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Population genetic study in ten endogamous groups of West Bengal, India

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With 2 figures and 3 tables in the text

Summary: Ten endogamous population groups of West Bengal (India) – Rabhas, Garos, Mechs, Rajbanshis, Jalia Kaibartas, Bagdis, Lodhas, Mundas, Brahmins, Vaidyas – have been typed for twelve polymorphic systems: ABO, Gm, Km, Hp, Cp, Tf, Alb, Hb, aP, EsD, AK and PGM_1. The results are compared with those obtained on other Indian populations. Serological and anthropometric data, which have been included into population comparisons, reveal a considerable genetic variability of the groups under study. This variability is obviously connected with the population history of West Bengal.

Zusammenfassung: An zehn endogamen Bevölkerungsgruppen aus West Bengalen (Indien) – Rabhas, Garos, Mechs, Rajbanshis, Jalia Kaibartas, Bagdis, Lodhas, Mundas, Brahmins, Vaidyas – wurden zwölf polymorphe Systeme untersucht: ABO, Gm, Km, Hp, Cp, Tf, Alb, Hb, aP, EsD, AK and PGM_1. Die Ergebnisse wurden mit denen an anderen indischen Populationen gewonnenen verglichen. Serologische und vorliegende anthropometrische Daten lassen eine erhebliche genetische Variabilität zwischen den untersuchten Populationen erkennen, welche in engem Zusammenhang mit der Bevölkerungsgeschichte West-Bengalens steht.

Introduction

Studies of gene frequencies of a set of traits in populations may not be enough to explain the variation until it is known as to how far the division and sub-division of a population incurred as a result of the set of mating pattern of the castes and tribes, which may be responsible in the stratification of genes from one place to another. In India, the situation is quite complex because of the very old and unique institution of the caste system, as well the presence of a large number of tribal groups with a high degree of inbreeding. It is necessary to have some detailed ethnohistorical background of the populations for studying their racial affinities and diversities in the scale of human evolution.

The origin of caste system in India can be traced as far as in "Manus" code (Veda) and that was absolutely based on function and occupation. Since then each caste and sub-caste behave as an endogamous entity.

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Hutton (1946) writes that the evolution of caste systems in India owes to many factors such as 1. the geographical isolation, climate etc., 2. primitive beliefs, taboo, totem etc., 3. clash of antagonistic cultures, 4. clash of races and colour prejudice, 5. exclusive family and ancestor worship ideas, 6. idea of pollution, ablution, purification etc., 7. development of classes with exclusive religious and social privileges, 8. heredity occupation and hereditary guild, and 9. deliberate economic and administrative policies etc. In course of time there is "gradual" and "insensible" transformation of tribes into castes all over India (Risley 1891). There are about 39 000 caste groups all over in India having rigid social hierarchy (Malhotra 1984).

The tribes in India are basically autochthons holding a unique position in the world tribal map. There are about four hundred tribal groups in India ranging from very small (Todas, Totos, Andamanese, Dangas etc.) to very large (Santal, Gond, Bhil etc.) and their total number being more than 38 millions (Census 1971). According to their physical make up (morphological and somatoscopic profile) the tribes in India can be classified into three major racial types as Mongoloid, Pre-Dravidian (Proto-Australoid) and Dravidian (Mediterranean). In addition to it Negrito racial strains are supposed to be present in some south-western India groups. The Mongoloids are mainly present in the northern and north-eastern zone of the Himalayan range, valleys, and eastern frontiers, and they speak languages of the Tibeto-Chinese language family. The Pre-Dravidian and Dravidian racial stocks are mainly concentrated in the hills and plateaus of central India, in the Indo-Gangetic plains, in some parts of southern and northern India. Their languages belong to Austro-Asiatic, Dravidian and Indo-European language families. The south western Indian tribes having some Negrito features speak in Dravidian language. In addition to all these, there are a number of Island dweller tribal groups in Andaman, Nicobar, Laccadev etc. (Roy et al. 1982).

The tribes are at various stages of developments with very primitive technologies to advanced ones. Some are still food gatherers and hunters, whereas others are pastorals or even settled. The tribes differ not only in respect to physical characters, but also regarding language, economy, socioculture and religious way of life. Rigid endogamy is practised by every tribe following clan exogamy. Migration and mobility amongst the tribes are very common since the time immemorial.

A series of anthropological investigations based on anthropometry and somatoscopy have clearly demonstrated the existence of a considerable amount of the Mongoloid element in some population groups of Bengal in addition to Dravidian and Caucasoid elements, which are corroborated by the ethnohistory of the populations. However, the extent of such admixture is as yet not known in quantitative terms. Serological and biochemical markers have great potentiality in studying the population variation as well as in estimating the extent of ethnic admixture in populations. In Bengali populations scanty informations are available as regards the distributions of red cell antigens, isozymes and serum proteins. In view of the above account an urgent need was felt to undertake a study among some well defined endogamous population groups of West Bengal with the following objectives: 1. to examine the nature of distribution of various serological and biochemical markers, which will be followed by inter-group analysis and comparison, 2. to study the intra- and inter-group diversity amongst the population groups using distance analysis technique, and 3. to estimate quantitatively the Mongoloid admixture in the populations studied.

The design of the survey was as follows: with the above purpose ten endogamous groups from W. Bengal were studied and the selection of the groups was made on the basis of 1. the groups, who are well defined endogamous, 2. at least one group from each of the social strata representing high caste, scheduled caste and tribes, and 3. that the populations are selected in such a way that areas with low and high probability of Mongoloid admixture are represented. Accordingly, four groups were chosen from north Bengal, where probability of Mongoloid admixture was high and three each from south west and south east zone of W. Bengal. The populations of these areas are likely to show low rates of Mongoloid admixture.

This study was a collaborative one between the Anthropometry and Human Genetics Unit, Indian Statistical Institute, Calcutta, and the Department of Human Biology/Physical Anthropology, University of Bremen, Bremen, W. Germany. Some more statistical analyses were done in collaboration with the Center of Demography and Population Genetics, The University of Texas, Houston, USA. The results of these studies have been published elsewhere (Chakraborty et al. 1986).

Racial components in Bengal

The racial composition of Bengal appears to be quite complex by inflow of a lot of racial elements from *Caucasoids, Proto-Australoids*, and *Mongoloids* in the long passage of the history of India, including West Bengal. Risley in his "The People of India" (1908) described seven physical types of Indian populations: 1. Turko-Iranian, 2. Indo-Aryan, 3. Scytho-Dravidian, 4. Aryo-Dravidian, 5. Mongolo-Dravidian, 6. Mongoloid, 7. Dravidian. According to Risley (1908) the castes of lower Bengal, mainly the Brahmin, Kayastha etc. belong to the Mongolo-Dravidian type. Probably, a blend of Dravidian and Mongoloid elements with a strain of Indo-Aryan blood exist in higher groups. Their head is broad, the complexion is dark, face hair is plentiful, the stature is medium as well as the nose, however, with a tendency to broad. In the upper Bengal and Himalayan region the Mongoloid type is found, including Gurung of Nepal, Bodo of Assam etc. They have a broad head, a dark complexion with yellowish tinge, scanty face hair, small stature or below average, fine to broad nose, a characteristic flat face with often oblique eye lid. The Dravidian type is found in some tribes like Santal, Munda etc. of south Bengal, who are originally from the Chota Nagpur region. Their stature is quite short. Other characteristic traits are: very dark complexion, plentiful hair on face with occasional tendency to curl, dark eyes, long heads and broad noses. The few available anthropometric measurements of the population groups under study are given in Table 1.

