PEOPLING OF INDIA

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Abstract

We examine the demographic history of India on the basis of a new investigation of mitochondrial DNA base sequences of 101 Indians, in light of the recent synthesis of global genetic history of humans by Cavalli-Sforza and his co-workers. To this population genetic evidence we add fresh insights into linguistic and anthropological pattern based on the People of India project of the Anthropological Survey of India and a review of the pertinent archaeological evidence on waves of diffusion of technological innovations over the subcontinent. The Indian subcontinent has been populated by a series of migrations propelled by significant technological innovations outside India since

the first major expansion of non-African *Homo sapiens*, probably around 65,000 years before present. The likely major migrations include (i) Austric language speakers soon after 65,000 ybp, probably from northeast (ii) Dravidian speakers around 6,000 ybp from mideast with the knowledge of cultivation of crops like wheat and domestication of animals like cattle, sheep, goats (iii) Indo-European speakers in several waves after 4000 ybp with control over horses and iron technology (iv) Sino-Tibetan speakers in several waves after 6000 ybp with knowledge of rice cultivation. A notable feature of Indian society is the persistence of thousands of tribe-like endogamous groups in a complex agrarian and now industrial society. In this society populations of dominant groups have continued to grow, while those of subjugated groups may have stagnated most of the time.

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Introduction

India is a country remarkable for its diversity; biological and human. The biological diversity owes itself to the country's position at the trijunction of the African, the northern Eurasian and the Oriental realm; its great variety of environmental regimes, and its relative stability of biological production. It is this biological wealth that has attracted to the subcontinent many streams of people at different times, from different directions; bringing together a great diversity of human genes and human cultures. Whereas in other lands the dominant human cultures have tended to absorb or eliminate others, in India the tendency has been to isolate and subjugate the subordinated cultures, thereby augmenting cultural diversity. This tendency to nurture diversity has been favoured by the diversity of the country's ecological regimes [Gadgil and Guha, 1992].

People migrate because of pulls from their destination and pushes in their homeland, often propelled along by some technological advantage. Thus in 16th century Europeans came to India in search of spices, pushed out by the little ice age that had gripped Europe, equipped with superior seagoing vessels and guns. That migration is well documented and understood; but it is the many earlier ones that have brought to India the bulk of human genes and cultural traits. It is our purpose in this paper to elucidate what we can of these many earlier migrations.

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Role of innovations

People have of course migrated out of India as well, but these out-migrations have been on a much smaller scale, and mostly over the last three centuries. This is related to the fact that India has never been the site of any significant technological innovations. A series of important innovations have, over the years taken place outside of India, innovations which have given an edge to people in control of these innovations, propelling major migrations [Habib, 1992].

In chronological order the most relevant of these include: (i) Evolution of symbolic language, probably by the first modern *Homo sapiens*, in Africa, perhaps around 100 kybp (kybp = thousand years before present);
(ii) Husbanding of wheat, barley, cattle, pig in the mideast around 10 kybp;
(iii) husbanding of rice, buffalo in China and Southeast Asia around 8 kybp;
(iv) Domestication of horse in Central Asia around 6 kybp;
(v) Use of iron in Anatolia around 5 kybp;
(vi) Use of stirrup for horse riding in Central Asia around 2 kybp;
(vii) Use of gunpowder in China around 2 kybp;
(viii) Use of canons and guns in war in Arabia in 15 th century

Our theme then is that these manifold innovations to the west, east and north of the Indian subcontinent have propelled many waves of people onto our land, giving rise to what is genetically as well as culturally the most diverse society in the world. There are diverse lines of evidence for these migrations - genetic, linguistic archaeological, anthropological. We will endeavour to draw on all these disciplines to reconstruct the story of peopling of India.

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Genetic affinities

Genetically and culturally India is perhaps the most diverse country on the face of the earth. The most authoritative summary of genetics of human populations is provided by Cavalli-Sforza in his magnum opus, *History and Geography of Human Genes* [Cavalli-Sforza, et. al 1994]. He provides global maps of frequencies of 82 genes for 42 population aggregates of indigenous people covering the entire world. The 82 loci show the highest levels of heterozygosity, 0.35-0.37 for northwestern India, west Asia and continental Europe (Fig.1).

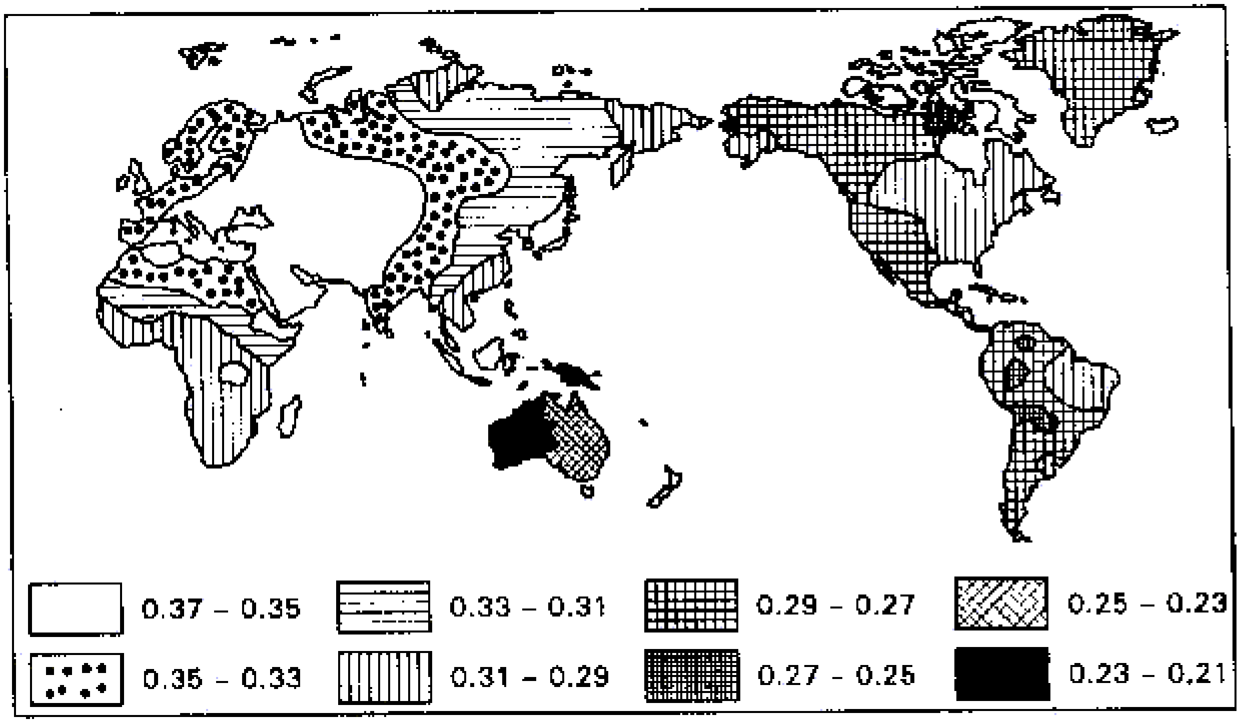


Fig. 1 *Global distribution of mean genetic heterozygosity of indigenous populations based on frequencies of 82 genes for 42 world population aggregates [Cavalli-Sforza et al., 1994]*

Parts of south and eastern India share slightly lower levels of 0.33-0.35 with Western China, Central Asia, Scandinavia an Northern Africa. The lowest levels of 0.21-0.23 occur in the New Guinea and Western Australia. Such genetic data is however rather limited, based on traditional markers such as blood groups. Modern genetic techniques have greatly added to the wealth of genetic information that may be obtained from a single individual by looking at the nucleotide base sequences themselves. Amongst the most variable of such sequences occur in two hypervariable regions of mitochondria, which are purely maternally inherited in humans. We have collaborated with Cavalli-Sforza and his colleagues at Stanford Medical School to examine base pair sequences of 791 base pair lengths from the "D" loop region of mitochondrial DNA for 101 Indians [Mountain et al. 1995] (Fig.2).

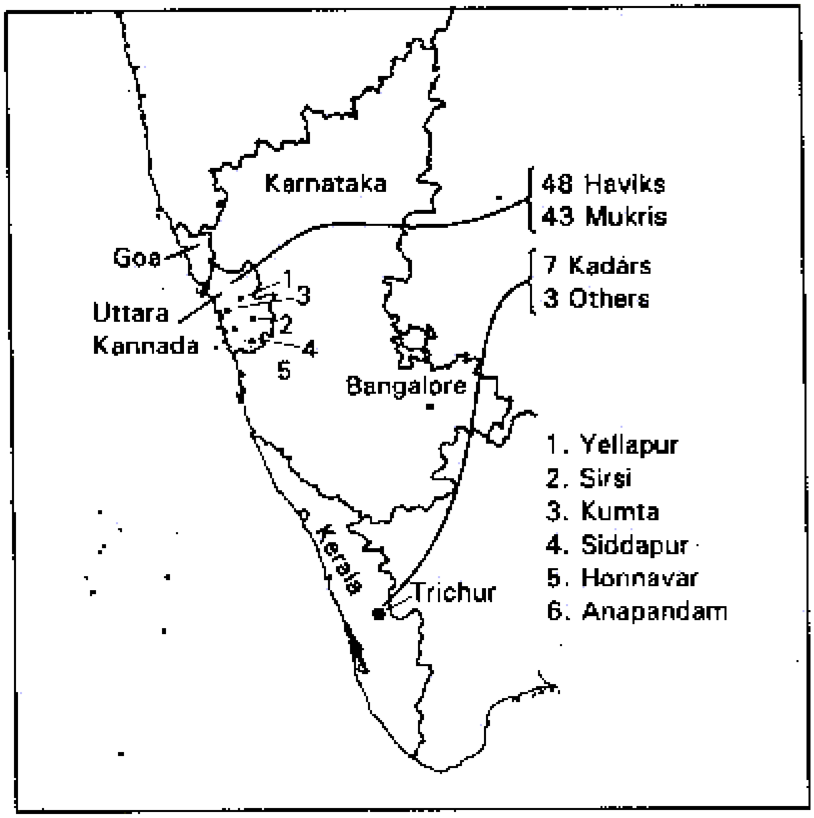


Fig. 2 *Geographical location of collection of genetic material from Havik (48), Mukri (43) and 7 Kadar populations in the South Indian states of Karnataka and Kerala [Mountain et al., 1995]*

Of these 48 belonged to an upper caste group Haviks,and 43 to a scheduled caste group Mukris from the coastal Uttara Kannada District of Karnataka, 7 to a tribal population called Kadars from Kerala, and 3 to to other Indians involved in field collection of samples of scrapings of cheek cells and scalp hair roots. 86 of these 791 sites demonstrated some variation amongst Indians, it was also possible to compare 745 from amongst these 791 sites with published data on 187 individuals from Africa, Europe, China and other parts of Asia along with one Australian and one Afro-American individual [Vigilant et al., 1991]. Figure 3 is a neighbour joining tree based on this genetic data on 294 individuals.

