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Genetics of Castes and Tribes of India: Somatometry

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ABSTACT The discipline of human population biology incorporates study of biology and environmental factors, as well as the forces of micro-evolution leading to macro-evolution which ultimately influence the biological structure of human populations. The unit of study in understanding variations in man is a 'breeding population' some times also referred to as 'Mendelian population'. India is inhabited by people of great diversity, different creeds and customs forming what may be designated as multiple (or plural) society. There are about 3000 castes in India, some have genesis in tribal stock while others are occupational, linguistic, religious and territorial entities. Each caste is a social unit or what may be called 'monopolistic guild' in itself. All these groups are not entirely independent; usually people belong to two or more of such groups at the same time. India is a country with distinct geographical entity and is marked off from rest of Asia by both mountains and sea. Indian sub-continent may be divided into four natural regions: (1) The Himalayan Mountain Complex, (2) The Indus-Ganga-Brahmaputra Plains, (3) The Peninsular Plateau and (4) The Islands. The climate of India has many regional variations determined by locations, altitude, distance from the sea or the mountains and the general relief. India is divided into eight climatic regions based on the monthly value of temperature and precipitation. India is a Union comprising 25 States and 7 Union Territories and these may be categorised into six zones (North, West, East, Central, South India and Islands). Himalayan region may be divided into three divisions (Western, Central and Eastern Himalayan Regions). The present paper aims at investigating first the variation in the people of India in *regional* (Natural Regions of India, Climatic Regions of India, Political Divisions of India), *ethnic* (castes, scheduled castes, scheduled tribes, communities), *traditional occupational* and *linguistic groups* and *families* with the help somatometry measurement and indices. Second, to study the variation with the help of biostatistics methods in the region, ethnic groups and linguistic groups. The basic data were collected from the literature and it was categorized in regional, ethnic, occupational and linguistic groups and coded accordingly for the analysis on computer.

INTRODUCTION

Biological relationships and distances between human individuals and groups can be assessed by the use of anthropometric data at least as successfully as this can be done by the use of serological traits with known modes of inheritance (Spielman and Smouse 1976). The obvious reason is that anthropometric dimensions are also genetically determined even if the polygenic nature of the genetic control and the environmental effect on the development of their phenotypic manifestation cannot be spelled out in detail (Brace and Hunt 1990; Brace et al. 1991).

Although the effects of physical environment such as temperature, rainfall, humidity, altitude etc. upon human physique have been widely discussed, from the available literature yet it is difficult to offer definitive explanations in terms of the causations of variations in body dimensions. As it appears, the variations may be caused by complex interactions of physical environmental factors with others *e.g.* biological (diseases—degenerative and contagious), nutritional, economic and cultural (behavioural norms and practices relating to habitation, food, diseases etc.) factors.

The environmental changes brought about by the factor of 'migration' of the original migrants and their progeny may be responsible for measurable variations that have been observed. The findings of many investigations are available in which attempt has been made to isolate the effect of dietary differences and climatic changes upon human physique.

Shapiro (1939) found that the Hawaiian-born children of Japanese-born immigrants are considerably taller than their parents, but their heads are significantly shorter and broader and thus they have greater stature with pronounced brachycephaly.

Mills from his studies on the effects of climate on body growth and development revealed that temperate climate is more favourable for growth and development than the tropics (Mills 1937) and that dietary modifications and altered vitamin intake in the tropics affect adult dimensions (Mills 1942).

Kaplan (1954) has reviewed 25 studies and

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observed that most of the investigators assume that bodily changes which they report are not evolutionary in nature, although several of them refer to long-range secular changes in size. She pointed out that in fact the changes are not evolutionary, but merely individual responses to the particular environment and it should be possible to find the precise facet or facets of the environment responsible for the changes observed. She found that dietary changes are most frequently mentioned as important and concluded one wonders, to what extent eating and living habits, improvements in housing and sanitary conveniences, greater attention to personal hygiene, shorter school and working days, or even psychological factors play their part.

Tobias (1985) discussed the concept of secular trend *i.e.* long-term systematic or non-random changes in a wide variety of traits in successive generations of a population living in the same territories (Wolanski 1966, 1967). He added that it is probably analytically more useful to distinguish between secular changes with a territorial restriction, and the effects of migration in general and of urbanization as a special case. He argued that the direction of the secular processes should always be specified *i.e.* first upward or positive secular trend, second negative secular trend and third absence of secular changes, positive or negative. On the basis of secular trend data, Tobias suggested a four-fold subdivision of the world's populace taking socio-economic status into consideration:

1. Have most (affluent) with absence of secular trend at present as they have reached upper phenotypic limit set by their genetic potential.

2. Have ample (less affluent) with positive secular trend at present as they are moving from middle to upper reaches of genetically determined growth rate and body size range.

3. Have little (pastoral/agriculture), absent or negative secular trend as they are moving from middle to lower reaches of genetically determined range of growth rates and body sizes.

4. Have least (hunters and gatherers) positive secular trend as they are rising from the lowest reaches of genetic potential towards the middle of the range of growth rates and body sizes.

Tobias pointed out that the biggest challenge facing planners is how to solve the problem of transforming the negative secular trend of the "has little" sector to the positive secular trend of the "have ample" sectors.

The anthropometric studies on the Indian populations started in 1868. However systematic surveys were carried on All India level by Risley (1915), v. Eickstedt (1934) and Guha (1935). The main emphasis of these studies was to classify the peoples of India into various 'Racial Types'. They recognized the existence of more than one 'Racial Type' and a great deal of anthropometric heterogeneity among the peoples of India. Later, a number of surveys were conducted to study the regional variations for example among the people of Gujarat (Majumdar and Sen 1949), Uttar Pradesh (Mahalanobis et al. 1949), Maharashtra (Karve and Dandekar 1951), Bengal (Majumdar and Rao 1960), Tamil Nadu (Malhotra et al. 1981), among others. Besides these a good number of other studies are available, and about 1200 population groups reported by different authors are listed by Bhasin et al. (1992).

There are a rather high number of anthropometric studies on populations of India. Unfortunately, technical differences exist, and therefore sometimes the results are not comparable. It has been observed that some of the measurements on face taken by different authors show variation in dimensions which obviously reflect technical deviations, probably in the determination of nasion and other landmarks. Moreover, the samples are not distributed homogeneously. Only a few studies are available from Central India, whereas rests of the zones are better represented. For the techniques, methods and analysis of the data, readers are referred to Martin and Saller (1957), Wiener and Lourie (1969, 1982), Lohman et al. (1988), Knussmann (1988) and Singh and Bhasin (1989, 2004).

The aim of the study is to have a satisfactory knowledge of micro-evolutionary processes as they are reflected in genetic and morphological traits in human populations. This variability has been studied in terms of natural regions, climatic factors, climatic regions, political division of India, ethnic groups, traditional occupations and linguistic groups (For details see Bhasin 1988; Bhasin et al. 1992, 1994; Bhasin and Walter 2001, Bhasin 2006a).

The studies on Genetics of Castes and Tribes have been reported on Serum Protein Polymorphisms KM and GM Systems (Bhasin and Walter 2002); Glucose-6-Phosphate Dehydrogenase Deficiency and Haemoglobin variants (Bhasin 2006b); Red and Green Colour

Vision Deficiency (Bhasin, 2006c); Taste Sensitivity (Bhasin 2006d) among the people of India and factors responsible to operate in favour of these traits.

IDENTIFY AND DISTINGUISH THE PEOPLE

For the biogenetical study of the people of India, researchers have generally used the following criteria to identify and distinguish the people: 1. Regional Groups, 2. Ethnic Groups, 3. Linguistic Groups, and 4. Religious Groups (For details see Bhasin et al., 1994; Bhasin and Walter 2001; Bhasin 2006)

It should, however, be kept in mind that these are the convenient units of study, although there are significant levels of overlapping between them. For example, an occupational group pursuing traditional job inhabits a region, shares religion with other categories, belongs to one or the other language group and has an aggregation of ethnic properties. But in the human population genetic studies, out of these criteria one is chosen (Bhasin 1988).

In the present study an attempt has been made to analyse the above mentioned biogenetical traits into 1. Regional Groups, 2. Ethnic Groups, 3. Traditional Occupational Groups and 4. Linguistic Groups.

I. Regional Groups

These can be divided into the following groups:

1. Natural Regions of India
2. Climatological Factors and Climatic Regions of India
3. Political Division of India

Each region has its own characteristics and a brief description of each one will give an idea of what it constitutes of.

1. Natural Regions of India

The natural regions have broad uniformity in their characteristics, such as relief, geomorphological history, drainage, climate, soil, natural vegetation and wild life. Broadly speaking the Indian sub-continent may be divided in the following natural regions:

1. The Himalayan Mountain Complex
2. The Indus-Ganga-Brahmaputra Plain
3. The Peninsular Plateau and
4. The Islands

2. Climatological Factors and Climatic Regions of India

Various climatological factors (Rainfall, Humidity, Temperature) and Altitude have been considered to study correlations with different biological traits. The values for the climatological factors are after "Climatological Tables of Observations in 1931-1960" Meteorological Department, Government of India, New Delhi.

A climatic region generally possesses a broad uniformity in climatic conditions produced by combined effects of climatic factors. India can be divided into the following climatic regions after Köppen's method, based on the monthly values of temperature and precipitation:

(1) Tropical Savannah Type, (2) Monsoon Type with Short Dry Season, (3) Monsoon Type with Dry Season in High Sun Period, (4) Semiarid and Steppe Climate, (5) Hot Desert Type, (6) Monsoon Type with Dry Winters, (7) Cold Humid Winters Type with Shorter Summer, and (8) Polar Type.

3. Political Division of India

India is a Union of States. Comprising 25 States1 and 7 Union Territories, according to the Census 1991, there are 4689 towns and 587,226 inhabited and 47,095 uninhabited villages in the country. The country had 466 districts in 1991.

India-Political and Ethnic Zones: The weighted mean values of various biological traits have been classified into 25 States and 7 Union Territories (U.T.) which have been categorised as follows (after Bhasin, 1988):

I. North India, II. West India, III. East India, IV. Central India, V. South India, and VI. Islands. Himalayan Region may be divided into three divisions, *i.e.*, A) Western Himalaya, B) Central Himalaya, and C) Eastern Himalaya as follows:

I. North India:

(A) Western Himalaya (S. No. 1, 2):

(1) Jammu and Kashmir, (2) Himachal Pradesh, (3) Punjab, (4) Chandigarh (U.T.), (5) Haryana, (6) Delhi (U.T.), (7) Uttar Pradesh

(B) Central Himalaya (S.No.7, Eight Districts of Uttar Pradesh)

[(i) Almora, (ii) Chamoli, (iii) Dehra Dun, (iv) Garhwal (Pauri), (v) Naini Tal, (vi) Pithoragarh, (vii) Tehri Garhwal, and (viii) Uttarkashi.] and 8. Rajasthan

II. West India:

(1) Gujarat, (2) Maharashtra, (3) Goa[2], (4) Daman and Diu[2] (U.T.) and (5) Dadra and Nagar Haveli (U.T.)

III. East India:

C) Eastern Himalaya: (S. No.1 to 8 and Darjeeling District of West Bengal)

(1) Arunachal Pradesh, (2) Assam, (3) Nagaland, (4) Manipur, (5) Mizoram, (6) Tripura, (7) Meghalaya, (8) Sikkim, (9) West Bengal, (10) Bihar, and (11) Orissa

IV. Central India:

(1) Madhya Pradesh

V. South India:

(1) Karnataka, (2) Andhra Pradesh, (3) Tamil Nadu, (4) Kerala and (5) Pondicherry (U.T.).

VI. Islands:

(1) Lakshadweep (U.T.) and (2) Andaman and Nicobar Islands (U.T.).

II. Ethnic Groups

An aggregation of biological and socio-cultural characteristics constitutes an ethnic group. Within the category of Ethnic Group, we include Castes, Scheduled Castes, Scheduled Tribes and Communities (the names of Scheduled Castes and Scheduled Tribes after Manual of Election Law 1982, Government of India, New Delhi). Biological anthropological studies of such ethnic groups as well as "Communities" have been reported in India. By Community we generally refer to a group of people who may have occupational, linguistic, religious or regional characteristics (Bhasin 1988).

III. Traditional Occupational Groups

In the traditional society, there were occupational guilds. The *Chaturvarna* system with its division into *Brahman* (priestly caste), *Kshatriya* (warrior caste), *Vaishya* (land owners and traders) and *Sudra* (labouring caste) was based on occupational differentiation. The occupations are grade manual labour is looked down upon, and those dealing with swine-herding, scavenging, butchery, removal of night soil are regarded as polluting (Bhasin 1988). The caste based division of occupation is 1. Priesthood, 2. Warfare, 3. Trade and Commerce, 4. Agriculture, 5. Animal Husbandry, 6. Artisan and 7. Menial Workers.

IV. Linguistic Groups

Although the Schedule VIII recognizes fifteen languages in India, there are innumerable dialects which change after few scores of kilometers. Linguistic diversity is an important factor in the formation of regional groups, and it also reflects the regional differentiation. The four- fold regional division can be seen for the major languages, *i.e.*, (i) the Dravidian region of the south; (ii) the Indo-Aryan regions of the north and north-west; (iii) the Mon Khmer and the Tibeto-Burman region of the north-east and the Himalayan region; and (iv) the Austric region of the Aravalli-Vindhya-Chota Nagpur complex. These languages are again divided into sub-families and groups as follows:

Language Classification—Indian Languages

The family, branch, group and language of India are as follows:

I. AUSTRO-ASIATIC FAMILY
- *Mon-Khmer Group (Mon-Khmer Branch)*
- *Munda Group (Munda Branch)*

II. TIBETO-CHINESE FAMILY
- *SIAMESE-CHINESE SUB-FAMILY*
- Tai Group
- *TIBETO-BURMAN SUB-FAMILY*
- *Tibeto-Himalayan Branch*
- Bhotia Group (Tibetan Group)
- Himalayan Group (Pronominalized/Non-Pronominalized Himalayan Group)
- *North-East Frontier Group (North Assam Branch)*
- *Assam-Burmese Branch*
- Bodo Group (Bara or Bodo Group)
- Naga Group
- Kachin Group
- Kuki-Chin Group
- Burma Group

III. DRAVIDIAN FAMILY
- South Dravidian Group
- Central Dravidian Group
- North Dravidian Group

IV. INDO-EUROPEAN FAMILY ARYAN SUB-FAMILY
- *Dradic (or Pisacha) Branch*
- Kafir Group
- Khowar Group
- Dard Group
- *Indo-Aryan Branch:*
- *Outer Sub-Branch*
- North-Western Group

Southern Group
Eastern Group
Bihari Group (Bhojpuri, Maithili & Magahi Sub-Group)
Mediate Sub-Branch/Inner Sub-Branch:
Mediate Group/Central Group/Pahari Group
Mediate Group/Central Group
Pahari Group
Eastern Pahari
Central Pahari
Western Pahari

Mean Weighted Values

To discern the pattern of regional groups, ethnic groups, traditional occupational groups and linguistic groups using the frequency data, the mean weighted values of the biological traits have been calculated and estimates for the various groups are presented.

1. MEASUREMENT

1.1. Stature

The mean value of stature among Indian populations is 163.06 cm (medium), which varies from 143.50 cm - very short (among Naya Kurumba of Tamil Nadu) to 181.90 cm - very tall (in Mohammedans from West Punjab). The value of stature is low (159.75 cm -short) among scheduled tribes as compared to other ethnic groups. In the natural regions, populations from Himalayan mountain complex are showing lower values (162.13 cm) as compared to other regions except from Islands from where different scheduled tribes are reported (Table 1), (Bhasin et al. 1994; Bhasin and Walter 2001). The dimension at Himalayan mountain complex is in conformity with Bergmann's and Allen's rule, which states that in warm-blooded animals body size, and consequently surface area/weight, as also the length of the extremities, are smaller in colder than in warmer climates to minimize heat loss. Similar observations have been reported by Harrison et al. (1969) in their Ethiopian study. Attention should also be given to the ideas of Roberts (Roberts 1953, 1973) who asserts that these significant relationships between the temperature of biome and body size have both direct (response to temperature) and/or indirect (acting through food, genetics etc.) relationship. However, from the available literature, it may not be possible to offer definitive explanations in terms of causations by altitudinal variations (as they reflect temperature values) as it appears that these variations may be caused by complex interactions of physical environment factors with other biological, socio-economic and cultural factors (e.g. Walter 1982).

