Phase (after Gupta 1996: 104)

		Early Indus-Saraswati phase	Mature Indus-Saraswati phase
Architecture	Fortification	✓	✓
	Fortification with Bastions	?	✓
	Citadel	?	✓
	Planned Cities	?	✓
	Cemetry	?	✓
	Civic Architecture	?	✓
Religion	Mother Goddess Figurines	?	✓
	Fire Altars	?	✓
Art	Stone Sculptures	?	✓
	Bronze Sculptures	?	✓
Pottery Motifs	Intersecting Circles	✓	✓
	Fish Scale	✓	✓
	Fish	✓	✓
	Pipal Leaf	✓	✓
Terracottas	Cart Frames	✓	✓
	Cart Wheel	✓	✓
	Cakes	✓	✓
	Bangles	✓	✓
	Animal Figurines Horse	?	✓
	Human Figurines	✓	✓
Semi Precious Stones	Turquoise	✓	✓
	Lapis Lazuli	✓	✓
	Cornelian	✓	✓
	Shell	✓	✓
	Ivory	✓	✓
	Stone Drills	✓	✓
Copper Bronze Technology	Lost Wax Process	?	✓
	Crucibles	✓	✓
	Flat Implements	✓	✓

Other Items	Graffiti Marks	?	✓
	Writing	?	✓
	Inscribed Seals & Sealing	?	✓
	Weight & Measures	?	✓
	Trade with Mesopotamia	?	✓

Mature Indus-Saraswati Period

The Mature Indus-Saraswati phase is now well dated by radiocarbon determinations in second half of 3rd millennium BC or *circa* 2600-2000 BC, and characterized by the complete growth of urban economy and society which is represented at many sites like Harappa, Mohenjo-daro, Kalibangan, Rakhigarhi, Lothal and Dholavira. A list of important excavated sites (Table 2) is given below:

Table 2: Important excavated sites of Indus-Saraswati civilization

Sites	Year of Excavation	Excavator	References
Mohenjo-daro	1931	Sir John Marshall	Marshall 1931
Chanhu-daro	1935-36	E.J.H. Macky	Mackay 1935-36, 1943
Kot Diji	1955-1957	F.A. Khan	Khan 1965
Amri	1964	J.M. Casal	Casal 1964
Balakot	1973 and 1976	George F. Dales	Dales 1979
Allahdino	1973	W.A. Fairservis	Fairservis 1982
Nausharo	1987-89	J.F. Jarrige	Jarrige 1990
Harappa	1940	M.S. Vats	Vats 1940
Shortughai	1989	H.P. Francfort	Francfort 1989
Rupar	1953-1955	Y.D. Sharma	Sharma 1956
Banawali	1974-1977	R.S. Bisht	Bisht 1978, 1982
Rakhigarhi	1997-2000	Amarendra Nath	Nath 1997-98, 2000-2001
Bhirrana	2003-2005	L.S. Rao	Rao 2004-05
Kalibangan	1961-1969	B.B. Lal & B.K.Thapar	Lal & Thapar 1967, 2003
Alamgirpur	1958-1959	Y.D. Sharma	Sharma 1989
Hulas	1978-79 and 1982-83	K.N. Dikshit	Dikshit 1981, 1984

Lothal	1954-55 and 1962-63	S.R. Rao	Rao 1973
Rangpur	1955-1962	S.R. Rao	Rao 1963
Surkotada	1970-72	J. P. Joshi	Joshi 1990
Dholavira	1986-1998	R.S. Bisht	Bisht 1991, 1997

Geographical Extent

This civilization is mainly confined to the plains of Indus and Saraswati valley. The area covered by this civilization extends from Punjab in Pakistan and India; Haryana and Ganga-Yamuna Doab in western Uttar Pradesh; the northern and western tracts of Thar Desert in Rajasthan and the plains of north Gujarat including Kutch and Saurashtra. It is extended on an area of more than one million sq. km. It covers a large area of the Indian sub-continent. The western most site is Sutkagen-dor (Makaran) near the present border separating Pakistan and Iran, located on the ancient shore of the Arabian Sea, the eastern-most site is Alamgirpur on the Hindon river in western Uttar Pradesh; Manda is the northern-most site located on the Beas river near Jammu and Bhagatrav is the southernmost site on the Tapi river in South Gujarat (Fig.14).

Major Characteristics of Indus-Saraswati Civilization

On the basis of combined material testimony of the above mentioned excavated sites, some major architectural characteristics of this civilization can be considered as planned cities having a citadel for the upper class and a lower town for the common people, with roads and streets running at right angles, private and public drainage system, generally covered with stones or bricks. The city is enclosed by a fortification with impressive gateways; public buildings like the Great Bath (Fig. 15) at Mohenjo-daro, dockyard at Lothal (Fig. 16) and granaries at several cities. The people of the Indus–Saraswati civilization had an excellent well-planned drainage system (Fig.17) comprising public and private drains, further proving that the Indus–Saraswati people paid great attention to sanitation and cleanliness. The planning and management of the city indicates the existence of an active and efficient law to administrating the activities of the city and ensuring maintenance of cleanliness. The streets were paved with baked bricks and houses were provided with paved baths. In construction activities, both kiln and sun-baked bricks with standardized dimensions in the ratio of 1: 2: 4

Fig. 14: Map showing the distribution of sites of mature Indus-Saraswati civilization (after Possehl 2002)

were used. The other characteristic features are sturdy wheel made pottery abundantly decorated by painted geometric and naturalistic motifs; pottery forms like goblets with pointed base, cylindrical pots with multiple perforations, jars with S-profile and dishes-on-stand; uniform chert weights and measures of metal and ivory; triangular terracotta cakes; uniform script depicted on steatite and other seals and tablets (Fig. 18); fine Jewellery made of gold, silver, copper, ivory, shell, semi-precious (Fig. 19: A, B, C) stones, steatite, faience and terracotta; typical shapes of copper artifacts like bent-bladed

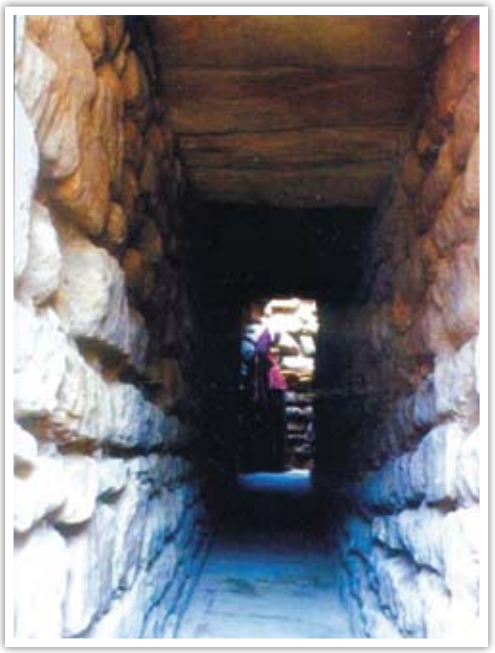

Fig. 17: A huge storm water drain from Dholavira (after Agrawal 2007)

Fig. 15: Great bath from Mohenjo-daro (after Agrawal 2007)

Fig. 16: Lothal Dockyard (after Chakrabarti 2004:14)

Fig. 18: Steatite seals from Dholavira (after Agrawal 2007)

Fig. 19 (A): Gold Ornaments from Banawali (after Agrawal 2007)

Fig. 19 (B): Agate beads from Banawali (after Agrawal 2007)

Fig. 19 (C): Gold necklace from Mohenjo-daro (after Agrawal 2007)

knives, double-edged razors, barbed triangular arrowheads with holes etc (Misra 2001: 504; Agrawal 2003: 23-28).

Town Planning

The general layout of the cities consisted of two parts, a citadel on the western side and a lower town on the eastern side. The citadel area was occupied by the ruling classes and the aristocracy as well as public building such as granaries and Great Bath at Mohenjo-daro and lower town was inhabited by the common people. At Dholavira the settlement consisted of three parts i.e. lower town, middle town and citadel, the citadel itself consisting of two parts. The geometrically designed towns had fortifications for protection against both intruders and floods. The citadel area had several distinct quarters, assembly halls, granaries

and manufacturing units of various types. The towns had public baths. Private baths were found in most of the houses, and sewerages were connected through underground drains. There was an efficient water management with numerous reservoirs and wells (Fig. 20: A, B). The streets were built on grid pattern and cut each other at right angles. Mohenjo-daro, for instance, had over 700 wells, some of them fifteen metres deep, built with special trapezoid bricks (to prevent collapse by the pressure of the surrounding soil), and maintained for several centuries. Dholavira had separate drains to collect rain water and six or seven dams built across the nearby rivers. The houses were almost always built with mud bricks (sometimes fired in kilns), which followed a standard ratio of 1: 2: 4, though the actual sizes varied: bricks for houses, for instance, might be 28 x 14 x 7 cm, while for fortification walls they are in size of 36 x 18 x 9 cm or even bigger (Misra 2001: 505; Agrawal 2007: 63-85).

Fig. 20 (A): Water tank from Dholavira

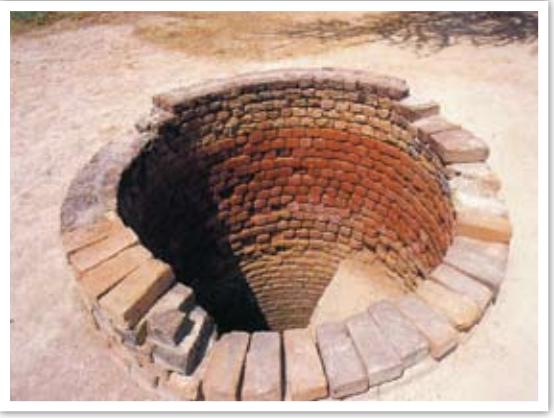

Fig. 20 (B): Well from Lothal (after Chakrabarti 2004:14)

Arts and Industries

The Indus-Saraswati people were also expert craftsmen. They made beads of carnelian, agate, amethyst, turquoise, lapis lazuli etc. They manufactured bangles out of shells, glazed faience and terracotta; they carved ivory and worked shells into ornaments, bowls and ladles. They were making bronze and copper objects such as weapons, tools, human and animal sculptures (Fig. 21: A, B, C,). They excelled in stone-carving, complex weaving and carpet-making, inlaid woodwork and decorative architecture. They also engraved their seals with remarkable

artistry (Fig. 21: D) mostly in steatite or soapstone; those seals, over 3,000 of which have been found, seem to have served various purposes like commercial, ritual or spiritual etc.

Fig. 21 (A): Copper Objects from Dholavira (after Agrawal 2003)

Fig. 21 (B): Copper mirror from Dholavira (after Agrawal 2007)

Fig. 21 (C): Bronze bull from Kalibangan (after Lal 2009)

Fig. 21 (D): Cylindrical seal from Kalibangan (after Madhubala 2004)

Weights and Measures

Indus-Saraswati people had evolved a highly standardized system of weights and measures. For linear measure two systems were in vogue: cubits and long foot. A cubit was about 52 cm and long foot 33.5 cm. Graduated scales have been reported from Mohenjo-daro, Lothal and Kalibangan. The Lothal scale has divisions of 1.7 mm with decimal graduations. It may be pointed out that *Arthasastra's angula* was 17.86 mm compared to 17.7 mm division on the Harappan scale. The weights are made out of chalcedony, black stone etc. and took cubical forms. They followed a binary system (1, 2, 4, 8, 16, 32 up to 12,800) in lower denominations. The first seven Indus-Saraswati weights are double in size from

1:2:4:8:16:32:64 and most common weight is the 16th ratio, which is approximately 13.7 grams. The traditional Indian ratio of 1:16 (1 seer = 16 *chhattacks*) seems to derive from this (Agrawal 2003:95).

Society and Religion

The society of Indus-Saraswati civilization was stratified on the basis of economic and social background. They were highly differentiated by houses, servant quarters, and citadels. The society comprised of farmers, artisans, traders, administrators, priests and workers. The religion of the Indus-Saraswati people is thought to have been centered around the worship of natural forces like the trees (*pipal* tree found engraved on the seals), mother goddesses and a male deity believed to be a proto type of *Shiva* in his form of *Pashupati* (Fig. 22). The worship of *Shiva Linga* was prevalent during Indus-Saraswati period. During excavation at Mohenjo-daro, some stone objects were found and identified by John Marshal as *Linga* and *Yoni*. But after this discovery, some scholars doubted Marshal's identification. Three decades after this discovery, it was further substanciated at Kalibangan in Rajasthan where a composite representation of *Linga*-cum-*Yoni* in terracotta has been found (Fig. 23) which is similar to the modern *Shiva* temple, leaves no space for doubt about *Shiva* worship being deep rooted in 3rd millennium BC (Lal 2009: 30-31). Another portrayal on a seal found recently at Harappa (Fig. 24) shows, on the right, a deity seated in yogic posture and three-pronged head gear, in the centre is a man and on the left, a buffalo. The man presses

Fig. 22: Terracotta seal having depiction of proto *Shiva* (after Agrawal 2007)

Fig. 23: Terracotta *Linga*-come-*yoni* from Kalibangan (after Lal 2009)

Fig. 24: Terracotta tablet, depicting the *Shiva*-like seated figure (right) and person attempting to kill a buffalo, perhaps as a sacrifice, from Harappa (after Lal 2009)

the head of buffalo by putting his right foot on it and holds the horns of the animal with his left hand. In his right hand there is a spear and with this he pierces the back of the animal. The scene seeks to depict the killing of the buffalo in the presence of *Shiva*, as a sacrificial act (Lal 2009: 31-32). Clay figurines of mother goddess are common at Mohenjo-daro and other sites in Baluchistan, but are rare in Saraswati valley and in Gujarat. Fire rituals were also practiced by Indus-Saraswati people and ample evidence in this regard has been obtained from Kalibangan, Banawali, Rakhigarhi and Lothal. This type of ritual is quite common in Hindu religion. *Havana* is performed quite often in many Hindu households. Tree worship is yet another feature that seems to have come down from the Indus-Saraswati times. *Pipal* tree seems to be the most popular and potent. Cutting a *pipal* tree or its branches is still a taboo. A *swastika* motif engraved on a seal from mature Indus-Saraswati period at Mohenjo-daro (Fig. 25) has been reported (Lal 2009: 35). The word *swastika* derived from the Sanskrit word *suastika*, which

Fig. 25: The *swastika* motif engraved on a seal from Mohenjo-daro (after Lal 2009)

means any lucky or auspicious object, thus it is a sign of prosperity and good luck. Surprisingly, some of the terracotta figurines performing the Yogic *asnas* have been reported both from Harappa and Mohenjo-daro (Fig. 26) during mature Indus-Saraswati period indicating that these practices of *Yogasana* still continue from five thousand years ago (Misra 2001: 505; Agrawal 2007: 213-229; Lal 2009: 30).

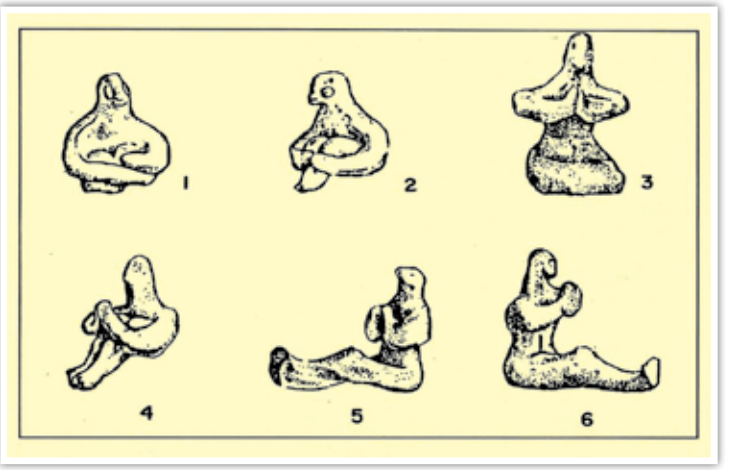

Fig. 26: Terracotta figurines in Yogic *asanas:* 1-4, from Harappa; 5-6 from Mohenjo-daro (after Lal 2009)

Besides these, there are various aspects of Indus-Saraswati civilization which need to be briefly described here. These are: a female figurine of terracotta having vermilion on her medial portion of hair (a sign of being married amongst Hindu women); an ivory comb from Mohenjo-daro; agricultural field of Kalibangan; terracotta model of a plough from Banawali; games objects like terracotta gamesmen from Lothal, stone gamesmen from Dholavira and a terracotta cubical dice from Mohenjo-daro; painted jars having depictions of the story i.e. 'The Thirsty Crow' and 'The Cunning Fox' from Lothal. Thus it is very clear that most of our cultural traits have their deep root and still continued in various forms of our Indian Culture (for a detailed discussion see Lal 2009: 5-42).

Early Farming Societies outside the Indus-Saraswati Zone

Archaeological researches during the last six decades have thrown a flood of light on the dispersal of farming- based settled societies beyond the domain of the Indus-Saraswati civilization. Thousands of sites covering all parts of the country have been discovered and divided into two cultural groups i.e. Neolithic Culture

and Chalcolithic Culture. The Neolithic period represented a food-producing settled village way of life. The advent of agriculture, pottery making technology and animal domestication, brought dramatic change in the economy, technology and demography of human societies. Subsequently copper was introduced and this period was termed as the Chalcolithic culture, representing a more advanced stage. Both groups of cultures are also called as Early farming cultures. Subsistence base of both the groups is fairly similar – being based on a combination of plant agriculture, animal husbandry, hunting, and gathering, fishing and fowling. Neolithic Cultures are confined to the: Kashmir Valley, the Northern Vindhyas, middle Ganga Plain, eastern and northeastern region and, South India. The Chalcolithic Cultures are much widely distributed, being found in entire Ganga plain, northern Vindhyas, eastern Rajasthan, Malwa or western Madhya Pradesh, some parts of Gujarat and western Maharashtra.

Data from Kashmir Neolithic: Some New Evidences

In Kashmir Valley, the understanding of the Neolithic culture is based on excavations at three sites i.e. Burzahom, Gufkral (Gofkral) and Kanishkapura (Kanispur) while there are a number of other Neolithic settlements in Kashmir valley which are still waiting to be excavated. Burzahom (*IAR* 1960-61:11; Kaw 1989) was excavated by T.N. Khazanchi for seven seasons (1960-1971) but Gufkral (*IAR* 1981-82:19-25) was excavated for only two seasons (1980-1982) by A.K. Sharma and Kanishkapura (Mani 2000) for only one season (1998-99) by B.R. Mani. A distinguishing feature of Kashmir Neolithic is mud plastered pit dwellings which are in round and oval shape. The largest is 3.96 m deep, with a diameter of 2.74 m at top and 4.75 m in bottom. Neolithic people lived in pit dwellings, obviously to protect themselves from freezing winds during winter. Evidence of human occupation in these pits occurred in the form of ovens, charcoal, ash, pottery, stone tools, burials etc. Technology of these settlers is consisted of tools made of stone, bone and antler. The stone tools are comprised of polished axes, chisels, harvesters, pounders, polishers, grinders and perforated discs. The early phase of Neolithic inhabitants was not familiar with the pottery but after some time they learnt its manufacturing technology. The pottery is largely handmade and subsequently in later phase, wheel-made pottery also appears. Some of the handmade pots having mat impressions on their bases indicate that they were placed on mats for drying. The vessel shapes comprise jars, vases, globular pots, basins, dishes-on-stand and bowls. Occasionally, the pots are decorated with

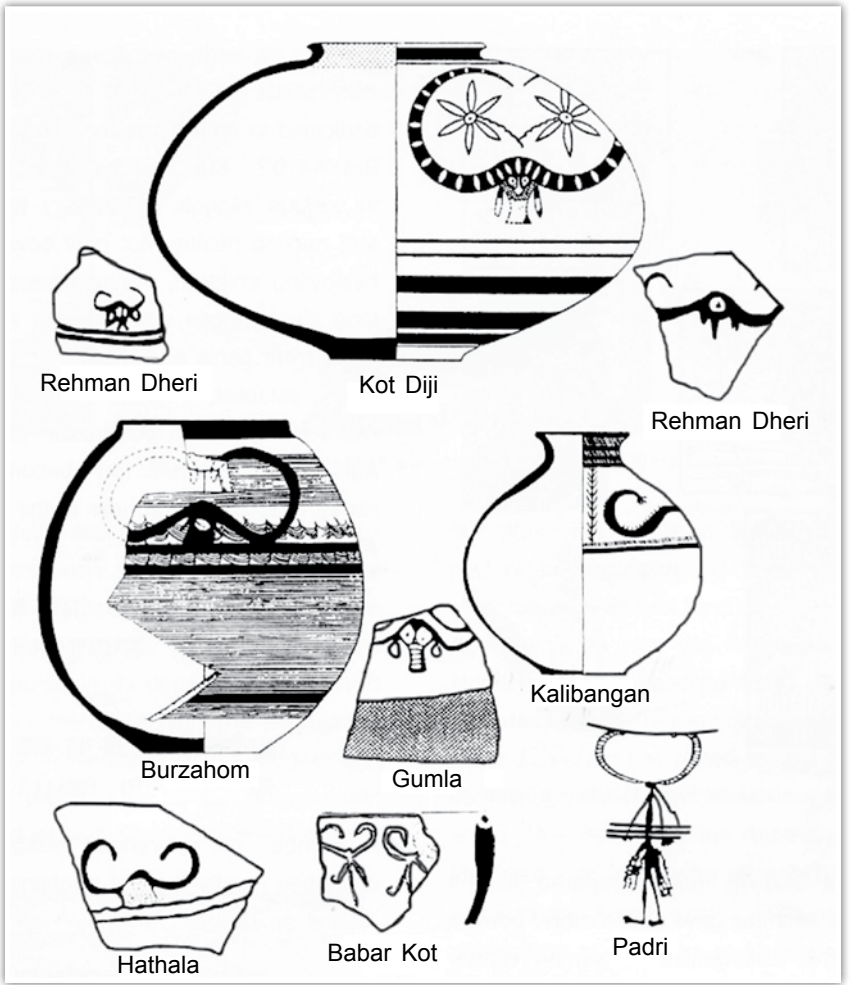

Fig. 27: Depiction of horned deity on pottery from various sites (after Mani 2006: 241)

paintings. Special mention may be made about a wheel made red pot containing about 950 agate and carnelian beads, found in early levels from Burzahom. Another globular pot with painting of horned deity, very similar to the specimens from Kot-Diji and Gumla in Pakistan and Kunal, Kalibangan and Padri in India (Fig. 27), suggests contact between the Kashmir Neolithic and Indus-Saraswati people (Mani 2006:234).

The new evidence of radiocarbon dates from Kanishkapura suggests the beginning of Neolithic age in the middle of the 4th millennium BC with ceramic

Neolithic appearing in the late 4th millennium BC in Kashmir and not in the first half of the 3rd millennium BC as popularly believed by archaeologists on the earlier evidences of Burzahom and Gufkral. A calibrated C 14 date of one charcoal sample from Kanishkapura is 3361 BC to 2937 BC (average being 3149 BC) (Mani 2006:235).

Middle Ganga Plain

The Gangetic plain occupies a significant position in the history and archaeology of India. The Middle Ganga plain covers a long physical area of 144,409 sq. km. Its maximum length from east to west is about 600 km while its width from north to south is approximately 330 km. It extends from the Himalayas in the north and Vindhyas in the south, Ganga -Yamuna confluence in the west and Bihar-Bengal border in the east. It includes modern eastern Uttar Pradesh and plains of Bihar. The region is mainly drained by Ganga and its tributaries (Singh 1971: 183-93). Archaeological investigations during last three decades in this region have significantly enriched the knowledge and understanding about Neolithic/ Chalcolithic culture, material remains and chronological sequence of the region. The recorded archaeological relics of the region up to the fifties of the 20th century looked prosaic (Misra 2010:124). The antiquity of the settlements of this region was placed in 1st millennium BC. Thereafter the pioneering work at Sohagaura in 1961-62, followed by excavations for seven season at Chirand, commencing from 1962-63, established the Neolithic-Chalcolithic antiquity of the region to 3rd millennium BC. However, it is further attested by several excavations from 1970-71 onwards (Tewari 2010) which was done by central/ state universities and government archaeological departments. The important excavated sites, their respective cultural periods, geographical locations and geo-coordinates are given below (see table 3). The sites, which are mentioned in table 3, have also been plotted on Google map (Fig. 28).

Table 3: Geographical locations, geo-coordinates and cultural periods of the sites

Site Name	Geo-Coordinates	Geographical Locations	Neolithic Period	Chalcolithic Period	District	References
Sohgoura	Lat. 26°32″N Long. 80°32″E	On the confluence of Rapti and Ami river	(Pd. I)	(Pd. II, III)	Gorakhpur (U.P)	Chaturvedi 1985
Narhan	Lat. 26°19′N Long. 83°24′E	Left bank of Ghaghara river	_____	(Pd. IA)	Gorakhpur (U.P)	Singh 1994

Imlidih Khurd	Lat. 26°30′30″N Long. 83°12′5″E	Half km N/W of Sikariganj town.	(Pd. I)	(Pd. II)	Gorakhpur (U.P)	Singh 1992-93
Khairadih	Lat. 26°10′N Long. 83°51′30″E	Right bank of Ghaghara river		(Pd. I)	Balia (U.P)	Singh 1987-88
Bhunadih	Lat. 25°19′10″ N Long. 84°5′11″	Right bank of Bahera *nala*, a tributary of Ghaghara	-	-	Balia (U.P)	Singh & Singh 1997-98
Waina	Lat.25° 45′ 05″ N Long. 84° 05″ E	Left bank of Tons, tributary of Ganga	(Pd. 1A)	(Pd. 1B)	Balia (U.P)	Singh & Singh 1995-96
Lahuradeva	Lat. 26°46′N Long. 82°57′E	On the Horse shoe lake	(Pd. IA & IB)	(Pd. II)	Santakabir Nagar (U.P)	Tewari *et al.* 2005-06
Koldihwa	Lat. 24°54′N: Long. 82° 02″E	Left bank of Belan river	(Pd. I)	(Pd. II)	Allahabad (U.P)	IAR 1973-74; 75-76
Jhusi	Lat. 25° 26′ 10″N Long. 81°54′30″E	Left bank of Ganga, very close to Ganga Yamuna Confluence	(Pd. I)	(Pd. II)	Allahabad (U.P)	Misra *et al.* 2009
Hetapatti	Lat. 25° 29′ 0″ Long. 81° 55′ 31″ E	Left bank of Ganga	(Pd. I)	(Pd. II)	Allahabad (U.P)	Pal 2007-08
Agiabir	Lat. 25°13′52″N Long. 82°38′41″E	Left bank of Ganga	_____	(Pd. I)	Mirzapur (U.P)	Singh & Singh 1999-2000
Malhar	Lat. 24°59′16″N Long. 83°15′46″E	Left bank of Karmnasa river	_____	(Pd. I)	Chandauli (U.P)	Tewari *et al.* 1999-2000
Raja Nal-Ka-Tila	Lat. 24°42′5″& 24°41′51″ N Long. 83°18′41″& 83°19′26″ E	Within a lop like curve of Krmnasa river	_____	(Pd. I)	Sonbhadra (U.P)	Tewari *et al.* 1996-97
Chirand	Lat. 25°45′N Long. 84°50′E	On the confluence of Ganga and Ghaghara	(Pd. I)	(Pd. II)	Saran (Bihar)	IAR 1970-72; Verma 1970-71
Chechar Kutubpur	Lat. 25° 30′ 10″ N Long. 85° 30′ 45″ E	Left bank of Ganga	(Pd. IA)	(Pd. IB)	Vaishali (Bihar)	IAR 1977-78
Senuwar	Lat. 24°56′N Long 83°56′E	Right bank of Kudra river	(Pd. IA)	(Pd. IB & II)	Rohtas (Bihar)	Singh 1988-89; 1995-96

Maner	Lat. 25° 30′ 45″ N Long. 84° 45′ 25″ E	On the bank of Ganga	(Pd. I)	(Pd. II)	Patna (Bihar)	IAR 1984-85
Sonepur	Lat. 24° 57′ N Long. 84° 50′ E	On the bank of Jamunai river	———	(Pd. IA)	Gaya (Bihar)	IAR 1970-71
Taradih	Lat. 24° 42′ N Long. 85° 0′ E	South-west of Mahabodhi temple	(Pd. IA)	(Pd. IB & II)	Gaya (Bihar)	IAR 1984-85

Fig. 28: Image showing distribution and locations of sites mentioned in the table 3

Recent excavations at Lahuradeva, Jhusi, Tokwa and Hettapatti have provided remarkable evidence about settled human occupation in Middle Ganga Plain from 6th/7th millennium BC. The cultural sequence of Lahuradeva has been suggested by the excavators (Tewari *et al.* 2005-06: 70) as below.

Cultural Periods	Cultural Sequence
Period I	Early Farming Phase (IA & IB) (Neolithic)
Period II	Developed Farming Phase (Chalcolithic)
Period III	Advanced Farming Phase (Early Iron Age)
Period IV	NBPW Phase
Period V	Early Historic Phase

Period IA is marked by handmade and wheel turned Red ware and Black and Red ware having coarse fabric, porous and uneven surface with fine slip. Potsherds with cord impression include bowls, knobbed vessels, miniature bowls and vases. In this period some structural activities have also been attested by post-holes for huts and burnt clay chunks with reed impression. The presence of cultivated rice (*Oryza sativa*) in the earliest phase of occupation (in 7th millennium BC) is significant. The C14 dates suggest a time span of 7th millennium BC to 5th millennium BC for this sub-period. Subsequently in sub-period IB, new shapes of beaker, perforated and legged vessels and spouts were introduced. Sherds with painted linear design over fine dark red slip on the interior and post firing incised design on exterior are found. Wheat, barley, lentil and field pea were introduced along with earlier grains. The radiocarbon dates suggest this period as around 3rd millennium BC.

Jhusi, also known as Pratisthanpur, is located on the left bank of Ganga, near to the Ganga -Yamuna confluence at a distance of about 7 km east of Allahabad city (Fig. 28). The excavations for four seasons at Jhusi on Samudrakup mound have revealed occupational deposits from Neolithic period to Early Medieval Period. Neolithic period is characterized by handmade and ill-fired cord impressed, rusticated and burnished ware (Misra *et al.* 2009: 26)

As a whole, the Neolithic culture of this region is represented by domesticated variety of plants with the presence of cord impressed pottery and marked by a rich variety of ceramic industry which includes ordinary Red ware, Burnished ware, Rusticated ware, Black and Red ware and Corded ware. Pottery shapes include bowl with varying profiles, vases, vessels, basins and miniature jars. Painting includes criss-cross design, concentric semi circles and wavy lines. Bone tools and weapons consisting of scrapers, chisels, hammers, needless, points, borers,

awls, arrowheads etc., besides these, the other bone objects comprise ornaments like pendants, earrings, bangles, discs, combs etc. Stone tools and terracotta objects have also been found in Neolithic context. On the basis of small scale excavation, evidence of mud hut dwelling structure in circular or oval shape has come to light. Screen walls of huts were made of split bamboo and reed, impression of which has been obtained through burnt clay lumps. Subsequently, the succeeding phase, termed as Chalcolithic is characterized by multiple crop raising, advanced form of farming, increasing number of settlements with the presence of variety of tools, weapons and ornaments and first appearance of copper tools with limited quantity of stone objects. In structural evidences one observes no substantial change in the dwelling structure. It is also characterized by the presence of Black and Red ware, Black Slipped ware, Red slipped ware and Red ware with the continuation of earlier ceramics. For making of such a large amount of pottery in this phase required fire wood in abundance. There are plenty of bamboo, reed and other wood available in the area which was possibly utilized as firing materials. However, cutting of wood and transporting them to the pottery making site is extremely labor intensive and hence one has to accept a reasonably well organized social structure existing in these settlements (Mishra 2010: 158).

As far as the chronology is concerned there are several radiocarbon dates obtained from different Neolithic sites. Three C14 dates from Koldihwa range between 6570 ± 210 BC to 4530 ± 185 BC (Sharma *et al.* 1980: 199-200). Lahuradeva has yielded three C14 dates which are cal. 5464 to 5298 BC and one AMS date of rice husk is cal. 6442 - 6376 BC (Tewari *et al.* 2001-02: 55-56). This would suggest that the beginning of Early Neolithic phase started around 7th millennium BC in this region. C14 dates obtained from Tokwa and Jhusi are cal. 6591, 5976 and 4797 BC (Pal 2007-08: 277) and cal. 7477, 5837 and 6196 BC (Pal 2007-08: 277) respectively. Eight C14 dates come from Chirand in various Neolithic strata falling between 1755 ± 155 BC to 1270 ± 105 BC (Agrawal 1982: 271-72).

The combined testimonies of the available C14 dates obtained from several excavated sites suggest a date of 6th-7th millennium BC for the early phase of Neolithic. The latter phase belongs to 3rd millennium BC or slightly later. The Chalcolithic phase started around first half of 3rd millennium BC and continues up to 1st millennium BC.

Significant Data from Chhattisgarh

From this region, records of the preservation of burnt earth, charcoal and plant remains (both wild and domesticated) in Kotumsar and Dandak caves, Kanger Valley National Park, Bastar district, Chhattisgarh have been obtained. Radiocarbon dates of the charcoal remains suggest a time range of 6940–4030 yrs BP. The presence of grains and seeds at ~ 7000 yrs BP indicates domestication of plants and initiation of agricultural activity by early settlers of the region. These plants (grasses and millets) still grow in the area, additionally; millets found in the layer are still gathered by the tribal people in the region for domestic consumption (Yadava *et al.* 2007:820-21).

Eastern India

The region is marked by Chota Nagpur plateau in Bihar, Orissa and West Bengal. Small scale excavations at a few sites in Orissa such as Kuchai in Mayurbhanj district, Golbai Sasan in Khurda district, Kuanr in Keonjhar district and Sankarjang in Angul district have yielded pointed-butt celts and cord-impressed pottery, bone tool industry and evidence of circular and rectangular wattle-and-daub houses and copper bangles. Radiocarbon dates from Golbai Sasan and Sankarjang suggest duration of 2500 BC for the Neolithic culture of this region (Singh 2002).

Northeast India

Major Neolithic sites are: Daojali Hading, Sarutaru and Marakdola in Assam; Selbalgiri and Pynthorlangtein in Meghalaya; Parsi-Parlo in Arunachal Pradesh; Phunan Hills, Napachik, Nongpoh Keithelmandi in Manipur; Chungliyaimati in Nagaland. Important findings are cord impressed pottery and different kind of stone tools. According to T.C. Sharma, the Neolithic people were practicing a kind of agriculture similar to the present day shifting cultivation. Very few C14 and TL dates have been obtained so far: 4460 ± 120 and 3450 ± 150 BP are a few examples (Sharma 1981, 1986; Hazarika 2006).

South Indian Neolithic

The Neolithic culture of south India is comparatively well understood. It is primarily a product of human adaptation to the semi-arid environment, marked by low rainfall. It has been found in northern Karnataka and western Andhra

Pradesh, southern Karnataka, coastal Andhra Pradesh and northern Tamil Nadu. Over two hundred sites of this culture are presently known, many of them occur on the flat tops, slopes and foot of granitic hills but some are also found on the alluvial banks of rivers like the Godavari, Krishna, Penneru, Tungabhadra and Kaveri. The major sites which have been excavated are given in table 4.

Table 4: Major excavated sites of South Indian Neolithic Culture

SL. No.	Sites	District	State	References
1	Sangnakallu	Bellary	Karnataka	Ansari & Nagaraja Rao 1969
2	Tekkalakot	Bellary	Karnataka	Nagaraja Rao & Malhotra 1965
3	Brahmagiri	Chitradurg	Karnataka	Wheeler 1948
4	Maski	Raichur	Karnataka	Thapar 1957
5	Piklihal	Raichur	Karnataka	Allchin 1960
6	Watgal	Raichur	Karnataka	Deavaraj *et al.* 1995
7	Hallur	Dharwad	Karnataka	Nagaraja Rao 1984
8	T. Narasipur	Mysore	Karnataka	Seshadri 1971
9	Hemmige	Mysore	Karnataka	Hanumanth Rao & Nagaraju 1974
10	Nagarjunakonda	Guntur	Andhra Pradesh	Subrahmanyam *et al.* 1975
11	Ramapuram	Kurnool	Andhra Pradesh	IAR 1980-81
12	Veerapuram	Kurnool	Andhra Pradesh	Sastry *et al.* 1984
13	Paiyampalli	North Arcot	Tamil Nadu	IAR 1964-65

Ash Mounds

A very distinctive feature of the Southern Neolithic culture is the presence of ash mounds, which are heaps of ash produced by the burning of cow dung. They are closely associated with habitation sites and provide tell-tale evidence of the role of cattle pastoralism in the economy. It is believed that dung from cattle pens was allowed to accumulate and periodically set ablaze, probably in a ceremonial way as is done at annual cattle festivals in south India even today (Allchin 1963; Murty 1989). Several ash mounds like Utnur in Mahbubnagar district (Alchin 1961) and Palavoy in Ananatpur of Andhra Pradesh (Reddy 1976); Kupgal in Bellary district (Majumdar & Rajaguru 1966), Kodekal and Budihal in Gulbarga district of Karnataka (Paddayya 1973, 1992) have been excavated.

The Neolithic people domesticated animals such as cattle (*Bos indicus*), buffalo (*Bubalus bubalis*), sheep (*Ovis aries*), goat (*Capra hircus aegagrus*), pig (*Sus scrofa cristatus*), dog (*Canis familiaris*) and fowl.

Neolithic people of south India were using ground stone tools like axes, adzes, wedges, chisels, microliths and stone blades. They lived in circular or rectangular wattle-and-daub huts with floors having stone paving, large stones were placed around the huts on the outside to protect them from winds. The pottery types are jars, spouted vessels and bowls of various sizes, sometimes decorated with incised designs. An important ceramic was the black-and-red ware. The Neolithic culture of South India is dated by C14 dating from the middle of the 3rd millennium BC to the beginning of the 1st millennium BC.

Chalcolithic Culture

The first discovery of Chalcolithic culture was identified at Jorwe in 1950 by S.A. Sali in Ahmadnagar district, Maharastra (Agrawal 2003:139). It opened a new chapter in Indian archaeology. Following its discovery, several Chalcolithic settlements were identified in various parts of India such as Ganeshwar-Jodhpura culture in north Rajasthan, Ahar/Banas culture in south-eastern Rajasthan, Kayatha and Malwa cultures in Malwa region, Savalda and Jorwe cultures in Deccan plateau and Chalcolithic cultures in Ganga plain (discussed earlier). These cultures are briefly described here.

Ganeshwar Jodhpura Culture

Ganeshwar and Jodhpura, both type sites of this culture, were discovered and excavated in 1970 by R.C Agrawal and Vijaya Kumar. Jodhpura is situated in Kotputli, Jaipur and Ganeshwar in Nim-Ka-Thana, Sikar District, Rajasthan. Evidence of copper smelting was noticed on the surface at Ganeshwar. Around 1000 copper objects, including variety of arrow heads, flat celts, and fish hooks were found in association with Red ware pottery. The C14 dates of Jodhpura, place this culture in early part of 3rd millennium BC (Agrawal 2003:141).

Ahar/Banas Culture

About 91 sites have been discovered in south eastern Rajasthan, traditionally known as Mewar region, all these sites are located on the banks of the river

Banas and its tributaries. Major excavated sites are Ahar and Balathal in Udaipur district, Gilund in Rajsamanad district, Ojiyana in Bhilwara district of Rajasthan. Ahar culture had a rich ceramic tradition consisting of Tan ware, thin Red ware, Black and Red ware and Grey ware. Shapes include dishes, dish-on-stand and globular jars etc. Copper objects include flat axes, choppers, knives, razors, chisels and tanged arrow heads. The ornaments of the Ahar people comprise beads of semiprecious stones, steatite and terracotta; rings of copper. Ahar people lived in single, double and multi-roomed; rectangular, squarish and circular houses made of stone and mud brick. At Balathal, evidence of planned settlement, granaries, stone, brick and mud brick structure have been reported. Nearly 35 C14 dates, mainly from Balathal have been found which have clearly established the duration of this culture from 3500 to 2000 BC (Misra 2001: 513-14; Agrawal 2003:145-153). The excavations at Balathal convincingly demonstrated that there was an indigenous development of village life which is dated to the first half of 4th millennium BC and gradual development reflected in their material culture, particularly in structures and pottery. This gradual cultural process culminated into the formation of flourishing and developed phases around the middle of 3rd millennium BC (Shinde 2007-08: 203).

Kayatha Culture

Malwa region of western Madhya Pradesh is a plateu drained by the Chambal, Narmada, Betwa and their tributaries. This culture was identified by V.S. Wakankar in 1964 at Kayatha, located about 25 km to the east of Ujjain. The site was excavated first by V.S. Wakankar in 1965 and 1966 and then by Z.D. Ansari and M.K. Dhavalikar in 1968 in collaboration with Wakankar (Wakankar 1967; Ansari & Dhavalikar 1975). This culture was found spread over almost the entire Chambal basin. The Kayatha culture people lived in small huts having well-rammed floors. The characteristic ceramics of Kayatha culture is the Chocolate-slipped, sturdy and well baked Kayatha ware. The important shapes in this ware are convex sided jars and carinated dishes; occasionally pots were decorated with linear designs in black pigment. The other wares of this culture are buff ware with painting in red and combed ware in which the decorations consist of group of incised wavy lines. The ornaments include copper bangles, beads of semiprecious stones and micro beads of steatite. Radiocarbon dates suggest a period of 2000 to 1800 BC.

Malwa Culture

Malwa region is the main area of the Malwa and Kayatha culture. The sites of Malwa culture have been reported both from Madhya Pradesh and Maharastra. The Major excavated sites are Nagda (Banerjee 1986), Kayatha (Ansari and Dhavalikar 1975), Navdatoli (Sankalia *et al.* 1971) and Eran (Singh 1962). Navdatoli was horizontally excavated and has provided the best evidence. The Malwa culture people lived in wattle-and-daub houses of rectangular and round shape. At Nagada and Eran, a defense wall made of mud and mud bricks, have been reported. The main pottery type is known as Malwa ware, which is made on wheel and has a buff or cream slip bearing dark brown or black pigment. Ornaments of Malwa People include beads of semiprecious stone, rings and bangles of copper. At Navdatoli, evidence of bead manufacturing has also been reported. Other findings are saddle quern, elongated rubbing stone, hammer stone and terracotta female figurines. The radiocarbon dates from Navdatoli suggest a period of 1800-1500 BC.

Deccan Chalcolithic Culture

The northern Deccan or western Maharashtra, particularly the semi-arid region to the east of the Sahayadris, drained by the Tapti, Godavari and Bhima rivers and their tributaries have provided the best evidence of the Chalcolithic cultures in India (Misra 2001: 516). The Major excavated sites of this region are Prakash (Thapar 1967), Kaothe (Dhavalikar *et al.* 1990a), Daimabad (Sali 1986), Nevasa (Sankalia *et al.* 1960), Jorwe (Sankalia & Deo 1955), Inamgaon (Dhavalikar *et al.* 1988) and Walki (Dhavalikar *et al.* 1990b). Inamgaon was horizontally excavated over more than a decade and has provided the richest evidence of Chalcolithic culture in this region. Deccan Chalcolithic culture is characterized by painted Black and red ceramics, developed copper technology and blade tool industry. Inamgaon yielded a variety of copper objects like bangles, pins, discs, rings, crescents, drills, antimony rods, chisels and arrowheads. At Daimabad, a hoard of four bronzes was discovered i.e. a chariot and bull, an elephant standing on a platform, a rhinoceros standing on two horizontal bars over two sets of wheels and a water buffalo. At Inamgaon and Diamabad, five categories of houses have been suggested (Shinde 1998: 25; Agrawal 2003:162)

1. Workshop
2. Craftsman's house

3. Priest's house
4. Religious place and
5. Unclassified types

Chalcolithic Sequence of Diamabad is represented by the following chronological order: (1) Savalda Culture 2300-2000 BC (2) Late Harappa Culture 2200-1800 BC (3) Malwa Culture 1800-1500 BC and (4) Jorwe Culture 1500-900 BC (Misra 2001: 516).

