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The Caingang Revisited: Blood Genetics and Anthropometry

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ABSTRACT A total of 248 individuals belonging to four populations of Caingang Indians from southern Brazil were studied in relation to 23 genetic systems that are expressed in blood and one manifested on saliva. These results were compared with those obtained in 400 members of these same communities that were subjected to 11 body measurements. Nine polymorphic loci (MNSs, P, Rh, Duffy, Diego, Hp, PGM_1, ESD, and Gc) were chosen for the calculation of the genetic distances between the four populations, which were compared with Mahalanobis's D^2 differences. The two sets of values proved to be intercorrelated but neither showed a relationship with the geographic distances separating the four communities. The Caingang were previously classified linguistically as Gê, and they show several affinities with the Gê tribes, both when hematological, and morphological, characteristics are considered. A variant PGD phenotype is also described, showing a curious storage effect.

The Caingang Indians of southern Brazil have been the subject of studies by members of our group for more than two decades now. Field work started in 1958 and the first results were published in Tondo and Salzano (1960) and Salzano (1961a,b,c,d). Subsequent investigations were reported in 16 other papers (listed in Salzano, 1978); they included demographic variables, morphology (anthropometry, dermatoglyphics, skin color, and other characteristics), hemoglobin types, blood groups and salivary secretion, serum proteins, color blindness, some rare genetic conditions, growth, active sweat-gland distribution, and the effects of consanguineous marriages. But no information about some of the recently discovered polymorphisms was available for this tribe. The development of new methods of population comparison involving genetic (Cavalli-Sforza and Edwards, 1967) and morphologic (Spielman, 1973) distances, on the other hand, furnished new tools for the analysis of their intratribal variability, and the comparison of their gene pool with those of other South American Indians. Therefore, when we decided to study their chromosome polymorphisms (unpublished data of B. Erdtmann and F.M. Salzano), the bloods collected were also tested for several genetic markers. The results thus obtained are reported below, together with information about anthropometric traits that have been only partially published before (Da Rocha, 1971; Marcellino et al., 1978).

MATERIALS AND METHODS

The Caingang were known in older times by the name of Guaianá. The word Caingang was introduced by Telemaco M. Borba to designate all non-Guarani Indians of the southern Brazilian States of São Paulo, Paraná, Santa Catarina, and Rio Grande do Sul. Their lan-

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guage was classified as Gê by many scholars and this view was shared by Loukotka until 1935. In his later classification, however, this linguist separated them as an independent stock (Loukotka, 1968). Information about the history, demography, social organization, and other aspects of the culture of this tribe can be found in Becker (1976).

The populations studied live in four reservations in the northern region of the Brazilian State of Rio Grande do Sul, which can be delimited between 27–28°S and 51–54°W (Fig. 1). Information about them can be summarized as follows: 1. *Ligeiro:* located in the district of Charrua, município of Tapejara, half-way in the road between Getúlio Vargas and Sananduva. Population: 350 persons; 2. *Guarita:* in the município of Tenente Portela, at 22 km from its seat. Population: 1,100 inhabitants; 3. *Nonoai:* in the município of Nonoai, at 5 km from its seat. Population: 1,250 individuals; 4. *Cacique Doble:* near a non-Indian locality with the same name, in the município of Machadinho, 21 km from Paim Filho. Population: 350.