The mean value of stature is highest from semi arid steppe type climatic region (165.39 cm) and lowest from monsoon type with short dry season region (156.80 cm), followed by cold humid winters with short summers (159.05 cm) whereas from monsoon type with dry season, tropical savannah type and monsoon type with dry winters region the values show less differences (163.07, 163.06 and 163.66 cm, respectively). Takahashi (1971) also reported geographical gradients of stature with respect to climatic environmental variables and observed that taller statures are found in the arid belt of the northern and north-western sectors of the subcontinent while shorter statures occur in the humid regions of the eastern and southern zones. There is a gradient of stature distribution from north-west to east and south positions of the Indian subcontinent.

The inhabitants of Punjab, Delhi and Rajasthan are in general of taller stature (168.85, 168.57, 168.69 cm, respectively) than the populations of other regions of India, a feature especially marked among castes as compared to other ethnic groups (Table 1, Fig. 1). From the states of Jammu and Kashmir and Himachal Pradesh of Western Himalayan region and from Central Himalayan region the mean values are almost similar (163.38, 163.13 cm, respectively). In the state of Jammu and Kashmir, Kashmiri Pandits and Muslims are taller (medium) as compared to Ladakhis (from high altitude) with Mongoloid affinities (lower medium, 160 - 163.9 cm), and also populations from Himachal Pradesh. The populations studied from Lahaul-Spiti and Kinnaur districts (middle to high altitude) with Mongoloid affinities are showing low medium height as compared to other populations and similar results have been observed from Central Himalayan region from where also populations with Mongoloid affinities living at middle to high altitude are showing lower medium stature (different groups of Bhotias). From the Eastern Himalayan region, the mean values of stature are quite low from all the states [Arunachal Pradesh (159.05 cm), Assam (162.04 cm), Nagaland (161.10

cm), Manipur (160.02 cm), Mizoram (163.26 cm), Tripura (160.17 cm). Meghalaya (158.50 cm), Sikkim (159.97 cm)] inhabited by populations with Mongoloid admixture of varying degrees at different altitudes (Table 1, Fig. 1). Among the different ethnic groups from the Himalayan region the mean value of stature is less than 164 (lower medium) with little differences, except from Eastern region where scheduled tribes are having low value (160.42 cm) as compared to other ethnic groups. From Nepal also the various populations having Mongoloid admixture in varying degrees and living in middle to low altitudes (Rai, Tamang, Sunwar, Newars, Magars, Gurungs, Gurkhas among others) show short to low medium stature.

As compared to the North Indian populations with taller stature (medium category) the values of height among populations inhabiting different states of West India, Orissa, Madhya Pradesh and States and Union Territories of South India fall in the category lower medium whereas Islanders have a short stature. Takahashi (1971) attributes this cline to differential diet noting that the western and northern inhabitants of South Asia include many herding groups who consume high quantities of dairy food. Milk products are high in protein relative to grains that make up diet of Indians living in eastern and southern habitats. Among the different ethnic groups, peoples belonging to castes are taller followed by communities as compared to scheduled castes (lower medium) and scheduled tribes (short stature). Caste groups from North India and East India zones are taller as compared to other zones, whereas tribes from South India and East India zones are short in stature (157.69 and 159.62 cm, respectively) as compared to other zones, and they are falling in lower medium category. Mahalanobis (1927) and Olivier (1963) also reported that caste status was positively

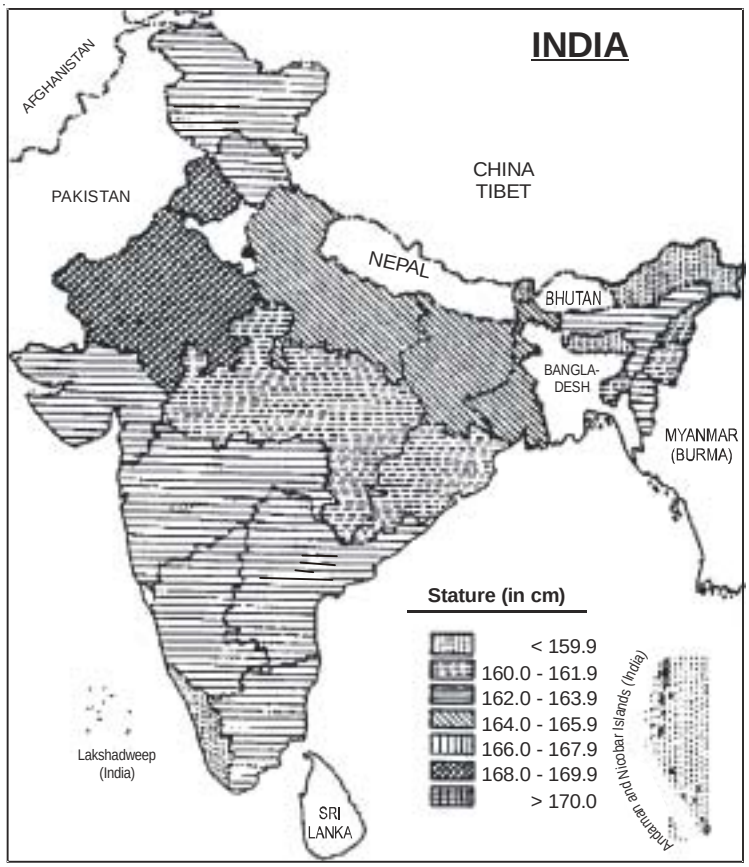

Fig. 1. Mean values of stature (in cm) in different regions of India (after Bhasin and Walter 2001)

correlated to stature.

From islands, among isolates very short stature (130.0 to 149.9 cm) is observed among Onge and Andamanese tribals and short to lower medium stature in Nicobarese tribals (Table 1, Fig. 1). The Andamanese and Onges are considered to have Negrito affinities and Nicobarese indicate their Malayan ancestry (Dutta 1978).

As observed, caste populations are on an average taller as compared to scheduled castes. This may be due to genetic differences between these groups since they belong to different racial affinities—Caucasoid (Aryan and/or Dravidian) in caste populations and Caucasoid and/or Australoid (Dravidian and/or Pre-Dravidian) among scheduled caste people. Further there is a difference between socio-economic conditions between the two groups. Therefore the taller stature may be largely but not solely attributable to genetic differences. The tribals who are considered to be autochthonous have had a longer stay in their habitat as compared to other ethnic groups. The short stature among tribal groups suggests in particular that the basic substratum of ethnic elements have been in favour of short individuals. In view of the advantages of the smaller body size in both 'undernourished' and 'hot climate' the smaller stature among the tribals might have developed in the process of adaptation to these conditions.

The mean values of stature correlations with various climatic factors and altitude by different ethnic groups although showing significant differences are not high except in scheduled tribes, where there are negative correlations of stature with climatic factors and altitude (Table 6).

For assessment of the environment - body dimension relationship, Basu et al. (1980) looked at the correlations between stature, cephalic index and nasal index on one hand and environmental variables like rainfall and temperature on the other. They found that none of them is significant except the correlation between stature and rainfall in the all India sample, and also that this correlation disappears when they restrict analysis to a relatively less heterogeneous group *i.e.* Brahmans. From this finding they pointed out that the relevant environmental factors are not the climatic ones they have considered but others *e.g.* social (*i.e.* castes/class), economic, nutritional etc.

To study the correlations between stature and caste status, Mahalanobis (1927) ranked castes in a hierarchical order and showed positive correlation between caste status and stature and sought to interpret these relations in terms of successively greater intrusion of Caucasoid genes into the higher castes through admixture. Olivier (1963) observed similar results on data from Tamil Nadu. Basu et al. (1980) stated that the immensely elaborate and rigid systems of social stratification, in which each strata was virtually closed to fresh intrusion at an unknown antiquity, seem to be a plausible enough determinant of anthropometric variations in India. They added that for this hypothesis to assume general validity, findings such as of Mahalanobis (1927) and Olivier (1963) should be repeated from diverse Indian populations, which is however not the case. They argued that for instance while an anthropometric survey conducted in the state of Uttar Pradesh (Mahalanobis et al. 1949) shows that castes of comparable hierarchical status tend to cluster together, a similar survey in Bengal shows that the clusters are not necessarily composed of castes of similar social status (Majumdar and Rao 1960). Further, the nature of biological similarity/differences among castes/subcastes of similar and different hierarchical status lead Karve and Malhotra (1968) to conclude that hierarchical affinity does not often correspond to biological similarity. Also Rakshit's (1966) study showing wide diversity among the Brahmins also points in the same direction. They concluded that it seems that both the hypotheses (a) of fission of an ancestral social group into castes/sub-castes, each of the latter having more biological similarities with the other than with sub-castes of other castes and (b) of coming together of social groups of disparate origins without fusion of their marital boundaries to constitute caste clusters/castes, are probable but not sufficient from the point of view of explaining the immense biological variations among the Indian population. Further in the few regional studies in which clusters have been worked out or at least distance matrices have been computed (Mahalanobis et al. 1949; Majumdar and Rao 1960; Karve and Malhotra 1968), the similarities/differences do not seem to follow any definite pattern. Mahalanobis et al.'s (1949) study does show some clusters which correspond to traditional caste affinities, but even then there are frequent exceptions. Further, they considered the tribal populations only and observed that variations among conventional racial categories

Table 1: Stature (in cm)

Particulars	*Subjects studied*	*No. of studies*	*Stature*		
			Mean	*Min*	*Max*
1. NATURAL REGION					
Himalayan Mountain Complex	8446	122	**162.13**	154.90	169.80
Indus-Ganga-Brahmaputra Plains	27932	300	**164.15**	154.80	181.90
Peninsular Plateau	49124	623	**162.77**	143.50	175.00
Islands	1124	18	**155.50**	146.80	161.93
2. CLIMATIC REGION					
Monsoon Type with Short Dry Season	5026	83	**156.80**	146.80	172.50
Monsoon Type with Dry Season	2727	59	**163.07**	154.91	174.00
Tropical Savannah Type	36813	379	**163.06**	147.52	174.00
Semi Arid Steppe Type	5015	110	**165.39**	143.50	175.00
Hot Desert Type	-	0	-	-	-
Monsoon Type with Dry Winters	35986	414	**163.66**	154.80	181.90
Cold Humid Winters with Short Summers	338	5	**159.05**	157.71	160.86
Polar Type	723	13	**162.49**	159.45	164.54
3. POLITICAL DIVISION OF INDIA					
I. NORTH INDIA					
A. Western Himalaya (S. No. 1, 2)					
1. Jammu and Kashmir	989	17	**163.84**	159.96	166.65
2. Himachal Pradesh	2695	28	**163.21**	159.45	165.40
3. Punjab	1077	15	**168.85**	159.78	181.90
4. Chandigrah UT	-	0	-	-	-
5. Haryana	-	0	-	-	-
6. Delhi UT	742	10	**168.57**	162.59	175.50
B. Central Himalaya (S. No. 7, Eight Districts of Uttar Pradesh)					
7. Uttar Pradesh	14833	161	**164.07**	156.21	171.91
8. Rajasthan	1698	11	**168.69**	158.80	174.80
II. WEST INDIA					
9. Gujarat	4956	49	**163.05**	159.02	169.51
10. Maharashtra	7696	130	**163.11**	158.40	174.00
11. Goa, Daman and Diu UT	-	0	-	-	-
12. Dadra and Nagar Haveli UT	-	0	-	-	-
III. EAST INDIA					
C. Eastern Himalaya (S. No. 13 to 20 and Darjeeling District of West Bengal)					
13. Arunachal Pradesh	338	5	**159.05**	157.71	160.86
14. Assam	4888	70	**162.04**	154.80	165.08
15. Nagaland	1021	18	**161.10**	155.87	165.84
16. Manipur	297	6	**160.02**	154.90	167.40
17. Mizoram	40	1	**163.26**	163.26	163.26
18. Tripura	311	5	**160.97**	155.76	160.90
19. Meghalaya	487	8	**158.50**	156.91	161.26
20. Sikkim	797	16	**159.97**	155.76	164.45
21. West Bengal	7822	63	**164.11**	157.00	169.80
22. Bihar	17048	84	**164.07**	147.52	171.38
23. Orissa	3884	54	**160.28**	153.64	166.30
IV. CENTRAL INDIA					
24. Madhya Pradesh	2578	37	**160.32**	156.10	164.36
V. SOUTH INDIA					
25. Karnataka	2193	49	**163.68**	153.13	168.70
26. Andhra Pradesh	1421	34	**162.98**	159.10	165.80
27. Tamil Nadu	2437	93	**163.73**	143.50	174.00
28. Kerala	4106	71	**157.38**	151.50	175.00
29. Pondicherry UT	1150	10	**162.80**	159.95	165.37
VI. ISLANDS					
30. Lakshadweep UT	-	0	-	-	-
31. Andman Islands and Nicobar Islands UT	400	11	**148.45**	146.80	151.80
	724	7	**159.39**	156.70	161.93
3A. ZONES OF INDIA					
I. North India	22034	242	**164.70**	156.21	181.90
II. West India	12652	179	**163.09**	158.40	174.00
III. East India	36933	330	**163.05**	147.52	171.38
IV. Central India	2578	37	**160.32**	156.10	164.36
V. South India	11307	257	**161.23**	143.50	175.00
VI. Islands	1124	18	**155.50**	146.80	161.93
INDIA (TOTAL)	86628	1063	**163.06**	143.50	181.90
3B. REGIONS OF HIMALAYA					
A. Western Himalaya	3684	45	**163.38**	159.45	166.65
B. Central Himalaya	1394	17	**163.13**	156.21	166.53
C. Eastern Himalaya	8745	138	**161.20**	154.80	169.80
HIMALAYA (TOTAL)	13823	200	**161.97**	154.80	169.80
NON-HIMALAYAN REGIONS	72805	863	**163.27**	143.50	181.90
4. ETHNIC GROUP					
A. ZONES OF INDIA					
1. NORTH INDIA					
Caste	6801	82	**165.69**	159.71	174.80
Scheduled Caste	3563	48	**163.30**	158.17	167.47
Scheduled Tribe	2799	29	**163.15**	156.21	171.30
Community	8871	83	**164.99**	159.78	181.90
II. WEST INDIA					
Caste	5401	86	**163.48**	159.86	167.95
Scheduled Caste	562	9	**161.64**	158.42	163.68
Scheduled Tribe	2340	28	**161.28**	158.40	168.22

Table 1: Contd.....