Data from Gujarat Chalcolithic Culture

Gujarat has been divided into four parts on the basis of ecological grounds i.e. Saurashtra, Kutch, southern Gujarat and northern Gujarat (Possehl 1993). These areas were occupied by several regional Chalcolithic cultures before the Indus-Saraswati people came to this region. The Saurastra region marked by Padri and Pre-Prabhas cultures termed after the sites of Padri and Prabhas-Patan. The ceramic industry associated with the Padri culture is termed as Padri ware which was first identified at Padri (Shinde *et al*. 1992). It is a coarse ware divided into thick and thin varieties. This ware is represented by the convex sided bowls with featureless rim, deep bowls with straight or incurved sides and bowls with slightly everted rims; basins, globular pots etc. The paintings are in black with vertical and horizontal bands. The Pre-Prabhas culture phase at the site of Prabhas - Patan is characterized by the ceramic assemblage such as coarse and handmade Red ware, coarse and without slip Incised Red ware, Black and Red ware and Grey ware. Major shapes are mouthed jars, basins, dishes and carinated *handi*. In north Gujarat the Anarta culture was identified at the sites of Nagwada and Loteshwar. They lived on rammed mud floors and used a variety of pottery, which include Black and Red ware, Reserve Slip ware, Fine Red ware, Buff ware, Grey ware, Gritty Red ware and Burnished Red ware. Bowl, basins, dishes and dish-on-stand. The other cultural material includes evidence of crafts made on semi-precious stones, shell, steatite, and terracotta cakes. The lithic industry consists of chalcedony blades and bladelets. At Nagwada there is good evidence of craft manufacturing activities such as gold objects and silver ornaments, long chert blades, terracotta triangular cakes, toy carts, wheels, votive tanks and bull figurines. At Prabhas- Patan the cultural material consists of few chalcedony blades, steatite and faience beads (Hegde 1988; Dhavalikar & Possehl 1992; Shirvalkar & Shinde 2007-8).

All these sites of North Gujarat and Saurastra are the earliest farming cultures of Gujarat which clearly indicate the beginning of village culture going back to middle of the 4th millennium BC. Several recent C14 dates from Loteshwar (3698 - 2991 BC), Padri (3680 - 3048 BC) and Parabhas Patan (2911 - 2892 BC) have suggested the time span around middle of 4th millennium BC to first half of 3rd millennium BC (Sonawane 2005).

Concluding Remarks

A rapid survey of the above data makes it clear that the Indus-Saraswati civilization originated from the early village cultures of northwestern region of Indian sub-continent and developed in a vast area stretching from Gujarat through Sindh, Jammu and Kashmir, Punjab, northern Rajasthan, Haryana and western Uttar Pradesh. In the northwestern region of the Indian sub-continent, Mehrgarh clearly indicates the existence of settled village life in the 7th millennium BC and a very impressive cultural sequence showing continuous development since then (Neolithic phase) to the late Bronze Age in 2nd millennium BC. The evidences of Mehrgarh also confirm that this region is one of the developmental zones of agriculture and agricultural communities. The recent discovery of 11 drilled molar crowns from nine adults at Mehrgarh, recovered from a Neolithic graveyard indicate the existence of ancient sophisticated technique of dentistry in 7500 - 9000 BC. The materials belonging to 4th- 3rd millennium BC are found interlinked in many ways, thus showing a cultural continuity in terms of material remains and gradual development and integration of various cultures having individual identities which finally shaped the backbone of the Indus-Saraswati civilization.

The Neolithic settlements of the northwestern frontier and middle Ganga plain have provided a comprehensive understanding of early farmers of these two regions. In mid Gangetic region, Lahuradeva, Jhusi and Koldihwa can be considered as the most distinctive archaeological sites due to the presence of cultivated rice during 7th-6th millennium BC. Archaeobotanical evidences of barley *(Hardeum vulgare)*, bread wheat *(Triticum aesitivum)* and other winter crops along with summer crop like rice (*Oryza sativa*) from early level of Jhusi in 7th-6th millennium BC are significant. The radiocarbon dates from Lahuradeva, Jhusi in middle Ganga plain and Tokwa in Vindhyan region indicated that this region was one of the early centers of agriculture in the world. Jhusi and Lahuradeva have also provided an uninterrupted history of cultural development in this

region. Subsequently, Chalcolithic period show substantial development in pottery making technology. Other practices such as preparation of bone artifacts, beads, earthen storage bins suggest that the inhabitants of this region were interactive and skilful in making crafts.

The mushrooming of western Indian Chalcolithic sites and their evidences clearly indicate that there was gradual indigenous development of village life from 4th millennium BC which subsequently culminated into the formation of flourishing and developed phases around the 3rd millennium BC. The archaeobotanical evidences of Kotumsar and Dandak caves, Bastar district, Chhattisgarh and their Radiocarbon dates indicate domestication of plants and initiation of agricultural activity by early inhabitants of this region during 5th to 2nd millennium BC.

We have seen that various cultures emerged in the Indian sub-continent in deferent geographical pockets from 8th millennium BC onwards and began to develop through 7th- 6th millennium BC. Thus, the Indian civilization is deeply rooted in the cultures that existed 8000 years ago and flourished in the 3rd millennium BC. The cultural elements found in large number of sites in the entire region of Indus-Saraswati-Ganga system indicate an indigenous evolution and gradual development of civilization for a period of almost eight thousand years.

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Radiocarbon Dating in Determining the Antiquity of Cultural Remains in India

C. M. Nautiyal
Scientist In-Charge, Radiocarbon Dating Laboratory
Birbal Sahni Institute of Palaeobotany, Lucknow
Email : cmnautiyal@yahoo.co.uk

ABSTRACT

Numerical dating of ancient cultures is based on dating of archaeological remains, mostly by radiocarbon (C14) method. The contribution highlights the antiquity of the Indian Culture. The fact of the antiquity of Indian culture- sites being much more than generally believed is illustrated from published dates from many sites especially in the Northern India. Considering that users of the radiocarbon dates are generally unfamiliar with radiocarbon dating method, the article also deals with the basic principles of radiocarbon dating even as avoiding intricate details of the technical processes or the mathematical aspect. The approaches in the modern AMS and conventional LSC are introduced. The understanding of the principles is important even for those who only use the dates because a correct application is not possible if we don't understand the meaning of the dates and limitations of the method.

Seldom a discovery in Chemistry had such an impact on the thinking in so many fields of human endeavor, seldom has a single discovery generated such wide public interest- Nobel Committee Citation for Willard F Libby (1960).

Introduction

Most of the great civilizations of the world have evolved near rivers. It, therefore, appeared surprising that Gangetic Plain had not yielded that many evidences

for ancient civilizations. Before the mid of 20th century, finding an exact date for archaeological material was not possible. But with the advent of radiocarbon dating method and later Thermo Luminescence (TL) and Optically Stimulated Luminescence (OSL) methods, the numerical dating became feasible. The radiocarbon dating may claim credit for dates for most of the archaeological material anywhere in the world. With its ability to date commonly occurring materials like charcoal and wood, and its range of about 50,000 years BP, the method gains a unique place in archaeological approach.

The discovery and evolution of the radiocarbon dating method got Willard F. Libby the Noble prize for Chemistry in1960, but this method has got application in many fields including Palaeobotany, Geology, Hydrology and Archaeology etc. Libby (1955, 1982) has chronicled the development of the method with technical details. The book edited by Taylor *et al.* (1992) and another one written by Faure (1986) gives detailed account of the evolution of the method. Libby attributed the birth of the idea to a paper by Korff and Danforth (1939) which reported the observation of neutrons in the atmosphere. The radiocarbon method and its application are based on knowledge of Chemistry, Nuclear and Cosmic Ray Physics, electronics and of the fields in which it is intended to be applied such as Archaeology, Anthropology, Sedimentology, Palaeoclimatology and Palaeobotany. Initially solid carbon was used, gradually giving way to methane counting (by gas proportional counter), benzene counting (by Liquid Scintillation Counter) followed by Accelerator Mass Spectrometry which also uses solid carbon (graphite). In India, Tata Institute of Fundamental Research, Mumbai; Physical Research Laboratory, Ahmadabad and Birbal Sahni Institute of Palaeobotany, Lucknow, are the institutions that have contributed to the radiocarbon dating of archaeological samples. There are some other laboratories too such as at Hyderabad and Roorkee dealing with radiocarbon measurement but in water samples.

The Basis of Radiocarbon Dating

1. The Principle of Dating using Radioactivity

The method is based on the principal of change in amount of radiocarbon (C14) with time at a known rate. Radiocarbon is a radioactive isotope of carbon with atomic weight of 14. Radiocarbon is radioactive and so it decays with the half life of 5730 years (Godwin, 1962). In the beginning, though, the dates were calculated

using a half life of 5568 years, and still used in publications. This means whatever amount of radiocarbon we start with, it will reduce to its half in 5730 years. By this rule of half, the process will go on which means that the remainder will reduce to further half (i.e. ¼ of the original material) in another 5730 years and so on. The measurement of the left over radiocarbon can give an idea of how much time has lapsed. The implicit assumption is that the archaeological context sought to be dated is contemporary to the component being dated. For example, we usually presume that the age deduced for a piece of charcoal found at an archaeological site is also the age for that of the inhabitants of that site. Similarly, the soil or sediment contains organic carbon of plant origin. When dated, the age of the sediment can be considered to represent time period when the plant was last alive.

2. Radiocarbon in the Sediment

The question is how radiocarbon gets into the sediment, carbonate and other deposits, organisms or the atmosphere is natural. Radiocarbon could not be coming from the Sun. We know that Sun has only helium- production due to nuclear fusion occurring in its core. Whatever other elements are there in the Sun, they have been there for four and a half billion years as they were inherited from the Nebula from which the Sun formed. So, if any radiocarbon was there at the time of formation of the Sun, it would have been reduced to zero by this time. The occasional influx of cometary material etc. is inconsequential especially in respect of radiocarbon. Thus the radiocarbon in the atmosphere cannot be coming from the Sun as Solar Energetic particles or solar wind. Similarly cosmic sources can be ruled out.

In 1934, F.D.N. Kurie (1934) demonstrated that bombardment of nitrogen with fast neutron yields radiocarbon. Kamen produced radiocarbon by bombarding C^{13} as graphite with deuterium. Soon it emerged that slow neutrons can also produce radiocarbon. Given the very high abundance of nitrogen in the atmosphere dominated by N^{14}, one is poised to think of the possibility of radiocarbon production from the reaction of neutron on N^{14} nuclei in the atmosphere (n, p reaction). This is a simple way to explain why we should have any radiocarbon in the atmosphere. Around the same time, the cosmic ray workers had been looking at neutrons in the Earth's atmosphere. An observation was made that the concentration of neutrons increases as one goes up from ground into the atmosphere. So, these neutrons are not coming from the earth. This increasing

trend continues up to about 15 km but then it reverses, meaning that the maximum neutron production occurs at an altitude of about 15 km. The two observations together suggested that neutrons are neither coming from ground nor from space. The cosmic ray particles may generate neutrons peaking in number at about 15 km as a result of interaction with the atmospheric nuclei. This is because there the combination of target (nitrogen) abundance, energy and flux of cosmic rays optimises for maximum neutron production. The subsequent cosmic ray observations confirmed that the production of radiocarbon indeed happens in the atmosphere in this manner. Neutron has a short life span as a free particle but neutrons are produced continuously due to cosmic rays' reaction with atmospheric atoms leading to the production of the observed radiocarbon in the atmosphere.

The main reaction is:

$${}_{7}N^{14} + {}_{0}n1 = {}_{6}C^{14} + {}_{1}H^{1} \qquad (99\%) \qquad (1)$$

{Cross section= 1.7×10^{-24} cm^2}

Other reactions:

$${}_{8}O^{17} + {}_{0}n^{1} = {}_{6}C^{14} + {}_{2}He^{4} \qquad \text{(v. low cross section)} \qquad (2)$$

$${}_{5}B^{11} + {}_{2}He^{4} = {}_{6}C^{14} + {}_{1}H^{1} \qquad \text{(v. low cross section)} \qquad (3)$$

Oxidation leads to formation of carbon dioxide and over a time scale of a few years, the gas spreads all over. So, we find that the radiocarbon- concentration in the atmosphere is more or less uniform. The inhomogeneity introduced between latitudes (due to nuclear tests) also vanished a few years after tests were stopped.

While assimilating the carbon dioxide, plants also get radiocarbon along with the two stable isotopes C^{12} and C^{13}, thus making radiocarbon also a part of the plant. Once that plant is chopped off, or it dies, there is no more in-take of radiocarbon.

Now on the two stable isotopes don't change in quantity while the radiocarbon starts decaying exponentially with a half life of 5,730 years. That means if a plant dies or is chopped off, after 5,730 years it will be left only with half of the original radiocarbon (N_0) that is what it has today. But the quantity of stable carbon isotopes C^{12} and C^{13} will remain the same. Another 5,730 years, and the left over amount of radiocarbon will reduce to further half that is one quarter of the

original. The law of exponential decay for radioactivity allows exact calculation of the left over radiocarbon N:

$$N = N_0 e^{-\lambda t} \quad (4)$$

Here λ is the decay constant and't', the time lapsed.

Using this, the equation for age (in years) turns out to be

$$t = 19.035 \times 10^3 \log (A_0/A) \quad (5)$$

Here A and A_0 respectively represent radiocarbon activity measured (present) and the original activity when the plant was alive. Karlen *et al.* (1966) reported a value of 13.56 ± 0.07 decay per minute/g for equilibrium with the atmosphere.

In course of time, the plant debris gets mixed in the soil. It may be carried to the basins. This plant material is also eaten by the animals and these herbivorous are eaten by some carnivorous animals. Therefore all living beings end up acquiring some amount of radiocarbon in them and, therefore, we all have certain Radioactivity within us.

One way to understand the principle of radiocarbon dating, in fact of any radiometric dating, is to consider a set of radioactive atoms. We know that radiocarbon, has a half life of 5,730 years. So if we find only half of the initial number of radiocarbon atoms left, the time lapsed is estimated to be 5,730 years. If this is one fourth of the number, the age is double i.e. 11460 years and so on. But this requires knowing the initial radiocarbon in the sample. This value is decided by the measurement on the atmospheric air before contamination by bomb-produced radioactivity. This value for the atmosphere is derived from the measurements on wood sample of pre- bomb and pre-industrial era (1840- 1860). The oxalic acid standard from the National Bureau of standards, USA (NBS No. 4990) allows wider use for inter laboratory comparison. The activity of the wood is 95% of this standard.

But there is another complication viz. secular variation in the cosmic ray flux.

- The cosmic ray flux on earth is modulated by the Solar magnetic activity and the entry into different geographical regions on Earth is governed by geomagnetic field. Neither of the magnetic field is constant. So the radiocarbon production in the atmosphere has been variable. Therefore, if we measure radiocarbon in today's atmosphere and base our calculations on this value, we are likely to go wrong.
- Since the industrial activities started picking up in the 19th century,

radiocarbon in the atmosphere has been diluting (called 'Suess Effect') due to the addition of 'dead carbon' from burning of the fossil fuels. The Fossil fuels, being very old materials, do not contain any radiocarbon. Now, when we burn it, that 'dead' carbon is getting added to the atmosphere and the proportion of radiocarbon is going down.

- The nuclear tests in 1950's, particularly during 1955-1969, added the neutron-reaction- generated radiocarbon to the air. In this way, the bomb- produced radioactivity and the dilution due to addition of the dead carbon (carbon free from C^{14}) are working in the opposite way on the radiocarbon level in the atmosphere.

So all through the last 50,000 years or so (the range for radiocarbon dating), the level of radiocarbon in the atmosphere could not have been the same. But correction for that can be applied if we know radiocarbon levels at different points of time in the past. This has been made possible by measuring radiocarbon level in the tree rings, corals and stalagmite samples which represent different periods, as determined by an independent dating method viz. Uranium-Thorium method. For the time being, we will take it that we know that radiocarbon level in the atmosphere has been 13.56±0.07 DPM/g and whatever decrease is observed in the sample, will be governed by the time lapsed. Later calibration is performed and we get age in calendar years.

Another complexity is introduced by isotopic fractionation. We presume that carbon 12, 13 and 14 have always maintained their ratio in the sample being studied but fractionation, that is change in the ratio of C^{12}, C^{13} and C^{14}, can take place in principle. There can be an exchange of isotopes with the surrounding, something very common in marine conditions. Measurement of the stable isotopic ratio (C^{12}/C^{13}) can give us an idea of the fractionation, and necessary correction which is typically less than 2%. This is in addition to the fractionation introduced during the sample- processing which can be minimized, however, by subjecting the sample and the standard to the same procedures.

Similarly, if the sample is from a place where there is a volcano nearby, then volcano would be emitting carbon-containing materials free from radiocarbon. Consequently, things growing near the volcano will be poor in radiocarbon and hence will have apparent ages higher than actual. The mixing of organic carbon from some other source (having a different age) with the sediment can also result in erroneous ages.

The materials that can be dated by the Radiocarbon method include geological deposits like carbonates, coral, mollusk or other calcareous deposits as well as biological materials like wood, charcoal, seeds, twigs, pollen grains and so on. Even a variety of anthropogenic deposits and agricultural produce are possible to date, for example burnt bones, iron slacks, resin glues, cloth, leather, paint etc. However, not all laboratories date all of the above materials. If the amount of organic carbon in the sample is very small, we have to resort to Accelerator Mass Spectrometry (AMS) dating which is capable of detecting and measuring radiocarbon quantity as small as a milligram. In the Liquid Scintillation Counter - based conventional method, which we follow at Birbal Sahni Institute of Palaeobotany, about a gram or more of organic carbon is desired in the sample (typically 300 grams of sediment) to get a meaningful date.

3. Measurement of Radiocarbon in the Samples

There are two methods in vogue for measuring radiocarbon in the sample. One can prepare benzene from the sample and place it in a Liquid Scintillation Counter (LSC) for radiocarbon measurement which we term LSC method. The practice of preparing methane is more or less abandoned.

The alternative of Accelerator Mass Spectrometry (AMS) involves directly

Fig. 1: The benzene preparation system at Birbal Sahni Institute of Palaeobotany, Lucknow

counting the radiocarbon atoms in the samples. Its efficiency is 100 to 1000 times compared to liquid Scintillation Counting as AMS can detect about 1% of the radiocarbon atoms present. It is achieved by first bringing the carbon of the sample in a graphite- pellet shape. The radiocarbon is extracted by sputtering with cesium atoms, and in the process negative ions are produced. There are no negative nitrogen ions possible. The NH- molecular ions can be eliminated being of different mass. Positive ion production by electron bombardment would have led to dominatingly larger number of N- (the same mass as radiocarbon) due to dominating abundance in the atmosphere. By accelerating the negative ions through electric field, filtering out/ removing the isobars like $^{13}CH^-$, $^{12}CH_2^-$, $^{7}Li_2^-$ using stripper gas or foil, and then analysing by passing the accelerated negative ions through a magnetic field, the amount of radiocarbon can be measured. The idea of difficulty may be gauged from the fact that the undesired background is about a billion times bigger than the desired radiocarbon. This method is becoming popular despite the requirement of bigger and more expensive set-up. The Inter University Accelerator Centre (IUAC), New Delhi already has AMS and is now in an advanced stage to use that for radiocarbon also.

The decay of radiocarbon is by beta mode:

$$_6C^{14} \rightarrow {}_7N^{14} + \beta + \upsilon^* \text{ (anti- neutrino)} + Q$$

In applying the LSC approach, the pre-treatments for different sets of samples like peat and sediment; charcoal, wood, paper or cloth; and carbonates etc. can be different. All samples have to be physically checked to remove rootlets etc. Some materials like carbonate (e.g. coral) are treated with 10% hydrochloric acid after cleaning to release carbon dioxide. Some like charcoal and sediment are given acid and alkali treatment before being combusted in oxygen flow to obtain carbon dioxide. After ensuring complete combustion to carbon dioxide and purification, the carbon dioxide is converted into acetylene and acetylene into benzene using appropriate catalysts for both stages. The actual process is detailed and lengthy after which, ultimately, we are able to get all the desired carbon from the sample in the form of benzene, preparing the stage for the process of performing the counting of the beta decays in the Benzene sample to estimate the radiocarbon amount present.

A commercially available Ultra Low Level background Liquid Scintillation Counter, **(Quantulus 1220)** is used for radiocarbon counting at BSIP. The counter has strong lead shielding to avoid interference from cosmic rays as well as

radiations like gamma rays emanating from radioactivity in the surrounding. By adding scintillator to the benzene, beta decay is caused to be accompanied by a luminescence in the benzene. The use of a set of photomultiplier tubes and sophisticated electronics incorporated in the counter, facilitate counting of the luminescence due to beta decay of radiocarbon atoms. The counts per minute are indicative of the quantity of radiocarbon and make it possible to calculate age.

4. Calculation of Age and Correction

For the calculation of age, the amount of radiocarbon present in the sample is compared to the initial abundance. It is essential to know radiocarbon level in the sample initially. The plant and the atmosphere are in equilibrium as long as the plant is alive (though the ratios of the 3 isotopes slightly differ in the 2 reservoirs). So we should know the radiocarbon concentration in the atmosphere. But atmospheric radiocarbon has been changing for several reasons like changes in the cosmic ray flux, Solar and Earth's magnetic fields and consequent modulation and entry of cosmic rays etc. Estimation of these changes individually is not possible but there is an easier way to solve the problem. The abundance of radiocarbon in the atmosphere is reflected in the tree rings which form annually and hence provide year-wise records. Precise measurements on samples from the individual tree rings allow to build up the past variations in the radiocarbon level. The radiocarbon level in the atmosphere has been deduced to be about 12 to 14% higher than today in 11,000 (dendro) years ago. There are tree ring chronologies going back in time as much as 10,000 years or more. The stalagmite and coral samples dated by Uranium-Thorium method are also used for calibration for going beyond what is possible by tree rings. The calibration allows us to correct the errors in age estimations caused by variation in the atmospheric radiocarbon abundance in the past.

In any kind of dating, we must be very clear as to what it is it that we are dating. In radiocarbon dating, we are dating the point of time when the process of assimilation of radiocarbon into plant from the atmosphere stopped. If that sediment flows to the ocean and there is a secondary deposition, the deduced age will be about 400 years older (also location- dependent) than the actually contemporary terrestrial sample, this is because they have derived their material from the older one and also because the mixing of water in the ocean takes time.

The ages determined at BSIP and quoted in this article are calibrated dates, using appropriate calibration curves and have been rounded to the nearest 10 years.

It is necessary to ensure that the measurements made are really correct. Inter laboratory comparisons are carried out every few years, the latest having been done in 2008 under coordination of Marian Scott of University of Glasgow. BSIP has been participating in them. The samples are distributed all over the world as blind samples and different laboratories measure radiocarbon in those samples. In all the materials of our interest, our measurements (A_m) agreed reasonably with the international consensus values (A_c) as shown in Table 1 (Nautiyal *et al.* 2010). The barley mash sample turned out to be modern as was also reflected in the consensus values.

Table 1: Radiocarbon Activity as Percentage of Modern Carbon (PMC) in standard samples distributed under VIRI

	Consensus Value (Ac)	**Ours** (Am)	**Deviation (%)** 100 (Am- Ac)/Ac
Charcoal (P)	80.457	81.49	+1.28%
Wood (M)	73.9	73.6	- 0.4%
Wood (L)	75.719	78.06	+3.1%
Murex Shell (R)	73.338	74.61	+1.7%
Humic Acid (U)	23.079	23.4	+1.39%

Radiocarbon Dating of Archaeological Remains

The dating of archaeological materials had been limited to radiocarbon dating till about two decades ago. In the recent times, the Thermo Luminescence and OSL dating has also been applied to a variety of materials like pottery and quartz successfully. However, the data base for archaeological artifacts is still largely based on radiocarbon dates. Radiocarbon dating has been applied to a variety of material recovered from sites spread all over the country. Earlier, a number of reports appeared for sites in the Western India of today and of pre-partition days. During the past few years, considerable occurrence and discovery of archaeological sites have also been reported for Ganga Plains. This is not surprising because civilizations are known to have generally blossomed near great rivers. Radiocarbon dating of archaeological materials in India, done mostly at BSIP Lucknow, applied to charcoal, wood etc from these sites has built up a

very strong data base to enable us to have a perspective on the issue of antiquity of civilization in India (Nautiyal and Sekar 2008).

In this article, the discussion has been based on those samples which dated to be older than 2000 BC. The younger dates have also been mentioned in case they occur along with older dates.

The work done by K.S. Saraswat and colleagues at BSIP; Rakesh Tewari and colleagues at Directorate of Archaeology, Lucknow; R.S. Bisht and colleagues of the Archaeological Survey of India (ASI) and others has conclusively shown that plant-derived materials were well known and used at early Harappan settlements like Banawali (29°37'5"N, 75°23'6"E), Hissar district in Haryana. The material collected under R.S. Bisht of ASI and studied by K.S. Saraswat (2007) included fruits of South Indian soap nut tree (*reetha)*, *shikakai* and *aanwla*. The materials recovered also included mixture of these three. The first two trees being common in Southern India and *aanwla* in Gujarat, the presence and use at a distant place like Banawali speaks also for the standards of communication/transportation in those days. The radiocarbon dating at BSIP indicates that all these things were known to Indians about 4,750-4,500 years ago. This is indicative of the advanced state of civilization during that period.

At Kunal (29° 30'N, 75° 41'E), Ratia tahsil, Hissar district, Haryana, **c**arbonised seed and grains were found along the palaeochannel of Saraswati. The samples were dated to be between 3016 BC to 2577 BC (Lal 1997, 2002; Saraswat and Pokharia, 2003). They divided the findings in three sub periods:

Sub Period IA: 3000- 2850 BC

Sub Period IB: 2850- 2600 BC

Sub Period IC: 2600- 2500 BC

According to B.B. Lal, no samples from the earliest three levels seem to have been dated indicating that there may be older specimens at the site, taking the antiquity to still older times which may be as old as 4th millennium BC.

The Neolithic culture at Tokwa (24°54'20"N, 83°21'65"E), Mirzapur district (UP), situated at the confluence of Belan and Adwa rivers**,** yielded charred remains of a variety of plants. Excavation was carried out by Misra *et al.* (2004) of Allahabad University. The dating of charcoal samples at BSIP yielded three dates though one of them differed considerably from the other two (Pokharia 2008).

Table 2: The radiocarbon dates for Tokwa samples (charred remains)

BS No.	Trench	Depth (m)	Layer	Age (Cal. BP)
2354	H-8	2.20-2.25	12A	3810-3570
2369	H-8	3.00-3.30	14	7930-7510
2370	I- 8	2.43-2-53	16	3640-3410

Charcoal is a very common material used for dating. Three charcoal samples were dated and the two ages turned out to be over 3500 BP. One age is, however, much higher. We will know what the real situation is if more sample are dated. But even if the (average) date of 7,720 BP or so is ignored (because it was suspected by the researcher that this could be a result of mix-up), the civilization in this region dates back to over 3500 Cal. BP as evidenced in botanical remains in the form of charred cereals including rice. However, lack of husk and there being several features in cultivated rice being common with the wild rice, make the authors term the identification as cultivated rice suspect. The dates are similar to those from Lahuradewa samples. Some of the Lahuradewa samples also yielded much older dates.

The dates of domesticated rice from Lahuradewa (26°46'N, 82°57'E) lake deposits, in Sant Kabir Nagar district (UP), also led to interesting results. The excavation was done by the Directorate of Archaeology, Uttar Pradesh.

Table 3: The radiocarbon date extracts for charcoal from Lahuradewa

BS. No.	Location (Period)	Age (Cal. BP)
1951	Lower most	(IA) > 6100
1967	"	(IA) > 7250
1950	Upper Level	(IB) > 4000
1939	Lowest Fe yield	(III) > 3100

The dates for cultivated rice from Lahuradewa (Table-3) were inferred on the basis of LSC-based radiocarbon dating of wood charcoal reported by Tewari *et al.* 2006. The lower most samples gave ages older than 6,100 Cal. BP and 7, 250 Cal. BP. The upper level (IB) gave an age of a little more than 4,000 BP and the lower iron bearing sample yielded an age of about 3,100 BP. The direct AMS

dating of barley grains (period II) yielded 2700 Cal. BC (or about 4650 Cal BP) as reported by Tewari *et al.* (2006). The AMS dating of the associated rice-husk carried out at AMS, Erlangen-Nuremberg, Germany pushed the date of rice cultivation further back into time viz. to about 6,400 Cal. BC.

The samples of sediments for phytolith study were collected from a trench of 2.8 m depth at the lake shore. The study was conducted by a multidisciplinary team, by studying the grains of rice, barley etc. (Tewari *et al.* 2006 and references therein) and phytoliths found at the site followed by dating the associated charcoal by LSC at BSIP and rice-husk by AMS. The AMS date on rice-husk is reported to be even older at about 8, 360 Cal. BP (based on personal communication from Sarawat to Saxena *et al*. 2006) while the age for wild variety is another 2000 years older. The phytoliths are basically microscopic silica particles, providing clues to the shape and size of the cells of the living plant tissues. There were two samples for the wild rice phytoliths at 2.7 m depth and for cultivated rice at 2.4 m depth. Increase in cultivated rice and decrease in the wild rice on going up from the bottom of the trench was reported. Distinction between wild and cultivated rice (O*ryza sativa* L) was based on some features like a larger number of scales at edges of the fans of the phytoliths (the distinction being set at 9), the signatures of the processing and also the higher smoothness and regularity of the scales. If there is an error in judging that, as the decision is based on statistically decided criterion, we may mistake the wild rice for cultivated rice.

Thus the age of domesticated rice deduced on the basis of Accelerated Mass Spectrometer (AMS) dating of rice husk as well as wood charcoal turned out to be even older than LSC-based dates. If the identification of the cultivated rice is correct, the results are very significant indicating rice being grown as early as 8,300 years ago in Gangetic plains.

The site of Samudrakup mound (25° 26′10′′N, 81° 54′30′′E) at Jhusi (Allahabad, UP) is a multicultural site evincing deposits of Neolithic, Chalcolithic, Early Iron Age, NBPW as well as Sunga and Kushan period, Gupta period and Early Medieval period (Misra *et al*. 2004). The site situated at the confluence of Ganga and Yamuna, also yielded a rich collection (in a charred/carbonized form) of rice, barley, dwarf wheat, horse gram, linseed, *aanwala* etc. and cereal, pulses, oilseeds from more than one season in addition to pottery. The dating of the charcoal samples was carried out at BSIP laboratory (Pokharia *et al.* 2009) and ages are similar to those from Lahuradewa and Koldihwa.

Table-4: Radiocarbon dates for charcoal from Samudrakup mound Jhusi (Allahabad)

BS	Trench	Depth (m)	Layer	Age (Cal. BP)
2524	SF-7	13.37- 13.47	50	7609- 7590
2525	SF-7	12.99-13.14	47	8140+_220
2526	SF-7	13.70-1380	53	7110-7880

Kanmer (Kachchh), Gujarat (23°23'N, 70°52'E) is an archeological site. It is also known as Bakar Kot and is close to the Little Rann of Kachchh. In a joint study involving researchers from BSIP, Institute of Rajasthan Studies, Gujarat State Department of Archaeology, Research Institute of Humanity and Nature (Japan) and DG (PG) College, Kanpur, multi- pronged analyses were carried out. In total, 25 samples were dated, nine by the conventional method at BSIP and 16 by the Acceleratory Mass Spectrometry at Palaeo- Laboratory Co. Ltd., Japan (Pokharia *et al.* 2011). The Accelerator Mass Spectrometry dates on rice grains as well as the radiocarbon dates by the conventional method in India turned out to be older than what anybody had expected. The LSC dates ranged from 3660 BC to 1785 BC while AMS dates on charcoal and grains ranged from 2564 BC to 1785 BC.

The samples dated were charcoal samples and along with these a rich collection of rice, barley, dwarf-wheat, gram, linseed, *aanwla*, cereal, pulses, oil seeds have been found. Earlier there was a practice of one crop every year prevalent in the region, but conclusion from this study was that farmers practiced double cropping even here during those times, most likely due to climate change. This was for the first time that such evidence was seen in Gujarat (Pokharia *et al.* 2011).

There are many other sites such as Balu and Kaithal in Haryana, showing evidence of a number of economically important plants from latter part of the third millennium BC (Saraswat and Pokharia, 2002) and evidence of rice from Malhar in Chandauli district (UP) dated in 4620 Cal. BC (Tewari *et al.* 2000).

The perception that India can't have ancient cultural records is a result of a mind setup shaped over centuries but it is now changing. There have been certain other myths too. In a less ancient example is the case of custard apple which was believed to be a gift of Portuguese to us during 16th century. But now there are at least at three sites known in Punjab and Uttar Pradesh (India) where evidence of custard apple or *sharifa* (*Annona squamosa L.*) has been found and the

dates come out to be more than 3,500 year BP. So occurrence of custard apple dates back to a time period much before Portuguese came to India (Pokharia *et al*. 2009). This doesn't fall in the scope of the subject of this article, which is focused on the period older than 2,000 BC. Nor does it ascribe any greatness to our culture, but shows that there may be other incorrect myths too necessitating serious scrutiny.

Conclusions

All physical dating methods used in Archaeology are based on sound principles, be it Radiocarbon dating, Thermo Luminescence dating or Optically Stimulated Luminescence dating. But all methods cannot be always applied to every sample. If we have a pottery sample, it may be better to use Thermo Luminescence. If the pottery sample has reasonable amount of radiocarbon, then we can use Accelerator Mass Spectrometry Radiocarbon method also to date it. Even if we have an iron item and it contains carbon, added during its making, it may be possible to date by AMS. If the sample is in form of quartz, feldspar etc. then we can resort to OSL. So, we have to apply a method depending upon our sample, sample- history, its age and also the sample amount. All the methods have some or the other underlying assumptions, which must be appreciated for a correct interpretation.

In the Indian sub-continent, there are several archaeological sites, which have now yielded evidences of culture and evolution that date back to times far beyond what was believed earlier. The evidences, though, are not always fool- proof. For instance, in some cases identification may have scope for further improvement such as refinement in distinction between cultivated rice and the wild rice, which is not very easy.

We also will have to consider the palaeoclimatic and palaeogeographic information while building up the cultural history. There are examples where a river changed its course or dried up for tectonic or some other reasons, thus influencing the habitation. In Gujarat, the climate changes modified the way people were farming. For illustration, a younger (than 2000 BC) case is being cited here. In Khajnavar (Saharanpur district, UP) in a seismic zone, there is evidence of habitation and desertion about 2600a BP and 1400a BP respectively. It was followed by another settlement at about 850a BP**.** The site was abandoned, most likely, due to an earthquake at about 350a BP (Thakur *et al.* 2010). So, we will also

have to incorporate the palaeoclimatic and palaeogeographic information while building up the archeological theories as they cannot be completely disassociated. Such sites may have even earlier records.

The sample and the date both are important, but what is of the greatest significance is the connection between the dated sample and the cultural context and this is where there is scope for be errors to creep in. For example, a charcoal piece is collected from a site, then dating the charcoal to know the age of the culture is meaningful if the charcoal is contemporaneous to the culture. The correctness of the date for the culture critically depends upon the correctness of the relationship of the sample with the culture. There are cases where there is a mix-up about this.

A century old Archaeological Survey of India (ASI) plans to adopt a very modern approach by introducing many new scientific aspects and by establishing several laboratories. Being the biggest Indian organization involved in archeological research, with this transformation, the things will change for much better. The ASI and many others like Indian Archeological Society, New Delhi; Deccan College, Pune and groups such as at Aligarh, Allahabad, Baroda, Goa, Hyderabad, Lucknow, Mumbai, Patna, Udaipur and Varanasi are engaged in such work. But results are bound to be better with higher level of collaboration because today Archaeology is a multi-disciplinary field. Arriving at truth will require treading many paths. An open but careful mind is the first requisite for the right discoveries and a multi- pronged approach to understand our rich past culture is necessary.

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Archaeobotanical Evidences of Ancient Cultures in Indian Sub-continent before 2000 BC

Chanchala Srivastava
Palaeobotanist
Birbal Sahni Institute of Palaeobotany (BSIP), Lucknow
Email : chanchalasrivastava@yahoo.com

The Stone Age is further divided into the Palaeolithic, Mesolithic and Neolithic Period. As the name suggests, the technology of these periods was primarily based on stone. The subsistent economy of first two stages was based on hunting-gathering while the Neolithic phase represented a food producing and settled village way of life. Mehrgarh represents the earliest stage of agriculture in the Indian sub-continent, and laid the foundation of Indus Valley Civilization. The first confirmed evidence of wheat and barley appeared at Mehrgarh in 7000 BC.

Palaeoethnobotany

The term Palaeoethnobotany was introduced by Helbaek in 1959. It is also known as Archaeobotany, a sub-field of archaeology. The subject matter of Palaeoethnobotany includes the study of plant remains, such as carbonized and silicified seeds, fruits, wood charcoals, phytoliths, traces of husk or glumes, fibers, imprints on pottery and burnt mud-clods etc. recovered from archaeological sites. The carbonized content of plant remains is separated from the soil in trenches by floatation method (a water floatation recovery method used to separate organic matter from the inorganic one utilizing differences in their density). By this way,

separation of organic remains from the soil matrix greatly enhances both the quantity and the range of botanical materials (in all size and classes) (Pearsall 2000).

Palaeoethnobotanical/Archaeobotanical Research in India and its Centers

Marshall for the first time in 1931 identified a leaf on the seal of Mohenjo-daro in Sindh as a leaf of *Ficus* sp. which is a genus of about 850 species of woody trees, shrubs etc, collectively known as fig trees or figs. Similar observations were made by Vats (1941) and Mackay (1943) from Harappa. In addition to this, melon seeds (*Cucumis* sp.), lemon leaf, pomegranate (*Punica granatum*), coconut (*Cocos nucifera*), lotus fruits and stones of date-palm (*Phoenix dactylifera*) were inferred from terracotta figurines from Harappa (Vats, 1941). First actual record of plant remains in the form of carbonized field-pea (*Pisum arvense*) was described by Sahni (1936) from Khokrakot. Thereafter Shaw (1943) reported it from Mohenjo-daro and Harappa.

Chowdhury and Ghosh (1946) of Forest Research Institute (FRI), Dehradun worked on plant remains, which in course of time was established as an important centre for research on timber remains. It received greater attention during 1950-1963. In 1961 Vishnu-Mittre and his co-workers (Vishnu-Mittre 1961) started palaeobotanical research at the Birbal Sahni Institute of Palaeobotany (BSIP) Lucknow. K.S. Saraswat has made valuable contributions to palaeoethnobotanical findings (Saraswat 1992). Today BSIP is a well established centre of research in this field.

K.A. Chowdhury of FRI, later continued work at Aligarh Muslim University (AMU) with his students G.M. Buth and K.S. Saraswat (Chowdhary *et al.* 1977). Buth and his colleague (Buth *et al.* 1982) have worked at the Department of Botany, Kashmir University. M.D. Kajale after receiving training from Vishnu-Mittre started work at the Deccan College, Pune which developed into another palaeoethnobotanical centre (Kajale 1991).

History of Agriculture in Archaeological Perspective in the Indian sub-continent

Neolithic period is marked by the beginning of agriculture and characterised by the domestication of plants and animals. The Neolithic culture of India have been divided into several regions/Zones (Fig. 1).

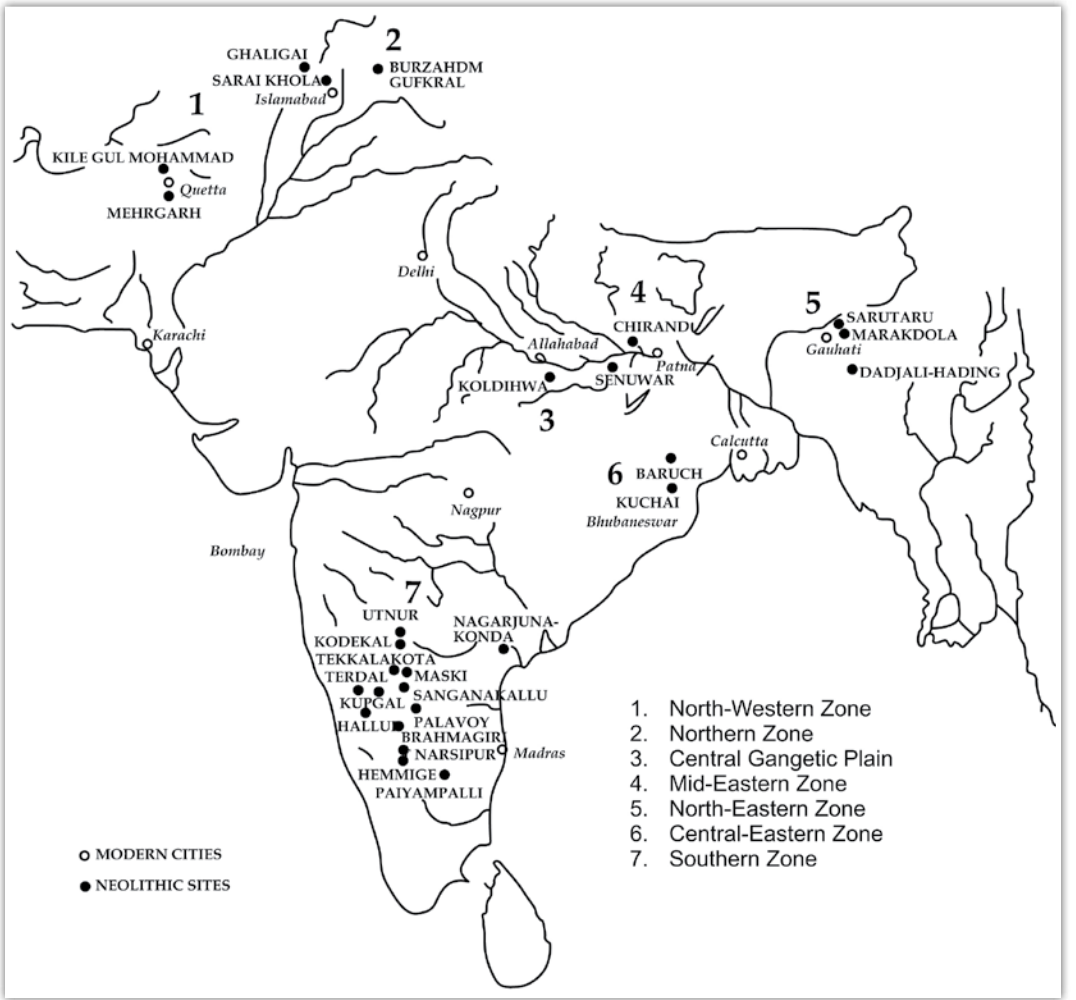

Fig. 1: Showing seven zones of Neolithic Culture

North-Western Zone

This zone covers the region of Baluchistan, Swat and the Upper Sindhu Valley in Pakistan. The beginning of wheat and barley cultivation in Neolithic settlement has been traced back as early as 7000 BC at Mehrgarh, situated on the Bolan river in Kachi plains of Baluchistan. The earliest aceramic Neolithic phase at Mehrgarh dated in 7000 BC yielded evidence of cereal grains of einkorn wheat (*Triticum monococcum*), emmer wheat (*Triticum dicoccum*), hard wheat (*Triticum* cf. *durum*), wild two-row barley (*Hordeum distichum*) and hulled and naked six-row

barley (*Hordeum vulgare* termed as *Hordeum sphaerococcum* and *Hordeum vulgare* var. *nudum*) cultivated date fruits (*Phoenix dactylifera*) (Jarrige and Meadow 1980; Costantini 1984; Costantini and Biasini 1985)

In the ceramic phase (mid-6th millennium BC) advancement in the crop husbandry was witnessed by the appearance of highly evolved hexaploid forms of bread wheat (*Triticum aestivum*), club wheat (*Triticum compactum*) and dwarf wheat (*Triticum sphaerococcum*) in addition to einkorn, emmer, hard wheats and hulled and naked forms of barley. Besides these, seeds and fruit remains of *Acacia* sp., *Phoenix dactylifera*, *Prunus* sp. and *Ziziphus* sp. have also been found (Costantini and Biasini 1985).