The bloods were collected in EDTA or ACD, refrigerated a few hours later, and transported this way to Porto Alegre. They arrived there 1 or 2 days after collection and were immediately tested for blood groups. Plasmas and glycerolized red blood cells were stored in the deep freezer and tested for the serum proteins and enzymes as the laboratory conditions permitted. In the locality of Guarita saliva samples were also obtained; they were boiled just after collection and studied in the same way as described in Salzano et al. (1970). Other laboratory determinations were performed as follows: (a) Blood groups: 2% washed red cell suspensions were prepared and tested in tubes using commercial reagents, following the manufacturer's specifications (Ortho, Raritan; Johnson and Johnson, São Paulo). The Diego studies were made with sera kindly donated by M. Layrisse and the A_2 phenotype investigated with extracts from *Ulex europaeus* prepared in our laboratory as described by Boyd and Shapleigh (1954). The ABO erytrocite results were confirmed by searching for the appropriate plasma agglutinins. (b) Hemoglobins were typed by horizontal starch gel electrophoresis according to the method presented in Salzano and Tondo (1968). (c) Glucose-6-phosphate dehydrogenase (G6PD) and 6-phosphogluconate dehydrogenase (PGD) were characterized by the starch gel method of Fildes and Parr (1963) but with EDTA in the gel as described by Beutler et al. (1968). Some special studies performed in variant samples are described in the following section. Phosphoglucomutase (PGM) was characterized with the techniques given in Spencer et al. (1964), with the staining procedure of Hopkinson and Harris (1969a). Adenylate kinase (AK) was investigated by the method of Fildes and Harris (1966); adenosine deaminase (ADA) with the buffer systems of these latter authors and the staining technique of Spencer et al. (1968). The esterase (ESD) and carbonic anhydrase (CA) studies were carried out at the School of Medicine of Ribeirão Preto in conditions described by Mestriner et al. (1976, 1980). The slight differences in the number of individuals tested reported here and in these publications are due to variability in the criteria for considering a person as "full blood." Those utilized in this paper are preferable for future citations; (d) Haptoglobin (Hp), transferrin (Tf), ceruloplasmin (Cp), and albumin (Al) were also typed by horizontal starch gel electrophoresis using the buffer systems of Poulik (1957) for Hp and Tf and of Bowman and Bearn (1965) for the other two. Amido black 10B was used to stain Al and Tf, benzidine to stain Hp, and orthodianisidine for Cp.

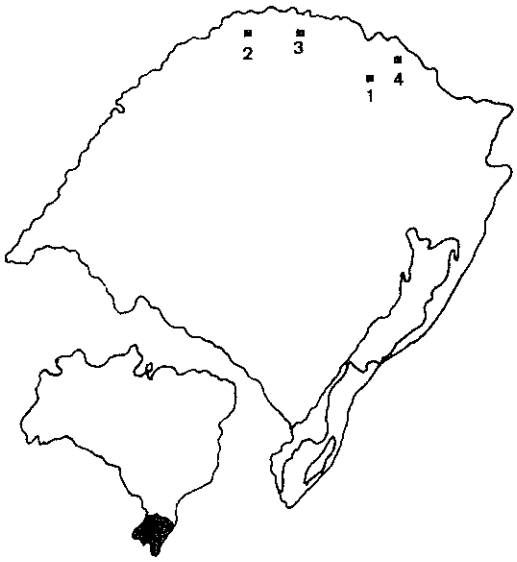

Fig. 1. Small map of Brazil (lower left) and enlarged map of the State of Rio Grande do Sul showing the location of the localities studied (numbers correspond to the order in which the populations are listed on Tables 1–3 and 5).

Genetic distances were calculated using the method of Cavalli-Sforza and Edwards (1967), using "chord distances" rather than the "stereographic projections" of these distances (cf. Edwards, 1971).

The morphological investigations were described in detail in Da Rocha (1971). The data reported in that publication were subjected to a careful scrutiny, some doubtful measurements were discarded, and the analysis was restricted to individuals between the ages of 18 and 50 in men and 15 and 45 in women. Eleven measurements were chosen for this study: 1. stature; 2. sitting height; 3. head length; 4. head breadth; 5. bizygomatic breadth; 6. bigonal; 7. height of forehead; 8. height of face; 9. nasal height; 10-nasal breadth; 11. minimum frontal breadth. Morphological distances between the populations were assessed using Mahalanobis's D^2 values and their separation into size and shape components as described in Spielman (1973).

