

## Study of Blood Groups, Abnormal Hemoglobins and other Genetical Characters in Some Tribes of Gujarat

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The classification of man on the basis of biological differences is comparatively recent. The two chief methods of study are (1) the morphological method and (2) the genetical method. Although Boyd ('50) made a strong case for the genetical method, it is now realized that a combined study with the two methods affords a better understanding of the biological differences between human populations. Sanghvi ('53) was the first to attempt a direct comparison of the two methods. Pollitzer ('58) applied a similar procedure to populations which are far apart. Mourant ('59) rightly says, "It is now realized, however, that when the two methods are used *with full precautions* against technical and statistical errors they supplement and support one another to a remarkable extent and that both are necessary in order to give the fullest possible information about the relations between populations."

Sanghvi and Khanolkar ('49) had undertaken a study of genetical diversity in some endogamous groups of Western India. Since then the Indian Cancer Research Center has been a nucleus of such work [Sanghvi et al. ('54), Sanghvi et al. ('56), Sirsat ('56) Vyas et al. ('58) and Varde et al. ('60)]. During the course of these investigations Sukumaran et al. ('56) encountered a high frequency of sickle-cell trait in some of the tribes of Gujarat. The genetical work was therefore extended to various districts of Gujarat where these tribes reside. Some of our work was conducted only for genetical studies but in three cases the work was carried out along with the anthropometrist deputed by the Gujarat Research Society. The results of

the anthropometric measurements are, however, not yet fully published. The Society has undertaken to publish comprehensive monographs on anthropological studies of five tribes of Gujarat in succession of which two are already published (Shah, '58 and '59).

### MATERIALS AND METHODS

Table 1 shows the number of unrelated subjects investigated from each of the seven endogamous tribes for  $A_1A_2BO$ , MN, Rh subtypes (-C, -c, -D, -E),  $Fy^a$  and P blood groups, secretor-nonsecretor of group specific substance in saliva, taste reaction to phenylthiocarbamide and red-green color blindness. Sickling wet preparations were put up on all blood samples using freshly prepared 2% sodium meta-bisulphite. The detailed serological, genetical and hematological methods employed were essentially the same as described earlier by Vyas et al. ('58) and Sukumaran et al. ('56). A brief account of these tribes is given in the Appendix.

The field work was usually arranged through the local tribal welfare organizations, Ashrams, Government authorities and more often through the Gujarat Research Society. Finger prick blood samples collected in citrate-dextrose mixture and boiled saliva samples were brought over in an ice box for testing at Bombay. Since the work was carried out in two series of tours over a period of three years it was not possible to test some of the samples with anti- $P_1$  and anti- $Fy^a$  sera, which were not available at the time of testing. During the first series of field visits only the samples showing sickling

TABLE 1  
Number of subjects investigated from seven endogamous tribal groups

Endogamous group	Abbreviations	District of investigation	Number of subjects			Total population
			Male	Female	Total	
Dubla	Du	Surat	109	103	212	174,369
Koli	Ko	Surat	95	81	176 + (6) <sup>2</sup>	13,407
Naika	Na	Surat	73	88	171 + (3) <sup>2</sup>	128,604
Dhodia	Dd	Surat	108	93	201 + (12) <sup>2</sup>	76,935
Gamit	Ga	Surat	147	56	203 + (4) <sup>2</sup>	111,901
Bhil	Bh	Panchmahal I <sup>1</sup>	121	37	158 + (48) <sup>2</sup>	847,879
		II <sup>1</sup>	152	37	189	
Dhanka	Dk	Broach	112	103	215	32,514

<sup>1</sup> Bhils were investigated in two series: I series was examined only for blood grouping and sickling and II series was examined for saliva, color blindness and p.t.c. taste reaction.

<sup>2</sup> Numbers in parentheses indicate the number of samples hemolyzed or accidentally lost and hence could not be tested for blood grouping and paper electrophoretic pattern. However, sickling on these samples was done during the field work.

were studied by paper electrophoresis technique, while in the second series of field visits all samples were studied by electrophoresis technique.