The other notable sites in this region such as Saraikhola (*c*. 3100-2800 BC) and Ghaligai (*c*. 2970-2920 BC) suggest that Neolithic culture in Baluchistan continued till the beginning of 2nd millennium BC. Barley (*Hordeum vulgare*), wheat (*Triticum* sp.), rice (*Oryza sativa*), lentil (*Lens culinaris*), field-pea (*Pisum arvense*) and grape seed (*Vitis vinifera*) have been found in period III at Loebanr in the sequence of Ghaligai settlements of the Swat Valley *(Allchin and Allchin 1982)*.

Northern Zone

It covers the area of the Kashmir Valley on the elevated flats of Karewas. There are dozen of ancient sites in the Kashmir Valley lying on the elevated flats of Karewas, out of which Burzahom, Semthan, Gufkral and Kanishkpur have been systematically excavated. Neolithic phase at Burzahom has been dated to about 2400 to 1500 BC (Khazanchi 1977) and at Gufkral dated to about 2600 BC. Three phases of evolution i.e. aceramic, ceramic and late phase of Neolithic have been identified (Sharma 1991). Subsistence economy was based on food gathering, hunting and farming. Neolithic settlers in the Kashmir Valley were also conversant with the cultivation of crops. Interestingly, remains of dwarf-wheat, bread-wheat, club-wheat, barley, lentil and field-pea have been reported from the earlier phases of Neolithic deposits at Gufkral and Burzahom (Vishnu-Mittre 1974; Kajale 1982; Buth and Kaw 1985). Rice which is the staple diet of present day population of Kashmir appeared at Gufkral in the later phase. In the Neolithic deposits at Kanispur (Kanishkapura), thirteen kinds of grains, seeds and fruits dated from about 3000 BC to 2000 BC have been found which include hulled and naked forms of barely (*Hordeum vulgare* and *H. vulgare var. nudum*),

bread wheat (*Triticum aestivam*), emmer wheat (*Triticum dicoccum*), lentil (*Lens culinaris*), fieldpea (*Pisum arvense*), grasspea (*Lathyrus sativus*), almond (*Prunus amygdalus*) and walnut (*Juglans regia*) evidenced by their fruit shells, acquired the dietary preference. Common vetch (*Vicia sativa*)- a common weed in pulse-crop fields, morning-glory (*Ipomoea* sp.) poppy (*Papaver* sp.) and alfalfa (*Medicago cf. lupulina*) have also turned up in the carbonized material examined. Fruit remains of date and grape have also been recorded from Neolithic Kanishkpur in Kashmir valley (Sarawat and Pokharia 2004). Wood charcoal remains of local timbers exploited by the ancient settlers have been reported from Burzahom and Gufkral (Savithri 1976; Chanchala 1986). Use of boxwood tree, indicates the technical skill of settlers at ancient Gufkral to utilize the quality forest products even from far distant places.

Central Gangetic Plain

It includes modern eastern Uttar Pradesh (UP) and plains of Bihar and extends from the Himalayas in the north and Vindhyas in the south, Ganga-Yamuna confluence in the west and Bihar-Bengal border in the east (Fig. 2). Neolithic culture in the Belan valley and Vindhyan plateau of UP has established the primacy of this culture at Chopani Mando, Koldihwa and Mahagara, about 85 km southeast of Allahabad, representing a sequence of transition from the stage of food gathering and selective hunting in Epi-palaeolithic period through incipient food producing (Proto-Neolithic) to settled village farming in the Neolithic times (Sharma *et al.* 1980; Sharma 1985). More recently, the remarkable evidence of rice cultivation in 7th millennium BC has been recorded at Lahuradewa and Jhusi in this region (Tewari *et al.* 2006; Misra *et al*. 2009). The excavations at Lahuradewa in Sant Kabir Nagar district, UP have revealed the deposits of five-fold culture sequence as given below:

Period I Early Farming Phase

Period II Developed Farming Phase

Period III Advanced Farming / Early Iron Age

Period IV NBPW Phase

Period V Early Historic (Early centuries BC/AD)

The earliest period I starting from the very beginning of sedentary occupation at the site has been subdivided into two sub-periods namely IA and IB. A well

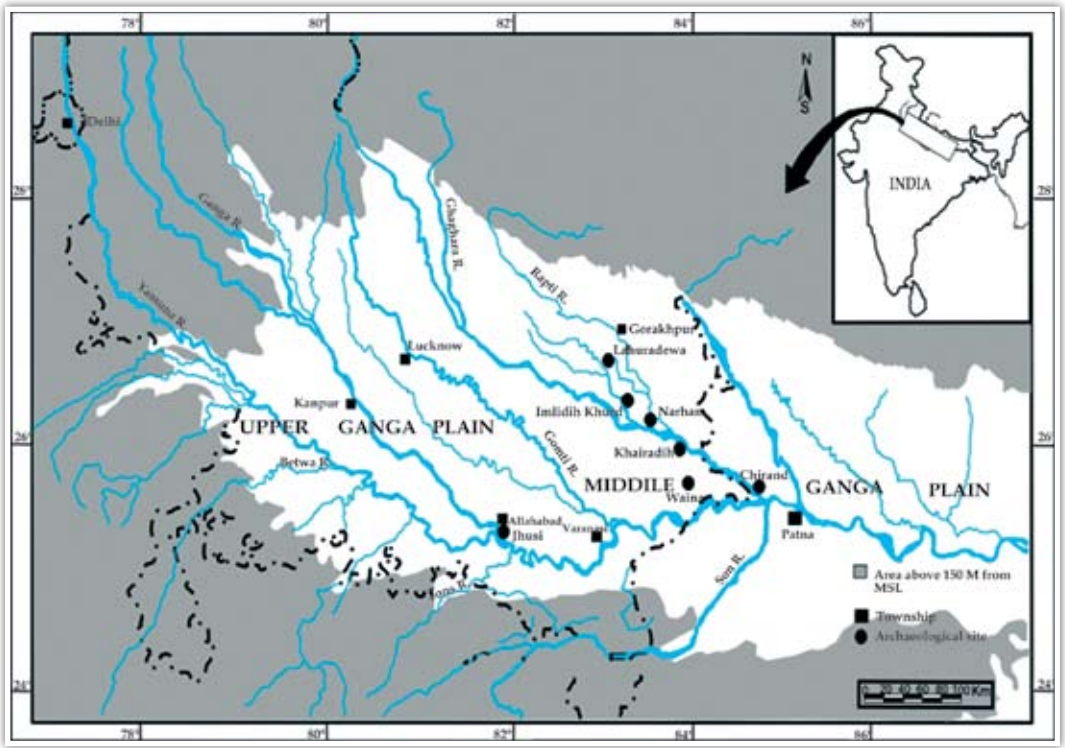

Fig. 2: Map showing the location of Middle Ganga Plain and Vindhyan region

expressed settled life at this site has marked the beginning of a ceramic and non-metallic occupational phase of Early Farming tradition characterized by cereal cultivation during 7th millennium BC spanning for several thousand years up to about 2000 BC. It was succeeded by an Advanced Farming phase and a few confined phases of cultures in the Early Historic times. The presence of carbonized grains of wild or weedy rice *(Oryza rufipogon)* and domesticated rice *(Oryza sativa)* were the most important finds of sub-period IA. The remains of domesticated rice husk were dated to 6,409 BC (cal. 8,359 BP). Remains of foxtail-millet *(Setaria cf. glauca)*, goose-foot/*bathua (Chenopodium album)*, job's tear *(Coix iachryma-jobi)*, Artemis *(Artemisia sp.)* flatsedge *(Cyperus sp.)* and catchfly *(Silene conoidea)* has also been recorded (Fig. 3). In sub-period IB barley, wheat, lentil and kodon-millet were also found in addition to the rice (Fig. 4 & 5) (after Tweari 2007-2008: 350-355).

The results in the first season's report had implications pertaining to the aspects of the commencement of early farming and the antiquity of the cultivation

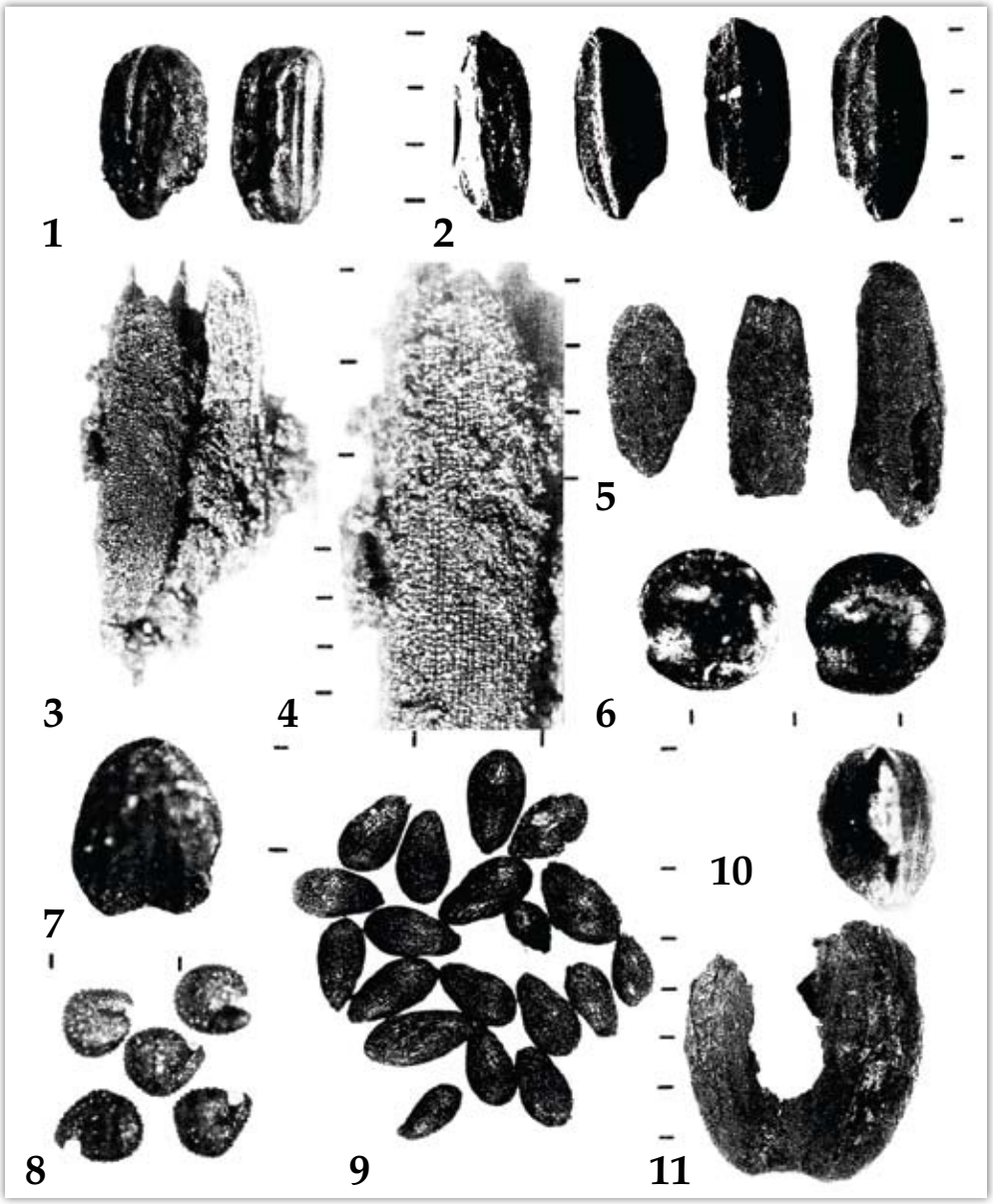

Fig. 3: (1) Grains of domesticated rice with puffing during carbonization; (2) Domesticated-rice grains; (3) Caryposis of some wild or weedy *Oryza rufipogon*; (4) Husk-surface tissue of *Oryza rufipogon*; (5) Grains of *Oryza rufipogon*; (6) Goosefoot *(Chenopodium album)* seeds; (7) Grain of faxtail-millet *(Setaria cf. glauca)*; (8) Seeds of catchfly *(Silene conoidea)*; (9) Mugwart *(Artemisia sp.)* nuts; (10) Flatsedge *(Cyperus sp.)* nut; (11) Job's-tear *(Coix lachryma-jobi)* grain. (Scale in mm) (after Tweari *et al*. 2007. 08:352)

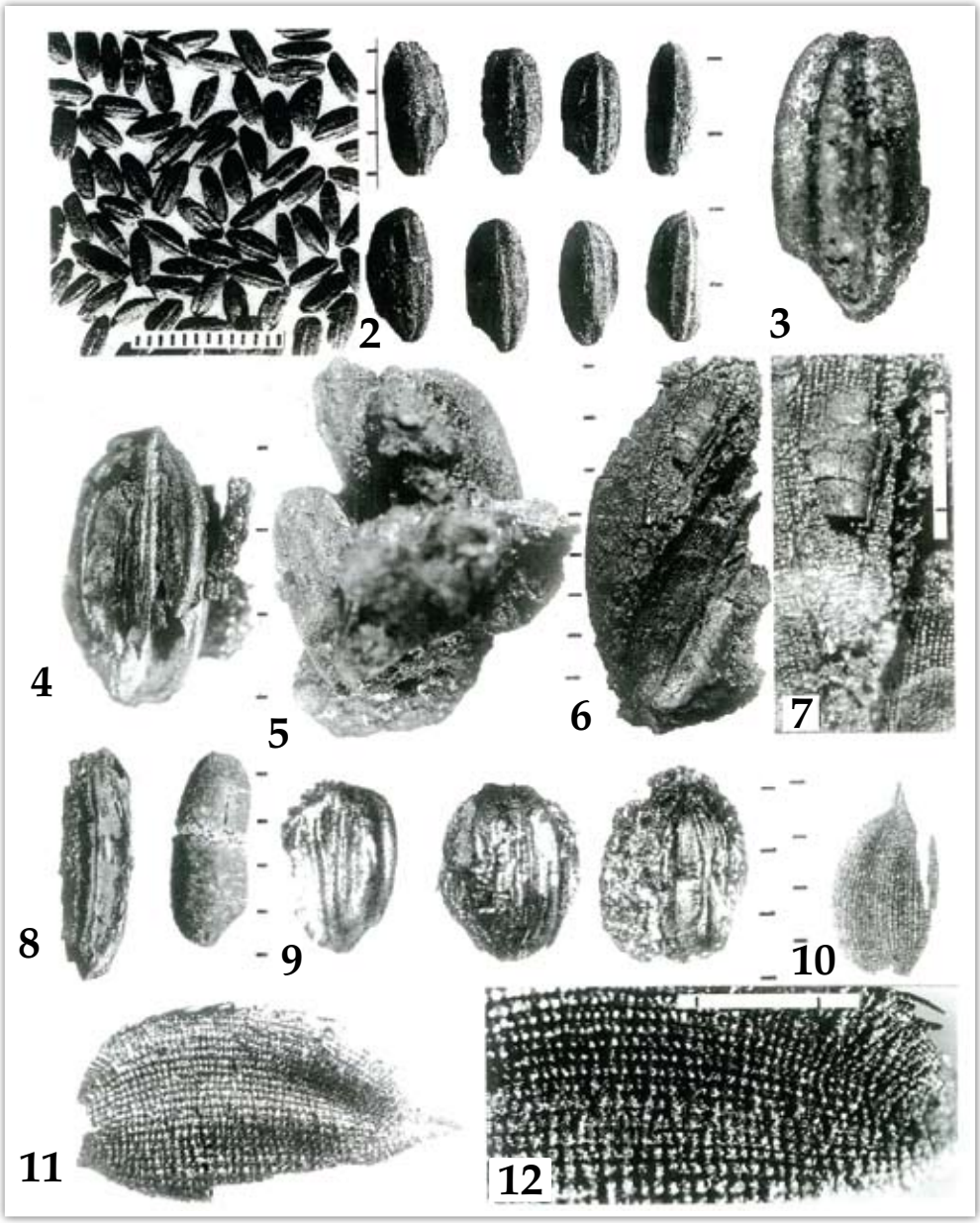

Fig. 4: Period IB, Lahuradewa: (1-4) Grains of domesticated rice *(Oryza sativa)*; (5) Two grains of domesticated rice congealed in carbonised content; (6-7) Husk-remains of domesticated rice, in carbonised matter; (8) Grains of *Oryza cf. rufipogon*; (9) Grains of wild rice *(Oryza officinalis)*; (10-11) Husk of *Oryza officinalis*; (12) Surface tissue (enlarged) of *Oryza officinalis*. Scale in mm (after Tweari *et al.* 2007. 08:353)

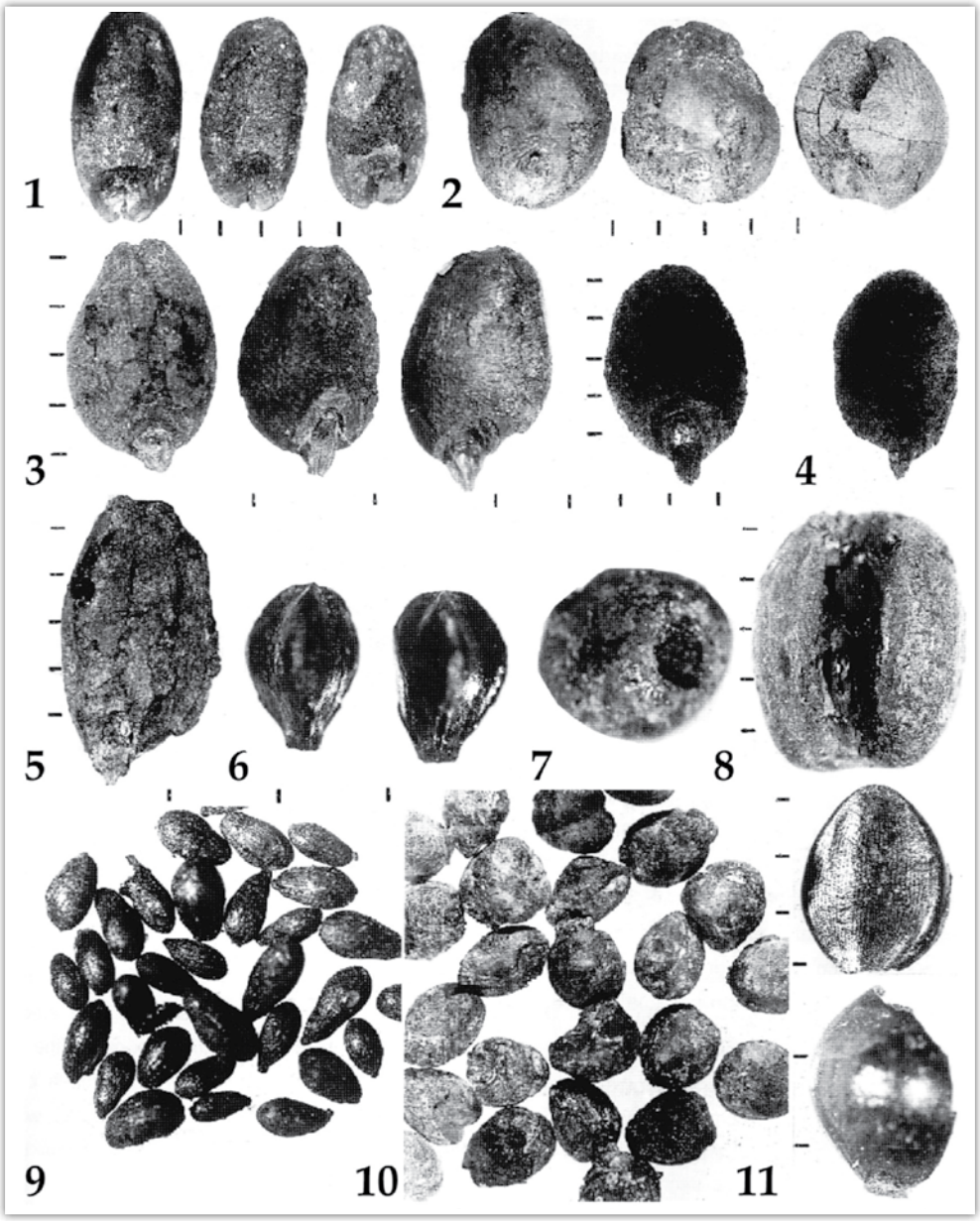

Fig. 5: Period IB. Lahuradewa: (1) Bread-wheat *(Triticum aestivum)*; (2) Dwarf-wheat *(Triticum sphaerococcum)*; (3, 4 & 5) Barley *(Hordeum vulgare)*; (6) Flatsedge *(Cyperus sp.)*; (7) Lentil *(Lens culinaris)*; (8) Job's tear *(Coix lachryma-job)* grain; (9) Nuts of mugawort *(Artemisia sp.)*; (10) Foxtail-millet *(Setaria ct. glauca)* grains; (11) Husk pieces of kodon-millet *(Paspalum scrobiculatum)*. (Scale in mm) (after Tweari *et al.* 2007-08:354)

in this region; the interactions of the early farming cultures in the region with contemporaries in other areas; the time of the diffusion and bringing into use of the barley and wheat in the subsistence economy of cultural groups in the Sarayupar region, from north-western region of sub-continent where important cereals were mainstay in the agriculture of still earlier farming cultures; and finally of the understanding the habitation patterns of early settlers in the region. In this region potential domestication were present from very early times.

Plant remains from Neolithic Ganga Plain and Vindhyan region have produced mass of data viz. barley, wheat, lentil, field-pea, grass-pea and Asian/African millets viz. ragi-millet, jowar-millet, italian-millet during 3rd/2nd millennium BC (Pokharia 2008).

Agricultural Crops in Vindhyan Region

Koldihwa (6500 BC)	Mahagara (2200-1800)	Tokwa (3rd-2nd millennium BC)	Senuwar (2200 BC)
Cultivated rice	Cultivated rice, Hulled barley, Lentil, Green gram, Black gram, Pigeon pea	Cultivated rice, Hulled barley, Bread wheat, Lentil, Field pea, Green gram	Cultivated rice, Hulled barley, Bread wheat, Dwarf wheat, Jowar, Ragi and Kodon millet, Lentil, Field pea, Chick pea, Green gram

(Pokharia 2008)

Wild rice husk impression of *Oryza rufipogon* (perennial form) has been reported from Koldihwa and Mahagara; *Oryza nivara* (Annual form) from Koldihwa.

Diffusion of Wheat and Barley in Ganga Valley

It must have been the Harappan or Pre-Harappan settlements (2500-2000 BC) that the diffusion of wheat and barley took place in Ganga valley, as evidenced by their cultivation during 2nd millennium BC in the Neolithic context of Bihar (Sarawat 2004).

Mid-Eastern Zone

A number of Neolithic settlements have come to light in the alluvial plains of Bihar. Chirand is the major excavated site in this region, situated in Saran district and dated to 2nd millennium BC. Food grains of hulled barley, dwarf wheat, rice, lentil, field-pea, grass-pea and wild rice (*Oryza rufipogon)* have been encountered (Vishnu-Mittre 1972).

In North-Eastern Zone, the only excavated site is Deojali-Hading in northern Cachar hills, Assam. There is no direct evidence of animal and plant domestication. Thapar (1978), however, suggested the practice of shifting cultivation. Similarly in Central-Eastern Zone, there is no remain of plants and animals found at Kuchai in district Mayurbhanj, Orissa (Thapar 1985).

Southern Zone

Neolithic culture in southern India is better known as compared to other zones. A large number of sites have been excavated in this region. The ancient sites are Utnur, Kodekal, Nagarjunakonda and Palavoy in Andhra Pradeseh, Tekkalakota, Maski, T. Narsipur, Sanganakallu, Kupgal, Hallur, Brahmagiri and Hemmige in Karnataka and Paiyampalli in Tamil Nadu dated to 2450-1900 BC. Fruit remains of date (*Phoenix* sp.) have been reported from Tekkalakota in Karnataka (Allchin and Allchin 1968); finger-millet (*Eleusine coracana*) is reported by Vishnu-Mittre (1971) from Hallur in Karnataka along with wild *Eleusine indica* (Indian goose grass). Fruit remains of teak (*Tectona grandis*) from this site are an interesting record meaning thereby the climate was not so dry at that time. Horse gram, an indigenous crop commonly used as a feed for cattle and horses is known from Tekkalakota in Karnataka (Vishnu-Mittre 1968) and Paiyampalli in Tamil Nadu (Allchin and Allchin 1968). Fruit stones of jujube (*Ziziphus vulgaris*) are also known from Kodekal in Karnataka (Kajale 1974). Thus the older suggestion that the southern Neolithic was totally pastoral must be disregarded. The recent archaeobotanical researches have clearly suggested that the staple cereals of the southern Neolithic were millets, derived from native grassland communities of peninsular India, rather than African origins as has been claimed in the past (Korisettar *et al.* 2002: 196). The consistently recovered pulses are two species native to the region, mungbean (*Vigna radiata*) and horsegram (*Macrotyloma uniflorum*) present from the earliest levels, while other pulses appear only in later levels. Other species are sporadic across the region, suggesting that these species were adopted by selected communities during the course of the Neolithic period. These include non-native taxa, such as wheat and barley, possibly rice (found in small quantities only at Hallur) and pigeonpea (*Cajanus cajan)*, from Orissa or adjacent parts of eastern India. Thus the staple taxa of the Southern Neolithic, on which the earliest agriculture in this region is likely to have been based, are native species, presumably domesticated within South India

independent of the introduction of agriculture from elsewhere (Fuller 2006: 50).

Early Chalcolithic Cultures in Baluchistan and Afghanistan Region

In the region of Baluchistan and Afghanistan, following the Neolithic culture (7th to mid-6th millennium BC) a continuing elaboration of Chalcolithic cultures across the vast area from the present Iranian border to north-western India, has shown progress in the crop husbandry as well till the end of 2nd millennium BC. Some cultures co-existed with the Harappan civilization (*c.* 2300-1700 BC). It seems that from the northern Baluchistan the cultural impulses traveled to southern Baluchistan and the Indus System. The Chalcolithic sites in Afghanistan and Baluchistan are widely scattered.

In the Kachi plains of Baluchistan at Mehrgarh marked change in the economic prosperity which has been noticed during an early Chalcolithic phase (*c.* 5500-4300 BC), following the preceding Neolithic phase. In Baluchistan, Mehrgarh is the best studied site to assess the gradual development of technical and economical innovations from 7000 BC to the Harappan times. The evidences collectively indicate that the Chalcolithic village farming begin on the north of Indus Valley in the mid-6th millennium BC and this established the foundation for the highly advanced agricultural economy of Harappan civilization (see Table 1).

During the 4th and 3rd millennium BC a large number of small village cultures flourished in the Quetta valley and Zhob valley of Baluchistan. Major excavated sites of this region are Kile Ghul Mohammad and Damb Sadaat (Fairservis 1956). Botanical evidences are known from Balakot (*c.* 4000-2900 BC) in southern Baluchistan (see Table 2). From Nindowari in Ornach Valley, Pakistan (3rd Millennium BC) botanical finds are known. The rice straw deposit at Pirak, near Jacobabad (2200 to 1000 BC) suggests paddy cultivation in Baluchistan (Table 2). Remains of Sorghum millet, an African domesticate, amply demonstrate its introduction in the economy of Baluchistan during the second millennium BC (Costantini & Biasini, 1985).

Mundigak near Kandahar (*c.* 4000-2000 BC) witnessed transformation of the rural culture into an urban settlement. At Shahr-i-Sokha (*c.* 3200-2100 BC) in Iranian Sistan, a rich plant economy is revealed (see Table 3 & 4). Other sites in Afghanistan are Deh-Morasi Ghundi (*c.* 2700-2600 BC) near Kandahar (Shaffer 1978) and Tarakai Qila in the same region. At Tarakai Qila, an incipient phase of urban development has been observed.

Table 1: Seed/Fruit Remains from Early Chalcolithic Cultures in Baluchistan

Plant Taxa Recovered	**Mehrgarh Period II** (c.5500-4300 BC)	**Mehrgarh Period III** (c. 4300-3500 BC)	**Mehrgarh Period IV** (c. 3500 BC)	**Mehrgarh** 3rd millennium BC	**Balakot** (c 4000-2900 BC)
Triticum monococcum (einkorn wheat)	+				
Triticum dicoccum (emmer wheat)	+		+		
Triticum cf. *durum* (hard wheat)	+				
Triticum aestivum (bread wheat)	+	+	+	+	
Triticum compactum (club wheat)	+	+	+	+	
Triticum sphaerococcum (dwarf wheat)	+	+	+	+	
Hordeum vulgare (hulled barley)	+	+	+	+	+
Hordeum vulgare var. *nudum* (naked barley)	+	+	+	+	
(*Avena* sp.) Oat				+	
Phoenix dactylifera (date)	+		+		
Ziziphus sp. (jujube)	+			+	+
Prunus sp. (apricot)	+		+		
Gossypium sp. (cotton)	+				
Vitis vinifera (grapes)			+	+	
Acacia sp.				+	
Lolium sp.				+	
Polygonum sp.				+	
Chenopodium sp.				+	
Vicia sp. (vetch)					+
Cucumis sp. (melon or gourd)					+

For Mehrgarh plant economy see Jarrige and Meadow 1980; Jarrige 1981; Allchin and Allchin 1982; Costantini and Biasini 1985; Possehl 1990 and for Balakot see Allchin and Allchin 1982.

Table 2: Seed/Fruit Remains from Early Chalcolithic Cultures in Baluchistan

Plant Taxa Recovered	**Nindowari** 3rd Millennium BC	**Pirak,** (2200 to 1000 BC)
Triticum monococcum (einkorn wheat)		
Triticum dicoccum (emmer wheat)		
Triticum cf. *durum* (hard wheat)		
Triticum aestivum (bread wheat)	+	+
Triticum compactum (club wheat)		+
Triticum sphaerococcum (dwarf wheat)		+
Hordeum vulgare (hulled barley)	+	
Hordeum vulgare var. *nudum* (naked barley)		+
Oryza sativa (Rice)		+
(*Avena* sp.) Oat		+
Phoenix dactylifera (date)		
Ziziphus sp. (jujube)		+
Prunus sp. (apricot)		
Gossypium sp. (cotton)		
(*Vitis vinifera*) grapes	+	+
Acacia sp.		
Lolium sp.		
Polygonum sp.		
Chenopodium sp.		
Vicia sp. (vetch)		
Cucumis sp. (melon or gourd)		
Sorghum sp.		+
Panicum miliaceum		+
Linum usitatissimum (flax)		+
Citrullus cf. *colocynthus*		+

For Nindowari see Costantini and Biasini 1985; for Pirak see Costantini and Biasini 1985.

Table 3: Seed/Fruit Remains from Early Chalcolithic Cultures in Afghanistan Region

Plant Taxa Recovered	**Mundigak** (c. 4000-2000 BC)	**Shahr-i-Sokha** (c. 3200-2100 BC)	**Deh-Morasi Ghundi** (c. 2700-2600 BC)	**Tarakai Qila**
Triticum monococcum (einkorn wheat)		+		
Triticum dicoccum (emmer wheat)		+		
Triticum cf. *durum* (hard wheat)				
Triticum aestivum (bread wheat)	+	+		+
Triticum compactum (club wheat)	+			
Triticum sphaerococcum (dwarf wheat)		+		
Hordeum distichum (two-row barley)		+		
Hordeum vulgare (hulled barley)	+	+	+	+
Hordeum vulgare var. *nudum* (naked barley)	+	+		
Secale cereale (secale)		+		
(*Avena* sp.) Oat				
Lens culinaris (lentil)		+		+
Pisum arvense (field-pea)				+
Linum usitatissimum (flax)		+		
Phoenix dactylifera (date)				
Ziziphus sp. (jujube)	+			
Prunus sp. (apricot)				
Cucumis sp. (melon or gourd)		+		
Citrullus colocynthus		+		
Gossypium sp. (cotton)				
(*Vitis vinifera*) grapes		+		

Acacia sp.				
Lolium sp.		+		
Polygonum sp.				
Chenopodium sp.		+		
Vicia sp. (vetch)		+		
Hordeum spontaneum		+		
Aegilops speltoides		+		
Aegilops tauschii			+	
Bromus sp.		+		
Phalaris sp.		+		
Polygonum sp.		+		
Rumex sp.		+		
Capparis sp.		+		

For Mundigak see Allchin and Allchin 1982; Costantini 1984; Costantini and Biasini 1985, for Shahr-i-Sokha see Costantini and Biasini 1985, for Deh-Morasi Ghundi see Chowdhury 1963, for Tarakai Qila see Allchin and Allchin 1982.

Table 4: Wood Remains from Early Chalcolithic Cultures in Baluchistan and Afghanistan Region

Timber Taxa	**Mehrgarh** 3rd millennium BC	**Mundigak** (c. 4000-2000 BC)	**Shahr-i-Sokha** (3200-2100 BC)	**Nindowari** 3rd Millennium BC
Tamarix sp.	+		+	
Prosopis sp.	+			
Populus sp.	+		+	
Ziziphus sp.	+			
Juniperus sp.	+			
Vitis sp.	+			
Salvadora persica		+		
Fraxinus sp.			+	
Ulmus sp.			+	
Acer sp.			+	
Celtis sp.			+	

Dalbergia sissoo			+	
Adnanthera cf. *pavoniana*			+	
Adina cordifolia sp.			+	
Pistachio			+	
Grapevine			+	+
Date palm			+	

For Mehrgarh wood charcoals see Thienault 1989; for Mundigak, Nindowari and Shahr-i-Sokha see Costantini and Biasini 1985.

Harappan Plant Economy

The information on plant economy is rather limited as compared to its wider expansion. The available data from Harappan sites is described under three areas:

1. The Indus Valley in Pakistan like Mohenjo-daro, Harappa and Chanhu-daro. The oldest Indian civilization developed along the river valleys i.e. Indus Valley Civilization. In this nuclear zone the information on the food economy at Mohenjo-daro, Harappa and Chanhu-daro are based on the earlier excavation reports. Vishnu-Mittre and Savithri (1982) have, however, revised the specific identification of some of the cereal grains. The principal food grains consumed by the Harappans have been found as belonging to the species of wheat (*Triticum aestivum*, *Triticum compactum*) and *Triticum sphaerococcum*) and the hulled and naked forms of six-row barley (*Hordeum vulgare* and *Hordeum vulgare* var. nudum). Sesame (*Sesamum indicum*) from Harappa and field-brassica (*Brassica juncea*) from Chanhu-daro were the main oil-seed crops. Carbonised field-pea (*Pisum arvense*) was reported from Mohenjo-daro and Harappa by Shaw (1943).

Among commercial crops, cotton occupied the foremost place. The cotton fiber found adhering to a silver vase at Mohenjo-daro was identified as belonging to a coarse variety of *Gossypium arboreum* (Turner & Gulati 1928). Apart from actual fiber, numerous woven textile impressions were found at Mohenjo-daro and Harappa (Marshall 1931). The earliest civilization to have spun and woven the cotton was the Harappan.

The exploitation of timbers for various purposes indicates that Harappans in

the Indus Valley must have had experience of this raw material for a pretty long period (Chowdhury & Ghosh 1951). For instance, to make coffin the Harappans used the scented woods of deodar (*Cedrus deodara*) and rosewood (*Dalbergia latifolia*) revealing their cultural significance. The Harappans knew the forest wealth of Himalayas and central India for the exploitation of deodar and rosewood respectively. Their choice of jujube wood (*Ziziphus* sp.) to make wooden mortar for pounding grains indicates their knowledge of the shock-absorbing quality of this timber (Chowdhury 1970). No remnants of agricultural implements have been found, but it is surmised that wooden ploughs and sickles of copper were known to them.

2. The Eastern Region in Rajasthan include (Kalibanagan), Haryana (Daulatpur, Kunal and Balu in Districts Kurukshetra, Hissar and Kaithal respectively) and Punjab (Rohira, Mahorana in District Sangrur and Sanghol in District Ludhiana); Hulas in western Uttar Pradesh. At Kalibangan in Ganganagar district of Rajasthan, Early Indus or pre-Harappan phase is dated from 2450 to 2300 BC. An agricultural ploughed field surface, showing criss-cross pattern of furrows recovered; is the most important evidence (Lal 1997). In the closely spaced furrows horse-gram or sesame is grown, intersected by the widely spaced rows of mustard (Allchin & Allchin 1982). However, wood charcoals of *Acacia* sp. (babul), *Dalbergia* sp. (shisham), and *Tectona grandis* (teak) have been found (Savithri 1976). The Mature Harappan phase, dated to about 2000 BC, food grains of hulled and naked barley, field-pea and chick-pea have been recovered (Vishnu-Mittre & Savithri 1982). Remains of timber taxa exploited by the ancient settlers were identified as *Calligonum* sp., *Ficus* sp., *Boswellia serrata*, *Tamarix dioica*, *Morus indica*, *Salvadora persica*, *Terminalia* sp., *Albizzia lebbeck*, *Anogeissus latifolia* in addition to timber remains recovered from pre-Harappan phase (Savithri 1976).

Systematization of work on Harappan Civilization in ancient Punjab and Haryana, has brought to light convincing evidence of the vast array of data to suggest cultivation of 29 types of crops of indigenous variety, characterized by rotation of crops, during 3rd millennium BC; in comparison to the early reports of only six or seven types of food grains from Harappa and Mohenjo-daro in Pakistan. Amazingly, Harappan plant economy is also shaped by the evidences reflecting on the highly developed horticultural practices, documented in the factual remains to suggest the cultivation of grapes (*Vitis vinifera*), green-legume of sem-bean (*Lablab purpureus*), henna (*Lawsonia inermis*), parijat or harsingar (*Nyctanthes arbortristis*), jasmine (*Jasminum* sp.), karonda (*Carissa carandas*), lemon (*Citrus*

limon) and pomegranate (*Punica granatum*), in their gardens. Their acquaintence with the possible use of opium-poppy (*Papaver somniferum* ssp. *setigerum*) can be surmised by the finds of poppy seeds, in medicine and as a narcotic of great antiquity, earlier known from Sumerian, Babylonian and Assyrian civilizations (Saraswat 1992, 1997; Saraswat & Pokharia 2002, 2003).

A carbonised sample of herbal shampoo from early Harappan settlement at Banawali, district Hissar, Haryana (2750-2500 BC), evidenced by the mixture of soapnut or reetha (*Sapindus* cf. *emarginatus*), anwala (*Emblica officinalis*) and shikakai (*Acacia rugata*), which are universally used even in the present times for shampooing hair, denotes the high standard of hygiene deeply rooted in the prehistory of India (Fig. 6). The evidence is unique in its own right, in the World Archaeological Context (Saraswat 2006-2007). The cultivation of grape-vine in India has been established from the Harappan times. The grape seeds and stem charcoals of *Vitis vinifera* have been an important source of information, about the cultivation of grapes, from Rohira, district Sangrur, Punjab (Saraswat 1988).

3. The Southern Region in the Peninsular India covers Kutch, Kathiawar, coastal flats of Gujarat and some areas of hinterland of Maharashtra. The important sites are Rangpur, Rojdi, Lothal, Prabhas Patan, Surkotada, Shikarpur and Kanmer etc. (Ghosh & Lal 1963; Weber 1991; Weber *et al.* 2010; Vishnu-Mittre & Savithri 1982; Chanchala 1994 & Pokharia *et al.* 2011). At Lothal and Prabhas Patan, the seaports and sea-trade were major stimulus for Harappans.

In this peripheral zone the local indigenous hunting and food-gathering communities were displayed. The information on archaeobotanical remains in the regions of Gujarat is limited. However, archaeobotanical studies at some of the sites have yielded the cultivated as well as wild taxa useful to human civilization as a food source. Records of some millets included *Pennisetum typhoides* (Pearl millet) from Rangpur in district Surendranagar (Ghosh & Lal 1963), *Eleusine coracana* (Finger millet) and *Setaria italic* (Italian millet) from Surkotada in district Bhuj (Chanchala, 1994) as well as Oriyo Timbo in district Bhavnagar (Wagner 1983), and *Eleusine coracana* from Shikarpur in the Runn of Kutch (Chanchala, 1994). These finds are dated from different levels between 2500 BC and 2000 BC. Rojdi in district Rajkot is best viewed as a permanent site. A large number of seeds and fruits of the cultivated and wild taxa have been recovered and reported by Weber (1991). The assemblage of crop plants from Rojdi includes *Eleusine coracana* (Finger millet), *Pennisetum typhoides* (Pearl millet), *Sorghum bicolor*

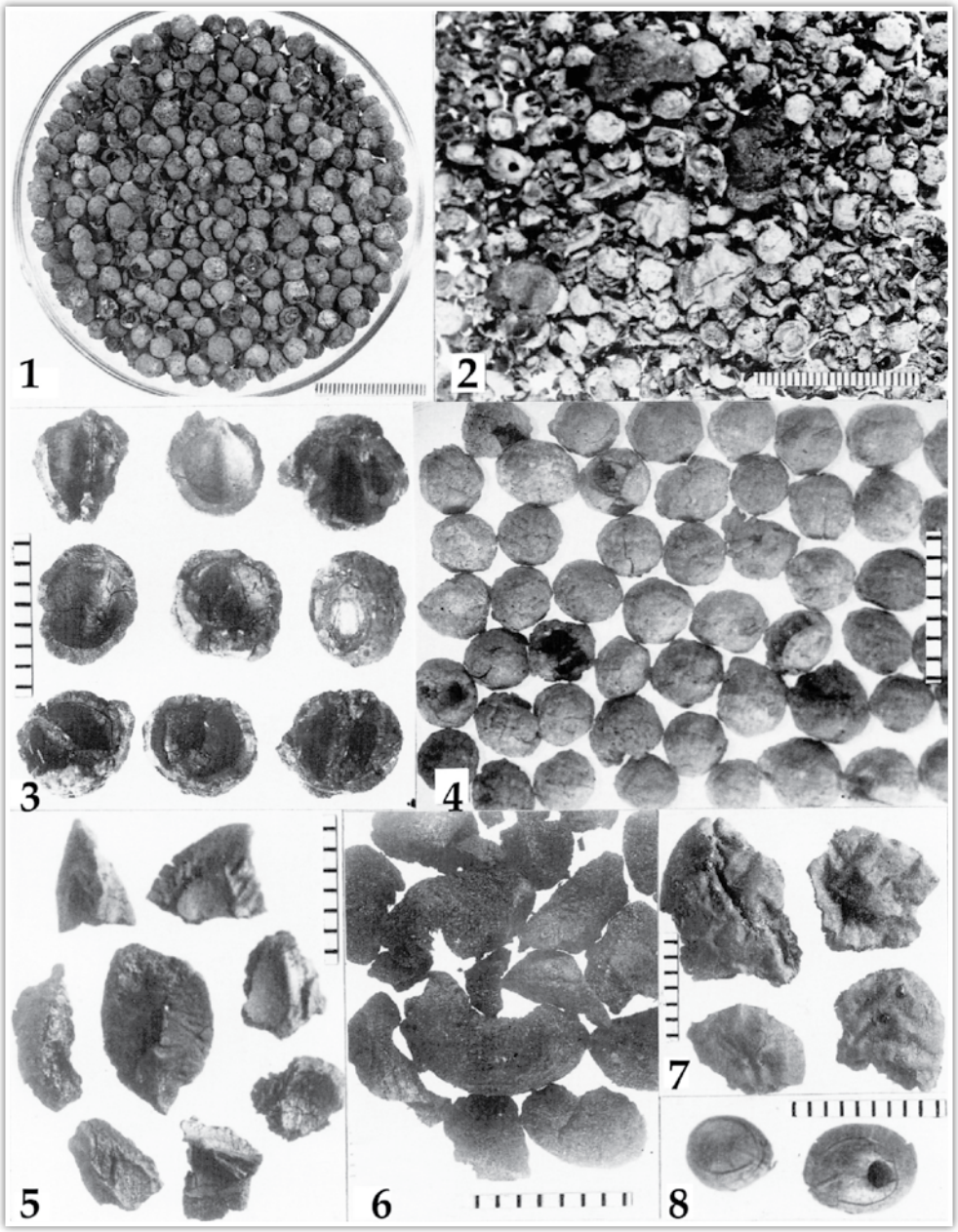

Fig. 6: (1) South Indian soapnuts/Reetha *(Sapindus cf. emarginatus)*; (2) Carbonised sample of Shampoo; (3-4) Broken and complete South Indian soapnuts (enlarged); (5) Endocarp pieces of Anwala *(Emblica officinalis)* fruits; (6) Fruit pieces of Anwala; (7) Shikakai *(Acacia rugata)* pod pieces; (8) Shikakai seeds (after Saraswat 2006-07:11)

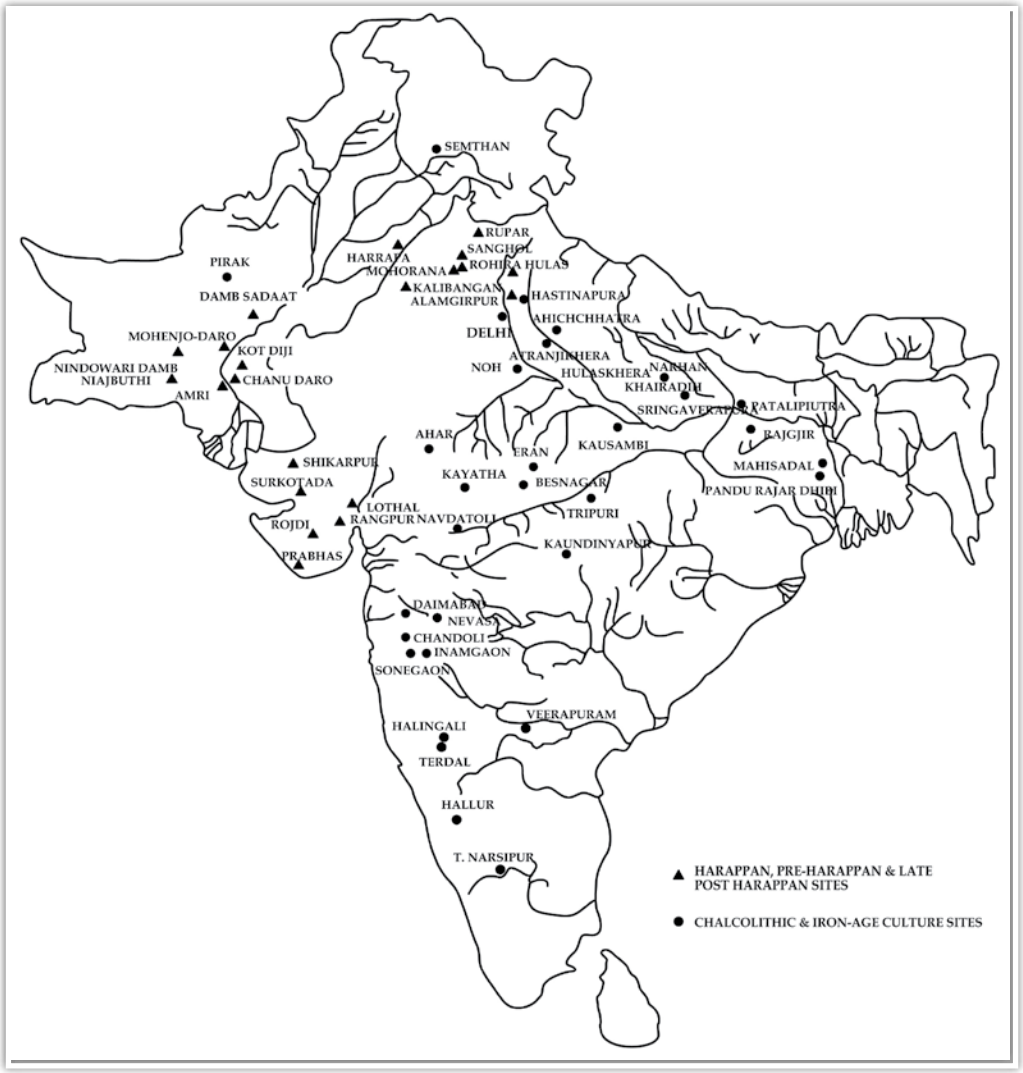

Fig. 7: Map showing the sites of Harappan and Copper/Iron using cultures

(Sorghum millet), *Echinochloa crus-galli* (Sawan), *Setaria italica* (Italian millet), *Panicum miliare, Hordeum vulgare* (hulled barley), *Linum usitatissimum* (flax), *Lens culinaris* (lentil), *Lathyrus sativus* (Grass-pea), *Vigna radiata* (Green gram), *Pisum arvense* (field-pea) and *Brassica campestris* (Mustard); including fruit remains of *Ziziphus mauritiana* (jujube) and *Cucumis* sp. (cucumber). Harappans during the phase of decline opted for the rice cultivation (Fairsrvis 1979) as evidenced at Lothal in the form of husk and spikelet impressions on pot-sherds and at Rangpur

rice husks, used as binding material for mud-plaster as seen in mud-lumps (Ghosh & Lal 1963). Wood charcoals are also studied at these sites (see Table-5). Except the Teak and *Lal-chandan*, rest are the elements of local dry-deciduous forests. Exploitation of quality timbers from far distant areas by the Harappans is quite evident. Harappan agricultural economies were based on annual rainfall in Gujarat. Where rainfall patterns were favorable and the irrigation possible, both winter (wheat, barley and pulses) and summer crops of millets were grown. In the areas where rainfall was not adequate, millets played an important role in the subsistence strategies.

