

The Seminole Indians of Florida: Morphology and Serology

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ABSTRACT The Seminole Indians of Florida were studied on their three reservations for blood types, red cell enzymes, serum proteins, physical measurements, and relationships. Both serologic and morphologic factors suggest their close similarity to other Indians and small amount of admixture. The Florida Seminoles are similar to Cherokee "full-bloods" in their absence of Rho and their incidence of O and M. In the presence of Di^a they are similar to other Indians, especially those of South America. While the presence of G-6-P-D A and the frequency of Hgb. S are indicative of Negro ancestry, the absence of Rho suggests that the Negro contribution must have been small. Physical traits give parallel results. Both serology and morphology further show that the Seminoles of the Dania and Big Cypress reservations are more similar to each other than to those of the Brighton reservation, in keeping with their history.

The Seminole Indians of Florida, numbering about 1,200, cluster today in three reservations, Dania just north of Miami, Big Cypress on the edge of the Everglades and Brighton on the northwestern rim of Lake Okeechobee; they also spread out along Tamiami Trail. In the summer of 1964, 150 Seminoles were studied at Dania; 263 additional Indians were studied at Big Cypress and at Brighton at Christmas time. The present article is a report on the morphology and serology of the Indians examined, a comparison with other populations, and the relationship between their physical anthropology and their history.

HISTORY

The following account is based primarily upon the work of Fairbanks.

When the Spanish occupied Florida in the sixteenth century they found numerous Indian tribes, but disease, warfare and slaving raids by Carolinians virtually destroyed the native population by 1715. This void was filled slowly in the eighteenth century primarily by Creeks with some Yemassee and Yuchi Indians. One group of Muskogean speakers, the Oconee, settled at Alachua near present Gainesville in northcentral Florida by 1750; they formed the nucleus of Cow Creek Indians who

later settled in the Brighton area and speak what is now called the Seminole language. The word "Seminole," possibly derived from the Spanish "Cimarron," best translated as "wild ones," was first applied in 1771 to the Indians who had separated from their Creek relatives in Georgia. A second group, speaking the Hitchiti dialect, settled at Appalachee around Lake Miccosukee near Tallahassee in northwestern Florida. The Big Cypress community, derived from this and nearby settlements, still speak the distinctive but related Mikasuki language. The settlement at Dania is composed of people more closely related to those at Big Cypress than to those at Brighton.

The defeat of the Creeks by Andrew Jackson in 1813 caused many Upper Creek tribes to cross the border and join the Seminoles in Florida. Increasing border tensions among the new Americans, the Spanish, and the Indians led to the First Seminole War (1817-1818), at the close

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of which Florida became part of the United States. Increasing agitation for removal to the West led to the Second Seminole War (1835-1842). The forced migration of a large number of Indians to Oklahoma came to be known as the Trail of Tears.

The history of the Indians in Florida is intertwined with that of the Negroes. Run-away slaves from the English colonies, and subsequently from the states, hid among the Indians. In some instances the Indians owned Negro slaves; in others the Negroes led a separate symbiotic existence in nearby towns. At the time of the removal many Negroes accompanied the Indians West.

The population of the Seminole Indians of Florida has varied widely over the centuries. In 1803 they numbered some 3,500; they swelled to a peak of about 5,000 in the 1820's, and fell to 2,833 at the close of the Second Seminole War. By 1853 when 2,500 Seminoles were in Oklahoma, only 500 lived in Florida. MacCauley's report of 1884 lists only 208, including seven mixed and three Negroes; he located 37 families in 22 camps in five settlements. Swanton ('53) reports 573 in Florida in 1919. Nash in 1930 reported 400 in Big Cypress, 150 near Lake Okeechobee, and 40 at Dania, all except ten being "full-bloods."

MacCauley paints a graphic picture of the life of the Seminole in 1880. He describes the men as dark, copper-colored, tall, with square faces, the women as under average height and shapely. The men wore a shirt, breech cloth, and a "turban;" the women wore a short skirt over a long one, a shawl and ornamental beads and silver disks. If one substitutes trousers for breech cloth and omits the turban the description would hold today. The typical house he describes, the chikee, open at the sides and covered with palmetto leaves, is still abundant. MacCauley's long list of food available to the Indians of his time bears witness to the rich semi-tropical environment of South Florida — meats, vegetables and fruit in abundance. He noted that the Seminoles had matriarchal clans, that slaving was non-existent, that health was good, that education was stoutly resisted and that Christian missionaries had had little influence on their religion.