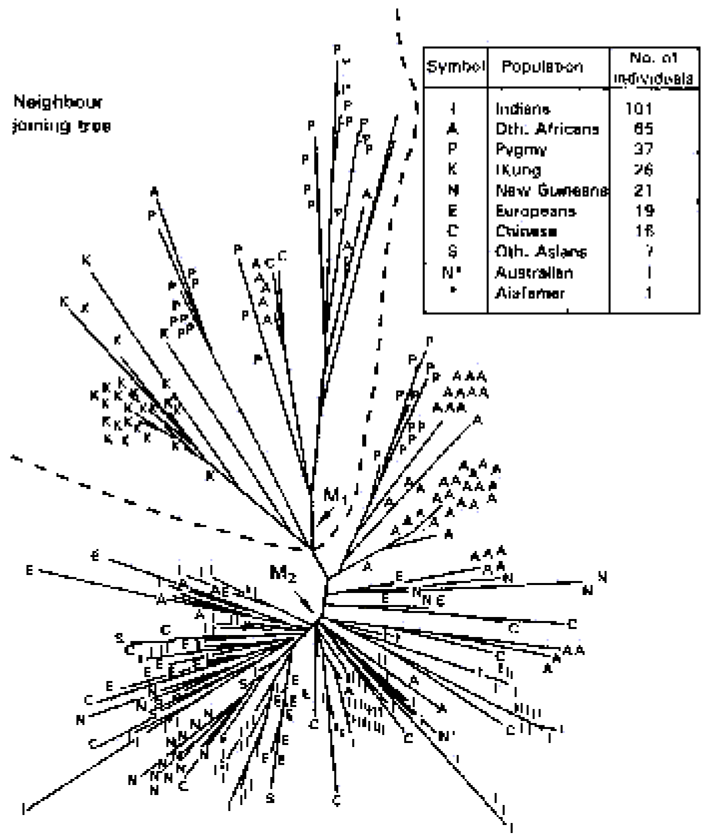
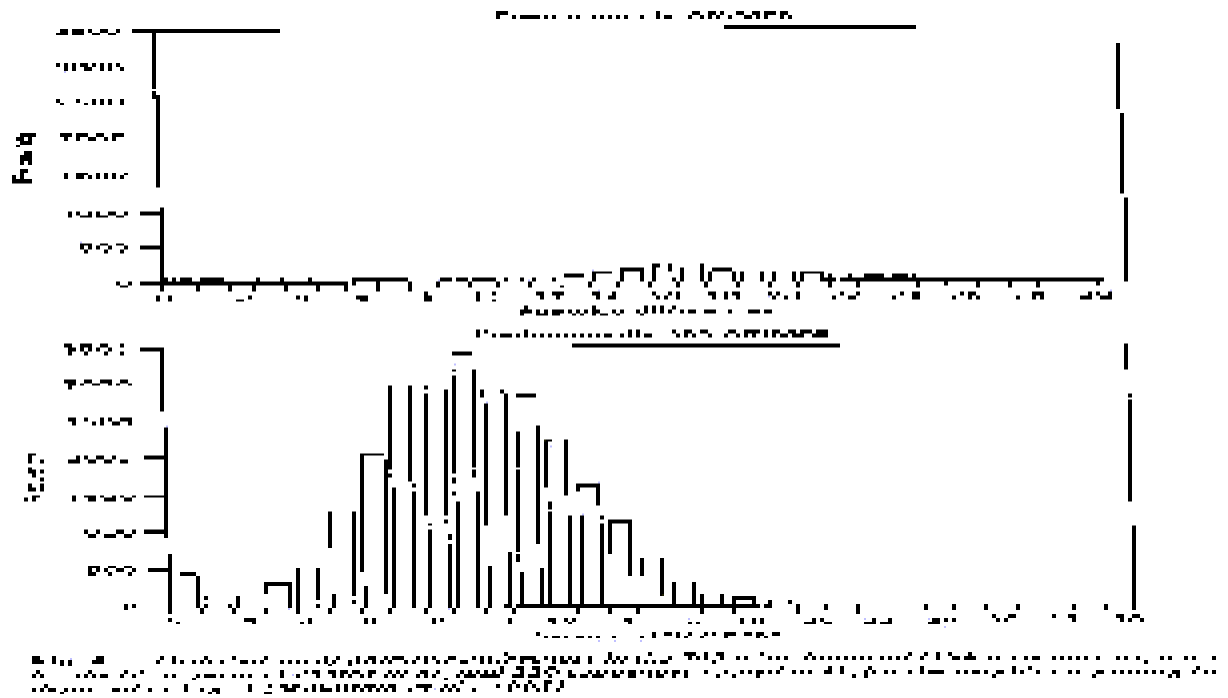


Fig. 3 *Neighbour joining tree based on 745 mitochondrial DNA sequences from 101 Indians, 36 Pygmies, 26 !Kung, 65 Other Africans, 21 New Guineans, 19 Europeans, 16 Chinese, 7 Other Asians, 1 Australian and 1 Afro-American (Mountain et al., 1995)*

The tree has two distinct trunks rooted in M1 and M2. The first trunk includes 65 sequences; all !Kung, most pygmies, 10 other Africans and two Chinese; the second trunk includes 229 sequences including 11 pygmies, 55 other Africans and all the non-Africans with the exception of the two Chinese. It is evident then that the primary genetic differentiation of the human species is between Africans and non-Africans, with Indians intermingling with Europeans and Chinese.

The magnitude of base pair differences in these sequences can permit us to estimate the time elapsed since common ancestry. Figure 4 presents such a distribution for the two trunks of the phylogenetic tree.



Evidently the group of 65 dominated by Africans with a mode around 17, are far more diversified genetically than the 229 primarily non-African sequences with a mode around 10. The time estimated to have elapsed since common ancestry of course depends on the mutation rate, which is probably somewhere between 10-5 to 10-6 for this hypervariable region of mitochondrial DNA. That gives us a range of 22 to 220 kybp for the first and 13.6 and 136 kybp for the second trunk. This is in conformity with the current view that modern *Homo sapiens* populations underwent a first expansion within Africa around 100 kybp, and a second expansion outside Africa around 65 kybp. The *Homo sapiens* peopling India are then a part of this second expansion around 65 kybp - an expansion that may have occurred in southern China [Ballinger et al., 1992] or in or close to the Indian subcontinent itself [Mountain et al 1995].

This data can also be used to construct a tree summarizing the relationship amongst the major human groups (Fig.5).

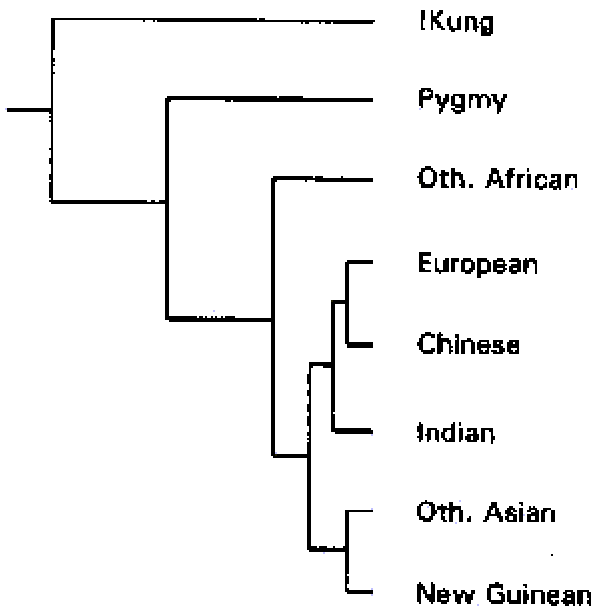


Fig. 5 *Dendrogram inferred according to average linkage algorithm based on simple genetic distances amongst the major population groups [Mountain et al., 1995]*

As expected this tree separates out Africans from non-Africans. Amongst the non-Africans the Europeans, Chinese and Indians are almost equally close to each other, being a little more separated from other Asians and New Guineans. The Indian population of today might then be surmised to have been put together by many ebbs and flows of people over the huge Eurasian continent.

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Gene analysis reveals people radiating out of the Middle East and the Orient

To assess the patterns of these ebbs and flows, Cavalli-Sforza et al (1994) have examined the frequencies of 69 genes from 42 populations covering all of Asia. Any given population is then represented as a point in the 69 dimensional space. This information can be summarized with the help of a multivariate analysis technique called principal components. The first principal component for Asia explains 35.1% of the total variation in the gene frequency; the second principal component 17.7% of the variation (Figs. 6 and 7).

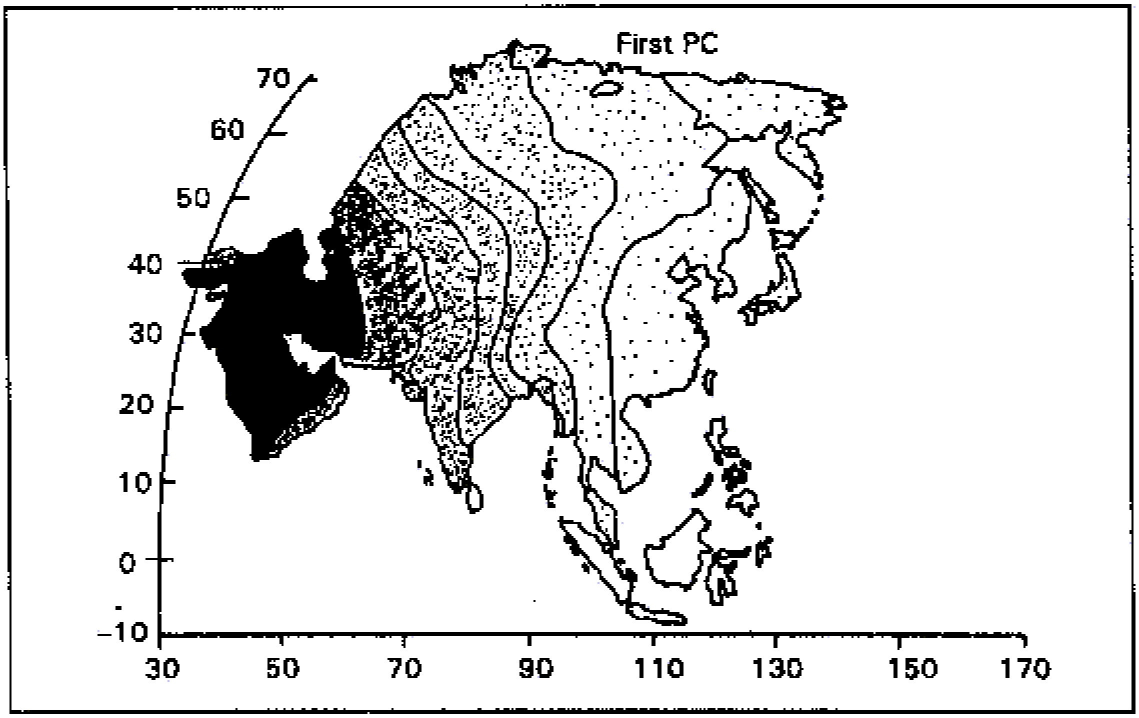

Fig. 6 *Synthetic genetic map of the first principal component for Asia based on 69 genes for 42 populations [Cavalli-Sforza et al., 1994]*

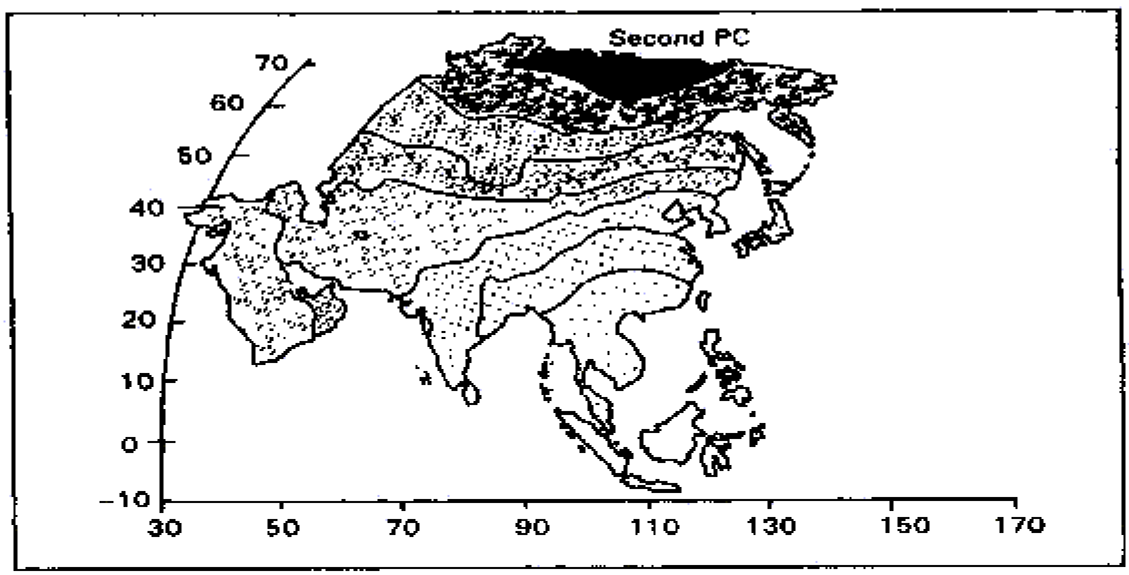

Fig. 7 *Synthetic genetic map of the second principal component for Asia based on 69 genes for 42 populations [Cavalli-Sforza et al., 1994]*

Subsequent components explain relatively little. These two maps are most instructive. The first PC map suggests that genetic affinities amongst Asian populations decline with distance along an east-west axis. This is compatible with movements of people radially fanning out of mid-east; although it could also result from a westward movement along a very broad front in eastern Asia. In a similar fashion the second principal component is compatible with fanning out of people from southeast Asia and China, although it could also result from a major movement originating in the northernmost reaches of Asia.