Particulars	Subjcects studied	No. of studies	Stature		
			Mean	Min	Max
Community	4349	56	**164.76**	159.63	174.00
III.EAST INDIA					
Caste	16671	75	**165.97**	156.20	171.38
Scheduled Caste	3982	42	**161.55**	157.70	165.05
Scheduled Tribe	12776	168	**147.52**	150.10	167.40
Community	3504	45	**163.42**	155.76	169.80
IV. CENTRAL INDIA					
Caste	104	2	**162.57**	160.91	164.36
Scheduled Caste	-	0	-	-	-
Scheduled Tribe	2424	34	**160.27**	156.10	163.64
Community	50	1	**158.17**	158.17	158.17
V. SOUTH INDIA					
Caste	3591	80	**163.79**	155.60	170.10
Scheduled Caste	1474	34	**160.91**	152.53	166.55
Scheduled Tribe	3827	80	**157.69**	143.50	175.00
Community	2415	63	**163.21**	153.13	174.00
VI. ISLANDS					
Caste	-	0	-	-	-
Scheduled Caste	-	0	-	-	-
Scheduled Tribe	1124	18	**155.50**	146.80	161.93
Community	-	0	-	-	-
INDIA					
Caste	32568	325	**165.25**	155.60	174.80
Scheduled Caste	9581	133	**162.11**	152.53	167.47
Scheduled Tribe	25290	357	**159.75**	143.50	175.00
Community	19189	248	**164.18**	153.13	181.90
B. REGIONS OF HIMALAYA					
A. Western Himalaya					
Caste	839	9	**163.62**	160.74	165.40
Scheduled Caste	75	2	**162.31**	162.11	165.08
Scheduled Tribe	1470	14	**163.30**	159.45	164.75
Community	1300	20	**163.38**	159.96	166.65
B. Central Himalaya					
Caste	60	2	**160.85**	160.80	160.89
Scheduled Caste	213	2	**166.05**	165.50	166.53
Scheduled Tribe	536	6	**161.35**	156.21	163.33
Community	585	7	**163.93**	161.61	164.90
C. Eastern Himalaya					
Caste	243	5	**163.21**	161.61	164.61
Scheduled Caste	1221	14	**162.77**	158.67	165.05
Scheduled Tribe	5785	92	**160.42**	154.80	167.40
Community	1496	27	**162.61**	155.76	169.80
5. TRADITIONAL OCCUPATION					
Priesthood	15726	78	**165.64**	159.86	168.50
Warfare	3452	31	**166.96**	160.44	174.80
Trade and Commerce	2383	29	**165.47**	161.20	169.48
Agriculture	1957	40	**163.52**	159.10	169.72
Animal Husbandry	880	12	**167.17**	161.37	175.50
Artisans	1463	20	**162.79**	159.90	166.37
Menial Workers	6571	72	**161.66**	152.53	166.33
No Information	54196	781	**162.05**	143.50	181.90
6. LANGUAGE GROUP					
I. AUSTRO-ASIATIC FAMILY					
Mon Khmer Group	1185	13	**158.78**	156.70	161.93
Munda Group	6379	65	**158.91**	147.52	164.40
II. TIBETO-CHINESE FAMILY					
(i) Siamese-Chinese Sub-Family					
Tai Group	85	1	**159.90**	159.90	159.90
(ii) Tibeto-Burman Sub-Family					
Bhotia Group	2285	27	**162.90**	156.21	164.90
Himalayan Group	1039	20	**159.69**	156.36	169.80
North East Frontier Group	1141	20	**160.80**	157.52	165.03
Bodo Group	1985	25	**161.48**	154.80	164.30
Naga Group	1228	24	**160.79**	155.70	167.40
Kachin Group	13	1	**160.50**	160.50	160.50
Kuki Chin Group	403	9	**160.12**	154.90	163.60
III. DRAVIDIAN FAMILY					
South Dravidian Group	11074	253	**161.14**	143.50	175.00
Central Dravidian Group	2215	34	**160.69**	156.67	162.89
North Dravidian Group	3008	11	**162.58**	157.52	163.40
IV. INDO-EUROPEAN FAMILY					
Dard Group	572	6	**164.08**	162.11	166.00
North Western Group	30	1	**165.81**	165.81	165.81
Southern Group	7818	124	**163.04**	158.40	174.00
Eastern Group	2025	36	**160.92**	155.14	166.30
Bihari	21075	111	**165.35**	156.20	171.38
Central Group	21246	249	**164.67**	158.17	181.90
Pahari Group	955	16	**163.11**	155.76	165.40
Unspecified	256	2	**162.84**	161.40	163.33
Other Languages	638	15	**154.69**	146.80	168.20
No Information	-	0	-	-	-
6A. LANGUAGE FAMILY					
I. Austro Asiatic Family	7564	78	**158.89**	147.52	164.40
II. Tibeto Chinese Family	8152	127	**161.37**	154.80	169.80
III. Dravidian Family	16297	298	**161.34**	143.50	175.00
IV. Indo European Family	53977	545	**164.52**	155.14	181.90
Other Languages	638	15	**154.69**	146.80	168.20
No Information	-	0	-	-	-

i.e., Australoid, Mongoloid, Mundari and Negroid are not significant and concluded that neither caste as such nor race, therefore, seem to be determinant of inter group anthropometric variability.

The correlation between nutritional factors and body size showed positive correlation between calorie intake and stature, fat intake and height and fat intake and weight, although no such correlation between protein intake and height or weight seems to exist (Basu et al., 1980). The protein-deprived individuals fail to attain their full ontogenetic growth potential and under these conditions of chronic deficiency stress smaller body size (of which stature is a critical component) may be highly adaptive for survival. Natural selection for reduction of body size and mass may continue in a population existing under these nutritional conditions which may persist over many generations. However the genotype is not altered and realization of full ontogenetic development may be attained in high proportion of the population when adequate protein is introduced into the diet.

Malhotra (1966) also demonstrated the effect of nutrition on height and weight. Considering that nutritional level is strongly influenced by economic condition, the source of much of the variations that are traditionally ascribed to racial properties can be traced to much less abstruse socio-economic variables.

A number of small scale studies from all over the world suggest that growth and maturation of children and adult body dimensions *e.g.*, height, weight etc. are positively related to urbanization, social, economic and professional status and family size. Basu et al. (1980) reported that Ganguly conducted a study in 1974 taking these factors into consideration and observed that rural/urban habitat does not have any effect on any of the anthropometric traits he considered and the well to do section of the population differs significantly from the poorer section almost in every character. They pointed that the weakness of Ganguly's (1979) study lies in the fact that the probable effects of occupational and sexual selection and nutrition on body dimensions have not been tested by any rigorous method (Basu et al. 1980). The effect of nutrition on height, weight and/or other measures of child growth and adult body dimensions have been more amply demonstrated by Pachauri et al. (1971), Gopalan et al. (1973), Easwaran et al. (1974), Rao and Satyanarayana (1974), Rao et al. (1975), Vijayalakashmi and Devaki (1976), Devdas et al. (1977) among others.

Among the higher occupational groups—priesthood, warfare, trade and commerce, the populations are taller (165.64, 166.96 and 165.47 cm, respectively) as compared to lower groups—artisans and menial groups (162.79 and 161.66 cm, respectively). Mahalanobis (1927) and Olivier (1963) reported positive correlations between stature and caste status. Whereas among pastoralists the value is maximum as compared to other groups (167.17 cm), which may be explained due to selection as suggested by Wolpoff (1980). He suggests that tallness was adaptive for prehistoric people, who were nomadic, travelling long distances in pursuit of game which migrated seasonally to different ecozones. The physical demands of the hunting-gathering life style which involved tracking of large and dangerous game placed a selective advantage on high muscular-skeletal robusticity and large body size, particularly among males who were involved in procurement of flesh foods under conditions of high risk and strenuous demands upon physical strength and stamina. Selection for large and robust body form was relaxed among sedentary food producing populations where the physical demands and risks are of a very different sort (in the present study stature mean value is 163.52 among agriculture group). Pastoralism may involve selection for efficiency of long-distance walking, and the tallest modern South Asians are from the northwest sector of the subcontinent where herding is a common way of life.

Among the speakers of Mon Khmer group (Austro-Asiatic family) and Tibeto-Chinese languages the mean value of stature is low (158.78 and 161.37 cm, respectively) as compared to Indo-European language groups (Dard group - 164.08 and Pahari group - 163.11 cm) from the Himalayan regions among whom most have Mongoloid affinities. Most of the tribals reported in the present study from peninsular region speak Munda group (Austro-Asiatic family) and Dravidian language and among them also the mean values of stature are low, whereas speakers of Indo-European languages (mostly caste groups) show taller stature as compared to the speakers of other languages (164.52 cm) (Table 1, Fig. 1) (Bhasin et al. 1994; Bhasin and Walter, 2001).

Indian populations are on an average medium in stature (163.06 cm) among whom caste people

are taller as compared to scheduled castes whereas tribals are short in stature, suggesting that the basic substratum of ethnic elements has been in favour of short individuals. In view of the advantages of the smaller body size in both 'under-nourished' and 'hot climate' the smaller stature among the tribals might have developed in the process of adaptation to these conditions. The inhabitants of Punjab, Delhi and Rajasthan are in general taller than the populations of other regions, which show a gradient of stature distribution from northwest to east and south positions of Indian subcontinent. Among occupational groups, the taller stature is found among pastoralists who indicate that pastoralism may involve selection for efficiency of a long distance walking. The speakers of Austro-Asiatic, Tibeto-Chinese and Dravidian languages are shorter in stature as compared to Indo-European language speakers.

2. INDICES

2.1. Cephalic Index

The mean value of cephalic index among Indian populations is 76.06, which is falling into the mesocephaly category, and it varies from 67.91 (hyperdolichocephalic from Kerala, South India) to 90.88 (hyperbrachycephalic in West Bengal, East India). The mean value of cephalic index is low among scheduled tribes (75.81 - dolichocephalic) as compared to other ethnic groups. From the natural regions, the population groups of Indus-Ganga-Brahmaputra plains with lower average mean value (75.67 - mesocephalic index) as compared to populations of other natural regions. The cephalic index from monsoon type with short dry season and cold humid winters with short summers climatic region are dolichocephalic as compared to other climatic regions, where mesocephalic index is observed (Table 2) (Bhasin et al. 1994; Bhasin and Walter 2001).

There are 244 studies available from North India and all the populations are showing mean values less than 76 which falls in the dolichocephaly category, except a few populations with Mongoloid affinities from the Himalayan regions—Ladakhi, Changpa, Kashmiri from the state of Jammu and Kahsmir; Kanets Lahoul, Keonthali of Mahasi, Bunan and Lahauli of Lahaul, Spiti, Tibetans and Nyamslat of Kinaur of Himachal Pradesh of Western Himalayan region; Bhotia groups, Tharus, Kewat who are mesocephalics and Burman Mongoloid (83.10 brachycephalic) of Central Himalayan region. The value of index is high among scheduled tribes of North India, who are mostly from Himalayan region with Mongoloid affinities as compared to other ethnic groups from North India. From Nepal, the Old Nepalese and Gurkha are having meso-to brachycephalic index and there is tendency towards higher indices in the East. Among the population groups from Eastern Himalayan region the mean value of cephalic index is high (78.09) as compared to Western and Central Himalayan regions (74.00 and 76.71, respectively). From the states of Arunachal Pradesh, Assam, Nagaland, Manipur, Mizoram, Tripura, Meghalaya and Sikkim, most of the populations studied show mean average value between 76.0 and 80.9 (mesocephaly) except Garo and Abor groups, Kuki Chin, Rengma and Sema Nagas, Kaipeng, Synteng, Pnar Khasi who are falling in dolichocephalic category and Ahom, Assamese Brahmin, Ao Naga, Bhutias, Chhetris (Sikkim), Rais and Limboos who are brachycephalics. From Darjeeling district of West Bengal also brachycephalics are observed among Lepchas, Limbus, Khambus, Gurungs, Bhutias population groups with Mongoloid affinities. From West Bengal in most of the populations the mean value of index is falling in mesocephalic category except a few namely Mal Pharia, Santal, Mala (tribal groups) and Rajbanshi, Barui, Mashiya, Rishi, Mahato (scheduled castes and caste groups) who are dolichocephalics. From West Bengal incidence of mesocephalic is predominant among populations belonging to different ethnic groups and this may be due to Mongoloid racial element present among them in varying degrees. From the states of Bihar and Orissa most of the tribal groups are dolichocephalics as compared to other ethnic groups who are mesocephalics (For details see Bhasin et al. 1992).

From the states of Gujarat and Maharashtra of West India, the mean values of cephalic index are quite high (78.89 and 77.79, respectively). The values are high among castes (78.69) and communities (78.68) as compared to scheduled tribes (76.55). The brachycephalic index is reported among Brahmin Nagar, Parsis, Ahir, Kunbis, Kshatriyas, Prabhu Pathare whereas dolichocephalic index is observed among Dhanuk, different groups of Bhils, Halbi, Govari, Koli,

Katkari, all scheduled tribes.

The mean value of cephalic index is 74.96 among the populations of Central India—who is mostly tribals and speaks Indo-European (Central group), Austro-Asiatic (Munda group) and Dravidian (Central Dravidian) languages and is falling in dolichocephalic category. Similarly from the states of Bihar and Orissa among the tribals the mean value of cephalic index is less than 76 (dolichocephalic) and they belong mainly to the speakers of Austro-Asiatic (Munda group) and Indo-European (Eastern group) in Bihar and Austro-Asiatic (Munda group) and Dravidian (Central Dravidian) from Orissa.

The value of cephalic index is quite high among the populations from the states of Karnataka (78.71), Andhra Pradesh (77.79) as compared to Tamil Nadu (75.71) and Kerala (74.21), from where the mean value is low among scheduled tribe (74.21 dolichocephaly, varies from 69.44 to 78.90) as compared to other ethnic groups who are mesocephalics and are having almost similar values. The brachycephaly (81.0) is observed among the populations namely—Gauda, Kodagu, Kunchitiga, Brahmin Havig, Pattasali, Gangadikara Vokkaliga from Karnataka state, Badaru and Kamti from Andhra Pradesh, Sukum Sale and Suka Sale from Tamil Nadu.

Onges and Andamanese of Andaman Islands are brachycephalics whereas among Nicobarese the differences are quite wide as observed from dolichocepalic Car Nicobarese to mesocephalic Nicobarese of Choura and Terressa Islands to hyperbrachycephalic Southern Nicobarese (Ganguly 1976). It appears that dolichocephalics are predominant in North, East and towards Southern tip of India, whereas mesocephalics are frequent in West and parts of South India and

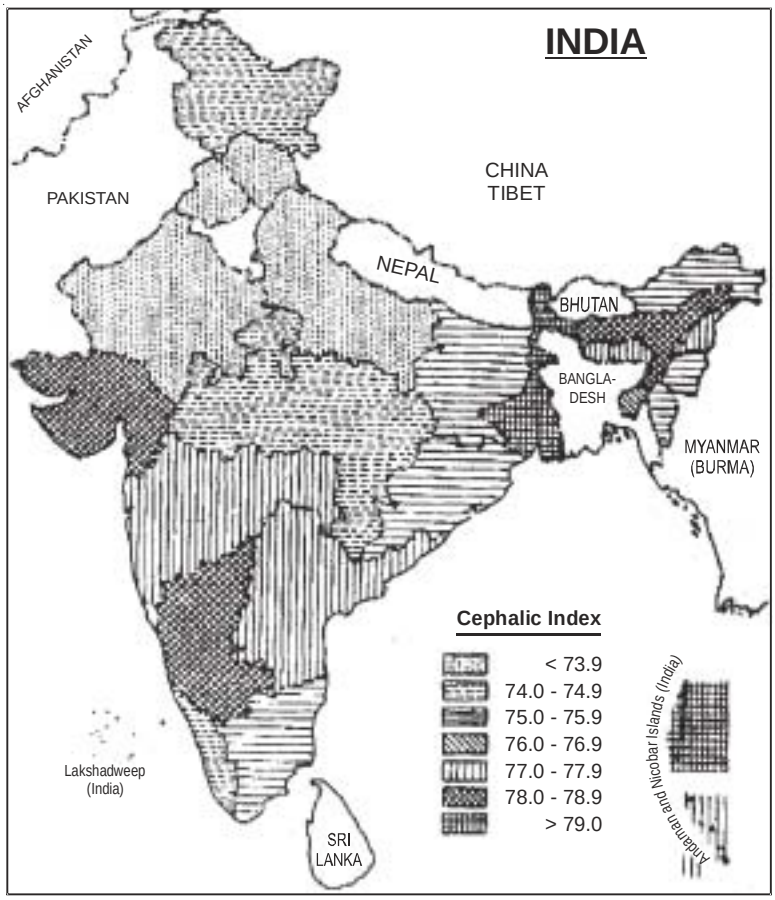

Fig. 2. Frequencies of cephalic index in different regions of India (after Bhasin and Walter 2001)

Eastern Himalayan region (Table 2, Fig. 2).

The correlations of mean value of cephalic index with various climatic factors and altitude by different ethnic groups though showing significant differences are not high (Table 6).

The brachycephalic element is observed among the population groups with Mongoloid affinities from the Himalayan region, particularly from Eastern Himalayan region. From West India, brachycephalics are observed among caste groups and a migrated community of Parsis and from the states of West Bengal, Karnataka, Andhra Pradesh and Tamil Nadu also this element is observed among the caste groups. From the Islands, among Onges, Andamanese and Nicobarese-Southern, brachycephaly is predominant. It is interesting to note that brachycephalic element, which is in general quite low among populations of India is observed among populations with Mongoloid affinities and caste groups of West and South India and state of West Bengal.

