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Genetic variation of five blood group polymorphisms in ten populations of Assam, India

Six Mongoloid and four Caucasoid populations of Assam, India, were examined for A₁A₂BO, Rhesus, Duffy and Diego blood groups. The distribution of their phenotypes and allele frequencies are presented. In the perspective of the ethnographic background, the results have been discussed in terms of genetic variability among these populations and probable reasons for its existence. The major groups, namely Caucasoids and Mongoloids, appear to form two separate groups in terms of these blood groups, though evidence is there to suggest intermixture.

Introduction

The State of Assam is situated in the northeastern part of India. It is surrounded by several other administrative units of the Indian Union as well as foreign countries like Bangladesh and Bhutan (Figure 1). On the basis of physical geography Assam can broadly be divided into three major regions, namely (a) the *Brahmaputra valley* or the *Assam valley* which covers the northern part of the State; (b) the *Barak valley* at the southern tip and (c) the *Karbi Anglong* and *North Cachar Hills* separating the two valleys. Assam is bounded by hills on all sides except a narrow plain towards west, by which it is connected with the mainland of India. It lies between the latitudes of 28° and 24°N and the longitudes of 89°46' and 96°4'E.



Fig. 1 - Location of Assam (black).
Bh = Bhutan, B.D. = Bangla Desh.

Assam, more particularly the Brahmaputra valley, is a meeting place of two major racial groups of mankind, namely Caucasoids and Mongoloids. The Mongoloids, who are referred to as the Indo-Mongoloids, came to Assam from different directions and at different times by various routes of migration, for example, the northern passes of Bhutan and Tibet, Assam-Burma routes on the eastern side, etc. They belong to the Tibeto-Chinese language family which has two major branches: Tibeto-Burman and Siamese-Chinese. The Tibeto-Burman speaking Indo-Mongoloids entered Assam in an undatable past. They came in batches, settled in different regions and assumed different names in course of time. They constitute the tribal population of Assam. Some of them live in the hills, while others are distributed in the valleys. In the first part of the 13th century Assam witnessed a large scale migration of a Mongoloid people by the northeastern routes. They were called the *Abom*, a Shan or Thai people, and hence linguistically they belong to the Siamese-Chinese language branch. A few other small populations of the same ethnic origin came to Assam in the recent past. Thus, migration of the Mongoloid people to Assam which started long ago can be called a continuous process.

However, perhaps after the Mongoloids came the Caucasoids. They entered Assam from the western direction by the valley formed by the Ganges and the Brahmaputra. The Caucasoid migration also occurred in succession and thereby different ethnic elements like Mediterraneanans, Alpino-Armenoids, Irano-Scythians, and Indo-Aryans were brought to Assam.

However, it is believed that the *Australoids* were the first to come to Assam. The latter immigrants partially or wholly absorbed the ancient Australoid elements. As result, traces of Australoid strains are still discernible in the physical make-up of certain populations of Assam.

Generally speaking, the Assamese Hindu castes and the Assamese speak an Indo-European language called Assamese, which has its root in the Sanskrit. Many of the Assam tribes speak their own dialects. Others have forgotten their own dialects and have accepted Assamese as their mother tongue. Thus, Assam is the homeland of several populations of different ethnic origins, who speak different languages and have varied

socio-cultural traditions. Each of these populations has its own cultural as well as biological identity.

In many parts of the Brahmaputra valley people belonging to these two major races, Caucasoids and Mongoloids, are living together since long past. Therefore, it is presumable that exchange of genes to varied degrees between the members of these two racial groups has taken place. As a matter of fact, gene flow from one population to another has clearly been demonstrated in case of the haemoglobin variant HbE (DAS *et al.*, 1980 a, 1980 b) and also in respect of cerumen type (DAS, 1977, 1978). Observation of certain somatoscopic traits by trained anthropologists also supports this fact. Though admixture to certain extent has taken place, the Caucasoid populations as a group are distinguishable from the Mongoloid ones. But at individual level in some cases a man of Mongoloid origin cannot easily be distinguished from a Caucasoid by observing physical features and vice versa.

The Mongoloid populations again show varied degrees among themselves in several anthropological traits (DAS, 1960, 1981; DAS *et al.*, 1981; DAS *et al.*, 1985 a). The constituent sections of a tribe may also exhibit microvariation (DAS, 1978; PHOOKAN, 1974). The same is true in case of the Caucasoid populations (DAS, 1973, 1979; DAS *et al.*, 1973 a, 1973 b). An anthropological study in Assam has reported intracaste regional variability also (DAS *et al.*, 1986 a, 1986 b). The Assamese Muslims, too, show such variability (DAS *et al.*, 1985 b). Most of these works are mainly concerned with certain anthropometric, dermatoglyphic, behavioural traits, medulla and cross section of head hair (DAS, 1971, 1974) besides ABO blood groups, Rh factor, G-6-PD deficiency, taste sensitivity to PTC, haemoglobin variant HbE, etc. (DAS *et al.*, 1980 c, 1985 c). However in early 1970s a few individuals of two populations, namely Caucasoid Assamese and the Khasi, a Mongoloid tribe, were investigated for haptoglobin (Hp), transferrin (Tf), group-specific component (Gc), red cell acid phosphatase (aP), phosphoglucomutase (PGM₁), adenylate kinase (AK), adenosine deaminase (ADA), 6-phosphogluconate dehydrogenase (6-PGD) besides ABO blood groups, G-6-PD and haemoglobin types (FLATZ *et al.*, 1972; GOEDDE *et al.*, 1972).

