THE BLOOD GROUPS AND HÆMOGLOBINS OF THE SIKHS

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BLOOD-GROUP studies show, beneath the diversity of the settled peoples of India, an underlying uniformity, whereas many of the aboriginal tribes differ from these people in a more marked and fundamental manner. The numerous and scattered references to these studies have been listed by Boyd (1939) and Mourant (1954) who have also collected most of the published data into tables.

The settled peoples show varying but always high frequencies of group B, and rather high frequencies of A. The aboriginal tribes may or may not show these features, and some show ABO frequencies which in different ways are near the extreme limits found among human populations. The only blood-group system other than the ABO, for which the data are adequate to show systematic differences within the Indian sub-continent, is the Rh system. With respect to the latter, most of the settled peoples so far sampled show frequencies closely similar to those of the Mediterranean peoples who have, however, very different ABO frequencies. There are usually 5 to 10 per cent. of Rh-negatives (mostly cde/cde), with a very high frequency of genotypes containing CDe (R_1), and with cDE (R_2) present but less frequent than in northern Europe. The chromosome: CDE (R_z) is absent or very rare.

Many of the aboriginal tribes, on the other hand, are entirely lacking in Rh-negatives and among them CDE is not very rare. Some of these tribes, of a Veddoid type, and living in the Nilgiri Hills, have a moderately high frequency of the sickle-cell trait which appears to be absent from the settled peoples of the same region (Lehmann and Cutbush, 1952). The settled peoples in general are, however, far from being genetically uniform—they are apparently less so, for example, than the peoples of northern and central Europe. This is particularly shown in the study by Sanghvi and Khanolkar (1950-51) of a number of different castes in Bombay. There is, therefore, still considerable scope for blood-group studies of different communities; especially if these tend to be exclusively endogamous. In order, however, to discover statistically significant differences between the communities, it will become necessary to test larger numbers of persons than have usually been examined in the past, and any considerable extension of the work must depend on the development of laboratory facilities and serum supplies in India.

In the present paper we describe an investigation which was in

the first place intended to cover the A_1A_2BO , MNS and Rh groups of the Sikhs. As the work proceeded the rapid progress of research on the abnormal hæmoglobins (one of which is responsible for sickling) made it desirable to look for those as well. All blood samples were

TABLE 1
The $A_1 A_2 BO$ blood groups of 213 Sikhs

Phenotype	Number observed	Frequency observed	Frequency expected	Number expected
O	69	0.324	0.329	70.1
A_1	37	0.174	0.167	35.5
A_2	11	0.052	0.052	11.2
B	79	0.371	0.365	77.8
A_1B	12	0.056	0.064	13.6
A_2B	5	0.023	0.023	4.9
Total . . .	213	1.000	1.000	213.1

Gene frequencies

A_1	0.123
A_2	0.044
B	0.260
O	0.573
Total . . .	1.000

TABLE 2
*The ABO blood groups of 600 Sikhs**

Phenotype	Number observed	Frequency observed	Frequency expected	Number expected
O	205	0.342	0.349	209.2
A	152	0.253	0.245	147.1
B	199	0.332	0.324	194.2
AB	44	0.073	0.083	49.6
Total . . .	600	1.000	1.001	600.1

* The 213 listed in table 1 are not included in these 600.

Gene frequencies

A	0.180
B	0.229
O	0.590
Total . . .	0.999

tested with the sera anti-A, -B, -C, -D, -E, -c, -M, -N, -S. Samples positive with anti-A were tested with anti- A_1 , and those positive with anti-E, with anti-e. Those which were negative with a saline anti-D were tested by means of the indirect anti-human-globulin technique

with several incomplete anti-D sera in order to detect the antigen D^u if present. The anti-C serum used had, as usual, the specificity anti-C+anti-C^w. Samples positive with this serum among the last 109 examined were further tested with pure anti-C^w. The same 109 samples were also tested with anti-Henshaw (all with negative results), and the hæmoglobin from them was tested at St Bartholomew's Hospital by means of paper electrophoresis. A further 170 specimens were tested electrophoretically but were not examined for blood groups. Samples from another 600 individuals were tested at Poona with anti-A and anti-B. The results of our tests are shown in tables 1-5. Gene frequency calculations were performed by the methods described by Mourant (1954).