Table-5: Wood Charcoal Remains

Timber Taxa	Lothal	Rangpur
Acacia sp.	+	+
Adina cordifolia (Haldu)	+	
Albizia sp.	+	+
Soymida febrifuga	+	+
Tectona grandis (Teak)	+	
Azadirachta indica (Neem)		+
Pterocarpus santalinus (*Lal-chandan)*		+
Tamarix sp.		+

For Lothal see Rao & Lal 1985; for Rangpur see Ghosh & Lal 1963.

Prior to the studies at Kanmer (in little Rann of Kachchh) it was suggested that Gujarat may have been a centre for the domestication of local, monsoon-adapted crops only. The evidence of winter crops in contrast to millets was extremely limited. However, Harappan Kanmer, shows a different agricultural system in response to climate change. Considerable quantity of winter crop, specifically barley during early phase from Kanmer and bread-wheat from Shikarpur is to be reckoned with (Pokharia *et al.* 2011 & Chanchala 1994). Cropping strategies in Little Rann of Kachchh in response to climate change is being observed at Kanmer in the recent past.

Keeping in view the vast area of Harappan culture spread in diverse geographical regions, the knowledge of plant economy of this culture is still inadequate. Continuation of systematic work is expected to take a long way

towards a clear understanding of various aspects of the exploitation pattern of botanical wealth.

Remains of weeds and wild taxa

In association with field crop finds, number of weeds giving enough indication about the ecological conditions in which the crops fit in and wild taxa have been recovered, belonging to wild grasses; sedges etc. which reflect upon the ecological conditions of the ancient habitational sites as revealed at ancient sites Surkotada in the Runn of Kachchh (Savithri 1976) and at Rojdi (Weber 1991). Many species also have economic uses, their seeds must have come through the direct or indirect human activities or might have come from the agricultural fields, along with the crop produce.

Chalcolithic plant economy in India

The Chalcolithic cultures, characterized by the use of copper, were spread in a wide time range from about 3rd millennium BC to first half of 2nd millennium BC. They are either partly contemporary with or posterior to the Indus Civilization. They cover the areas in south-eastern Rajasthan, Malwa region in central western India, Maharashtra and the entire Ganga plain.

Chalcolithic cultures share a common level of agricultural economy and technology except for some cultural equipments. Their basic economy was based on crop-husbandry, stock-raising, hunting and fishing. The settlers of Chalcolithic cultures in India were the skilled farming communities with know-how of floral wealth for exploitation.

Conclusion

The physical evidences for plant consumption by ancient Indians are virtually non-existent because of poor preservation of organic plant parts. The Fertile Crescent of south-western Asia and the Indian sub-continent offered many varieties of wild plants and animals, which were ideal for domestication.

The new advances in the recovery and analysis of plant remains during recent times have given higher yield of material evidence in comparison to past, thus adding more information to our existing palaeoethnobotanical concepts. The palaeoethnobotanical dataset is increasing and recent interpretations of it promise

to broaden scope and our understanding of the man-plant relationships during Dark Ages.

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Signatures of Palaeo Rivers Network in Northwest India using Satellite Remote Sensing

J.R. Sharma and B.K. Bhadra
RRSC-W, NRSC/ISRO, Dept. of Space (GOI)
CAZRI Campus, Jodhpur
Email : jrsharma@hotmail.com

ABSTRACT

The northwestern region of Indian sub-continent witnessed a number of mighty flowing rivers in the past. Like present day Indus River system, a sub-parallel river system known as `Vedic Saraswati River' was flowing with full majesty around 6000 BC. River Saraswati originated in the Higher Himalayas and flowed through the western part of Indo-Gangetic alluvial plains along several tributaries like Sutlej, Yamuna, Chautang and Drishadvati. The Saraswati river system passed through the states of Himanchal Pradesh, Punjab, Haryana and Rajasthan and finally discharged into Rann of Kachchh in Gujarat. The river dried up subsequently and disappeared around 3000 BC due to climatic and tectonic changes in Himalayan region. The relict of this lost river is still found as palaeochannels in the above states.

However, establishing the exact course of Vedic Saraswati and its perennial source remains a debatable topic among the researchers due to lack of proper scientific database. The mystery is unraveled through modern tools like Remote Sensing and GIS by using multi-spectral and multi-resolution satellite images.

For this purpose, optical satellite data (Landsat ETM and IRS P3 WiFS and IRS P6 AWiFS, LISS-3 and LISS-4) as well as microwave (Radarsat SAR) data have been used to delineate the palaeochannels. The mapped courses have been validated with a variety of ground information like archaeology, sedimentology,

hydrogeology and drilling data. The relative ages of the discovered archaeological sites and the radiocarbon dating of ground water and sediment samples all along the palaeochannels are highlighted in the present study. The satellite image interpretation shows the obscured signature of 'palaeo-rivers' below the aeolian sands in the Thar Desert. An attempt has been made to trace the entire drainage network of the 'Lost Vedic Saraswati' from the Siwalik foothills to Arabian sea and its possible link to the perennial source in higher Himalaya.

Introduction

The river Saraswati is described in the Rigveda literature as the *Ambitame, Naditame* and *Devitame* that is best of mother, best of river and best of goddess. It was a life stream of the people of ancient India, mostly in the Vedic and Puranic ages. The discovery of sites of Harappan civilization on the banks of Saraswati also indicates towards existence of the mighty river more than 8000 years ago. The Vedic Saraswati, a mighty and holy river of northwest India during 6000 BC., originated from Bandarpunch glacier in Garhwal Himalayas and finally discharged into the Gulf of Khambat in Gujarat coast and disappeared around 3000 BC. Several remnants of this river exist as palaeo channels (Ghose *et al.* 1979; Gupta, 1996; Misra, 1995; Radhakrishna, 1999; Valdiya, 2002; Yashpal *et al.* 1980). Today the Vedic Saraswati river is represented by the Ghaggar river which flows on palaeochannel of Vedic Saraswati, located in the western part of the Haryana state (Bhadra *et al.* 2009). The Vedic Saraswati river has been flowing sub-parallel to the Indus river in northwest (NW) India (Krishnan, 1953; Oldham, 1893; Stein, 1942; Wilhelmy, 1999). The study of river Saraswati becomes a fascination and poses unflagging interest in the minds of Geologists and Archeologists.

Drainage System of NW India

Physiography and drainage pattern of NW India can be viewed through SRTM Digital Elevation Model (Fig. 1). The flood plains of the Saraswati River slope towards southwest (SW) direction from Siwalik foothills (elevation > 270m) to the low lying marshy stretch of the Great Rann of Kachchh. Rivers of Punjab, Haryana, western Rajasthan and the northern Gujarat, represent an interesting and complex evolutionary history of drainage development dating back to middle Pleistocene. A few thousand years back several mighty rivers drained the northwestern part of India and these now stand disrupted, partly destroyed and preserved only

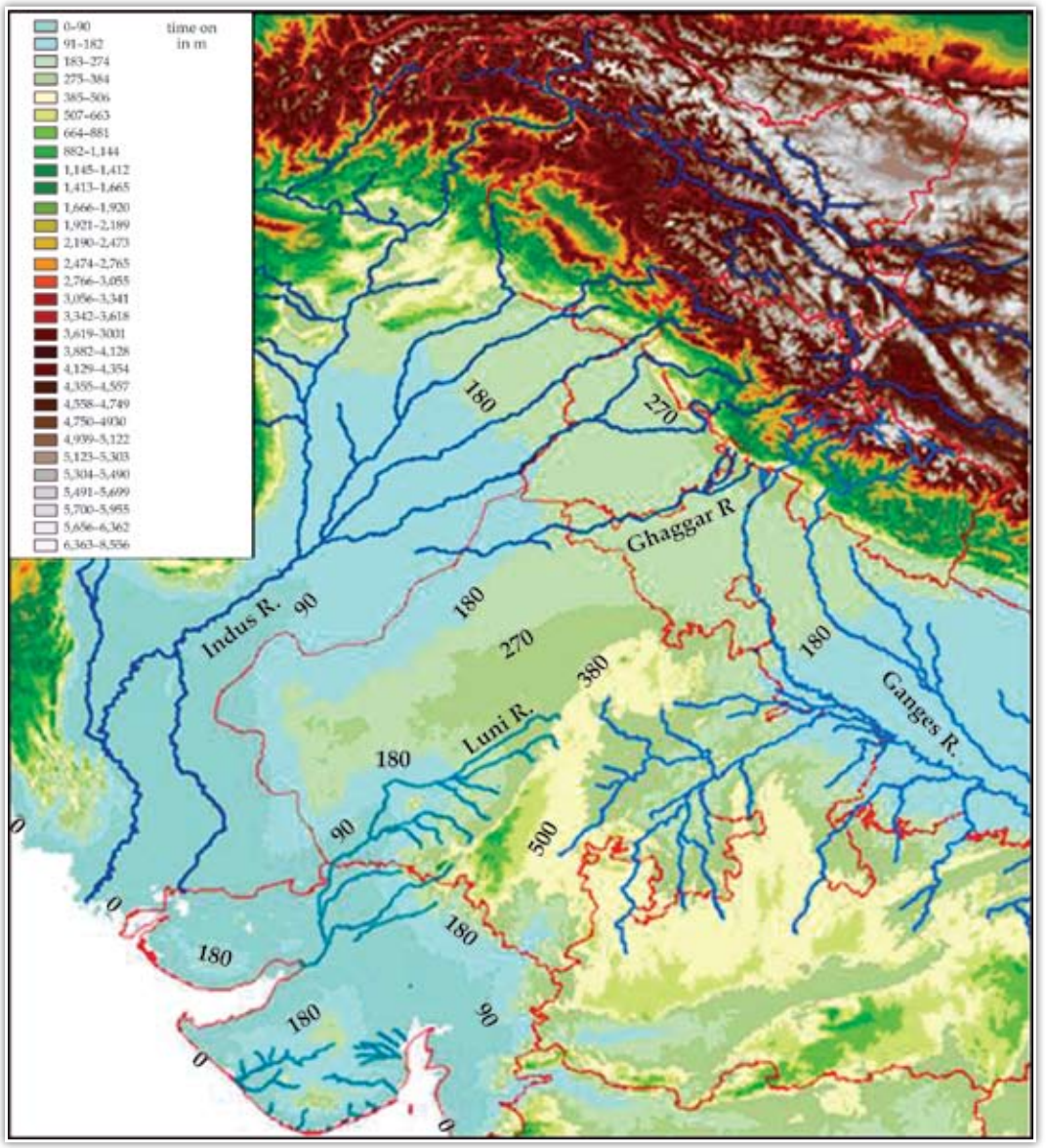

Fig. 1: SRTM derived DEM/elevation map of NW India, showing major drainage systems (Indus, Ganges and Luni)

as poor relicts making up the present day drainage system. The vast tract of Indo-Gangetic alluvium plains and the aeolian plains of Thar Desert represents a powerful drainage system in the past. The stretch of land is manifested by the 'Lost River Saraswati' between Indus and Ganges River Systems (Fig. 2). The northern plains of Haryana and Punjab are drained by three major independent river systems namely Yamuna, Sutlej and Ghaggar (Saraswati). Yamuna and Sutlej are perennial river systems while the Ghaggar is mainly ephemeral. The Sutlej river originates in the Himalayas from the holy lake of Mansarovar in Tibet and enters the plains near Ropar (Punjab), where it takes a sharp right-angled turn and flows westward over a distance of 150 km before being joined by the Beas river near Firozpur. The Yamuna, which was supposed to be a major tributary of Saraswati, got diverted through the Yamuna tear fault, was earlier flowing through the Bata river course and joining the Markanda river. The wide valley of the small Bata river supports this. The Ghaggar river raises in the Siwaliks from

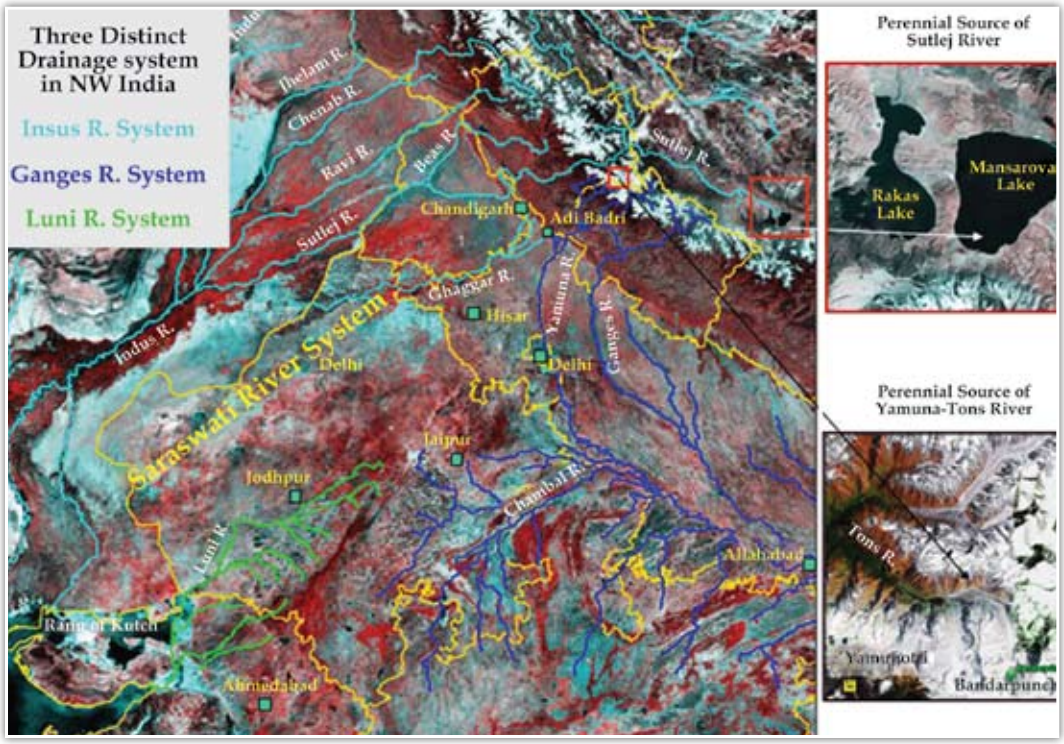

Fig. 2: Satellite image showing the Lost Saraswati River System, surrounded by westerly flowing Indus and Luni River Systems and easterly flowing Ganges River System in NW India

the Morni hills and enters the plains near Ambala (Haryana). After covering a distance of 175 km it joins the Saraswati at Rasula (Patiala district). The combined river now known as Ghaggar flows through Sirsa (Haryana), Hanumangarh and Ganganagar districts (Rajasthan). The river Saraswati was probably stretched for 1600 km long and 3 to 12 km wide, significantly broad and perennial. Saraswati River used to receive water from Yamuna and Sutlej and ceased its flow due to eastward shifting of Yamuna and westward deflection of Sutlej. As a result of neo- tectonic activity and climatic changes, river Saraswati dwindled finally and got lost in the sand of the Thar Desert.

Remote Sensing for Palaeochannel Mapping

With the advent of Remote Sensing technology and the available satellite images, it is possible to trace the drainage course in the form of buried palaeochannels. Palaeochannels are basically the old course of river channels which appears on the satellite image as serpentine drainage course with high moisture content (dark tone). Remote Sensing techniques helped in locating these buried channels as they are clearly seen in the satellite images (Ghose *et al.* 1979, 1980; Yashpal *et al.* 1980; Sood and Sahai, 1983; Bakliwal and Grover, 1988; Ramasamy *et al.* 1991; Kar, 1995; Sahai, 1999). Pioneering works in Remote Sensing has been carried out by Yash Pal *et al.* (1980), Sahai (1993), Rajawat and Narain (1996) who have compiled various studies pertaining to the palaeo drainage network of Northwestern India. Recently the entire course of River Saraswati has been traced from satellite images by the authors like Gupta *et al.* (1984), Bhadra *et al.* (2009), Bhadra *et al.* (2005), Sharma and Bhadra (2009a and b), Sharma *et al.* (2006), Bhadra and Sharma (2011) and others.

Delineation of Palaeochannels in Rajasthan

Gupta *et al.* (2004) have mapped the course of Saraswati, buried below sands of Thar Desert, using IRS P3 WiFS and LISS-3 satellite data and showed presence of Saraswati channels which are self-evident on satellite images (Fig. 3). "Piece-wise Histogram stretching" technique has been used to enhance the palaeo channel signatures on the image. This technique has been found unique in enhancing palaeo channel details in the sandy as well as alluvial and vegetated areas. The feature enhancement is carried out by way of loading sub-scenes of 1k × 1k size on computer terminal in full resolution and improving the feature contrast by

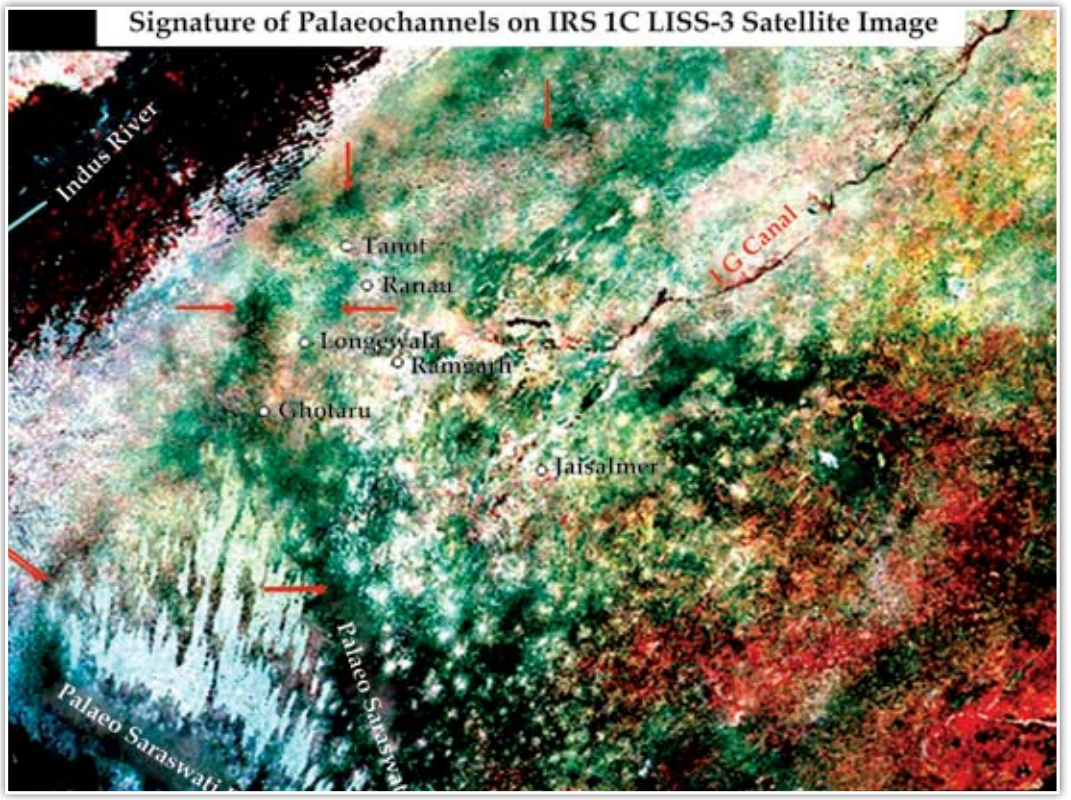

Fig. 3: Satellite image (IRS 1C LISS-3) showing the signatures of palaeo Saraswati river (dark tone) amidaeolian sands of Thar Desert

histogram stretching interactively. They have also validated the course of Vedic Saraswati river through collateral data such as geomorphic anomalies, drilling data (litholog) of tube wells, age of ground water, archaeological data and published old maps. The drilled tube wells in Jaisalmer district of Rajasthan shows potable water with high discharge from the sub-surface fluvial palaeochannels. Isotopic dating of trapped water is correlated with the Harappan Civilization. Thus, a palaeochannels network of Saraswati river in Rajasthan and parts of northern Gujarat has been established across the Thar Desert (Fig. 4).

Delineation of Palaeochannels in Haryana and Punjab

The Saraswati River System (present day drainages along with palaeochannels) in Haryana and Punjab (Fig. 5) has also been studied in detail by using IRS

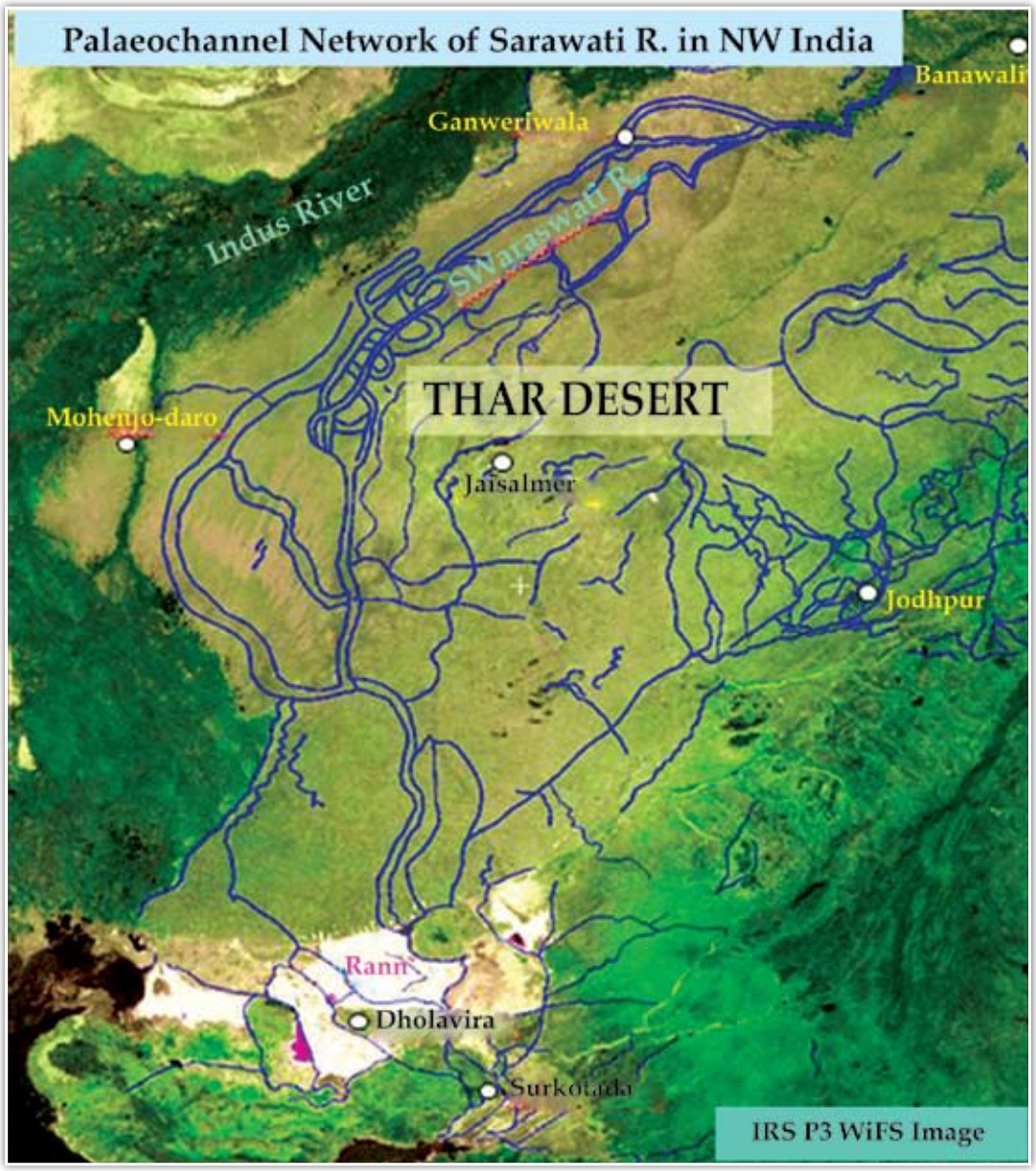

Fig. 4: Satellite image (IRS P3 WiFS) showing the network of Saraswati palaeochannels in parts of Rajasthan and Gujarat

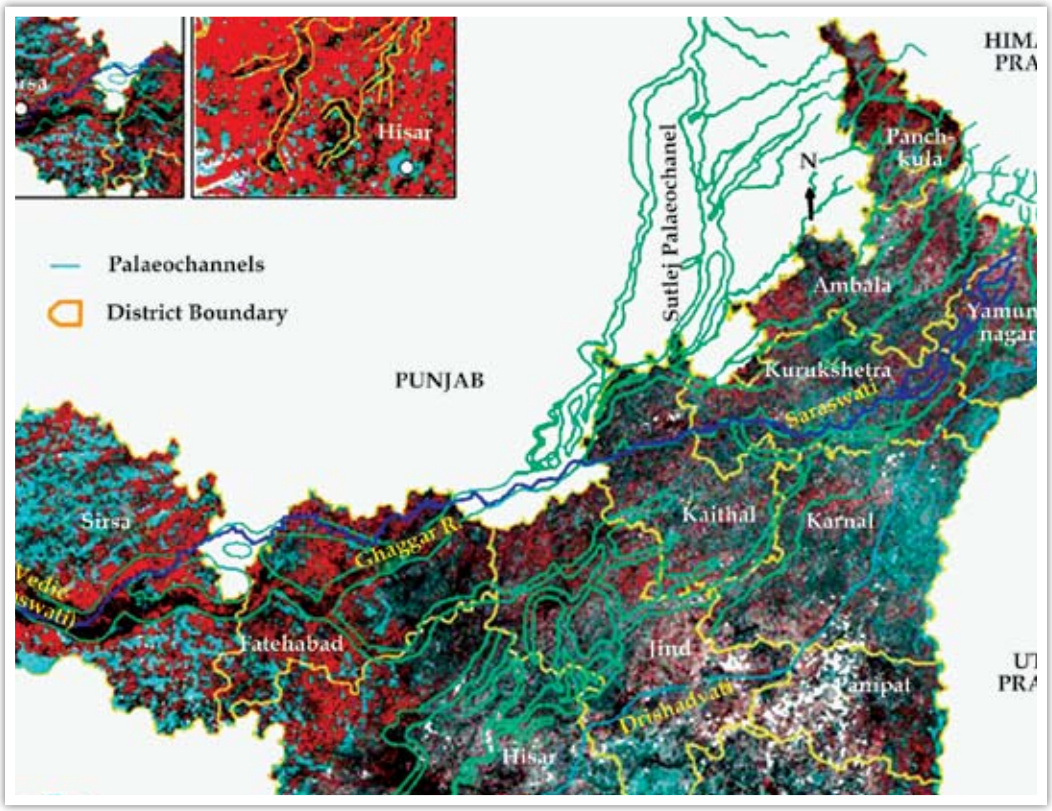

Fig. 5: Satellite image showing the delineated palaeochannels in northern Haryana and Punjab. Inset shows the signature of palaeochannels, marked by highly moist zones with dark tone in Sirsa and Hisar districts

P6 AWiFS, LISS-3 and LISS-4 satellite data (Bhadra *et al.* 2006; Bhadra *et al.* 2009; Sharma and Bhadra, 2009; Bhadra and Sharma, 2011). For delineation of palaeochannels in Haryana, digital image processing techniques like histogram equalization, linear stretching, contrast and brightness enhancement etc. have been applied on a small area of the satellite images. Drainage features are highlighted on applying local stretching on ~10X10 sq. km area out of the full LISS-3 scene (141×141 sq. km). Using this process, the possible course of Saraswati and Drishadvati palaeochannels in Haryana are delineated with proper care by avoiding the canals, existing ephemeral drainages and water logged areas. An attempt has been made to identify the continuity of Saraswati palaeochannels in eastern Punjab also. For this purpose, satellite images of IRS P6 LISS-3 data

(23.5m resolution) of February, 2004 and Radarsat SAR data (50m resolution) of December, 2002 have been processed to delineate palaeochannels (Fig. 6). In this area, Radarsat SAR image could be able to pick up moist zone (torquous channel with dark tone), possibly indicating a subsurface palaeochannel. The delineated palaeochannel between Ropar and Patiala is named as Sutlej palaeochannel which is an N-S trending tortuous palaeochannel extending for a length of about 75 km with having width between ~1 to 6 km. The Sutlej palaeochannel is connecting the present day Sutlej river near Ropar and the Ghaggar river in the south of Patiala. The delineated palaeochannels in Haryana and Punjab have been validated on the ground by using archaeological sites, hydrogeological and drilling data, rainfall data and stream discharge rate in the last 60 years. Thus, the Sutlej, Saraswati and Drishadvati palaeochannels possibly contributed to the main Vedic Saraswati to form a mighty flowing river in the past.

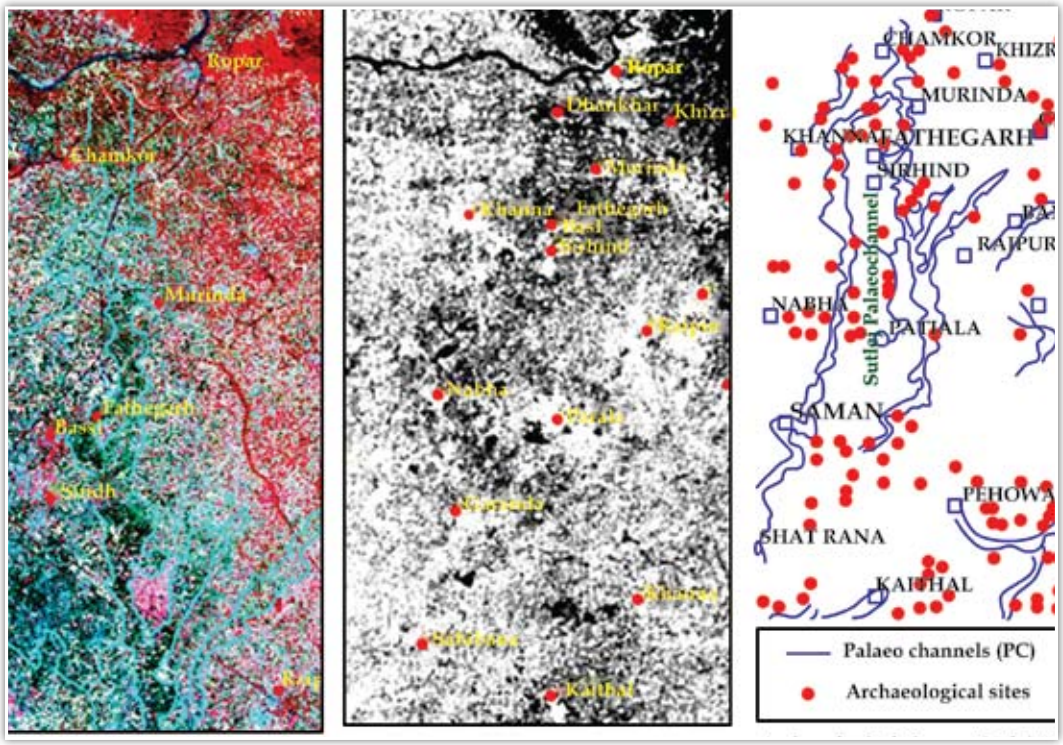

Fig. 6: Signature of palaeochannels (dark tone) on Optical image (IRS P6 LISS-III) and Microwave (Radarsat SAR) image in eastern Punjab. Sutlej palaeochannels show a close affinity with the discovered archaeological sites in Punjab

Saraswati Delta Structure at Rann of Kachchh (Gujarat)

The Saraswati river is supposed to be the mightiest river in the proto-historic times which might have flowed through Rann of Kachchh and finally discharged into a Gulf of the Arabian Sea. The Rann is today a salt impregnated marshy tract, which gets flooded during the rainy session. A number of references have been made about the Saraswati river meeting the Sea along the existing Kori Creek (Oldham, 1893). Further, it has been mentioned that major independent rivers like Sindhu and Saraswati met the Rann of Kachchh close to one another. Recent investigations have revealed that more than one river were involved in building up the deltaic deposits in the Great Rann. According to Roy and Merh (1977**)** the channels represent relicts of a delta of Nara river which is a tributary of Indus river. The Saraswati delta is characterized by strikingly uneven topography, marked by areas of higher grounds (bet of river borne sandy and silty sediments) and depression or distributary channels (Malik *et al.* 1999).

Digital image processing of IRS-P6 AWiFS and Radarsat SAR images reveals deltaic drainage pattern (Bird's Foot type) which is made up of complex intertwined channels (Fig.7). This structure was formed in the past by huge sediment discharge of Saraswati river within marshy land of Great Rann of Kachchh. The delta structures are restricted by the E-W fault, known as Allah Band. However, these palaeochannels can be traced upto the Gulf of Katchchh which might have a link to the submerged Dwarka of Mahabharata times.

Archeological Evidence

Discovery of the great Harappan site at Majenjodaro (Pakistan) and contemporary sites at Kalibangan (northern Rajasthan) gave a tremendous impetus to the archaeologists to study the Harappan civilization in this sub-continent (Lal, 1979, 2009). Joshi *et al.* (1984) have compiled the data on Early Harappan, Mature Harappan and Late Harappan sites in northern states of India. The following table shows a large number of archaeological excavations in Haryana along with two other states.

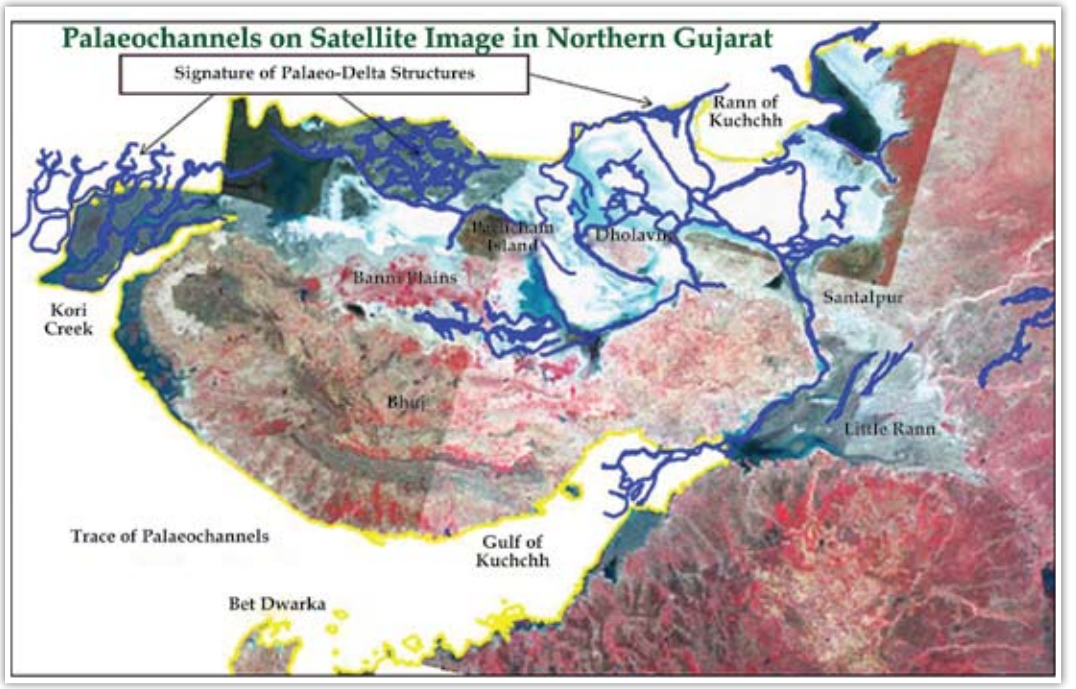

Fig. 7: IRS LISS-3 image showing the signatures of palaeo delta structures within marshy land of Rann of Kuchchh in northern Gujarat. Note the trace of the palaeochannels into the Gulf of Kuchchh possibly linked to Dwarka in the west

States	Sites in Saraswati Valley (India)		
	Early Harappan (*c.*2500-2200 BC)	Harappan (*c.*2200-1700 BC)	Late Harappan (*c.*1700-1000 BC)
Punjab	23	32	102
Haryana	103	44	297
Rajasthan	8	28	-
Total	**134**	**104**	**399**

Yash Pal *et al.* (1980) made an effort to superpose data of these Harappan sites on the palaeochannels, as deciphered from Landsat imagery.

Affinity of Archaeological Sites and the Palaeochannels in Rajasthan

Gupta *et al.* (2004) studied a large number of archaeological sites, discovered in the area covered by the Saraswati river basin (Fig. 8). More than 1200 of the

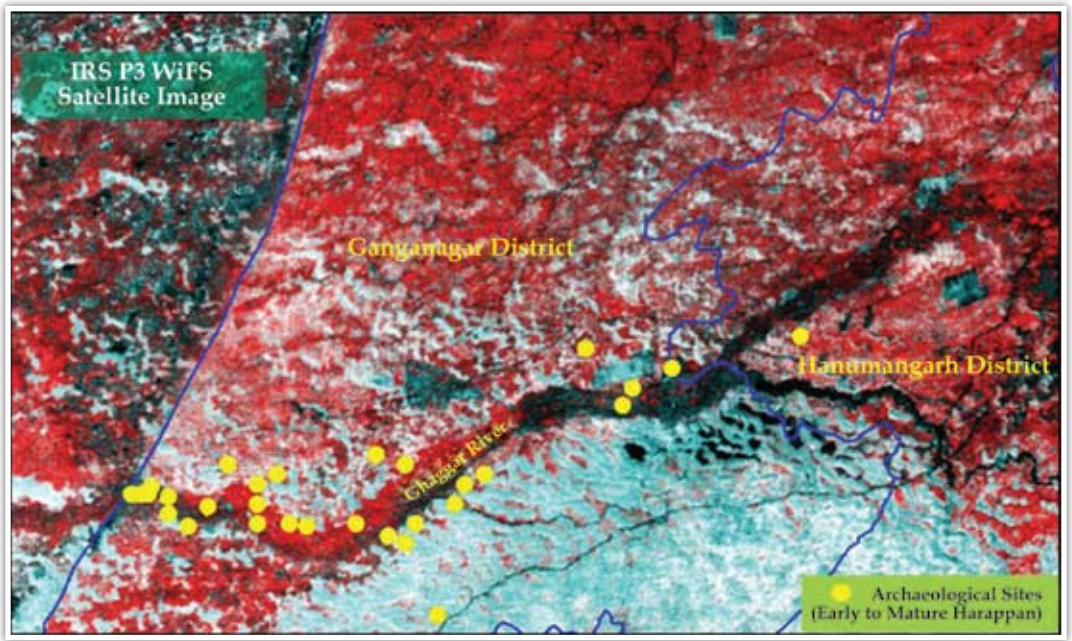

Fig. 8: Satellite image showing the locations of clustered Archaeological Sites along the Ghaggar river in Ganganagar and Hanumangarh districts of Rajasthan

1600 settlements including many prosperous towns of Harappan culture (3000-1500 BC) existed along banks of Saraswati river (Misra, 1995; Valdiya, 1996). A large number of sites of Harappan culture have been found in the Saraswati river basin along the palaeo channels mapped using satellite remote sensing and other methods (Kalyanraman, 1999). Out of the archaeological sites discovered by the Archaeological Survey of India in the Saraswati river basin (Possehl, 2000), 54 sites of Early-Harappan and Mature Harappan period falling in the western Rajasthan have been plotted on to the palaeo channel map prepared from WiFS data to observe if any correlation exist between the two types of data. It is observed that most of the archaeological sites of Harappan period discovered in Ganganagar and Hanumangarh districts fall along the Ghaggar river, indicating Ghaggar to be the palaeo Saraswati course (Gupta *et al.* 2001).