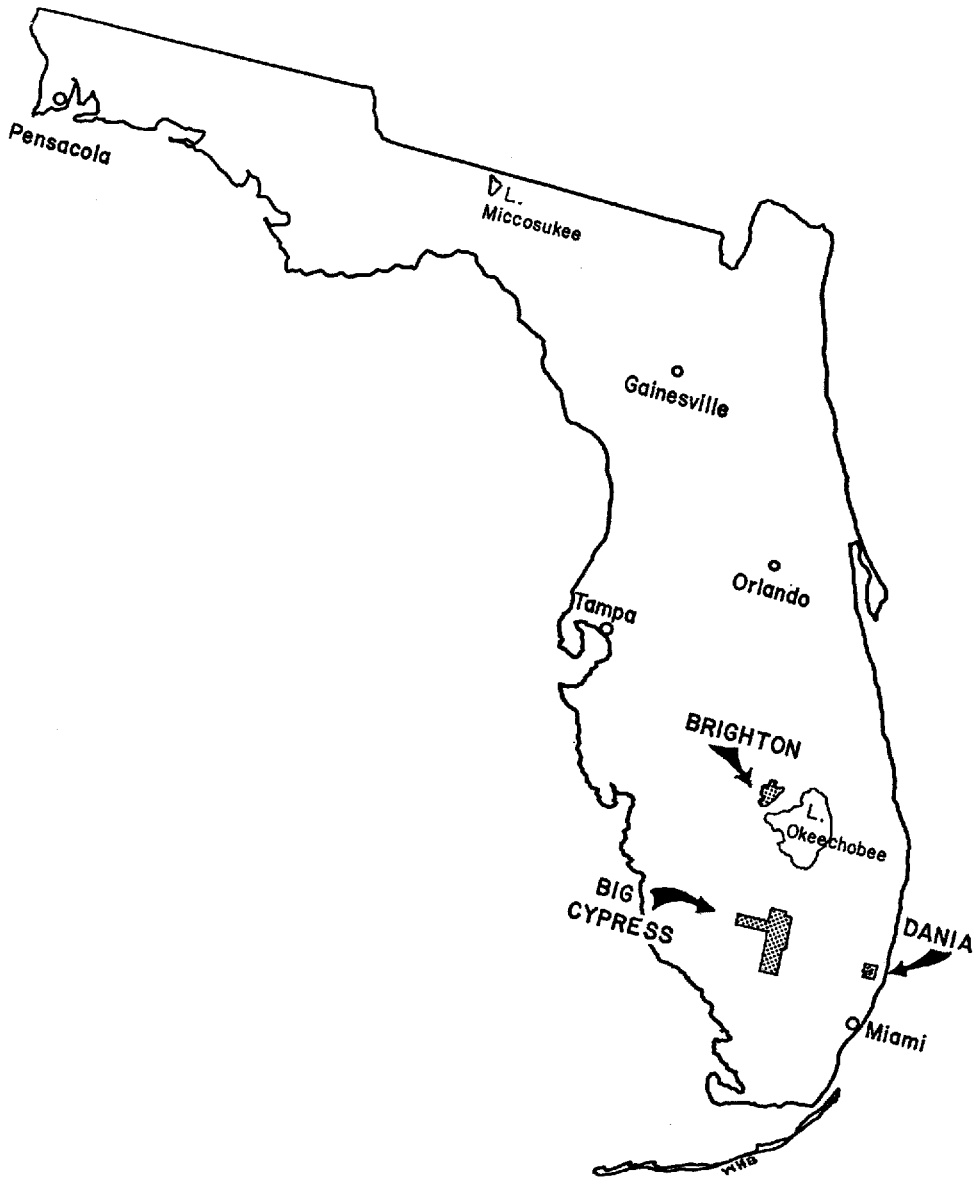
His report sharply contrasts with that of Nash a half century later. Nash stresses the overload of starch and meat eaten, and the presence of hookworm, malaria, venereal disease and wretched teeth. He traces in poetic and often bitter language the fruitless and sometimes misguided efforts to acculturate the Indians in the preceding 50 years.

The Seminole Indians of today have their own tribal organization, able assistance from the local agency of the Bureau of Indian Affairs, schools, medical facilities and the rights of United States citizens. The location of their three reservations is shown on Map 1.

MATERIALS AND METHODS

All Seminole Indian families on the reservations were urged to participate in a health survey. The 413 or approximately 40% who responded are believed to be representative of the reservation population: 150 subjects were from Dania, 128 from Brighton, and 135 from Big Cypress. Blood and urine specimens were collected on all Indians six years old and above. (Studies of glucose in blood and urine will constitute a separate report.) Blood samples collected in ACD were shipped by air to NIH; samples in EDTA were shipped by air to Ann Arbor, Michigan; and a third tube in EDTA was used for determination of hematocrit, for removal of serum for sugar determination, and for typing of red cells either in the field or at Chapel Hill.