#### STATISTICAL METHODS

The ABO gene frequencies were calculated by Fisher's method published by Dobson and Ikin ('46) and Fraser Roberts ('48). The A<sub>1</sub> and A<sub>2</sub> gene frequencies were calculated by the formulae suggested by Sanghvi ('52) viz.,

$$p_1 = 1 - \sqrt{1 - \frac{ap(2-p)}{a+1}} \text{ and } p_2 = p - p_1,$$

where p = gene frequency for A and a =

$$\frac{A_1 + A_1B}{A_2 + A_2B}.$$

The MN gene frequencies were calculated by the gene-counting method. The gene frequencies in the P and Duffy blood group systems and for ABH secretion were all calculated from the frequency of homozygous recessives by the square-root method. The frequency of homozygous normal was used to calculate the gene frequencies for hemoglobin A and S.

The Rh chromosome frequencies were calculated by the formulae recommended by Mourant ('54).

The method followed for evaluating intergroup differences between the seven endogamous tribal groups was the same as that reported by Sanghvi and Khanolkar ('49). In order to avoid small numbers, the Rh phenotypes were grouped into four classes viz., CCDee, CcDE, CcDee and others. The analysis on color-blindness was confined to males. All  $\chi^2$  values were

calculated from  $2 \times 2$  and  $2 \times n$  tables, using actual phenotype values (see table 13) as well as per cent phenotype frequencies (see table 14). Yate's corrections were made wherever necessary.

The method used for assessing the overall genetical differences between any two endogamous tribal groups was that evolved by Sanghvi ('53).

#### RESULTS

The results of each genetical character in seven tribes are tabulated in tables 2-12. Dubla tribe formed a part of the previous published work (Vyas et al., '58) but, its results are included here to consider the genetical affinity between the other tribes studied. In the case of P.T.C. taste reaction serial double dilutions from 1,600 p.p.m. to 25/16 p.p.m. were used and it was found that 1:50 was the threshold dilution. Hence persons tasting 1:50 and lower concentration of P.T.C. were considered tasters and persons tasting 1:100 and higher concentrations of P.T.C. were considered non-tasters. The subjects failing to taste quinine 1:200 p.p.m. were discarded from calculations.

#### DISCUSSION

ABO, MN and Rh blood group data for seven tribes do not show any highly significant  $\chi^2$  value except in Gamit ( $\chi^2 = 6.36$  for 1 degree of freedom for ABO blood groups. This remains unexplained on any grounds except a probable heterogeneity within the tribe. In the same tribe, no individual with phenotype ccddee (rr) was found in a series of 203, although

TABLE 2  
Comparison of observed and expected numbers in the A<sub>1</sub>A<sub>2</sub>BO blood groups and the gene frequencies

Group	No. tested	No. observed						No. expected						Gene frequency					
		O	A <sub>1</sub>	A <sub>2</sub>	B	A <sub>1</sub> B	A <sub>2</sub> B	O	A <sub>1</sub>	A <sub>2</sub>	B	A <sub>1</sub> B	A <sub>2</sub> B	χ <sup>2</sup>	d.f.	P <sub>1</sub>	P <sub>2</sub>	q	r
Du	212	71	43	4	76	16	2	70.99	42.81	4.19	75.99	16.21	1.81	0.033	2	0.1505	0.0168	0.2540	0.5787
Ko	176	80	28	2	53	10	3	82.34	27.34	3.54	54.55	7.21	1.01	5.807	2	0.1035	0.0145	0.1980	0.6840
Na	171	57	45	5	53	11	-	55.25	44.65	3.82	51.37	14.45	1.46	1.989	1	0.1911	0.0193	0.2212	0.5684
Dd	201	76	74	3	33	15	-	76.93	75.46	2.47	33.40	12.25	0.48	0.572	1	0.2493	0.0099	0.1222	0.6186
Ga	203	70	74	3	33	23	-	73.48	78.47	2.35	34.64	13.56	0.50	6.362 <sup>1</sup>	1	0.2607	0.0095	0.1282	0.6016
Bh	158	46	39	2	52	19	-	46.94	40.49	1.33	53.05	15.58	0.61	0.920	1	0.1968	0.0076	0.2505	0.5451
Dk	205	66	49	6	71	13	-	63.64	48.55	4.49	68.46	17.92	1.94	3.071	1	0.1779	0.0193	0.2456	0.5572
Total	1326	466	352	25	371	107	5												

<sup>1</sup> 0.01 > P > 0.02.

one instance of phenotype Ccddee (R'r) and a large number of cases of CcDee were observed, suggesting the presence of r (cde) chromosome. The method of calculation employed however has given a large value for the chromosome R' (Cde) which, we feel, would also include the chromosome r (cde). There is nothing remarkable to comment upon the results of other genetical characters. It was not possible to undertake further family studies on the five cases of homozygous SS electrophoretic pattern encountered in Gamit and Dhanka. No other hemoglobin variant was encountered during the later series of field visits.