Materials and methods

In this paper the distribution of the red cell antigens, isozymes and serum proteins in ten endogamous groups is presented with their ethno-history and anthropometric characteristics. The distribution of the populations groups with their social status and the sample size studied is given in Table 2. Figs. 1 and 2 show the geographical locations of the distribution of the samples. A total of 1000 blood samples was collected from ten population groups as follows: Rajbanshis (115), Rabhas (114), Garos (97) from the Cooch Behar district; Mechs (96) from the Jalpaiguri

Table 1. Anthropometric profile of ten endogamous populations of West Bengal and Assam (males only).

Population	n	Stature (mm)	Cephalic Index	Nasal Index	Facial Index	References
Brahmins	220	1638.56 ±7.14	78.30 ±0.37	69.44 ±0.61	–	Majumdar & Rao (1960)
Vaidhyas	100	1661.70 ±3.21	79.84 ±0.20	70.76 ±0.44	–	Roy Choudhury (1952)
Bagdis	100	1585.80 ±4.30	77.07 ±0.22	76.55 ±0.44	–	Roy Choudhury (1952)
Kaibartas	130	1610.23 –	76.78 –	71.11 –	–	Majumdar & Rao (1960)
Rajbanshis	100	1603.30 ±3.60	75.78 ±0.20	72.36 ±0.48	85.33 ±0.34	Roy (1946)
Rabhas (Assam)	100	1624.50 ±5.00	76.31 ±0.31	78.85 ±0.73	84.54 ±0.46	Das (1956)
Garos	72	1586.53 ±6.59	76.40 ±0.43	79.86 ±0.82	–	Majumdar & Rao (1960)
Mechs (Assam)	10	1643.00 –	79.40 –	90.60 –	–	Waddell (1900)
Mundas (Bihar)	250	1581.52 ±2.04	74.34 ±0.14	83.29 ±0.30	84.90 ±0.19	Basu (1932–33)
Lodhas	200	1591.30 ±4.40	76.06 ±0.28	85.50 ±0.56	82.98 ±0.37	Bhowmick (1956)

district; Rarhi Brahmins (100), Vaidyas (103) and Jalia Kaibartas (101) from the 24-Parganas district and Calcutta; Bagdis (100), Lodhas (74) and Mundas (100) from the Midnapore district. Cooch Behar and Jalpaiguri districts lie in the northern end of West Bengal, in the Tarai region of Himalaya, while 24-Parganas and Midnapore districts are in the southern part of West Bengal in the coastal region. The distance between these two zones is about 500 km. The blood samples were collected in the field, kept in a fridge and dispatched to the Human Genetics Laboratory, Indian Statistical Institute, Calcutta, where the analysis of the blood for the following markers were performed: ABO system by tube technique; Gamma globulin grouping (Gm and Km) using anti-Gm(1), -Gm(2), -Gm(5) and anti Km(1) sera, from Ortho Diagnostics (Heidelberg) and Behringwerke (Marburg/L.); Haptoglobin (Hp), Transferrin (Tf), Ceruloplasmin (Cp), and Albumin (Alb) by horizontal starch gel electrophoresis, according to Ashton & Braden (1961); red cell enzyme systems: acid phosphatase (aP), adenylate kinase (AK), and esterase D (EsD) by starch gel electrophoresis following the methods described by Harris & Hopkinson (1977). The haemoglobins were screened at B. J. Medical College Pune by Kate et al. (1984). The test for PGM_1 for Rabhas and Rajbanshis was performed by starch gel electrophoresis according to Harris & Hopkinson (1977), and the rest of the samples was analysed by isoelectric-focusing in polyacrylamide gel according to Mukherjee et al. (1982).

Ethno-historical notes of the populations

Rabhas: The Rabhas are mostly concentrated in two districts of north Bengal: Jalpaiguri and Cooch Behar. They are a very small tribe. There are various views about the origin of the Rabhas. Some believe that the Rabhas are the descendants of a Hindu father, who lost his caste identity by marrying a Kachari woman. According to Das & Raha (1967) the Rabhas of north Bengal mostly belong to the Koch Rabha group and few to Pati Rabhas – two distinct sub-classes of Rabhas. Dalton (1872) stated that the Rabhas are the offshoot of the Kachari race and are connected with the Garos. Risley (1908) treated them as a branch of the Bodo group of Assam.

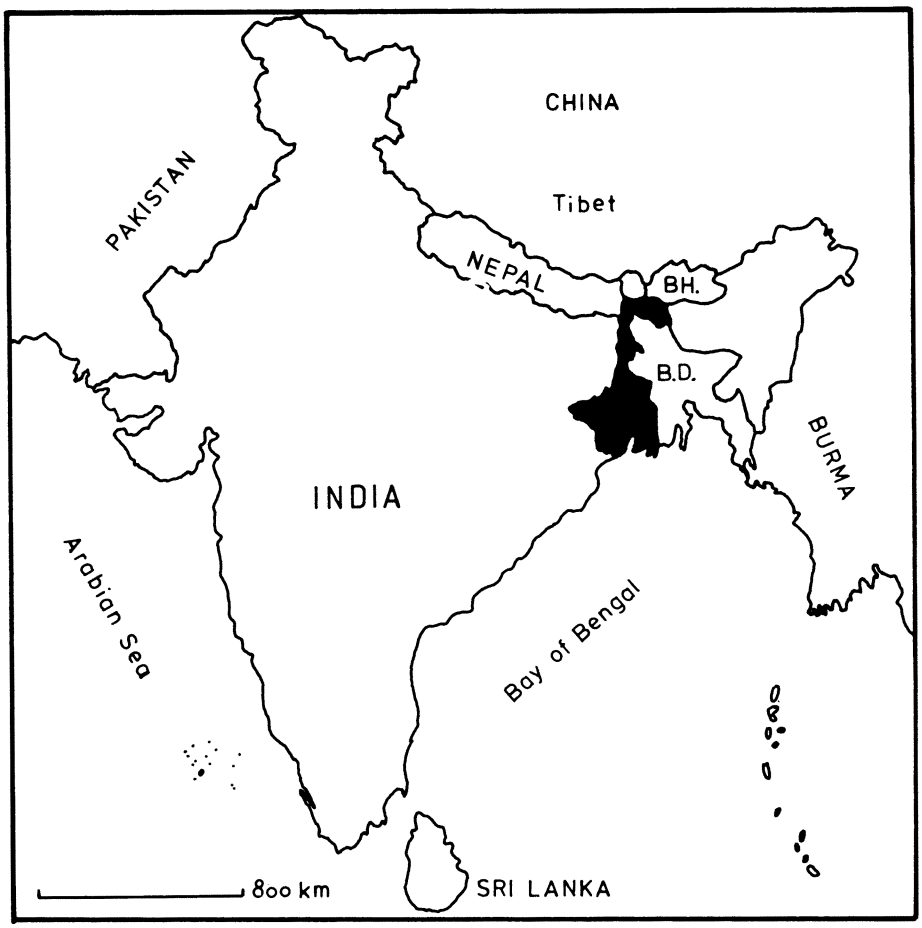

Fig. 1. Location of West Bengal (black). B. H. = Bhutan, B. D. = Bangla Desh.

They are also a migratory group in Bengal in recent past. The Rabhas are now mostly settled agriculturist. Rabhas living in the forest areas practise Animism, while those who live in the villages mostly profess Hinduism. The Rabhas also exhibit some Mongoloid features. Most of the Rabhas speak in Bengali, though some also adhere to their own language, which as striking resemblance with the *Atong* dialect of the Garo language and also with the Bodo language.