Three hundred and eighty-one samples of red cells (123 from Dania, 127 from Brighton and 131 from Big Cypress) were typed at NIH and at Chapel Hill for ABO, Rh (D, C, E, c, e), MNS, Kell and Duffy. In addition, all 381 samples of red cells were typed at NIH for subgroups of A, s, U, P¹, C², Di¹, k, Kp^a, Kp^b, Le^a and He. At the University of Michigan the following electrophoretic techniques were employed for the indicated number of specimens: 369 samples for hemoglobin (Hb) types (Smithies, '65), 343 for acid phosphatase (AP) (Hopkinson, Spencer, and Harris, '64), 364 for 6-phosphogluconate dehydrogenase (6-PGD) and 360 for glucose-6-phosphate dehydrogenase (G-6-PD) (Shows et al., '64), 94 for lactic dehydrogenase (LDH) (Vesell and Bearn, '62), 111 for



Map 1

carbonic anhydrase I (CA I) (Tashian, '65), 374 for haptoglobin (Hp), 375 for transferrin (Tf), and 373 for group specific component (Gc), all on the same starch gel electrophoresis using high voltage and lithium hydroxide-citrate buffer (Bowman and Bearn, '65.) The Gc types were also determined using an immunoelectrophoretic technique (Rucknagel, Shreffler and

Halstead, '68). Discrepancies with the starch gel electrophoresis were re-examined. In view of the subsequent discovery of bisalbuminemia in North American Indians, photographs of the starch gel electrophoretic patterns of the sera were reviewed. Specimens having patterns suggestive of albumin variants were re-examined by cellulose acetate electrophoresis,

a method proven adequate to detect the albumin variants in other groups of Indians.

Skin color was determined on 413 subjects of all ages by the spectrophotometer (Photovolt 410) with the search unit held against the medial surface of the upper arm; readings were made with both the tristimulus filter and the red filter. Hair form and hair color were noted, and physical measurements were made on all persons 16 and above, 95 men and 144 women: height, weight, length and width of head, face and nose, and (in most cases) lip thickness. Dental casts were taken by R. M. Menegaz-Bock, and their analysis will constitute a separate publication. Age, date and birthplace, number of offspring of married women, and kinship data sufficient for the construction of pedigrees were obtained by interview.

The collection of demographic, serologic and morphologic data permits an analysis of the variables by age and by location, the correlations and associations between them and an estimate of the racial elements that entered into the composition of the people.

RESULTS

Results of the blood typing and electrophoretic studies are shown in the first column of table 1. Group O is by far the most abundant of the four groups as expected in most Indians; A₂ and B are rare, and AB is absent. All but 13 had M, and in more than three-fourths of the samples M was homozygous; S is only half as common as s, and the most common combination is MSs. All bloods were positive for U and negative for He. P¹ constitutes more than half of the sample. Rh₀ is notably absent despite the fact that 10% had sickle cell trait; rh is extremely rare; the most common Rh types are those with Rh₁, followed by Rh₂, while Rh₃ types comprise 14%. All bloods were negative for C^w. Only 15 Kell positives and one Kp^a positive were encountered among 381 typed, and all bloods were k and Kp^b positive. Only one was Le^a positive. Fy^a was present in 88% and Di^a in 6% of the samples.

No abnormal hemoglobins other than Hgb S were encountered. Of variants of G-6-P-D, 97% were the common B homozygous while the remainder showed A of nor-

mal enzyme activity in either homozygous or heterozygous form. Of red cell acid phosphatase varieties, the majority were B, followed by BA, then A, and one case of CB. All samples tested showed the usual pattern for 6-PGD, for LDH and for CA I.

Among inherited serum proteins, haptoglobin was absent in two out of 374 samples tested; 2-2 types were most common, followed by 2-1 and 1-1. Among Gc types, 2-1 was most common followed by 1-1 and by 2-2. All transferrins were the common C variety. No examples of bisalbuminemia were found.

The physical traits of the adult Seminole Indians as presented in table 2 show them to be tall, brachycephalic, mesoprosopic and mesorrhine. Men are taller, heavier and slightly darker than women; head, face and nose dimensions are greater in men but the indices and lip thickness are similar in the two sexes. The standard deviation, minimum and maximum, indicate the wide variability shown in these measurable physical traits. Both skin color means suggest a light tan or copper shade, but considerable variation is found.

Hair color and form, shown in table 3, indicate that in three-fourths of the persons examined hair is black and that in two-thirds it is straight. No case of frizzly hair was encountered.

The correlations between physical measurements for males and females separately are shown in table 4. Those significantly different from zero at the 1% level are indicated by a superior one (*). Lip thickness is the only morphologic trait (skin color excluded) which generally shows a negative correlation with the other morphologic variables. The two skin color measurements show an expected high positive correlation with each other in females only. Head and face widths also show high positive correlations with each other and with weight in both sexes. The highest correlation with age is the negative one with lip thickness manifest in both sexes.