*Intergroup genetical differences between the tribes.* There are two ways in which intergroup differences have to be considered (i) the number of characters for which any two groups differ from each other and (ii) the degree of significance for the character in which they differ from each other.

The final values of χ<sup>2</sup> for intergroup differences with respect to each of the genetical characters are shown in table 13. It will be observed that several of the differences are significant as indicated in table 13. Thus it will be observed that Dhodia differs from most of the tribes except Gamit, in two or more genetical characters with high degree of significance. Gamit also differs significantly from the other groups. However, Dhodia and Gamit significantly differ only in the MN character. Koli differs from the rest of the groups except Dubla in two or more genetical characters with fairly high degree of significance. Bhil, Dubla and Naika do not differ significantly from one another except that Dubla × Naika differ in MN character.

To understand this complex situation in a simpler form and to assess the overall G<sup>2</sup> differences, 2 × 2 and 2 × n tables were formed for each one of the 21 group combinations for the phenotype percentage of ten genetical characters and the χ<sup>2</sup> values were determined for each genetical character. Finally these χ<sup>2</sup> values for various genetical characters of each group combination were added up and divided by the total number of degrees of freedom to give the final genetical difference, G<sup>2</sup>, be-

TABLE 3

Comparison of observed and expected numbers in the MN blood groups, and the gene frequencies

Group	No. tested	No. observed			No. expected			$\chi^2$ (d.f. = 1)	Gene frequency	
		M	MN	N	M	MN	N		m	n
Du	212	75	106	31	77.28	111.44	33.28	0.428	0.6038	0.3962
Ko	176	70	84	22	71.27	81.45	23.27	0.181	0.6364	0.3636
Na	171	45	79	47	41.76	85.49	43.76	0.974	0.4942	0.5058
Dd	201	45	90	66	40.30	99.40	61.30	1.797	0.4478	0.5522
Ga	203	58	102	43	58.53	100.94	43.53	0.022	0.5370	0.4630
Bh	158	58	69	31	54.15	76.70	27.15	1.593	0.5854	0.4146
Dk	204	59	107	38	62.04	100.92	41.04	0.740	0.5515	0.4485
Total	1325	410	637	278						

TABLE 4

Observed numbers of the Rh phenotypes in seven endogamous tribes

Group	No. tested	No. observed with phenotypes										
		CCDE	CCDee	CCddee	CcDE	CcDee	Ccddee	ccDE	ccDee	ccD <sup>ue</sup> ee	ccddE	ccdde
Du	212	—	103	1	21	68	—	8	7	—	—	4
Ko	176	1	80	—	14	55	—	7	6	—	—	13
Na	171	1	99	—	18	40	—	5	6	—	—	2
Dd	199	1	129	—	23	35	—	4	5	—	—	2
Ga	203	—	130	—	17	45	1	6	4	—	—	—
Bh	156	5	72	—	12	51	—	3	8	—	2	3
Dk	204	1	119	—	16	59	—	4	3	1	—	1
Total	1321	9	732	1	121	353	1	37	39	1	2	25

TABLE 5

Rh chromosome frequencies in seven endogamous tribes

Group	No. tested	Rh chromosomes frequencies							
		CDE (R <sub>2</sub> )	CDe (R <sub>1</sub> )	Cde (R')	cDE (R <sub>2</sub> )	cDe (R <sub>0</sub> )	cD <sup>ue</sup> e (R <sup>u</sup> <sub>0</sub> )	cdE (R'')	cde (r)
Du	212	—	0.6842	0.0163	0.0709	0.0908	—	—	0.1378
Ko	176	0.0041	0.6522	—	0.0605	0.0489	—	—	0.2343
Na	171	0.0038	0.7506	—	0.0691	0.0883	—	—	0.0882
Dd	199	0.0031	0.7959	—	0.0699	0.0612	—	—	0.0699
Ga	203	—	0.7260	0.0695	0.0584	0.1461	—	—	—
Bh	156	0.0230	0.6725	—	0.0132	0.1215	—	0.0370	0.1328
Dk	204	0.0032	0.7688	—	0.0497	0.0655	0.0331	—	0.0797

tween the two groups. Table 14 embodies the values of the  $\chi^2$  for each genetical character with reference to 21 pairs of the group combinations and their respective genetical differences,  $G^2$  values.