Guha in Census of India 1931 has made a coloured map of the distributions of the head form in India to which Keith (1936) has referred as follows:

"Guha's map shows brachycephaly (red) sweeping southwards rounds both ends of Himalayas. From Pamir it descends through Afghanistan, Baluchistan and Sind and then extends continuously along the west, broadening out from Bombay so far as the whole of Deccan is included. The red band sweeps across the peninsular so as to include the South Madras. Only a small area in South is left as blue (dolichocephalic), it is along the Malabar Coast. From the eastern end of the Himalaya the brachycephalic (red) area passes from Bhutan and Tibet southward through Assam to spread over

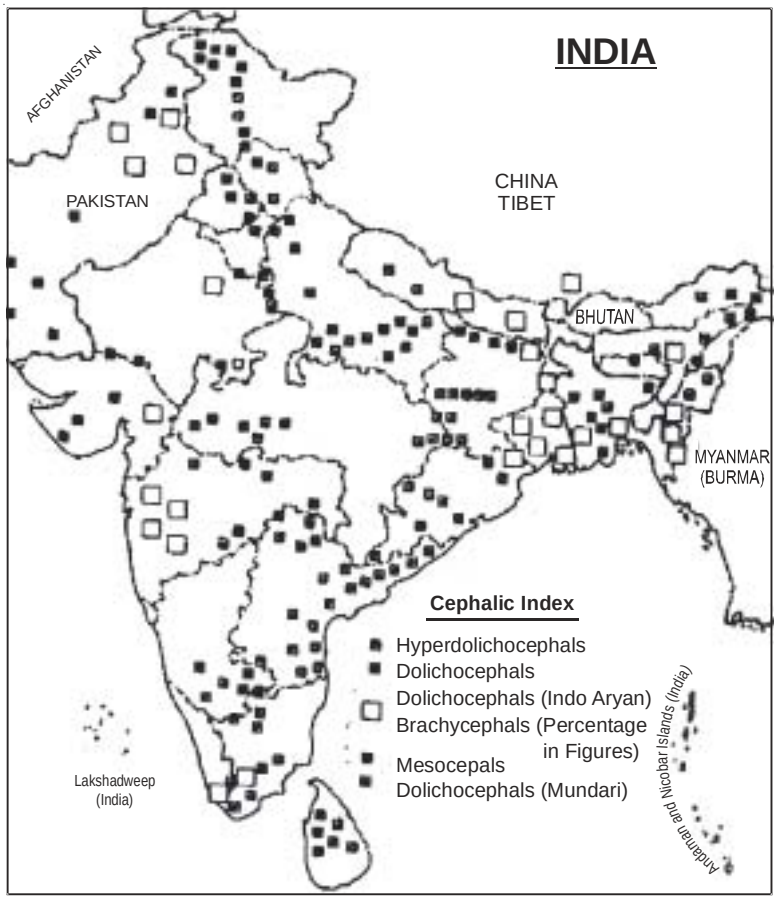

Fig. 3. Distribution of type of cephalic index in different regions of India (after Sarkar 1958)

Table 2: Cephalic Index

Particulars	*Subjects studied*	*No. of studies*	*Cephalic Index*		
			Mean	*Min*	*Max*
1. NATURAL REGION					
Himalayan Mountain Complex	8860	140	**76.38**	69.29	86.51
Indus-Ganga-Brahmaputra Plains	27517	294	**75.87**	70.80	90.88
Peninsular Plateau	49096	597	**76.07**	67.91	87.00
Islands	762	14	**78.64**	74.33	86.11
2. CLIMATIC REGION					
Monsoon Type with Short Dry Season	4223	72	**75.00**	67.91	86.11
Monsoon Type with Dry Season	3000	61	**76.16**	70.00	80.87
Tropical Savannah Type	34622	362	**76.23**	71.80	87.00
Semi Arid Steppe Type	4945	102	**76.00**	69.06	83.00
Hot Desert Type	-	0	-	-	-
Monsoon Type with Dry Winters	36574	431	**76.01**	69.29	90.88
Cold Humid Winters with Short Summers	338	5	**75.79**	73.23	78.06
Polar Type	533	12	**76.24**	73.44	79.56
3. POLITICAL DIVISION OF INDIA					
I. NORTH INDIA					
A. Western Himalaya (S. No. 1, 2)					
1. Jammu and Kashmir	1139	24	**74.15**	69.29	79.56
2. Himachal Pradesh	2294	24	**73.92**	70.70	78.54
3. Punjab	1077	15	**73.60**	72.30	74.40
4. Chandigrah UT	-	0	-	-	-
5. Haryana	-	0	-	-	-
6. Delhi UT	742	10	**74.14**	72.35	76.00
B. Central Himalaya (S. No. 7, Eight Districts of Uttar Pradesh)					
7. Uttar Pradesh	14813	160	**73.54**	70.80	83.10
8. Rajasthan	1698	11	**73.85**	72.40	76.50
II. WEST INDIA					
9. Gujarat	4749	50	**78.89**	74.90	83.76
10. Maharashtra	6964	122	**77.79**	72.40	83.15
11. Goa, Daman and Diu UT	-	0	-	-	-
12. Dadra and Nagar Haveli UT	-	0	-	-	-
III. EAST INDIA					
C. Eastern Himalaya (S. No. 13 to 20 and Darjeeling District of West Bengal)					
13. Arunachal Pradesh	338	5	**75.79**	73.23	78.06
14. Assam	4846	66	**78.11**	73.47	82.83
15. Nagaland	1700	35	**77.83**	75.69	81.87
16. Manipur	280	4	**75.87**	74.19	77.25
17. Mizoram	40	1	**75.15**	75.15	75.15
18. Tripura	312	5	**76.56**	74.98	76.93
19. Meghalaya	887	12	**77.04**	73.40	77.81
20. Sikkim	797	16	**80.06**	76.46	86.51
21. West Bengal	7470	62	**79.93**	71.75	90.88
22. Bihar	16028	76	**75.11**	72.40	78.20
23. Orissa	3700	53	**75.23**	72.22	78.40
IV. CENTRAL INDIA					
24. Madhya Pradesh	2525	36	**74.96**	71.80	79.80
V. SOUTH INDIA					
25. Karnataka	2187	48	**78.71**	73.10	83.00
26. Andhra Pradesh	1426	34	**77.79**	72.89	87.00
27. Tamil Nadu	2635	90	**75.71**	69.16	82.20
28. Kerala	3665	64	**74.01**	67.91	78.40
29. Pondicherry UT	1161	8	**76.26**	72.44	80.87
VI. ISLANDS					
30. Lakshadweep UT	-	0	-	-	-
31. Andman Islands and Nicobar Islands UT	187	8	**82.65**	81.18	84.80
	575	6	**77.33**	74.33	86.11
3A. ZONES OF INDIA					
I. North India	21763	244	**73.65**	69.29	83.10
II. West India	11713	172	**78.24**	72.40	83.76
III. East India	36398	335	**76.82**	71.75	90.88
IV. Central India	2525	36	**74.76**	71.80	79.80
V. South India	11074	244	**76.07**	67.91	87.00
VI. Islands	762	14	**78.64**	74.33	86.11
INDIA (TOTAL)	84235	1045	**76.06**	67.91	90.88
3B. REGIONS OF HIMALAYA					
A. Western Himalaya	3433	48	**74.00**	69.29	79.56
B. Central Himalaya	1394	17	**76.71**	71.13	83.10
C. Eastern Himalaya	9766	153	**78.09**	73.23	86.51
HIMALAYA (TOTAL)	14593	218	**77.00**	69.29	86.51
NON-HIMALAYAN REGIONS	69642	827	**75.86**	67.91	90.88
4. ETHNIC GROUP					
A. ZONES OF INDIA					
1. NORTH INDIA					
Caste	6803	82	**73.40**	69.88	77.50
Scheduled Caste	3558	47	**73.26**	71.00	75.30
Scheduled Tribe	2428	27	**75.01**	71.14	79.89
Community	8974	88	**73.62**	69.29	83.10
II. WEST INDIA					
Caste	4656	78	**78.69**	74.50	83.76
Scheduled Caste	561	9	**77.42**	76.51	78.64
Scheduled Tribe	2107	27	**76.55**	72.40	80.27

Table 2: Contd.....

Particulars	Subjcects studied	No. of studies	Cephalic Index Mean	Min	Max
Community	4389	58	**78.68**	75.20	83.15
III. EAST INDIA					
Caste	16721	76	**76.51**	72.99	90.88
Scheduled Caste	3927	42	**78.03**	73.89	80.48
Scheduled Tribe	12598	175	**76.25**	71.75	86.51
Community	3152	42	**79.23**	73.77	84.30
IV. CENTRAL INDIA					
Caste	104	2	**74.83**	74.30	75.53
Scheduled Caste	-	0	-	-	-
Scheduled Tribe	2371	33	**74.96**	71.80	79.80
Community	50	1	**75.17**	75.17	75.17
V. SOUTH INDIA					
Caste	3295	82	**76.98**	71.43	87.00
Scheduled Caste	1337	32	**76.50**	73.10	83.00
Scheduled Tribe	3316	65	**74.21**	69.44	78.90
Community	3126	65	**76.89**	67.91	81.70
VI. ISLANDS					
Caste	-	0	-	-	-
Scheduled Caste	-	0	-	-	-
Scheduled Tribe	762	14	**78.64**	74.33	86.11
Community	-	0	-	-	-
INDIA					
Caste	31579	320	**76.20**	69.88	90.88
Scheduled Caste	9383	130	**75.96**	71.00	83.00
Scheduled Tribe	23582	341	**75.81**	69.44	86.51
Community	19691	254	**76.17**	67.91	84.30
B. REGIONS OF HIMALAYA					
A. Western Himalaya					
Caste	858	10	**73.78**	69.88	77.50
Scheduled Caste	70	1	**71.87**	71.87	71.87
Scheduled Tribe	1098	12	**74.43**	71.14	78.54
Community	1407	25	**73.90**	69.29	79.56
B. Central Himalaya					
Caste	60	2	**75.66**	74.82	76.84
Scheduled Caste	213	2	**74.21**	73.69	74.80
Scheduled Tribe	536	6	**77.33**	73.90	79.89
Community	585	7	**77.16**	71.13	83.10
C. Eastern Himalaya					
Caste	243	5	**79.08**	77.08	81.41
Scheduled Caste	1221	14	**78.22**	75.78	80.12
Scheduled Tribe	6811	108	**77.57**	73.23	86.51
Community	1491	26	**80.19**	77.96	84.30
5. TRADITIONAL OCCUPATION					
Priesthood	15528	76	**75.60**	70.70	81.56
Warfare	3491	33	**74.45**	69.88	81.81
Trade and Commerce	2383	29	**77.18**	71.30	81.40
Agriculture	1950	39	**75.34**	71.87	80.12
Animal Husbandry	880	12	**73.85**	72.40	81.28
Artisans	710	11	**77.33**	72.98	82.20
Menial Workers	6409	71	**76.27**	71.00	80.48
No Information	52884	774	**76.27**	67.91	90.88
6. LANGUAGE GROUP					
I. AUSTRO-ASIATIC FAMILY					
Mon Khmer Group	1436	16	**77.34**	74.33	86.11
Munda Group	5441	58	**75.18**	71.75	80.48
II. TIBETO-CHINESE FAMILY					
(i) Siamese-Chinese Sub-Family					
Tai Group	85	1	**78.48**	78.48	78.48
(ii) Tibeto-Burman Sub-Family					
Bhotia Group	2098	27	**77.34**	70.38	86.51
Himalayan Group	1039	20	**79.66**	72.98	85.04
North East Frontier Group	1111	19	**78.11**	73.23	82.83
Bodo Group	1983	24	**76.89**	73.74	80.13
Naga Group	1901	39	**77.90**	75.69	81.87
Kachin Group	13	1	**76.06**	76.06	76.06
Kuki Chin Group	388	8	**75.55**	73.40	77.25
III. DRAVIDIAN FAMILY					
South Dravidian Group	10836	240	**76.06**	67.91	87.00
Central Dravidian Group	2031	33	**75.41**	71.80	79.80
North Dravidian Group	3009	11	**73.67**	72.30	75.79
IV. INDO-EUROPEAN FAMILY					
Dard Group	652	10	**74.05**	69.88	76.20
North Western Group	30	1	**82.91**	82.91	82.91
Southern Group	7064	115	**77.93**	74.30	81.81
Eastern Group	1892	34	**76.20**	72.40	78.40
Bihari	20718	109	**76.94**	72.99	90.88
Central Group	20853	249	**74.49**	70.80	83.76
Pahari Group	969	16	**74.10**	69.29	81.49
Unspecified	256	2	**76.46**	73.90	77.33
Other Languages	430	12	**79.29**	74.29	84.80
No Information	-	0	-	-	-
6A. LANGUAGE FAMILY					
I. Austro Asiatic Family	6877	74	**75.63**	71.75	86.11
II. Tibeto Chinese Family	8616	139	**77.67**	70.38	86.51
III. Dravidian Family	15876	284	**75.52**	67.91	87.00
IV. Indo European Family	52434	536	**75.99**	69.29	90.88
Other Languages	430	12	**79.29**	74.29	84.80
No Information	-	0	-	-	-

Bengal and to end in Orissa. The actual data on which Guha based his map has not been published. So Guha's map cannot be studied or checked by other researchers".

Sarkar et al. (1955) made an attempt to find out whether brachycephaly is restricted to certain zones or it has sweeping distribution as shown in Guha's map. In their paper, they placed the data into four tables and found the following zones with highest concentration of brachycephaly (Fig. 3).

Zone A: North West Frontier Provinces (NWFR), Punjab, Rajputana, and Southern Extension

Zone B: Himalayan foot hill

Zone C: Chittagao Hill Tracks, Bengal and Assam

Others excluding zones A, B, and C in which states are Uttar Pradesh, Bihar and then from Melghat Orissa, Nilgiri Hills, Travancore, Tinnevalley.

It has been observed that brachycephaly confines more or less to certain zones and these zones are not interrelated. It does not appear as clear sweeping continued and evenly distributed strain as reported by Guha (1931).

In Zone A, the highest value is 76.8 per cent of Northwest Frontier Provinces to about 60 per cent in Punjab and Baluchistan and then it falls by 1 to 2 per cent in certain groups. The southward extension of the above is justified because of the absence of the high percentage of brachycephaly similar to N.W.F.P., only in Prabhu highest is 52 per cent which falls to 46 in Nagar Brahmin and 40 per cent in Vadnagar Nagar Brahmin. The other groups of these areas show very low percentage of brachycephaly. They suggested that Pamir have always been recognized as centre of brachycephaly and the same is true for Hindukush region. It would therefore be not out of place to assume that N.W.F.P. brachycephaly has its source in the above region.

In Zone B, high brachycephaly has been with Limbu of Nepal (82 per cent). This appears to be of Mongoloid origin.

Zone C has the highest brachycephaly among Chakama (76 per cent). It therefore appears that whatever brachycephaly is found in this area has its origin in the east and this is all the more evident in the absence of any influx of brachycephaly from the Zone B.

The latter argument of Sarkar et al. (1955) is born out of the fact that the brachycephaly appears to decrease appreciably and significantly in the region further from the nucleus. The Kayasthas (Uttar Radhi) of Bengal have only 10 per cent of brachycephaly and it has been found to be very low in the western region of Bengal. They observed that the source of this brachycephaly is Southeast Asia, which is predominantly brachycephalic and closer to Eastern India.

Sarkar et al. (1955) have not grouped in any category the people of Tinnevalley in the southern tip of peninsula among whom they found fairly high brachycephaly (Parwars and Shanars, who show 34.0 ± 6.7 and 51 ± 4.9 per cent of brachycephaly, respectively). Hornwell (1923) who has studied them in course of his research on the origin and ethnological significance of Indian Boat was of the opinion that there have been separate waves migrations from Southeast Asia and the first wave was of Polynesian and second of Malayanesians. He emphasized the similarities between the Sharnas and Malayanesian people of Java. It is therefore not improbable that Malayan element has been responsible for the brachycephaly in East India to a certain extent. (Basu et al. 1980).

Among the higher occupational groups—priesthood and warfare, the mean value of cephalic index is low (75.60 and 74.45) and are dolichocephalics as compared to the artisans and menial workers who are mesocephalics. However among all these occupational groups the differences in the mean values are not high and the values are either dolichocephalic or near the lower range of mesocephaly (76.0 to 80.9), which indicates gene flow among them, as also observed for other biological traits (Table 2) (Bhasin et al. 1994; Bhasin and Walter 2001).