When the individuals sampled are classified by decades this marked decline of lip thickness with age is clearly evident. Although the skin color of both men and women appears lighter with increasing age (as measured by both filters) a clear trend by decades is not discernible. In both

sexes head and face dimensions appear to increase slightly with age into the mid-fifties; nose dimensions increase consistently with each decade. Both sexes appear to increase rapidly in weight into the mid-forties, more gradually through the mid-sixties, and then decline. The extent to which age differences on the three reservations are responsible for trends in physical traits will be explored later.

Age differences are also discernible in the serologic traits. When the frequency of the serologic factors in those under 16 is contrasted with the frequency of the factors in those 16 and over, A_2 , N_s , rh , Kp^a happen to occur in the younger age group while the one Le^a and the one acid phosphatase CB occur in the older age group only. Hemoglobin AS is almost twice as common in the older as in the younger group while haptoglobin 1-1 is almost twice as common in the younger as in the older group.

To see whether these serologic differences could reflect age differences in the reservations, the serologic traits were examined by age groups and reservations. The marked excess of AS hemoglobin in the older group is still evident both among the Dania-born and the Big Cypress-born Indians. Similarly the N phenotype is absent in the older group at both of these reservations. But Gc and Rh now show a more nearly equal distribution among age groups at all three reservations. In Brighton the haptoglobin distribution is peculiar; 1-1 is twice as frequent in the younger and 2-2 is twice as frequent in the older group.

Subsequent tables show the distribution of variables by birthplace: "Dania" includes neighboring Broward and Dade Counties, "Big Cypress" includes neighboring Hendry and Collier Counties, and "Brighton" includes neighboring Glades, Highlands and Okeechobee Counties. Phenotype frequencies are shown in table 1 and gene frequencies in table 5 for all Seminoles and for the three subgroups by birthplace on or near one of the three reservations. Maximum likelihood estimates of the gene frequencies were calculated by various methods: the general program of Kurzynski and Steinberg ('67) for ABO and MNS; square root for P,

Lewis, Duffy and Diego; and gene count for the remainder.

Chi-square tests for goodness of fit of Hardy-Weinberg equilibrium were performed on all loci where such a test was possible; it was assumed for this purpose, that the samples were independently drawn. Viewing the Seminoles provisionally as one interbreeding group, there is significant deviation from equilibrium with significance at 0.05 level for MN, Rh and Gc, and deviation with significance at 0.01 level for haptoglobins in the total Seminole sample. Calculating gene frequencies and chi-squares for three subpopulations shows Dania to deviate from equilibrium frequencies at 0.05 level for MNS and Gc and Brighton for Rh and haptoglobin. Big Cypress did not show significant deviation at any of the genetic loci. Of all loci showing significant deviations, MN, Rh, and haptoglobin had an excess of homozygous classes, while Gc had an excess of heterozygotes. The differences in gene frequencies among the three reservations and the deviations from equilibrium among all Seminoles indicate the heterogeneity of the Indians.

The Dania population appears to resemble the Big Cypress population more than the Brighton population in several gene frequencies such as those at the MNSs locus. The Brighton group lacks Kell, Diego and sickle-cell hemoglobin found in the other two groups, and Haptoglobin 1 is three times more common in Brighton than in Big Cypress.

Physical traits in the three reservations are compared in table 6. In many of these features, weight, skin color, head width, nose width and lip thickness, Dania and Big Cypress are similar to each other and both are differentiated from Brighton. Men from Brighton appear to be shorter, lighter in weight, darker in skin color, wider in face, shorter and narrower in nose and thicker in lips than those from the other two reservations. Brighton women also show the wider face, smaller nose and darker coloration (by tri-stimulus filter), but they are slightly taller than women from the other reservations. To test the hypothesis that all three subpopulations are random samples from the same normal population, one way analysis of variance