The overall genetical difference,  $G^2$  shown in table 14 can be diagrammatically represented to get a clearer perspective of the relationship between these tribes. Figure 1 is a two dimensional representation of the multidimensional genetical relationship between these tribes, based on the values of the genetical difference,  $G^2$ ,

in table 14. The genetical difference between Gamit and Dhodia is small and they cluster together with respect to the other five groups. Similarly the genetical differences between Dubla, Bhil, and Naika are small and they cluster together with respect to the other four groups. These two clusters can be taken as situated at two ends of an axis representing the average difference between the two clusters. For locating the position of Dhanka on the figure, two arcs are drawn with radius of each being the average difference between

TABLE 6  
Comparison of the observed and expected numbers of the Rh phenotypes

Group	Rh phenotypes												$\chi^2$ (2 d.f.)						
	CCDE		CCDee		CcDE		CcDee		ccDE		ccDee			ccdde					
	Obs.	Exp.	Obs.	Exp.	Obs.	Exp.	Obs.	Exp.	Obs.	Exp.	Obs.	Exp.							
Du	-	-	103	103.96	1	1.01	21	21.06	68	66.95	8	7.94	7	7.05	-	-	4	4.03	0.025
Ko	1	0.93	80	74.86	-	-	14	14.39	55	65.02	7	6.68	6	4.46	-	-	13	9.66	3.615
Na	1	0.97	99	96.34	-	-	18	18.04	40	45.32	5	4.98	6	4.00	-	-	2	1.33	2.048
Dd	1	0.98	129	126.06	-	-	23	22.40	35	41.51	4	4.62	5	2.45	-	-	2	0.97	4.946
Ga	-	-	130	127.50	1	0.98	17	18.85	45	47.18	6	4.15	4	4.33	-	-	-	-	1.192
Bh	5	4.90	72	70.56	-	-	12	12.72	51	53.35	3	2.63	8	7.33	-	-	2	1.75	0.357
Dk	1	1.02	119	120.58	-	-	16	15.87	59	55.93	4	4.11	3	3.89	1	1.30	1	1.30	0.535

CCddee (R'R') and Ccddee (R'r) have been grouped for the comparison.

TABLE 7  
Observed numbers in the P blood groups and the gene frequency

Group	No. tested	P <sub>1</sub>	P <sub>2</sub>	Gene frequency	
				P <sub>1</sub>	P <sub>2</sub>
Ko	82	68	14	0.5868	0.4132
Na	45	36	9	0.5528	0.4472
Dd	71	46	25	0.4066	0.5934
Ga	67	49	18	0.4817	0.5183
Dk	104	49	55	0.2728	0.7272
Total	369	248	121		

TABLE 8  
Observed numbers in the Duffy blood groups and the gene frequency

Group	No. tested	Fy <sup>(a+)</sup>	Fy <sup>(a-)</sup>	Gene frequency
				Fy <sup>a</sup>
Du	198	129	69	0.4097
Ko	78	50	28	0.4009
Na	82	55	27	0.4262
Dd	89	58	31	0.4098
Total	447	292	155	

Dhanka and the respective cluster. For locating Koli on the figure, the distances were rounded up to nearest approximation in order to make its position representative in relation to rest of the groups.

It will be observed from the figure that Koli stands out separate from both the clusters. The two clusters are not far from each other but the GaxDu cluster is further away from Koli than the Du × Bh × Na cluster. Moreover, Dhanka also stands out separate and far from Koli but close enough to Du × Bh × Na cluster.

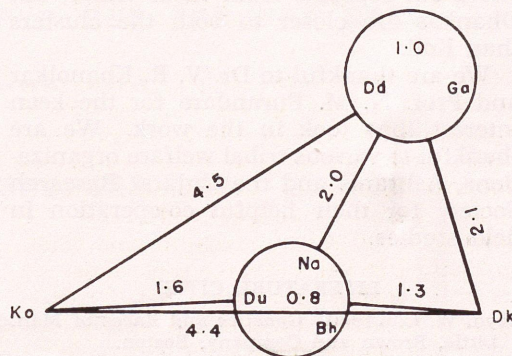


Fig. 1 Diagrammatic representation of the genetical difference between the seven endogamous tribes of Gujarat.