Materials and Method

In the early part of 1984 a collaborative research project was launched by a team of workers belonging to the Department of Human Biology/Physical Anthropology, University of Bremen, West Germany; Department of Anthropology, Gauhati University, Guwahati, Assam; Department of Anthropology, Dibrugarh University, Dibrugarh, Assam; Anthropometry & Human Genetics Unit, Indian Statistical Institute, Calcutta and Center for Demographic and Population Genetics, University of Texas, Houston, USA, in order to examine the extent and cause of genetic variation among some populations of Assam in respect of a large number of polymorphic traits, namely: ABO, MNs, Rhesus, Duffy, Diego, Hp, Gc, Gm, Km, Tf, aP, EsD, AK, ADA, LDH; Hb-variants. Keeping in view the ethnic composition of the people of Assam, representative populations of Mongoloid and Caucasoid as well as of known mixed origin were selected for this purpose. It has already been mentioned that the Mongoloid populations show variation among them with regard to certain morphological traits. The Caucasoid populations also do so. Again, the Caucasoid populations are distinguishable from the Mongoloid populations. What picture will emerge, if genetic traits are taken into account? To what extent do the Caucasoid and Mongoloid populations show intragroup and intergroup genetic variation?



Fig. 2 - Map of Assam, showing the places of the population groups under study.

How to account for these variabilities? In the present series of work, attempts will be made to give answers to questions of such nature.

The samples were drawn from two different regions of the Brahmaputra valley (Figure 2): one, the Dibrugarh area in eastern part or Upper Assam, and the other around Guwahati, that is western part of Lower Assam. The Ahom, Chutiya and Sonowal samples were collected from the Dibrugarh area, the rest from the Guwahati area. Proper care was taken not to include closely related individuals in the sample. The subjects were of both sexes and of different age groups.

In the present paper the phenotype and gene frequencies of the following blood groups will be reported: A_1, A_2, B, O , MNSs, Rhesus ($CcDEe$), Duffy and Diego. The extent of variation in the other polymorphic systems under study as well as detailed statistical evaluations based on the whole set of the genetic data will be communicated in a series of forthcoming papers.

Tube technique through centrifuge and incubation as per RACE & SANGER (1975) has been followed. All the anti-sera were purchased from Ortho Diagnostics, Heidelberg (W. Germany).

The populations

From the Caucasoid group three Assamese Hindu castes, namely Brahmins, Kalitas and Kaibartas, besides the Assamese Muslims, have been included in the present study. These three castes represent three social strata of the Assamese caste society. So far as these castes are concerned, in the caste hierarchy, the Brahmins occupy the highest position and the Kaibartas the lowest, and in between them stand the Kalitas. In this connection it may perhaps be mentioned that caste among the Assamese Hindus is not rigid to that extent as in other parts of India. The nature and extent of caste stratification, horizontal and vertical, of the Assamese Hindus seem to differ from that of other regions. However, caste endogamy is very much there among the Assamese and thereby biological isolation is maintained by each caste.

Brahmins: Traditionally the Brahmins form a priestly caste and occupy the topmost position in the caste hierarchy. However, «besides their scriptural duties, the Brahmins also held high administrative offices. Ministers, administrators, and court poets were mostly members of their class» (BARUA, 1951). At present they are in different professions. Clan (gotra) exogamy is strictly practised by the Brahmins. The Brahmins are distributed all over the Brahmaputra valley, but certain regions can be identified where they are concentrated.

Kalitas: The Kalitas form one of the numerically predominant castes of Assam. In the caste hierarchy their position is next to the Brahmins (Census of India 1891). The Kalita caste is a speciality of Assam though «the name occurs in other parts of India besides Assam, namely, in the Sambalpur district of Orissa and in Cuttak and Chota Nagpur. In the Tons valley and Jaunsar Barwar in Nepal there is a class of people called Kalitas» (DALTON, c.f. BARUA, 1951).

As regards the original homeland and migration of the Kalitas there seems to be two views. The common view is that their ancestors came from the West. The other view may be expressed in the language of Captain Neufville, who wrote in 1828 that «the country to the eastward of Bhot and northward of Sadiya, extending on the plain beyond the mountains is said to be possessed by a powerful nation called Kalitas or Kultas, who are described as having attained to a high degree of advancement and civilization equal to any of the nations of the East» (c.f. BARUA, 1951). Different views have been expressed regarding their origin. One view is that they were originally Kayasthas, but as they took to agriculture they assumed a new name and formed a separate caste. Another view is that they are descendants of the Kshatriyas who fled from the wrath of Parasurama, and to conceal their caste identity threw away their sacred thread and thus became Kula (caste) *lupta* (gone) or Kalita. Again, some say that they were not Kshatriyas, but nonvedic Aryans, that came to Assam before the coming of the vedic Aryans. Some are of opinion that they were originally Buddhist. Others say that they were priests of the Boros. Whatever might be the real fact it cannot be denied that they are Caucasoid people and form a very ancient population of Assam. The Kalitas are met with all over the Brahmaputra valley, though their heavy concentration is in Lower and Middle Assam.