Garos: This is a small migrating tribe from Assam to north Bengal in recent period, mostly settled in the Cooch Behar district. It is believed that they are originally migratory from Tibet and the present-day Garos are a result of admixture of Tibetans with Hindus. They are mostly agriculturists. A section of them profess Hinduism, and the rest Christianiy. They are bilingual in West Bengal, can speak in both Bengali and Garo dialects, which belong to the Bodo group of the Tibeto-Chinese language family.

Mechs: The Mechs are a small tribe mostly living in the sub-hilly regions of Jalpaiguri and Cooch Behar districts of the northern part of West Bengal. Most of the scholars consider that the Mechs and the Kacharis of Assam have a common origin. Some believe that the Mechs are of some Nepali origin. However, the Mechs show some distinct features of Mongoloid racial characters. Earlier they were mostly engaged in shifting cultivation and now, in addition, they do

Table 2. Districtwise distribution of the ten endogamous groups under study (HC = High Caste, SC = Scheduled Caste, T = Tribe).

Population	Caste/ tribe	n	Place	District	Total no. in the district	Total no. in West Bengal	% of total no. in West Bengal
Rarhi Brahmins	HC	100	Barasat, Sodepur, Madhyam Gram	24-Parganas	–	–	–
Vaidhyas	HC	103	Barasat, Madhyam Gram, Baranagar	24-Parganas	–	–	–
Bagdis	SC	100	Makrampur, Hirapur, Chaturi Bhara, Narayangarh, Middapara, Bidisa, Pakursani	Midnapore	119187	1096885	15.92
Jalia Kaibartas	SC	101	Dum Dum, Beliaghata, Bowbasar	Calcutta	5561	117384	1.70
Rajbanshis	SC	115	Putimari, Dinhata, Cooch Behar Town	Cooch Behar	418893	1201717	17.45
Rabhas	T	114	Chhatrampur, Barasal Bari, Taliguri, Tufangung Town	Cooch Behar	1608	6053	0.29
Garos	T	97	Garopara, Baro Atlabari, Phalkata	Cooch Behar	1279	2535	0.12
Mechs	T	96	Mahakalguri, Nawabgung	Jalpaiguri	153	13915	1.37
Mundas	T	100	Belda, Doharpur, Makrampur, Hirapur, Kataighora, Bidisa	Midnapore	16960	160245	7.80
Lodhas	T	74	Kuki, Shaldanga, Bidisa, Markunda, Belda, Narayan, Garh, Birkanda	Midnapore	11205	40898	1.99

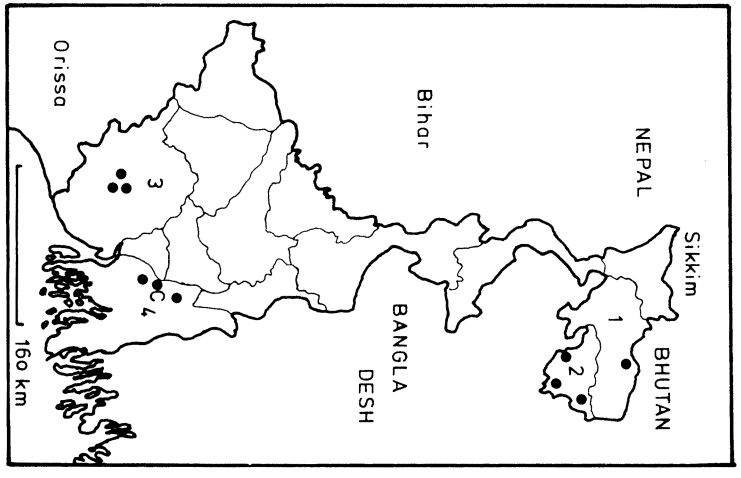

Fig. 2. Map of West Bengal showing the sample locations (black dots). 1 = Jalpaiguri, 2 = Cooch Behar, 3 = Midnapore, 4 = 24-Parganas, C = Calcutta.

spinning, weaving, fishing etc. Regarding the religion the Mechs mainly follow their own tribal deity "Bathos"; some practise Hinduism. The Mechs are generally bilingual. They have their own dialect, which belongs to the Tibeto-Chinese family, and which is akin to that of the Kacharis of Assam. They speak Bengali quite well.

Rajbanshis: The Rajbanshis constitute the largest scheduled caste community in West Bengal (about 17.45 % of total scheduled caste in the state), and are mostly concentrated in Cooch Behar, Jalpaiguri, West Dinajpur and 24-Parganas. According to Risley (1891) the Rajbanshis have affiliation with the tribal groups, and possibly they are a converted Koch tribe in contemporary period. He observed that Rajbanshis, Kochs and Poliyas have the same origin and are possibly from the Dravidian stock with suspected admixture of Mongoloid blood. Apparently the Rajbanshis exhibit some Mongoloid physical features. According to some reports the Rajbanshis of southern Bengal (24-Parganas) are known as Tiyars or Keyots. Rajbanshis are mainly agriculturists, though fishing is also practised by them. In the caste hierarchy their position is somewhat low, but they have improved their position in recent period. They are Hindus by religion and their mother tongue is Bengali. They do not follow any consanguinity.

Jalia Kaibartas: This is a scheduled caste community, a sub-caste of the Kaibarta caste, distributed widely throughout West Bengal. It is believed that being a fishing caste they are one of the earliest inhabitants of Bengal. Risley (1891) stated: "The nucleus of the group was probably Dravidian but that their original caste of feature may have been to some extent refined by a slight infusion of Aryan blood". They are Hindus by religion and speak in Bengali language. In the social hierarchy they occupy a low position. Consanguinity practice is not allowed.

Bagdis: Bagdis are one of the major scheduled castes of West Bengal, they are widely distributed throughout all the districts of the state except in north Bengal, where their concentration is small. There are many views about the origin of Bagdis. They claim themselves as *Byagraksatriyas* and according to *Brahmavaivatar Purana, Bagatita* is the offspring of *Kshatriya* father and *Vaisya* mother. According to Dalton (1872) the Bagdis are the remnants of an aboriginal race, who by intermarrying with the low caste Hindus drove away from the tribal way of life and became fishermen and Palki bearer. The Bagdis are divided into several subcastes such as Tentulias, Dules, Matias etc. Risley (1908) described them as a cultivating, fishing and menial caste. Their religion is a mixture of Hinduism and nature worship. Their mother tongue is Bengali. They hold a very low rank in the caste hierarchy. Cross cousin or uncle nice marriage is prohibited.

Lodhas: The Lodhas are a small tribal group mostly found in the Midnapore district, but also in the Hooghly district. Some consider that they are also early migratory to West Bengal from Madhya Pradesh (Central province). Risley (1908) considered them as allied to the "Savar" tribe of Mayurbhanja of Orissa. The Lodhas also prefer to declare themselves as "Savar", which is mentioned (Savari) in the legend of *Ramayana.* Till now the Lodhas adhere to their traditional occupation of collection of jungle produce, though some are getting engaged in agriculture and daily labour. Lodhas look upon themselves as Hindus of low rank. They are divided in nine exogamous clans based on totems. They speak a corrupt form of Bengali with some amount of Oriya influence. Practice of consanguinity is unknown to them.