Affinity of Archaeological Sites and the Palaeochannels in Haryana

The delineated palaeochannels of Saraswati and Drishadvati in the northern parts of Haryana show a great affinity with the discovered Harappan sites. It provides

a good evidence of the presence of an ancient civilization, known as "Harappan Civilization" or "Indus Valley Civilization". Most of the sites of this civilization have shown a common characteristic like (a) Presence of houses made of bricks, (b) Well planned city, (c) Ploughed agricultural field, etc.

The locations of 436 archaeological sites, discovered till 2000 in Haryana (Possel, 2000) and a few recently discovered archaeological sites have been plotted (Fig. 9) and overlaid on the mapped river courses for age determination. The archaeological sites are classified into four categories viz. Mature Harappan, Sothi Harappan, Late Harappan and Post to Harappan, as given in table 1. In northern Haryana, mostly Late Harappan sites have been found to lie in Yamunanagar, Kurukshetra and Kaithal districts.

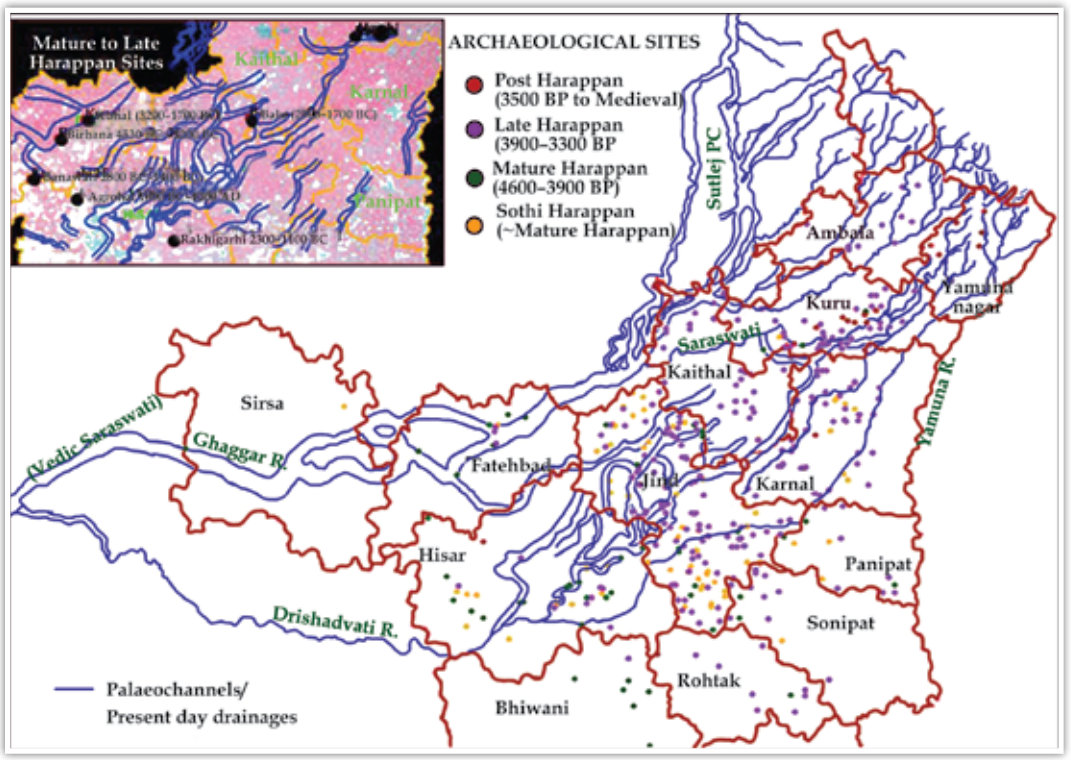

Fig. 9: Spatial Distribution of Archaeological Sites in northern Haryana. Inset shows the locations of important Mature Harappan sites close to Saraswati/Drishadvati palaeochannel

Table 1: Classification of Archaeological sites in Haryana

Classes (Period, BP)*		Remarks
Post Harappan (3500 to Medieval)		Represents all the sites which are post to Harappan period. It includes OCP, PGW, Pre- Historic, Buddhist, Medieval, etc.)
Harappan	Late Harappan (3900-3300)	Mostly Post-Urban Harappan
	Sothi-Siswal (~ Mature Harappan)	Sothi-Siswal sites have distinct Hakra culture but resembles Mature Harappan culture
	Mature Harappan (4600-3900)	Exclusive Harappan sites

Criterion: The archaeological sites, reported in Possehl (2000) and other sources are plotted on the map. It is observed that archaeological assemblages (cultures) of many periods are found over a single site. To plot on the map, only the oldest period out of many cultures present over a site, has been considered for a particular class. Other lower period cultures are not depicted on the maps.

* **Source:** Valdiya, 2002: 38

However, clustered Mature Harappan/Sothi Harappan sites are found to occur in Jind and Karnal districts, where many palaeochannels have been demarcated. It has been observed that most of the Mature Harappan sites (Kunal, Bhirana, Banawali, Agroha and Rakhigarhi) lie on the Ghaggar (Saraswati) palaeochannels. Similarly, a cluster of Harappan sites are found to lie along Drishadvati river. Thus, a close association of Harappan civilization can be established with the delineated palaeochannels which might have a link with the Vedic Saraswati Civilization.

Geochronological Ages of Saraswati River Basin

1. Age of Sediments in the Palaeochannels in Haryana

Based on the collection of subsurface lithofacies data from well logs, Saini *et al.* (2009) attempted to map the buried channel-floodplain systems of a part of the northwestern Haryana plains and provides evidence of buried major sand bodies at various depths. They have identified four lithological facies based on

lithology data analysis:

(i) Brown sandy facies – Well-sorted very fine sand, deposited by eolian activity

(ii) Brown silt facies – This sequence is of 20-40 cm thick, formed by floodplain.

(iii) Grey sandy facies – Fluvial deposit

(iv) Brown clay/mud facies – Floodplain or lacustrine deposit

Further, Sediment characteristics from litholog data and Optical Stimulated Luminance (OSL) dating of sand (quartz) samples suggest the following evolutionary history of fluvial activity in western part of Haryana (Saini *et al.* 2009):

F-3 Phase (< 2.9 ka) – Weak, piedmont-fed Ghaggar system, semi-arid climate

~~~~~~Desiccation of the channel between 4.3 Ka and 2.9 Ka~~~~~~

F-2 Phase (2.9 to 5.9 ka) – Vedic Saraswati Channel, buried with relict landform, sub-humid climate.

~~~~~~Aeolian Phase with accumulation of sand dunes and sheets, arid climate between 15 Ka and 20 ka ~~~~~~

F-1A Phase (~21 ka) – Disorganization phase, weak fluvial activity, buried at 3-6m depth, terminated around Last Glacial maximum (LGM)

F-1 Phase (26-28 ka) – Himalayan-fed channel network, including palaeochannels courses at Sirsa-Phaggu, Fatehbad-Agroha and Hisar at 6m depth, humid climate. Active channel during interglacial period (MIS-3)

Thus, OSL dates of sands at different levels suggest the existence of much older palaeochannels (~26 to 28 ka) than the Saraswati palaeochannels (2.9 to 5.9 ka), as estimated by most of the previous workers.

2. Age of Aeolian Sands in Rajasthan

Using Thermoluminescence (TL) and Optically Stimulated Lumeinisance (OSL) dating of sands, Singvi and Kar (2004) advocates that the Quaternary aeolian activities in Thar Desert is more than 150ka old. There were four major phases of pre-LGM (Last Glacial Maximum) aeolian accumulation during the Late Pleistocene viz. 100 and 115 ka, ~75 ka, ~55 ka and between 30 and 25 ka.

LGM was a period of high aridity, when the desert could have extended far beyond its present boundary. The LGM also experienced reduced fluvial activity. Maximum sand mobility and accumulation took place when the SW monsoon wind strength was sufficient during the transition period from an arid phase to a wetter phase and vice versa. Thus, the peak of aridity at ~18ka was marked by very less Aeolian activities. The Aeolian deposition following the LGM started at ~16ka, but the major activities took place roughly between 14 and 10ka, when sand spread to areas far beyond its present eastern limit.

A northward shift in dune forming climate during the Holocene was also seen. Thus the southern margin of mega-Thar in Gujarat did not experience any dune building activity after 10ka, the north Gujarat plain experienced dune aggradation activity up to 5ka, while large parts of west Rajasthan, containing the core of the Thar experiences dune activity even after 2ka. Within the present desert boundary, the major phases of Aeolian activities after the Holocene Climatic Optimum were between 5 and 3.5ka, and 2 and 0.8ka (0.6ka in the western part). The Harappan and pre-Harappan civilization in the northern part of the desert flourished during a waning phase of SW monsoon, when rainfall events were more aberrant, and Aeolian activities high.

3. Age of Ground water in the Palaeochannels using Isotope Technique

The isotopic ages (^{3}H, ^{18}O and C^{14}) of 17 ground water samples from the existing wells along the palaeochannels in Jaisalmer district of Rajasthan were analysed by the Bhabha Atomic Research Center (BARC), Mumbai on the basis of Pearson model. The analysis indicates the variation in ground water ages from 1340 to 18880 BP at different localities from NE to SW (Rao and Kulkarni, 1997; Nair *et al.* 1999). These areas lie either on the palaeo channel or very close to it viz. Kuriaberi (1340 BP), Ghantiyali (550 BP), Ranau (1930 BP), Sadewala (18800 BP), Longewala (12400 BP), Ghotaru (8910 BP), Dost Mohd. (2000 BP) etc. Hence, age analysis of water samples indicate towards a palaeo source of water along the channels that may be linked to Ghaggar (Saraswati) palaeochannels. The shallow (>30m) and deep (>60m) groundwater along the palaeochannels have similar chemical and isotopic characteristics. The ground water do not have isotopic signature of present day Himalayan rivers. However, the deep groundwater indicates towards origin from Himalayan source. Based on the relative radiocarbon ages, ground water movement (velocity) along the palaeochannels has been estimated as 5m/yr.

River Linking of Vedic Saraswati with Himalayan Sources

Rising in the Himalayas from the holy lake of Mansarovar in Tibet, the Sutlej river enters the plains near Ropar (Punjab), when it takes a sharp right–angled turn and flows westward a distance of 150 km before being joined by the Beas river. The Ghaggar river rises in the Siwalik from the Morni Hills and enters the plains near Ambala (Haryana). After covering a distance of 175 km it joins the Saraswati at Rasula (Patiala district). The combined rivers now known as Ghaggar flows through Sirsa (Haryana), Hanumangarh and Ganganagar district (Rajasthan) and through the Bahawalpur state (Pakistan). The Saraswati rises in the Sirmur region of the Siwalik and enters the plains at Adi Badri (Yamunanagar). After flowing through Karnal in Haryana it joins the Ghaggar near Rasula in Patiala. The Ghaggar bed dries up near Sirsa; Markanda river originates from Nahan and enters the plains near Shahabad.

To be a vibrant mighty river, the Saraswati in Vedic Period must have been contributed by any major river system of the Himalaya. Presently, Sutlej and Yamuna are the two perennial rivers which are likely to be the feeder channels of Vedic Saraswati River in the past. Beyond the range of Siwalik and Lesser Himalaya, these two rivers are fed with the permanent glaciers in the Higher Himalaya. It has been observed from the satellite images that the size of the glacier of Sutlej river is much larger than the size of the Yamunotri and Bandarpunch glaciers. But, due to tectonic changes in the past, these two perennial rivers shifted their course viz. Sutlej to the west to join river Indus and Yamuna to east to join river Ganges near Allahabad. Based on the analysis of several satellite images coupled with the Remote Sensing techniques, the entire course of Saraswati palaeochannels have been delineated from the Himalayan foothills to the Rann of Kachchh, passing through the Thar Desert in NW India (Fig. 10).

Based on the review of different literatures, archaeological findings and synthesized scientific evidences, three following possible connectivity of the Vedic Saraswati with the Himalayan river sources (Sharma and Bhadra, 2009b) have emerged viz. (a) Connectivity of Vedic Saraswati with Sutlej river (2) Connectivity of Vedic Saraswati with Yamuna through Bata/Markanda river (Puri, 2001) and (3) Connectivity of Vedic Saraswati with Yamuna through Drishadvati.

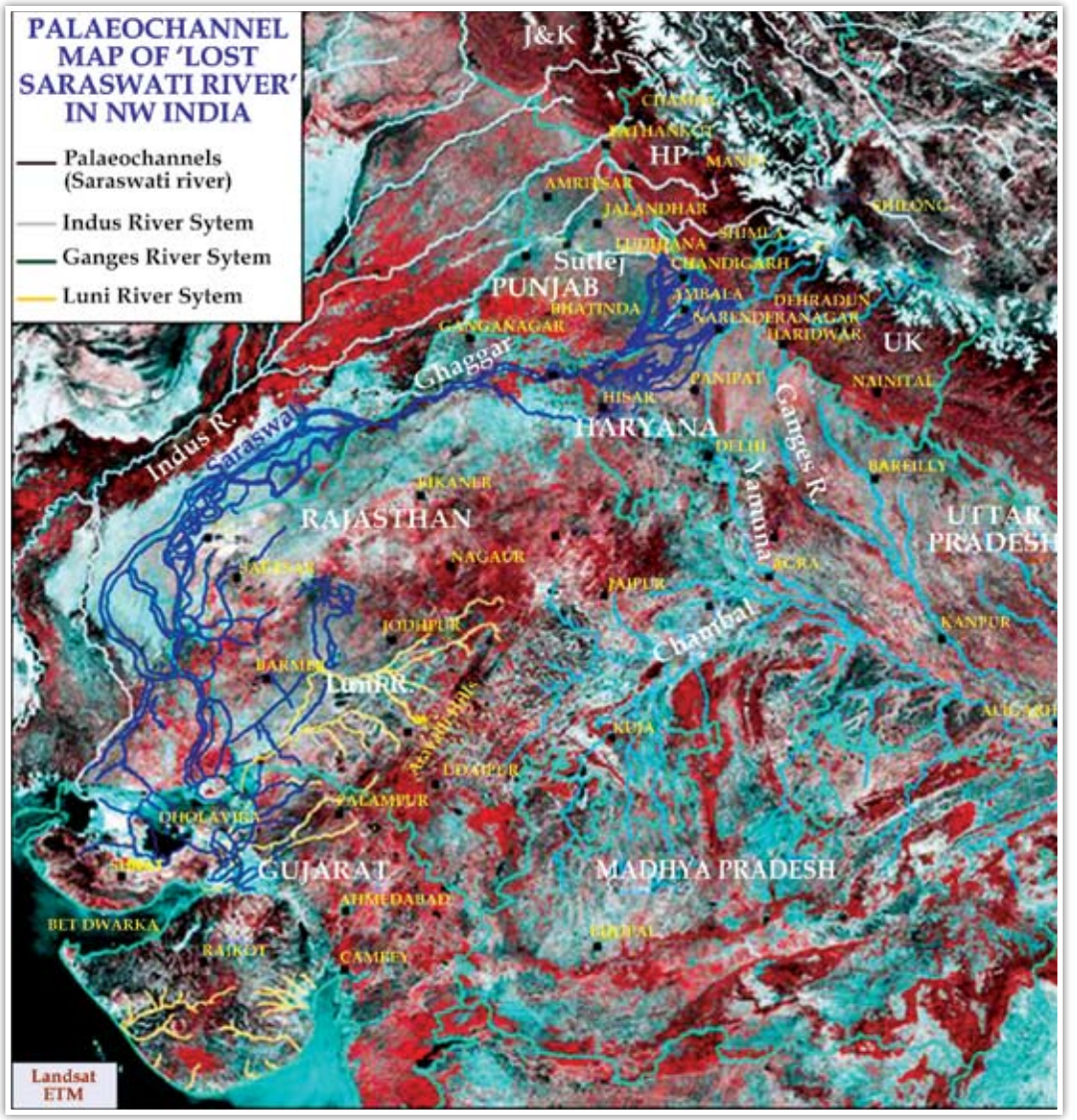

Fig. 10: Satellite image showing the entire network of Saraswati palaeochannels (dark blue lines) in NW India.

Conclusion

The entire course of Vedic Saraswati River has been delineated using latest satellite images. The mapped course is validated with a variety of ground data such as archaeological sites, drilling and hydrogeological data. Radiometric ages of river

sediments suggests that the age of Vedic Saraswati River (older palaeochannels) may be as old as 28,000 years and flourished during 5900 to 2900 years ago which may be represented by younger palaeochannels in Haryana. However, the age of trapped ground water in the palaeochannels in Rajasthan shows contemporary age of Saraswati (1340-8910 BP) and as old as 18800 BP. Present day perennial sources of Sutlej and Yamuna/Tons rivers up to the Siwalik foot hills have been considered as part of Vedic Saraswati River. Apart from Yamuna-Drishadvati connectivity, there is a strong possibility of Yamuna joining through Bata-Markanda river, passing through Adi Badri area. However, more information is required to substantiate the hypothesis.

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Sea Level Fluctuations during last 15000 years and their Impact on Human Settlements*

Rajiv Nigam
Scientist G,
National Institute of Oceanography, Goa
Email : nigam@nio.org

As an oceanographer, I am taking you into the deep of the Indian Ocean. I must admit that my work was not to provide any answer to archaeological problem, rather the intention was to work on past and future climate. But, it is the influence of originally Dr. S.R. Rao that we have started providing certain explanation to unresolved questions of archaeology.

Every year, every day, everybody is talking about the change in climate, and all these things are related to global warming (Fig. 1). The global warming is likely to create problems in the form of the accelerated rise in sea level changes, in monsoon patterns, and in the intensity and frequency of the storms. With reference to the sea level fluctuations we have certain questions to answer; the impact of human behaviour and of anthropogenic changes. The sea level kept fluctuating when man was not on this planet. There are references to such fluctuations available in several ancient books and religious writings. *Gita* contains a reference indicating that Krishna knew pretty well that the city of Dwarka is going to be submerged. If you refer to Quran or see in Bible when Hazarath Nooh was building an ark in the desert area, he was ridiculed by his fellow citizens that he is building a boat but there is no water. Probably he knew pretty well that in future there is going to be water there and he may require that boat.

* Text of invited talk prepared through transcription

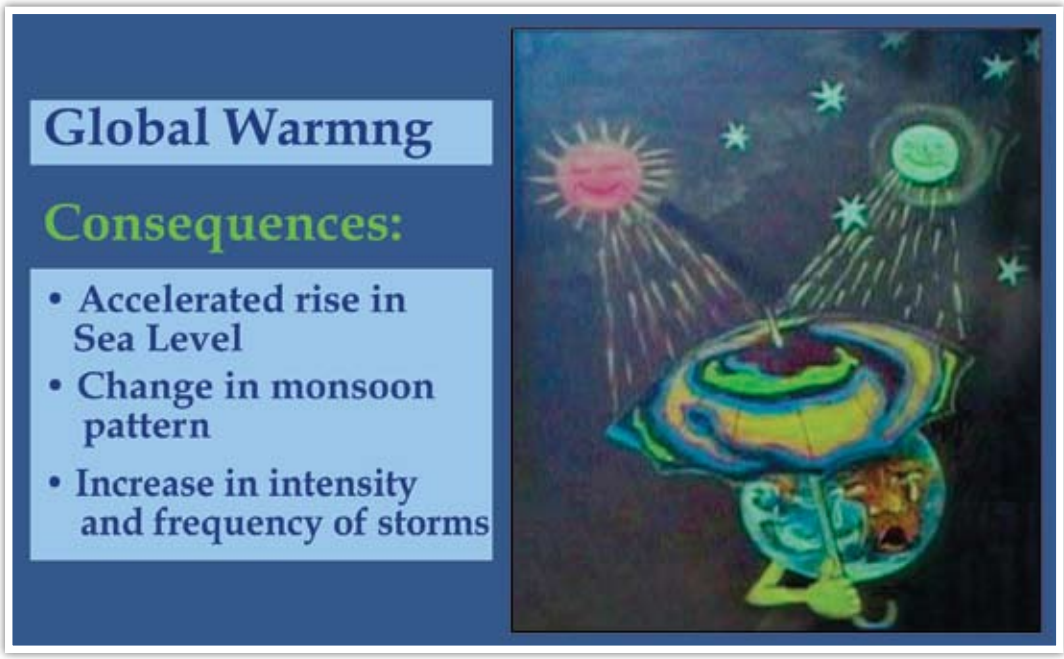

Fig. 1: Showing the Global Warming

As geologists we all know that where the mighty Himalaya stands today there was a sea, the Tethys Sea, once upon a time, but these stories are very old. However, Holocene records of the sea level fluctuations and the sea level curves have also been generated by many scientists for many parts of the world (Fig. 2). In fact the sea level has been going up and down with reference to the mean sea level.

We wanted to have a record of sea level fluctuations in our region. Earlier, it was the climate, which was deciding the destiny of man. Now, probably for the first time it is going to be recorded in the history that man is affecting the climate. Let us see how this relationship goes and how to generate a sea level curve for our region. In order to know how much it will fluctuate there is a growing need to delineate the natural and human induced changes.

Now, here we come in contact with archaeology. The archaeology may be subtly defined as a systemic study of antiques as the means to reconstruct past. The marine sediment can be used to decipher the changes of the Oceanic conditions due to climatic variations in the past. Then the archaeologist and the oceanographer both are reconstructing their past, therefore they have to be

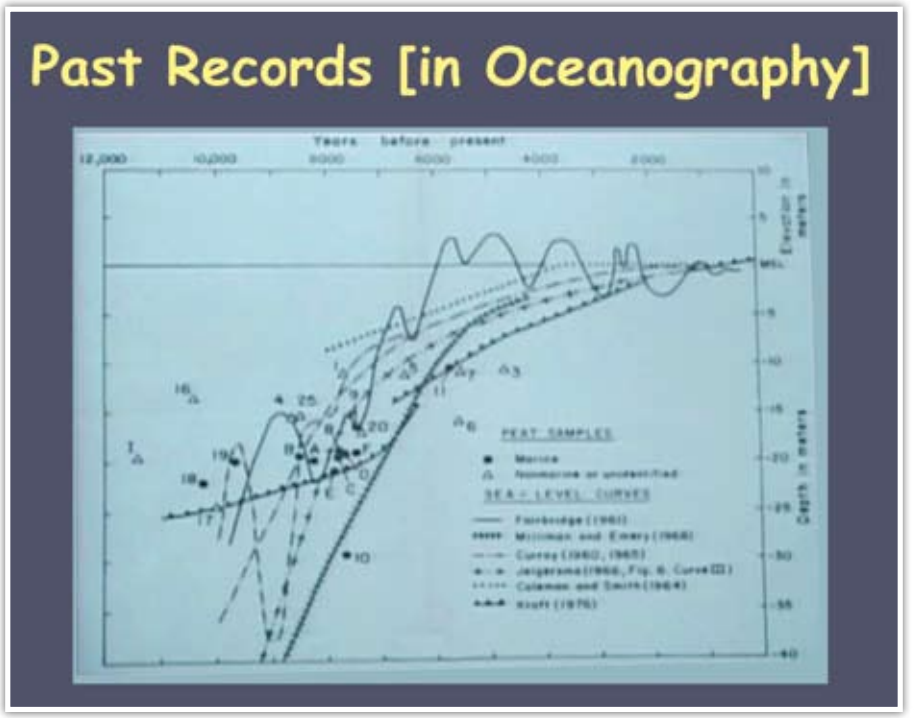

Fig. 2: Sea level curves, generated for many parts of the world

synchronistic in their interpretations. And because of that, we started looking into the results with the reference to the archaeology in the Indian region.

But the big question is how to get the idea of the relative sea level changes during last thousands of years? Therefore our thrust is to enhance the understanding of past sea level changes through the study of micro fossils in marine sediments from the Indian Ocean and adjoining seas. How we get the information? Our tool from which we get the idea about past changes is Foraminifera, a type of micro fossils.

The rivers and the winds bring the sediments into the ocean. The ocean itself is also having a number of small organisms, micro-organisms, which reveal the environment of their lifetime. After their death they all get to the bottom of the sea and form layer after the layer (Fig. 3). If you can collect these layers from sediments at the bottom of the sea and take the core sample, you can separate out these layers and then you can tell about the climate. The sea level at that time and about the types of palaeoclimatic changes which have taken place.

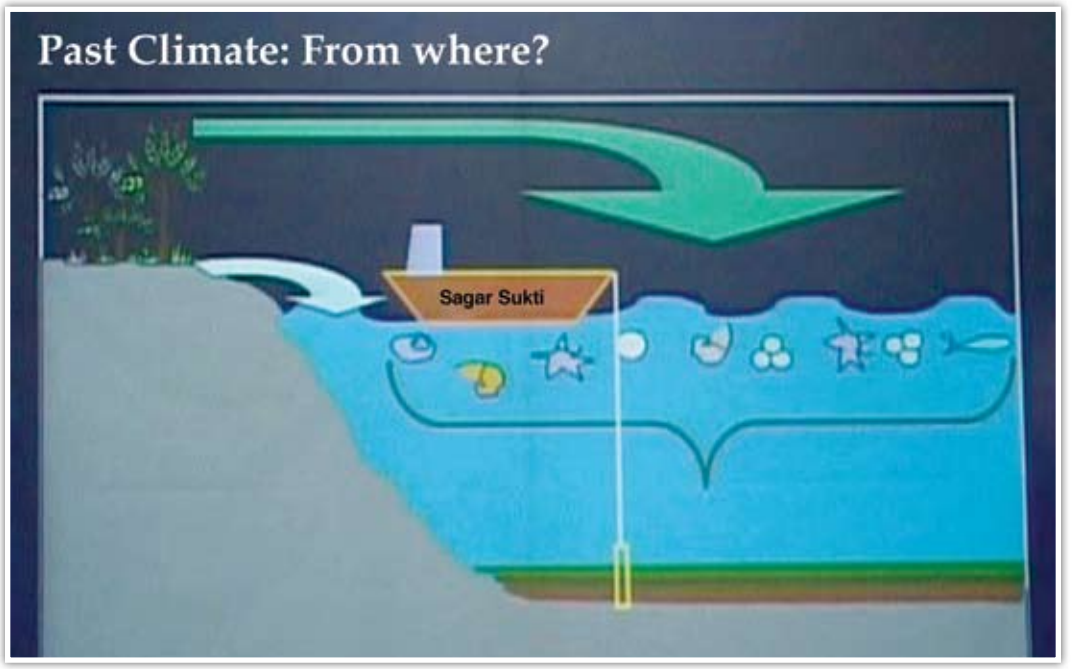

Fig. 3: Showing deposition of microorganisms in bottom of the sea.

This is a basic concept on which out of so many type of microfossils, we take a microorganism called Foraminifera. There are two types of Foraminifera; one is called Planktic Foraminifera and other one is Benthic Foraminifera (Fig. 4).

You can see all of them are something like balloons put together. And some of these live at the bottom of the sea, and after their death get preserved at the bottom of the sea. We have identified about more than 1,000 species from the Indian Ocean. They are less than a millimetre, they are exclusive marine organisms and very sensitive to the environmental changes. Therefore, we use them for deciphering the sea level changes, past monsoon changes and for palaeotsunamis. We also use them for engineering aspects, for pollution monitoring and so on. Today, I will just state a few examples, how did they help for ascertaining the sea level changes? Five slides in Fig. 5 show the Benthic Foraminifera and one shows Planktonic Foraminifera (Fig. 5).

Now, how we can use Foraminifera for determining the palaeo sea levels. Methods of determining palaeo sea level changes based on Foraminifera include: presence or absence of Foraminifera, spacious occurrences, ratios of different groups, oxygen isotopes and morphological variations etc. There are also a number

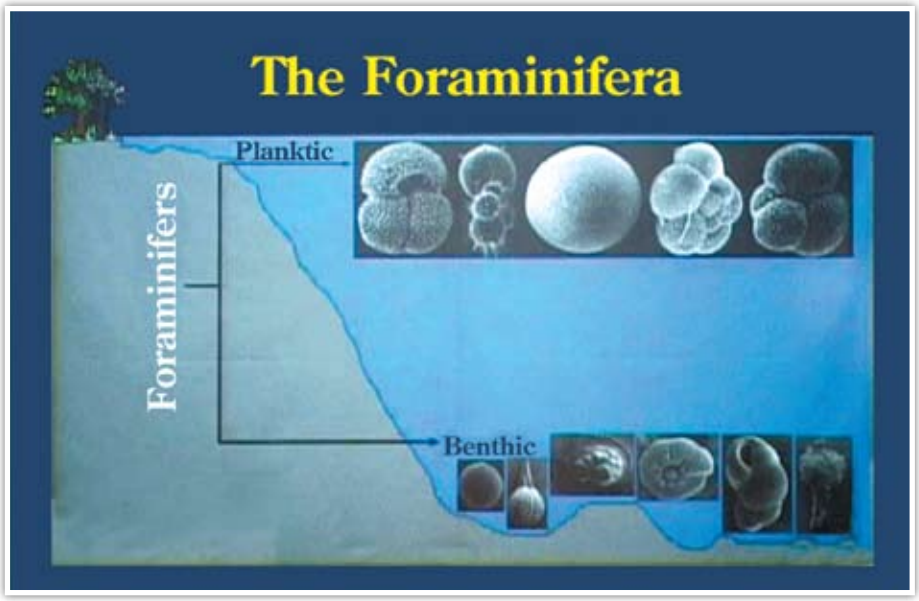

Fig. 4: Various types of Foraminifera

Fig. 5: Showing the Benthic Foraminifera and one is Planktonic Foraminifera (shown in yellow colour)

of other parameters, which we can use to decide further changes in sea levels. I will not go into detail. I will just show some examples. If we want to generate the record of past sea level changes, our strategy has to be two folds. When sea level was higher than today we have to look for those records on land today and when sea level was lower than today we will discuss a little later. First, let us see when sea level was higher than today.

You need not be a palaeontologist or geologists to have this type of application. Since Foraminifora are exclusively marine organisms, we used these for marine archaeology.

Archaeologists use the artefacts like coins or pottery etc, we use these micro fossils. In this context, we may take an example of the site of Lothal which is roughly about 10 to 12 kilometres away from the sea, and few meters above the present sea level (Fig. 6).

In 1954, S. R. Rao had excavated the site which was a very famous discovery! See the picture of the water body called the dockyard (Fig. 7).

Fig. 6: Lothal and other archaeological sites of Gujarat, in red colour

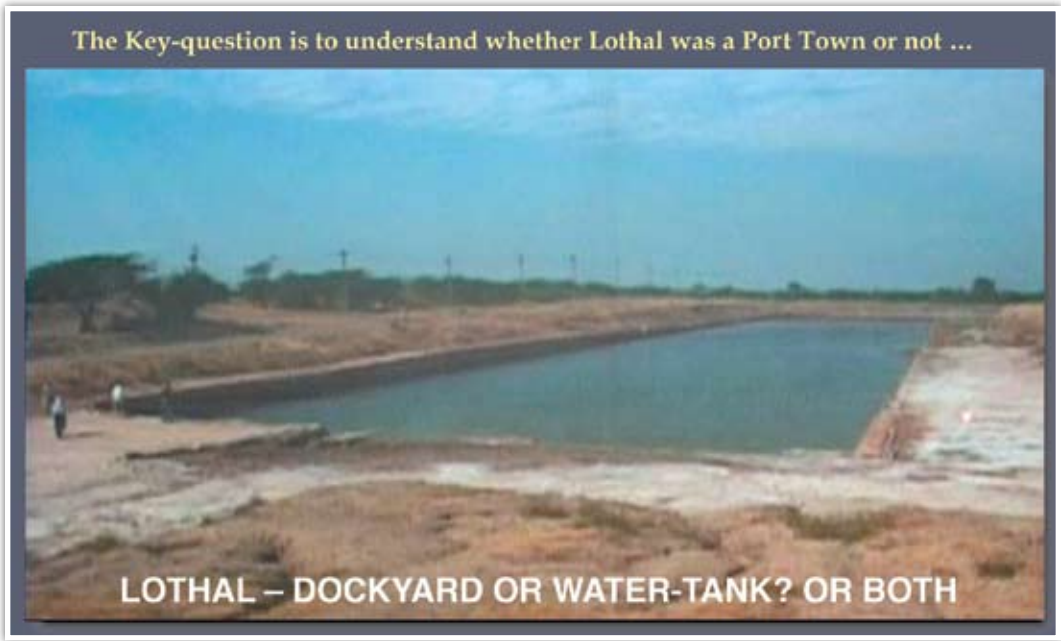

Fig. 7: Dockyard of Lothal

Whether it is science or whether it is archaeology nothing goes without controversy. The moment it was discovered, the controversies also got created. Dr. Assad was of the opinion that it was a dockyard about 4 to 5 thousand years back, and according to him it is a first ever dockyard discovered anywhere in the world, supported by I think Mortimer Wheeler and the other group led by Professor Sankalia of Pune University were of the opinion that this was a fresh water irrigation tank. This controversy went on for about 30 to 40 years. Out of many other arguments I will pick up the argument on how this controversy got created. We found a few stones with the holes like those for an anchor and this indicated that it was a dockyard.

One group said that this stone was used as an anchor stone, and since we found the anchor there must be a boat, therefore, it has to be dockyard. It is not the only argument. There were several other arguments, but others said that the stone was used as a counter weight to lift the water for the irrigation. So, the stone is the same, but interpretations were different.

This controversy went on for a long time because no geologists or palaeontologist were asked to solve this problem. Finally National Institute of Oceanography

(NIO) team was asked to supply the answer after carrying out scientific research. We collected a few samples and analyzed in our lab, and we found existence of well preserved Foraminifera populations (Fig. 8). As we know, Foraminiferas are exclusively marine organisms. So, when these organisms are found in a water body, it cannot be a fresh water body but it has to be a marine water body. And therefore it substantiated the evidence in favour of dockyard theory. Now, still a few things remain to be answered. If this was a dockyard, why is it 12 kilometres away from the sea? What is it doing two meters above the present sea level? Does it indicate that actually this was a dockyard when sea level was higher than today?

This dockyard was connected to the sea through the channel which was also later on discovered by Aniruddha Khadkikar and his team through the remote sensing providing the missing link (Khadkikar *et al.* 2004). When sea level started going down, it went out of use, and the water logged inside slowly evaporated

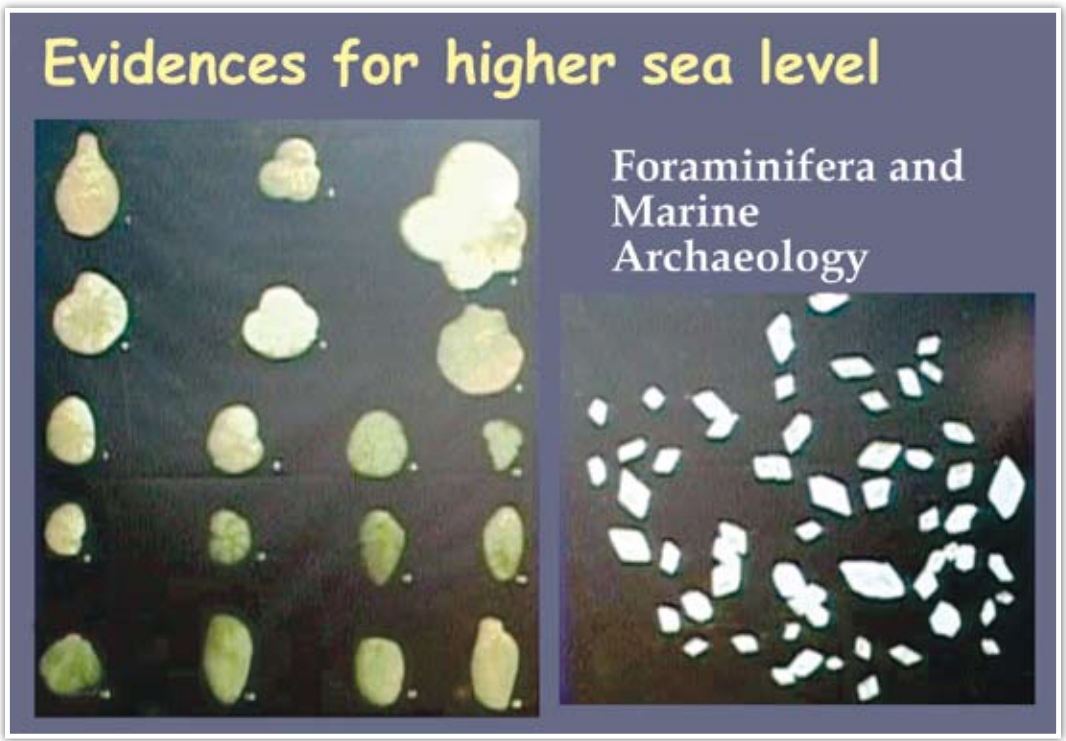

Fig. 8: Samples of Foraminifera (in yellow) and gypsum crystals (in white) collected form Lothal Dockyard

forming some gypsum crystals (Fig. 8). So this is a very classical example emphasizing the need for adoption of an integrated approach. If archaeologists argue among archaeologists or geologists argue among geologists, they cannot solve the problem. If archaeologists, geologists, and space scientists had all come together, they could have provided a credible answer based on pure scientific evidence within two days. In this way it was concluded that this was the first dockyard ever discovered in the world.

It is possible to adopt a two way strategy and you should have knowledge about the shoreline indicator. If today the sea level is increasing the beach and the shoreline move towards the land and if sea level is going down the shoreline moves towards the seaside. Either of these would tell us something about our past. If the sea level is going up, the depth is increasing and if the sea level is going down, the depth is decreasing. Can we get the reports on such kind of fluctuations? Yes, the first report on this region came from Dr. R.R. Nayer (Fig. 9). He proposed a theory that probably sea level was lower than today about 60 to 80 meters around 10,000 years back because fossils in the sediments are found at that depth. Again, controversy never leaves the science. He was criticized that

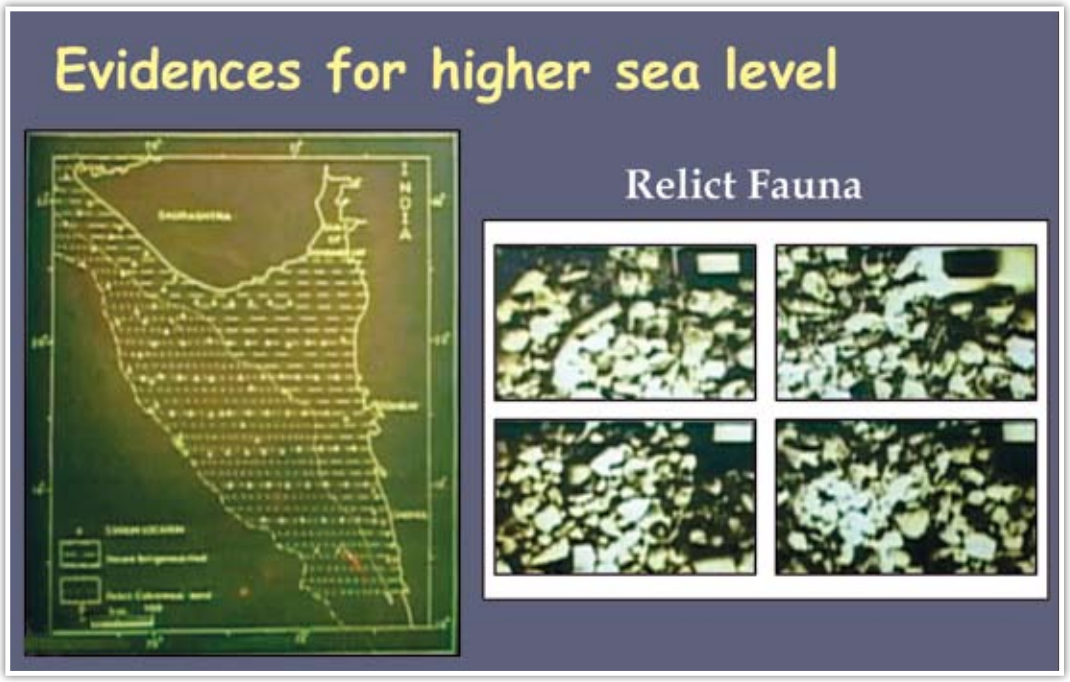

Fig. 9: Showing the evidences for lower sea level, lower then today

these are the rounded particles, formed on the shallower depth and under the force of gravity, these rolled and got deposited at 60 meter depth and therefore may not be true indicators of lower sea level. The answer to this question lies in the fact that if you keep a ball on the slope it can roll down, but if you keep a one rupee coin it cannot roll down. Deposits of Foraminifera get clustered and deposited in a disk shape, something like a one rupee coin but only a few millimetres in size. These cannot roll down and are found at the level where these got deposited.

During the course of investigations it has been discovered the red incrustation of Barnacle fouling on relict Foraminiferal specimens particularly species called *Tetraclita squamosa* is a good shoreline indicator (Fig. 10). *Tetraclita squamosa* shows a high salinity, high energy and intertidal depth of deposition. Today, this species is absent in the modern environment of the west coast of India indicating that they were present in this environment when the sea level was low and later became extinct from the Indian region and migrated towards the Persian Gulf

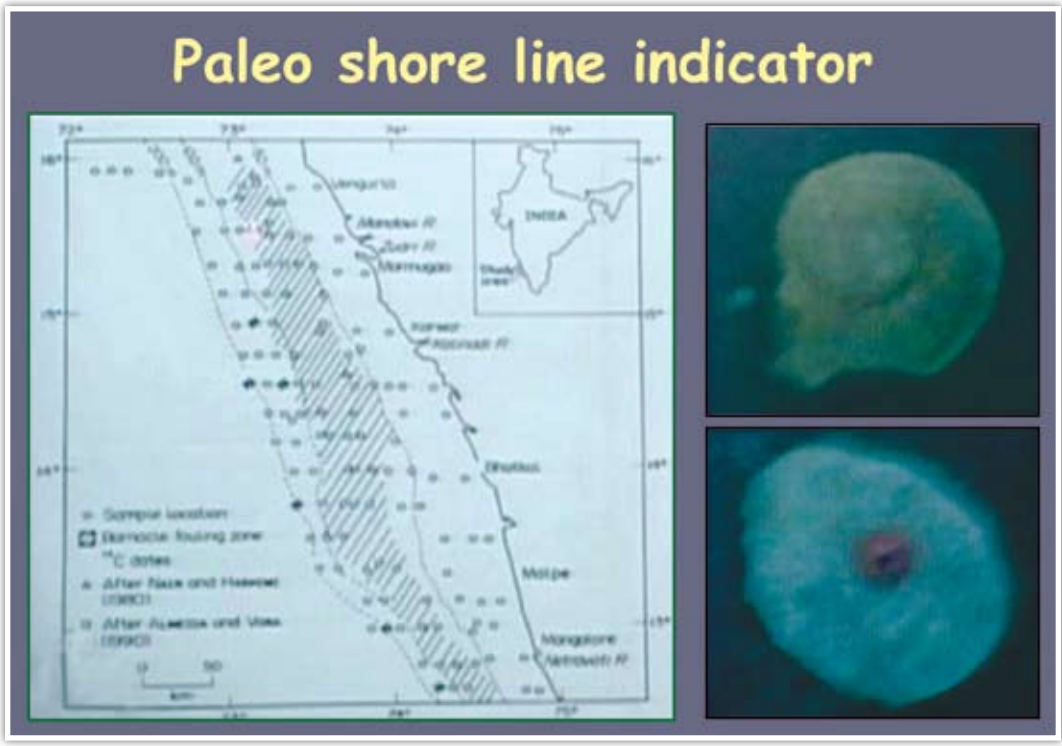

Fig. 10: Showing the red incrustation of Barnacle fouling on relict Foraminiferal specimens

and the Red Sea. So, these became the palaeoshoreline indicators which help us to generate the final curve. Therefore, the specimens of relict Foraminifera with barnacle growth could be considered as tools to monitor palaeo sea levels.