Kaibartas: The Kaibartas constitute one of the scheduled castes of Assam. Their traditional occupations are fishing and plying boats. One old record suggests that the Kaibartas were in charge of collecting state-toll on the rivers. Therefore, their settlements are mostly on river banks or near some sources of water. However, some of them own land and practise agriculture, too. They are scattered all over the Brahmaputra valley.

Muslims: History tells that Assam came into contact with the Muslims for the first time in the beginning of the 13th century, when Muhammed Bin Bakhtiyar Khiliji, a Muslim general of Kutubuddin led a Turkish army to this region. In the subsequent centuries there were several Muslim invasions to Assam. In the second quarter of the 16th century one noteworthy Muslim invasion to Assam took place, when an army commanded by Turbak made an attempt to conquer Assam. He was defeated and lost his life. His soldiers were taken as prisoners by the Ahom king and were given settlement in different parts of Assam.

They are regarded as the earliest Muslim settlers in the Brahmaputra valley, though it is presumable that during the earlier invasions also some soldiers preferred to stay in Assam instead of going back with their defeated leader. In the second quarter of the 17th century a Muslim saint Hazart Shah Milan by name, but popularly known as Azan Fakir came to Assam. He was a Syed Muslim. He promoted and stabilized Islam religion in Assam. Many local people under his influence were converted to Islam. However, many

conversions generally took place through marriage, because the soldiers did not come with their wives and hence they had to marry local girls. Again, the Ahom kings brought some Muslim artisan families from outside to do different types of work. Thus, there were slow infiltrations of Muslims into Assam in small numbers over a considerably long period of time.

The traditional Assamese Muslim community, which was gradually formed includes the descendants of four different groups of people: 1. the war prisoners, 2. the artisans, 3. the Muslim immigrants, who occasionally came, including the preachers, and 4. the local converts. Again they can be divided into three broad groups, namely Syeds, Sheikhhs, both names connoting «nobles», and Marias. All of them belong to the Sunni Sect of Islam. The Sheikhhs from the major bulk of the Assamese Muslims.

The sample included in the present study comprises the Sheikh Muslims only, firstly because of their numerical strength, and secondly, it appears that the Marias have maintained their physical anthropological peculiarities to a great extent (DAS *et al.* 1985 b). Further, the Sheikhhs are distributed all over the Brahmaputra valley in large number.

Ahoms: The Ahoms are a Mongoloid population of Assam. In the early part of the 13th century their ancestors migrated from original homeland in the upper courses of the Irrawady river in Burma and entered Assam crossing the Patkoi range. First, in the northeastern corner of Assam they established their settlement, which they developed into a kingdom fighting against and defeating the earlier settlers like the Borahis, Morans, Chutiyas, and gradually extended their territory down the Brahmaputra valley. The Ahom dynasty was ruling Assam till 1826, when the annexation of Assam by the British took place. The Ahoms are a Shan or Thai people, and linguistically form a member of the Siamese-Chinese branch of the Tibeto-Chinese family. But coming to Assam they gradually abandoned their language and accepted Assamese. Hence since long past their language is Assamese and they form a part and parcel of the Assamese speaking Assamese. By the 15th century they became Hindu. At present the Ahoms are chiefly met with in large numbers in Upper Assam.

Karbis: The Karbis form a Mongoloid tribe of Assam. They mostly live in the Karbi Anglong Hills as well as in some parts of the plains district of Middle and Lower Assam. The tribe is interesting because of its linguistic peculiarities. No doubt they speak Tibeto-Burman. But unlike the other Tibeto-Burman tribes they are neither put under the Boro group nor any other linguistic group. Different authors have expressed different views as regard their linguistic affinity. According to some the Karbi language shows mixture of Austro-Asiatic and Boro languages, but it is more similar to the latter than to the former, and hence they are put under Tibeto-Burman. Again, in the opinion of some scholars the Karbi language has similarities with the Naga dialects as with the Boro dialects. One has assigned their position between the Boro and Kuki-Chin. In this context it may be mentioned that the Karbis are significantly different from the Garos, Rabhas, Kacharis and Tiwas, members of the Boro group, in respect of haemoglobin variant HbE (DAS *et al.*, 1980 a).

Boro Kacharis: The Kacharis, which form a Mongoloid tribe, are distributed all over Assam. The tribe has several divisions of which mention may be made of the Boro Kacharis, Dimasas, Sonowals, Thengals and Jharuas. The Dimasas are primarily a hill people and are concentrated in the North Cachar hills. The Sonowals, Jharuas and Thengals are met with in the plains district of Upper Assam. The Kacharis of Lower and Middle Assam are very often referred to as the Boro Kacharis or simply Kacharis. PHOOKAN (1974) observed that through there is a general similarity among the divisions of the Kachari tribe in respect of ABO blood groups and taste sensitivity to PTC, yet with

regard to anthropometric traits the Dimasas, who live in the hills, show differences from the plains divisions. The data included in the present study were collected from the Boro Kacharis of Lower Assam.