In both these cases, the first explanation, namely fanning out of people from middle-east and from China and Southeast Asia is far more likely. These are known to have been two independent centres of origin of cultivated plants, the middle east being the earliest in the world around 10 kybp and China and southeast Asia a little later around 8 kybp. Cultivation permits substantial increases in population density. This numerical superiority as well as availability of stored grain and meat on hoof as a buffer permits agricultural people to expand into regions till then under hunting-gathering economy, replacing and absorbing the local populations and leaving definite genetic footprints. Excellent archaeological evidence from Europe provides conclusive evidence of such a process of a northward fanning out of farming people. It is then very likely that Asian populations today represent two major radiations of people out of two centres of origin of cultivation, one in the middle-east. the other in China and Southeast Asia. The Indian population too must have been profoundly influenced by these two migrations, one through its northwestern frontiers near Khyber pass in present day Pakistan, and the other through the northeast near the China - Myanmar-India border in Manipur. The first one appears to be more significant, since it explains twice as much of the total variation.

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Language families reveal people's ancestries and movements

Humans not only transmit genes from one generation to the next, they also transmit cultural traits. Some of these are extremely conservative, being transmitted quite faithfully from parents to offspring. Foremost amongst these is language; children almost invariably acquire their mother tongue from their parents and other relatives. Language and other conservative traits such as practices relating to disposal of the dead are therefore excellent devices to trace historical changes. If this be so linguistic and genetic divergence ought to go hand in hand. To test this proposition, Cavalli-Sforza et al (1994) plot genetic distance amongst members of a human groups against the number of different languages spoken by members of the group (Fig 8).

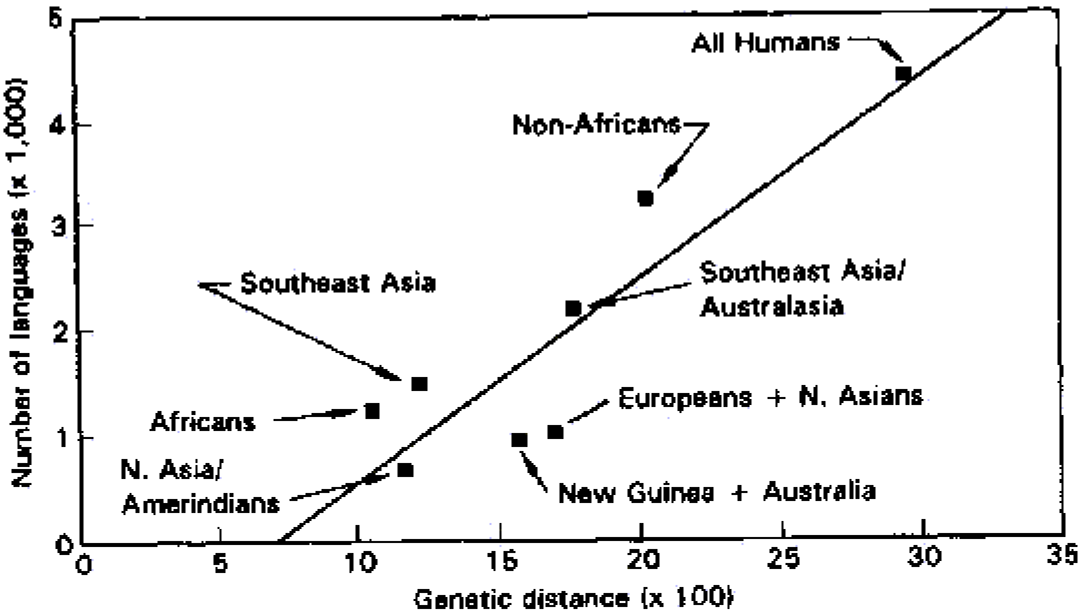

Fig. 8 ***Number of languages versus genetic distance in major regions of the world and for all of human populations [Cavalli-Sforza et al., 1994]***

The excellent correlation confirms our faith in languages as good markers for unraveling the ancestries and movements of people.

The languages of the world have been classified in a number of major families. There are of course a few which are stand-alone, which cannot be assigned to any family. Nahali, a tribal language of Central India and Burushaski, spoken by a small group of people on the border of Pakistan and Afghanistan are two such. But all other languages of India, can be assigned to one of four major language families - Austric, Dravidian, Indo-European and Sino-Tibetan. An excellent information base on the speakers of these languages is provided by the People of India project of the Anthropological Survey of India. This project involved assigning the entire Indian population to 4635 ethnic communities and putting together detailed information on each of them through interviews of over 25000 individual informants spread over all districts of India, along with compiling information from a variety of published sources [Joshi, et al., 1993]. This project records as the mother tongue the following number of languages of different families spoken by Indian ethnic communities:

Table 1
Global distribution

Austric	Southeast Asia, Eastern and Central India
Dravidian	South and Central India, Pakistan, Iran

Indo-European	Europe, West Asia, North, West and East India
Sino-Tibetan	China, Southeast Asia, India bordering Himalayas

It is reasonable to assume that speakers of these four language families represent at least four major lineages [Parpola, 1974]. The first question to ask is whether these language families developed within the country, or came in with migrations of people from outside the subcontinent. The geographical range of distribution of Austric, Indo-European and Sino-Tibetan speakers is extensive; India harbours only a minority of the languages within these families. The geographical range of distribution of Dravidian languages is however restricted largely to India; there are only two outlying populations - Brahui in Baluchistan and Elamic in Iran. Dravidian languages might then have developed within India, others are less likely to have done so, for we have no evidence of any major technological innovations that could have served to carry speakers of those languages outside India.

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Language and economy

We may look for evidence on how long the lineages speaking different language families have been in India in two different ways. Firstly we may examine the current levels of economic activities of the communities speaking those languages, and to compare them with levels of economic activities of speakers of other language families. The tribal communities of India continue to extensively hunt and gather as well as practice low input shifting cultivation. These communities are likely to have migrated to India relatively early, perhaps prior to the beginning of agriculture and animal husbandry. Some tribal groups or other speak languages belonging to each of the four families. Korkus, Mundas, Santals, Khasis speak Austric languages; Gonds, Oraons Dravidian languages, Nagas and Kukis Sino-Tibetan languages and Bhils and Varlis speak Indo-European languages. (Figs. 9-12).