RESULTS

Table 1 presents the phenotype frequencies for 24 genetic systems in the four populations investigated and Table 2 the corresponding gene frequencies. The collections were performed independently of the individuals' phenotypic appearance; 34 of them, however, were classified as Mestizos on the basis of the presence of genetic markers that are indicative of White or Black ancestry. The analyses to be presented below were restricted to putative "full blood" individuals.

Previous information was available for 11 of the 24 genetic systems listed in Tables 1 and 2 (Tondo and Salzano, 1960; Salzano, 1961c, 1964a, 1964b, 1968; Salzano and Sutton, 1963, 1965; Salzano and Tondo, 1968). The present findings essentially confirm the absence of variation at the ABO, Kell, Transferrin, and Hemoglobin loci. The Rh, Diego, and Haptoglobin results are very similar to those of the earlier investigations, but the value for L^M ($L^{MS} + L^{Ms}$) is somewhat higher (0.79) than the one obtained previously (0.67). *Se* also occurred in homozygosis in 100% of the 58 "full bloods" studied in Guarita, while the combined figure for its frequency in earlier studies was 0.77. Wide divergence was observed in the prevalences of P^1 (present 0.40; previous: 0.22) and Fy^a (0.71 and 0.48, respectively). These two differences may be due to bad (weak) reagents used in those older tests.

How "typical" are the Caingang gene frequencies, when compared with those from other South American Indian tribes and particularly with those from the Gê groups, with which they have been frequently associated? The monomorphism observed in 13 systems (ABO, Kell, Tf, Cp, Al, Hb, G6PD, PGM_2, ESA, CA_1, CA_2, ADA, and AK) comes as no surprise, since it is the most prevalent finding in other tribes, despite the occurrence, in some, of variants or "private polymorphisms." In the 6-phosphogluconate dehydrogenase locus we observed a variant that may not have been previously described, to be discussed below. Ten systems remain, which show variability in South American Indians and can be used for further analyses. All of the 16 alleles that can be recognized in them show prevalences among the Caingang that fall within the range of frequencies previously found in Indians of this continent. Comparisons with three Gê tribes (Xavante, Cayapo, and Krahó; cf. Salzano et al., 1977) yield the following results: frequencies higher in the Caingang than in these three: L^{MS}, L^{Ms}, R^z, R^o or *r*, Jk^a, Di^a, *Se*, Hp^1, PGM_1, ESD^1 (10); intermediate: R^1, Fy^a (2) lower: L^{Ms}, L^{Ns}, P^1, R^2 (4).

The blood of a 20-year old male from the locality of Ligeiro showed at the electrophoretic conditions previously described (pH 7.0), besides the common PGD A band a more anodal one (Fig. 2). To establish if this was an artifact or a true variation arrangements were made for the re-collection of blood from this individual and the sampling of several of his relatives. The presence of the variant was confirmed in his hemolysate and identical patterns were seen in his mother, one brother, and one sister; two other sibs (one male and one female) showed PGD A only. The electrophoretic mobility of the aberrant samples suggested that the pattern seen could be due to PGD A-Bombay (Blake et al., 1974) or PGD A-Richmond (Parr, 1966). A sample of this material was sent to Prof. C.W. Parr's laboratory in London for direct comparisons with other types but the hemolysate deteriorated in transit.

After 1-year storage in glycerol at −20°C we decided to reexamine the variant samples and observed that the fast band had reverted to a mobility similar to that of PGD A. Treatment of the aged hemolysates with mercaptoethanol and reduced glutathione by the method described by Hopkinson and Harris (1969b), however, led to dissociation in two bands and thus to a reversion to the previous pattern. Shortage of material and sample denaturation prevented further studies. Since this curious storage effect was not reported for PGD Bombay or PGD Richmond we believe that this may be a new variant, which we are tentatively calling PGD Caingang I. The reversion obtained after treatment with the thiol reagents suggest that a cysteine residue is involved in the production of this phenotype (cf. Blake et al., 1974).