TABLE 9  
Incidence of ABH secretion, and the secretor gene frequencies

Group	No. tested	Secretor	Non-secretor	Gene frequency	
				Se	se
Du	202	167	35	0.5838	0.4162
Ko	128	97	31	0.5079	0.4921
Na	81	60	21	0.4908	0.5092
Dd	99	77	22	0.5286	0.4714
Ga	203	164	39	0.5617	0.4383
Bh	89	77	12	0.6328	0.3672
Dk	182	142	40	0.5312	0.4688
Total	984	784	200		

This observation is in conformity with the fact that Koli is a semi-tribal group and not a scheduled tribe. This brings out an interesting fact that there are no remarkable genetical differences between the various tribes studied, except that Koli stands out as a separate group from the rest. Though Dhanka is also separated out, it is close enough to Du × Bh × Na cluster.

#### SUMMARY

Seven tribes were investigated for A<sub>1</sub>A<sub>2</sub>BO, MN, Rh (-C,-c,-D,-E), Duffy and P blood groups, secretion of ABH substances in saliva, threshold determination of P.T.C. taste reaction, color-blindness, sickling and paper electrophoresis for other hemoglobin variants. The results show a closer affinity between Dubla, Bhil, and Naika on one hand and Gamit and Dhodia on the other hand, the two clusters themselves showing no remarkably large difference between them. Koli and Dhanka, stand out separate from these tribes, but Dhankas are closer to both the clusters than Koli.

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TABLE 10  
Results of taste reaction to P.T.C.

Group	Sex	No. tested	P.T.C. parts per million parts of water											Tasters	Non-tasters	
			25/16 T <sub>2</sub>	25/8 T <sub>3</sub>	25/4 T <sub>4</sub>	25/2 T <sub>5</sub>	25 T <sub>6</sub>	50 T <sub>7</sub>	100 T <sub>8</sub>	200 T <sub>9</sub>	400 T <sub>10</sub>	800 T <sub>11</sub>	1,600 T <sub>12</sub>			Quinine T <sub>13</sub>
Du	M	105	—	4	3	17	13	12	1	5	3	6	8	33	49	56
	F	102	—	4	14	13	16	17	1	1	—	3	12	21	64	38
	Tot.	207	—	8	17	30	29	29	2	6	3	9	20	54	113	94
Ko	M	66	3	5	7	12	11	5	1	2	—	—	10	10	43	23
	F	62	6	9	11	7	2	1	—	1	3	4	6	12	36	26
	Tot.	128	9	14	18	19	13	6	1	3	3	4	16	22	79	49
Na	M	34	—	—	4	5	6	6	—	1	1	—	3	8	21	13
	F	44	3	2	6	4	4	2	—	2	1	5	5	10	21	23
	Tot.	78	3	2	10	9	10	8	—	3	2	5	8	18	42	36
Dd	M	45	2	2	6	8	4	6	—	—	1	2	9	5	28	17
	F	38	3	7	2	4	—	4	—	—	2	1	6	9	20	18
	Tot.	83	5	9	8	12	4	10	—	—	3	3	15	14	48	35
Ga	M	144	1	10	18	8	15	8	3	2	6	15	23	35	60	84
	F	56	3	12	6	5	5	2	1	—	1	7	5	9	33	23
	Tot.	200	4	22	24	13	20	10	4	2	7	22	28	44	93	107
Bh	M	151	—	6	16	20	26	16	—	7	2	15	14	29	84	67
	F	37	—	6	1	7	4	1	—	1	2	2	2	11	19	18
	Tot.	188	—	12	17	27	30	17	—	8	4	17	16	40	103	85
Dk	M	110	1	2	4	16	12	6	—	3	5	14	14	33	41	69
	F	101	3	9	11	13	12	3	2	1	4	6	16	21	51	50
	Tot.	211	4	11	15	29	24	9	2	4	9	20	30	54	92	119
Total	M	655	7	29	58	86	87	59	5	20	18	52	81	153	326	329
	F	440	18	49	51	53	43	30	4	6	13	28	52	93	244	196
	Tot.	1095	25	78	109	139	130	89	9	26	31	80	133	246	570	525

Note: T<sub>1</sub> = Distilled water.