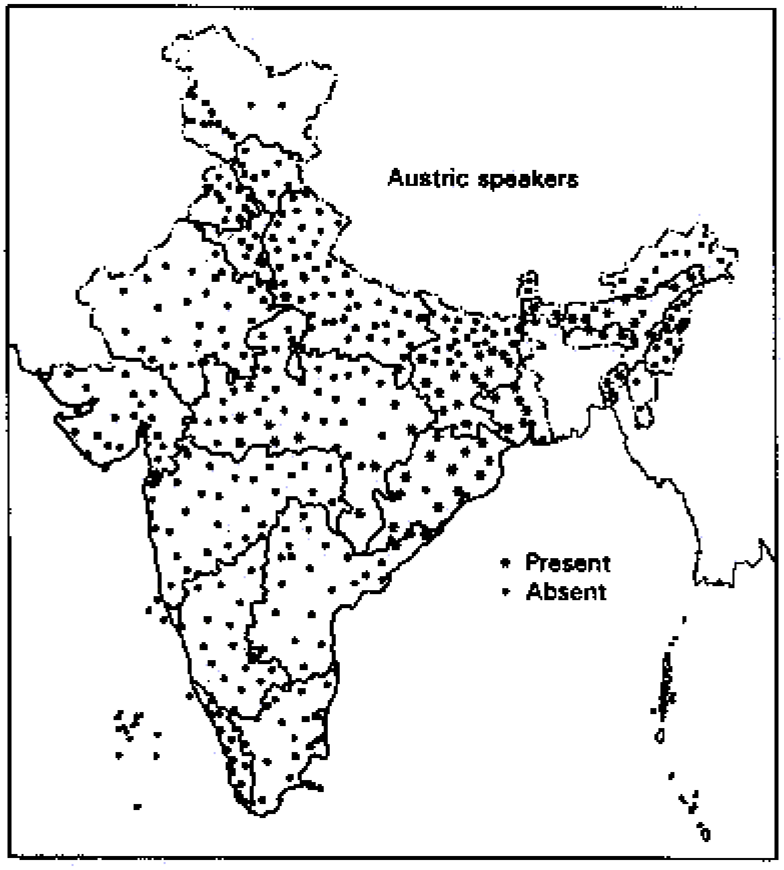

Fig. 9 *District level distribution of Austric language speakers in India*

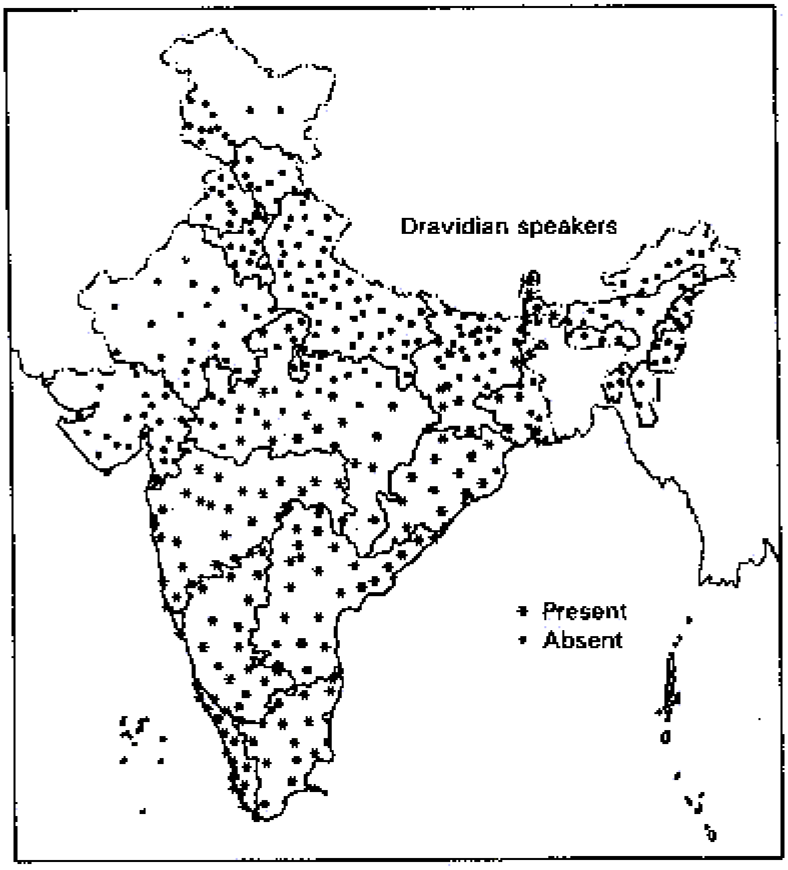

Fig. 10 *District level distribution of Dravidian language speakers in India*

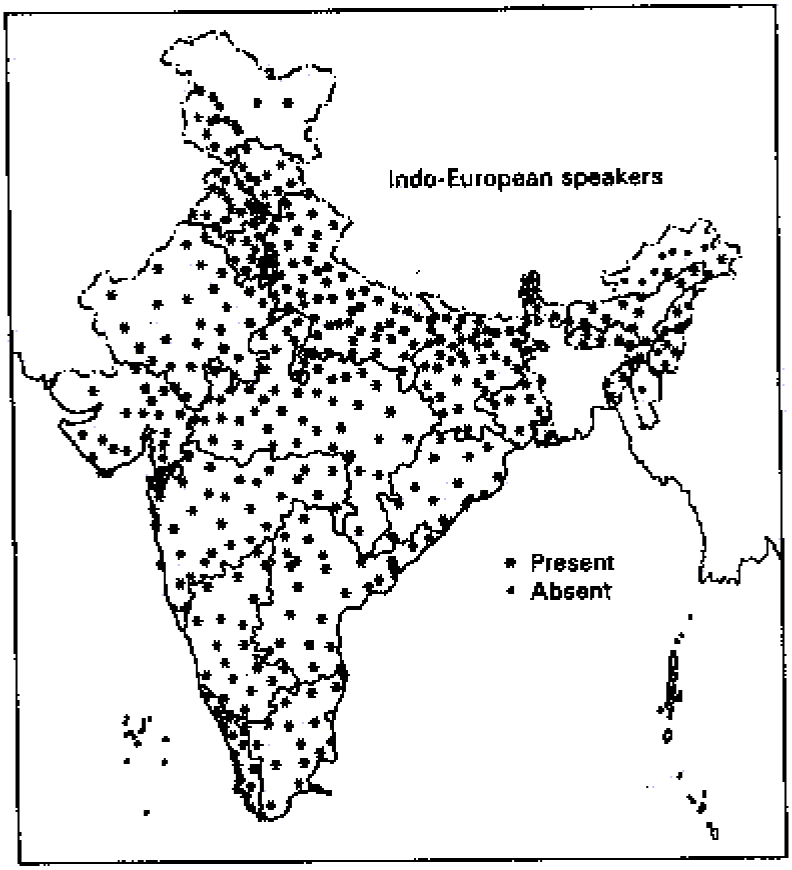

Fig. 11 *District level distribution of Indo-European language speakers in India*

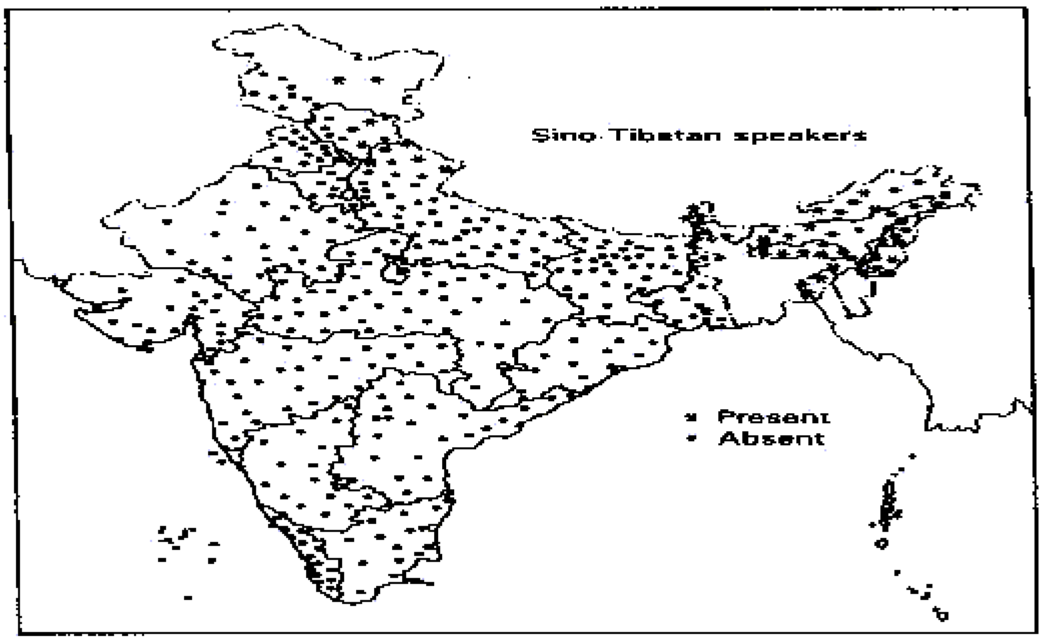

Fig. 12 *District level distribution of Sino-Tibetan language speakers in India*

But it is amongst Austric speakers that all communities are exclusively tribals. Outside India also most Austric speaking communities practice very primitive technologies. This suggests that Austric speaking people may be the oldest inhabitants of India. They may be amongst the first group of *Homo sapiens* to have reached India, perhaps some 50-65 kybp. Since over 98% of Austric speakers today lie in southeast Asia, they may have entered India from the northeast.

Sino-Tibetan speakers of India also include many tribal groups, though they also include communities like Maites of Manipur valley practicing advanced agriculture. Their concentration is along the Himalayas; only one community of West Bengal has reached mainland India. Many of them report having moved into India from Myanmar or China within last few generations. They are therefore peripheral to the broader peopling of India.

The bulk of Indian mainland populations are Dravidian and Indo-European speakers. Both include communities at all economic levels from tribals to the most advanced cultivator, pastoral, trader or priestly groups. Many of the technologically less advanced amongst these communities such as Dravidians speaking Kanis of Kerala or Indo-European speaking Bhils of Rajasthan may have acquired these languages in more recent times through the influence of the economically more advanced mainstream societies. It is however notable that while there are several Dravidian speaking forest dwelling tribal communities such as Gonds or Oraons in a matrix of more advanced Indo-European speaking communities, there are no enclaves of forest dwelling tribal Indo-European speakers surrounded by more advanced Dravidian speaking communities. The tribal Indo-European speakers of south India are all nomadic communities such as Banjaras or

Pardhis with known history of migration from Rajasthan to south India in recent centuries. This is strongly suggestive of Dravidians being older inhabitants of the Indian subcontinent, having been pushed southwards, surrounded by or converted to Indo-European languages by later arriving Indo-European speakers [Lal, 1974; Rakshit and Hirendra, 1980].

One may then suggest the following sequence of migrations of these major language speaking groups into India: Austric-Dravidian-Indo-European. If this be correct, another interesting prediction follows. Austric languages having arrived in India earliest may show the most diversified vocabulary, Indo-European languages the least. To test this we have compiled words for universally used nouns such as mother, water, tree in severalAustric, Dravidian, Indo-European and Sino-Tibetan languages. While a more objective analysis of the extent of such variation is under way, it appears true that Austric languages show the greatest and Indo-European the least divergence.

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Archaeological evidence

While tool using *Homo erectus* populations have been in India for over 500 kybp, fossil human remains appear only after 45-50 kybp, associated with middle palaeolithic, or stone age tools [Agarwal, 1982; Agarwal and Ghosh, 1973; Agarwal and Ghosh, 1973; Agarwal and Kusumgar, 1974; Kennedy, 1980](Fig.13).

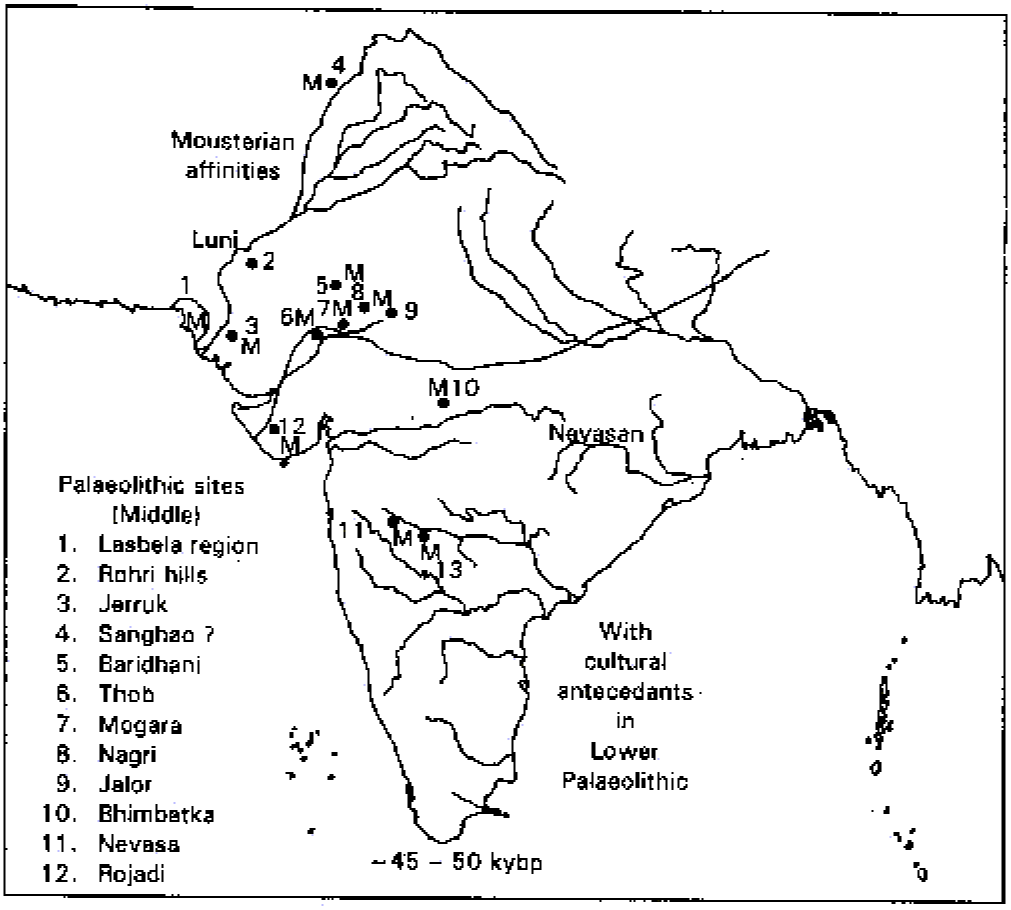

Fig. 13 *Major Middle Palaeolithic sites of India*

It has been suggested that these sites fall in two groups, the northern sites showing affinities with the Mousterian tool industries of Europe, while the southern sites show cultural antecedents in lower palaeolithic. This may reflect two separate streams of migration of newly expanding *Homo sapiens* populations; one coming into India from the northwest, the second from the northeast. One may surmise that the stream coming in from the northeast may have included early speakers of Austric languages.

The next important event on the Indian archaeological scene is the beginnings of cultivation of plants and use of pottery [Agarwal and Pande, 1977; Megaw, 1977; Vishnu Mittre, 1977; Jarrige and Lechevallier, 1973; Dani et.al, 1967; Vishnu Mittre, 1989] (Figs. 14 - 15).