Sonowal Kacharis: As has already been mentioned above the Sonowals are a division of the Kachari tribe. Some differences between the Kacharis of Lower Assam and the Sonowals of Upper Assam in respect of anthropometric traits are observed (PHOOKAN, 1974).

Chutiyas: The Chutiyas are of Mongoloid origin. They form a very old population of Assam. Their original language was Tibeto-Burman and in this respect they are akin to the Boro group of tribes. But long back they accepted Assamese as their mother tongue and they now form an inseparable part of the Assamese speaking Assamese. In Upper Assam the Chutiyas had their own kingdom which flourished in the former times. But with the advent of the Ahoms they had to be at war with the latter for several centuries. Ultimately it ended with the defeat and death of the Chutiya king in the beginning of the 16th century, The Chutiyas mostly live in Upper Assam.

Rajbanshis: The Rajbanshis form a very interesting population of Assam. It can be cited as an example of tribe-caste continuum not only in terms of socio-cultural aspect, but also with regard to biological process (DAS, 1981). They live in different parts of Assam. Outside Assam in Bengal they are also found. In Assam the Rajbanshis have been recognized as a backward caste by the government. «Rajbanshi» is an integrative term connoting «servants to the king».

Different views have been expressed as regards the ethnic affiliation of the Rajbanshis. The Census Report of 1891 says «in Assam Rajbanshis are mainly persons of Koch and Mech tribes who have assumed this name on conversion to Hinduism». Allen (in District Gazatteers, Goalpara, 1908) has described them as one of the «race castes» of Assam who generally claims to be an «outlying branch of the Kshatriyas» (RISLEY, 1915). According to DALTON (1872) they belong to the Dravidian stock. Risley believes that they (this Dravidian stock) were brought into contact with the Mongoloid races of the Lower Himalayas and the Assam border. WANDEL (1901) describes them as «distinctly Mongoloid though somewhat heterogenous». This heterogeneity is perhaps for the fact that in different parts of Assam persons of various tribal (Rabhas, Tiwas, Kacharis, Garos, Karbis etc.) origin after conversion to Hinduism are called by the name Rajbanshi. They have their own place in the Hindu caste fold. This process was started in the long past and is still going on. Being accepted as a Hindu caste they have been admixed with certain Caucasoid castes. Thus, the present Rajbanshis are a population of mixed origin. To their original Mongoloid stock Caucasoid elements have been added from time to time.

Results

A₁A₂BO system: Table 1 shows the distribution of phenotypes and Table 2 that of the allele frequencies of the A₁A₂BO blood groups in the ten populations of Assam. All the populations are in genetic equilibrium. Through some heterogeneity in the distribution of the A₁A₂BO blood group alleles is seen no statistical significance is present with the exception of A₂, which is completely absent among Kaibartas and Karbis. In any case no clear distribution pattern emerges (Table 2).

MNS_s system: Phenotype and allele frequencies are shown in Table 3 and Table 4, respectively. Genetic equilibrium is seen in some of the populations only (Brahmins,

TABLE 1 - A_1A_2BO phenotype frequencies in ten Assamese populations.

Population		A_1	A_2	B	A_1B	A_2B	O	Total	χ^2
Brahmins	Obs.	25	1	30	10	—	34	100	
	Exp.	26.2	0.7	30.9	8.7	0.3	33.3	100.0	0.70
Kalitas	Obs.	21	3	35	5	2	39	105	
	Exp.	19.8	3.7	34.5	6.5	1.3	39.4	105.0	0.82
Kaibartas	Obs.	19	—	40	2	—	41	102	
	Exp.	15.9	0.0	37.2	5.3	0.0	43.6	102.0	3.02
Muslims	Obs.	22	1	31	4	1	46	105	
	Exp.	20.8	1.6	30.3	5.3	0.4	46.6	105.0	1.32
Ahoms	Obs.	33	5	31	6	—	48	123	
	Exp.	32.1	4.0	29.1	7.1	1.0	49.7	123.0	1.63
Karbis	Obs.	27	—	38	10	—	36	111	
	Exp.	27.0	0.0	37.9	10.1	0.0	36.0	111.0	<0.01
Kacharis	Obs.	33	4	31	5	—	40	113	
	Exp.	30.8	3.2	28.0	7.5	0.9	42.6	113.0	2.55
Sonowals	Obs.	29	4	29	4	3	38	107	
	Exp.	26.5	5.4	27.8	6.8	1.6	38.9	107.0	2.98
Chutiyas	Obs.	10	4	22	2	1	25	64	
	Exp.	9.2	3.8	21.1	2.8	1.3	25.8	64.0	0.43
Rajbanshis	Obs.	24	1	34	6	—	40	105	
	Exp.	23.1	0.7	32.9	7.0	0.3	41.0	105.0	0.57

TABLE 2 - A_1A_2BO allele frequencies in ten Assamese populations.