Mundas: The Mundas of West Bengal comprises about 7.80 % of the total tribal population of the state and are mainly concentrated in the districts of Burdwan, Midnapore, Purulia, 24-Parganas, West Dinajpur and Darjeeling. The name "Munda" is probably of Sanskrit origin. The Mundas an early settlers in eastern India, and a large Dravidian tribe of Chota Nagpur hills and plateau area (Ranchi, Singbhum and Manbhum districts of Bihar). They are classed as Kolarian on linguistic grounds and close to the Hos and Santals and to some extent with the Kandhs. In West Bengal the Mundas are a migratory group engaged in agriculture, and a large number of them is employed as plantation labourers in tea gardens. The Munda speak in their "Mundari" mother tongue, and many of them also speak both in Mundari and Bengali. In the plantation area some speak in *Sadri* language. They are basically animists and their diety is well known as *Sing Bonga*, which means sun. The Mundas are divided into 13 endogamous groups, which are again sub-divided into a number of clans based on distinct totems. Generally, practice of consanguinity is not allowed.

Brahmins: In the Indian caste hierarchy the Brahmins stand at the top, which is also true in Bengal. In the *Rigveda* the *Brahamana* is a priest pure and simple living on the good grace of princly petrons, and they were used to be considered as demigod, at least akin of the Gods. In India the Brahmin caste was commonly divided into ten large classes according to their locality: five on the north and five on the south of Vindhya range (Central India). Bengal Brahmins mainly

belong to the "Gaur" class of the above divisions, which are again divided into five main sub-castes as Rarhi, Barendra, Vaidik, Saptasati and Madhyasrini.

The Rarhi Brahmins derive their name from Rarh, the high-lying alluvial tract on the west bank of the river Ganges. They claim to be of comparatively pure Aryan descent. According to history, Adsura, the then king of Bengal in the eleventh century A. D., imported five Brahmins with their wives from Kanauj to perform certain *Vaidic* ceremonies about which the existing Brahmins were ignorant. The descendents of these five Brahmins constitute the Rarhi sect. On the other hand, these Brahmins contracted second and more marriages with the local women of Bengal and their children were the ancestors of Brendra Brahmins. The Brahmins males were polygamous, though certain restriction of selection of their partners were imposed by the "Kulin" system introduced by Ballal Sen, the king of Bengal in the middle of eleventh century. Practice of consanguinity is strictly forbidden amongst the Brahmins. Their mother tongue is Bengali. Though in early periods the Brahmins were engaged exclusively in priestly services and teaching, the present-day Brahmins are mostly doing white colour jobs. Inter-subcaste marriage is not objected amongst the Rarhi Brahmins nowadays, and inter-caste marriage is also not uncommon.

Vaidyas: The Vaidyas are a typical caste found only in Bengal, occupying a high rank in the society. Regarding their orign their are several opinions, but there are no authentic records of Vaidyas as a caste. Some people think that they are an offshoot of the Brahmins who intermarried with other castes like Vaisyas, Sudras etc., assumed the occupation of physicians and in course of time emerged as a caste. They claim themselves as a purely Aryan descent. There is a long standing belief that since the 16^{th} century the Vaidyas are *Ambasthas*, who happened to be a powerful tribe of northern India in ancient times. It is difficult to distinguish the Vaidyas physically from the other high castes. The Vaidya's mother tongue is Bengali. They are mostly engaged in white colour jobs at present. The Vaidyas are divided into four sub-castes as Rarhi, Banga, Barendra and Panchakati according to the areas of Bengal, in which their ancestors resided, like the distribution of Brahmins.

Results and discussion

The results of the phenotypic distribution with the Hardy-Weinberg Chisquare values of the markers studied are given in Table 3. The corresponding gene frequencies and the S. E. have also been tabulated in Table 3. The Hardy-Weinberg test shows complete consistency in respect to all the markers for all the population groups, except for ABO system in Jalia Kaibartas and EsD and PGM_1 in Mundas, where the Chi-square values show significant differences.

ABO system: From the pattern of the ABO distribution it appears that the highest B phenotype (41.24 %) and gene (0.255) frequencies are in the Garos, which show similarity (40.85 %) to that of earlier findings of Mazumdar (1950) – cited in Bhalla (1966) –, while the lowest B phenotype frequency (21.93 %) is found in the Rabhas. Both of them have Mongoloid physical features. The Rabhas also show the highest A phenotype (35.97 %) and gene (0.256) frequency, which appears to be in consistence with the general trend of higher A phenotype and gene frequencies in the Mongoloids of the N. E. region of India (Sarkar 1954). The Mechs, another Mongoloid tribe, on the contrary show a low A phenotype (17.71 %) and gene frequency (0.116) like the Garos, but the highest O phenotype (52.08 %) and gene (0.720) frequencies. Both Garos and Mechs seem to be quite closer in respect to the ABO system, and the position of Rajbanshis is somewhat inbetween Rabhas and Garos. The two high caste groups – Rarhi Brahmins and Vaidyas – show a very close picture regarding the ABO system, which is comparable with the earlier findings of Choudhuri et al. (1969). Generally in the caste population of West Bengal the B group tends to be more frequent, which is also reflected here (about 30 % in Jalia Kaibartas to 38 % in Vaidyas). The Lodhas and Mundas of the southern part of the

Table 3. Phenotype and gene frequencies of the ten endogamous groups under study.

System	Rarhi Brahmins		Vaidhyas		Bagdis		Jalia Kaibartas		Rajbanshis		Rabhas		Garos		Mechs		Mundas		Lodhas	
	obs.	exp.	obs.	exp.	obs.	exp.	obs.	exp.	obs.	exp.	obs.	exp.	obs.	exp.	obs.	exp.	obs.	exp.	obs.	exp.
ABO																				
A	28	28.0	28	26.4	30	29.6	22	27.0	29	28.3	41	41.2	14	12.5	17	17.3	33	32.0	24	24.7
B	33	33.0	39	37.5	35	34.6	30	34.8	28	27.3	25	25.2	40	38.6	25	25.3	30	29.0	23	23.7
AB	11	11.0	10	11.9	14	14.4	17	11.2	5	5.8	10	9.8	3	4.6	4	3.7	10	11.2	13	12.1
O	28	28.0	26	27.3	21	21.4	32	28.0	53	53.6	38	37.8	40	41.3	50	49.7	27	27.8	14	13.5
	100	100.0	103	103.1	100	100.0	101	101.0	115	115.0	114	114.0	97	97.0	96	96.0	100	100.0	74	74.0
p^A	0.219 ± 0.031		0.207 ± 0.030		0.252 ± 0.033		0.212 ± 0.030		0.161 ± 0.025		0.256 ± 0.031		0.092 ± 0.021		0.116 ± 0.024		0.246 ± 0.033		0.291 ± 0.041	
q^B	0.252 ± 0.033		0.278 ± 0.034		0.287 ± 0.035		0.262 ± 0.033		0.156 ± 0.025		0.167 ± 0.026		0.255 ± 0.034		0.164 ± 0.028		0.227 ± 0.032		0.282 ± 0.032	
r^O	0.529 ± 0.039		0.515 ± 0.039		0.461 ± 0.040		0.526 ± 0.039		0.683 ± 0.032		0.577 ± 0.036		0.652 ± 0.037		0.720 ± 0.034		0.527 ± 0.039		0.427 ± 0.047	
	1.000		1.000		1.000		1.000		1.000		1.000		1.000		1.000		1.000		1.000	
χ^2	0.000		0.517		0.026		5.176[x]		0.149		0.007		0.805		0.043		0.205		0.118	
Haemoglobin																				
AA	39	39.0	27	27.0	161	161.1	84	84.1	50	50.7	79	79.3	19	19.0	17	17.8	153	153.1	178	178.5
AE	3	2.9	2	1.9	9	8.8	5	4.8	13	11.7	11	10.3	2	1.9	9	7.4	8	7.8	19	18.0
EE	0	0.1	0	0.1	0	0.1	0	0.1	0	0.6	0	0.3	0	0.1	0	0.8	0	0.1	0	0.5
	42	42.0	29	29.0	170	170.0	89	89.0	63	63.0	90	89.9	21	21.0	26	26.0	161	161.0	197	197.0
Hb^A	0.964 ± 0.020		0.966 ± 0.023		0.974 ± 0.009		0.972 ± 0.012		0.897 ± 0.025		0.939 ± 0.017		0.952 ± 0.032		0.827 ± 0.048		0.975 ± 0.008		0.952 ± 0.010	
Hb^E	0.036 ± 0.020		0.034 ± 0.023		0.026 ± 0.009		0.028 ± 0.012		0.103 ± 0.025		0.061 ± 0.017		0.048 ± 0.032		0.173 ± 0.048		0.025 ± 0.008		0.048 ± 0.010	
	1.000		1.000		1.000		1.000		1.000		1.000		1.000		1.000		1.000		1.000	
χ^2	0.058		0.037		0.126		0.074		0.834		0.382		0.053		1.139		0.105		0.506	
Haptoglobin																				
1	2	3.4	0	1.4	3	2.1	3	2.4	0	1.3	1	3.3	0	2.3	0	0.9	1	1.5	3	2.9
2-1	31	28.2	23	20.2	23	24.8	24	25.3	10	7.5	33	28.5	26	21.3	12	10.1	22	21.0	26	26.1
2	57	58.4	73	74.4	73	72.1	68	67.4	10	11.2	60	62.3	46	48.3	26	26.9	74	74.5	58	57.9
0	0	0.0	2	2.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
	90	90.0	98	98.0	99	99.0	95	95.0	20	20.0	94	94.1	72	71.9	38	37.9	97	97.0	87	86.9
Hp^1	0.194 ± 0.029		0.119 ± 0.023		0.147 ± 0.025		0.158 ± 0.026		0.250 ± 0.068		0.186 ± 0.028		0.181 ± 0.032		0.158 ± 0.042		0.124 ± 0.024		0.184 ± 0.029	
Hp^2	0.806 ± 0.029		0.870 ± 0.024		0.853 ± 0.025		0.842 ± 0.026		0.750 ± 0.068		0.814 ± 0.028		0.819 ± 0.032		0.842 ± 0.042		0.876 ± 0.024		0.816 ± 0.029	
Hp^0	0.000		0.011 ± 0.001		0.000		0.000		0.000		0.000		0.000		0.000		0.000		0.000	
	1.000		1.000		1.000		1.000		1.000		1.000		1.000		1.000		1.000		1.000	
χ^2	0.891		1.778		0.496		0.238		2.222		2.363		3.496		1.336		0.206		0.002	