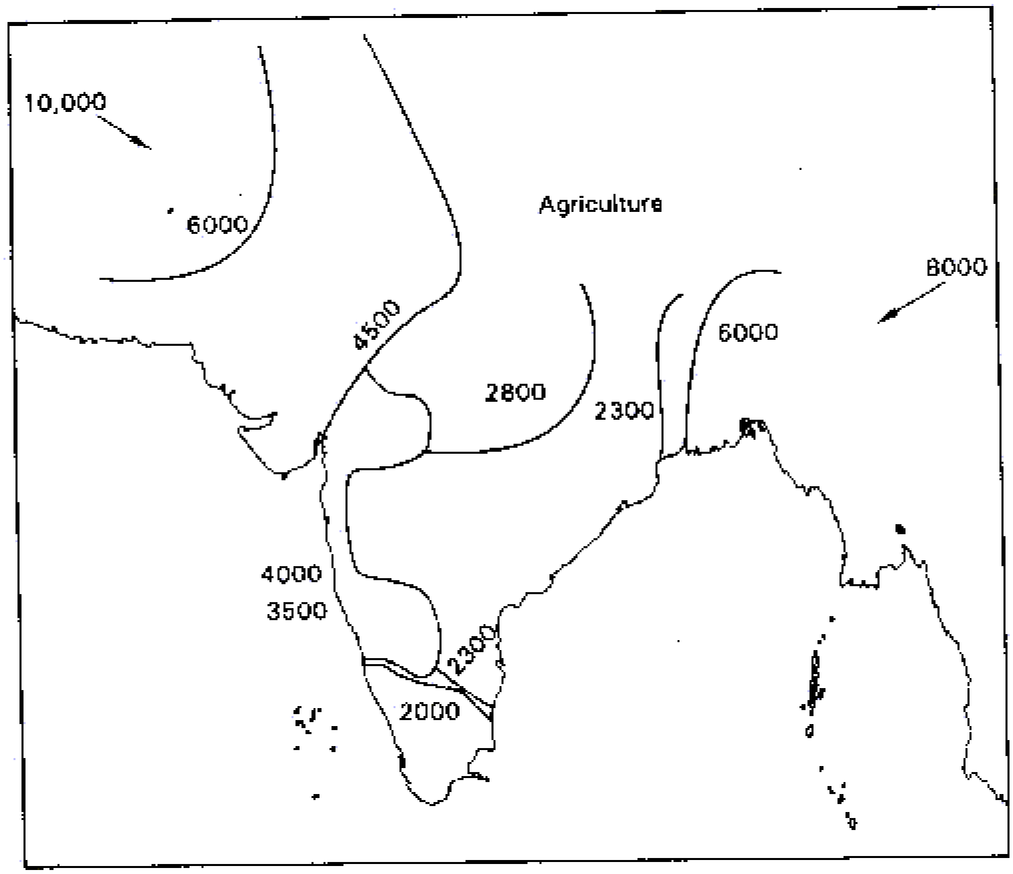

Fig. 14 *Contours of earliest dates of definite evidence of cultivation of crops in India*

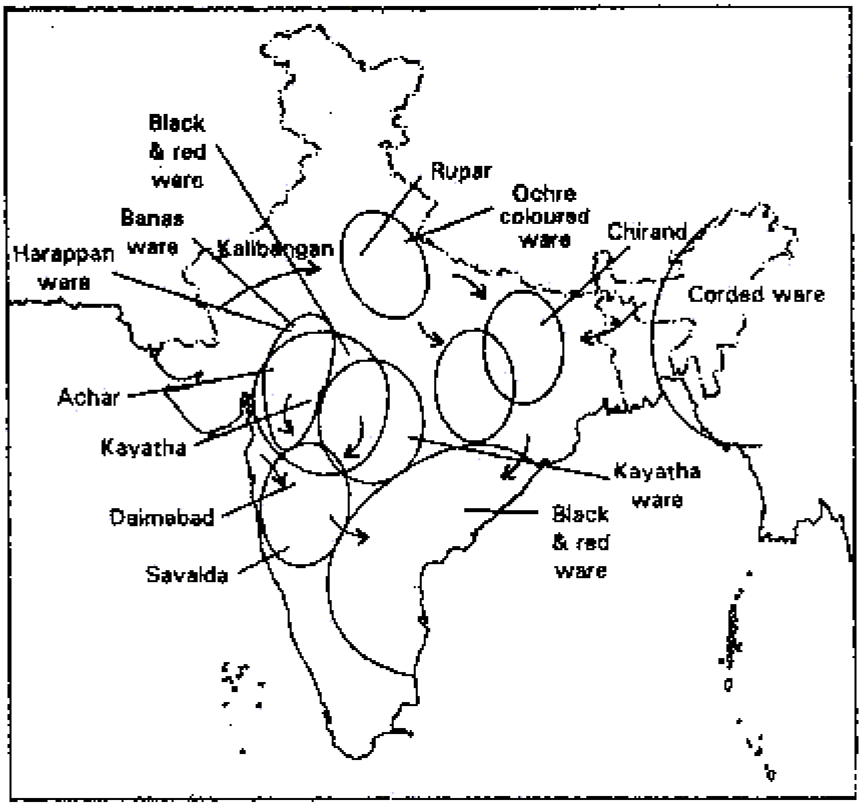

Fig. 15 *Major pottery traditions of India*

Cultivation of plants evidently reached India simultaneously, around 6 kybp from two different directions, from the two centres of origin in the mid-east and China and Southeast Asia. The steady advance beyond this stage seems however to have been primarily driven by the crop-animal complex derived from the mid-east, reaching the tip of southern India some 4000 years later around 2 kybp. The diffusion of pottery traditions, which arise in response to the need to store and cook grain shows similar evidence of the two influences from northwest and northeast, with the western influence predominating over much of the country. Thus the Black and Red Ware reflects western, while the Cordedware Chinese influence [Sankalia, 1977; Brice, 1977; Rao, 1965, 1969].

It is likely that the farmers entering India from the northwest passage were either Dravidian or Indo-European speakers; those entering the subcontinent from the northeastern passage may have been Sino-Tibetan or perhaps Austric speakers. If, as the linguistic evidence suggests Dravidian speakers entered India well before Indo-European speakers then middle-eastern farmers entering India from the northwest may have been Dravidian speakers. The remnants of related languages, Elamite and Brahui in Iran and Pakistan is consistent with such a migration of Dravidian speakers from mid-east to India.

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Horse and iron as pointers of heritage

If this is true, then the Indo-European speakers must have come to India with some other major advantage. Two other technological innovations, known to have originated outside of India are excellent candidates. They are the domestication of horse, around 6 kybp on the shores of Black Sea in present Ukraine, and the use of iron, around 5 kybp in Anatolia in present day Turkey. Riding of horses or hitching them to carts greatly increases the mobility and the military or trading capabilities of a group. While cattle, sheep, goat, pig were all domesticated in mid-east around 10 kybp, the horse was domesticated 4000 years later in a separate centre in the Asian steppes. The most favoured theory of the spread of India-European languages today is that it was the language of these horse people who came to dominate Europe, west Asia and much of India over the next 4000 years. As a ruling class, they are believed to have imposed their language over Europe, without making any major genetic contributions to the populations. They may have wielded parallel influence in India.

The horse appears in archaeological records between 2000 to 500 years after the first appearance of cultivation of crops and husbanding of cattle, sheep, goat and pigs in different parts of India (Fig. 16).

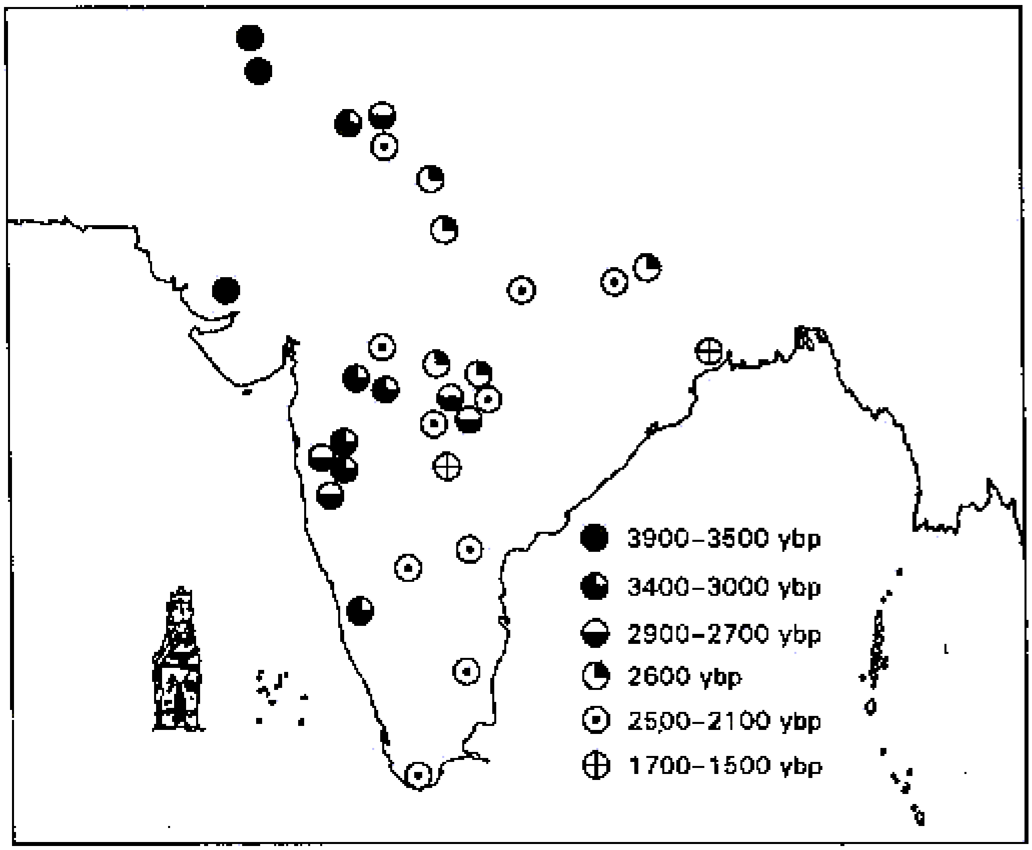

Fig. 16 *First dates of appearance of domesticated horse in different parts of India*

Particular styles of burial appear to accompany the horse people. These burial styles show links with styles noted in Central Asian homeland of Indo-European speakers strengthening our belief in the possibility that the Indo-European speakers indeed made their way to India propelled by the advantage that the control over horses conferred.

The people associated with Vedic traditions and Sanskrit language definitely used horses, and may have been one group, though perhaps not the only group of Indo-European speakers to enter the subcontinent. These people also seem to have been associated with cremation as a method of disposal of the dead. Cremation is today the dominant mode amongst most Indo-European speaking communities of India, burial remains common amongst Dravidian speaking communities, especially those affected little by the process of Sanskritisation (Fig.17).

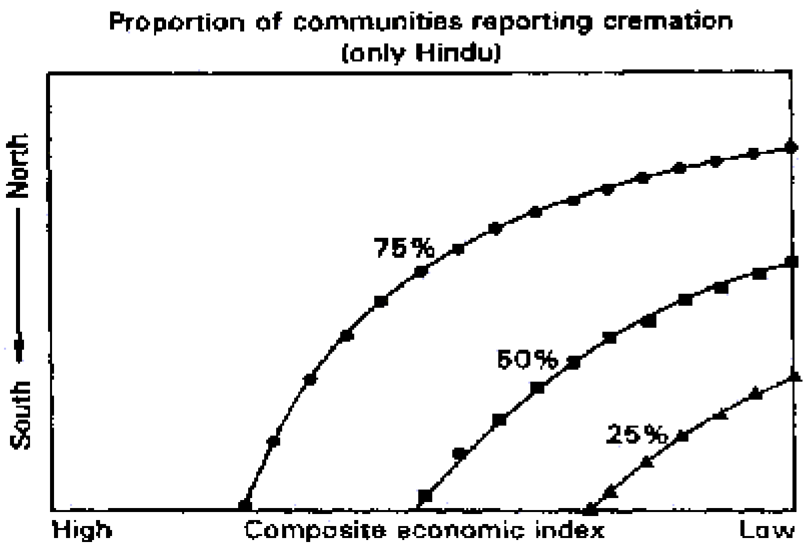

Fig. 17 *The distribution of cremation vs burial of the dead in mainland India along a north-south geographical axis and amongst different social strata*

This also suggests that Indo-European speakers came to India after Dravidian speakers, probably associated with the use of horse and the practice of cremation.

It is also possible that it was the use of iron that conferred an important advantage to certain groups of people migrating to India; groups that may have included speakers of Indo-European languages. The archaeological evidence suggests that use of iron is not necessarily associated with that of the horse, and appears either later than or ahead of the former in different parts of the country (Fig.18 and 19).