TABLE 1
Serological factors by reservations in Seminole Indians

Factor	All Seminoles		Dania		Big Cypress		Brighton	
	Number	Frequency	Number	Frequency	Number	Frequency	Number	Frequency
Group: 0	364	0.9554	109	0.9478	98	0.9899	66	0.9167
A ₁	12	0.0315	3	0.0261	0	0.0000	5	0.0694
A ₂	2	0.0052	1	0.0087	1	0.0101	0	0.0000
B	3	0.0079	2	0.0174	0	0.0000	1	0.0139
Total	381	1.0000	115	1.0000	99	1.0000	72	1.0000
M-N-S: MSS	43	0.1129	11	0.0957	10	0.1010	15	0.2084
MSs	144	0.3780	43	0.3739	43	0.4344	20	0.2777
Mss	107	0.2808	41	0.3565	33	0.3333	15	0.2084
MNSS	15	0.0394	3	0.0260	1	0.0101	5	0.0694
MNSs	36	0.0945	6	0.0522	8	0.0808	9	0.1250
MNss	23	0.0604	8	0.0696	2	0.0202	5	0.0694
NSS	2	0.0052	1	0.0087	0	0.0000	0	0.0000
NSs	6	0.0157	0	0.0000	1	0.0101	2	0.0278
Nss	5	0.0131	2	0.0174	1	0.0101	1	0.0139
Total	381	1.0000	115	1.0000	99	1.0000	72	1.0000
P: P ₁ -	158	0.4147	62	0.5391	32	0.3232	30	0.4166
P ₁ +	223	0.5853	53	0.4609	67	0.6768	42	0.5834
Total	381	1.0000	115	1.0000	99	1.0000	72	1.0000
Rh: Rh ₂ Rh ₁ (DCE/DcE)	137	0.3596	43	0.3739	26	0.2627	37	0.5139
Rh ₂ Rh ₂ (DcE/DcE)	42	0.1102	16	0.1391	18	0.1818	1	0.0139
Rh ₁ Rh ₂ (DCE/DcE)	114	0.2992	33	0.2869	24	0.2424	20	0.2777
Rh ₁ - (DCE/- ce)	24	0.0630	5	0.0435	3	0.0303	5	0.0694
Rh ₂ - (DcE/- ce)	7	0.0184	1	0.0087	1	0.0101	4	0.0556
Rh ₂ Rh ₁ (DCE/DcE)	38	0.0997	14	0.1218	18	0.1818	1	0.0139
Rh ₂ Rh ₂ (DCE/DcE)	12	0.0315	3	0.0261	6	0.0606	2	0.0278
Rh ₂ Rh ₂ (DCE/DCE)	4	0.0105	0	0.0000	3	0.0303	1	0.0139
rh rh (dce/dce)	3	0.0079	0	0.0000	0	0.0000	1	0.0139
Total	381	1.0000	115	1.0000	99	1.0000	72	1.0000
Kell: K-Kp ^a -	365	0.9580	113	0.9826	90	0.9091	72	1.0000
K+Kp ^a -	15	0.0394	2	0.0174	8	0.0808	0	0.0000
K-Kp ^a +	1	0.0026	0	0.0000	1	0.0101	0	0.0000
Total	381	1.0000	115	1.0000	99	1.0000	72	1.0000

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Lewis: Le ⁻	380	0.9974	115	1.0000	99	1.0000	72	1.0000
Le ⁺	1	0.0026	0	0.0000	0	0.0000	0	0.0000
Total	381	1.0000	115	1.0000	99	1.0000	72	1.0000
Duffy: Fy ⁺	335	0.8793	101	0.8783	92	0.9293	61	0.8473
Fy ⁻	46	0.1207	14	0.1217	7	0.0707	11	0.1527
Total	381	1.0000	115	1.0000	99	1.0000	72	1.0000
Diego: Di ⁺	24	0.0630	15	0.1305	3	0.0303	0	0.0000
Di ⁻	357	0.9370	100	0.8695	96	0.9697	72	1.0000
Total	381	1.0000	115	1.0000	99	1.0000	72	1.0000
Hgb: AA	332	0.8997	106	0.9298	73	0.7935	72	1.0000
AS	37	0.1003	8	0.0702	19	0.2065	0	0.0000
Total	369	1.0000	114	1.0000	92	1.0000	72	1.0000
G-6-P-D: A	9	0.0250	2	0.0190	2	0.0217	3	0.0417
B	349	0.9694	103	0.9810	89	0.9674	69	0.9583
AB	2	0.0056	0	0.0000	1	0.0109	0	0.0000
Total	360	1.0000	105	1.0000	92	1.0000	72	1.0000
AP: A	26	0.0758	6	0.0600	7	0.0795	4	0.0606
B	185	0.5394	57	0.5700	41	0.4659	42	0.6363
RA	131	0.3819	37	0.3700	40	0.4546	20	0.3031
CB	1	0.0029	0	0.0000	0	0.0000	0	0.0000
Total	343	1.0000	100	1.0000	88	1.0000	66	1.0000
Hp:	0	0.0054	2	0.0175	0	0.0000	0	0.0000
1-1	65	0.1738	14	0.1228	1	0.0105	30	0.4167
2-1	142	0.3797	41	0.3596	34	0.3472	25	0.3472
(wk) 2-1	4	0.0107	3	0.0263	0	0.0000	0	0.0000
2-2	154	0.4118	50	0.4387	58	0.6106	16	0.2222
(wk) 2-2	7	0.0187	4	0.0351	2	0.0210	1	0.0139
Total	374	1.0001	114	1.0000	95	1.0000	72	1.0000
Gc: 1-1	148	0.3968	33	0.2920	45	0.4736	32	0.4507
2-2	37	0.0992	14	0.1239	13	0.1369	3	0.0423
2-1	188	0.5040	66	0.5841	37	0.3895	36	0.5070
Total	373	1.0000	113	1.0000	95	1.0000	71	1.0000

All 381 blood samples were also positive for Kp, k and U, and negative for He and C⁺.
 All 364 tested for B-PGD, all 94 tested for LDH, all 111 tested for Ca I and all 375 tested for transferrins were normal.
 The number for the three reservations does not total that for "All Seminoles" because 95 persons born away from the three reservations have been omitted.