The frequencies of the A, B and O genes fall well within the range

TABLE 3
The MNS blood groups of the Sikhs

Phenotype	Number observed	Frequency observed	Frequency expected	Number expected
MMS . . .	50	0.235	0.251	53.5
MsMs . . .	39	0.183	0.159	34.0
MNS . . .	51	0.239	0.221	47.1
MsNs . . .	44	0.207	0.239	50.9
NNS . . .	8	0.038	0.039	8.4
NsNs . . .	21	0.099	0.090	19.1
Total . . .	213	1.001	0.999	213.0

Chromosome frequencies

MS	0.242
Ms	0.399
NS	0.060
Ns	0.299
Total	<u>1.000</u>

of frequencies characteristic of north Indian populations. The A₂ gene is present; its frequency appears higher than in most north Indian populations, but the difference is not statistically significant. The MNS frequencies also are similar to the values previously found for the region but the frequency of the Ms chromosome is among the higher reported values.

The Rh frequencies also are fairly typical of the north Indian region, but with the frequency of chromosomes CDe and cDe among the higher of the values previously reported, and that of cde among the lower. The C^w gene had previously been found in the Indian sub-continent (in Pakistan) (Chaudhri *et al.*, 1952), only in the rare combination C^wcde. In the present series, in the absence of the genotype C^wcde/cde, it is presumed that, as in Europe, C^w occurs in the combination C^wDe. The typically African cDe chromosome

TABLE 4
The Rh blood groups of the Sikhs

Phenotype	Number observed	Frequency observed	Frequency expected	Number expected
CCDee *	91.636	0.430	0.423	90.2
CCD ^u ee	1	0.005	0.001	0.3
C ^w CDee *	4.364	0.020	0.019	4.1
CCddee	0	...	0.000	0.0
CcDEe	30	0.141	0.154	32.7
C ^w cDEe	0	...	0.003	0.7
CcDee *	57.156	0.268	0.266	56.6
CcD ^u ee	0	...	0.010	2.2
C ^w cDee *	1.844	0.009	0.006	1.3
Ccddee	1	0.005	0.005	1.0
ccDEE	5	0.023	0.014	3.0
ccDEe	9	0.042	0.051	10.8
ccDee	3	0.014	0.012	2.5
ccD ^u ee	1	0.005	0.004	0.8
ccddee	8	0.038	0.031	6.6
Total	213.000	1.000	0.999	212.8

* For the first 104 specimens tested, no distinction was made between C and C^w. It has therefore been assumed that the phenotypes CCDee and CcDee among these specimens included C^wCDee and C^wcDee respectively in the same proportions as for the 109 specimens tested subsequently.

Chromosome frequencies

CDe	0.612
C ^w De	0.015
CD ^u e	0.027
Cde	0.013
cDE	0.118
cDe	0.029
cD ^u e	0.011
cde	0.176
Total	<u>1.001</u>

TABLE 5
The hemoglobins of the Sikhs

Genotypes	Numbers observed	Frequencies observed	Frequencies expected	Numbers expected
AA	274	0.9821	0.9786	273.03
AD	4	0.0143	0.0213	5.94
DD	1	0.0036	0.0001	0.03
Total	279	1.0000	1.0000	279.00

Gene frequencies

A	0.9892
D	0.0108
Total	<u>1.0000</u>

has a frequency below that usually found in the Mediterranean area, or even in northern Europe. The cD^ue chromosome, recognisable in one individual, is almost completely absent in northern Europe but is found, with very much higher frequencies than in the present case, in certain Mediterranean and African populations.

Five persons out of 279 were found to carry hæmoglobin D. Four of these had hæmoglobins A and D: one had only D and is presumed to be homozygous for the corresponding gene, but this conclusion must be accepted with reservations until confirmed by family investigations. It is clear, however, that hæmoglobin D, though not common, is something more than a sporadic mutant as had been suspected when it had been found only in one Sikh (Bird, Lehmann and Mourant, 1955) and in two families of European ancestry. At the same time as the tests on the Sikhs, specimens from 13 Punjabi Hindus were tested, with the discovery of one individual heterozygous for hæmoglobins A and D. The production of hæmoglobin D thus seems to be essentially a Caucasoid character. Hæmoglobin S, typical of Africans and of Indian and Arabian Veddoids, was not found, nor was hæmoglobin E, typical of S.E. Asia but penetrating into India.

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