TABLE 1. Phenotype frequencies for 24 genetic systems in four populations of Caingang Indians'

System and phenotype	Ligeiro		Guarita		Nonoai		Cacique Doble		All localities		
	"Full bloods"	Total	"Full bloods"	Total	"Full bloods"	Total	"Full bloods"	Total	"Full bloods"	Mestizos	Total
ABO											
O	63	65	80	82	35	42	36	36	214	11	225
A_1	0	4	0	2	0	5	0	0	0	11	11
A_2	0	0	0	4	0	0	0	1	0	5	5
B	0	2	0	1	0	3	0	1	0	7	7
Total	63	71	80	89	35	50	36	38	214	34	248
MNSs											
MS	14	17	11	12	4	7	13	13	42	7	49
MSs	18	19	34	41	9	14	10	10	71	13	84
Ms	4	4	5	5	4	5	4	4	17	1	18
MNS	11	11	4	4	4	5	3	4	22	2	24
MNSs	14	16	20	20	7	7	4	4	45	2	47
MNs	0	0	6	6	5	9	0	1	11	5	16
NS	2	3	0	0	0	0	1	1	3	1	4
NSs	0	1	0	1	2	3	1	1	3	3	6
Total	63	71	80	89	35	50	36	38	214	34	248
P											
P_1	49	57	44	51	22	30	23	24	138	24	162
Total	63	71	80	89	35	50	36	38	214	34	248
Rh											
CDE	2	3	1	1	0	1	0	0	3	2	5
CDEe	5	6	7	8	0	1	2	3	14	4	18
CDe	14	15	20	22	9	14	17	17	60	8	68
CcDE	3	3	14	15	1	1	1	1	19	1	20
CcDEe	28	31	30	32	7	11	8	8	73	9	82
CcDe	2	3	5	7	6	10	4	5	17	8	25
cDE	8	9	2	2	9	9	2	2	21	1	22
cDEe	1	1	1	1	1	1	2	2	5	0	5
cDe	0	0	0	0	1	1	0	0	1	0	1
Cce	0	0	0	1	0	0	0	0	0	1	1
ce	0	0	0	0	1	1	0	0	1	0	1
Total	63	71	80	89	35	50	36	38	214	34	248

Kell											
K−	63	71	80	89	35	50	36	38	214	34	248
Duffy											
a+	60	68	76	84	25	37	35	36	196	29	225
Total	63	71	80	89	35	50	36	38	214	34	248
Kidd											
a+	nt	nt	69	78	nt	nt	nt	nt	69	9	78
Total	nt	nt	80	89	nt	nt	nt	nt	80	9	89
Diego											
a+	36	38	27	27	8	12	18	18	89	6	95
Total	63	65	80	82	35	42	36	36	214	11	225
ABH secretion											
Sec.	nt	nt	58	66	nt	nt	nt	nt	58	8	66
Haptoglobin											
1-1	31	32	37	44	17	24	26	27	111	16	127
2-1	31	35	30	32	13	16	9	10	83	10	93
2-2	1	2	13	13	4	7	1	1	19	4	23
2-1M	0	0	0	0	0	1	0	0	0	1	1
0	0	2	0	0	1	2	0	0	1	3	4
Total	63	71	80	89	35	50	36	38	214	34	248
Transferrin											
C	63	69	80	89	35	49	36	38	214	31	245
BC	0	0	0	0	0	1	0	0	0	1	1
CD_1	0	1	0	0	0	0	0	0	0	1	1
Total	63	70	80	89	35	50	36	38	214	33	247
Ceruloplasmin											
B	63	70	80	89	35	49	36	38	214	32	246
AB	0	0	0	0	0	1	0	0	0	1	1
Total	63	70	80	89	35	50	36	38	214	33	247
Albumin											
A	63	71	80	89	35	50	36	38	214	34	248
Hemoglobin											
A	63	71	80	89	35	50	36	38	214	34	248
G6PD											
Men											
A	0	0	0	0	0	1	0	0	0	1	1
B	31	35	37	41	17	21	17	18	102	13	115
Total	31	35	37	41	17	22	17	18	102	14	116

(Table 1 continued.)