Population	A_1	A_2	B	O
Brahmins	0.193 ± 0.029	0.006 ± 0.006	0.224 ± 0.031	0.577 ± 0.038
Kalitas	0.133 ± 0.024	0.028 ± 0.012	0.226 ± 0.031	0.613 ± 0.036
Kaibartas	0.110 ± 0.023	—	0.236 ± 0.032	0.654 ± 0.036
Muslims	0.133 ± 0.024	0.011 ± 0.008	0.190 ± 0.028	0.666 ± 0.034
Ahoms	0.174 ± 0.025	0.025 ± 0.011	0.165 ± 0.025	0.636 ± 0.033
Karbis	0.183 ± 0.027	—	0.247 ± 0.031	0.570 ± 0.036
Kacharis	0.187 ± 0.027	0.023 ± 0.011	0.176 ± 0.027	0.614 ± 0.035
Sonowals	0.171 ± 0.027	0.041 ± 0.015	0.186 ± 0.028	0.603 ± 0.036
Chutiyas	0.099 ± 0.027	0.045 ± 0.020	0.221 ± 0.039	0.635 ± 0.046
Rajbanshis	0.155 ± 0.026	0.006 ± 0.005	0.214 ± 0.030	0.625 ± 0.036

TABLE 3 - MNSs phenotype frequencies in ten Assamese populations.

Population	MSS	MSs	Mss	MNSS	MNSs	MNs	NSS	NSs	Nts	Total	χ^2	
Brehmins	Obs.	3	9	17	4	16	—	4	7	100		
	Exp.	2.0	12.8	20.0	2.0	16.1	0.5	4.9	11.4	100.0	9.4	
Kalitas	Obs.	2	11	27	2	9	2	1	12	105		
	Exp.	1.2	11.3	27.7	1.1	12.9	0.3	3.6	11.4	105.0	15.0*	
Kaibaras	Obs.	6	11	19	5	12	2	3	11	102		
	Exp.	3.1	15.1	18.3	2.8	18.4	0.7	5.3	10.6	102.0	12.3*	
Mindims	Obs.	3	11	28	4	7	—	3	9	105		
	Exp.	1.5	13.2	28.7	1.2	13.0	0.2	3.0	10.1	105.0	12.7*	
Ahomis	Obs.	7	13	34	4	14	—	—	14	123		
	Exp.	3.6	20.7	29.7	1.2	16.4	0.1	2.1	11.8	123.0	16.4**	
Karbis	Obs.	1	6	52	—	5	42	—	5	111		
	Exp.	0.4	8.7	52.2	0.0	3.4	38.9	0.0	0.1	7.3	111.0	3.7
Kacharis	Obs.	2	—	61	—	2	40	—	8	113		
	Exp.	0.1	4.3	58.1	0.0	1.5	41.6	0.0	7.4	113.0	1.7	
Sonowals	Obs.	3	5	53	1	6	30	—	1	8	107	
	Exp.	0.5	10.2	48.4	0.3	6.8	33.7	0.1	1.1	5.9	107.0	17.1**
Chutiya	Obs.	1	7	22	2	4	21	—	3	4	64	
	Exp.	0.6	7.4	21.5	0.7	7.6	19.6	0.2	1.9	4.5	64.0	5.2
Rajbanshis	Obs.	2	4	31	3	8	42	1	4	10	105	
	Exp.	0.5	7.6	30.4	0.9	12.1	37.1	0.4	4.6	11.4	105.0	14.1*

* Significant at 5% level.

** Significant at 1% level.

TABLE 4 - MNS₁ allele frequencies in ten Assamese populations.

Population	MS	Ms	NS	Ns
Brahmins	0.143 ± 0.028	0.447 ± 0.038	0.072 ± 0.023	0.338 ± 0.036
Kalitas	0.105 ± 0.024	0.514 ± 0.037	0.052 ± 0.020	0.329 ± 0.035
Kaibartas	0.174 ± 0.032	0.424 ± 0.038	0.080 ± 0.025	0.322 ± 0.038
Muslims	0.120 ± 0.025	0.523 ± 0.037	0.046 ± 0.019	0.311 ± 0.034
Ahoms	0.171 ± 0.026	0.492 ± 0.035	0.028 ± 0.014	0.309 ± 0.031
Karbis	0.057 ± 0.016	0.686 ± 0.031	0.001 ± 0.004	0.256 ± 0.029
Kacharis	0.026 ± 0.011	0.717 ± 0.030	—	0.257 ± 0.029
Sonowals	0.071 ± 0.020	0.672 ± 0.033	0.023 ± 0.013	0.234 ± 0.030
Chutiyas	0.100 ± 0.030	0.580 ± 0.046	0.056 ± 0.025	0.264 ± 0.042
Rajbanshis	0.067 ± 0.020	0.538 ± 0.036	0.066 ± 0.020	0.329 ± 0.034

Karbis, Kacharis, and Chutiyas). One can suppose, however, that deviation from Hardy-Weinberg equilibrium in the other populations is due to small sample size. As comes out from Table 4 the interpopulation variability in the distribution of allele frequencies is considerable and — with the exception of Ns — statistically significant (Table 9). It is interesting to state that in the Caucasoid populations (Brahmins, Kalitas, Kaibartas, Muslims) the MS, NS, and Ns frequencies are generally higher than in the Mongoloid group (Ahoms, Karbis, Kacharis, Sonowals, Chutiyas), in which Ms frequencies are predominant. The Rajbanshis show somewhat intermediate position. Thus, Caucasoids and Mongoloids exhibit some obvious differences in the distribution pattern of the MNS₁ alleles.