Table 3 continued: Part 1

System	Rarhi Brahmins		Vaidhyas		Bagdis		Jalia Kaibartas		Rajbanshis		Rabhas		Garos		Mechs		Mundas		Lodhas	
	obs.	exp.	obs.	exp.	obs.	exp.	obs.	exp.	obs.	exp.	obs.	exp.	obs.	exp.	obs.	exp.	obs.	exp.	obs.	exp.
Transferrin																				
C	97		48		96		93		14		109		99		86		98		87	
CD	1		0		1		0		0		0		0		0		0		0	
CB	0		0		1		0		0		0		0		1		0		0	
Var.	0		0		3		0		0		0		0		0		0		0	
	98		48		101		93		14		109		99		87		98		87	
Tf^C	0.995 ± 0.005		1.000		0.975 ± 0.011		1.000		1.000		1.000		1.000		0.994 ± 0.006		1.000		1.000	
Tf^D	0.005 ± 0.005		0.000		0.005 ± 0.003		0.000		0.000		0.000		0.000		0.000		0.000		0.000	
Tf^B	0.000		0.000		0.005 ± 0.003		0.000		0.000		0.000		0.000		0.006 ± 0.006		0.000		0.000	
Tf^{var}	0.000		0.000		0.015 ± 0.006		0.000		0.000		0.000		0.000		0.000		0.000		0.000	
	1.000		1.000		1.000		1.000		1.000		1.000		1.000		1.000		1.000		1.000	
Ceruloplasmin																				
B	98		51		100		–		57		93		98		86		50		87	
AB	0		0		0		–		0		0		0		1		1		0	
Var.	0		0		0		–		–		0		1		0		0		0	
	98		51		100		–		57		93		99		87		51		87	
Cp^B	1.000		1.000		1.000		–		1.000		1.000		0.995 ± 0.005		0.995 ± 0.006		0.990 ± 0.010		1.000	
Cp^A	0.000		0.000		0.000		–		0.000		0.000		0.000		0.005 ± 0.006		0.010 ± 0.010		0.000	
Cp^{var}	0.000		0.000		0.000		–		0.000		0.000		0.005 ± 0.005		0.000		0.000		0.000	
	1.000		1.000		1.000		–		1.000		1.000		1.000		1.000		1.000		1.000	
aP																				
A	11	8.5	4	4.8	6	5.1	7	7.0	8	5.7	10	11.3	6	4.4	6	5.4	4	4.0	4	3.1
AB	36	41.0	36	34.3	35	36.8	39	39.0	34	38.6	51	48.5	23	26.3	28	29.2	32	32.0	30	31.8
B	52	49.5	60	60.8	67	66.1	54	54.0	68	65.7	51	52.2	41	39.4	40	39.4	64	64.0	83	82.1
	99	99.0	100	99.9	108	108.0	100	100.0	110	110.0	112	112.0	70	70.1	74	74.0	100	100.0	117	117.0
p^a	0.293 ± 0.028		0.220 ± 0.026		0.218 ± 0.025		0.265 ± 0.028		0.227 ± 0.025		0.317 ± 0.027		0.250 ± 0.032		0.270 ± 0.032		0.200 ± 0.025		0.162 ± 0.022	
p^b	0.707 ± 0.028		0.780 ± 0.026		0.782 ± 0.025		0.735 ± 0.028		0.773 ± 0.025		0.683 ± 0.027		0.750 ± 0.032		0.730 ± 0.032		0.800 ± 0.025		0.838 ± 0.022	
	1.000		1.000		1.000		1.000		1.000		1.000		1.000		1.000		1.000		1.000	
χ^2	1.478		0.240		0.251		0.000		1.584		0.299		1.073		0.123		0.000		0.386	