TABLE 11  
Incidence of color-blindness

Group	Male				Female		
	NV	CB	Total	% C.B.	NV	CB	Total
Du	106	3	109	2.75	103	—	103
Ko	61	6	67	8.96	63	—	63
Na	35	1	36	2.78	46	—	46
Dd	45	—	45	—	40	—	40
Ga	143	4	147	2.72	54	—	54
Bh	141	1	142	0.70	27	—	27
Dk	109	2	111	1.80	102	—	102
Total	640	17	657	2.59	435	—	435

TABLE 12  
Incidence of sickling, with results of paper electrophoresis

Tribe	No. examined	No. of sickling	Electrophoresis pattern		Gene frequency		Remarks
			A + S	SS	Hb - A	Hb - S	
Du	211	20	20	—	0.9514	0.0486	Only positive samples for electrophoresis.
Ko	182	8	8	—	0.9778	0.0222	No electrophoresis of first fifty samples negative for sickling.
Na	174	28	26	—	0.9160	0.0840	Two samples lysed.
Dd	213	38	38	—	0.9064	0.0936	
Ga	207	65	26	2	0.8282	0.1718	35 samples not tested for electrophoresis and two lysed (showing sickling).
Bh	206	32	32	—	0.9190	0.0810	
Dk	215	44	41	3	0.8918	0.1082	

#### APPENDIX

The castes and tribes of India pose an interesting and complex problem to anthropologists. The origin of several of the tribal groups is lost into obscure antiquity. Very little data about the ethnology of tribes of Gujarat is available in literature. A brief account of the ethnological background mostly abstracted from Euthoven's book (The tribes and castes of Bombay Vols. I, II and III Government Central Press, '22) may be a worthwhile appendix to this paper.

The tribal population of India numbers 19 million ('51) and consists of about 1,100 tribes listed in President's orders. The number of tribes in Gujarat is small compared to this formidable figure. The tribes reported in this paper are the major

tribes of Gujarat and are endogamous groups. Unlike most of the caste groups of Gujarat, the tribes are nonvegetarian in their dietary habits. They do not permit consanguineous marriages. Most of them are farmers or farm laborers.

The following map (fig. 2) shows the districts where the tribes are concentrated and the places where they were investigated.

*Dubla.* Dublas numbering about 174,369 ('51) are found chiefly in Bharuch, Surat and Thana districts of Western India. They are classed among the Rani-paraj or Kaliparaj, i.e. dark people, a common term in general use for the aboriginal tribes of Gujarat. Dublas differ from other aboriginal tribes in that they live in plains and not in forests or mountains and they

TABLE 13

Chi-square showing difference between the tribal groups with respect to the different genetical characters

Group combination	Genetical characters					Duffy	Secretion	P.T.C. taste	Color blindness	Sickling
	ABO	A <sub>1</sub> A <sub>2</sub>	MN	Rh	P					
Du × Ko	5.908	0.006	0.916	2.872	—	0.001	1.915	1.365	2.136	3.086
Du × Na	3.061	0.012	10.453 <sup>3</sup>	4.684	—	0.029	2.179	0.000	0.335	3.240
Du × Dd	24.389 <sup>4</sup>	1.529	21.157 <sup>4</sup>	16.010 <sup>3</sup>	—	0.017	0.743	0.138	0.233	5.588 <sup>2</sup>
Du × Ga	24.655 <sup>4</sup>	1.880	4.003	10.654 <sup>2</sup>	—	—	0.131	2.349	0.139	29.660 <sup>4</sup>
Du × Bh	2.449	0.961	2.161	0.575	—	—	0.420	0.000	0.602	2.969
Du × Dk	1.669	0.049	2.472	6.630	—	—	1.039	4.618 <sup>1</sup>	0.000	9.226 <sup>3</sup>
Ko × Na	8.958 <sup>1</sup>	0.061	14.577 <sup>4</sup>	9.126 <sup>1</sup>	0.029	0.052	0.013	0.936	0.604	12.132 <sup>4</sup>
Ko × Dd	23.989 <sup>4</sup>	2.332	26.099 <sup>4</sup>	22.769 <sup>4</sup>	5.671 <sup>2</sup>	0.000	0.038	0.176	2.675	15.960 <sup>4</sup>
Ko × Ga	26.954 <sup>4</sup>	2.762	7.768 <sup>1</sup>	16.913 <sup>4</sup>	1.469	—	0.899	6.651 <sup>3</sup>	2.738	44.578 <sup>4</sup>
Ko × Bh	11.076 <sup>2</sup>	1.569	3.163	1.588	—	—	3.162	1.228	7.194 <sup>3</sup>	11.788 <sup>4</sup>
Ko × Dk	9.154 <sup>1</sup>	0.024	5.943	14.111 <sup>3</sup>	23.687 <sup>4</sup>	—	0.106	9.748 <sup>3</sup>	3.454	20.971 <sup>4</sup>
Na × Dd	11.376 <sup>3</sup>	0.945	1.501	2.921	2.386	0.010	0.163	0.123	0.013	0.102
Na × Ga	13.317 <sup>3</sup>	1.206	2.018	1.677	0.369	—	1.189	0.936	0.304	11.139 <sup>4</sup>
Na × Bh	3.700	0.572	5.093	5.156	—	—	3.439	0.000	0.029	0.000
Na × Dk	0.607	0.036	4.181	3.432	12.552 <sup>4</sup>	—	0.294	2.009	0.101	0.947
Dd × Ga	1.921	0.097	7.234 <sup>1</sup>	2.110	0.764	—	0.211	2.576	0.272	9.710 <sup>3</sup>
Dd × Bh	18.188 <sup>4</sup>	0.194	12.066 <sup>3</sup>	15.956 <sup>3</sup>	—	—	1.862	0.111	0.351	0.252
Dd × Dk	18.361 <sup>4</sup>	1.352	10.868 <sup>3</sup>	7.923 <sup>1</sup>	4.622 <sup>1</sup>	—	0.011	4.282 <sup>1</sup>	0.015	0.322
Ga × Bh	15.203 <sup>3</sup>	0.124	2.748	9.747 <sup>1</sup>	—	—	1.039	2.341	0.745	13.596 <sup>4</sup>
Ga × Dk	20.437 <sup>4</sup>	1.681	0.434	2.513	10.237 <sup>3</sup>	—	0.297	0.241	0.005	6.025 <sup>2</sup>
Bh × Dk	3.649	0.837	3.129	6.209	—	—	2.261	4.540 <sup>1</sup>	0.046	1.412
d.f.	3	1	2	3	1	1	1	1	1	1