Rhesus system: Table 5 demonstrates the distribution of the Rhesus phenotypes and Table 6 that of the haplotypes. It is seen in Table 5 that most of the populations are in genetic equilibrium. Deviations found among Karbis, Kacharis and Sonowals might be due to sample size. The distribution of the Rhesus haplotypes shows a considerable interpopulation variability (Table 6), which is statistically significant with the exception of CdE (Table 9). Looking at the haplotype frequencies presented in Table 6 one can see, however, that they are not distributed randomly but show some connections with the two major racial groups. Thus CDE, CDe cDE and cDe are generally more frequent in the Mongoloids than in the Caucasoids, in which on the other hand the cde haplotype occurs in higher frequencies. It is highly noteworthy that in regard of cDE and cde the Rajbanshis show an intermediate position between Caucasoids and Mongoloids.

Duffy system: Duffy phenotype and allele frequency are shown in Table 7. The interpopulation heterogeneity in the distribution of Fy^a is considerable and statistically significant (Table 9). With the exception of the Ahoms (0.628) Fy^a frequencies are much higher in the Mongoloids as compared to the Caucasoids exhibiting thus another clear difference between these two major racial groups of Assam.

Diego system: Diego phenotype and allele frequencies are presented in Table 8. The interpopulation heterogeneity in the distribution of Di^a frequencies is not significant (Table 9). However, the distribution of this allele shows an interesting picture as it occurs in generally higher frequencies among the Mongoloid populations than in the Caucasoid ones. Whereas along Brahmins and Kaibartas Di^a is completely absent it is found in low frequencies among Kalitas and Muslims. As this allele is supposed to be a Mongoloid marker one can assume that its presence among these two Caucasoid groups indicates some gene flow from the Mongoloid side.

TABLE 5 - *Rbcus phenotype frequencies in ten Assamese populations.*

Phenotype	Brahmins		Kalitias		Kaibaras		Mutlains		Ahoms		Karbhis		Kacharis		Sonowals		Chutiya		Rajbanshis			
	Obs.	Exp.	Obs.	Exp.	Obs.	Exp.	Obs.	Exp.	Obs.	Exp.	Obs.	Exp.	Obs.	Exp.	Obs.	Exp.	Obs.	Exp.	Obs.	Exp.		
CCD,EE	—	0.0	—	0.0	—	0.0	—	0.0	—	0.0	—	0.1	—	0.0	—	0.0	—	0.2	—	0.0	—	0.0
CCD,Ee	1	0.8	1	0.9	—	0.0	1	0.8	1	0.9	—	5.4	—	8.2	—	8.2	1	1.7	—	8.2	—	0.0
CCD,ee	57	53.2	56	52.8	58	55.9	63	64.5	76	74.7	67	62.7	82	75.4	82	70.6	34	33.6	71	71.3	—	0.0
CcD,EE	—	0.1	—	0.1	—	0.0	—	0.1	—	0.1	—	1.0	—	0.0	—	0.7	—	0.7	—	0.3	—	0.0
CcD,Ee	11	13.2	12	12.1	9	9.6	9	8.7	15	18.8	25	24.4	14	20.1	9	11.9	14	13.1	11	11.5	—	0.0
CcD,ee	20	25.7	24	30.6	26	29.6	28	25.5	23	21.9	11	12.2	9	13.7	8	13.3	10	11.1	20	18.9	—	0.0
ccD,EE	2	0.8	—	0.7	—	0.4	—	0.3	3	1.2	4	2.3	4	1.3	1	0.4	—	1.2	—	1.2	—	0.5
ccD,Ee	3	3.1	5	3.4	4	2.6	2	1.7	3	2.8	2	2.3	2	1.8	2	1.1	3	2.1	1	1.5	—	0.0
ccD,ee	1	0.5	1	0.6	1	0.8	1	2.2	—	0.0	—	0.6	2	0.7	2	0.5	—	0.0	—	0.0	—	0.0
CCd,EE	—	0.0	—	0.0	—	0.0	—	0.0	—	0.0	—	0.0	—	0.0	—	0.0	—	0.0	—	0.0	—	0.0
CCd,Ee	—	0.0	—	0.0	—	0.0	—	0.2	—	0.1	—	0.0	—	0.0	—	0.0	—	0.0	—	0.0	—	0.0
CCd,ee	—	0.0	—	0.0	—	0.0	—	0.0	—	0.0	—	0.0	—	0.0	—	0.0	—	0.0	—	0.0	—	0.0
CcCd,EE	—	0.0	—	0.0	—	0.0	—	0.0	—	0.0	—	0.0	—	0.0	—	0.0	—	0.0	—	0.0	—	0.0
CcCd,Ee	—	0.0	—	0.0	—	0.0	—	0.1	—	0.8	—	0.0	—	0.0	—	0.0	—	0.0	—	0.0	—	0.0
CcCd,ee	—	0.0	—	0.0	—	0.0	—	0.0	—	0.0	—	0.0	—	0.0	—	0.0	—	0.0	—	0.0	—	0.0
Ccd,EE	—	0.0	—	0.0	—	0.0	—	0.0	—	0.0	—	0.0	—	0.0	—	0.0	—	0.0	—	0.0	—	0.0
Ccd,Ee	—	0.0	—	0.0	—	0.0	—	0.0	—	0.0	—	0.0	—	0.0	—	0.0	—	0.0	—	0.0	—	0.0
Ccd,ee	—	0.0	—	0.0	—	0.0	—	0.0	—	0.0	—	0.0	—	0.0	—	0.0	—	0.0	—	0.0	—	0.0
ccDd,EE	—	0.0	—	0.0	—	0.0	—	0.0	—	0.0	—	0.0	—	0.0	—	0.0	—	0.0	—	0.0	—	0.0
ccDd,Ee	—	0.0	—	0.0	—	0.0	—	0.0	—	0.0	—	0.0	—	0.0	—	0.0	—	0.0	—	0.0	—	0.0
ccDd,ee	5	2.6	6	3.8	4	3.1	—	0.4	1	1.7	—	0.0	—	0.0	—	0.0	—	0.0	—	0.0	—	1.3
Total	100	100.0	105	105.0	102	102.0	105	105.0	123	123.0	111	111.0	113	113.0	107	107.0	64	64.0	105	105.0	—	—
χ^2	6.59		4.59		2.10		2.66		4.34		38.25**		12.08**		47.31**		3.53		0.93			