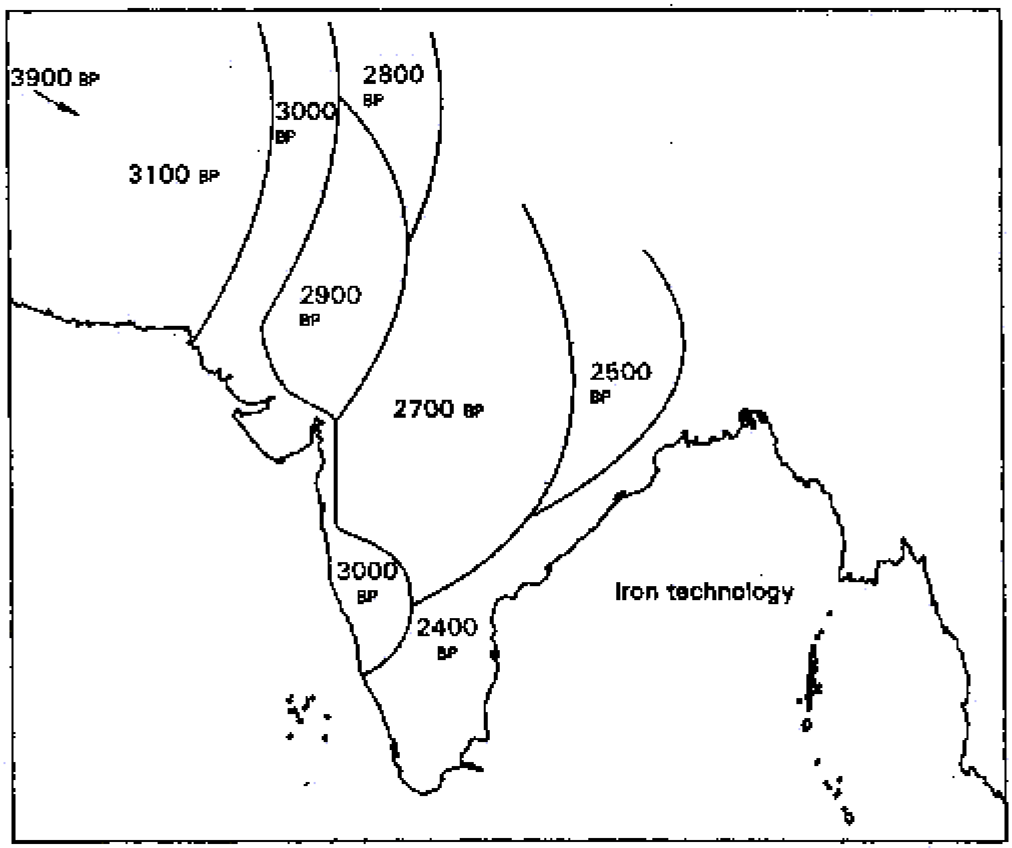

Fig. 18 *The earliest known dates of appearance of iron technology in different parts of India*

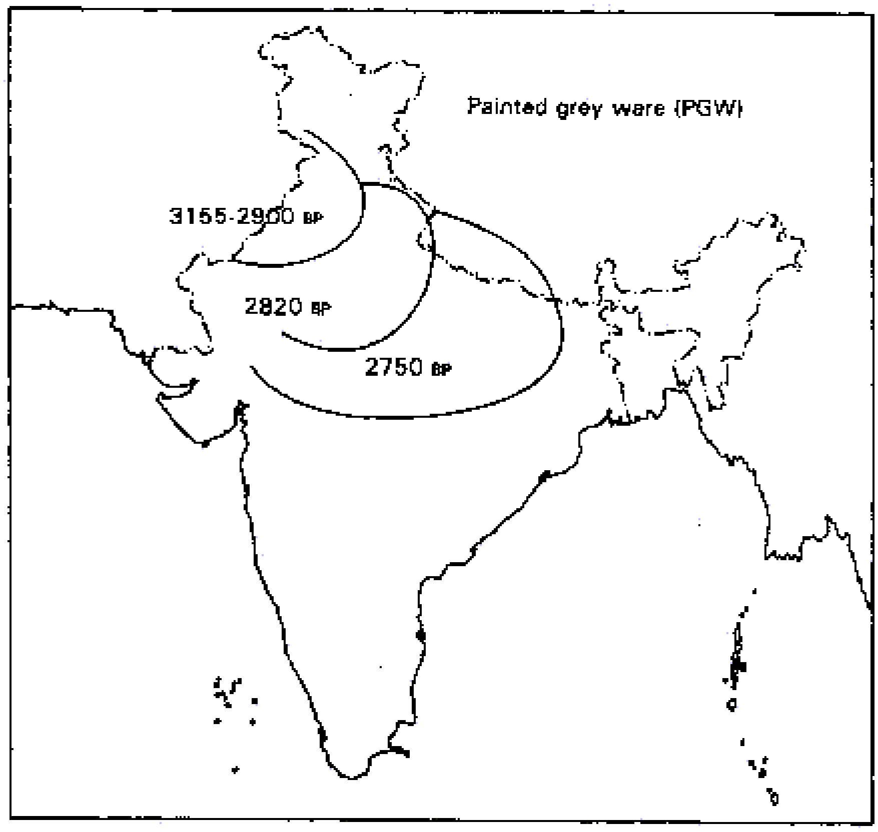

Fig. 19 *Known dates of appearance of painted grey ware pottery known to be associated with users of iron technology*

It is then likely that iron was brought to India by people other than horse people, people other than Vedic people. Indeed there may have been many waves of Indo-European speakers into India, waves that may have brought into the country different languages of that family. Thus some linguists believe that the present day Indo-European languages came to India in at least two distinct streams, the first stream bringing in languages related to Bengali, Oriya, Marathi, Sindhi and Kashmiri and the second stream languages related to Punjabi, Hindi and Rajasthani [Gupta, 1979; Misra and Bagor, 1973; Stein, 1984; Jha, 1981; Parasher, 1992; Emmerick; Verma, 1971].

It is not at all clear whether the Harappan people spoke Dravidian or Indo-European languages. This civilization is contemporaneous with the first appearance of horse, most likely associated with Indo-European speakers in the archaeological record. It could therefore have been a Indo-European speaking civilization. But there is a greater possibility that it may have emerged out of the earlier Dravidian speaking communities of agriculturists. What seems more plausible is the equation of *Dasas* of Vedic people with the earliest, probably Austric speaking hunter-gatherers and *Dasyus* with the Dravidian speaking cultivating communities. It is notable that the Vedic people were engaged in a far more violent conflict with *Dasyus*; such conflict may relate to struggle over fertile land [Possehl, 1979].

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A plausible scenario

There are then many still unanswered questions pertaining to how our subcontinent was peopled. But the most plausible scenario is the one depicted in Figs. 20-23.

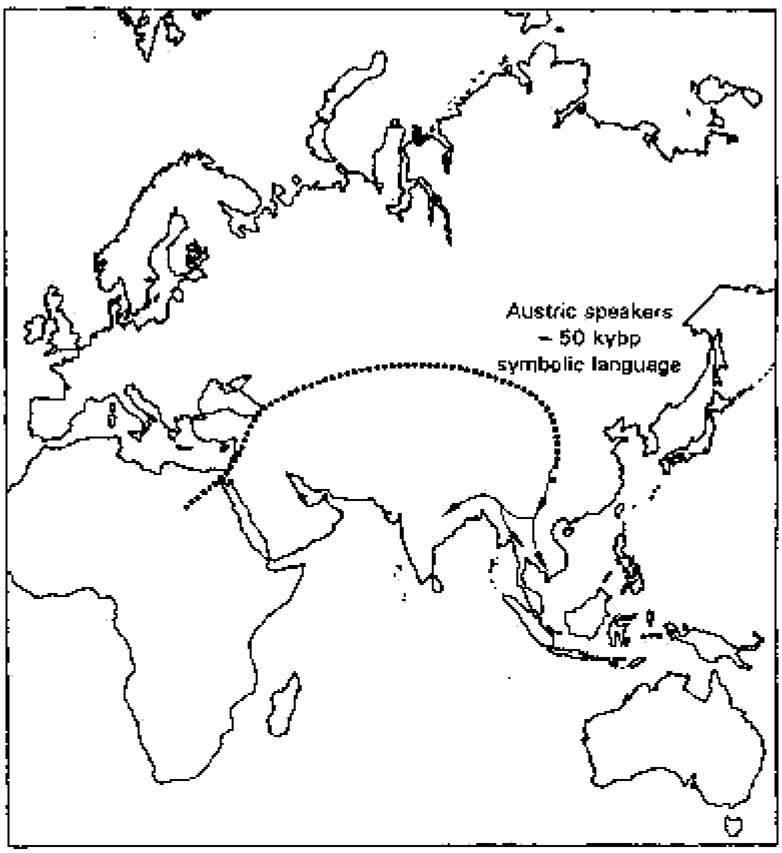

Fig. 20 *A possible scenario of the earliest migrations of Austric speaking people into India*

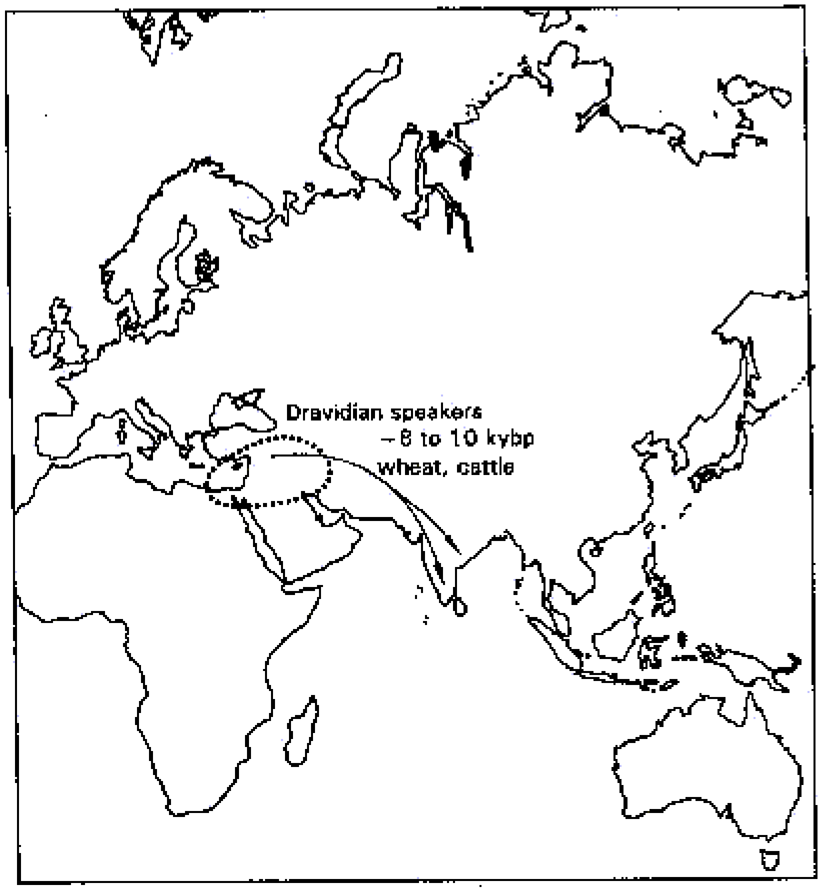

Fig. 21 *A possible scenario of migrations of Dravidian speaking people into India*