Among the speakers of Munda group of Austro-Asiatic and North and Central Dravidian groups of Dravidian languages, the predominant element present is dolichocephaly and they are mostly tribals. The mean value of cephalic index is high among speakers of Mon Khmer group (Austro-Asiatic family), Bhotia group, Himalayan group, North East Frontier group, Naga group (Tibeto-Chinese family) and Northwestern group (Indo-European family) languages who are having Mongoloid affinities. The speakers of Central group are dolichocephalics as compared to Bihari, Eastern (East India) and Southern groups (Maharashtra) who are mesocephalics (Table 2) (Bhasin et al. 1994; Bhasin and Walter 2001).

Zone	*Incidence*		
	High	*Medium*	*Low*
North India	Dolichocephaly	-	Meso-and Brachycephaly
Central India	Dolichocephaly	Mesocephaly	-
West India	Mesocephaly	-	Brachy-and Dolichocephaly
East India	Mesocephaly	Dolichocephaly	Brachycephaly
South India	Mesocephaly	Dolichocephaly	Brachycephaly
Islands	Brachycephaly	-	Meso-and Dolichocephaly

In India, cephalic index value varies from dolichocephaly to mesocephaly barring a few population groups from West, East, South and Islands among whom brachycephaly has been observed; the mean value of the index is 76.06 which are mesocephaly. In various zones, the distribution of cephalic index is mostly dolichocephaly in North and Central India and brachycephaly is absent; West, East and South India are predominantly mesocephalic with low frequency of brachycephaly, while the brachycephaly element is prominent from Islands. In the Hiamalayan region the low mean value of cephalic index is observed from Western region which is dolichocephalic than in Central and Eastern regions which fall in mesocephaly class. The value is low in the scheduled tribe ethnic groups as compared to others in all zones and India except in North India, where it is higher than other groups. No correlation is observed with climatic factors and altitude with different ethnic groups. Among the different occupational groups value of cephalic index is low among priesthood and warfare groups as compared to artisans and menial workers groups but the differences are not significant. Among the language families, high value of the index is observed among speakers of Tibeto-Chinese languages who are having Mongoloid affinities whereas low value is recorded in Central and North Dravidian (Dravidian family) and Munda group (Austro-Asiatic family) speakers who are mostly tribals.

2.2. Nasal Index

The nose, like the dentition, is more directly regulated by the forces of selection than is true for other aspects of cranial morphology (Brace 1964; Brace and Hunt 1990; Brace et al. 1991).

Global variation in the human nasal index is widely viewed as the result of an adaptive response to climatic variability. Thomson and Buxton (1923) first, and many later investigators (Davies 1932; Weiner 1954; Crognier 1981; Beals et al. 1984) found that nasal indices are positively associated with both temperature and humidity. Nasal indices are also related to latitude, which underlies variation in temperature and humidity (Newman 1953; Kelso 1970). In addition, nasal height and breadth, the components of the index, have been studied with respect to climate (Wolpoff 1968; Hiernaux and Froment 1976; Corgnier 1981). Nasal height is more strongly associated with temperature, covarying negatively, whereas nasal breadth is most strongly associated with humidity, covarying positively. However, the nasal index shows a higher correlation with climatic gradients than do either nasal height or nasal breadth alone. These patterns have been explained as evolutionary adaptations optimizing respiratory heat and moisture exchange in nasal mucosa, primarily to prevent ciliary and lung alveoli damage, as well as to moderate body water loss and maintain thermal equilibrium (*e.g.*, Thomson and Buxton 1923; Davies 1932; Weiner 1954).

Despite the associations described above, the nasal index is not universally accepted as a reflection of climatic adaptation (Hoyme 1965; St. Hoyme and Iscan 1989).

The mean value of nasal index is 75.53 among Indian populations (varies from 51.40 - hyperleptorhinae in Jain Pancham of Maharashtrato 96.75 - chamaerhinae in Garo or Mande of Assam).

The value is high (79.40 - mesorhinae) among scheduled tribes as compared to other ethnic groups (scheduled caste - 75.61; caste - 74.78 and community - 71.57).The value of index is low in Himalayan mountain complex region (70.68) followed by Indus-Ganga-Brahmaputra plains (72.13) and then gradually increases towards peninsular plateau (78.01) and islands region (79.98). From the climatic regions, the value is lowest from polar region (66.38) and starts increasing towards cold humid winters with short summers (71.31) and monsoon type with dry winters (72.11) regions and reach quite high values in tropical savannah type (78.05) to maximum in monsoon type with short dry season

Table 3: Nasal Index

Particulars	Subjects studied	No. of studies	Nasal Index Mean	Min	Max
1. NATURAL REGION					
Himalayan Mountain Complex	8408	129	**70.68**	60.83	92.86
Indus-Ganga-Brahmaputra Plains	22844	249	**72.13**	50.90	96.75
Peninsular Plateau	46480	563	**78.01**	51.40	95.90
Islands	751	13	**79.98**	69.58	93.01
2. CLIMATIC REGION					
Monsoon Type with Short Dry Season	4179	68	**80.62**	65.70	93.01
Monsoon Type with Dry Season	2827	48	**76.75**	67.92	95.10
Tropical Savannah Type	34389	354	**78.05**	51.40	95.90
Semi Arid Steppe Type	4768	92	**76.10**	64.52	92.90
Hot Desert Type	-	0	-	-	-
Monsoon Type with Dry Winters	31449	375	**72.11**	59.00	96.75
Cold Humid Winters with Short Summers	338	5	**71.31**	70.34	72.90
Polar Type	533	12	**66.38**	62.18	68.46
3. POLITICAL DIVISION OF INDIA					
I. NORTH INDIA					
A. Western Himalaya (S. No. 1, 2)					
1. Jammu and Kashmir	926	15	**64.74**	61.75	75.54
2. Himachal Pradesh	2294	24	**65.81**	60.83	74.10
3. Punjab	1035	13	**69.78**	64.71	75.20
4. Chandigrah UT	-	0	-	-	-
5. Haryana	-	0	-	-	-
6. Delhi UT	740	10	**67.96**	65.92	71.17
B. Central Himalaya (S. No. 7, Eight Districts of Uttar Pradesh)					
7. Uttar Pradesh	12232	123	**71.01**	59.00	86.10
8. Rajasthan	1698	11	**73.63**	70.03	84.10
II. WEST INDIA					
9. Gujarat	4750	50	**73.53**	65.84	80.80
10. Maharashtra	6935	120	**77.45**	51.40	94.80
11. Goa, Daman and Diu UT	-	0	-	-	-
12. Dadra and Nagar Haveli UT	-	0	-	-	-
III.EAST INDIA					
C. Eastern Himalaya (S. No. 13 to 20 and Darjeeling District of West Bengal)					
13. Arunachal Pradesh	338	5	**71.31**	70.34	72.90
14. Assam	4847	66	**76.05**	65.69	96.75
15. Nagaland	1699	35	**77.46**	64.42	92.86
16. Manipur	280	4	**75.93**	70.84	80.95
17. Mizoram	40	1	**69.98**	69.98	69.98
18. Tripura	311	5	**72.92**	70.63	75.31
19. Meghalaya	887	12	**79.16**	73.58	87.63
20. Sikkim	797	16	**70.13**	65.15	78.20
21. West Bengal	5378	55	**72.18**	65.40	94.70
22. Bihar	15650	70	**78.46**	58.80	95.90
23. Orissa	3700	53	**81.53**	70.46	91.81
IV. CENTRAL INDIA					
24. Madhya Pradesh	2504	35	**82.09**	72.92	92.20
V. SOUTH INDIA					
25. Karnataka	2149	47	**76.60**	65.20	92.62
26. Andhra Pradesh	1426	34	**75.30**	69.70	81.90
27. Tamil Nadu	2323	68	**76.72**	64.52	90.81
28. Kerala	3632	61	**81.31**	65.70	95.10
29. Pondicherry UT	1161	8	**76.04**	70.82	81.21
VI. ISLANDS					
30. Lakshadweep UT	-	0	-	-	-
31. Andman Islands and Nicobar Islands UT	176	7	**84.15**	71.60	93.01
	575	6	**78.70**	69.58	83.87
3A. ZONES OF INDIA					
I. North India	18925	196	**70.13**	59.00	86.10
II. West India	11685	170	**75.86**	51.40	94.80
III. East India	33927	322	**77.07**	58.80	96.75
IV. Central India	2504	35	**82.09**	72.92	92.20
V. South India	10691	218	**77.99**	64.52	95.10
VI. Islands	751	13	**79.98**	69.58	93.01
INDIA (TOTAL)	78483	954	**75.53**	51.40	96.75
3B. REGIONS OF HIMALAYA					
A. Western Himalaya	3220	39	**65.51**	60.83	75.54
B. Central Himalaya	1157	15	**72.85**	65.78	83.00
C. Eastern Himalaya	9765	153	**75.56**	64.42	96.75
HIMALAYA (TOTAL)	14142	207	**73.05**	60.83	96.75
NON-HIMALAYAN REGIONS	64341	747	**76.07**	51.40	95.90
4. ETHNIC GROUP					
A. ZONES OF INDIA					
1. NORTH INDIA					
Caste	6290	68	**70.27**	59.00	84.28
Scheduled Caste	2638	38	**75.16**	63.00	86.10
Scheduled Tribe	2389	26	**71.20**	62.18	84.10
Community	7608	64	**67.92**	60.83	83.40
II. WEST INDIA					
Caste	4656	78	**74.98**	65.84	82.81
Scheduled Caste	562	9	**78.86**	74.79	81.90
Scheduled Tribe	2108	27	**80.04**	69.27	94.80

Table 3: Contd....

Particulars	Subjects studied	No. of studies	Nasal Index		
			Mean	Min	Max
Community	4359	56	**74.39**	51.40	87.56
III. EAST INDIA					
Caste	14694	69	**76.34**	58.80	90.16
Scheduled Caste	3684	40	**74.44**	66.39	88.70
Scheduled Tribe	12551	172	**79.95**	64.42	96.75
Community	2998	41	**71.87**	65.40	82.06
IV. CENTRAL INDIA					
Caste	104	2	**79.26**	72.92	85.14
Scheduled Caste	-	0	-	-	-
Scheduled Tribe	2350	32	**82.30**	75.90	92.20
Community	50	1	**77.91**	77.91	77.91
V. SOUTH INDIA					
Caste	3199	75	**76.03**	65.70	85.50
Scheduled Caste	1304	30	**78.45**	69.70	82.31
Scheduled Tribe	3183	62	**81.34**	64.52	95.10
Community	3005	51	**76.33**	62.50	92.62
VI ISLANDS					
Caste	-	0	-	-	-
Scheduled Caste	-	0	-	-	-
Scheduled Tribe	751	13	**79.98**	69.58	93.01
Community	-	0	-	-	-
INDIA					
Caste	28943	292	**74.78**	58.80	90.16
Scheduled Caste	8188	117	**75.61**	63.00	92.31
Scheduled Tribe	23332	332	**79.49**	62.18	96.75
Community	18020	213	**71.57**	51.40	92.62
B. REGIOUS OF HIMALAYA					
A. Western Himalaya					
Caste	818	8	**64.90**	62.11	74.10
Scheduled Caste	70	1	**65.39**	65.39	65.39
Scheduled Tribe	1059	11	**66.48**	62.18	75.54
Community	1273	19	**65.09**	60.83	69.58
B.Central Himalaya					
Caste	60	2	**69.17**	68.54	70.06
Scheduled Caste	213	2	**79.98**	75.98	83.00
Scheduled Tribe	536	6	**72.09**	65.78	79.50
Community	348	5	**70.73**	66.30	73.14
C. Eastern Himalaya					
Caste	243	5	**69.08**	65.69	70.17
Scheduled Caste	1221	14	**73.34**	66.39	83.70
Scheduled Tribe	9810	108	**76.69**	64.42	96.75
Community	1491	26	**73.27**	65.75	82.06
5. TRADITIONAL OCCUPATION					
Priesthood	14940	70	**75.89**	58.80	82.81
Warfare	3114	26	**69.01**	62.11	82.48
Tade and Commerce	1937	26	**73.16**	63.00	79.60
Agriculture	1846	33	**72.74**	64.00	83.70
Animal Husbandry	478	10	**71.32**	65.74	78.95
Artisans	708	11	**71.94**	63.00	81.71
Menial Workers	5359	64	**75.98**	64.00	88.70
No Information	50001	714	**76.08**	51.40	96.75
6. LANGUAGE GROUP					
I. AUSTRO-ASIATIC FAMILY					
Mon Khmer Group	1436	16	**79.57**	69.58	87.63
Munda Group	5395	55	**82.28**	69.00	95.00
II. TIBETO-CHINESE FAMILY					
(i) Siamese-Chinese Sub-Family					
Tai Group	85	1	**77.26**	77.26	77.26
(ii) Tibeto-Burman Sub-family					
Bhotia Group	1774	23	**66.05**	60.83	75.54
Himalaya Group	1039	20	**71.33**	65.15	78.50
North East Frontier Group	1111	19	**74.05**	69.66	90.58
Bodo Group	1982	24	**77.64**	68.54	96.75
Naga Group	1901	39	**77.96**	64.42	92.86
Kachin Group	13	1	**81.26**	81.26	81.26
Kuki Chin Group	388	8	**75.69**	69.98	82.67
III. DRAVIDIAN FAMILY					
South Dravidian Group	10454	215	**78.04**	64.52	95.10
Central Dravidian Group	2010	32	**82.06**	73.67	91.81
North Dravidian Group	3009	11	**72.82**	67.00	89.12
IV. INDO-EUROPEAN FAMILY					
Dard Group	572	6	**63.34**	62.11	66.50
North Western Group	30	1	**73.58**	73.58	73.58
Southern Group	7057	114	**76.77**	51.70	88.40
Eastern Group	1892	34	**81.30**	70.46	93.60
Bihari	18294	99	**75.29**	58.80	88.70
Central Group	18438	210	**72.13**	59.00	94.80
Pahari Group	929	14	**67.43**	62.42	77.93
Unspecified	256	2	**77.05**	69.10	79.50
Other Languages	418	10	**79.95**	-	93.01
No Information	-	0	-	-	-
6A. LANGUAGE FAMILY					
I. Austro Asiatic Family	6831	71	**81.72**	69.00	95.90
II. Tibeto Chinese Family	8293	135	**73.87**	60.83	96.75
III. Dravidian Family	15473	258	**77.55**	64.52	95.10
IV. Indo European Family	47468	480	**74.23**	51.40	94.80
Other Languages	418	10	**79.95**	69.10	93.01
No Information	-	0	-	-	-

(80.62) region. The value of index increases as one moves from cold climate towards hot climate (Table 3), (Bhasin et al. 1994; Bhasin and Walter 2001).

The value of nasal index is low from the North India zone (70.13) as compared to other zones. The nasal index is leptorhinae among the populations from the states of Jammu and Kashmir (64.74), Himachal Pradesh (65.81) of Western Himalayan region, and also from Punjab and Delhi (69.78 and 67.96, respectively) as compared to the peoples from any other State or Union Territory of India, where the nasal index is mesorhinae type (Table 3, Fig. 4). From Central Himalayan region among the population groups with Mongoloid affinities the value of index is less than 70.0 (different groups of Bhotias, Jaunsari) as also among caste groups compared to scheduled castes in which the value is quite high (79.28). From Rajasthan also the value of the index is high among scheduled tribes (different groups of Bhils) as compared to the caste groups.