* Significant at 5% level.

** Significant at 1% level.

TABLE 6 - *Rhesus haplotype frequencies in ten Assamese populations.*

Population	CDe	DcE	cDE	cDe	CdE	Cde	cdE	cde
Brahmins	0.006 ±0.006	0.729 ±0.032	0.089 ±0.020	0.016 ±0.020	—	—	—	0.160 ±0.032
Kalitas	0.006 ±0.006	0.708 ±0.031	0.080 ±0.019	0.015 ±0.018	—	—	—	0.191 ±0.032
Kaibartas	—	0.740 ±0.031	0.064 ±0.017	0.021 ±0.022	—	—	—	0.175 ±0.033
Muslims	—	0.743 ±0.047	0.052 ±0.015	0.097 ±0.044	0.005 ±0.005	0.042 ±0.038	—	0.061 ±0.042
Ahoms	0.005 ±0.004	0.753 ±0.036	0.097 ±0.019	—	—	0.027 ±0.025	—	0.118 ±0.021
Karbis	0.032 ±0.012	0.752 ±0.025	0.143 ±0.065	0.058 ±0.019	—	—	—	0.015 ±0.011
Kacharis	—	0.817 ±0.025	0.109 ±0.021	0.074 ±0.019	—	—	—	—
Sonowals	0.047 ±0.010	0.812 ±0.057	0.064 ±0.014	0.040 ±0.011	—	—	—	0.037 ±0.017
Chutiyas	0.018 ±0.013	0.724 ±0.040	0.138 ±0.031	—	—	—	—	0.120 ±0.029
Rajbanahis	—	0.823 ±0.026	0.067 ±0.017	—	—	—	—	0.110 ±0.022

TABLE 7 - *Duffy phenotype and allele frequencies in ten Assamese populations.*

Population	Fy(a+)	Fy(a-)	Total	Fy ^a	Fy ^b
Brahmins	78	22	100	0.531 ± 0.044	0.469 ± 0.044
Kalitas	75	30	105	0.466 ± 0.041	0.534 ± 0.041
Kaibartas	92	10	102	0.687 ± 0.047	0.313 ± 0.047
Muslims	93	12	105	0.662 ± 0.046	0.338 ± 0.046
Ahoms	106	17	123	0.628 ± 0.042	0.372 ± 0.042
Karbis	104	7	111	0.749 ± 0.046	0.251 ± 0.046
Kacharis	108	5	113	0.790 ± 0.046	0.210 ± 0.046
Sonowals	100	7	107	0.744 ± 0.047	0.256 ± 0.047
Chutiyas	62	2	64	0.823 ± 0.062	0.177 ± 0.062
Rajbanahis	100	5	105	0.782 ± 0.048	0.218 ± 0.048

TABLE 8 - Diego phenotype and allele frequencies in ten Assamese populations.

Population	Fy(a+)	Fy(a-)	Total	Di ^a	Di ^b
Brahmins	—	100	100	—	1.000
Kalitas	2	103	105	0.010 ± 0.007	0.990 ± 0.007
Kaibartias	—	102	102	—	1.000
Muslims	1	104	105	0.005 ± 0.005	0.995 ± 0.005
Ahoms	2	121	123	0.008 ± 0.006	0.992 ± 0.006
Karbis	2	109	111	0.009 ± 0.006	0.991 ± 0.006
Kacharis	4	109	113	0.018 ± 0.009	0.982 ± 0.009
Sonowals	6	101	107	0.028 ± 0.011	0.972 ± 0.011
Chutiyas	1	63	64	0.008 ± 0.008	0.992 ± 0.008
Rajbanshis	4	101	105	0.019 ± 0.010	0.981 ± 0.010

TABLE 9 - Heterogeneity analysis for the distribution of the blood group data.