TABLE 1. Phenotype frequencies for 24 genetic systems in four populations of Caingang Indians[1] (continued)

System and phenotype	Ligeiro		Guarita		Nonoai		Cacique Doble		All localities		
	"Full bloods"	Total	"Full bloods"	Total	"Full bloods"	Total	"Full bloods"	Total	"Full bloods"	Mestizos	Total
Women											
A	0	0	0	0	0	1	0	0	0	1	1
B	32	36	42	46	17	26	19	20	110	18	128
AB	0	0	0	1	0	0	0	0	0	1	1
Total	32	36	42	47	17	27	19	20	110	20	130
6-PGD											
A	59	66	79	88	33	48	36	38	207	33	240
AC	0	1	0	0	0	0	0	0	0	1	1
Caingang I	4	4	0	0	0	0	0	0	4	0	4
Total	63	71	79	88	33	48	36	38	211	34	245
PGM_1											
1-1	52	58	71	79	26	37	34	36	183	27	210
2-1	11	13	6	7	8	12	2	2	27	7	34
2-2	0	0	0	0	1	1	0	0	1	0	1
Total	63	71	77	86	35	50	36	38	211	34	245
PGM_2											
1-1	63	71	77	86	35	50	36	38	211	34	245
ESA											
Normal	63	71	79	88	35	50	36	38	213	34	247
ESD											
1-1	23	27	34	40	27	38	19	20	103	22	125
2-1	24	26	37	39	8	12	17	18	86	9	95
2-2	16	18	9	9	0	0	0	0	25	2	27
Total	63	71	80	88	35	50	36	38	214	33	247
CA_1											
Normal	63	71	80	88	35	50	36	38	214	33	247
CA_2											
1-1	63	71	80	88	35	48	36	38	214	31	245
2-1	0	0	0	0	0	1	0	0	0	1	1
Total	63	71	80	88	35	49	36	38	214	32	246
ADA											
1-1	63	71	nt	nt	35	49	36	38	134	24	158
2-1	0	0	nt	nt	0	1	0	0	0	1	1
Total	63	71	nt	nt	35	50	36	38	134	25	159
AK											
1-1	63	71	80	89	35	50	36	38	214	34	248

[1]Thirty-seven bloods from Guarita were also tested for C^w (Rh system), yielding uniformly negative results.

nt: not tested.

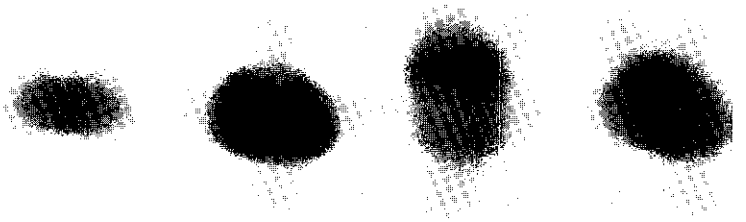

Fig. 2. Starch gel electrophoresis, phosphate buffer, pH 7.0 of four bloods of Caingang Indians. Slots 1, 2, and 4, PGD A only; slot 3: PGD A-PGD Caingang I. Direction of migration from bottom to top.

Nine polymorphic loci (MNSs, P, Rh, Duffy, Diego, Hp, PGM_1, ESD, and Gc) were used for an intratribal comparison between the four populations of Caingang Indians. The last locus (Gc) was chosen because it was used in a previous analysis involving the Gê groups; the data was taken from Salzano and Shreffler (1966) and was obtained in different samples from these same populations. As can be seen in Table 3, the smallest genetic distance was found between Ligeiro and Cacique Doble (306) and the largest between Ligeiro and Nonoai (520). When a comparison is made between these distances and the road distances that separate these localities (upper triangle of Table 3) no apparent relationship is disclosed (Spearman's correlation coefficient, r_s: 0.03, clearly not significantly different from zero). The average genetic distances between each locality and all others yielded the following results: Cacique Doble 359; Guarita 372; Ligeiro 408; Nonoai 452.