Table 3 continued: Part 2

System	Rarhi Brahmins		Vaidhyas		Bagdis		Jalia Kaibartas		Rajbanshis		Rabhas		Garos		Mechs		Mundas		Lodhas	
	obs.	exp.	obs.	exp.	obs.	exp.	obs.	exp.	obs.	exp.	obs.	exp.	obs.	exp.	obs.	exp.	obs.	exp.	obs.	exp.
PGM (1)																				
1	44	43.5	15	16.2	90	88.4	66	65.9	51	49.0	69	68.5	50	47.3	44	42.9	52	46.9	55	53.2
2-1	8	9.1	11	8.7	26	29.2	22	22.2	33	37.0	38	38.9	34	39.4	39	41.2	33	43.2	45	48.7
2	1	0.5	0	1.2	4	2.4	2	1.9	9	7.0	6	5.5	11	8.3	11	9.9	15	9.9	13	11.2
	53	53.1	26	26.1	120	120.0	90	90.0	93	93.0	113	112.9	95	95.0	94	94.0	100	100.0	113	113.1
PGM^1	0.906 ± 0.027		0.789 ± 0.051		0.858 ± 0.023		0.856 ± 0.024		0.726 ± 0.029		0.779 ± 0.025		0.705 ± 0.029		0.676 ± 0.030		0.685 ± 0.029		0.686 ± 0.027	
PGM^2	0.094 ± 0.027		0.211 ± 0.051		0.142 ± 0.023		0.144 ± 0.024		0.274 ± 0.029		0.221 ± 0.025		0.295 ± 0.029		0.324 ± 0.030		0.315 ± 0.029		0.314 ± 0.027	
	1.000		1.000		1.000		1.000		1.000		1.000		1.000		1.000		1.000		1.000	
χ^2	0.721		1.872		1.428		0.071		1.095		0.066		1.839		0.270		5.538[x]		0.651	
AK																				
1	90	90.1	75	74.5	82	82.7	87	86.5	91	91.0	94	94.1	38	38.0	52	52.0	87	87.4	97	97.0
2-1	4	3.9	11	12.0	17	15.6	13	13.9	2	2.0	5	4.9	0	0.0	1	1.0	13	12.2	4	3.6
2	0	0.0	1	0.5	0	0.7	1	0.6	0	0.0	0	0.0	0	0.0	0	0.0	0	0.4	0	0.4
	94	94.0	87	87.0	99	99.0	101	101.0	93	93.0	99	99.0	38	38.0	53	53.0	100	100.0	101	101.0
AK^1	0.979 ± 0.009		0.925 ± 0.018		0.914 ± 0.018		0.926 ± 0.017		0.990 ± 0.007		0.975 ± 0.010		1.000		0.991 ± 0.009		0.935 ± 0.016		0.980 ± 0.009	
AK^2	0.021 ± 0.009		0.075 ± 0.018		0.086 ± 0.018		0.074 ± 0.017		0.010 ± 0.007		0.025 ± 0.010		0.000		0.009 ± 0.009		0.065 ± 0.016		0.020 ± 0.009	
	1.000		1.000		1.000		1.000		1.000		1.000		1.000		1.000		1.000		1.000	
χ^2	0.044		0.636		0.873		0.411		0.011		0.066		0.000		0.004		0.483		0.041	
EsD																				
1	58	58.6	63	61.6	55	53.8	63	63.3	52	51.8	32	34.5	14	15.2	20	18.7	44	39.2	29	28.8
2-1	34	32.8	31	33.8	41	43.4	34	33.3	40	40.3	53	47.9	20	17.7	9	11.5	36	45.6	54	54.4
2	4	4.6	6	4.6	10	8.8	4	4.4	8	7.9	14	16.6	4	5.1	3	1.8	18	13.2	26	25.8
	96	96.0	100	100.0	106	106.0	101	101.0	100	100.0	99	99.0	38	38.0	32	32.0	98	98.0	109	109.0
EsD^1	0.781 ± 0.026		0.785 ± 0.025		0.712 ± 0.027		0.792 ± 0.025		0.720 ± 0.028		0.591 ± 0.010		0.632 ± 0.048		0.766 ± 0.026		0.633 ± 0.029		0.514 ± 0.029	
EsD^2	0.219 ± 0.026		0.215 ± 0.025		0.288 ± 0.027		0.208 ± 0.025		0.280 ± 0.028		0.409 ± 0.010		0.368 ± 0.048		0.234 ± 0.026		0.367 ± 0.029		0.486 ± 0.029	
	1.000		1.000		1.000		1.000		1.000		1.000		1.000		1.000		1.000		1.000	
χ^2	0.125		0.666		0.336		0.049		0.006		1.140		0.651		1.497		4.308[x]		0.007	

[x] = $0.05 > p > 0.01$

state show almost equal proportions of A and B groups (about 32 and 30 %, respectively), which is compatible with the findings of MacFarlane (1938). There are no comparable data available for Lodhas, Mechs and Jaila Kaibartas. However, the Bagdis, a low caste group, show a resemblance with the Lodhas and Mundas and have a closer picture with that of the Duley Bagdis of the Hooghly district (Kumar 1957). From the available information of the ABO distribution in India it seems that the A gene is higher in the aborigins of Proto-Australoid, Negroid and Mongoloid racial stock with few exceptions, while the Mundaris and Dravidians show high B gene frequencies. Differences of gene frequencies in the populations of the same racial stock are likely due to the influence of migration, intermixture, isolation and inbreeding, which is common in the Indian sub-continent. It is also possible to show different gene frequencies in the same tribe due to variation in the mating patterns, which are influenced by various cultural taboos.

Haemoglobin: The results of haemoglobin typing show the presence of HbE in all the groups. The highest Hb AE frequencies are seen in the Rabhas (12.22 %), Rajbanshis (20.63 %), Garos (9.52 %) and Mechs (34.61 %). No homozygous HbE phenotype was observed (Kate et al. 1984). HbE is widely distributed in north-eastern India including West Bengal. In earlier studies by Chaudhuri et al. (1964), Swarup et al. (1960) and Chatterjee et al. (1957) HbE was observed about 3—5 % amongst the Hindu caste groups and Muslims of West Bengal. According to Flatz (1967) the prevalence of the HbE gene is characteristic for Mongoloid populations.

Gm and Km systems: There are few studies about gammaglobulin allotypes in India. Here, except Mechs all the groups were screened for Gm and Km antigens. The haplotype Gm (1, 5) is more frequent in most of the groups and being highest in the Lodhas (79.34 %). In both high caste groups — Rarhi Brahmin (34.69 %) and Vaidyas (35.48 %) — it appears low. Type Gm (1, 2) is more common in Vaidyas (16.13 %), Rarhi Brahmins (11.22 %) and Jalia Kaibartas (13.27 %). — Km (1) phenotypes are rather frequent in all the groups ranging from 36.46 % in Garos to 6.61 % in Lodhas. As there are no much comparable data for India, it is not worthwhile to comment anything on the Gm distribution. Steinberg (1980) pointed out that haplotype Gm (1, 3, 5, 10, 11, 13, 14, 26) is possibly of Mongoloid origin and in the present groups the preponderence of Gm (1, 5) may suggest a gene flow from neighbouring southeast Asian countries. A detailed discussion of the distributio of Gm and Km allotypes among the populations of West Bengal will be given elsewhere (Chakraborty et al. 1987).

Haptoglobin: Perhaps next to the ABO blood group system the haptoglobin polymorphism is one, which has been screened for a large number of population groups in India. In Indian populations the Hp 1-1 phenotype is generally present in a rather low frequency, which is also reflected in the present samples. Amongst Rajbanshis, Garos and Mechs Hp 1-1 is totally absent, whereas in the rest of the groups it has a very low frequency (from 1.03 % in the Mundas to 1.06 in the Rabhas). The corresponding Hp^1 gene frequencies ranges from 0.119 in the Vaidhyas to 0.194 in the Rarhi Brahmins. The sample sizes for Rajbanshis and Mechs are not adequate for any comparison. Amongst the Vaidyas two cases of ahaptoglobinaemia (Hp 0) are detected. It can be mentioned that amongst the New Guineans and Melanesians the Hp^1 allele is present in a very high frequency (about 0.560), while amongst Caucasoids it is about 0.400, in African populations it has a wide range (0.288 to 0.873) and in the Japanese and Chinese it ranges from about 0.235 to 0.381 (Mourant et al. 1976). When the present figures are compared with the world Hp^1 frequencies

they appear to be quite low, but are within the range of Indian populations (Mukherjee & Das 1984). Hp 0 is found in some groups in India being as high as 13.07 % in the Mopla Muslims of Bombay (Hakim et al. 1972), but in most of the population it is absent.