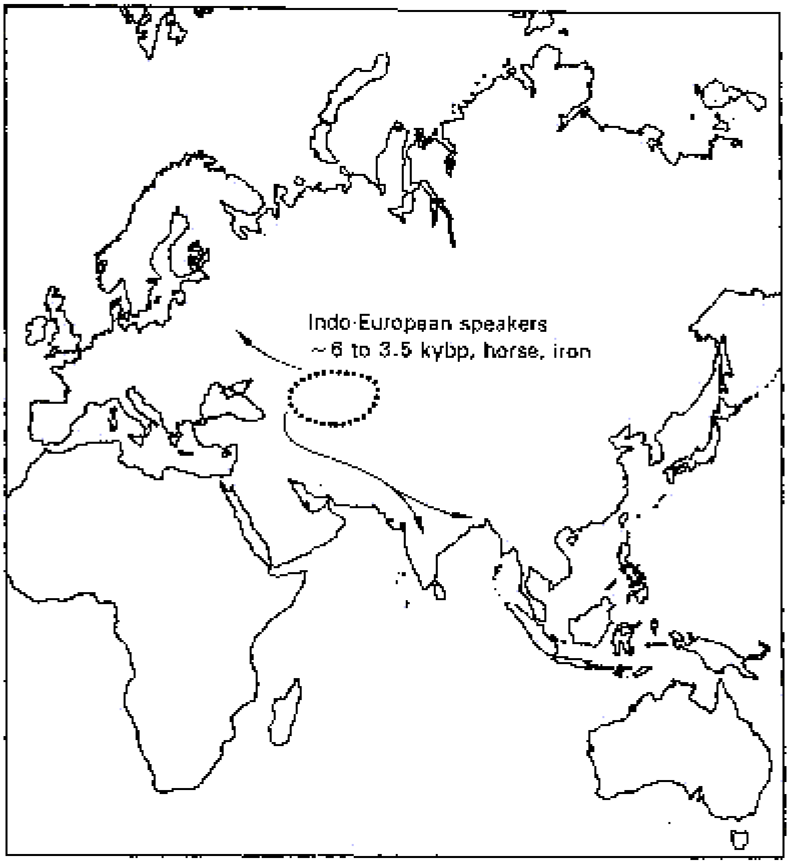

Fig. 22 *A possible scenario of migrations of Indo-European speaking people into India*

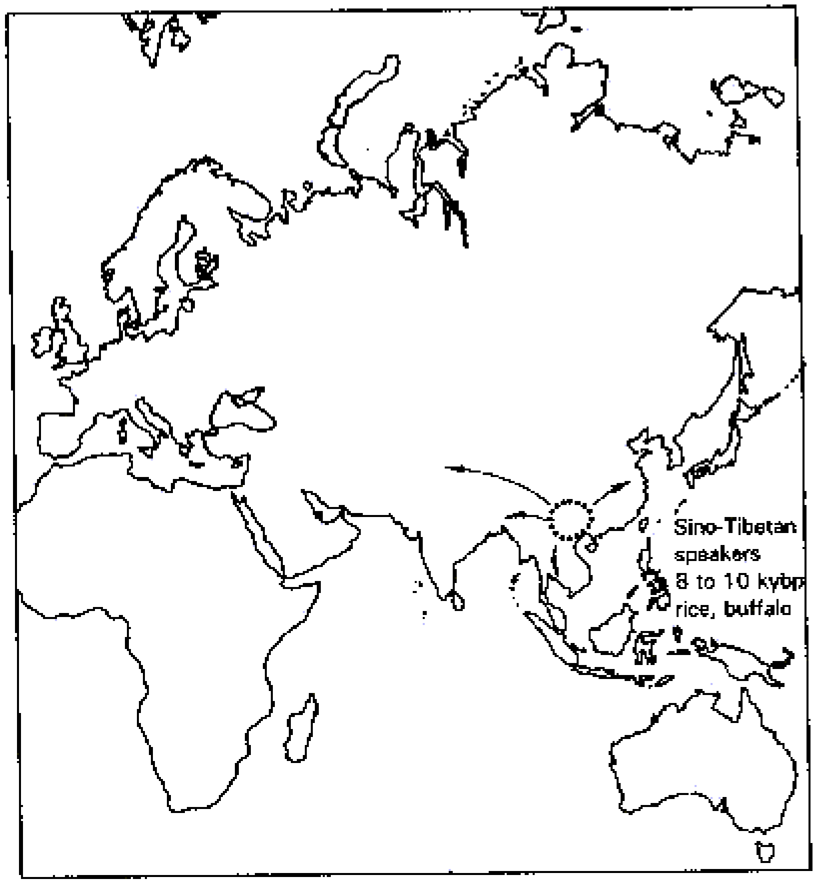

Fig. 23 *A possible scenario of migrations of Sino-Tibetan speaking people into India*

The earliest migrants into India, perhaps 50 kybp may have been the Austric speaking *Homo sapiens*, with the advantage conferred by the mastery over a symbolic language. Their genetic footprints may be discerned in the trends evident in the 2nd P.C of the synthetic genetic map of Asia. The next major waves of migrations around 6 kybp may have been those of wheat cultivators from the middle east and the rice cultivators from China and south east Asia. The former are likely to have been Dravidian speakers and contributed to the trend evident in the 1st P.C. of the synthetic genetic map of Asia. the latter may have been Sino-Tibetan speakers who would have contributed further to the trend revealed by 2nd P.C. The latest major migration around 4 kybp may have included several waves of Indo-European speakers equipped with horses and iron technology.

These might have been the most massive migrations peopling India. Others have followed, largely from the west, through the Khyber pass on the northwestern frontiers of the subcontinent. These seem to have been propelled by superior weaponry, increasingly better control over horses and finally seagoing ships.

Such significant innovations may include some of the following. An important early development in weaponry was the composite angular bow which appeared in west Asia around 5 kybp. Bending through the length of the limb, releasing this bow string produced no kick leading to a smooth and accurate shot. The extremely long draw length of over 1 m led to a greatly enhanced cast. A crucial piece of equipment associated with control over horse is stirrup, which helps in balancing the rider and permits him to stand up to threw the lance. The earliest form of the stirrup was a string with two loops on either side for the rider's foot. The first known instance of iron stirrups comes from China in sixth century A.D. reaching Iran by 7th century, and arriving in India with Turkish warriors in 11th century. Another significant invention was the iron horse shoe first known from Siberia in 9th Century A.D., reaching India with Turkish warriors in 13th Century A.D. The gunpowder was invented in China around 100 A.D. and slowly reached Iran, Arabia and finally Europe with Mongols around 1400 A.D. It reached India with the arrival of the first Mughal emperor Babur who used it in the first battle of Panipat in 1526 A.D.(Fig. 24).

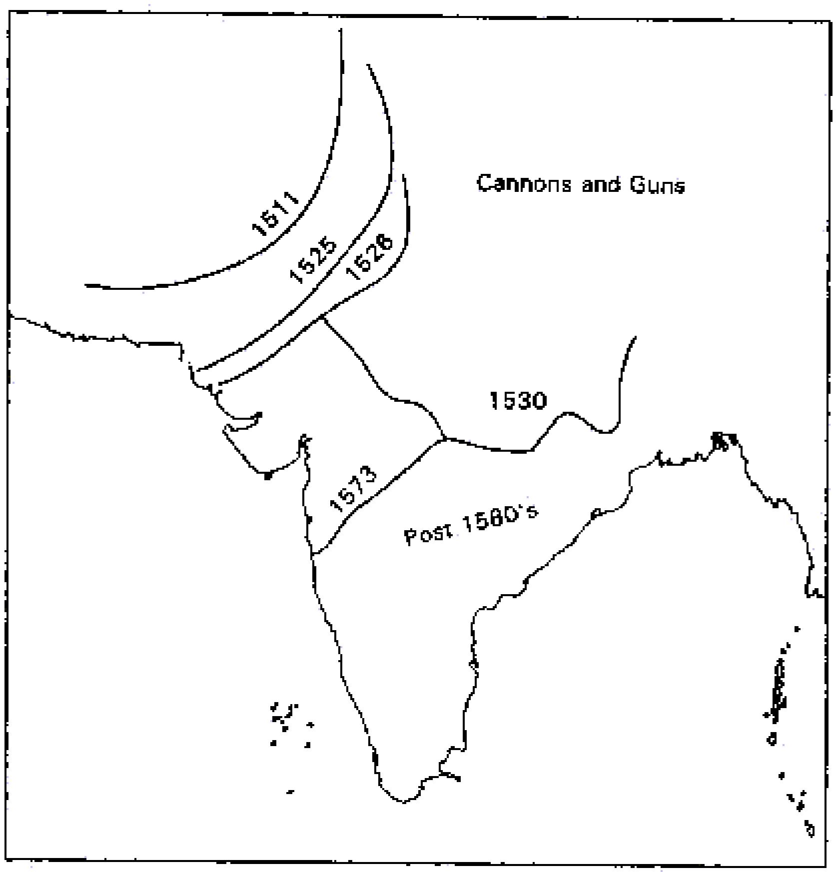

Fig. 24 *The earliest known usage of cannons and guns in India*

The early canons in India were made by welding together many iron rods. The Europeans introduced cast iron canons in the next century; these could fire more accurate and powerful volleys. The Europeans also developed superior ocean-going vessels from which canons could be fired by 16th century [Deloche, 1983; Habib, 1992].

These many developments taking place in China, Central Asia and finally Europe brought in many people, enjoying a military advantage (Fig. 25).

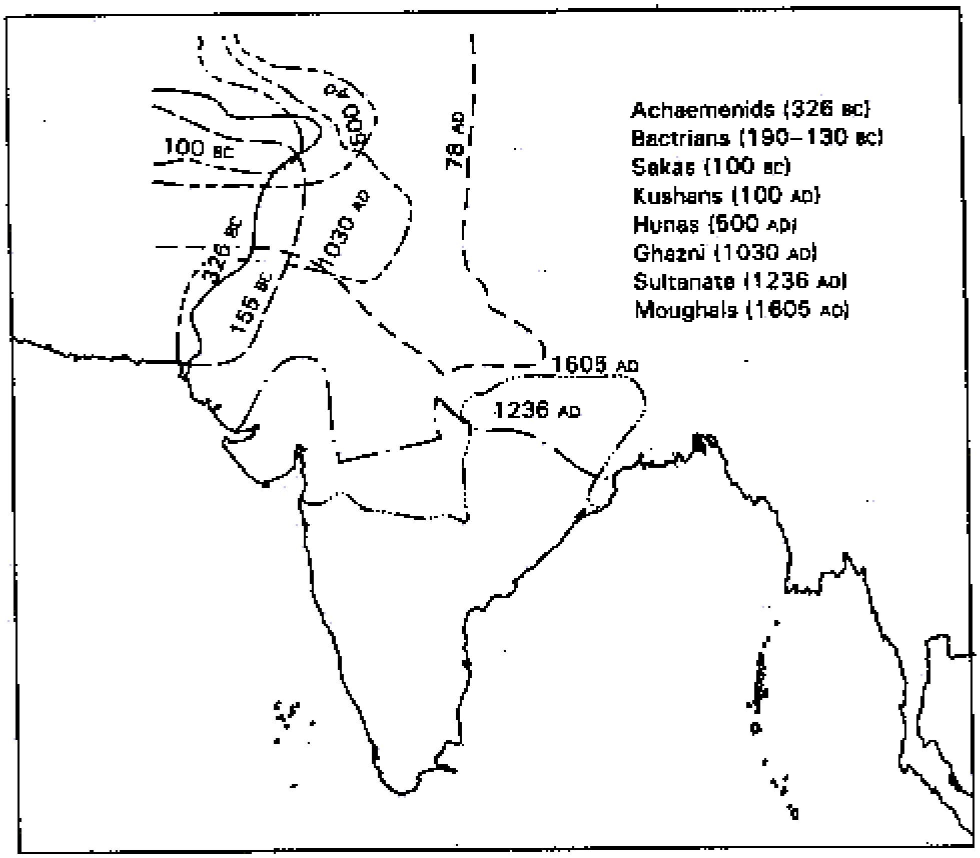

Fig. 25 *Migrations of people enjoying a military advantage through the northwestern passage into India between 300 BC and 1600 AD.*

The number of people thus coming in were probably not very large, but they contributed immensely to the cultural diversity of the country by bringing in new languages, new forms of religion, and of course new technologies. Amongst these technologies was spinning wheel, apparently invented in China and brought to Europe by Mongols around 12th Century A.D. It seems to have reached India in 13th-14th Century and created a tremendous commercial potential for textile production in India. Similarly Indian agriculture too must have been greatly influenced by the introduction of the Persian wheel, first referred to by Babur in 1526-30 in his memoir *Babur Nama*.