From East India, from the states of Assam, Nagaland, Manipur, Meghalaya of Eastern Himalayan region the values of index are quite high (76.05, 77.46, 75.93, 79.16, respectively) among the population groups with Mongoloid affinities as compared to the population groups from Western and Central Himalayan regions and Sikkim state (70.13). This may be due to racial elements present among the peoples from Eastern Himalayan region—Australoid (Pre-Dravidian), Caucasoid (Dravidian, and/or Aryan) and Mongoloid in varying degrees. From Nepal, among Sherpas, Chhetris, Rais, Thakurs, Tamangs, Newars, Sunwars, Limbus the nasal index is leptorhinae as also observed among

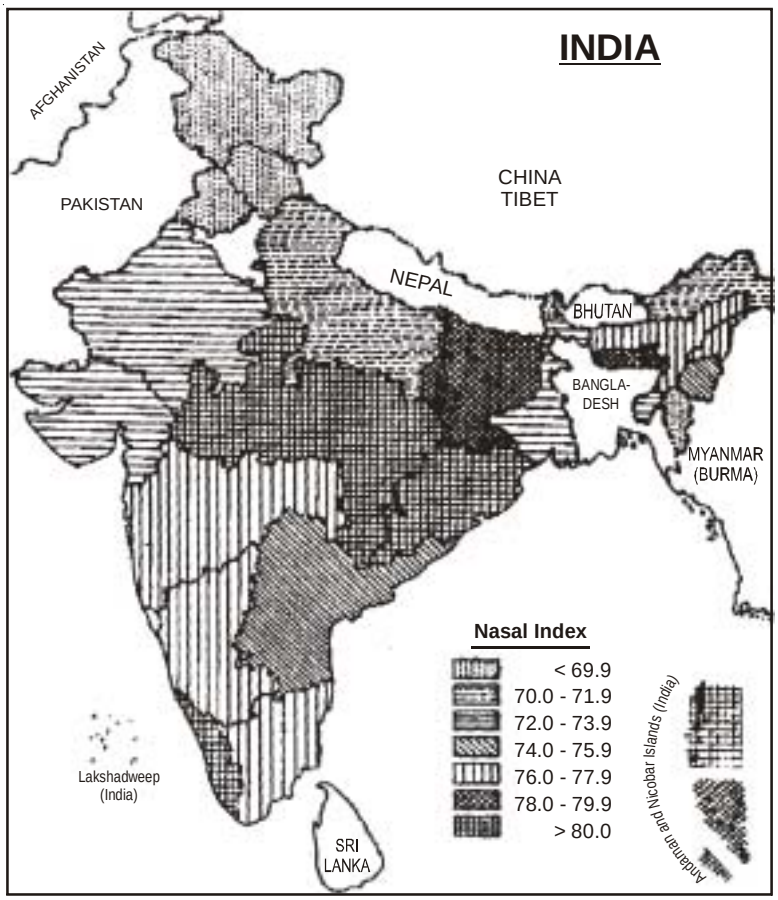

Fig. 4. Frequencies of nasal index in different regions of India (after Bhasin and Walter 2001)

different populations from Sikkim among whom Nepalis are in majority.

From West India the value of the index is 75.86 (mesorhinae) and quite high value is found among the populations from Maharashtra (77.45) as compared to Gujarat (73.53). The value is highest among the scheduled tribes (80.04 - mesorhinae) followed by scheduled castes (78.86) as compared to other ethnic groups. From West India, however, the value of index below 70 (leptorhinae) is observed among a few castes (Brahmin, Rajput, Khatri, Jain) and Parsis - a migrant community from Southwest Asia.

Among the populations from Central India (Madhya Pradesh) the value of index is quite high (82.09) followed by the states of Orissa (81.53) and Bihar (78.46) from which the studies are on scheduled tribes. From these states, as well as from West Bengal, the values of index are quite high (above 85) among tribals (*e.g.* Santal, Munda, Oraon, Paharia, Gond, Muria) and low (less than 70) among caste groups (mostly Brahmin).

The mean value of nasal index is again high from the states of South India (77.99) and in this zone also, the value is highest among scheduled tribes (81.34) followed by scheduled castes (78.45), as also observed from West India zone. The low values (less than 70) are observed among a few populations—Curgs, Lambadi-nomads migrated from North India, Toda, Kaku and Mohammadans. Whereas quite high values (more than 85) have been reported among Kuruba, Yeruvas, Sholega, Siddi (a community with black ancestry), Kadar, Malasar, Paniyan, Malavetan, Ulladan, Muthuvan, Urali, Nayadi, Malser, Malapulayan, Malayarayan. From this zone, the studies available on different caste populations are falling in mesorhinae class.

From Islands, among Andamanese from North and South the nasal index is quite high (more than 85), whereas others are falling in mesorhinae class except Nicobarese Southern who are having leptorhinae nasal index.

In general, it has been observed that the value of nasal index is low among population groups from the Himalayan region, however, differences are observed among the peoples from western and central Himalayan regions who are having Caucasoid (Aryans) affinities and Caucasoid (Aryan) and Mongoloid admixture in varying degrees in which value of nasal index is low while that of Eastern Himalayan region who are having admixture of Australoid (Pre-Dravidian), Caucasoid (Dravidian and/or Aryans) and Mongoloid racial elements in varying degrees have high value.

As one moves towards Indus-Ganga-Brahmaputra plains region, the value of nasal index increases a little whereas among castes and communities who are Caucasoid (Aryans) the value of index is low as compared to scheduled castes and scheduled tribes and they are having Caucasoid (Aryan, Dravidian) and Austraoloid (Pre-Dravidian) racial elements in varying degrees.

In the peninsular region, the value of the index increases sharply and it has been observed that in West India, Central India and state of Orissa, the mean values are quite high among scheduled tribes and scheduled castes who are having mostly Australoid and/or Caucasoid (Dravidian) admixture, albeit higher caste groups from this region are having leptorhinae type of nose. In South India, among Dravidians, the value of nasal index is quite high among all the ethnic groups with highest in scheduled tribes who are having Australoid (Pre-Dravidian) and/or Caucasoid (Dravidian) racial element (s).

The nasal index shows a correlation with climatic gradients, but as it appears from the above discussion, the differences observed are also due to different racial elements present among them and due to various ethnic groups from the same natural regions.

Further when nasal index correlations are calculated with various climatic factors and altitude by different ethnic groups significant differences are observed but correlations are not high (Table 6). Therefore it appears difficult to evaluate to what extent there is an association of the nasal index with climatic adaptation.

The value of nasal index among different occupational groups is low in warfare (69.01 - leptorhinae), animal husbandry (71.32) and artisans (71.94) followed by agriculture (72.74) and trade and commerce (73.16) group as compared to priesthood and menial workers among whom the values are quite high (75.89 and 75.98, respectively) (Table 3), (Bhasin et al. 1994; Bhasin and Walter 2001). Most of the studies reported on priesthood group are from West Bengal, West India and South India among whom the value of nasal index is observed high as compared to other groups, particularly warfare group. The social stratification is most clearly shown in the nasal index—with increasing social rank the nasal index become slower *i.e.* nose becomes narrower and

more pronounced (Risley 1915; v. Eickstedt 1952; Büchi 1968). However in present study it is not so with the highest rank *i.e.* priesthood.

The value of the index is high among the speakers of Mon Khmer group (79.57) of Austro Asiatic; Bodo group (77.84), Naga group (77.96), Kachin group (81.26), Kuki Chin group (75.69), Tai group (77.26) and North East Frontier group (74.05) of Tibeto-Chinese languages from Eastern Himalayan region who are having Mongoloid affinities as compared to Dard group (63.34), Pahari group (67.43) of Indo-European and Bhotia group (66.05), Himalayan group (71.33) of Tibeto-Chinese languages from Western and Central Himalayan regions and state of Sikkim. Among the speakers of Eastern group of Indo-European, Munda group of Austro-Asiatic and Central Dravidian group of Dravidian languages who belong mostly to tribals the values are quite high (81.30, 82.28 and 82.06). In general, the values of nasal index are low among the speakers of Tibeto-Chinese (73.87) and Indo-European (74.23) languages as compared to others (Table 3) (Bhasin et al. 1994; Bhasin and Walter 2001).

In India, the nasal index is observed of mesorhinae type (75.53) among various population groups of India. The mean value of the index is observed high in Central India and Islands from where mostly scheduled tribe groups are reported, followed by South, East, West and North India. The value of nasal index is high in Eastern region (mesorhinae) as compared to Western and Central regions of Himalaya. In general, the high value of nasal index is observed among scheduled tribe groups followed by scheduled caste as compared to caste and community from various zones and regions. The value is high in Austro-Asiatic followed by Dravidian language speakers as compared to Indo-European and Tibeto-Chinese language speakers. No correlations are observed with various climatic factors and altitude by different ethnic groups. Leptorhinae type of nose is observed mostly from North India and in few caste groups from West and East India, although a few cases have also been reported from South India among inbreeding groups (Muhammadans and Curg), small ethnic groups (Kapu and Toda) and a group which is originally not from South India (Lambadi) and chamaerhinae type of nose is reported generally among scheduled tribe and scheduled caste groups from West, East, South India and Islands zones.

2.3. Facial Index

The mean value of facial index is 86.34 (mesoprosopic) among Indian populations, which varies from 75.00 (hypereuryprosopic type among Naga Sundan of Nagaland) to 122.80 (hyperleptoprospic in Bhil Khandesh of Maharashtra). Among all the ethnic groups the index falls in mesoprosopic class (84.0 - 87.9) with low value in scheduled caste (85.79) and high in community (86.58). The facial index is leptoprosopic among population groups from Himalayan mountain complex natural region (88.33) and as one moves towards south the value starts decreasing gradually as observed in Indus-Ganga-Brahmaputra plains (87.00 - mesoprosopic) and peninsular plateau (85.84 - mesoprosopic) whereas in Islands region, the value is quite low among Andamanese who are having Negrito affinities (83.48 - euryprosopic) and high among Nicobarese (86.10 - mesoprosopic) among whom Mongoloid element is present. From the climatic regions—polar type, monsoon type with short dry season and monsoon type with dry season, the facial index is above 88.0 (leptoprosopic) followed by monsoon type with dry winters (87.21) as compared to semi arid steppe type and tropical savannah type regions where the values are low (84.78 and 85.34, respectively) (Table 4), (Bhasin et al. 1994; Bhasin and Walter 2001).

The facial index is leptoprosopic among the populations of North India zone as compared to other zones from where it is falling in mesoprosopic class. The values are quite high among the populations from the states of Jammu and Kashmir (90.71 - leptoprosopic) and Himachal Pradesh (89.50 - leptoprosopic) of Western Himalayan region (89.92 - leptoprosopic) as compared to Central Himalayan region (87.71 - mesoprosopic). From East India in the Eastern Himalayan region the value of index is low (85.47 - mesoprosopic) as compared to Western and Central Himalayan regions. However, a few exceptions have been observed from Manipur, Mizoram and Tripura states where the value of index is above 88 (leptoprosopic) which may be due to smaller number of studies reported from these states. From West Bengal the value of index is high (88.43) as most of the studies are among the caste and community populations as compared to Bihar and Orissa states from where the tribals are studied in majority (86.74 and 84.88, respectively). Among the scheduled tribes from

Central India the value of index is high (87.31) as compared to that observed from East and West India tribals (85.29 and 86.69, respectively).

Among the scheduled tribes from the West and South India zones, the mean values of facial index are high (86.69 and 89.49, respectively) as compared to other ethnic groups from these zones. From West India, the value of index is low (84.52) as compared to other zones and the index is euryprosopic among caste populations in this zone. In different states of South India zones the mean value varies from 83.99 (Karnataka) to 90.01 (Kerala); the value of index is quite high among the tribals of Kerala (in most cases above 88) as compared from other states.

In general the value of index is high in Northern India and decreases towards peninsular region (Table 4, Fig. 5).

The facial index correlations with various climatic factors and altitude by different ethnic groups though showing significant differences are not high (Table 6).

The values of facial index among priesthood, agriculture, artisans and menial workers traditional occupational groups are almost similar (86.03, 86.21, 85.30 and 86.04, respectively) as compared to warfare, trade and commerce and animal husbandry groups which have high values (87.93, 87.51 and 86.76, respectively). However, the differences observed are not significant which indicates gene flow among these groups as also observed for other traits (Bhasin et al., 1994; Bhasin and Walter 2001).

Among the speakers of Dard group, Pahari group of Indo-European and Bhotia group and Himalayan group of Tibeto-Chinese languages,

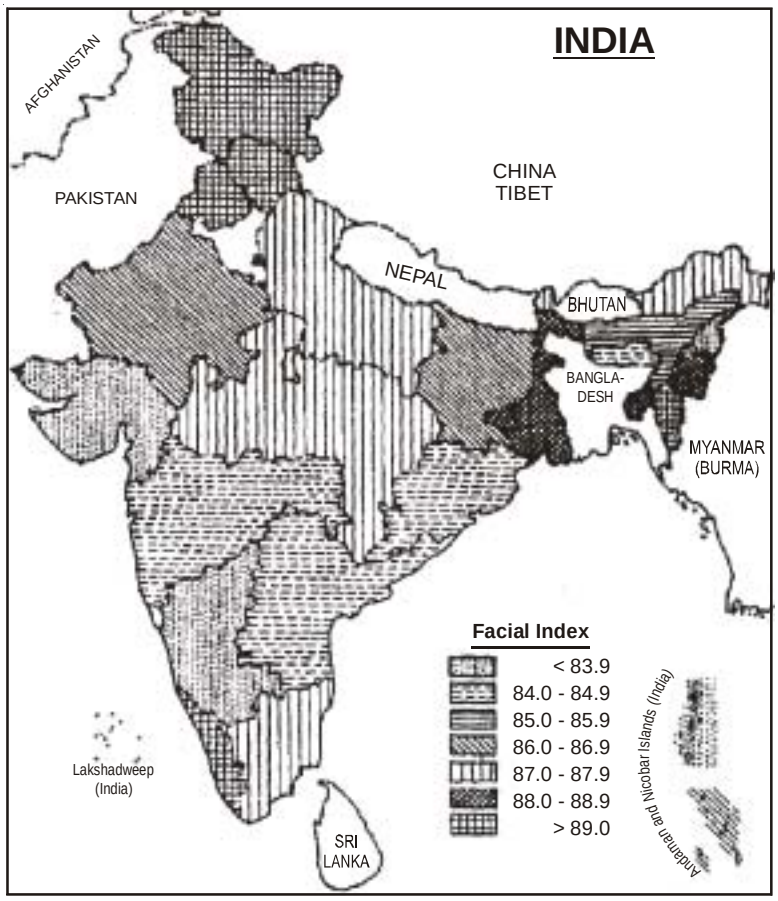

Fig. 5. Frequencies of facial index in different regions of India (after Bhasin and Walter 2001)