Transferrin: Transferrin variants are not so common in India, but both Tf B and Tf D variants have been reported in earlier studies. In the present study Tf CD phenotypes are present in the Rarhi Brahmins and Bagdis (one in each case), and one Tf BC in Mechs and Bagdis. In the other groups only Tf C phenotypes are seen. In Eastern India the Tf^D allele frequency ranges between 0.000 and 0.048, with an average of 0.0271 (Bhasin et al. 1981). In this study it is about 0.010. In West Bengal a number of Tf CD phenotypes were encountered earlier amongst Mahishyas, Muslims, Poundra Kshatriyas (Mukherjee et al. 1974, 1975), Kaoras (Das et al. 1970), Mahato, Caste Hindus and Tribes (Walter et al. 1972), while this phenotype is quite seldom in Northern India. Walter & Bajatzadeh (1971) suggested that Tf^D may be of some selective value in hotter climates, which seems to be partially true in the present study.

Ceruloplasmin: The occurrence of Cp variants is sporadic in India, and mostly are the common Cp B phenotypes found. Cp AB and Cp BC phenotypes have been found in some population. In the present samples one case of Cp AB in Mechs and Mundas has been identified. Cp AB and Cp B-NH were earlier reported in the Kaoras and Muslims of West Bengal (Mukherjee et al. 1974, Das et al. 1974 and Das Gupta et al. 1981).

Albumin: Albumin variants are very seldom in all the populations including India. In the present study no albumin variant was found.

Acid phosphatase: Three phenotypes of acid phosphatase namely aPA, aP AB and aP B are found in all the groups studies here, and aP A ranges between 4 % (Mundas) and 9 % (Rabhas), approximately. The most frequent phenotype is aP B, which varies between about 45.5 % in Rabhas and 71.0 % in Lodhas. The lowest p^a frequency is found in the Lodhas (0.162) and the highest in the Rabhas (0.317). In India this allele varies between 0.20–0.40, and this range covers most of the world population except Eskimos, Alëuts and Alaskan Indians (Mukherjee 1979). The p^c gene is in India either absent or shows only sporadic occurrence in some Bengalis, Assamese, Khasis, Gujaratis, North Indian Khatris and Rajputs etc. (Mukherjee & Das 1974). The allele p^b ranges here in a higher order, which is comparable with the Chinese of Singapore (above 0.80; Lai & Kwa 1968).

Phosphoglucomutase at locus 1: Most of the world populations show three common phenotypes of PGM_1 − 1, 2-1 and 2 −, which are also exhibited in the present study, except Vaidyas, in which $PGM_1 2$ appears absent (possibly for the small sample size). $PGM_1 2$ is less frequent and ranges between 2 % (Rarhi Brahmins) and 15 % (Mundas), approximately. $PGM_1 1$ is found highest in the Rarhi Brahmins (83.02 %) and lowest in the Mechs (46.81 %). PGM_1^2 allele frequencies vary widely between 0.094 (Rarhi Brahmins) and 0.324 (Mechs). From earlier studies in India it is known that PGM_1^1 frequencies range between 0.55–0.78 (Mukherjee 1979) and the present findings lie almost within this range. In most of the world population the frequency of this gene lies within a range of 0.06 (Amazonas of Venezuela) to 0.34 (Eskimos of Greenland), Mourant et al. (1976). A number of rare variants at PGM_1^1 locus have been detected in India including a PGM_1^6 allele in Bengalis (Das et al. 1970). In our samples no variant was seen.

Adenylate Kinase: In most of the world populations the adenylate kinase shows mostly two common phenotypes AK 1 and AK 2-1, of which AK1 being the maximum. Here one case of AK 2 is present in Vaidyas and Jalia Kaibartas. In the rest of the populations only AK 1 and AK 2-1 phenotypes are present. The frequency of AK 1 ranges between 82.83 % in Bagdis and 98.11 % in Mechs. In the Garos both AK 2-1 and AK 2 phenotypes are absent (possibly for small sample). The corresponding AK^2 allele frequency varies from 0.00 (Garos) to about 0.09 (Bagdis). Caucasoids show AK^2 frequencies from slightly below 0.02 to nearly 0.14, and in the Mongoloids this allele varies between 0.02 and 0.50 (Mourant et al. 1976). In other Indian populations it ranges between 0.08 to 0.12 (Mukherjee 1979).

Esterase D: In Indian populations this enzyme appears to be polymorphic representing three common phenotypes – 1, 2-1, 2 –, which are present in all the population groups under study. EsD 2 is found in low range between 3.96 % in Jalia Kaibartas and 23.85 % in Lodhas. The lowest EsD 1 frequency is found in Lodhas (26.61 %) and the highest in Mechs 62.50 %). In the Lodhas the EsD^2 allele frequency is about 0.50, which is maximum amongst all the groups; the lowest frequency is found in the Jalia Kaibartas (about 0.21). In other Indian populations this allele varies between 0.17 and 0.28. The world distribution of this allele varies between 0.055 in Negroids (Cameroons) and 0.531 in American Indians (Kraho) (Papiha & Nahar 1977).

Reviewing all the data presented above one can point out a considerable genetic variability among the ten West Bengal population groups under study. The reasons therefore can be seen in the fact that all these population groups are endogamous, that means no or only trifling gene flow took place among them. Thus genetic peculiarities of these groups, which are to be seen in the connection with their different geographic and racial origins, could be preserved.

However, in spite of this genetic intergroup variability a detailed statistical analysis of the distribution of the polymorphic loci under study showed the existence of several clusters: 1. Rarhi Brahmins, Jalia Kaibartas; Vaidyas, Bagdis; 2. Rajbanshis, Mechs; Rabhas, Garos; 3. Mundas, Lodhas (Chakraborty et al. 1986). These clusters reflect the existence of three main racial groups in West Bengal: *Caucasoids, Mongoloids*, and *Proto-Australoids*. Following Chakraborty et al. (1986) one can point out "that the genetic constitutents of Bengali populations is truly a conglomerate of gene pools from at least three distinct sources: Proto-Australoids, Caucasoid and Mongoloid, which is in accordance with the ethnohistorical and anthropological classifications that have been done in the past. These three components are probably at very dissimilar proportions in various groups, classified by caste hierarchy. The high caste groups and some scheduled castes that are in close genetic proximity with them are mostly of Caucasoid type (with some minor Mongoloid and Proto-Australoid elements in them); some tribes and scheduled castes have greater Mongoloid affiliation; and lastly a strong Proto-Austaloid component it seen in some tribes, who probably arrived in Bengal at different times by routes distinctly different from others".

It would be worth to follow up these observations in further population surveys in West Bengal, which should also consider specific polymorphic system such as the complete Rhesus system, Diego, Tf and Gc subtypes and the full set of Gm factors.

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References

Ashton, G. C. & Braden, A. W. H., 1961: Serum β-globulin polymorphism in mice. – Austr. J. Exp. Biol. Med. Sci. **14**, 248–255.

Basu, P. C., 1932–33: Racial affinities of Mundas. – Transactions of the Bose Research Institute **8**, 211- 247.

Bhalla, V., 1966: Blood group distribution pertaining to ABO, MNSs and Rh-Hr system in the Indian sub-continent (An ethno-geographical variation). – Anthropologie (Prag) **4**, 67–86.

Bhasin, M. K., Walter, H., Singh, I. P. & Meena, R.: 1981 Geographic and ethnic distribution of genetic markers in India. 1. Haptoglobin and transferrin polymorphisms. – Anthrop. Anz. **39**, 36–60.

Bhowmik P. K., 1956: Physical affinity of the Lodhas of Midnapore. – Man in India **36**, 110–131.

Chakraborty, R., Walter, H., Mukherjee, B. N., Malhotra, K. C., Sauber, P., Banerjee, S. & Roy, M., 1986: Gene differentiation among ten endogamous groups of West Bengal, India. – Amer. J. Phys. Anthrop. **71**, 295–309.