With these many streams of *Homo sapiens* coming in to the country over 50,000 years or more, India has developed what Cavalli-Sforza calls an incredibly complex genetic landscape. Our mitochondrial DNA data on 101 Indians permits us to estimate the time to common ancestry of our people on the basis of the pairwise differences in the mitochondrial DNA sequences. These estimates of course, depend on the assumed value of mutation rates; but 65,000 years is close to a reasonable estimate for the modal value of 9 (Fig.26).

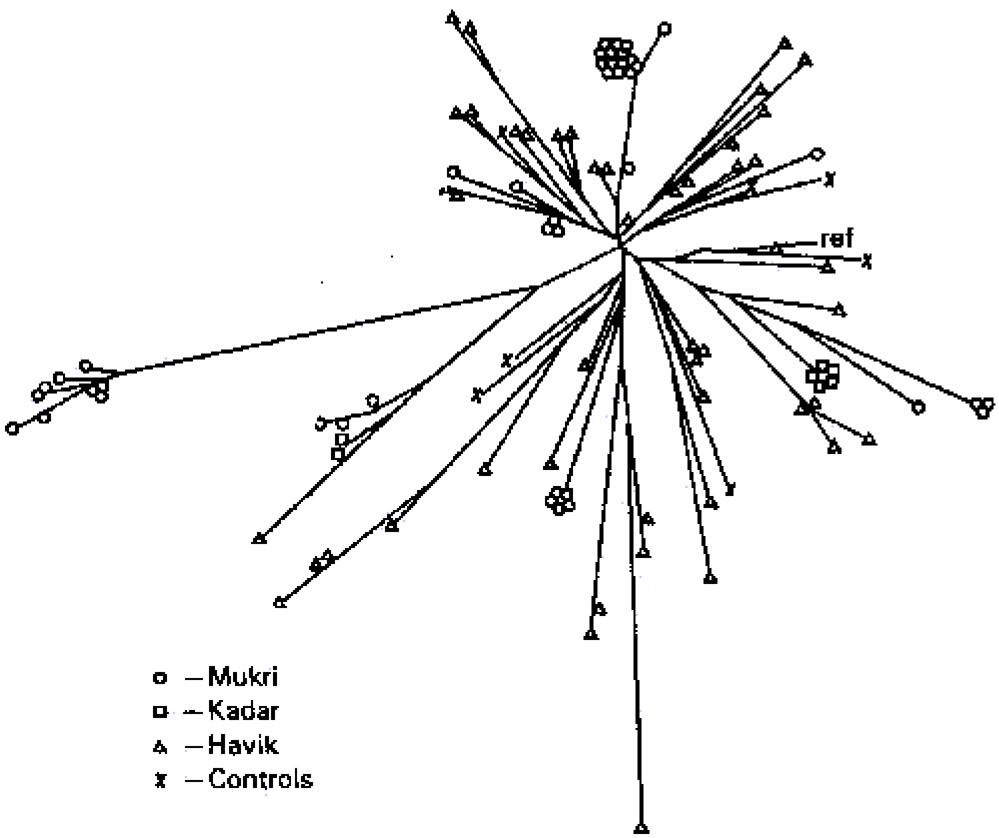

Fig. 26 *Neighbour joining tree depicting 101 Indian sequences [Mountain et al., 1995]*

So the Indian population has been put together by people drawn from many different streams ultimately derived from the major expansion of non-African *Homo sapiens* around this time.

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A segmented society

What the Indian population is remarkable for is the segmentation of this large population into thousands of endogamous groups. The People of India data recognizes 4635 such ethnic communities. Many of these are however clusters of endogamous groups with similar traditional occupations and social status. The actual number of endogamous groups is decidedly much larger, of the order of 50 to 60 thousand (Joshi, Gadgil and Patil 1993; Gadgil and Malhotra 1983). This persistence of tribe like endogamous groups, characteristic of hunter-gatherer-shifting cultivation stage all over the world, in a complex agrarian, and now industrial society of India is a unique phenomenon. It seems to be a result of a peculiarly Indian tradition of subjugation and isolation, rather than the worldwide practice of elimination or assimilation of subordinated communities by the dominant groups.

Our mitochondrial DNA studies provide some notable insights into the structure of this social mosaic. For this purpose we chose two communities, Haviks and Mukris from the same district of Uttara Kannada. Haviks are a Brahmin group well known for their skills at growing multi-storeyed spice gardens of cardamom, pepper and betelnut. They also perform priestly functions, and are today prominent in many white collar occupations. Their current populations is around 100,000 individuals concentrated in an area of about 20,000 km2. The Mukri, on the contrary are members of a scheduled caste, earlier treated as untouchables. Their current population numbers around 9000 individuals concentrated in an area of 2000 km2. They continue to indulge in substantial amounts of hunting, gathering and fishing to this date and serve as unskilled labour on Havik and other farms.

Figure 26 depicts the neighbour joining phylogenetic tree for 48 Haviks, 43 Mukris, 7 Kadars and 3 other Indians. Note that Haviks and Mukris, although they lie at opposite ends of the social hierarchy do not constitute two distinct trunks. Their sequences are intermingled suggesting past genetic exchanges, although these may have occurred well before the formation of the Indian caste society some 2000 years ago; indeed they may even derive from the time of common ancestry some 65 kybp, perhaps as a part of population expansion of non-Africans outside of India. But intermingled as they are, the Havik sequences form a distinctive star-like pattern with many short branches joining the centre, unlike the Mukri sequences which are bunched in a few clusters on long branches. The star like Havik pattern is suggestive of a history of population expansion, the clustered Mukri pattern suggests long history of a stationary population, or a population that has experienced several bottlenecks. This is further brought out in the distribution of pairwise mitochondrial DNA base pair sequence differences for the Havik and Mukri populations (Fig.27).

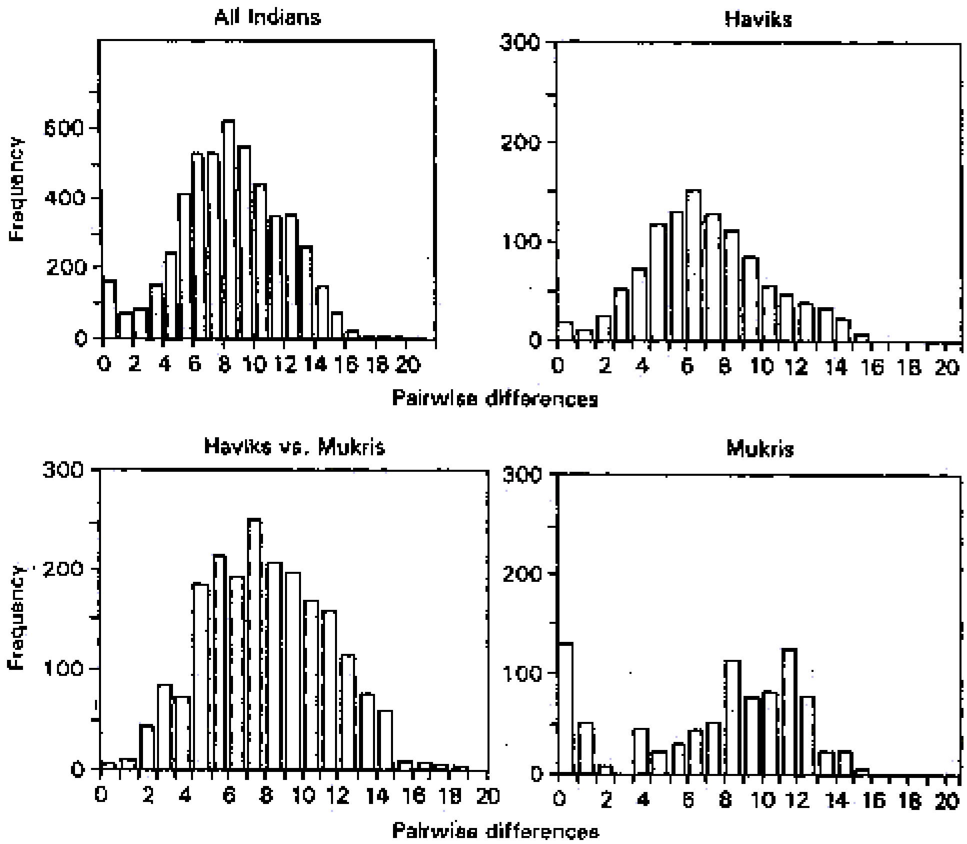

Fig. 27 *Distribution of pairwise differences in mitochondrial DNA sequences of 101 Indians [Mountain et al., 1995]*

The unimodal pattern for Haviks is compatible with a history of population growth, the multimodal Mukri pattern with a history of population stationarity or bottlenecks.

Such differences in genetic structure suggestive of different population histories have been suggested from other human populations earlier, but never before for two population groups living together in such a restricted geographical locality as a single district of Uttara Kannada. This reflects the unique history of Indian population, with dominant groups like Haviks enjoying high levels of resource access and expanding in numbers and range, while subjugated populations like Mukris existed side by side with much more limited resource access and stagnant populations (Fig.28).

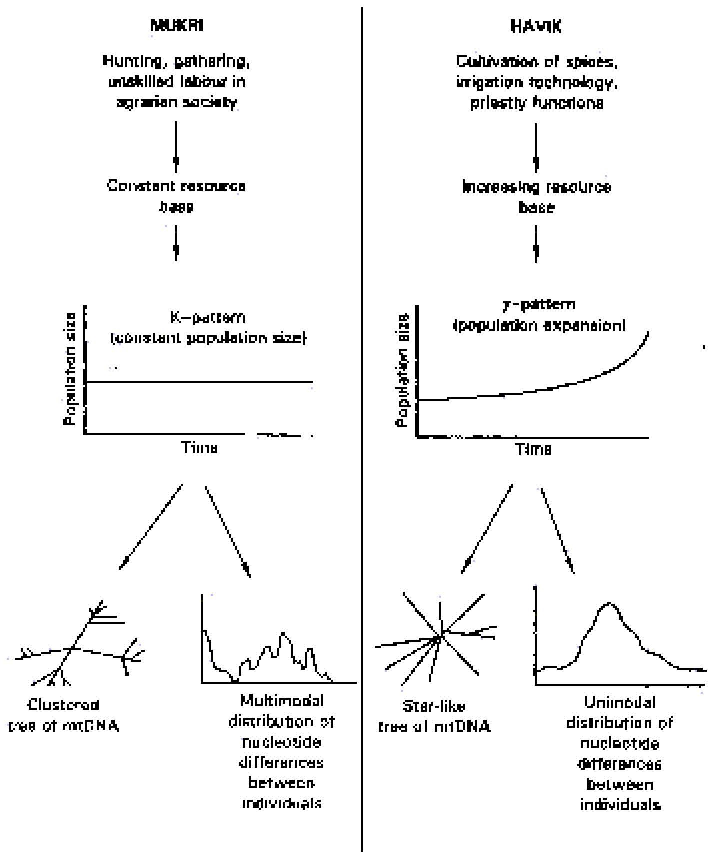

Fig. 28 Possible scenarios leading to the difference between the trees and pairwise difference distributions of the Mukri and Havik samples

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Such scenarios have probably characterized the Indian social mosaic for long, perhaps since the beginnings of cultivation and animal husbandry 6000 years ago. As groups with technologies conferring superiority in resource appropriation have migrated into and spread throughout India, they have subjugated other groups, restricted their resource access and permitted their continued existence, while the dominant groups have themselves grown in numbers and expanded in geographical range, perhaps dividing further into more endogamous groups.

This process of maintenance of large number of communities in isolation from each other has been accompanied by extreme specialization of occupation. It is perhaps this specialization of occupation that has prevented Indians from cross-fertilization of ideas and innovations, so that the Indian society has always been at the receiving end of technological innovations.

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