In intertribal analyses the number of loci employed has to be less, due to lack of uniform data. Our studies have concentrated so far in six of them (MNSs, Rh, Kidd, Duffy, Diego, and Hp) and for comparative purposes we used only these six to calculate the genetic distances between the Caingang and three Gê-speaking tribes previously studied by our group (Salzano et al., 1977). The results are shown in Table 4. The average genetic distance between the Caingang and these three tribes is 303,—somewhat higher than the average obtained within Gê (257), but less than that encountered among 22 Middle or South American Indian tribes of different linguistic affiliations (358; see Salzano et al., 1978).

Turning now to the morphological differences, Table 5 shows the size and shape within-sex distances between the four populations of Caingang Indians under consideration. The smallest distance is found between Guarita and Cacique Doble (1.8 in males and females) and the largest between Nonoai and Cacique Doble (males: 6.0; females: 6.4). Most of these differences are due to shape, this factor being from 5 × to 521 × higher than size in the contribution to the total D^2 value. There is no correlation between the D^2s and the geographic distances between the localities (r_s: −0.257, statistically nonsignificant). But the correlation *is* significant (at the 5% level) between these morphological and the genetic distances (r_s: 0.83). The average D^2s between each locality and all others are as follows: Guarita 2.153; Ligeiro 2.733; Cacique Doble 3.338; Nonoai 4.346. This last locality, therefore, is the most differentiated from the others when we consider both the blood and the anthropometric characteristics.

Morphological intertribal comparisons between the Caingang and two Gê tribes (Cayapo and Xavante) were made by Marcellino et al. (1978) using six of the characteristics considered here (stature, face height, nose height, nose breadth, head length, and head breadth). Interestingly, the distance between Caingang

TABLE 2. Allele frequencies for 24 genetic systems in four populations of Caingang Indians

System and allele	Ligeiro		Guarita		Nonoai		Cacique Doble		All localities		
	"Full bloods"	Total	"Full bloods"	Total	"Full bloods"	Total	"Full bloods"	Total	"Full bloods"	Mestizos	Total
ABO											
I^o	1.00	0.96	1.00	0.96	1.00	0.92	1.00	0.98	1.000	0.656	0.953
I^{A1}	0.00	0.03	0.00	0.01	0.00	0.05	0.00	0.00	0.000	0.166	0.023
I^{A2}	0.00	0.00	0.00	0.02	0.00	0.00	0.00	0.01	0.000	0.074	0.010
I^B	0.00	0.01	0.00	0.01	0.00	0.03	0.00	0.01	0.000	0.104	0.014
MNSs											
L^{MS}	0.45	0.47	0.47	0.47	0.36	0.37	0.56	0.55	0.465	0.441	0.466
L^{Ms}	0.32	0.29	0.34	0.35	0.36	0.36	0.29	0.28	0.325	0.309	0.318
L^{NS}	0.23	0.22	0.05	0.06	0.12	0.11	0.12	0.12	0.126	0.118	0.121
L^{Ns}	<0.01	0.02	0.14	0.12	0.16	0.16	0.03	0.05	0.084	0.132	0.095
P											
P^1	0.53	0.56	0.33	0.35	0.39	0.37	0.40	0.39	0.404	0.458	0.411
Rh											
R^1	0.49	0.49	0.50	0.47	0.44	0.49	0.66	0.65	0.516	0.264	0.499
R^2	0.38	0.37	0.30	0.28	0.39	0.30	0.21	0.19	0.318	0.147	0.296
R^z	0.10	0.11	0.15	0.15	0.01	0.05	0.04	0.06	0.098	0.162	0.105
R^o	0.03	0.03	0.05	0.00	0.08	0.08	0.09	0.10	0.034	0.081	0.022
r'	0.00	0.00	0.00	0.04	0.00	0.00	0.00	0.00	0.000	0.265	0.021
r	0.00	0.00	0.00	0.06	0.08	0.08	0.00	0.00	0.034	0.081	0.057
Kell											
k	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.000	1.000	1.000
Duffy											
Fy^a	0.78	0.79	0.78	0.76	0.46	0.49	0.83	0.77	0.710	0.616	0.695
Kidd											
Jk^a	nt	nt	0.63	0.65	nt	nt	nt	nt	0.629	1.000	0.648
Diego											
Di^a	0.34	0.36	0.19	0.18	0.12	0.15	0.29	0.29	0.236	0.326	0.240