Chakraborty, R., Walter H., Mukherjee, B. N., Sauber, P., Malhotra, K. C., Banerjee, S. & Roy, M., 1987: Immunglobulin (Gm and Km) allotypes in nine endogamous groups of West Bengal, India. – Ann. Hum. Biol. **14**, 155–167.

Chatterjee, J. B., Swarup, S., Ghosh, S. K. & Ray, R. N., 1957: Incidences of Haemaglobin E and Thalassemia trait in Bengalees. – Bull. Calcutta Sch. Med. **59**, 159.

Chaudhuri, S., Chakravartti, M. R., Mukherjee, B. N., Sen, S. N., Bhosh, J. & Maitra, A., 1964: Study of haematological factors, blood groups, anthropometric measures and genetics of some of the tribal and caste groups of (i) South India – Kerala, Nilgiris and Andhra Pradesh, (ii) North Eastern India (Indo-Bhutan Border) – Totopara. – Proc. 9th Congr. Int. Soc. Blood Transf. Mexico, pp. 196–205.

Choudhuri, S., Mukherjee, B. N., Ghosh, J. & Ray Chowdury, A. K., 1969: Study of blood groups, ABH secretor and haemoglobin variants in three upper castes of W. Bengal, India. – Amer. J. Phys. Anthrop. **30**, 129–132.

Dalton, E. T., 1872: Descriptive Ethnology of Bengal. – Calcutta.

Das, A. K. & Raha, M. K., 1967: The Rabhas of West Bengal. – Cultural Research Institute, Govt. of West Bengal, Calcutta.

Das, B. M., 1956: Physical characters of the Rabhas of Assam. – Man in India **36**, 92–99.

Das, S. R., Mukherjee, B. N., Das, S. K., Blake, N. M. & Kirk, R. L., 1970: The distribution of some enzyme group system among Bengalis. – Ind. Jour. Med. Res. **55**, 866–875.

Das Gupta, P., Mukherjee, B. N., Das, S. K., Pakrasi, K. & Mukherjee, D., 1981: A study of anthropometry and genetic markers amongst the Kaoras of West Bengal. – Ind. J. Phys. Anthrop. Hum. Genet. **7**, 19–37.

Flatz, G., 1967: Haemoglobin E: distribution and population dynamics. – Humangenetik **3**, 187–194.

Hakim, S. M. A., Baxi, A. P., Balakrishnan, V., Kulharni, K. V., Rao, S. S. & Jhala, H. J., 1972: Haptoglobin, transferrin and abnormal haemoglobins in Indian Muslims. – Ind. J. Med. Res. **60**, 699–701.

Harris, H. & Hopkinson, D. A., 1977: Handbook of Enzyme Electrophoresis in Human Genetics. North-Holland Publishing Co., Amsterdam.

Hutton, J. H., 1946: Caste in India – its nature, function and origin. – Cambridge University Press, London.

Kate, S. L., Mokashi, G. D., Khedkar, V. A. & Mukherjee, B. N., 1984: Prevalence of Haemoglobin E in ten population groups of West Bengal, India. – Ind. J. Haemat. **11**, 221–223.

Kumar, N., 1957: A genetical survey among the Tentulia Bagdi and the Duley of Hooghly district in West Bengal. – Bull. Dept. Anthrop. (Govt. of India) **6**, 81–88.

Lai, L. Y. C. & Kwa, S. B., 1968: Red cell acid phosphatase types in some populations of south-east Asia. – Acta genet. (Basel) **18**, 45–48.

McFarlane, E. W. E., 1938: Blood groups distribution in India with special reference to Bengal. – J. Genet. **36**, 225–337.

Majumdar, D. N. & Rao, C. R., 1960: Race elements in Bengal. – Indian Statistical Series No. 3, Calcutta.

Malhotra, K. C., 1984: Population structure among the Dhangar caste-cluster of Maharashtra, India. – In: Lukacs, J. R. (ed.), The people of South Asia. The biological anthropology of India, Pakistan and Nepal. Plenum Press, New York/London, pp. 295–324.

Mourant, A. E., Kopec, A. C. & Domaniewska-Sobczak, K., 1976: The distribution of the human blood groups and other polymorphisms. – Oxford University Press, London.

Mukherjee, B. N., 1979: Enzyme polymorphism: Variation in Indian populations. Acta Anthropogenetica **3**, 167–192.

Mukherjee, B. N., Sauber, P., Walter, H. & Malhotra, K. C., 1982: Isoelectric focusing in the detection of extended genetic polymorphism of PGM_1 in ten endogamous groups of West Bengal and Orissa, India. – Proc. Recent Trends in Immunohaematology 1982, 182–188.

Mukherjee, B. N. & Das, S. R., 1974: Distribution of some polymorphic enzyme group systems in India. – Proc. of the 1st Conf. of the Ind. Soc. of Hum. Genet., Vol. I: Human population genetics in India, 21–49.

Mukherjee, B. N. & Das, S. R., 1984: Haptoglobins: Genetics and variations in Indian populations. – Ind. J. Phys. Anthrop. Hum. Genet. **10**, 96–120.

Mukherjee, B. N., Das, S. K. & Kellermann, G., 1974: Study of some serum groups systems in the Mahishyas and the Muslims in 24-Parganas district of West Bengal. – Humangenetik **21**, 27–32.

Mukherjee, B. N., Das, S. K. & Dash Sharma, P., 1975: Investigation of serum protein and red cell enzyme polymorphism in Oraon tribes. – Ann. Hum. Biol. **2**, 201–204.

Papiha, S. S. & Nahar, A., 1977: The world distribution of the electrophoretic variants of the red cell enzyme esterase D. – Hum. Hered. **27**, 424–432.

Risley, H. H., 1891: Tribes and Castes of Bengal. – Ethnographic Glossary 1 and 2. Bengal Secretariate Press, Calcutta. Reprinted by Firma Mukhjophadhay, Calcutta (1981).

Risley, H. H. 1908: The People of India. – Thacker, Spinker & Co., London.

Roy, U. K. Das, A. K. & Chowdhury, M. K., 1982: Planning for the Scheduled Tribes and Scheduled Castes (West Bengal perspective). – Bull. Cultural Research Institute **27**, Calcutta.

Roy, Gautam Sankar, 1946: A study of the physical characteristics of Rajbanshis. – Royal Asiatic Society of Bengal **12**, 31–42.

Roy Choudhury, T. C., 1952: The racial problem of Bengal. Presidential Address. Section of Anthropology and Archaeology. – Proc. of the 39th Indian Science Congress, 169–18.

Sarkar, S. S., 1954: The aboriginal races of India. – Bookland Ltd., Calcutta.

Steinberg, A. G., 1980: Gm and Inv studies on eight Iranian populations with distance measures among the six from the Caspian Littoral. – Amer. J. Phys. Anthrop. **53**, 375–382.

Swarup, S., Ghosh, S. K. & Chatterjee, J. B., 1960: Haemoglobin E disease in Bengalees. – J. Ind. Med. Ass. **35**, 13.

Waddell, L. A., 1900: The tribes of the Brahmaputra Valley: a contribution on their physical types and affinities. – Asiatic Society of Bengal **69**, 1–27.

Walter, H. & Bajatzadeh, M., 1971: Investigations on the geographical variability of the human transferrins. – Humangenetik **12**, 267–274.

Walter, H., Kellermann, G., Bajatzadeh, M., Krüger, J. & Chakravartti, M. R., 1972: Hp, Gc, Cp, Tf, Bg and Pi phenotypes in Leprosy patients and healthy controls from West Bengal (India). – Humangenetik **14**, 314–325.

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