TABLE 2
Physical traits in the Seminole Indians

	No.	Mean	S.D.	Min.	Max.
Males					
Height	94	1694.4	78.0	1384	1887
Weight	94	168.7	35.8	108	279
Skin color -R	95	43.9	5.9	27	75
Skin color -T	95	27.7	7.1	6	40
Head length	95	188.6	6.7	170	204
Head width	95	156.4	7.0	140	171
Head index	95	83.0	4.1	74.7	96.6
Face width	95	145.8	7.4	124	166
Face length	93	125.1	7.0	105	145
Face index	93	85.8	5.0	71.3	99.2
Nose length	94	57.5	4.8	47	72
Nose width	95	41.1	3.9	31	54
Nasal index	94	71.9	6.5	50	90.2
Lip thickness	78	15.7	4.3	6	23
Age	97	42.5	18.5	16	99
Females					
Height	143	1571.8	65.5	1180	1732
Weight	143	152.1	33.2	88	260
Skin color -R	141	45.3	4.2	32	58
Skin color -T	141	29.4	5.0	15	45
Head length	143	183.3	6.7	168	210
Head width	144	150.1	6.3	134	164
Head index	143	82.0	4.0	69.5	91.2
Face width	144	137.8	7.0	114	160
Face length	142	117.1	6.5	102	143
Face index	143	84.9	5.7	70.2	99.9
Nose length	144	53.0	4.1	43	63
Nose width	141	38.3	5.8	30	91
Nasal index	141	71.4	8.7	57.7	93.2
Lip thickness	118	15.6	4.5	3	36
Age	146	39.8	17.7	16	89

Weight is in pounds; all measurements of distance are in millimeters; indices are ratios of width and length times 100. Skin color is the measurement of reflectance of light from the medial surface of the arm with spectrophotometer (Photovolt 410) in which 100 represents the whiteness of magnesium oxide; R is with the red filter and T is with the tristimulus or amber filter. Age is in years.

TABLE 3
Hair color and hair form in Seminole Indians

Hair color	Number	Frequency	Hair form	Number	Frequency
Blond	1	0.003	Straight	209	0.647
Brown	73	0.227	Wavy	98	0.303
Black	244	0.758	Curly	16	0.050
Grey	3	0.009			
Red	1	0.003	Total	323	1.000
Total	322	1.000			

was performed for each of the 14 physical variables and age, and the F values are given in table 6. The results show that the F values in males for nose length and in females for head width and face index are significant at the 0.05 level and in females for face width the F values are highly significant at the 0.01 level.

Statistical tests were performed to analyze the effect of age differences among

the three subpopulations on these physical differences, as the Brighton males average 15 years younger than the males on the other two reservations, and the Brighton females average eight years younger. In males the regression on age of nose length, nose width and lip thickness are significant; in females the regression on age of these traits plus weight, head width, face width and face index are significant. When

TABLE 4

Correlation coefficients among physical traits and age in Seminole Indians

	Height	Weight	Skin color -R	Skin color -I	Head length	Head width	Head index	Face width	Face length	Face index	Nose length	Nose width	Nose index	Lip thickness	Age
Height		0.325 ¹	-0.023	0.028	0.233	0.197	0.008	0.394 ¹	0.500 ¹	0.144	0.218	0.154	-0.023	0.145	-0.028
Weight	0.252 ¹		-0.124	-0.137	0.473 ¹	0.511 ¹	0.115	0.618 ¹	0.421 ¹	-0.121	0.187	0.462 ¹	0.314 ¹	0.029	0.141
Skin color -R	0.052	-0.199		0.460 ¹	0.045	-0.161	-0.169	-0.052	-0.166	-0.103	-0.083	-0.103	-0.018	-0.108	0.183
Skin color -I	0.040	-0.144	0.877 ¹		-0.058	0.315 ¹	-0.246	-0.175	-0.350 ¹	-0.179	-0.209	-0.259	-0.070	-0.008	0.155
Head length	0.198	0.402	-0.031	-0.053		0.277 ¹	-0.476 ¹	0.410 ¹	0.291 ¹	-0.063	-0.046	0.304 ¹	0.349 ¹	-0.027	-0.044
Head width	0.164	0.538 ¹	0.010	0.025	0.232		0.710 ¹	0.694 ¹	0.377 ¹	-0.238	0.189	0.345 ¹	0.195	-0.045	-0.003
Head index	0.001	0.151	0.038	0.070	-0.535 ¹	0.687 ¹		0.335 ¹	0.129	-0.170	0.208	0.090	-0.080	-0.027	0.032
Face width	0.128	0.651 ¹	-0.049	-0.037	0.304 ¹	0.635 ¹	0.309 ¹		0.404 ¹	-0.469 ¹	0.279 ¹	0.291 ¹	0.089	-0.176	0.173
Face length	0.109	0.232	-0.029	-0.018	0.177	0.194	0.020	0.158		0.612 ¹	0.507 ¹	0.373 ¹	-0.093	0.218	0.076
Face index	-0.031	-0.271 ¹	0.016	0.004	-0.061	0.284 ¹	-0.198	-0.571 ¹	0.670 ¹		0.284	0.117	-0.170	0.354 ¹	-0.076
Nose length	-0.058	0.114	0.147	0.179	0.121	0.272 ¹	0.137	0.153	0.414 ¹	0.258 ¹		0.405 ¹	-0.452 ¹	-0.126	0.487 ¹
Nose width	0.078	0.385 ¹	-0.012	0.030	0.133	0.305 ¹	0.159	0.367 ¹	0.109	-0.162	0.282 ¹		0.611 ¹	-0.105	0.303 ¹
Nose index	0.076	0.268 ¹	-0.222	-0.187	0.153	0.006	-0.105	0.168	-0.211	-0.297 ¹	-0.378 ¹	0.355 ¹		0.001	-0.101
Lip thickness	0.172	-0.041	-0.127	-0.184	-0.139	-0.196	-0.081	-0.193	0.233	0.339 ¹	-0.289 ¹	-0.238	-0.015		-0.634 ¹
Age	-0.135	0.250 ¹	0.055	0.141	0.233	0.262 ¹	0.075	0.315 ¹	-0.001	-0.231	0.489 ¹	0.421 ¹	0.070	-0.645 ¹	