ABH Secretion											
Se	nt	nt	1.00	1.00	nt	nt	nt	nt	1.000	1.000	1.000
Haptoglobin											
Hp^1	0.74	0.72	0.65	0.67	0.69	0.68	0.85	0.84	0.716	0.694	0.713
Transferrin											
Tf^B	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.000	0.015	0.002
Tf^C	1.00	0.99	1.00	1.00	1.00	0.99	1.00	1.00	1.000	0.970	0.996
Tf^{D1}	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.000	0.015	0.002
Ceruloplasmin											
Cp^B	1.00	1.00	1.00	1.00	1.00	0.99	1.00	1.00	1.000	0.985	0.998
Albumin											
$A1^{A_1}$	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.000	1.000	1.000
Hemoglobin											
Hb^A	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.000	1.000	1.000
G6PD											
Gd^B	1.00	1.00	1.00	1.00	1.00	0.95	1.00	1.00	1.000	0.929	0.991
6-PGD											
PGD^A	0.97	0.96	1.00	1.00	1.00	1.00	1.00	1.00	0.990	0.985	0.990
PGD^C	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.000	0.015	0.002
$PGD^{Caiua\ 1}$	0.03	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.010	0.000	0.008
PGM_1											
PGM_1^1	0.91	0.91	0.96	0.96	0.86	0.86	0.97	0.97	0.931	0.897	0.926
PGM_2											
PGM_2^1	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.000	1.000	1.000
ESA											
ESA^1	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.000	1.000	1.000
ESD											
ESD^1	0.56	0.56	0.66	0.68	0.89	0.88	0.76	0.76	0.682	0.803	0.698
CA_1											
CA_1^1	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.000	1.000	1.000
CA_2											
CA_2^1	1.00	1.00	1.00	1.00	1.00	0.99	1.00	1.00	1.000	0.944	0.998
ADA											
ADA^1	1.00	1.00	nt	nt	1.00	0.99	1.00	1.00	1.000	0.980	0.997
AK											
AK^1	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.000	1.000	1.000

nt: not tested

TABLE 3. Nine-locus genetic distances (× 10^4) compared with the geographic distances between four populations of Caingang Indians[1]

	Ligeiro	Guarita	Nonoai	Cacique Doble
Ligeiro		285	133	67
Guarita	397		152	326
Nonoai	520	392		174
Cacique Doble	306	328	443	

[1] Lower triangle: genetic distances; upper triangle: geographic distances.

TABLE 4. Six-locus genetic distances (× 10^3) between three Gê-speaking tribes and the Caingang

	Xavante	Cayapo	Krahó
Cayapo	237		
Krahó	308	226	
Caingang	264	296	349

TABLE 5. Size and shape within-sex distances between four populations of Caingang Indians[1]

		Ligeiro	Guarita	Nonoai	Cacique Doble
Ligeiro	Si^2		0.004	0.081	0.071
	Sh^2		2.085	5.013	1.832
	D^2		2.089	5.094	1.903
Guarita	Si^2	0.112		0.048	0.110
	Sh^2	1.791		3.207	1.718
	D^2	1.904		3.255	1.829
Nonoai	Si^2	0.489	0.132		0.305
	Sh^2	2.829	1.887		6.056
	D^2	3.319	2.020		6.362
Cacique Doble	Si^2	0.043	0.296	0.825	
	Sh^2	2.045	1.521	5.199	
	D^2	2.089	1.818	6.024	