Degree of significance is indicated as follows: <sup>1</sup> 0.05 > P > 0.02; <sup>2</sup> 0.02 > P > 0.01; <sup>3</sup> 0.01 > P > 0.001; <sup>4</sup> P < 0.001.

TABLE 14

*Chi-square, calculated on the observed populations, and the coefficient of genetical difference between the tribal groups*

Group combination	ABO	A <sub>1</sub> A <sub>2</sub>	MN	Rh	P	Duffy	Sec.	P.T.C.	CB	Sick.	Genetical difference, G <sup>2</sup>
Du × Ko	3.056	0.105	0.475	1.471	—	0.000	1.054	0.772	2.462	1.289	0.763
Du × Na	1.613	0.000	5.409	2.492	—	0.019	1.704	0.001	0.175	1.411	0.916
Du × Dd	11.858	2.109	10.197	7.831	—	0.021	0.477	0.102	1.129	2.297	2.573
Du × Ga	11.919	2.382	1.928	5.145	—	—	0.026	1.006	0.177	13.456	2.772
Du × Bh	1.340	2.040	1.182	0.327	—	—	0.312	0.013	0.325	1.165	0.516
Du × Dk	0.801	0.021	1.191	3.204	—	—	0.422	1.997	0.001	3.919	0.889
Ko × Na	5.159	0.331	8.375	5.272	0.123	0.086	0.013	0.967	2.428	6.214	1.931
Ko × Dd	12.894	3.941	14.071	12.036	7.608	0.000	0.028	0.174	7.403	7.829	4.399
Ko × Ga	14.387	4.293	4.137	8.834	2.259	—	0.473	4.072	2.497	23.000	4.568
Ko × Bh	6.657	3.850	1.881	0.967	—	—	3.101	0.723	5.733	5.719	2.202
Ko × Dk	4.837	0.178	3.143	7.252	26.640	—	0.043	5.879	3.727	10.429	4.438
Na × Dd	6.039	1.437	0.814	1.573	5.052	0.018	0.201	0.180	1.156	0.020	1.099
Na × Ga	7.085	1.668	1.078	0.897	0.960	—	0.936	0.806	0.165	5.655	1.375
Na × Bh	2.239	1.378	3.096	3.152	—	—	4.143	0.000	0.341	0.007	1.104
Na × Dk	0.327	0.009	2.217	1.827	21.940	—	0.239	1.712	0.000	0.382	2.047
Dd × Ga	0.953	0.090	3.577	1.052	1.259	—	0.123	2.138	1.103	4.250	1.039
Dd × Bh	10.092	0.136	6.811	8.951	—	—	2.043	0.085	0.129	0.062	2.178
Dd × Dk	9.047	1.832	5.355	3.939	5.638	—	0.017	3.501	0.359	0.086	2.127
Ga × Bh	8.359	0.073	1.536	5.440	—	—	0.818	1.063	0.310	6.156	1.827
Ga × Dk	10.021	2.089	0.213	1.234	13.045	—	0.096	0.073	0.001	2.567	2.096
Bh × Dk	1.977	1.767	1.752	3.394	—	—	1.928	2.077	0.004	0.526	1.033