Planktonic Foraminifera species are found in abundance in deeper seas above calcium carbonate composition depth. They have been used extensively to record past oxygen and carbon isotopic fluctuations. Attempts were made to use certain morphological properties (e.g. diameter) of Planktonic Foraminifera for the study of sea level fluctuations during last 10,000 years. The Planktonic Foraminifera species *Orbulina universa* d'Orbigni are found in all oceans. Bé *et al.* (1973) and Hecht *et al.* (1976) studied the variation in mean diameter of the spherical test (external shell) of this species and found that a direct correlation between mean test diameter of *O. universa* and surface water temperature. Some time back Haenel (1987) statistically reanalysed the data of Bé *et al.* (1973) and showed that mean diameter of this species is directly proportional to temperature ($r = 0.90$) and inversely proportional to salinity ($r = -0.46$) and density ($r = -0.93$).

A study of the area of western shelf in Indian Ocean was done. They estimated the percentage of Planktonic specimens in Foraminifera assemblages in 126 surface sediment samples (depth range from 13 to 1050 m) and the resultant model could be expressed in the following equation:

$$P = 20.18 \text{ Log. } D - 61.27$$

P = % of Planktonic Foraminifera in fauna and D = depth in meters

We develop a palaeodepth model based on the percentages. Now, in this if you put the percentage of the Planktonic Foraminifera you can get the depth. It means you take a core sample and then simply see how many of the Planktonic Foraminifera at given different depths are found at different times in the past 10,000 years. Then you get the palaeodepth, put the time versus the depth and you get the sea level curve. Accordingly we find out that around 8800, 5500, and 2200 the sea level was high, punctuated by the lower sea level twice (Fig. 11).

There is another attempt, along the west coast of India, and along the Myanmar coast. If we see the seismic record we see the collection of relict Foraminifera at deferent depths under the sea on the pinnacle points. These indicate the presence of ancient coral reef and we can date them because their potassium carbonate can be dated. When the sea level was going up these became dead reefs, and the reefs moved because these can live only at a particular depth. So as the sea

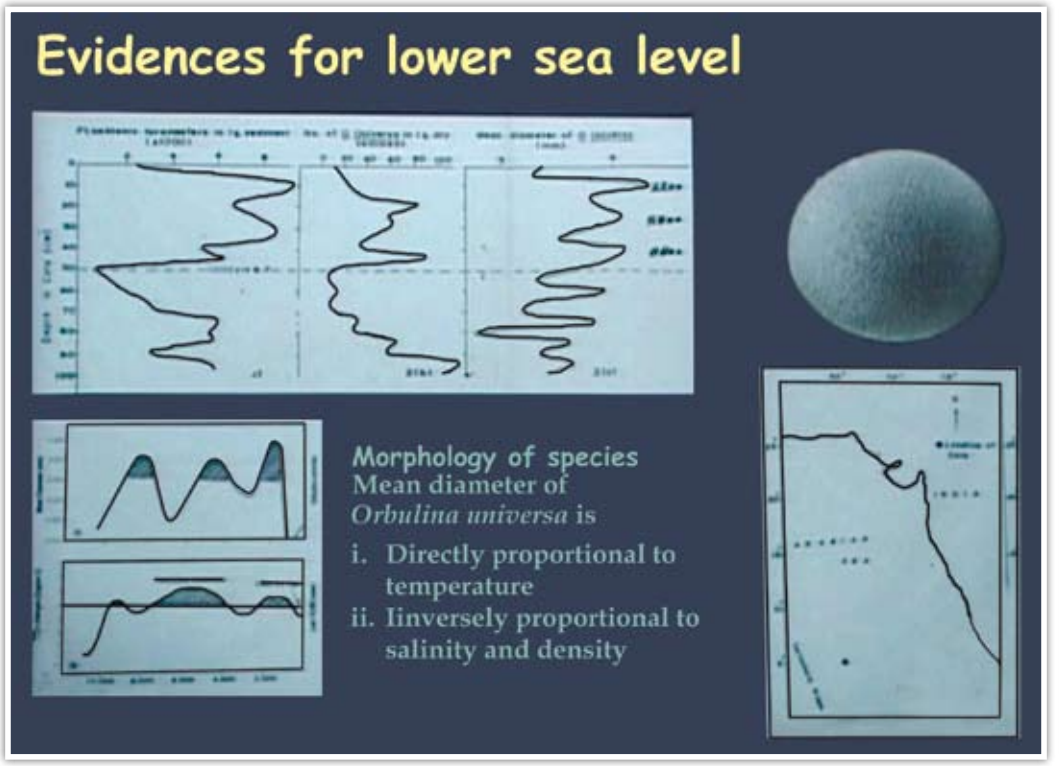

Fig. 11: The palaeodepth model based on the percentages of Planktonic Foraminifera

level started going up they started moving up and finally we got all these dead reefs (Fig. 12), because rise in the sea level was so fast that the reef could not keep the pace and became extinct. If you date these sediments, you can identify the oldest and the youngest.

If you put the depth versus the time you get the sea level curve. Now, by putting all the information together which has been summarized above, the sea level curve for the west coast of India was generated.

Now, let us come back to Lothal, which is around 4500 years BP. The sea level at present is at the dividing line between red and green. The sea level fluctuation curve makes it clear that 4500 years back sea level was at the white dot on the curve on green portion (Fig. 13), which is now land locked. This also explains without a doubt that at Lothal we have a dockyard which is the oldest dockyard in the world.

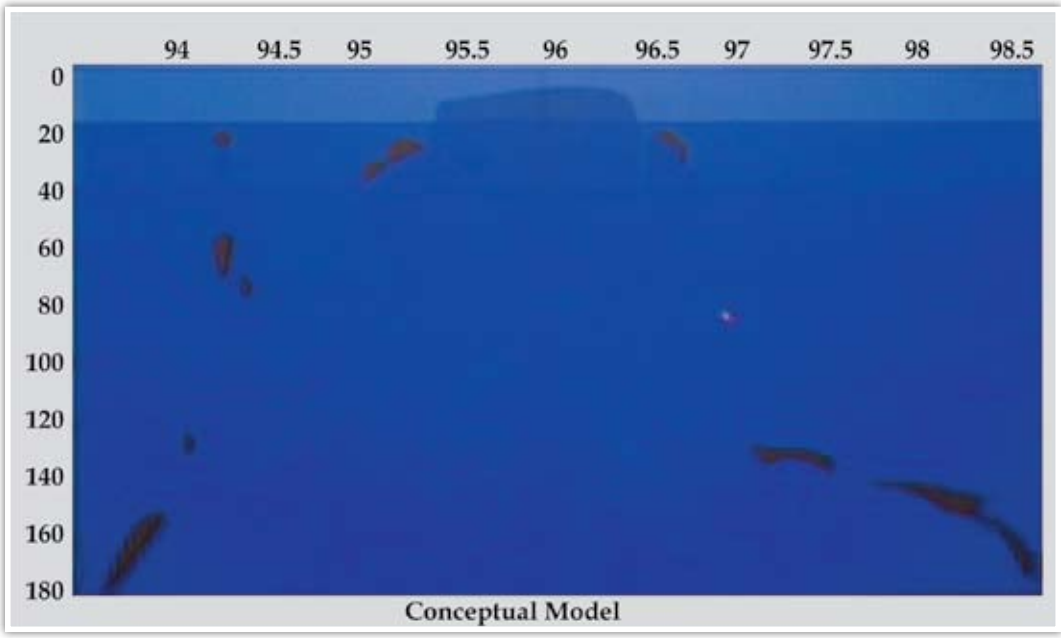

Fig. 12: Showing the deposition of dead reefs in red colour

After that you can see the sea level is going down. This explains another big phenomenon. We are very proud of having excavated the Ancient Dwarka. We got a lot of fame and name for this discovery. This exploration was done by Dr. S. R. Rao and his team (Fig. 14). Dr. Rao was a great pioneer of marine archaeology and he was instrumental in establishing a unit of marine archaeology at the National Institute of Oceanography (NIO) at Goa. There are some very important evidences of the submerged city of Dwarka. We all remember that in Mahabharat it has been stated that Lord Krishna had reclaimed the land from the sea to build the city of Dwarka. When can you reclaim the land? Obviously land can be reclaimed only when the sea level is going down. The curve in the slide clearly reveals that after 4500 BP water level was going down. Consequently Lothal did not remain a port town anymore and slowly became land locked. Since the sea level had come down by more than 4-5 meters in next 1000 years, it became possible to reclaim the land and build the city of Dwarka here around 3500 BP. Various artefacts have been found i.e. lustrous Red ware and other pottery, a copper *lota,* and a bronze bell which have been assigned dates around 3500 BP. Therefore references to building the city of Dwarka by Krishna after reclaiming a part of land get corroborated by this sea level curve. Subsequently

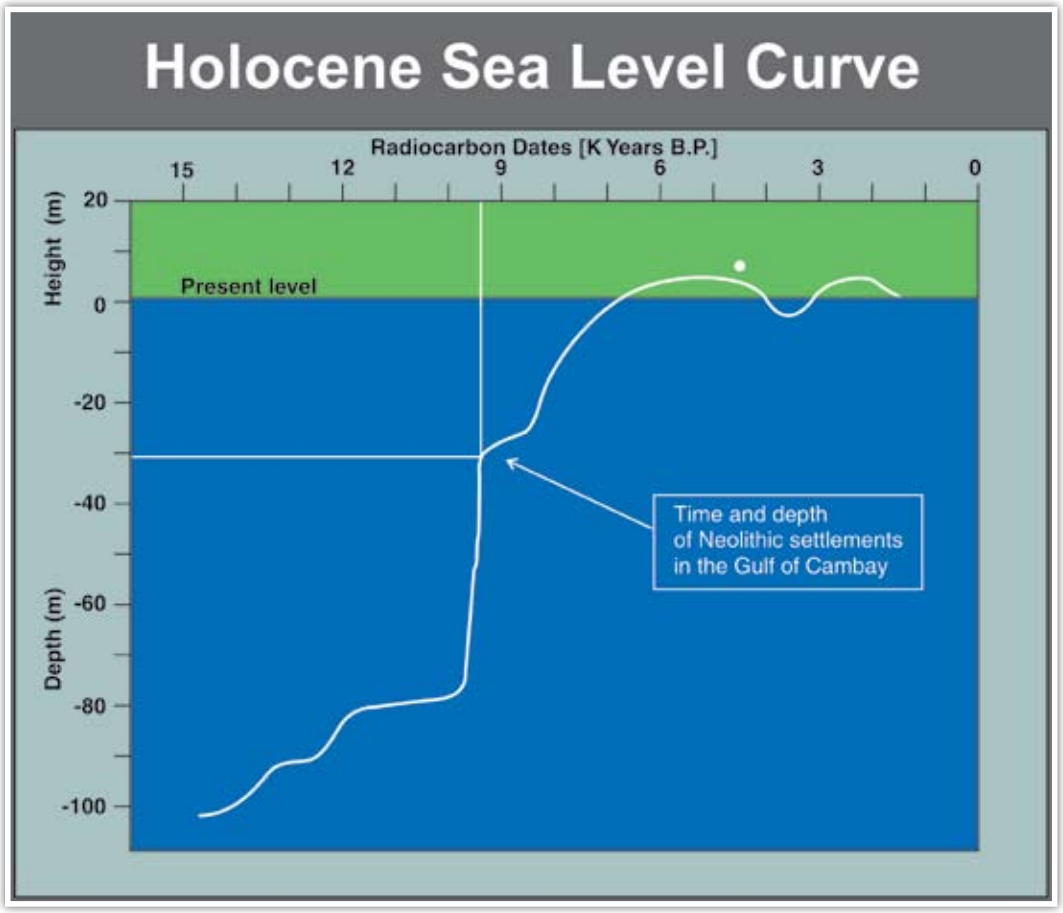

Fig. 13: The Holocene Sea level curve

the sea level started rising and there was some event like Tsunami, under which the city of Dwarka got submerged.

Now, here lies a lesson for all of us. When we talk about reclamation of land from the sea at Bandra, does it not mean the same thing? And when you come very close to the sea and reclaim the land, what can happen? The sea had not pardoned even Lord Krishna and it will not pardon the man also. Therefore never go very close to the sea to construct your properties because due to the global warming sea level might go up and you may lose your property. Therefore laws framed by the government in this regard are people friendly and deserve to be followed.

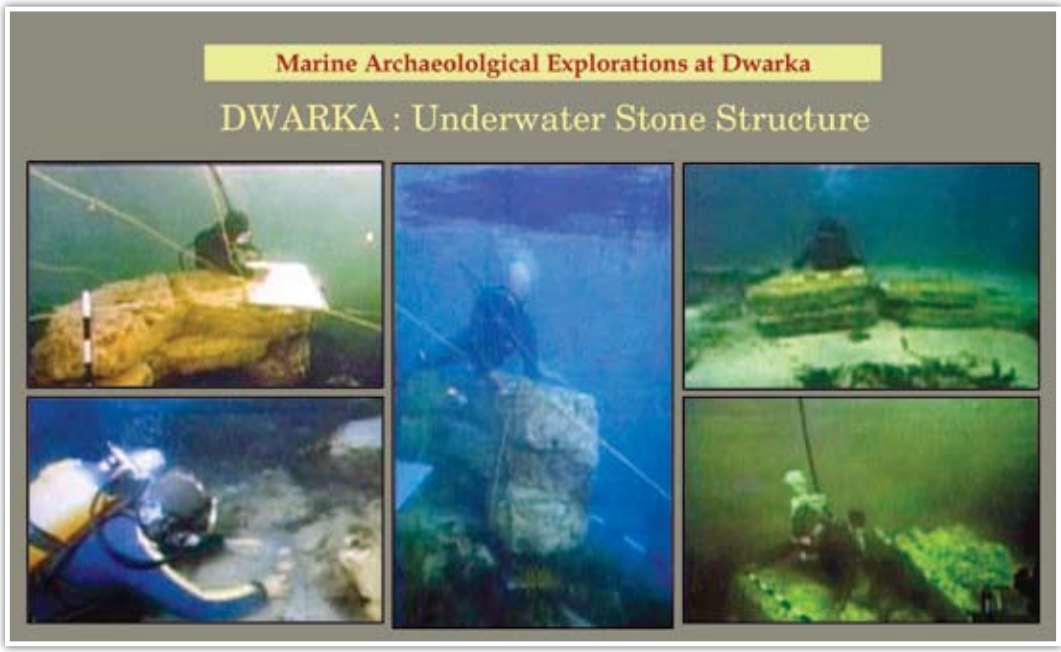

Fig. 14: Showing underwater documentation at Dwarka

But, the story doesn't end here. So far we have explained Lothal and we have explained the submerged city of Dwarka. In the same sequence there was another discovery in Gulf of Khambhat between 20 and 40 km west of Hazira near Surat (Gujarat), which was covered by India Today in a special issue on the archaeology in 2000. National Institute of Ocean Technology by a chance discovery found the remains of an ancient city submerged deep into the ocean. It was really exciting and was a milestone in the field of marine archaeology. The materials collected at the site include artefacts, possible construction elements with holes and studs, pot sherds, beads, fossil bones etc., which provide significant evidence of human activity in the area. A detailed examination in the area has revealed riverine conglomerate at water depth of 30-40 m between 20 and 40 km west of Hazira near Surat (Gujarat). This was dated to be in existence in 7,500 BC. And this was a very sensational study because this was the world's oldest city. Minister gave a press conference and India Today brought out a special magazine. But again nothing goes without controversy. Within a few months the Outlook magazine brought out another issue claiming that it was all hoax and that the story was not true. An important reason due to which such an important discovery got questioned was; how you can have a city at 30-40 meter

water depth? Those who had found it probably were not aware of the history of sea level changes. They tried to answer or explain it in terms of earthquake and tectonic movements etc.

It may be recalled that the news about the 9500 years old submerged city was published in 2000, and the sea level curve explained above was published in 1995. So, nobody can say that we generated a curve to suit a discovery. The sea level curve for the west coast of India shown above may be referred to if this submerged settlement is plotted over this curve, it gives a water depth between 30 to 40 m. This exactly matches with the depth zone in which new findings are reported.

These details thus revealed that a Neolithic settlement in Gulf of Khambhat, setup in 7500 BC, was lost because it submerged under the sea due to the rise in the water level (Fig. 13). Thereafter a civilised port town settlement at Lothal, which was flourishing in 2500 BC, went out of use because of fall in sea level. By 1500 BC the sea level had gone down to such an extent that land could be resumed for setting up the city of Dwarka. However, the rise in sea level and occurrence of Tsunami like phenomenon devoured by the sea again. These discoveries push back the hither to held view of the first human settlement from around 3500 BC to 7500 BC.

A separate sea level curve has not so for been drawn by us for the east coast of India. Since both the west coast as well as the east coast are extended arms of the Indian Ocean, the fluctuations in water level would have been quite similar. Around 7000 years back the sea level was not the same as at present. One look at the sea level curve in the slide makes it clear that between 7000–7200 BP the water level was about three meter below the present level. The astronomical dating of the Rama era has been placed around 7100 BP and Ram Sethu is found submerged at about three meters depth. The above study suggests a need for more concentrated efforts to compile historic and archaeological records through the fluctuations of the sea levels and correlation of fluctuations in sea level curve with the other scientific evidences to arrive at the scientific dating of ancient events and occurrences. The need for collaborative interdisciplinary studies is even more important for Indians because it is likely to make them proud of their most ancient rich cultural heritage. If we shared the pride in this rich heritage, we shall work hard to maintain the high level of civilization and try to enhance the living standard of our fellow citizens:

Who else can be more proud than us as we had the oldest city, dated in 9500 BP within our territory?

Who else can be more proud than us as we had the first ever dockyard, dated in 4500 BP within our territory?

And who else can be more proud than us to have Lord Krishna's Dwarka, dated 2500 BP within our territory, which is the best explored marine archaeological finding in the world?

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Genetic Profile of the People of India during Holocene: Some Inferences

V. R. Rao
Professor, Department of Anthropology
University of Delhi, Delhi
Email : drraovr@yahoo.com

Out of Africa expansion of anatomically modern humans and Palaeolithic continuity of the present day Indian populations is the most parsimonious explanation as of now, based on maternal and paternal haploid DNA lineages and high density autosomal DNA markers. Archaeological dating corroborate with DNA clock of expansion to about 1, 60,000 YBP (years before present). The rout of this expansion, whether north via Levant or south via horn of east Africa to Indian coast to east- Asia to euro-Asia is an intense debate. However, large amount of empirical data from India generated on complete mt DNA sequences of more than 3000 samples from 37 tribal populations by Anthropological Survey of India is irrevocable in support of the southern-rout. Now, it is increasingly believed that the southern-rout is the only expansion by which modern humans moved out of Africa and peopled all other non- African continents. Further support to this tantalizing proposition, even pointing out that Indian populations have ancestral foot prints to Chinese, has come from high density DNA mapping of large number of populations from Asia-Pacific region by international collaborative study.

While situating people of India as representatives of earliest anatomically modern human expansion that resulted in the peopling of the world, the Indian genetic data is also forth-with in explaining the socio-cultural and historical

paradigms like Tribe, Caste, language categories, large scale north-west Indo-Aryan invasion etc. The results are emphatic that ancient genetic substratum and continuity resulted in sharing and Tribe-Caste continuum; language is later super-imposition and shifting of languages is a common phenomenon; large scale invasion which could have resulted in non-Indian genetic lineages in the hierarchical structure of Indian populations does not exist.

DNA dating for Palaeolithic continuity in Indian scenario starts from 60-65 KYBP (thousand years before present) and glacial-inter glacial climatic fluctuations could have largely affected the ancient anatomically modern humans largely surviving on hunter-gatherer subsistence. We do have populations like Jarawas, Onge and Sentinelese of Andaman and Nicobar Islands as direct descendents of earliest human expansion, while all other populations share this ancient substratum.

Holocene Scenario

Continuity of Palaeolithic substratum into Holocene starting from about 13,000 YBP to the present, that witnessed domestication of plants/animals, agricultural expansion, more arid post glacial climatic conditions and the onset of monsoons, has brought in tremendous changes in the genetic profile of Indian populations, especially with respect to change from protein diet of hunter gatherers to starch metabolism as a result of agriculture. The copy number variation of 'amylase gene' for starchy food and regulatory sequence variation of 'lactase gene' for milk consumption are well studied genetic paradigms. Even the genes responsible for present day non-communicable diseases like diabetes, coronary heart diseases, cancer etc have a bearing on the ecological-environmental and cultural conditioning of Indian populations in the Holocene. The most significant outcome of this period is geographical deep rooting of individual populations, with far reaching medical implications, still not realised by the Indian Scientific community, while west has already realised the commercial importance of this human genetic resource.

Without delimiting the medical importance of Holocene genetic architecture of Indian populations, the objective of present presentation is to re-construct the genetic history of people of India during Holocene, particularly with reference to the existing paradigms:

1. Large scale migration from Central Asia or Western Europe pushing the already existing populations to south thereby crediting the Indus Valley Civilization to this exodus.

2. Related issue of paramount contemporary social importance i.e. independent origin of Tribes and Castes.

A deeper understanding of these paradigms require corroborating evidences in the form of scientific dating of ancient events from fields like astronomy, geology, archaeology, flora, fauna, folk tales etc, and Genetics has provided an intense supportive evidence in view of its recent DNA technology with the advantage of coalescence dating and high density markers.

In the present paper, as it is meant for experts from other fields than Genetics, I intend to first explain the DNA technology as is being used for reconstructing the past (archaeogenetics) in simple terms, then proceed with examining the recent findings that is available in reputed scientific journals contributing scientific evidences for a debate on the above mentioned two paradigms. While examining the DNA evidence addressing issues that are of Holocene period (13000 YBP –present), I have briefly touched upon the existing 'Out of Africa Expansion' theory in view of the fact that this theory is crucial in understanding the peopling not only India, but also all other continents, except Africa.

DNA Lineages and Dating

DNA is the blue print of life. All life forms are composed of DNA. It is just a chemical molecule that has an inbuilt mechanism of self replication and codes for proteins, the building blocks of life. The DNA is composed of nucleotides and each nucleotide is a composition of a nucleotide base (commonly known as bases, A,T,G, C), a sugar and phosphate molecules. In Humans, it is found that there are 3 billion pairs of these, A, T, G, Cs. Ultimately the individual uniqueness is in terms of particular arrangement of these 3 billion base pairs. For example if we consider (hypothetical) there are 10 nucleotides, then A,C,T,T,T,C,C,A,G,G could be one combination (array), that defines one individual, where as G,T,A,A,G,C,C,T,C,G could be another combination that defines another individual. Like that we will have 10 to the power 10 number of combinations with each defining an individual (uniqueness). Imagine the immense possibility of this uniqueness if we consider 3 billion. During the life time of an individual, this combination of nucleotides does not change. But, when he or she passes on this combination to his or her child, the child will inherit a further combination (reshuffled) of these nucleotides from two sources i.e. father and mother, a further source of variation and uniqueness. Not only reshuffling but also there can be changes

(mutation) introduced as the DNA passes from generation to generation. It is estimated that approximately there will be one nucleotide change in 2.2 million years. That much is the conservation of the genetic code. This is the principle on which DNA dating is based.

In the reconstruction of ancestry, it is not possible to follow one change (mutation) from generation to generation if reshuffling due to mating (parental) occurs. For that reason, scientists found DNA that does not participate in reshuffling, but passed on from generation to generation, as the changes (mutations) go on accumulating. These DNA are called haploid markers or non-recombinant DNA. In Humans we have two haploid marker systems that are called a) mt DNA (mitochondrial DNA) that passes on from mother to all children, b) non-recombinant portion of Y chromosome (nY), that passes on from father to sons only. Hence, we have a system which can infer maternal inheritance (mt DNA) and paternal inheritance (nY).

Mt DNA is 16569 nucleotides (also known as base pairs) long and nY a million. By sequencing (determining the exact combination, array of nucleotides also known as haplotype), it is possible to determine an individual specific array, which is called DNA lineage. So, we have literally maternal and paternal lineages depending upon which DNA we are using to determine lineages. Depicted below is figure 1 in which we have an ancestral lineage, in which down the time line (say 2.2 million years) a mutation occurred (mutation A) and the lineage is called Haplogroup A (Hg A). Subsequently down the line (2.2 million years) another mutation (mutation B) occurs and the lineage is called Haplogroup B (Hg B). Ultimately at a particular point in time (that is, suppose today) if we analyse DNA in a population, we may find some people with ancestral lineage, some with Hg A and some with Hg B. As far as dating is considered we can date the DNA lineage based on the number of mutations it has accumulated.

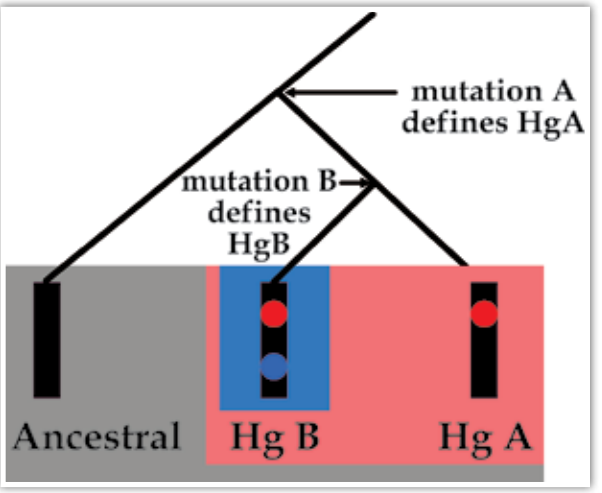

Fig. 1: Showing a General Depiction of Mutations Defining Lineages (World Wide Web source)

Out of Africa Hypothesis and the Rout of Expansion

Cann *et al.* (1987), based on the analyses of mt DNA sampled from contemporary populations from across the world found more diversity (accumulation of more mutations) in African populations, than other continental populations. This finding was further supported by more empirical data by Watson *et al.* (1997) and the hypothesis that a small number of anatomically modern humans possessing mt DNA, L3 lineage migrated out of Africa around 1,60,000 YBP, and expanded forming into continental populations of Asia, Europe, Americas was formulated. Several studies from various populations all over the world with astounding massive empirical data of both mt DNA (maternal) and Y (paternal) markers, support postulated ancient migration histories of populations based on mutations (Fig. 2) and further supported the hypothesis, which is now famously known as 'Out of Africa' hypothesis.

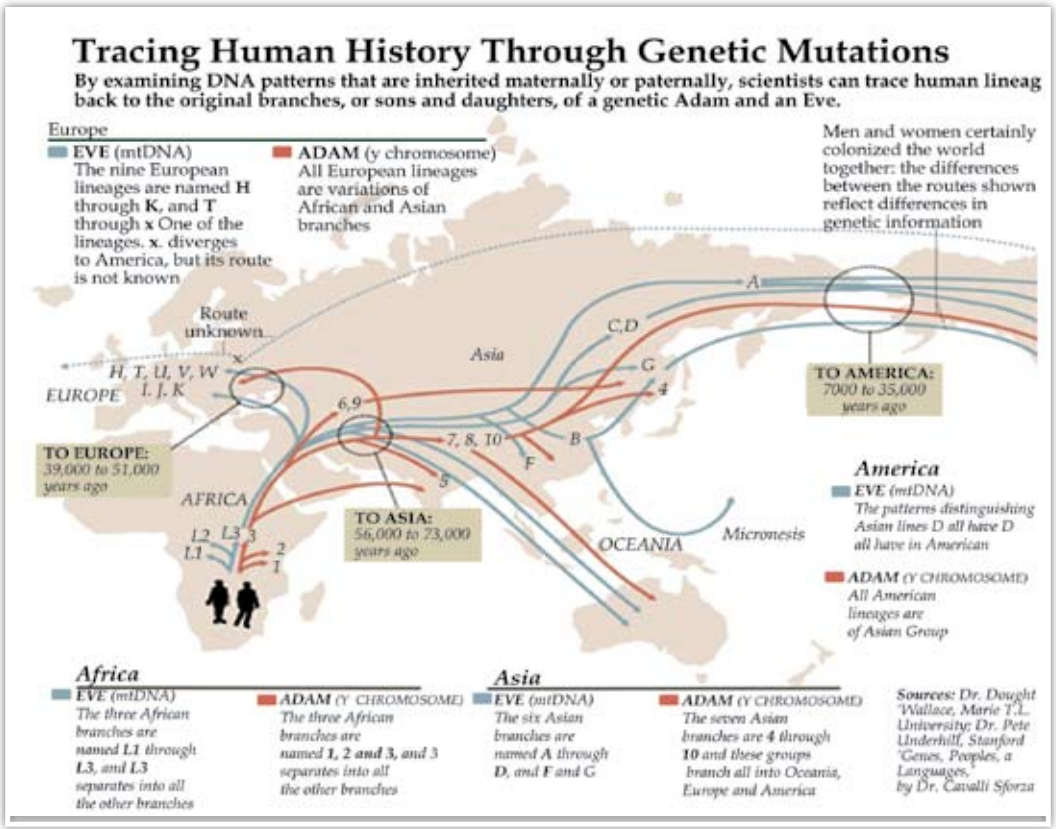

Fig. 2: Showing Major Paternal and Maternal Lineages and Routs of Migrations

The rout of the out of Africa expansion to other continents, whether via Europe, Mediterranean to Asia or via horn of east Africa to South Asia by coastal migration to western, central and eastern Asia to Europe is an intense debate even now (Fig. 3).

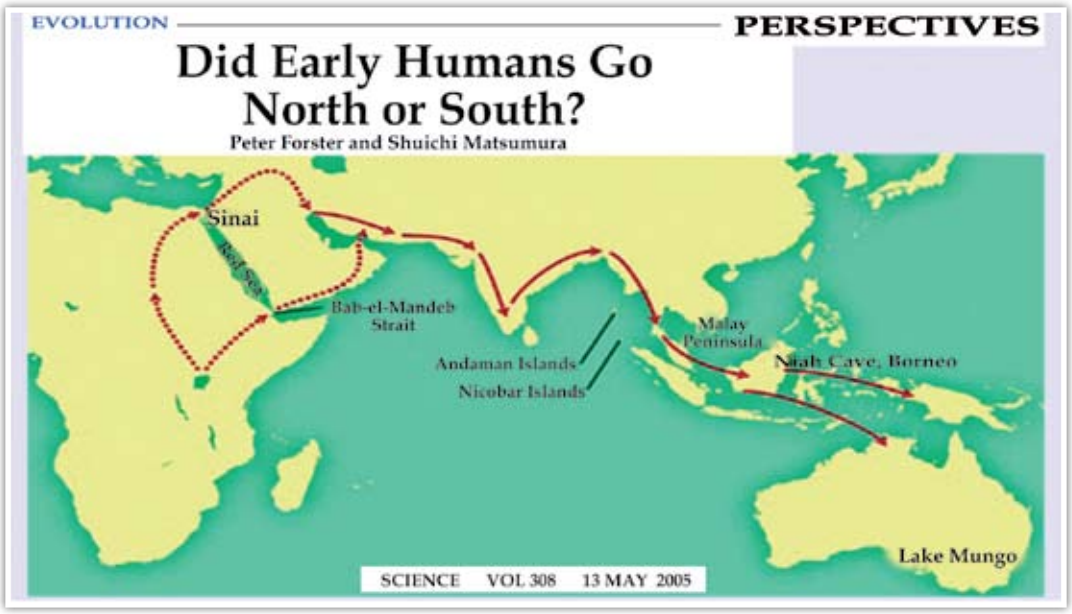

Fig. 3: Showing the Southern Rout Migration of 'Out of Africa Expansion' of Modern Humans

However, extensive population data on Indian Tribal populations by the Anthropological Survey of India publications (Barik *et al.* 2008; Chandrasekar *et al.* 2009; Kumar *et al.* 2009) are equivocal in terms of deep rooted 'in situ' origin of mt DNA lineages and especially the scientific evidence in support of Andaman populations as the direct descendents of out of Africa expansion and sharing of DNA lineages between Indian main land tribes and Australian Aborigines.

The most forthcoming evidence for the importance of South Asia as the corridor of ancient human expansion is from South Asia Pacific Consortium study (Fig. 4), wherein with advanced high density markers, it is conclusive that Indian sub-continent is the place from where other continents including China was populated.

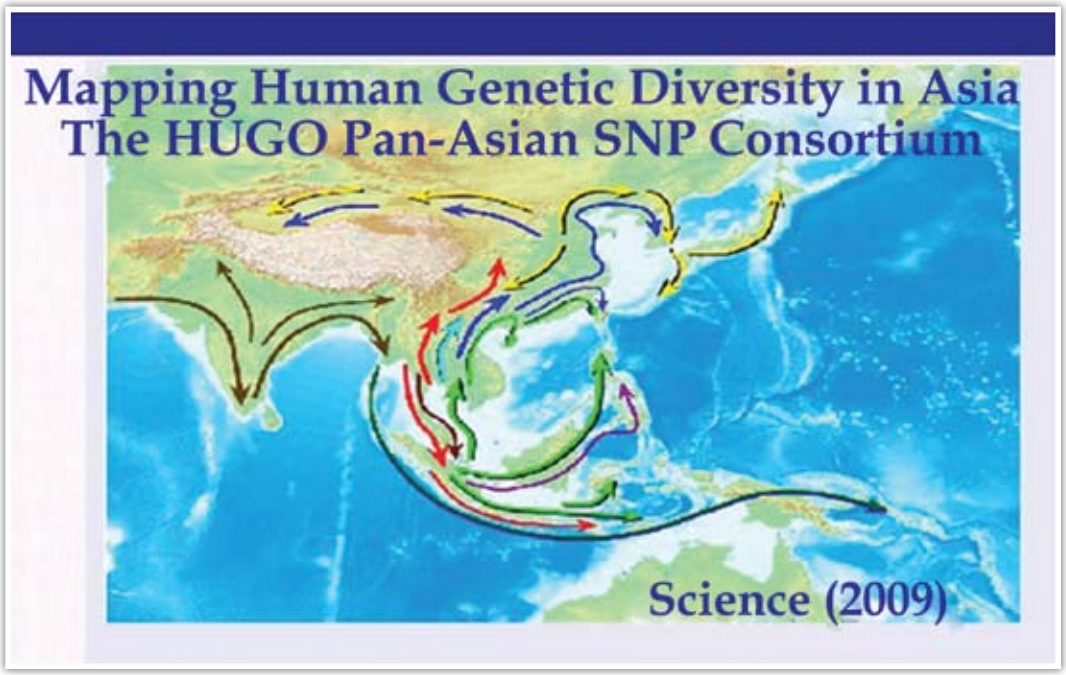

Fig. 4: Showing Major Migratory Routs and Modern Human Expansion from Peninsular India

Challenging the Existing Paradigms

Paradigm 1: *Large scale migration from Central Asia or Western Europe pushed the already existing populations to south thereby crediting the Indus Valley Civilization to this exodus', is being questioned based on the recent DNA studies from Central Asia, Western Europe, Indian sub-continent and other continental populations.*

The notable studies and their conclusions in this respect are:

1. *Deep common ancestry of Indian and western-Eurasian mitochondrial DNA lineages* (Kivisild *et al.* 1999) study summarised that 'the extensive deep late Pleistocene genetic link between contemporary Europeans and Indians, provided by the mtDNA haplogroup U, which encompasses roughly a fifth of mtDNA lineages of both populations estimated to be split and close to the suggested time for the peopling of Asia and the first expansion of anatomically modern humans in Eurasia and likely pre-dates their spread to Europe'.

2. *An Indian Ancestry: a Key for Understanding Human Diversity in Europe and Beyond* (Kivisild *et al.* 2000) concluded that 'Through the analyses of about

1000 mtDNA genomes and 400 Y chromosomes from various locations in India, we reached the following conclusions, relevant to the peopling of Europe in particular and of the Old World in general.

- First, we found that the node of the phylogenetic tree of mtDNA, ancestral to more than 90 per cent of the present-day typically European maternal lineages, is present in India at a relatively high frequency. Inferred coalescence time of this ancestral node is slightly above 50,000 BP.
- Second, we found that haplogroup U is the second most abundant mtDNA variety in India as it is in Europe.

Summing up, we believe that there are now enough reasons not only to question a 'recent Indo-Aryan invasion' into India some 4000 BP, but alternatively to consider India as a part of the common gene pool ancestral to the diversity of human maternal lineages in Europe. Our results on Y-chromosomal diversity of various Indian populations support an early split between Indian and east of Indian paternal lineages, while on a surface, Indian (Sanskrit as well as Dravidic speakers) and European Y-chromosomal lineages are much closer than the corresponding mtDNA variants'.

3. *Polarity and Temporality of High-Resolution Y-Chromosome Distributions in India Identify both Indigenous and Exogenous Expansions and Reveal Minor Genetic Influence of Central Asian Pastoralists* (Sengupta *et al.* 2006) opined that 'using high-resolution data on 69 informative Y-chromosome binary markers and 10 microsatellite markers from a large set of geographically, socially, and linguistically representative ethnic groups of South Asia, we found that the influence of Central Asia on the pre-existing gene pool was minor. The ages of accumulated microsatellite variation in the majority of Indian haplogroups exceed 10,000–15,000 years, which attests to the antiquity of regional differentiation'.

The basic premise of these studies is that DNA lineages are much more ancient in Indian populations than Western Europe and Central Asia, and there is no evidence what so ever of 'Indo-Aryan Exodus' and a proof of it in Indian Populations.

4. *The Genetic Heritage of the Earliest Settlers persists both in Indian Tribal and Caste Populations* (Kivisild *et al.* 2003), the summary of this study is that 'two tribal groups from southern India-the Chenchus and Koyas, were analyzed for variation in mitochondrial DNA (mtDNA), the Y chromosome, and one autosomal locus and were compared with six caste groups from different parts of India, as

well as with western and central Asians. The results show that Indian tribal and caste populations derive largely from the same genetic heritage of Pleistocene southern and western Asians and have received very limited gene flow from external regions since the Holocene. The phylogeography of the primal mtDNA and Y-chromosome founders suggests that these southern Asian Pleistocene coastal settlers from Africa would have provided the inocula for the subsequent differentiation of the distinctive eastern and western Eurasian gene pools.

Paradigm 2: Independent Origin of Tribes and Castes

The premise that out of Africa exodus via coastal route along the Indian sub-continent and Palaeolithic genetic substratum is evident across hierarchical populations of different regions in India. Sharing of genetic elements across tribal and caste populations, challenges the independent and separate origins of Tribes and Castes.

To conclude, in simple language for the common man, anthropological researches have established that DNA dating for Palaeolithic continuity starts from 60000 BC. The genomic evidences in terms of haploid (mt DNA, Y) and high density DNA studies in India have revealed that:

- Palaeolithic continuity and Tribe-Caste continuum, as DNA markers are shared; and the Tribe, Caste divisions are not reflected in the biology.
- Ancient genetic substratum across India cuts across linguistic boundaries, as this substratum is dated much earlier i.e. 60-70 thousand years before present.
- There is no substantial proof for Indo-Aryan invasion, as the DNA lineages have in situ development signatures. Even Eurasian lineages have founder nodes (roots) in Indian lineages, indicating that dispersal probably happened the other way round.

The Genome studies during the Holocene have revealed that the genetic profile of humans settled in north, south, east and west of India is a result of extensive sharing of ancient substratum which is reflected since Holocene (11000 years BP) to the present. It is also significant to note that the inhabitants of the Harappan Civilization were not a mysterious people of unknown biological origins, or migrants from western/central Asia, but they were the indigenous people identified with the pre/early Harappan cultures of north-western region of

the Indian sub-continent. Therefore, contrary to the popular belief, the Dravidians as well as north Indians have common ancestors and both are originals of India, have common genetic profile and had common ancestors.

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For more coverage on the subject, please refer the following books.

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Historicity of Ramayan Era: Scientific Evidences from the Depths of Oceans to the Heights of Skies

Saroj Bala
Director, I-SERVE Delhi Chapter
Email : sarojbala44@yahoo.co.in

The beginning of the Holocene (post last ice age) is now universally accepted to be around 12000 BP. Consequently the civilizations of the world naturally and simultaneously started developing near the rivers which initially started flowing due to the melting of glaciers near the Equator *e.g.* South India, Sri Lanka and Africa. When populations multiplied, these river waters became insufficient. Therefore some people started travelling from south to north. Such northward migration continued for several centuries and finally when these people from south India reached the banks of Himalayan Rivers, they got climatic conditions conducive to long term development of civilization on the banks of these rivers providing security of water, food and shelter for a very long time. Thousands of years later, when some of these Himalayan Rivers became non-perennial or started drying up, some of these people started moving towards Central Asia and Europe. As per ecologists the ecological cycle has been repeating itself and will get repeated after every ice age and during the beginnings of all Holocene cycles. Therefore the history of growth of civilization in the world is not 4 to 5 thousand years old but it is more than 10,000 years old.

So far history of the world, particularly of Indian sub-continent, is based on linguistic guesswork and religious beliefs/hearsay. However, during last 30-40 years, several new scientific tools and techniques have been developed, which are

capable to determining the dates of any ancient events in scientific and precise manner. *For example*:

1. Computer aided extraction of planetary references from ancient books.
2. Planetarium softwares for astronomical dating of such references
3. Satellite based Remote Sensing techniques
4. Underwater explorations and Geospatial Technologies
5. Radiocarbon dating, Thermo Luminescence dating methods
6. Human Genome studies, Biological and Cultural Anthropology
7. Palaeobotanical, Palaeozoological and Palaeoclimatic studies
8. Geographic and Geological research tools.

Multi-disciplinary scientific research reports, prepared during last three-four decades by making use of such scientific tools and techniques, were used for dating the events narrated in Valmiki Ramayan and resuts were amazing! Once the astronomical dating was determined around 7000 BP, it appeared that almost all research reports were corroborating such conclusions and opening before us the pages of our true history; shifting many events from the domain of mythology to the realm of realty.

The story of Shri Ram's life was first narrated by Maharishi Valmiki in the 'Ramayan' which was written after Shri Ram was crowned as the king of Ayodhya, Maharishi Valmiki had a great sense of astronomy as he has made sequential astronomical references on important dates related to the life of Shri Ram indicating the location of planets vis-à-vis the zodiac constellations and other visible stars (*nakshatras*). Needless to add that similar position of planets and *nakshatras* vis-à-vis zodiac constellations and the equinoxes is not repeated in 25690 years. By entering the precise details of the planetary configuration of the important events in the life of Shri Ram as given in the Valmiki Ramayan in the software named 'Planetarium Gold' corresponding exact dates of these events according to English calendar can be known. Sh. Pushkar Bhatnagar of Indian Revenue Service had acquired from USA the software named 'Planetarium Gold' (of Fogware Publishing) which is used to predict the solar/lunar eclipses and distance and location of other planets from earth by the scientists and astronomers. He entered the relevant details about the planetary positions vis-à-vis zodiac constellations narrated by Maharishi Valmiki and obtained very interesting and convincing results, which almost determine the important dates starting from the

birth of Shri Ram to the date of his coming back to Ayodhya after 14 years of exile. Sh. Pushkar Bhatnagar has given very authentic and convincing details of these dates in his book titled 'Dating the Era of Lord Ram' published by Rupa and Co., some extracts from which are also being summarised in the succeeding paras.

Date of Birth of Lord Ram

The following verse in the Valmiki Ramayan provides the details of planetary configuration at the time of Shri Ram's birth.

ततो यज्ञे समाप्ते तु ऋतूनां षट् समत्ययुः।
ततश्च द्वादशे मासे चैत्रे नावमिके तिथौ ॥८॥

नक्षत्रेऽदितिदैवत्ये स्वोच्चसंस्थेषु पञ्चसु।
ग्रहेषु कर्कटे लग्ने वाक्पताविन्दुना सह ॥९॥

प्रोद्यमाने जगन्नाथं सर्वलोकनमस्कृतम् ।
कौसल्याजनयद् रामं दिव्यलक्षणसंयुतम् ॥१०॥ वा.रामा. ॥ १/१८/८-१० ॥

To a man totally unaware of astronomical knowledge of ancient India, this verse may not convey explicitly the details of planetary configurations at the time of Shri Ram's birth. However when one becomes familiar with the basics of Vedic astronomy and compares these with the planetary positions seen in the sky view generated by modern software 'planetarium', one will find the precision with which planetary positions are described by Valmiki as amazing! When Kaushalya gave birth to Sri Ram, the *Janma Lagna i.e.* cancer was rising on the horison; Jupiter and Moon were just rising in Cancer as is clear from the expression 'Prodyamane'. Five planets were in their '*Uchha Sthan*' and were approaching their most exalted positions. This has been the way of expressing the location of planets vis-à-vis constellations in India since Vedic times, which has remained unaltered till date in respect of seven planets (including Sun and Moon), as shown in Table 1.