Locus/Allele, Haplotype	No. of populations	χ^2	d.f.	p	
ABO: A ₁	A ₁	10	13.88	9	0.127
	A ₂	10	26.07	9	0.002
	B	10	9.07	9	0.431
	O	10	7.57	9	0.578
MNSs: MS	MS	10	65.38	9	<0.001
	Ms	10	88.69	9	<0.001
	NS	10	34.88	9	<0.001
	Ns	10	13.32	9	0.149
Rhesus: CDE	CDE	10	47.21	9	<0.001
	CDe	10	17.98	9	0.035
	cDE	10	21.95	9	0.009
	cDe	10	65.94	9	<0.001
	CdE	10	9.90	9	0.359
	Cde	10	60.75	9	<0.001
	ode	10	102.39	9	<0.001
	Duffy: Fy ^a	Fy ^a	10	111.94	9
Diego: Di ^a	Di ^a	10	14.24	9	0.114

Discussion

The Caucasoid and Mongoloid populations of Assam appear to form two more or less distinct clusters with respect to MNSs, Rhesus, Duffy and Diego blood groups systems, though there are some exceptions, which as a matter of fact provide clues for further investigation. It should be mentioned here briefly that such a clustering was also found concerning serum protein groups, red cell enzymes and haemoglobin variants. The results of these studies will be published elsewhere.

In general, the Assamese Caucasoids and Mongoloids differ in the distribution of the following alleles and haplotypes, respectively: MS, NS, Ns more frequent in Caucasoids, Ms in Mongoloids; CDE, CDe, cDE and cDe less frequent in Caucasoids than in Mongoloids, in which cde frequencies on the other hand are comparatively less frequent than in Caucasoids; Fy^a more frequent in Mongoloids than in Caucasoids; Di^a — though generally rather infrequent — obviously more common in Mongoloids than in Caucasoids. Hence, it can be said that the two major population groups have maintained their own genetic peculiarities, but at the same time gene flow from one to the other has taken place.

These observations are in good agreement with that obtained on other Caucasoid and Mongoloid populations of East India (Manipur and Sikkim). SINGH *et al.* (1986), who could analyse the distribution of 16 polymorphic systems among Brahmins (Caucasoid origin) and Meiteis (Mongoloid origin) of Manipur, observed different gene frequency pattern in these two populations. BHASIN *et al.* (1986) studied 17 polymorphic systems in 13 population groups of Sikkim and found also a clear difference in the genetic make-up of the populations of Caucasoid or Mongoloid origin, respectively. In Sikkim these observations are corroborated by the distribution pattern of colour blindness, ear lobe attachment, mid-phalangeal hair and behavioural traits (BHASIN *et al.*, 1987). The Ahoms are a Shan people, while the other Mongoloid population of Assam are of Tibeto-Burman origin. This appears to be reflected e.g. by their higher MS and Ns and lower Ms frequencies as compared to other Mongoloid populations, just as by their comparatively low Fy^a frequency.

The peculiar position of the Karbis among the Tibeto-Burmans has been mentioned above already. They appear to have also maintained certain peculiarities in terms of their genetic make up. For example: A₂ has not been found, their B frequency is the highest, and also with regard to the MNSs and Rhesus systems some peculiarities are observed.

The Ahom, Chutiyas and Sonowal samples were drawn from the same small geographic area, but that has not brought them closer to each other. Each one appears to have maintained their own distinctiveness with regard to the polymorphic blood group systems under study.

The Chutiyas and Sonowals since long past have formed an integral part of the Assamese speaking populations of Assam. But in general with regard to the blood group systems considered here they depict appreciable differences from the Caucasoid Assamese.

The Kacharis and Sonowals are two divisions of the same tribe. But they do not appear to be similar to one another in respect of the blood group polymorphisms under study. This is in part because of the fact that they live in two separate geographic areas and are hence in genetic isolation from each other. Gene flow from neighbouring populations in the respective areas, founder effects etc. may also have contributed to the genetic differences of these two groups.

The speciality and antiquity of the Kalita caste has been mentioned above. Do the factors like presence of comparatively high A₂, Di^a, and also their peculiarities in the MNSs, Rhesus and Duffy systems suggest anything noteworthy? All these peculiarities

depicted by this caste certainly indicate an appreciable Mongoloid admixture, which, of course, has to be subjected to further research.

The Rajbanshis appear, in some genetic markers, more akin to their — Mongoloid — ancestral group, while in other they more or less occupy an intermediate position between the Mongoloids and Caucasoids. Considering the ethnic history of the Assamese Rajbanshis one can suppose that this position reflects the results of intermixture processes.

However, a clear picture of genetic relationships between the ten Assamese populations under study will be measured applying proper statistical methods and considering the whole set of genetic data. This will be done in a forthcoming paper (CHAKRABORTY *et al.*, in preparation). Even then, it can be said that an examination of the ethnographic background of the populations provides interesting data with regard to their genetic relationships.

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