Table 4: Facial Index

Particulars	*Subjects studied*	*No. of studies*	*Facial Index*		
			Mean	*Min*	*Max*
1. NATURAL REGION					
Himalayan Mountain Complex	4907	71	**88.33**	75.00	99.00
Indus-Ganga-Brahmaputra Plains	10526	106	**87.00**	79.65	93.90
Peninsular Plateau	23433	320	**85.64**	79.97	122.80
Islands	596	8	**86.10**	82.08	88.91
2. CLIMATIC REGION					
Monsoon Type with Short Dry Season	1455	20	**88.48**	82.08	110.99
Monsoon Type with Dry Season	1466	11	**88.47**	84.50	90.75
Tropical Savannah Type	17486	238	**85.34**	79.97	122.80
Semi Arid Steppe Type	2662	47	**84.78**	80.24	87.71
Hot Desert Type	-	0	-	-	-
Monsoon Type with Dry Winters	15552	173	**87.21**	75.00	99.00
Cold Humid Winters with Short Summers	338	5	**87.13**	84.35	90.10
Polar Type	503	11	**90.03**	88.25	92.00
3. POLITICAL DIVISION OF INDIA					
I. NORTH INDIA					
A. Western Himalaya (S. No. 1, 2)					
1. Jammu and Kashmir	895	14	**90.71**	88.25	99.00
2. Himachal Pradesh	1679	19	**89.50**	88.01	94.15
3. Punjab	199	4	**90.69**	87.30	93.90
4. Chandigrah UT	-	0	-	-	-
5. Haryana	-	0	-	-	-
6. Delhi UT	100	1	**88.95**	88.95	88.95
B. Central Himalaya (S. No. 7, Eight Districts of Uttar Pradesh)					
7. Uttar Pradesh	3186	39	**87.27**	80.80	92.83
8. Rajasthan	722	5	**86.57**	86.34	87.40
II. WEST INDIA					
9. Gujarat	3160	30	**83.99**	81.40	86.18
10. Maharashtra	5440	101	**84.83**	79.97	122.80
11. Goa, Daman and Diu UT	-	0	-	-	-
12. Dadra and Nagar Haveli UT	-	0	-	-	-
III. EAST INDIA					
C. Eastern Himalaya (S. No. 13 to 20 and Darjeeling District of West Bengal)					
13. Arunachal Pradesh	338	5	**87.13**	84.35	90.10
14. Assam	4104	43	**85.29**	79.65	91.23
15. Nagaland	704	14	**83.89**	75.00	97.37
16. Manipur	100	1	**88.15**	88.15	88.15
17. Mizoram	40	1	**90.50**	90.50	90.50
18. Tripura	312	5	**88.73**	87.32	90.72
19. Meghalaya	860	11	**84.99**	82.00	88.89
20. Sikkim	80	1	**87.75**	87.75	87.75
21. West Bengal	3653	30	**88.43**	82.98	91.68
22. Bihar	3369	33	**86.74**	81.59	92.10
23. Orissa	3081	39	**84.88**	80.59	95.30
IV. CENTRAL INDIA					
24. Madhya Pradesh	2189	29	**87.45**	80.45	90.58
V. SOUTH INDIA					
25. Karnataka	1840	39	**83.99**	80.24	87.60
26. Andhra Pradesh	490	8	**84.39**	82.76	87.30
27. Tamil Nadu	158	4	**87.63**	83.50	89.94
28. Kerala	901	13	**90.01**	82.10	110.99
29. Pondicherry UT	1266	8	**88.74**	86.99	90.75
VI. ISLANDS					
30. Lakshadweep UT	-	0	-	-	-
31. Andman Islands and Nicobar Islands UT	22 574	2 6	**83.48** **86.20**	83.38 82.08	83.54 88.91
3A. ZONES OF INDIA					
I. North India	6781	82	**88.33**	80.80	99.00
II. West India	8600	131	**84.52**	79.97	122.80
III. East India	16641	183	**86.27**	75.00	97.37
IV. Central India	2189	29	**87.45**	80.45	90.58
V. South India	4655	72	**86.61**	80.24	110.99
VI. Islands	596	8	**86.10**	82.08	88.91
INDIA (TOTAL)	39462	505	**86.34**	75.00	122.80
3B. REGIONS OF HIMALAYA					
A. Western Himalaya	2574	33	**89.92**	88.01	99.00
B. Central Himalaya	659	10	**87.71**	86.26	89.15
C. Eastern Himalaya	6638	82	**85.47**	75.00	97.37
HIMALAYA (TOTAL)	9871	125	**86.78**	75.00	99.00
NON-HIMALAYAN REGIONS	29591	380	**86.20**	79.97	122.80
4. ETHNIC GROUP					
A. ZONES OF INDIA					
1. NORTH INDIA					
Caste	2781	28	**87.29**	80.80	90.63
Scheduled Caste	207	4	**88.53**	87.86	92.83
Scheduled Tribe	1344	18	**88.53**	86.26	92.29
Community	2449	32	**89.37**	86.32	99.00
II. WEST INDIA					
Caste	2664	53	**83.66**	79.97	92.41
Scheduled Caste	462	8	**81.74**	80.71	84.29
Scheduled Tribe	1436	20	**86.69**	80.24	122.80

Table 4: Contd.....

Particulars	Subjcects studied	No. of studies	Facial Index Mean	Min	Max
Community	4038	50	**84.63**	80.18	120.60
III. EAST INDIA					
Caste	3504	41	**87.95**	82.41	91.68
Scheduled Caste	2679	24	**86.80**	80.75	91.41
Scheduled Tribe	8835	101	**85.29**	75.00	97.37
Community	1623	17	**87.05**	83.95	91.43
IV. CENTRAL INDIA					
Caste	104	2	**88.98**	88.30	89.61
Scheduled Caste	-	0	-	-	-
Scheduled Tribe	2035	26	**87.31**	80.45	90.58
Community	50	1	**89.83**	89.83	89.83
V. SOUTH INDIA					
Caste	1509	30	**86.17**	80.24	90.75
Scheduled Caste	543	10	**83.21**	80.38	87.66
Scheduled Tribe	854	13	**89.49**	83.50	110.99
Community	1749	19	**86.65**	80.65	89.74
VI. ISLANDS					
Caste	-	0	-	-	-
Scheduled Caste	-	0	-	-	-
Scheduled Tribe	596	8	**86.10**	82.08	88.91
Community	-	0	-	-	-
INDIA					
Caste	10562	154	**86.45**	79.97	92.41
Scheduled Caste	3891	46	**85.79**	80.38	92.83
Scheduled Tribe	15100	186	**86.26**	75.00	122.80
Community	9909	119	**86.58**	80.18	120.60
B. REGIONS OF HIMALAYA					
A. Western Himalaya					
Caste	575	5	**90.12**	89.75	90.60
Scheduled Caste	-	0	-	-	-
Scheduled Tribe	726	9	**89.13**	88.01	92.00
Community	1273	19	**90.29**	88.25	99.00
B. Central Himalaya					
Caste	60	2	**88.88**	88.50	89.15
Scheduled Caste	-	0	-	-	-
Scheduled Tribe	280	4	**87.08**	86.26	87.75
Community	319	4	**88.05**	87.25	88.75
C. Eastern Himalaya					
Caste	101	2	**87.54**	84.06	91.23
Scheduled Caste	1098	11	**85.30**	83.90	87.72
Scheduled Tribe	4552	59	**85.32**	75.00	97.37
Community	887	10	**86.18**	83.95	90.25
5. TRADITIONAL OCCUPATION					
Priesthood	3483	51	**86.03**	80.80	91.68
Warfare	2030	19	**87.93**	83.02	91.54
Trade and Commerce	709	11	**87.51**	81.37	90.56
Agriculture	781	13	**86.21**	82.40	88.95
Animal Husbandry	193	4	**86.76**	82.73	93.90
Artisans	385	4	**85.30**	82.52	87.84
Menial Workers	2899	28	**86.04**	80.71	91.41
No Information	28982	375	**86.29**	75.00	122.80
6. LANGUAGE GROUP					
I. AUSTRO-ASIATIC FAMILY					
Mon Khmer Group	1354	15	**85.33**	82.00	88.91
Munda Group	4056	35	**85.79**	80.59	95.30
II. TIBETO-CHINESE FAMILY					
(i) Siamese-Chinese Sub-Family					
Tai Group	85	1	**85.81**	85.81	85.81
(ii) Tibeto-Burman Sub-Family					
Bhotia Group	1508	18	**88.69**	86.26	92.00
Himalayan Group	216	4	**89.49**	87.75	92.29
North East Frontier Group	964	12	**86.97**	83.95	90.25
Bodo Group	1788	18	**85.45**	80.27	91.15
Naga Group	872	16	**83.09**	75.00	97.37
Kachin Group	-	0	-	-	-
Kuki Chin Group	181	4	**88.56**	83.54	90.50
III. DRAVIDIAN FAMILY					
South Dravidian Group	4510	71	**86.60**	80.24	110.99
Central Dravidian Group	1871	29	**86.08**	80.45	90.58
North Dravidian Group	752	7	**87.37**	81.87	89.45
IV. INDO-EUROPEAN FAMILY					
Dard Group	502	5	**90.29**	89.76	91.88
North Western Group	30	1	**81.40**	81.40	81.40
Southern Group	5110	91	**84.23**	79.97	120.60
Eastern Group	1149	19	**85.21**	80.75	89.61
Bihari	6170	63	**87.55**	83.90	91.68
Central Group	7561	84	**86.63**	80.80	122.80
Pahari Group	561	8	**90.38**	89.50	94.15
Unspecified	-	0	-	-	-
Other Languages	222	4	**85.41**	83.38	86.37
No Information	-	0	-	-	-
6A. LANGUAGE FAMILY					
I. Austro Asiatic Family	5410	50	**85.68**	80.59	95.30
II. Tibeto Chinese Family	5614	73	**86.47**	75.00	97.37
III. Dravidian Family	7133	107	**86.54**	80.24	110.99
IV. Indo European Family	21083	271	**86.42**	79.97	122.80
Other Languages	222	4	**85.41**	83.38	86.37
No Information	-	0	-	-	-

the value of facial index is above 88 (leptoprosopic) who are inhabiting Western, Central Himalayas as also among Lepcha, Bhutias of Sikkim state, whereas from Eastern Himalayan region the value of index varies between 84.0 and 87.9 (mesoprosopic) as observed among the speakers of Mon Khmer group (85.33) of Austro-Asiatic and North East Frontier group (86.97), Bodo group (85.45) and Naga group (83.09) of Tibeto-Chinese languages except Kuki Chin group speakers (88.56). In the Southern groups of Indo-European language speakers the value of index is low as observed from the West as compared to the Eastern group (85.21) and Bihari group from Eastern India (87.55). Among the speakers of Munda group the value of index is either low (85.79) as compared to North Dravidian group (87.37) or similar to Central Dravidian group, who are mostly tribals. However, in general, the differences among the speakers of different languages are not significant (Bhasin et al. 1994; Bhasin and Walter, 2001).

The mesoprosopic facial index is observed among various population groups of India and from all the zones of India except North India (Leptoprosopic). In the Himalayan region mesoprosopic type is predominant except in Western Himalayan region where leptoprosopic type is found. The value of index is high in the Himalayan region and it gradually starts declining towards South. Leptoprosopic facial index is observed among caste groups from West Bengal and Tamil Nadu, Kerala and Pondicherry of South India. Euryprosopic type of facial index is observed among caste groups of Gujarat and scheduled caste groups of West and South India zones. However, generally a high frequency is observed among Community or Caste>Caste or Community>Scheduled Tribe> Scheduled Caste except from West and South India where high value is observed among scheduled tribes. No correlations are observed with various climatic factors and altitude by different ethnic groups. The differences observed in the various language families for facial index are not significant (Dravidian>Tibeto-Chinese>Indo-European> Austro-Asiatic).

Considering India as a whole, the biogenetical traits distribution is seen to follow a pattern that might have been expected from the complex structure of its people. Indian populations are living in different natural and climatic regions. The composition of Indian populations is multiethnic consisting of elements of autochthonous (Pre-Dravidian/Australoids), Caucasoids (Dravidians) who are inhabiting South of India and to some extent Central India, Caucasoids (mostly Aryans) in the North and Northwest India, Mongoloids in the Himalayan region, mostly in North East and East India and Negrito/Negroids in the Andaman Islands. Except for the Caucasoids, the other three groups mainly involve tribal populations and are numerically relatively smaller. The Caucasoids, Mongoloids and autochthonous elements have interbred in varying degrees to give mixtures which are difficult to unravel. The peoples are categorized into caste (on the basis of their traditional occupation, who are considered to have come in successive waves of immigration of known and sometimes unknown antiquity) and tribal (most of them are considered to be original inhabitants of India). The existence of caste and tribal systems made the Indian population genetically isolated. Indians speak different languages of various families—Austro-Asiatic, Tibeto-Chinese, Dravidian and Indo-European, which are represented within specific boundaries. In addition other factors that have influenced the distribution of biological traits in India are genetic drift, mutation and selection.

It is rather difficult to evaluate the effect of environmental factors on the somatometric traits as observed from the foregoing text. Generally in the Himalayan region, the populations are of lower medium stature, head and nose indices are mesocephalic and mesorhinae with leptoprosopic facial index, but the differences are observed between the peoples from Western and Central Himalayas and that of Eastern Himalayas, which are due to genetic composition *i.e.* different racial elements present among these populations (Table 5). Again from the Indus-Ganga-Brahmaputra plains region the differences are well marked between the population groups from the states of Punjab, Haryana, Uttar Pradesh (North India) and that of Bihar and West Bengal (East India) which are due to different racial elements present in these two regions. Further in latter two states, along with Orissa and Madhya Pradesh (peninsular region), the scheduled tribes are in majority and having Australoid (Pre-Dravidian) racial element show significant differences with the other ethnic groups who are predominantly Caucasoid (Aryan). Towards West of India also scheduled tribes who speak Indo-European languages show significant

Table 5: Classification of stature and indices

Particulars	*Stature*	*Cephalic Index*	*Nasal Index*	*Facial Index*
INDIA	L. Med. (163.06)	Meso (76.06)	Meso(78.53)	Meso (88.34)
Natrual Region				
Himalayan Mountain Complex	L. Med. (162.13)	Meso (76.38)	Meso (70.68)	Lepto (88.33)
Indus-Ganga-. Brahmaputra Plains	Med. (164.15)	Dolicho (75.87)	Meso (72.13)	Meso (87.00)
Peninsular Plateau	L. Med. (162.77)	Meso (76.07)	Meso (78.01)	Meso (85.64)
Islands	Short (155.50)	Meso (78.64)	Meso (79.98)	Meso (86.10)
Zones of India				
North India	Med. (164.70)	Dolicho (73.65)	Meso (70.13)	Lepto (88.33)
West India	L. Med. (163.09)	Meso (78.24)	Meso (75.86)	Meso (84.52)
East India	L. Med. (163.05)	Meso (76.82)	Meso (77.06)	Meso (86.27)
Central India	L. Med. (160.32)	Dolicho (74.96)	Meso (82.09)	Meso (87.45)
South India	L. Med. (161.23)	Meso (76.07)	Meso (77.99)	Meso (86.61)
Islands	Short (155.50)	Meso (78.64)	Meso (79.98)	Meso (86.60)
Regions of Himalaya				
Western Himalaya	L. Med. (163.38)	Dolicho (74.00)	Lepto (65.51)	Meso (89.92)
Central Himalaya	L. Med. (163.13)	Meso (76.71)	Meso (72.85)	Meso (87.71)
Eastern Himalaya	L. Med. (161.20)	Meso (78.09)	Meso (75.56)	Meso (85.47)
Ethnic Groups				
Caste	Med. (165.25)	Meso (76.20)	Meso (74.78)	Meso (86.45)
Scheduled Caste	L. Med. (162.11)	Dolicho (75.96)	Meso (75.61)	Meso (85.79)
Scheduled Tribe	Short (157.75)	Dolicho (75.81)	Meso (74.49)	Meso (86.26)
Community	Med. (164.18)	Meso (76.17)	Meso (71.57)	Meso (86.58)
Language Family				
Austro-Asiatic Family	Short (158.89)	Dolicho (75.63)	Meso (81.72)	Meso (85.68)
Tibeto-Chinese Family	L. Med. (161.37)	Meso (77.67)	Meso (73.87)	Meso (86.47)
Dravidian Family	L. Med. (161.34)	Dolicho (75.52)	Meso (77.55)	Meso (86.54)
Indo-European Family	Med. (164.52)	Dolicho (75.99)	Meso (74.23)	Meso (86.42)

L. = Lower, Med. = Medium

Table 6: Correlations with climatic factors and ethnic groups

Ethnic groups	*Somatometry*			
	Stature	*Cephalic Index*	*Nasa Index*	*Facial Index*
Mean Annual Temperature				
Caste	0.025	0.098	0.126^{1}	0.027
Scheduled Caste	-0.110	0.081_{3}	0.033_{3}	-0.007
Scheduled Tribe	-0.151^{2}	-0.209^{3}	0.267^{3}	-0.107_{3}
Community	0.002	0.084	0.205^{2}	-0.470^{3}
Total	0.068^{1}	0.027	0.082^{1}	-0.179^{3}
Mean Annual Rainfall				
Caste	0.023_{2}	-0.141^{1}_{2}	0.011	0.314^{3}_{2}
Scheduled Caste	-0.249^{2}	0.247^{2}	$-0.031_{.}$	0.400^{2}
Scheduled Tribe	-0.272^{3}	0.317^{3}	-0.157^{2}	$0.052_{.}$
Community	-0.187^{2}	0.078	0.016	0.189^{1}
Total	-0.331^{3}	0.055	0.126^{3}	0.176^{3}
Mean Annual Humidity				
Caste	-0.052_{2}	-0.028_{3}	0.088	0.190^{1}
Scheduled Caste	-0.253^{2}	0.321^{3}	$-0.025_{.}$	0.215
Scheduled Tribe	-0.308_{3}	0.252^{3}	-0.170^{2}	$-0.040_{.}$
Community	-0.206^{2}	0.156^{1}	0.129	0.261^{2}
Total	-0.296^{3}	0.125^{3}	0.093^{2}	0.103^{1}
Mean Altitude				
Caste	$-0.089_{.}$	0.065_{2}	-0.010	-0.169^{1}_{2}
Scheduled Caste	0.177^{1}	-0.236^{2}	0.174_{2}	-0.418^{2}
Scheduled Tribe	0.201^{3}	0.078	-0.173^{2}	$0.045_{.}$
Community	-0.068	-0.086	-0.021	0.192^{1}
Total	-0.047	-0.022	0.015	-0.004

1. Significant at $P < 0.05$ 2. Significant at $P < 0.01$ 3. Significant at $P < 0.001$

differences with other ethnic groups. As one moves towards South India, there are a number of scheduled tribes which are numerically smaller as compared to the tribes from the adjoining states of West India, Madhya Pradesh and Orissa. Though they speak Dravidian languages, they are showing significant differences from other ethnic groups of South India who are Caucasoids (Dravidian). It appears that they are basically Australoid (Pre-Dravidian) having some admixture with Caucasoid (Dravidians) and adopted their language. From Islands, Andaman is inhabited by Andamanese and Onges who are considered to be Negritos and Nicobarese and Shompens, who are having Mongoloid affinities. The differences which are observed among the various populations of India are due to different racial elements present among them and the division of the peoples into caste and tribal systems *i.e.* different ethnic groups. The differences are well marked between tribals and other populations whereas among caste, scheduled caste and community the differences are invariably in relation to their proximate category *e.g.* between castes and scheduled castes between communities and castes etc. This may be explained as caste system is based on traditional occupational groups and it has been observed that there is gene flow among them as the differences observed between various occupational groups are not high, whereas communities are those which are not identifiable on the basis of caste system or are not denoted as tribes and which are much more heterogeneous than either a caste group or a tribe. Further the differences observed between scheduled tribes and other ethnic groups can also be explained by the fact that they are the oldest inhabitants in their ecological niches as compared to other ethnic groups who have migrated to this area only a few thousand years back. The effect of different climatic factors (temperature, rainfall, humidity) and altitude on stature and different indices in relation to ethnic groups shows significant differences but correlations observed are not high.