Table 1 : Exalted (Uchcha) position of *Grahas* in Indian System

ग्रह	*Graha*	उच्च स्थान की राशि	Constellation of Exalted Position
सूर्य	Sun	मेष	Aries
चन्द्रमा	Moon	वृषभ	Taurus
मंगल	Mars	मकर	Capricorn
बुद्ध	Mercury	कन्या	Virgo
बृहस्पति	Jupiter	कर्कट	Cancer
शुक्र	Venus	मीन	Pisces
शनि	Saturn	तुला	Libra

Since it is astronomical fact that if Sun is in its exalted position *i.e.*, in *Mesha* (Aries), *Buddha* (Mercury) cannot be in exalted position in *Kanya* (Virgo). Therefore five planets referred to by Valmiki do not include Mercury (*Buddha*) (Ref. Varaha Mihir in 'Brihat Jatak' and Narsinga Rao in 'Date of Sri Rama').

Therefore it is concluded that as per Valmiki (1/18/8-10), Shri Ram was born on 9th *tithi* of *Chaitra* month during day time when the position of different planets vis-à-vis zodiac constellations and *nakshatras* (visible stars) was as under:

1. Sun in Aries
2. Saturn in Libra
3. Jupiter in Cancer
4. Venus in Pisces
5. Mars in Capricorn
6. Lunar month of *Chaitra*
7. Ninth day after *Amavasya*
8. *Lagna* as Cancer
9. Moon near the star *Punarvasu* (Pollux in Gemini Constellation). Moon and Jupiter were shining together in Cancer.

This data was entered into the 'Planetarium Gold' software, the results indicated that this was exactly the location of planets/stars vis-à-vis zodiac constellations on the 10th of January noon time in the year 5114 BC if viewed from latitude/longitude of Ayodhya (25°N 81°E). If we start the software an hour before the time of birth, we can clearly see the moon moving from Gemini to Cancer at about 12.10 PM. Thus Shri Ram was born on 10th January in 5114 BC (7125 BP).

By making use of software to compute the dates of luni-solar calendar *(Indian*

panchang), it was found that this date also happened to be the 9th day of *Shukla Paksha* in '*Chaitra*' month and the time was around 12 to 1 noontime. This is exactly the time and date when *Ramnavmi* is celebrated all over India till date (Fig. 1).

Date of Exile of Shri Ram

In Valmiki Ramayan it is mentioned in *Ayodhya Kaand* (2/4/18) that Dashratha wanted to make Shri Ram the king because Sun, Mars and Rahu had surrounded

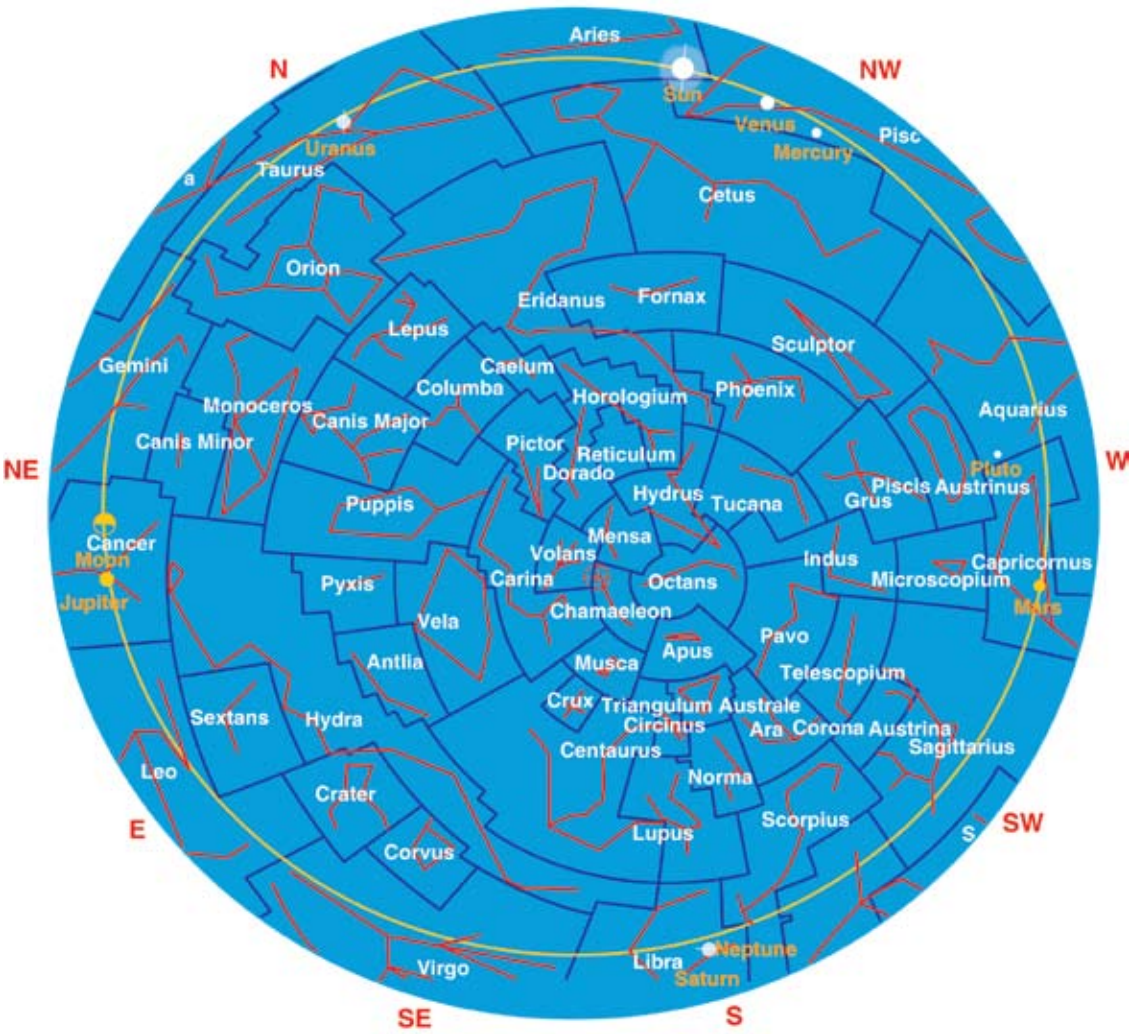


Fig. 1: Showing Planetary position on 10th January, 5114 BC, the date on which Lord Ram was born

his *nakshatra* and normally under such planetary positions the king dies or becomes a victim of conspiracies. Zodiac sign of king Dashratha was Pisces and his *nakshatra* was *Rewati*. This planetary position was prevailing on the 5th of January 5089 BC and it was on this day that Shri Ram had to leave Ayodhya for 14 years. Thus he was 25 years old at that time (5114-5089) and there are several *shlokas* in Valmiki Ramayan which indicate that Shri Ram was 25 years old when he left Ayodhya for his 14 years of exile.

Solar Eclipse during War with Khar-Dushan

Ramayan refers to the solar eclipse at the time of war with Khar-Dushan in later half of 13th year of Shri Ram's stay in the forests. Valmiki has also mentioned that it was *Amavasya* day and planet Mars was in the middle. When this data was entered, the sky view generated by computer software indicated that there was a solar eclipse on 7th October, 5077 BC (*Amavasya day*) which could be seen from Panchvati (20° N; 73° E) (Fig. 2). On that date planetary configuration was the same as has been described by Valmiki *i.e.* Mars was in the middle; on one side were Mercury, Venus and Jupiter and on the other side were Sun, Moon and Saturn.

Other Eclipses mentioned in Ramayan

In Kishkindha kaand there is a reference to solar eclipse (4/15/3) on the day Bali was killed. Software shows a solar eclipse on 3rd April 5076 BC which was the only solar eclipse during the entire year.

In Sunder Kaand there is a reference to lunar eclipse when Hanuman spots Sita in Ashok Vatika (5/19/14, 5/29/7, 5/35/87). Sky view reveals lunar eclipse starting from 4.15 pm on 12th September 5076 BC from Colombo (7°N; 80°E)

All these sequentially fully tally with the description in Ramayan.

Other Important Dates

Only six of the twelve constellations remain above the horizon at the same time. Valmiki Ramayan contains graphic and poetic details of eight constellations during Hanuman's return journey from Sri Lanka to Sunaabh Hill in the middle of the sea which apparently took about four and a half hours from 6:30 AM to 11 AM. All these details of planets and *nakshtras* with reference to eight

Fig. 2: Showing Planetary position on 7th October, 5077 BC (Amavasya), the day of Solar Eclipse, when Lord Ram fought the battle with Khar.

constellations described in Sarga 57 (1, 2, 3) of chapter five tally exactly with the sky view generated by the software for the morning of 14th September 5076 BC from Lanka (7°N, 80°E) (Fig. 3 and 4).

Slide at figure 3 shows the sky at 6.30 AM on 14th September 5076 BC from Sri Lanka. As described in Ramayan, see that the Sun and Moon are shining

Fig. 3: Showing Planetary position on 14th September, 5076 BC at 6.30 AM, when Hanuman started his return journey from Lanka.

together and Jupiter could also be seen very clearly. Punarvasu nakshatra in Gemini constellation which resembles a large fish, Pushya nakshatra in Cancer Constellation and Swati Nakshatra in Virgo Zodiac could be seen shining in the sky. Scorpio Zodiac which resembles the trunk of an elephant (Airavat) could also be seen. This is the sky view at the time when Hanuman started his return journey at about 6:30 AM on 14th September, 5076 BC.

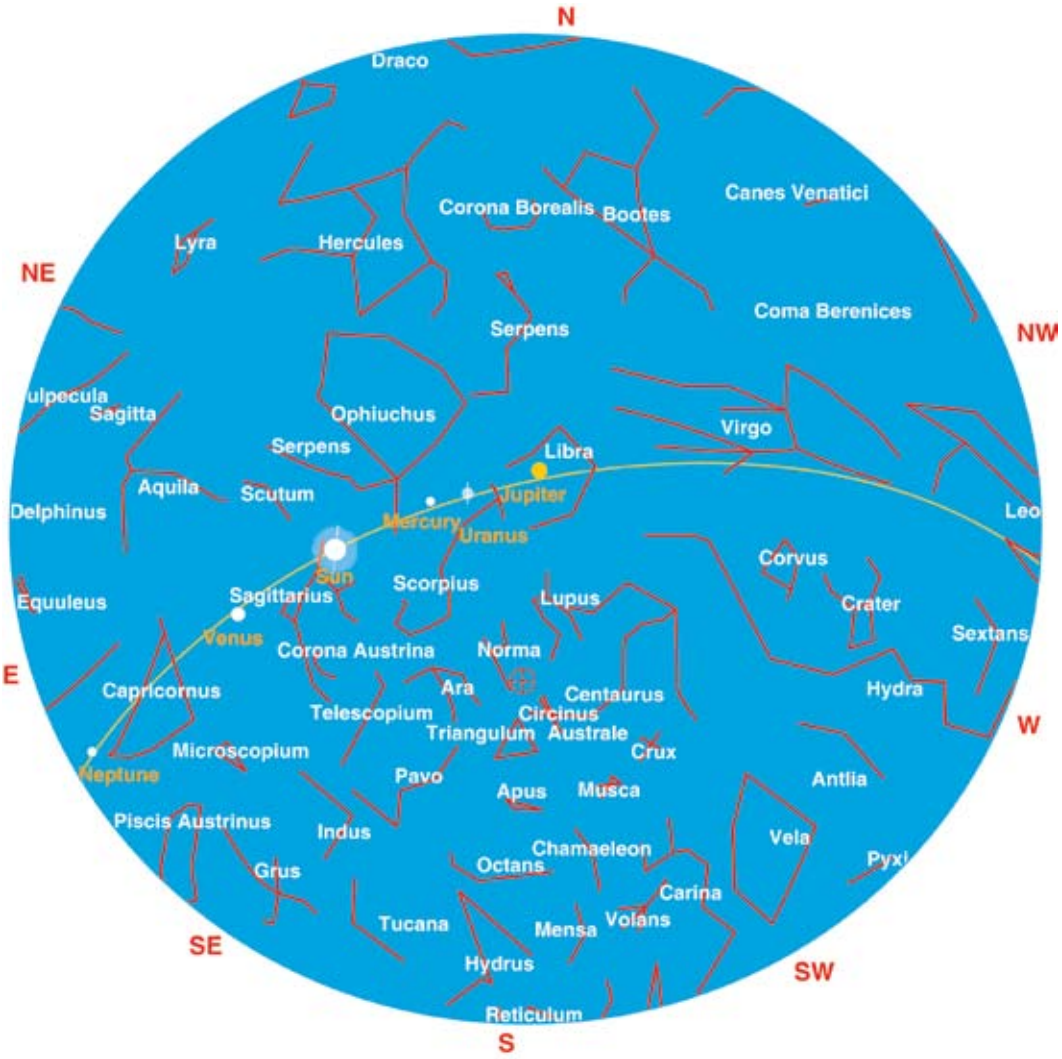


Fig. 4: Shows the sky of 14th September 5076 BC at 10 AM when Hanuman reached Sunaabh hill in the middle of the sea

Slide at figure 4 shows the sky of 14th September 5076 BC at 10 AM from Sri Lanka. While the slide showed the time of Hanuman starting his return journey, this slide shows the time when he reached the middle of the sea to rest on Sunaabh hill. The only nakshatra, which could not be displayed in the previous slide, was the Shrawan in Capricornus zodiac since it rises at about 10:30 AM.

Note that Capricorn constellation looks like an island if the sky is taken as sea as is described by Valmiki.

On the basis of planetary configurations described in various other chapters of Valmiki Ramayan, the date on which Ravana was killed works out to be 4th December 5076 BC and Shri Ram completed 14 years of exile on 2nd January, 5075 BC and that day was also *Navami* of *Shukla Paksha* in *Chaitra* month. Thus Shri Ram had come back to Ayodhya when he was 39 years old (5114-5075).

Such sequential matching of important dates in the life of Lord Ram narrated in Valmiki Ramayan with astronomical dating of planetary references done with help of planetarium software cannot be a mere coincidence. In fact if we extract more than fifty references to location of planets and nakshatras described in Valmiki Ramayan relating to important events in the life of Lord Ram and then put the skyview generated by planetarium on timer starting with the skyview at the time of birth of Shri Ram *i.e.* on 10th Jan, 5114 BC, the sequence is entirely matching and there is almost total internal consistency!

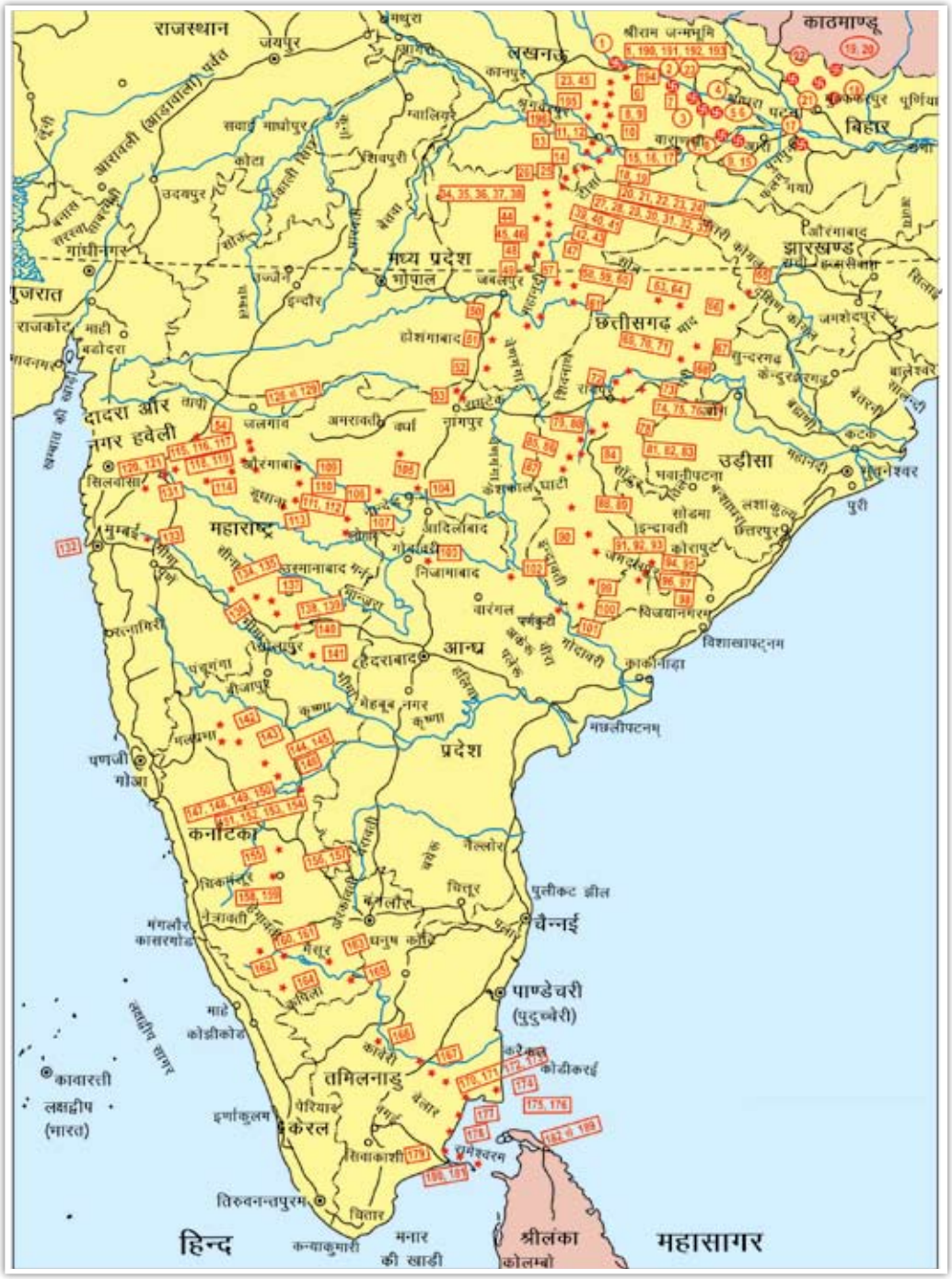
Sequential Details of Places visited by Shri Ram during 14 years of exile: Geographic Evidences

Many researchers, particularly a colleague Dr. Ram Autar, have researched on places visited by Shri Ram during 14 years of exile. They sequentially moved to the places stated as visited by Shri Ram in the Valmiki Ramayan. Starting from Ayodhya, they went right up to Rameshwaram. They found 189 (+60 identified later on) places, most of which still have the memorials connected to the events relating to the life of Shri Ram and Sita and also match the description given in Ramayan (Map 1).

The locals believe that Shri Ram had actually visited these places. These details have been compiled in his book 'In the Footsteps of Shri Ram'. These details can be broadly divided into five phases.

First Phase-Gangetic Belt

They went to Tamsa Nadi Tal (Mandah), 20 km from Ayodhya, thereafter crossed Gomti river (Point no. 2 to 7 of map 1) and reached on the banks of Saryu river. After crossing the boundary of Kosal Desh, they entered Shringaverapura (Srigraur) which was kingdom of Nishadraj Guh and is famous for Kewat taking them across Ganga in his boat (20 km from Allahabad).



Map 1 : Showing places visited by Lord Ram during Exile (shown in red spots)

After crossing Yamuna near Sangam they reached Chitrakoot on Uttar Pradesh (UP) and Madhya Pradesh (MP) borders – memorials here include Valmiki Ashram, Mandavya Ashram, Bharat Koop etc which still exist. After Bharat Milap they left Chitrakoot and went to Atri Ashram located in Satana in MP.

Second Phase in *Dandak Van*

Along with Laxman and Sita, Shri Ram extensively travelled through this land of rivulets, water bodies and dense forests in and around MP and Chhattisgarh. They roamed around in *Dandak Aranya* area and visited Sharbhang and Sutikshan *Muni ashrams* in Satna (Points 36 to 41 of map 1). Thereafter, they visited several *Rishi ashrams* in Madhya Pradesh and Chhattisgarh area, along Narmada and Mahanadi rivers for 10 years, and then came back to Sutikshan *ashram*. Several memorials in Panna, Raipur, Bastar and Jagdalpur still exist which include Mandavya *ashram*, Shringi *ashram*, Ram Laxman *Mandir* and Koti Maheshwar etc.

After crossing many rivers, lakes, hills and forests they went to Agastya *ashram* in Nasik. As per Valmiki, weapons made in *Agnishala* were given to Shri Ram by Agastya *Muni* in this *ashram*.

Third Phase along Godavari

Shri Ram, Laxman and Sita travelled along Godavari, From Agastya *ashram* they went to stay in Panchavati – a place with 5 *Vatavriksha* located on the banks of Godavari in Nasik (Point no. 116 of map 1). This place is famous for Surpanakha episode and war with Khar and Dushan. There are memorials at the place where Mareech was stated as killed; these include Mrigvyadheshwar and Baneshwar. In fact, Nasik area is full of memorials, *e.g.* Sita *Sarovar*, Ram *Kund* and Triambakeshwar and Janasthan etc. After this incident, Sita was abducted by Ravana, who also killed Jatayu relating to which memorial '*Sarvatiratha*' in Taked Village, 56 km from Nasik, is still preserved.

Fourth Phase along Tungbhadra and Kaveri

Shri Ram and Laxman extensively travelled through these areas in search of Sita. After meeting Jatayu and Kabandh they moved towards south to reach Rishyamook *Parbat*. On the way they visited Shabari *ashram* in Pampasarovar area which is now known as Sureban in Belgaon and is still famous for *Ber* trees. (Point no. 146 and 147 of map 1). After crossing forests of Sandalwood, many gardens and water bodies, they went towards Rishyamook. Here they met

Hanuman and Sugreev, and were shown Sita's ornaments. Shri Ram killed Bali in this area. Rishyamook and Kishkindha are located in Hampi, Bellary District of Karnataka.

Fifth Phase

Ram with his *sena* marched towards the sea. After crossing Malay *Parbat*, Chandan forests, many rivers and ponds they went along Kaveri River. After crossing Trishirapalli, Thanjavur and Ramanathapuram, they reached Rameshwaram. **Almost all the details of travel narrated in all these five phases in Valmiki Ramayan tally with the existing geographic locations and memorials preserved**.

Places in Sri Lanka

The location and physical features of areas, covered under Ravana falls, Ravana caves and Ashok Vatika in and around Nuwara Elya Hills in Sri Lanka, will persuade anyone to believe that *Valmiki*, the author of Ramayan, was fully familiar with all these places. Vibhishan palace is also located almost at the same place as is described in Ramayan.

Most of these places have similar geographic features, flora, fauna and memorials as have been described in Ramayan. If Valmiki had not visited/known about these places, how could he give such precise details in Ramayan which was composed as biography of Shri Ram when he was coronated as the King of Ayodhya in 5075 BC (1/4/1, 2). Originally it was passed on through *shruti smriti* tradition for hundreds of years but was available in text form by around 1000 BC. References of Ram's story are available in:

- Kautilya's Arthasastra of 4th century BC.
- Buddhist literature in the form of 'Dasharatha Jaraka' ascribable to 3rd century BC.
- Terracotta figures of Ram ascribable to 2nd century BC excavated from Kaushambi.
- Stone panels excavated at Nagarjunakonda in Andhra Pradesh of 3rd century AD showing Ram-Bharat milap at Chitrakoot.
- Terracotta panels of 4th century AD excavated from Nachara Khera in Haryana.

- 'Janaki Haran', a poetic composition of Kumaradasa of Sri Lanka who lived in 7th century AD.

There are hundreds of other evidences found not only from India but from countries like Sri Lanka, Tibet, Thailand, Malayasia, Combodia and Indonesia. In Nepal oldest manuscript of Valmiki Ramayan written in 1041 AD in Newari script is still preserved, probably the oldest preserved manuscript of the world.

Corroborating Archaeological and Geological Evidences found at some of these places referred to in Ramayan:

The latest archaeological excavations, geological researches and remote sensing images have provided a large volume of new data revealing the indigenous origin and development of civilization in the Indian sub-continent since 10,000 BP (8000 BC). Many of these reports are related to the sites located in and around places referred to in Ramayan. Some important examples are:

- In Allahabad district, referred to in Ramayan as Sangam (confluence of Ganga and Yamuna), archaeological excavations at Koldihwa, Jhusi and Hetapatti have revealed remarkable evidence of continued and developing human settlements since 6th–7th millennium BC. Excavations at Sringaverpura and Bhardwaj Asram, which is located just opposite Anand Bhawan, have thrown important evidences corroborating references in Ramayan.

- In Ayodhya, which was the capital of Kosal Kingdom, archaeological excavations carried out twice on the orders of the court revealed existence of civilized settlements through many millennia as well as damaged remains of ancient Hindu temples [Ayodhya Matter Ram Janam Bhumi – Babri Masjid Disputes (Special Bench judgement) Allahabad High Court (Lucknow Bench) published by Malhotra Law House]. In adjacent district of Sant Kabir Nagar at Lahuradeva, excavations have revealed five cultural periods showing continuous cultural development from 7th millennium BC to the beginnings of Christian era. The evidence of cultivated rice, ornaments of steatite disc beads and copper arrowheads before 5th millennium BC has also been found at Lahuradeva; these articles have also been referred to in Ramayan. (Fig. 5A, B, C and D respectively).

Geological evidences gathered from Kotumsar caves located in the thick Dandak forests in Bastar district of Chhattisgarh, from areas around Sarbhang

Fig. 5A: Grains of domesticated rice from Lahuradeva, 7000 BC

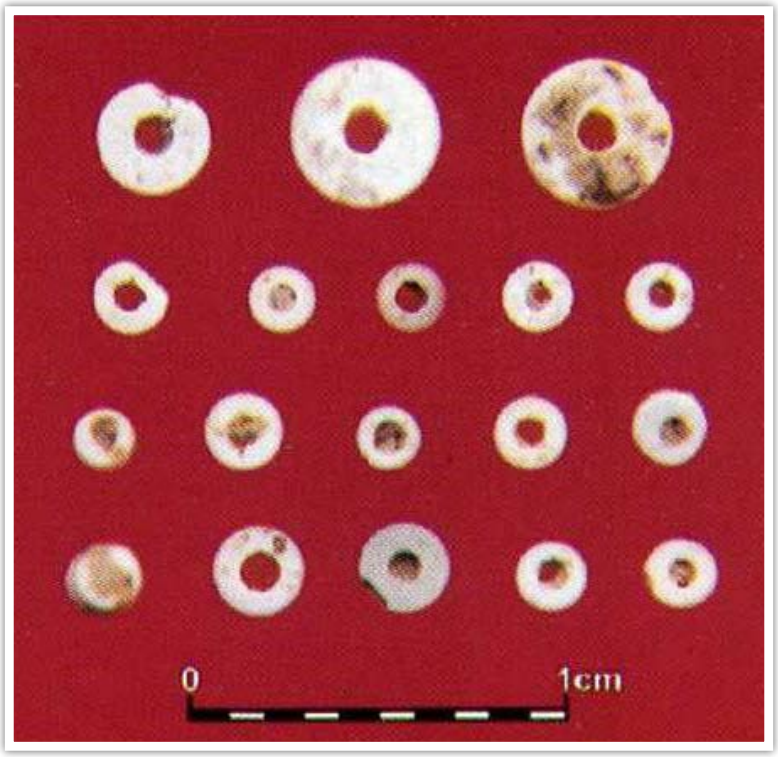


Fig. 5B: Micro to medium size steatite disc beads from Lahuradeva, 7000 BC

Fig. 5C: Copper arrowhead from Lahuradeva period IB 5000 BC

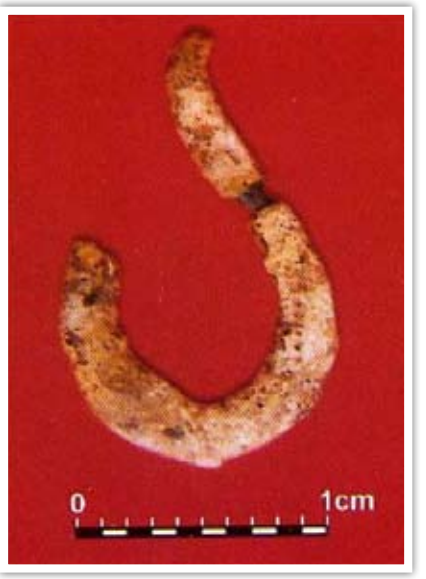


Fig. 5D: Broken copper object from Lahuradeva period IB, 5000 BC

Ashram, Agastya Ashram and Panchvati in Nashik also have very important evidentiary value.

Some related places described in Ramayan: continuity of physical features

Some of the places described in Ramayan were personally visited by the author in the company of archaeologists and geologists. These included Ayodhya in Faizabad district; Sringaverpura, Akshayavat inside Akbar Fort and Bhardwaj Ashram opposite Anand Bhawan in Allahabad district; Chitrakoot; Kotumsar caves in Bastar district; Agastya Ashram and Panchvati in Nashik district; Ramsethu approaching from Rameshwaram as well as from Dhanushkoti and places related to Ramayan in Sri Lanka (Map 2).

Srigaverpura

One look at the excavated site at Sringaverpura situated on the left bank of Ganga in Allahabad district of Uttar Pradesh, brought back the vivid memories of several references in Ramayan to Guh Nishad and his little kingdom adjoining

Map 2 : Map showing places visited by author

the boundary of Kosal Desh *i.e.* Sringaverpura (Ramayan- 2/50-52). The unique water tank complex was having elaborate arrangements to bring in Ganga water through a channel, *nullahs* for water distribution, arrangements for harnessing the overflowing water through silting chamber and provision for sub-soil-water wells in the bed of the tank to guard against loss through seepage (ASI Report of 1993)! In which engineering college had those engineers studied and should not we feel proud of them?

Akshayavat and Bhardwaj Ashram

The roots of Akshayavat inside Akbar Fort at Allahabad are several meters

below the existing land level and are spread in hundreds of meters all around, reminding us of references in Ramayan about this extraordinary tree (2/53/33, 2/54/1). Even more interesting are the excavations relating to Bhardwaj Ashram underneath a municipal garden just opposite Ananda Bhawan, the ancestral house of Nehru family in Allahabad. The location is exactly at the place described in Ramayan *i.e.* near Sangam (2/54/8-13). The deposits of sandy loam with sherds of Northern Black Polished Ware (NBPW) and lumps of clay with reed-marks, indicating wattle-and-daub huts in an ashram-like setting were found during excavations!

Chitrakoot

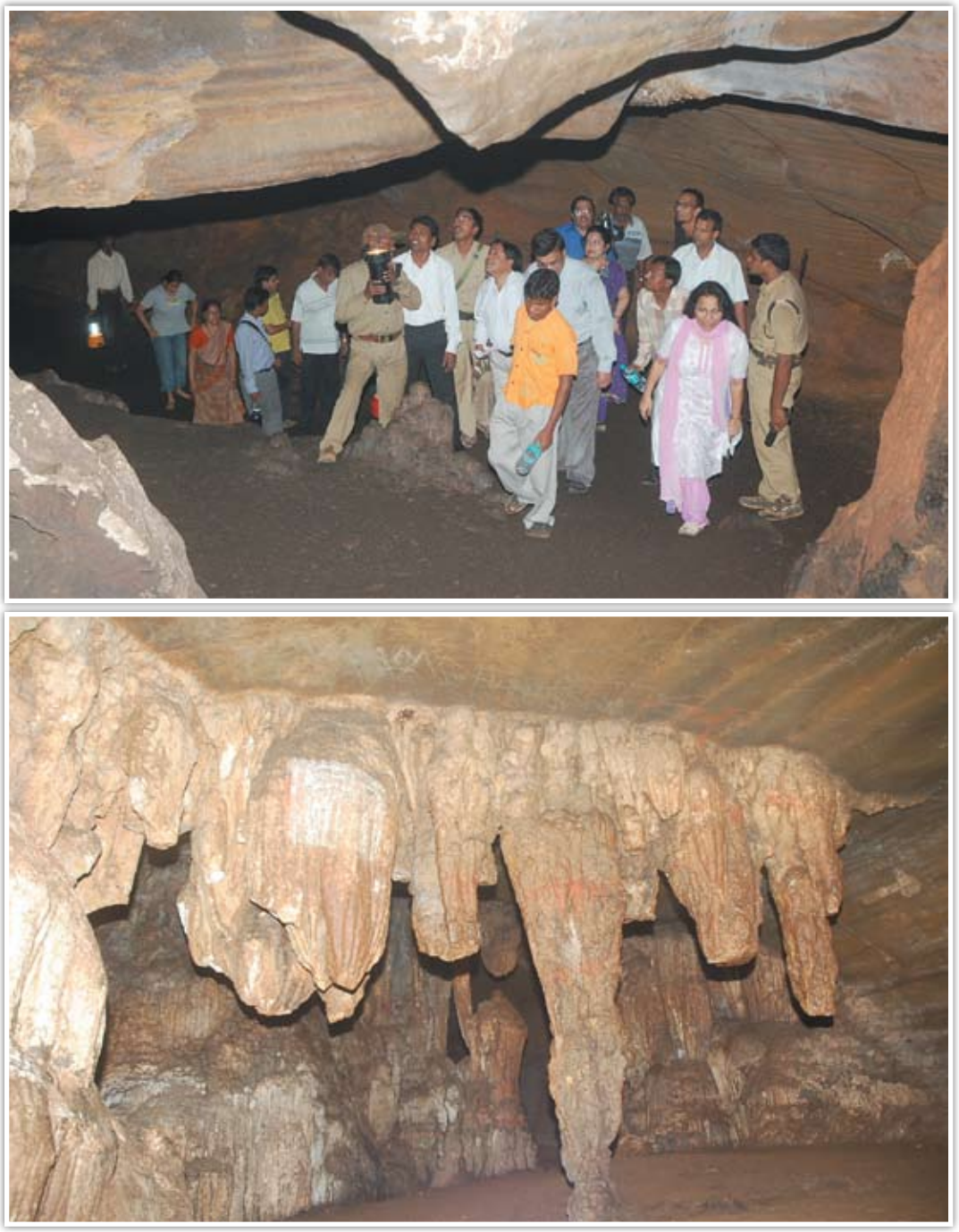
In Ramayan, Chitrakoot has been described as a place of unparalleled beauty, located at the bank of river Mandakini, a tributary of Ganga (2/94-95). Very rich in flora and fauna and having large variety of birds, fruits and flowers, Chitrakoot is described as having stunning cascades, fountains and springs. It also had beautiful caves for human habitation. One visit to Chitrakoot would reveal that all these features are still the same; with springs and fountains all around, ancient caves still being used by saints, birds chirping and singing on Kamadgiri and places full of fruit tree and flowering plants.

Kotumsar Caves in Dandak Van

Ramayan makes several references to thick forests, caves, lakes, gardens and *rishi-ashrams* in Dandak Van which were repeatedly visited for about 10 years by Lord Ram during exile (3/7-11 sargas). The existence of one such place named Kotumsar caves (Koti Maheshwar), situated in the middle of a dense forest in Bastar district having entry from the top of the hill, was discovered in 1958 but the entrance as well as passage through these magnificent caves were cleared only by 1993. Radiocarbon dates of the charcoal remains of grains and seeds found from the cave suggest a time range of 6940-4030 yrs BP. There are two drinking water wells inside these caves! One look at the pictures (Fig. 6 & 7) taken by the author will make its correlation with Ramayan description very clear!

Nasik

Ramayan also contains graphic details of Agastya *Muni's Ashram*, situated near Godawari and having ponds and gardens around; having an Agnishala in which various types of weapons were made (3/11-12). He had given several weapons,



Figs. 6 & 7: Inside view of Kotumsar caves

like *Diviya Dhanush, Amogh Vaan*, various kinds of arrows, and a sword, to Shri Ram which would enable him to eliminate cruel *asuras*. Site of Agastya *Ashram* and remains of Agastya temple are still identified by locals in *Ankai-Pinplner* area of Nashik. Shri Ashok Bhatnagar, an eminent astronomer, has displayed (elsewhere in this book) the sky view generated by planetarium software to show that star Canopus, named after sage Agastya, became visible from Vindhyas only around 5100 BC. This confirmed the legend referred to both in Ramayan and Puranas and also correlated the references to sage Agastya in both these books confirming that the events pertained to 7000 BP.

Ramsethu

During visit to Rameshwaram, author got an extra-ordinary opportunity to observe the depth at which Ramsethu was found submerged under the sea which measured 9.5 feet on the fisherman's oar. Author had also seen small portion as shown in figure 8 indicating contribution of human hand with marked boundaries and stone filling seen through the mask used for snorkeling.

Fig. 8 : Boundaries looking like ropes & the fillings in between

Places in Sri Lanka

In Ramayan there is a reference to labyrinth of caves and tunnels in the central hilly areas of Sri Lanka. The height of these hills is also stated to be similar to the height of hills in Malaya Giri (Cardamom hills) of Kerala (Sundar kand/1/204). A visit to the hills located around 90 kilometers from Nuwara Eliya towards Bandarawela in Sri Lanka appeared to be almost matching this description. As is clear from the Figs. 9A, 9B, 9C & 9D on the three sides of this hill *(9A)* are

Fig. 9A: Hill top near Bandarawela, having network of caves

Fig. 9B: Ravana caves

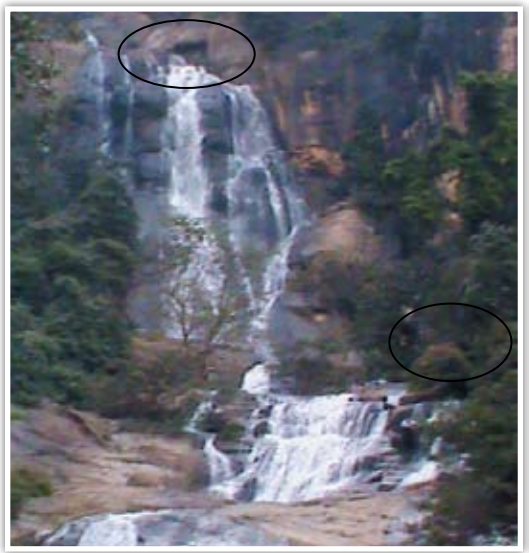


Fig. 9C: Ravana falls with caves encircled

Fig. 9D: Udakirinda caves

Ravana Falls at 3500 feet above sea level *(9C)*, Ravana Caves at 4500 feet *(9B)* and Udakirinda Caves *(9D)*. The locals affirmed that such caves from all four sides have a meeting point deep inside but it was not possible to verify the accuracy of this assertion because it was impossible for us to go deep inside as the caves were full of webs, bats, insects and reptiles. A visit to Ashok vatika in Nuwara Eliya brought alive the memories of its references in Ramayan. Sri Lankans have also preserved the place where Vibhishan was coronated as Vibhishan Palace but most probably it will very soon be turned into a Buddhist site and its links with Ramayan era will get erased from the public memory.

Ram's Bridge – its satellite image and oceanographic evidences:

Ram-sena first camped in Koddikarai but after surveying the sea area, the location was found unsuitable for constructing the bridge. Therefore, Shri Ram shifted the entire army to Rameshwaram. In *Yuddh Kand, sarg 22* (*shlokas* 45-73) Valmiki has given graphic details of Lord Ram carrying out research and exploration to identify a suitable location for construction of the bridge. After identifying the location, he requested Sugriva to search for an expert *Shilpakar* who could construct such a bridge. Sugriva recommended the name of Nal, a famous *shilpakar*, who had the expertise similar to that of Vishwakarma in constructing the bridge. Accordingly Nal was called; he concurred that bridge could indeed to constructed at the location identified by Shri Ram. He accepted the challenge and constructed the bridge (6/22/45, 6/22/53).

Satellite Image

A few years back, NASA had put pictures on internet of this bridge, the ruins of which are found submerged in Palk Strait between Rameshwaram (Dhanush Koti) and Mannar (Thalaimannar). The bridge is composed of a series of islands, rocks, and shoals and it is stated to be 30 kilometers long. It is found exactly at the location narrated in Valmiki Ramayan. See NASA picture of this Bridge (Fig. 10).

The construction of this bridge was completed under the supervision of Nal in five days by filling up of the gaps in the existing natural chain of land route consisting of islands, rocks and shoals (6/22/68-73).

The armymen of Lord Ram utilized various tools and implements for uprooting trees like *saal*, *taar*, coconut, mango, ashoka, arjun, *bakul* and *bilva* etc (6/22/47).

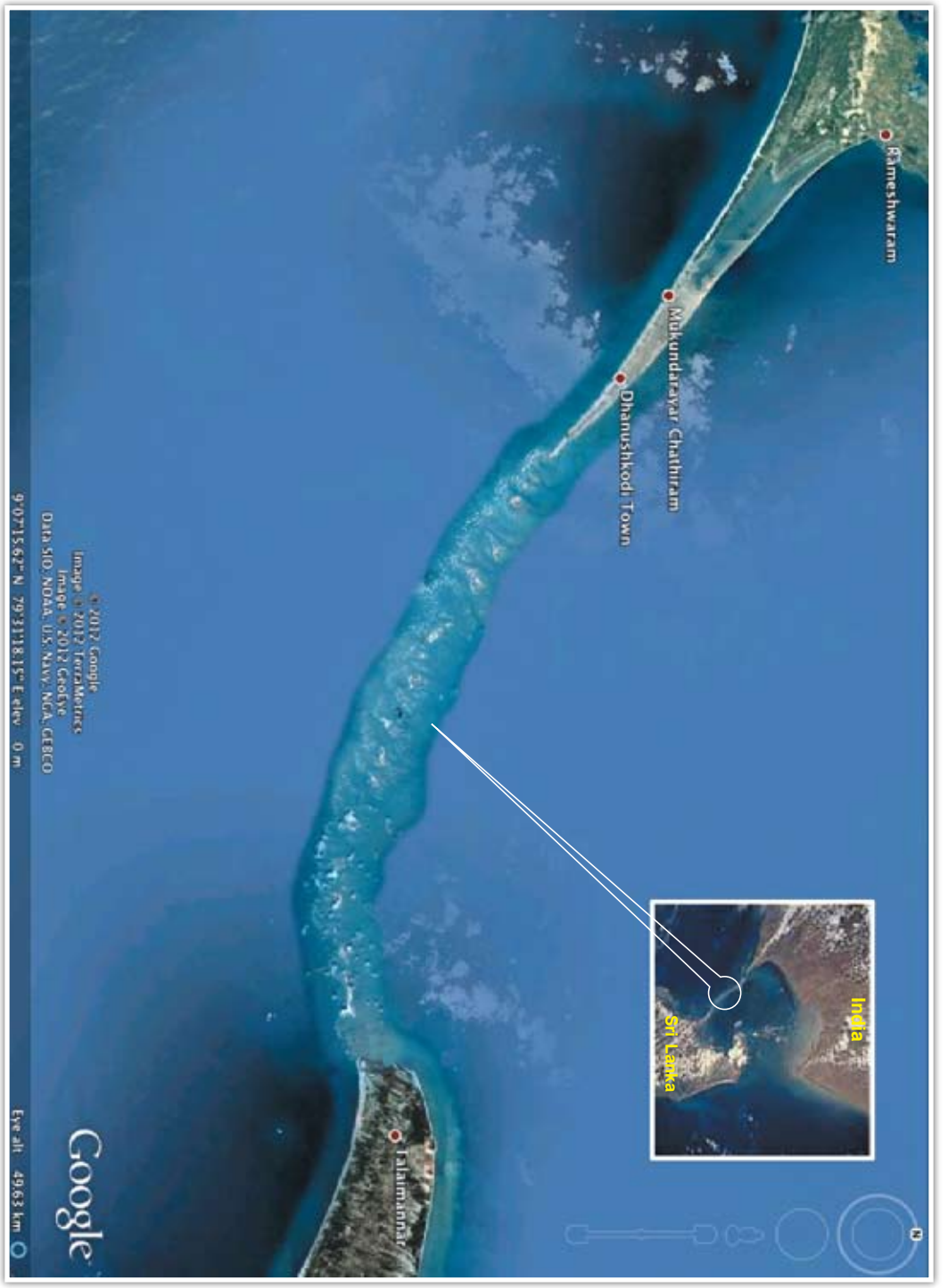


Fig. 10: Image showing Sethu built by Sri Ram

With the help of various *yantras* they transported these stones, trees, creepers, and boulders to the seashore (2/22/60). *Shilpakar* Nal directed the armymen to stand with long ropes on either side and got the bridge constructed in five days by binding such transported materials together. Even the use of measuring tools has been described (6/22/65).