[1] Lower triangle: men; upper triangle: women. Number of individuals studied: males: Ligeiro: 40; Guarita: 71; Nonoai: 91; Cacique Doble: 27; females: Ligeiro: 41; Guarita: 67; Nonoai: 35; Cacique Doble: 28.

and Cayapo (males: 2.124; females: 2.581) was much lower than that obtained between Cayapo and Xavante (males: 12.147; females: 10.252).

DISCUSSION

There are not many examples of populations of hunter-gatherers or simple agriculturalists that have been studied more than once by the same researcher (with a relatively long space of time elapsing between the two investigations). This may be a defense mechanism developed by the scholar, who does not want to see the sometimes devasting effects of contact with the outside world. Caspar (1957) described the dramatic changes he observed among the Amazonian Tuparí in a short period between his first visit to them, in 1948, and the second in 1955. The population had decreased from 200 to 66 and the impact on their culture can be classified as calamitous. But such studies can yield important data if the group has not suffered so much, and an example of this is the work of Friedlaender (1975), reporting photographs and measurements obtained in the same indi-

viduals with a 28-year interval (1938–39 and 1967) at Bougainville, Melanesia. As for the Caingang, the differences observed between 1958 and 1975 were not large. The tendency towards integration into the non-Indian world is now more pronounced, with a concomitant increase in interracial crosses. To avoid this possible "noise" factor we have left out of our analyses individuals with at least one indication of non-Indian admixture. We verified, however, that their inclusion would not influence the genetic distances in a marked way (data available on request).

The electrophoretic behavior of the PGD variant described here is interesting in two respects. Hopkinson and Harris (1969b) had already emphasized the interest of using thiol reagents to detect structural gene mutations leading to the acquisition or loss of cysteine residues in enzyme proteins; on the other hand, it is useful to remember that variant bands in untreated aged hemolysates may revert to the normal pattern, thus leading to underestimates of the molecule's degree of variability.

The lack of correlation between the genetic or anthropometric distances on one hand and the geographical distances on the other is not surprising considering the fact that these localities are placed rather close to each other. In addition, many factors besides road distances influence the choices of marriage and interchange in human populations. The correlation obtained between the degree of differentiation ascertained through the hematological markers and the morphological traits is of course expected. But it should be emphasized that the present results do not confirm the earlier suggestion of two evolutive complexes, one involving the Nonoai-Guarita and the other the Cacique Doble-Ligeiro populations, which was made taking into consideration migration patterns and genetic studies obtained at that time (Salzano, 1961a,d).

The relationship between the Caingang and the Gê tribes is substantiated by the lower morphological distance observed between the Caingang and the Cayapo, as compared to that of the latter in relation to the Xavante (as well as by the intermediate average genetic distance encountered between them and the Gê tribes, compared to the within-Gê and between-tribes of different linguistic affiliations distances). It is obvious that these variables can be influenced by demographic factors, and in this regard it should be stressed that the Caingang show an index of opportunity for selection (1.28) that is higher than those obtained for the Xavante (0.90), Cayapo (0.82), and Krahó (0.73; see Callegari Jacques and Salzano, 1979).

Our study essentially confirms the finding of Spielman (1973) on the intratribal variation among the Yanomama and the finding of Marcellino et al. (1978) on the variability between six South American Indian tribes. Shape seems to be the most important factor influencing the interpopulation differences.

Despite recent efforts we are still very far away from a reasonable understanding of the main factors that led to the present biological differentiation of South American Indians. The number of tribes studied for the vast array of polymorphic markers now available is small, preventing global analyses with more sophisticated methods. This paper may be regarded as a further step in this direction; if it at least raises interest for new investigations it will have fulfilled its role.

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