FEMALES

¹ Significant at 1% level.

TABLE 5
Gene frequency estimates on serological factors in Seminole Indians:
(Total sample and three subgroups based on birthplaces.)

Factor	Allele	All Seminoles	Dania	Big Cypress	Brighton
ABO	O	0.9775	0.9737	0.9949	0.9577
	A ₁	0.0159	0.0131	0.0051	0.0354
	A ₂	0.0027	0.0044	0.0000	0.0000
	B	0.0039	0.0088	0.0000	0.0069
MNS	MS	0.3424	0.3085 ¹	0.3405	0.4176
	M _s	0.5263	0.5915	0.5838	0.4088
	NS	0.0592	0.0350	0.0332	0.0754
	N _s	0.0721	0.0650	0.0425	0.0982
M	M	0.8687 ¹	0.9000	0.9243	0.8264
S	S	0.4015	0.3435	0.3737	0.4930
P	P	0.3561	0.2658	0.4315	0.3546
Rh	R ₁	0.5869 ¹	0.5983	0.4874	0.6914 ²
	R ₂	0.2811	0.2983	0.3358	0.1913
	R _x	0.0798	0.0756	0.1541	0.0378
	r	0.0522	0.0278	0.0227	0.0795
Kell	KKp ^a	0.0000	0.0000	0.0000	0.0000
	KKp ^b	0.0197	0.0087	0.0404	0.0000
	kKp ^a	0.0013	0.0000	0.0050	0.0000
	kKp ^b	0.9790	0.9913	0.9546	1.0000
Lewis	Le ^a	0.0013	0.0000	0.0000	0.0000
Duffy	Fy ^a	0.6526	0.6512	0.7341	0.6092
Diego	Di ^a	0.0320	0.0675	0.0153	0.0000
Hgb	A	0.9499	0.9642	0.8908	1.0000
G-6-P-D	A	0.0278	0.0190	0.0271	0.0417
AP	A	0.2668	0.2450	0.3068	0.2121
	B	0.7318	0.7550	0.6932	0.7879
	C	0.0014	0.0000	0.0000	0.0000
Haptoglobin	1	0.3710 ²	0.3214	0.1896	0.5902 ¹
Gc	1	0.6488 ¹	0.5841 ¹	0.6684	0.7042

¹ χ^2 significant at 5% level.

² χ^2 significant at 1% level.

these traits are age-corrected, a one-way analysis of variance yields F values no longer significant for male nose length; however, female head width, face width and face index are now more highly significant, as shown by the F values in parenthesis in table 6. When age differences and reservation differences are examined simultaneously by a two-way analysis of variance the results confirm this importance of both reservation and age differences in those three physical traits in females.

The study of physical traits by families permits knowledge of the correlation between husband and wife for each trait as

an indication of assortative mating. The highest correlation shown among 45 to 48 couples so analyzed was that for skin color with the tristimulus filter, 0.56, followed by 0.30 with the red filter. The highest positive correlation between husband and wife for a morphologic trait is 0.27 for face width, almost twice as much as 0.14 for weight. The correlation for height is a surprising negative one of 0.26. By comparison with these figures the age of husband and wife show a positive correlation of 0.91.