Sea Level Curve

The use of this bridge as land route between India and Sri Lanka depended on the fluctuations in sea level for thousands of years as it was sometimes above the sea level and was at other times submerged under the seawater. **Dr. Rajiv Nigam**, *Scientist-G and Head of Palaeoclimate Project, Geological Oceanography Division, National Institute of Oceanography, Goa*, in his paper on **"Sea level Fluctuations during last 15000 years and their Impact on Human Settlements"**, has explained that the oceanographic reports on fluctuations of water levels in the oceans have revealed the existence of many coastal archaeological sites, either submerged or now found land locked, dated from 7500 BC onwards. With the help of Sea Level Curve (Fig. 11), he explained that between 7000 – 7200 BP the water level was about three meters below the present level. Incidentally, the astronomical dating of the Ram era has been placed around 7100 BP (DoB 10th Jan, 5114 BC) and Ramsethu is found submerged at about three meters depth at present, implying thereby that in 5100 BC this Sethu was above the sea level and could be used as a land route between Rameshwaram and Sri Lanka.

Fluctuations in sea level corroborate reference in Ramayan

This sea level curve corroborates another very important but little known fact. In 6/19/31 and 6/22/50, Valmiki has stated that water volumes in the sea were augmented by the ancestors of Lord Ram, particularly by Maharaja Sagar and Maharaja Bhagirath. Sagar was the 40th ruler and Shri Ram was the 64th ruler of *Surya Vansha* dynasty. Giving an average of 40 years for each ruler, a period of 900-1000 years is covered. See the way water levels have risen between 8000 BP to 7000 BP (6000 BC to 5000 BC)! Not only this, there are graphic details in Ramayan of attempts made by Ram's ancestors, from Maharaja Sagar to king Bhagirath, for diverting massive volumes of Ganga waters from their source *i.e.* glaciers of Shivlinga peak towards east to reach the Bay of Bengal so that western parts of India could be saved from floods and eastern territories could be saved from severe droughts. (1/39-45).

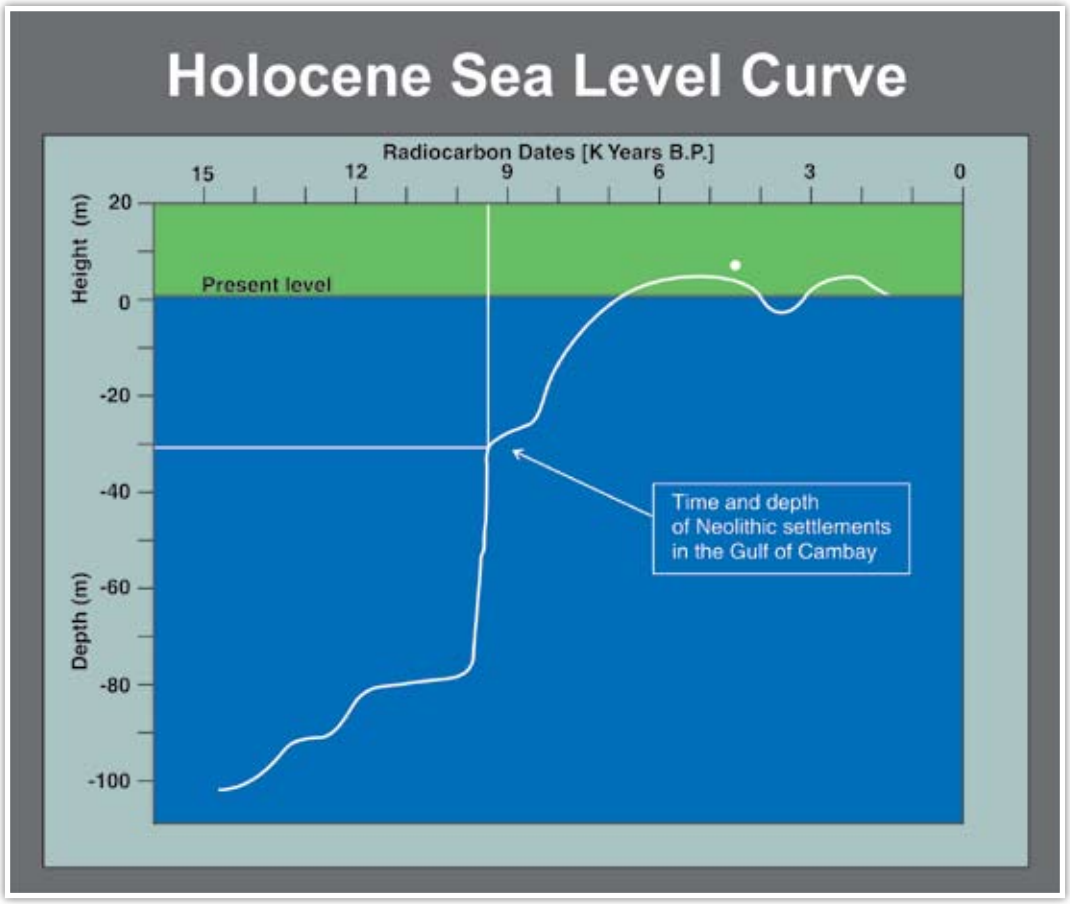


Fig. 11: Sea level curve of Holocene period

The sea level curve also indicates that within about 200 years of the completion of this bridge, the sea level had risen by about 1 to 3 meters, therefore the bridge submerged and remained submerged till 4000 BP (2000 BC). Thereafter, for about 1000 years water level had gone down; therefore the bridge would have come above the sea level to submerge again by around 1000 BC. This is also corroborated by the geological reports and remote sensing data as per which Saraswati River was flowing with full majesty from higher Himalayas to Rann of Kachchh in Gujarat around 6000 BC but it dried up during 2500-1500 BC due to the onset of arid phase as well as tectonic and palaeoclimatic changes in Himalayan region. This led to a drought like situation in north western areas of Indian sub-continent also leading to substantial reduction in water level of the sea.

Report by Department of Earth Sciences

According to Dr. Badrinarayan, former Director of Geological Survey of India, under whom geological aspects of the Sethusamudram Shipping Channel Project (SSCP) were studied, "Ramsethu is a natural formation, the top portion of which appears to be man-made" because in between marine sands, there is assemblage of corals, sandstones and boulders etc. The Ministry of Earth Sciences in a response sent to the then President of India Dr. Abdul Kalam (reported in The Telegraph of May, 2007) stated, "in the case of Adam's bridge area we observe that the coral formations hardly occur 1 to 2.5m in length and resting on loose marine sands. Most of these coral rock pieces seem to be rounded pebbles of corals. These things appear to point that these coral rock pieces and pebbles have been transported and placed in these areas. There are some raised Teri formations that supported a rich assemblage of Mesolithic – microlithic tools indicating the presence of strong human habitation and activity in these areas as early as 8000 to 9000 BP and as recent as 4000 BP" (Ref. Ram Setu by S. Swamy).

Report of National Remote Sensing Agency

The National Remote Sensing Agency of the Union Ministry of Space has published a book of satellite photographs (ISBN: 8175256524) claiming that "archaeological studies show" that the Setu "may be man-made" (page 67 of Ram Setu by S. Swamy). It is surprising that instead of taking pride in the achievements of our distant past, we continue to live in self-denial mode!

Other Interesting facts

All attempts to create shipping route by completing the Sethu Samudram project have so far failed. Shri Subramnian Swamy summarized the report dated January 23, 2007 published in the Asian Age stating that "the Dredging Corporation of India's (DCI) dredger imported from Holland had broken into two and sunk into the sea when it began work on the Ram Setu. The DCI crane that went to pick up the dredger pieces also broke and sank. The Russian engineer consultant who went to inspect the mishap broke his leg." As a result all efforts made on behalf of the Government so far to destroy remains of Ram Setu have failed and consequently Sethusamudram Shipping Canal could not become a reality.

In Rameshwaram, particularly from Dhanushkoti, the boatmen earlier used to take visitor in glass boats to show remains of Ram Setu found submerged around three meters deep, but it has become fashionable to call it Adam's bridge, probably because the expression 'Adam' is considered to be more secular or more British than the expression 'Ram'. Sri Lankan government wanted to construct a land route over this submerged bridge whereas Government of India wanted to blast it for shipping *i.e.* Sethusamudaram project. Shri Jaisurya, Energy Minister of Sri Lanka had proposed construction of land route between India and Sri Lanka on this submerged Ram Setu. There are several multi-nationals offering to construct the bridge under BOT (Build-Operate-Transfer) scheme. Can one imagine the number of people from India who will walk over this reconstructed Ram Setu every year and the kind of profit the builder as well as Indian and Sri Lankan Government would be able to earn.

Ancestors of Shri Ram: Co-relation of genealogy with genetic studies

Indian history has recorded that Shri Ram belonged to Surya Vansh and he was the 64th ruler of this dynasty. Most of the names and other relevant particulars of previous 63 kings are listed in '*Ayodhya Ka Itihas*' written about eighty years back by Rai Bahadur Sita Ram. In fact most of the names of these ancestors of Lord Ram have been listed in Valmiki Ramayan itself as narrated by Vashistha Muni to Raja Janak (1/70 and 71).

Professor Subhash Kak of Lousiana University (USA), in his book "The Astronomical Code of the Rigveda" has also listed 63 ancestors of Shri Ram who ruled over Ayodhya. The ancestors of Shri Ram have been traced out as under:

Shri Ram, s/o King Dashratha, s/o King Aja, s/o King Raghu, s/o Dirghabahu s/o King Dilipa-II, s/o King Visvasaha and so on) …… …… King Sagar (40th Ruler) ……..…… Satyavadi Harish Chandra (33rd King) ……..…… (all listed in table 2)

Professor Kak has also traced out 29 descendants of Shri Ram starting with his son Kusa f/o Atithi, f/o Nisadha, f/o Nala ……

…… 94th Ruler of Ayodhya being Brihatksaya (all listed in table 2).

Table 2: Showing Ancestors and descendants of Shri Ram

1. Manu	25. Anaranya	49. Ayutayus	73. Ahinagu
2. Iksvaku	26. Trasadsva	50. Rtuparna	74. Paripatra
3. Vikuksi-Sasada	27. Haryasva (II)	51. Sarvakama	75. Bala
4. Kakutstha	28. Vasumata	52. Sudasa	76. Uktha
5. Anenas	29. Tridhanvan	53. Mitrasaha	77. Vajranabha
6. Prithu	30. Trayyaruna	54. Asmaka	78. Sankhan
7. Vistarasva	31. Trishanku	55. Mulaka	79. Vyusitasva
8. Ardra	32. Satyavrata	56. Sataratha	80. Visvasaha (II)
9. Yuvanasva (I)	33. Hariscandra	57. Aidavida	81. Hiranyabha
10. Sravasta	34. Rohita	58. Visvasaha (I)	82. Pusya
11. Brihadasva	35. Harita, Cancu	59. Dilipa (II)	83. Dhruvasandhi
12. Kuvalasva	36. Vijaya	60. Dirghabahu	84. Sudarsana
13. Drdhasva	37. Ruruka	61. Raghu	85. Agnivarna
14. Pramoda	38. Vrka	62. Aja	86. Sighra
15. Haryasva (I)	39. Bahu (Asita)	63. Dasaratha	87. Maru
16. Nikumba	40. Sagara	64. Ram	88. Prasusruta
17. Samhatasva	41. Asamanjas	65. Kusa	89. Susandhi
18. Akrsasva	42. Amsumant	66. Atithi	90. Amarsa
19. Prasenajit	43. Dilipa (I)	67. Nisadha	91. Mahashwat
20. Yuvanasva (II)	44. Bhagiratha	68. Nala	92. Visrutavant
21. Mandhatr	45. Sruta	69. Nabhas	93. Brihadbala
22. Purukutsa	46. Nabhaga	70. Pundarika	94. Brihatksaya
23. Trasadsyu	47. Amabarisa	71. Ksemadhanvan	
24. Sambhuta	48. Sindhudvipa	72. Devanika	

These genealogy details are partly described in Ramayan itself through the words of Guru Vashishth at 1/70. The ancestry of king Janak of Mithila is also described in 1/71 and is traced through Hrasvaroma …… to Keertiratha …… to Suketu …… to Janak, the first king who gave his name to the Raja Janak's dynasty.

Having shown that the date of Shri Ram was arround 5100 BC and the names of 63 predecessors Surya Vanshi Kings are mentioned in Ramayan and Purans, the date of the first king, Manu is pushed back by atleast 2000 years to 7000 BC. It is obvious that it would have taken at least two thousand years for the civilization to develop practices relating to agriculture and irrigation, trade and industry, navigation and shipping, urban planning and civil administration; leading to formation of large kingdoms and the institution of kingship. It would have taken a few thousand years for an evolving society to attain the level of intellectual, philosophical and scientific activity as evident in the Vedas and epics.

Almost all the major Genome studies carried out so far have revealed an amazing correlation of this genealogy with the genetic profile of humans settled in north, south, east and west of India since the Holocene (about 11000 years BP) to the present. Almost all the important studies in palaeo-anthropology, including those carried out by Kenneth A. R. Kennedy and Cavalli-Sfroza, have concluded that genetic profile of people of the Indian sub-continent has remained the same for last more than 55000 years and that for last 11000 years this profile is of culturally developing people who had started speaking a structured language and were taking cooked food.

The Essence

From Kashmir to Kanyakumari and from Bengal to Gujarat, everywhere people of India believe in the reality of Shri Ram's existence and most of our festivals revolve around the events related to the life of Shri Ram. The events and places referred to in Ramayan represent our most ancient heritage, which has developed and got enriched subsequently during the eras of Lord Krishna, Mahatma Buddha, Mahavir Jain, Jesus Christ, Prophet Mohammed and Guru Nanak Dev.

The story of Shri Ram, when appreciated in its true perspective, would emerge as the biggest unifying factor for India and it establishes many ideals which we need to emulate today. He remains unparalleled as an ideal son, an ideal brother, an ideal warrior and an ideal king; that is why he is described as *Maryada Purushottam Ram*! He was a nationalist par excellence who left his kingdom to help the small kings located all over India to save their kingdoms from being usurped by wicked King Ravana of Sri Lanka and his relatives and devils like Khar, Dushan and Maarich representing him in India. Shri Ram moved from place to place to spread the message of unity by showing very high level of

respect for the people from backward tribes and those considered untouchable. He embraced Guh Nishad who belonged to a lower caste; he gave a strong message against untouchability by eating with great affection *jootha berries* of *Bhilni* (Shabri). He sent his wife and children to be brought up and educated by Maharishi Valmiki who is stated to be *Shudra* but was a great scholar in the ancient world. Shri Ram tried and succeeded in establishing victory of good over evil. He helped *rishis* and *munis* in living a life of honor. He got the kingdoms of small noble kings restored to them and acted as the biggest unifying factor.

The astronomical dating of planetary references given in Valmiki Ramayan with corroborating archaeological, geological, oceanographic, geographic evidences, further supported by genealogical studies duly correlated with genome studies have established with a fair amount of certainty that Shri Ram was actually born more than 7000 year back. Therefore discovering the physical details relating to the life and times of Shri Ram would be much more difficult as destruction caused by floods, droughts, earthquakes, tectonic movements, tsunamis and wars etc is bound to be far greater. But should that stop our quest for learning more and more about our most ancient rich cultural heritage? As Indians, let us all take pride in the fact that Indian civilization is the most ancient civilization surviving on planet earth. It is certainly more than 10,000 years old and has been growing and developing indigenously. Let us admit that during British Rule, we were educated in the schools based on Macaulay school of thinking which believed that Indians were inferior to the Englishmen and that entire 'Indian literature was not worth even one book rack in England'. If there were similarities in certain features of language of Indian people and people from Central Asia/ Europe then automatic inference drawn was that the Aryans coming from Central Asia/Europe invaded India and settled here. No one dared of thinking in any other way. Therefore, there is urgency for the historians, scientists and all other intellectuals to stop reducing Indian history to myth.

There is need to gather, dig out, search, and analyse all the evidences, which would throw more light on ancient Indian civilization and culture. This in turn would facilitate unearthing scientific knowledge from Vedic and Post-Vedic literature which is needed by mankind today for developing nature friendly and pollution free technologies. The Government is requested to constitute a multidisciplinary team in order to carry out scientific research pertaining to most ancient events narrated in our ancient books and this team should consist of Sanskrit scholars, astronomers, archaeologists, geologists, oceanographers,

palaeobotanists, anthropologists, space scientists etc. This team should be asked to rewrite the history of Indian sub-continent based on purely scientific evidence. There is need for the print and the electronic media to take note of these facts and create atmosphere which would motivate our young and educated youth to carry out research and unearth true facts about ancient Indian civilization and wisdom and would also encourage them to put across the results of their research before the world fearlessly and with a sense of pride.

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Address by Shri Pawan Kumar Bansal, Chief Guest and Guests of Honour

Summary of the valedictory address delivered by Shri Pawan Kumar Bansal, Hon'ble Minister, Ministry of Parliamentary Affairs and Ministry of Water Resources on 31st July, 2011.

Hon'ble Minister Shri Pawan Kumar Bansal appreciated the initiative taken by I-SERVE and expressed his curiosity for knowing more details of the outcomes of the research on scientific dating of ancient events. Referring to the inaugural address, he said that Dr. A.P.J. Abdul Kalam has spent his lifetime in inculcating the scientific temperament amongst the people of India, therefore, appreciation by him of the scientific dating of the ancient events undertaken by I-SERVE is a matter of great pride not only for I-SERVE but for all of us.

While referring to the multi disciplinary scientific research papers presented during the Seminar, he recollected his earlier visit to the Birbal Sahni Institute of Palaeobotany, Lucknow, where scientists had explained that large variety of cultivated herbs, referred to in our ancient manuscripts, have been found in existence in India for thousands and thousands of years. As a Minister for science and technology, he was also informed about the creation of a *Digital Library* of *Traditional Knowledge* listing more than two lakhs of medicinal formulations existing in ancient India. He felt happy that such researches are being discussed in the context of scientific dating of ancient events.

The unveiling of the clock depicting the sky view on 10th January, 5114 BC i.e. at the time of birth of Lord Ram exactly matching the planetary configurations described in Valmiki Ramayan impressed Shri Pawan Bansal the most as it indicated that Ramayan was not merely a mythological story but was probably rooted in reality. Such evidences proving the antiquity of our civilization do promote a sense of shared national pride amongst all of us.

The Hon'ble Minister referred to the presentation on genetic profiling which had revealed that genetic profile of north Indians as well as of Dravidians is the

same and has remained the same for more than 10,000 years, revealing that they had common ancestors who were all indigenous people. Therefore, the existing divisions are man-made and are not based on reality. In order to promote unity, there is a need for disseminating such knowledge and information amongst all Indians, especially amongst the school children and college students.

Referring to the Remote Sensing imagery of dry palaeochannels of ancient Saraswati River and other corroborating evidences discussed during the Seminar, he stated that such studies can help in exploring the sources of much needed potable water in these days of water scarcity when India is having 16% of world population and only 4% of world's water resources. He desired that such information should be shared by I-SERVE with the concerned government agencies so that it is used for the benefit of our countrymen. He expressed satisfaction at some kind of synergy developing between those who have been studying Vedas and those who could make use of the information contained therein for the benefit of mankind. He complimented I-SERVE for taking initiative to dispel the darkness and spread the light of awareness!

Address by Hon'ble Justice Ashok Bhan, Chairman, National Consumer Disputes Redressal Commission on 30th and 31st July, 2011

On 30th July, during inaugural ceremonies, Hon'ble Justice Ashok Bhan said that he was deeply interested in the research project named 'Scientific Dating of Ancient Events' taken up by Delhi Chapter of the Institute of Scientific Research on Vedas. It was interesting to learn that multi disciplinary scientific research reports have revealed that India was having a thriving civilization more than 10,000 years back and that this civilization was developing indigenously, unsettling our long standing belief that Aryans came from Central Asia to civilize us in 1500 BC.

He went on to add that the major objectives of I-SERVE which was set up in the year 2004 under the patronage of our late Dr. R. Venkataraman, former President of India are: (i) establishing synergy between the scientific wisdom of ancient India and modern scientific inventions and (ii) determining historicity and dating of ancient events by making use of modern scientific tools are laudable. This Seminar organized by Delhi Chapter in the pursuit of second objective also aims at bridging the gap between the outcomes of scientific research reports on one hand and the contents of school and college books on the other.

In his address during the valedictory Session on 31st July, 2011, Hon'ble Justice Ashok Bhan complimented the I-SERVE Research team for doing a commendable job in attempting to determine the historicity and authenticity of ancient events by making use of scientific evidences and tools which not only push back the antiquity of our civilization but also generate a sense of shared pride in our glorious past. This is being done not by relying upon any linguistic guesswork or religious beliefs but by compiling credible and convincing evidence which proves that the Indian sub-continent had a thriving civilization more than 10000 years back. During his inaugural address, Dr Kalam had expressed the belief that such scientific dating of ancient events has the potential of transforming mythology into history and we shall also be able to benefit from tremendous scientific knowledge, particularly of mathematics and astronomy, contained in our ancient texts.

Hon'ble Justice Ashok Bhan further added that the presentation on Genome studies made during the Seminar revealed that the genetic profile of all Indians, whether living in north, south, east or west, is the same and has remained the same for last more than 10000 years and it does not match the genetic profile of people from central Asia and Europe. This has the potential of integrating the entire nation as the artificial divisions which got created between the Dravidians and the north Indians would evaporate once they realize that they had common ancestors and that all of them were the originals of India.

He felt that all these facts have the potential of bringing about a revolutionary change in our sense of history, geography and civilization. He emphasized that the National Seminar has made the beginning of this great idea of rewriting the history not only of India but of the whole world by correlating multi-disciplinary scientific research reports with astronomical dating of events narrated in ancient books.

Address by Shri Jawhar Sircar, IAS, Secretary, Ministry of Culture, Govt. of India

As the inaugural ceremony got started, Shri Jawhar Sircar stated that he felt fortunate in getting an opportunity to hear eminent and revered personalities like His Excellency Dr. A.P.J. Abdul Kalam and Hon'ble Justice Ashok Bhan. He decided to participate in the Seminar as he was very curious to know what large number of eminent scientists, from different disciplines and backgrounds who

have assembled in the packed hall, have got to say on the subject. He referred to the book 'Orion' written by Bal Gangadhar Tilak attempting astronomical dating of Rigveda, which was published more than 70 years back. He also referred to the book written by Dr. Vartak on scientific dating of Ramayan and Vedas, but he remained unimpressed with these attempts. He cautioned the research team of I-SERVE that the conclusions on dating of ancient events should be empirical, scientific and convincing so that these are acceptable to the world.

Shri Sircar expressed the opinion that almost all ancient religious texts also served the purpose of legislative and prescriptive structures in pre-legislative period and therefore caution needs to be exercised while dealing with their contents. In 21st century when we are emerging as a big economic power in the world, India may not necessarily need proof of the antiquity of its civilization. Let us not forget that antiquity has a lot of respectability also attached to it! He wanted compilation of all the presentations made during the seminar expressing keen desire to read them all.

Address by Shri Manbir Singh, IFS, Secretary (ER), Ministry of External Affairs, Govt. of India as Guest of Honour on 31st July, 2011

Shri Manbir Singh expressed the view that with the presentations made during the Seminar, the haze caused by time and history seems to be receding and the events of our ancient past seem to be unfolding and crystallizing right in front of us. It is the beginning of a new initiative and road ahead appears to be very exciting as it pushes back the antiquity of our civilization!

Shri Singh took note of the fact that this Seminar is not only about the theoretical aspects of scientific dating of ancient events but also talks of the business opportunities being thrown open by this kind of research. It talks of the practical applications of the research outcomes in food production, water resource management, reinventing medicines for treatment of several diseases, promotion of tourism to cover the ancient sites covered by the research project of I-SERVE, addressing environmental issues etc. He emphasized that while the Seminar has attempted to know the truth and historicity behind our beliefs, yet beliefs remain most important; these are rooted in antiquity and they give us our civilization, heritage and our value systems. Science is important but these beliefs are probably above science and they represent the truth we have all believed in through the ages.

Address by Smt. Poonam Kishore Saxena, Member, Central Board of Direct Taxes (CBDT), as Guest of Honour on 31st July, 2011

Smt. Poonam Kishore Saxena was of the opinion that the topic of the Seminar was such that it would immediately spark curiosity in the listeners. We are normally aware of our ancient manuscripts and we often learn about the individual scientific studies being conducted by archaeologists, astronomers, geologists, oceanographers etc. in their individual fields, but no one had so far attempted to analyze and correlate these studies for determining the historicity of ancient events narrated in our ancient texts.

She appreciated the Institute of Scientific Research on Vedas (I-SERVE) for carrying out intensive research to connect all these credible evidences from varied scientific fields to prove the historicity and dating of ancient event. The astronomical dating of planetary references in ancient manuscripts and the co-relation seen of these dates with archaeological, geological, anthropological, oceanographic, ecological and remote sensing evidences is the most path breaking finding in research that could be done by anyone. This is the first initiative of its kind and the Seminar has succeeded in bringing the idea to the fore that a combination of various scientific studies can provide credible scientific evidence that not only the Indian sub-continent's Civilization is of great antiquity but also that it was greatly advanced and perhaps indigenous. The events narrated in our ancient scriptures were not imaginary or just myths but truly happened and rolled out in the manner so depicted.

Smt. Saxena further added that the first thrust, has been admirably achieved in this ongoing study and wished I-SERVE all success in its endeavors. She expressed her desire as well as hope that the eminent scientists, who have made presentations during the Seminar revealing their expertise as well as in-depth knowledge on different aspects of the research project, will focus on bridging the gap between information contained in their research reports on one hand, and contents of the books meant for schools and colleges all over India on the other. She hoped that His Excellency Dr. A.P.J. Abdul Kalam's wish that 'let there be a hundred Ph.Ds on the topic' is fulfilled. This knowledge will then lead to a shared national pride among all Indians in our most ancient rich cultural heritage.

Recommendations and Follow-up Action

Based on presentations made during the seminar, some very valuable recommendations were made for taking certain steps/ follow-up action by the Government departments, universities and autonomous bodies like National Institute of Oceanography and Archaeological Survey of India, as under:

1. The invention of new scientific tools and methods over last 30-40 years have made scientific dating of ancient events very much possible, thus making the reliance on linguistic guesswork and religious beliefs unnecessary. The History should no more be a subject belonging to Faculty of Social Sciences or of Arts, rather it needs to be made an integral part of the Faculty of Sciences and placed as a multi-disciplinary science subject by the Universities of the world.

2. Such scientific dating can transform the ancient India's events mentioned in Vedas and Epics from the realm of mythology to that of history, creating a shared pride amongst all Indians in our rich and most ancient cultural heritage. The historicity of Epics like Iliad and Odissey would also probably get established. This in turn will facilitate the creation of a more peaceful and united world by removing artificial and false divisions which got created amongst the communities of the world, particularly of India, on account of linguistic guesswork and lack of scientific knowledge.

3. Ancient Sanskrit books contain a rich wealth of knowledge of ancient sciences and of historical events which occurred in remote ancient past. The presentations indicated a close correlation between the astronomical dating of ancient events and fluctuations in water volumes of ancient rivers and oceans. Such fluctuations in water volumes in ancient books got almost fully corroborated by the fluctuations in sea level curve prepared by NIO for India's West Coast. There is need for more exploration at greater depth both along the east coast and west coast by NIO, Goa.

4. Rashtriya Sanskrit Sansthan was requested to modify its policy regarding allocation of subjects to Ph.D students so that they take up topics like: extraction

of planetary references from Vedas and Epics, extracting references to glaciers & fluctuation of water volumes in rivers and oceans, reconstructing genealogies from Puranas and Epics etc. These could be made available to the other scientists along with Hind/ English translation

5. Universities were requested to make modifications to their policy relating to Research and Ph.D so that two to four research scholars could take up multidisciplinary research with Guides from different departments and a coordinator. This can lead to a major initiative in scientific dating of ancient events referred to not only ancient books of India but of the whole world.

6. Ancient History of India, being taught in schools and colleges so far is generally based on linguistic guesswork and religious beliefs/hearsay. There is an urgent need to unearth the evidences of ancient events buried under land and sea through multi-disciplinary scientific research, which should include astronomical dating of planetary references in ancient books by making use of planetarium software.

7. Indian Council of Historical Research deserves to be reconstituted by Ministry of HRD so as to include Sanskrit scholars, Astronomers, Geologists, Oceanographers, space scientists, palaeobotanists and Ecologists so that ancient Indian history is rewritten purely on objective and scientific basis. These disciplines were not represented in the past.

8. Considering that latest scientific tools and researches have proved that Vedas and Epics of India refer to several events, the historicity of which is scientifically verifiable; there is need to carry this research to its logical conclusion by launching at least 100 Ph.Ds on the subject by accepting the recommendation of His Excellency Dr. A.P.J. Abdul Kalam.

9. The presentations made during the Seminar be used to promote tourism in a big way by taking some initiatives which could include: (i) setting up an underground museum on the site of submerged Dwarka connected through a transparent tube, (ii) package tours to cover places excavated around ancient Saraswati river, and (iii) trips to important places visited by Lord Ram still having similar physical features, flora and fauna as well as ancient memorials.

10. Remote Sensing images read with literary references, geological and archaeological research reports have revealed a vast network of palaeo-channels of rivers, including that of Saraswati river system. The Ministry of Water Resources

may constitute a multi-disciplinary team for identifying and harnessing the drinkable water trapped under the dry beds of these rivers for solving the water scarcity problems of our countrymen in these areas.

11. The genome studies presented during the seminar have revealed that humans settled in all parts of India, including North Indians, Dravidians and tribals, share their genetic profile and had common ancestors since 11000 BP (9000 BC), rather since 55000 BP (53000 BC). This fact should be widely publicized by Ministry of Culture so that the north-south divide, which got created due to Aryan invasion theory that has now been proved to be untrue, is removed from the textbooks and all Indians have the opportunity to share common pride in having common ancestors.

12. In the interest of historical and medical research, the Ministry of Culture is requested to direct the Anthropological Survey of India and Anthropology departments of Universities to carry out Genome/DNA studies of the people of Indian sub-continent over last 12000 – 15000 years. This will facilitate development of DNA based medicine system for diseases which have been prevailing in certain areas for thousands of years. Correlation of such Genome studies with the genealogies of ancient rulers and of other classes be ascertained scientifically, which is likely to prove as a great unifying factor for different communities and classes in India.

13. The presentations made revealed that 99 percent of Indians do not know about 99 percent of scientific research reports which prove the historicity and antiquity of India's ancient civilization, apparently because such reports are not being regularly passed on by the ministries of Earth Sciences, Culture, Science & Technology and Water Resources to Ministry of HRD. It was suggested that a system be put in place to incorporate such research outcomes in books meant for schools and colleges all over India.

14. To create and develop mechanism for disseminating the outcomes of such multidisciplinary research reports in every nook and corner of India so that people from all casts, colour, creed and background become aware that they are originals of India, had common ancestors and have inherited a very rich and most ancient civilization.

— Saroj Bala

अनुशंसायें एवं कार्य योजना

'2000 वर्ष ई॰ पू॰ से पहले प्राचीन भारतीय साहित्य में वर्णित घटनाओं का वैज्ञानिक तिथि निर्धारण' विषय पर आई-सर्व नई दिल्ली शाखा द्वारा एक अखिल भारतीय संगोष्ठी का आयोजन 30-31 जुलाई, 2011 को किया गया।

संगोष्ठी में प्रस्तुतियों के आधार पर कई अमूल्य सुझाव निकल कर आये। इनमें सम्बन्धित सरकारी विभागों, विश्वविद्यालयों, स्वायत्तशासी एवं सांविधिक निकायों जैसे राष्ट्रीय समुद्र विज्ञान संस्थान (एन आई ओ), भारतीय पुरातत्व सर्वेक्षण, भारतीय भूवैज्ञानिक सर्वेक्षण एवं भारतीय मानव विज्ञान सर्वेक्षण जैसी संस्थाओं द्वारा अमल में लाई जाने वाली कुछ निम्नलिखित अनुशंसायें शामिल थी:

(i) विगत 30-40 वर्षों में नवीन वैज्ञानिक विधाओं एवं उपकरणों के आविष्कार से प्राचीन घटनाओं का तिथिकरण काफी कुछ संभव है जिससे अनावश्यक भाषाई अनुमान और धार्मिक विश्वासों मात्र पर निर्भर रहने की आवश्यकता में कमी आयी है। यह महसूस किया गया कि इतिहास को अब समाज विज्ञान एवं कला संकाय से हटकर विज्ञान संकाय का अभिन्न अंग होना चाहिए और संसार के विश्वविद्यालयों द्वारा इसे विज्ञान के बहु-आयामी रूप में स्वीकार करना चाहिए।

(ii) वैज्ञानिक रीति से तिथि निर्धारण से प्राचीन भारत की महत्त्वपूर्ण घटनाएँ जिनका वर्णन वेदों एवं अन्य ग्रंथों में किया गया है वह गल्प की श्रेणी से निकलकर इतिहास का अंग बनेंगी जिससे हम सभी भारतीयों में अपनी समृद्ध और सर्वाधिक प्राचीन परम्पराओं के प्रति गर्व का संचार होगा। इस प्रकार भाषाई अनुमानों पर आधारित एवं वैज्ञानिक सोच से वंचित कारणों से आभासी रूप से विश्व के विभिन्न समुदायों में जो कृत्रिम खाई दिखाई देती है, विशेष रूप से भारत में, उसके स्थान पर एक अधिक संगठित एवं शांतिप्रिय विश्व के सृजन में सहायता मिलेगी।

(iii) सुदूर अतीत की ऐतिहासिक घटनाओं एवं प्राचीन विज्ञान के ज्ञान से संस्कृत के ग्रन्थ भरे पड़े हैं। संगोष्ठी की प्रस्तुतियों ने खगोलीय विधि से तिथि निर्धारण की गई घटनाओं एवं प्राचीन

नदियों तथा समुद्र में पानी के उतार–चढ़ाव में परस्पर एक सह–सम्बन्ध स्थापित किया। भारत के पश्चिमी घाट के लिए राष्ट्रीय समुद्र विज्ञान संस्थान द्वारा तैयार किये गए आँकड़ों से समुद्र की सतह में होने वाले परिवर्तन की प्राचीन ग्रंथों से पूर्ण पुष्टि होती है। पूर्वी और पश्चिमी घाटों पर इस प्रकार के और गहन वैज्ञानिक शोध की आवश्यकता महसूस की गयी।

(iv) पीएच. डी. शोध हेतु राष्ट्रीय संस्कृत संस्थान से अपनी नीति में आवश्यक परिवर्तन हेतु अनुरोध किया गया जिससे छात्र कुछ ऐसे विषय ले सकें जैसे वेदों और महाकाव्यों में वर्णित ग्रहीय सन्दर्भ; ग्लेशिअर, नदियों और समुद्र के सतह में परिवर्तनों का सन्दर्भ; पुराणों और ग्रंथों में वर्णित वंशावलियों का पुर्ननिर्माण आदि। शोध के इन परिणामों को हिंदी और अंग्रेजी में अन्य इच्छुक वैज्ञानिकों को उपलब्ध कराया जा सकेगा।

(v) विश्वविद्यालयों से अनुरोध किया गया कि शोध एवं पीएच. डी. हेतु अपनी नीतियों में ऐसे परिवर्तन करें जिससे दो–चार छात्र ऐसे बहु–आयामी शोध कर सकें जिसमें एक समन्वयक के साथ–साथ विभिन्न विभागों के सक्षम गाइड भी सहयोग कर सकें। न केवल अपने देश वरन विश्व की पुस्तकों में वर्णित प्राचीन घटनाओं के वैज्ञानिक तिथिकरण में यह एक बहुत बड़ा योगदान होगा।

(vi) अब तक स्कूलों और कालेजों में पढ़ाया जा रहा प्राचीन इतिहास आम तौर पर भाषायी अनुमानों और धार्मिक मान्यताओं पर आधारित है। बहुआयामी वैज्ञानिक अनुसन्धान की मदद से समुद्र और भूमि के नीचे दबे प्राचीन प्रमाणों को खोजने की तत्काल जरूरत है। इनमें प्राचीन ग्रंथों में निहित ग्रह संदर्भों का खगोलीय काल–निर्धारण भी शामिल है। इस कार्य में तारामण्डल साफ्टवेयर का इस्तेमाल किया जा सकता है।

(vii) मानव संसाधन विकास मंत्रालय को भारतीय इतिहास अनुसन्धान परिषद का पुनर्गठन करना चाहिये और इसमें खगोल शास्त्रियों, संस्कृत के विद्वानों, पुरातत्वविदों, भू–विज्ञानियों, समुद्र–विज्ञानियों, अन्तरिक्ष विज्ञानियों, पुरावनस्पति शास्त्रियों और पारिस्थितिकीविदों को शामिल किया जाना चाहिये ताकि प्राचीन भारतीय इतिहास की शुद्ध वैज्ञानिक रूप से और सोद्देश्य पुनर्रचना की जा सके। इन विधाओं का पूर्व में इतिहास लेखन में उपयोग नहीं किया गया है।

(viii) नवीनतम वैज्ञानिक उपकरणों और अनुसन्धानों से साबित हुआ है कि भारत के महाकाव्यों और वेदों में वर्णित कई घटनाओं और ऐतिहासिकता की वैज्ञानिक पुष्टि की जा सकती है, अतः इसके तर्कसंगत निष्कर्षों के लिए इसमें शोध की आवश्यकता है। इसके लिए महामहिम डॉ० ए० पी० जे० अब्दुल कलाम के सुझावों के अनुसार इस विषय पर कम से कम एक सौ शोधार्थियों को शोध शुरू करना चाहिए।

(ix) सेमिनार में दी गयी जानकारी का उपयोग पर्यटन को बड़े पैमाने पर बढ़ावा देने के लिए किया जा सकता है। इन उपायों में शामिल है:

(क) जलमग्न द्वारका को पारदर्शी ट्यूब से जोड़कर वहाँ भूमिगत संग्रहालय की स्थापना।

(ख) प्राचीन सरस्वती नदी के आसपास जिन क्षेत्रों की खुदाई की गयी है वहाँ के लिये पर्यटकों को आकर्षित करने के लिए पर्यटन पैकेज देना और

(ग) भगवान राम जिन महत्वपूर्ण स्थानों पर गये थे उनमें से जिन स्थानों पर अब भी उसी तरह पेड़, पौधो, जीव-जन्तु और अन्य स्थितियाँ हैं, वहाँ के लिए भ्रमण कार्यक्रम आयोजित करना।

(x) साहित्यिक संदर्भों, भू-वैज्ञानिक और पुरातात्विक अनुसन्धानों के साथ दूरसम्वेदी छवियों से सरस्वती नदी समूह और अन्य नदियों के प्राचीन जलमार्गों की व्यापक श्रृंखला का पता चलता है। जल संसाधान मंत्रालय को इन क्षेत्रों में लोगों की पानी की कमी की समस्या के समाधान के लिए इन नदियों की सूखी सतह के नीचे पेयजल के दोहन के लिए शोध कर्त्ताओं की एक टीम का गठन करना चाहिए।

(xi) सेमिनार के दौरान प्रस्तुत किए गए आनुवांशिक अध्ययनों से पता चला है कि न केवल 11,000 वर्ष (9,000 ई०पू०) से, बल्कि 55,000 वर्ष (53000 ई०पू०) से भारत के सभी भागों में बसे उत्तर भारतीयों, द्रविडों और आदिवासियों सहित सभी का आनुवांशिक प्रोफाइल एकसमान रहा है। इस प्रकार उन सबके पूर्वज एक ही थे। संस्कृति मंत्रालय को इस वास्तविकता का व्यापक प्रचार करना चाहिए, ताकि झूठ साबित हो चुके आर्यों के आक्रमण के सिद्धांत के तहत उपजे उत्तर-दक्षिण विभाजन की धारणा को मिटाया जा सके। इससे सभी भारतीयों को, उनके पूर्वजों के एक होने पर गर्व करने का मौका मिल सकेगा।

(xii) चिकित्सा और इतिहास के क्षेत्र में शोध के लिए संस्कृति मंत्रालय से अनुरोध किया गया कि वह भारतीय मानवविज्ञान सर्वेक्षण एवं विश्वविद्यालयों के मानवविज्ञान विभागों को विगत 12,000-13,000 वर्षों पूर्व तक के भारतीय उप-महाद्वीप के लोगों के जीनोम/डीएनए विषय से सम्बंधित अध्ययन को बढ़ावा दें। इससे हजारों वर्षों से कतिपय क्षेत्रों में चली आ रही बीमारियों के डीएनए आधारित चिकित्सा पद्धति के विकास में सहायता मिलेगी। प्राचीन शासकों की वंशावलियों और अन्य वर्गों के लोगों की वंशावलियों में सह-सम्बन्ध वैज्ञानिक दृष्टिकोण से सुनिश्चित किये जाने से विभिन्न भारतीय वर्गों एवं समुदायों के लोगों में एकरूपता स्थापित किये जाने में सहायता मिलेगी।

(xiii) इस प्रस्तुति में यह भी बताया गया कि 99 प्रतिशत भारतीयों को भारत की प्राचीन सभ्यता की ऐतिहासिकता और प्राचीनता को प्रमाणित करने वाली 99 प्रतिशत वैज्ञानिक शोध रिपोर्टों के बारे में जानकारी नहीं है। ऐसा इसलिए है, क्योंकि पृथ्वी विज्ञान, संस्कृति, विज्ञान और प्रौद्योगिकी मंत्रालय ऐसी रिपोर्टें मानव संसाधन विकास मंत्रालय को नियमित रूप से प्रेषित नहीं करते है। इसके

अलावा इस प्रकार के शोध के निष्कर्षों को देश भर के स्कूलों और कालेजों की पाठ्य पुस्तकों में शामिल करने के लिए एक सार्थक प्रणाली विकसित करने की सेमिनार में संस्तुति की गयी।

(xiv) भारतवर्ष के कोने-कोने में उक्त बहु-आयामी शोध परिणामों के प्रचार-प्रसार हेतु एक प्रणाली के सृजन एवं विकास पर बल पूर्वक कहा गया जिससे सभी जातियों, रंगों, मतावलंबियों एवं पृष्ठभूमि के लोगों में इस भावना का संचार हो सके कि वही वास्तव में इस भारत भूमि के वासी हैं, उनके पूर्वज एक ही रहे हैं जो कहीं बाहर से नहीं आये थे और उन्हें एक समृद्ध एवं प्राचीन सभ्यता विरासत में मिली है।

हिन्दी रूपान्तर

कृष्णानन्द सिन्हा
वैज्ञानिक (सेवानिवृत्त)
आर्यभट प्रेक्षण विज्ञान शोधसंस्थान, नैनीताल

सरोज बाला
निदेशक, आई-सर्व, दिल्ली शाखा

Shri K.V. Krishna Murthy, Chairman (I-SERVE) welcoming H.E. Dr. A.P.J. Abdul Kalam

Smt. Saroj Bala, Chief Research Co-ordinator, presenting an overview of the Seminar theme during the Inaugural session

H.E. Dr. A.P.J. Abdul Kalam unveiling the Seminar Memento which depicts the sky view

H.E. Dr. A.P.J. Abdul Kalam presenting the Seminar Memento to Smt. Pushpa Bhatnagar, mother of late Shri Pushkar Bhatnagar, author of the book 'Dating the Era of Lord Ram'

H.E. Dr. A.P.J. Abdul Kalam delivering the inaugural address
at the National Seminar on 30th July, 2011

Delegates attending the National Seminar on 30th July, 2011

Experts on the Panel (from left to right) Shri D.V.N. Sharma, Dr. Shanti Pappu,
Dr. B.R. Mani, Shri K.N. Dikshit and Prof. V.H. Sonawane

Hon'ble Shri Pawan Kumar Bansal delivering the valedictory address at the National Seminar.