The differences observed among Indian populations are mainly due to the presence of various racial elements and prevailing of ethnic groups among them. Differences due to climatic factors are observed but no association is established between biological traits and climatic factors since the values of correlations observed are not high.

3. GENETIC DISTANCES

For anthropometric measurement (stature) and indices the number of investigations is maximum from East India (about 45 per cent for Eastern Himalayan region) followed by North and South India.

The distribution of the available studies shows that about 30 per cent of the total reports are on scheduled tribes followed by castes, communities and scheduled castes. Again in all the zones of India, in general, more studies are available among scheduled tribes (around 35 per cent), followed by castes (about 26 per cent), communities and scheduled castes (about 13 per cent) except from North India where the distribution is high in castes, communities, scheduled castes followed by scheduled tribes. Further about 50 per cent of the caste groups studied from India belong to North India zone and scheduled tribes to East India zone.

In the language families—the maximum studies are from Indo-European family followed by Dravidian, Tibeto-Chinese and Austro-Asiatic families.

The dendrograms generated on the basis of anthropometric for various Indian populations subdivided by zones (North, West, East, Central and South India) are represented in figure 6. The trend observed in the dendrogram is that West,

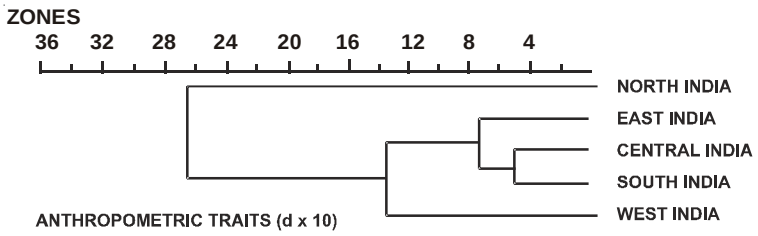

Fig. 6. Dendrograms of anthropometric traits according to different zones of India (after Bhasin and Walter 2001)

East, South and Central India together form one major cluster and separating out from them is North India. It is noted that from North India, maximum studies are available among castes and communities and it has been reported by Balakrishnan (1978) that considerable homogeneity has been demonstrated among populations of North-West India and it has been further pointed out by Balakrishnan (1981) that homogeneity is increased in certain regions by excluding the tribal populations.

Figure 7 shows dendrograms for various Indian populations based on social ranking. It is observed that caste group is invariably clustered with the scheduled caste and the community, while the scheduled tribe is distinct from all. An explanation of this phenomenon can be found in the fact that the scheduled castes may have in them a substantial contribution of gene flow from the higher castes in past generations (Majumdar, 1965). Since the communities are grouped on the basis of religion, occupation etc. they represent a fairly heterogeneous group. The distribution of major ethnic components may be present in the proportions similar to those observed in caste groups as the groups forming the communities in one way or the other are the offshoot of the major Indian ethnic stock (mainly the groups based on *Varna* system of Manu) at different periods of time in Indian history. The scheduled tribes, who represent mainly the Australoid (Pre-Dravidian), or Mongoloid strain, understandably are distinct from all the other groups subdivided by social ranking. Similar findings have also been reported by many other investigators (for example Balakrishnan 1978; Bhasin et al. 1986; Char et al. 1989; Chakraborty et al. 1986; Danker-Hopfe et al. 1988; Mukherjee et al. 1979, 1989; Roychoudhury 1984; Saha et al. 1976; Walter et al. 1993).

The dendrogram for different Indian populations subdivided by language families are presented in figure 8. As observed, from the dendrograms, the speakers of Tibeto-Chinese linguistic group show small differences with the Indo-European linguistic group and they are closer to Austro-Asiatic and Dravidian linguistic groups. From this dendrogram it is reasonable to believe that the current population of Indian Region is the product of differential admixture of Austro-Asiatic with Dravidian, Dravidian with Indo-Aryan and Tibeto-Chinese with Indo-European and also with Dravidian and Austro-Asiatic.

Clustering of the population groups of India subdivided by geographical proximity and social ranking on the basis of anthropometric distances is clearly seen in the dendrogram presented in figure 9.

It has been observed that except for North India, where all the four ethnic groups fall nearer to each other in social rank— caste, community or/and scheduled caste and scheduled tribe while for the rest of the zones it is generally observed that caste, scheduled caste and community groups are closer to each other, whereas scheduled tribe groups are nearer to one another. The ethnic groups of West India are closer to South India as observed before and scheduled tribes of East India and South India. Thus, overall the various ethnic groups of North India are showing less difference, different ethnic groups of West India and South India are falling nearer to each other and scheduled tribes of East India and South India are showing small distances and, in general, scheduled tribes are falling apart from the other ethnic groups.

In the dendrogram generated on the basis of anthropometric traits (Fig. 10) for Indian populations classified by language families and social-ranking it has been observed that Tibeto-Chinese join the main cluster which consists of Indo-European and Dravidian speaking people and Austro-Asiatic (Scheduled Tribe) make a cluster with Dravidian (Scheduled Tribe) and Indo-European (Scheduled Tribe). This is understandable, since as reported earlier the Tibeto-Chinese speakers are dominating Eastern Himalayan region in Eastern India and this zone is the meeting ground of three ethnic groups: people with Mongoloid elements from the Northeastern region, non-tribals of Caucasoid origin from Northwestern region and tribals from the Southern and Southwestern regions. Whereas Austro-Asiatic (Scheduled Tribe) make a cluster with Dravidian (Scheduled Tribe) and Indo-European (Scheduled Tribe) and these are showing small differences with the Tibeto-Chinese (Scheduled Tribe) speakers. It has already been established that Austro-Asiatic speaking tribals are predominating in Bihar, Orissa, as well as also in Central India, Assam and Nicobar Islands, and admixture has taken place among them and other linguistic groups—Dravidian, Indo-European and Tibeto-Chinese, as well as between these groups in varying degrees. The Indo-European and Dravidian speakers are showing small distances and it has been suggested that the Dravidians who entered

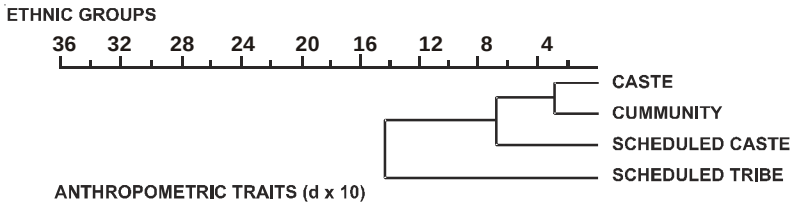

Fig. 7. Dendrograms of anthropometric traits according to different ethnic groups of India (after Bhasin and Walter 2001)

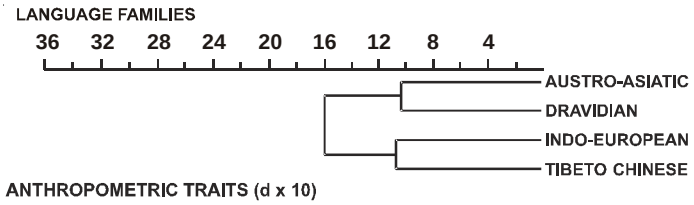

Fig. 8. Dendrograms of anthropometric traits according to different language families of India (after Bhasin and Walter 2001)

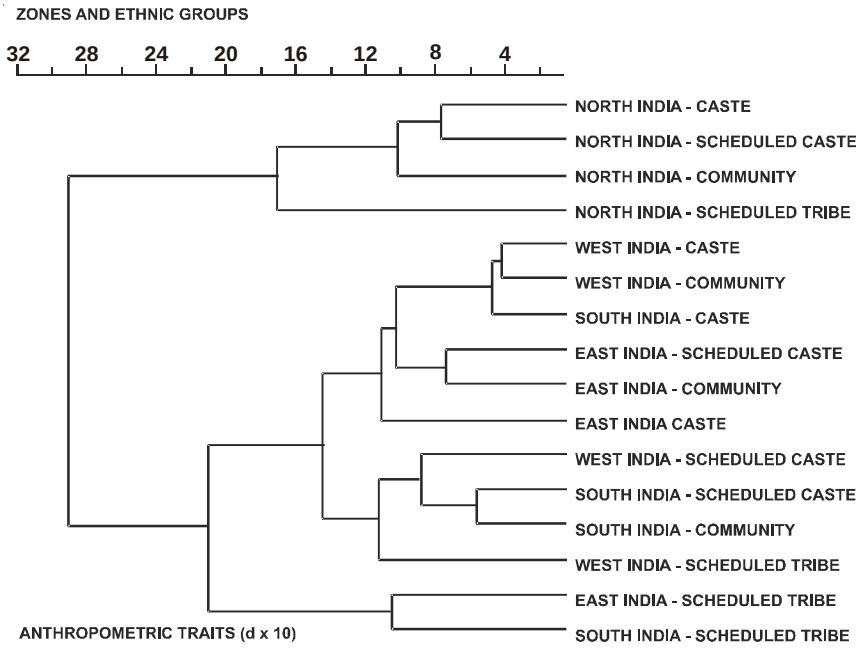

Fig. 9. Dendrogram of anthropometric traits according to different zones and ethnic groups of India (after Bhasin and Walter 2001)

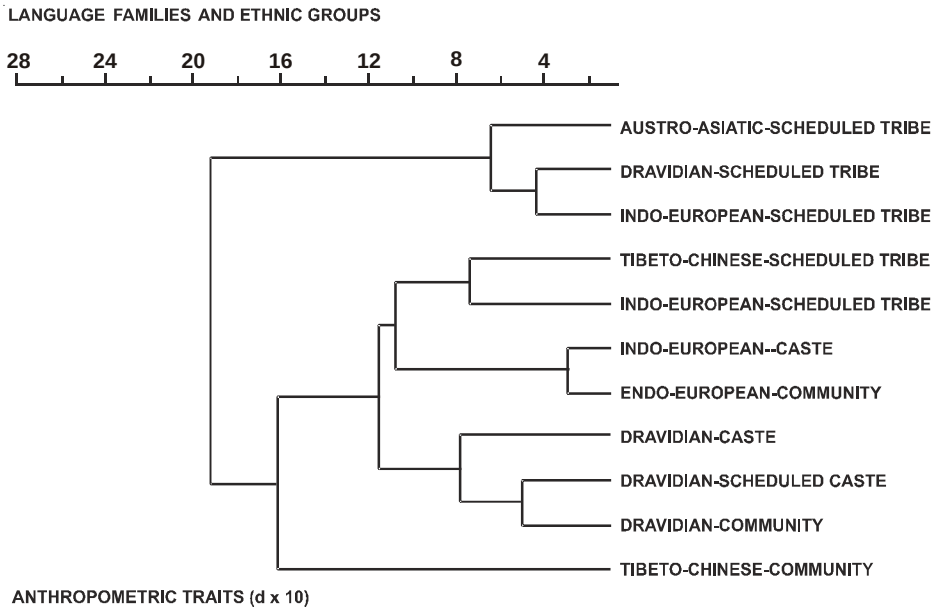

Fig. 10. Dendrogram of anthropometric traits according to different language families and ethnic groups of India (after Bhasin and Walter 2001)

Indian region early and moved southward with the arrival of Aryans have had admixture with them.

The above discussion was based on the dendrograms generated from different Indian populations subdivided by geographical regions, social status and linguistic division that have been considered separately as well as in combination *viz.*, geographical regions/zones with social ranks and social ranks with linguistic groups. From the dendrograms derived from various geographical regions/zones (North, West, East, Central and South India) it has been observed that there is a general tendency of correlation between morphological distance with geographic distance. The dendrograms based on social ranking and morphological traits show that the scheduled tribes are distant from all the other groups and caste group is invariably clustered with the scheduled caste and the community, which shows that scheduled caste population may have in them a substantial trace of gene flow from upper castes or/and from communities, who are grouped on the basis of religion, occupation, region, etc. Considering now India as a whole, the biological trait distribution is seen to follow a simpler pattern than that might have been expected from the complex history of its people. The scheduled tribe groups stand out as a uniform and unique population, showing less similarity with the neighbouring peoples and certainly much less when compared to the caste groups of India. From the dendrograms based on different linguistic groups, it has been observed that Austro-Asiatic, Dravidian and Indo-European linguistic categories form one cluster and Tibeto-Chinese category stand out separately. It may be concluded that the current population of India is the product of differential admixture between three distinct population entities *viz.*, Austro-Asiatic (Australoid or Pre-Dravidian), Dravidian and Indo-European (Caucasoid) linguistic groups, whereas the Tibeto-Chinese linguistic group along the northeastern and northern peripheries of the subcontinent is the product of admixture between Mongoloids and Australoid and Caucasoid populations in varying degrees.

The migration of early *Homo sapiens sapiens* from Africa to Asia and Pacific might be through Indian subcontinent. Modern humans are believ-

ed to have arisen in Africa and subsequently migrated to the rest of the world beginning around 100, 000 years ago. India may be in the path of this and subsequent migration events out of Africa and thus these migrants were the ancestors of the original inhabitants of Indian subcontinent (Mourant 1983; Cavalli-Sforza et al. 1994).

Descendants of Paleolithic expansion into India believed to have contributed substantially to tribal populations, which constitute 8.1 percent of the total population of India (Census of India, 1991).

Later migration events spread Austrics – Austro-Asiatic (may be either from Indo-China and South China or a very off-shoot of the Mediterranean people who came to India from the West even before the Dravidian), Dravidian, Tibeto-Chinese (the area of the speeches stretches from Baltistan in the West to the north eastern frontiers of the country and further reaching up to southern most portions of Assam) followed by Indo-European speakers in to the Indian subcontinent. The Indo-European speakers introduced the caste system, a social hierarchy that strictly governs marriage and mating practices. The later migrants i.e., Indo-European speakers of North India had less influence on Dravidian speakers of South India, therefore both the groups are genetically and linguistically distinct from each other (Bhasin et al., 1994; Bhasin and Walter 2001).

The genetic diversity of caste and tribal population groups is well established (Bhasin et al. 1994, Bhasin and Walter 2001; Cordaux et al. 2004).

NOTES

1. Three more states have come into existence recently. Now Bihar has been divided into Bihar and *Jharkhanda;* from Madhya Pradesh have resulted the states of Madhya Pradesh and *Chattisgarh;* the earlier state of Uttar Pradesh is now divided into Uttar Pradesh and *Uttaranchal*. The states in italics are newer ones. India at present comprises 28 states.
2. The frequency distributions for the State of Goa and Union Territory of Daman and Diu have been listed under Goa, Daman and Diu.

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