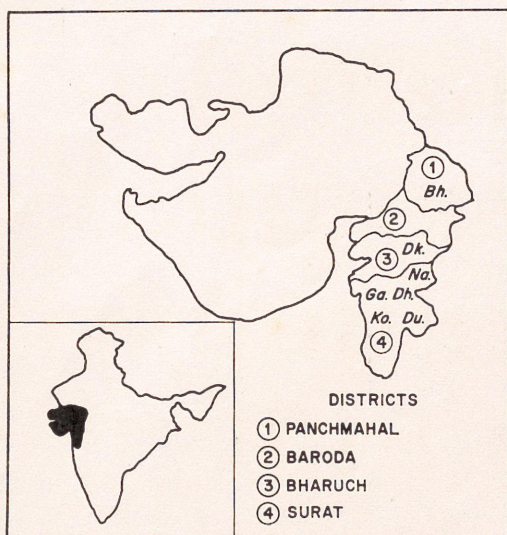


Fig. 2 The various districts of Gujarat where the different tribes were investigated.

have been living as farm labourers. "The term Dubla means weakling but actually they are not weaklings. They work very hard and are fond of liquor hence they age soon." They claim a strain of Rajput blood speaking of their near relations and connections, the Rathods. The Dublas admit higher castes such as Rajputs, Kumbis, Koli and Dhodia without any ceremony.

*Koli.* Numbering 13,407 ('51) are not a scheduled tribe but a link between the caste groups and tribal groups. They are socially higher than the tribes residing in the same area. Koli is a term of vague meaning, covering a number of tribes of inferior status which have little in common beyond a position inferior to the Kunbi or cultivating caste. As the Kolis now stand they are a very mixed group, with too little pride in their descent to trace distant relationship or form large and distinct marriage groups. The inferior of Rajput and Bhil blood is most marked in some of the groups of Gujarat Kolis and the distinction between Rajput and Koli as well as Bhil and Koli in extreme cases is almost non-existent.

*Naika.* Numbering 128,604 ('51) is one of the major tribes of Gujarat. They are concentrated in Surat District. Another group called Naikadas also exists in Panchmahal district but that group has no social relations with this group. Of their

origin as a separate class two stories are told. One that their ancestors were grooms to the musalman nobles and merchants of Champaner who took to the woods when, on the fall of that city (1550-1573), their employment was lost. A second account states that they are descended from an escort sent into Western Gujarat by the Raja of Champaner. There seems little doubt that they were largely employed in Champaner in some menial capacity.

*Dhodia.* Numbering 76,935 ('51) are one of the more civilized and economically better off group than Naika or Dubla and regard themselves as superior to these two groups. In their customs and social habits they do not differ much from Dublas or Naikas.

*Gamit.* Numbering 111,901 ('51) is another tribe of Surat District. There is hardly any authentic data available in connection with their origin. In social customs they have similarity with other tribes of Surat District. They are mainly agriculturists and are economically better off than Dublas.

*Bhil.* The Bhils are one of the largest and most interesting tribes of India. Bhils are chiefly found in Gujarat and Khandesh. Gujarat Bhils numbering 847,879 ('51) speak a cognate dialect of Gujarati, called Bhili. Panchmahal district has a large majority of Bhils residing in interior villages. The characteristic weapon of the tribe is a bow and arrows. The Bhils are light limbed, active and some have handsome, though rough features. The women are fond of ornaments made of silver and tin. It is very difficult to ascertain the customs of the original Bhil tribe, as the tribes now belonging to it represent various grades of culture, from the primitive man to the fully hinduised Kunbi or cultivator. They have their typical birth ceremonies and marriage ceremonies.

*Dhanka.* Numbering 32,514 is a smaller tribe, more concentrated in Rajpipla Division of Bharuch District. Dhankas are supposed to be related to Bhils but Dhankas of Broach and Bhils of Panchmahal differ remarkably in their dress, social customs and appearance. They are mainly agriculturists and economically better off than the tribal groups in Surat District.