The 113 adult women who have ever borne offspring have had 424 children, an average of 3.75 children per woman. The

TABLE 6¹
Means for physical traits by reservations in Seminole Indians

	Dania	Big Cypress	Brighton	F Values
Males				
Sample size	19	33	14	
Height	1711	1682	1667	1.24
Weight	171	171	150	1.71
Skin color -R	44.4	44.2	42.6	0.36
Skin color -T	27.0	29.2	24.9	1.55
Head length	188	188	189	0.26
Head width	156	155	158	0.65
Head index	83.2	82.4	83.6	0.49
Face width	145	144	145	0.10
Face length	127	124	124	0.89
Face index	87.4	86.0	85.4	0.79
Nose length	59 (58)	58	54 (56)	3.80 ² (1.30)
Nose width	42	42	39 (40)	2.99 (1.29)
Nose index	71.8	72.2	72.3	0.03
Lip thickness	16	16	19 (16)	2.11
Age	46	44	30	3.79 ³
Females				
Sample size	33	48	21	
Height	1558	1560	1569	0.18
Weight	146	146 (147)	147 (152)	0.03
Skin color -R	46.4	44.8	45.0	1.63 (0.25)
Skin color -T	30.4	29.3	28.6	0.99
Head length	183	182	182	0.30
Head width	149 (150)	148	152 (153)	4.27 ² (5.64 ³)
Head index	81.8	81.2	83.3	2.44
Face width	135	136	140	5.35 ³ (7.71 ³)
Face length	119	116	116	0.78
Face index	87.3	85.7	83.1 (82.4)	3.97 ² (5.13 ³)
Nose length	53	54 (53)	52 (53)	0.70 (0.28)
Nose width	38	38	36 (38)	1.30 (0.23)
Nose index	71.5	71.8	70.3	0.30
Lip thickness	15	17 (16)	16 (15)	1.06 (1.89)
Age	39	38	31	1.65

¹ See legend for table 2. F values are obtained by one way analysis of variance with among groups degrees of freedom 2 and within groups degrees of freedom approximately 65 for males and the corresponding degrees of freedom 2 and 100 for females.

² F value significant at the 0.05 level.

³ F value significant at the 0.01 level. Means in parentheses are age corrected wherever they differed significantly from the uncorrected ones; they are the values expected if each subpopulation had the same pooled age distribution. F values in parentheses are those calculated from the age corrected measurements.

age-specific fertility of married women as measured by the total number of living children is given in table 7. The ratio of children per married woman increases with age, levelling off at the end of the reproductive period.

In an attempt to relate fertility to physical variables, and minimize the effect of age on both, all married women 40 and above were selected. The distribution of the number of their children was partitioned at its mean, and 2 × 2 chi-square tests were performed. Significant at the 0.05 level were skin color (with tristimulus filter) and face width. When correlations were calculated between the physical traits and the number of offspring for all mar-

ried women 40 and above, both measurements of skin color were significant at the 0.01 level, and face length at the 0.05 level. Darker pigmentation is associated with larger family size, by both tests; the association with face dimensions, while not as clear, is in the direction of larger face with more offspring.

DISCUSSION

The Seminole Indians of Florida represent one of the few distinctive and isolated Indian populations left in the southeastern United States. In morphology, they are somewhat shorter, more round-headed, round-faced and wider nosed than the "full-blood" Sioux of the plains measured

TABLE 7
Age-specific fertility of Seminole Indian married women

Age group	Number of women	Number of children	Average number of children per woman
15-19	13	3	0.230
20-24	21	24	1.142
25-29	15	42	2.800
30-39 ¹	20	78	3.900
40-54 ¹	42	164	3.904
55-59	8	33	4.125

¹ Larger interval to remove the disturbing effect of small sample size on the woman-child ratio.

by Sullivan ('20). In blood types they are very similar to the Cherokee "full-bloods" of North Carolina (Pollitzer et al., '62) in their absence of Rh, and their high incidence of Group O and of M. The presence of Di^a departs from the Cherokee but is similar to other Indian groups especially those of South America.

Many of the differences in gene frequencies noted between the younger and older age groups in the Seminoles as a whole remain after subdivision into the three reservation subisolates. They are probably due to chance and illustrate how genes may be "lost" in a single generation.

From gene frequencies an estimate can be made of the contribution of hypothetical parental groups of the past to the Seminole Indians of today. As different elements entered into the Seminoles at different times no earlier "pure" Seminole "base-line" exists, and no well-defined present-day populations can be cited as clearly ancestral to the Seminoles. But as a first approximation to those populations who contributed genes to the Seminoles, the Cherokee Indian "full-bloods" of North Carolina for whom serologic data are available (Pollitzer et al., '62) are taken as genetically similar to the original Indian components; English gene frequencies available for many loci from thorough typing are utilized for a white component (Race and Sanger, '62); and Gullah Negroes of South Carolina (Pollitzer, '58) represent the Negro component. For morphology, the Sioux Indians of the Plains, extensively measured by Sullivan ('20), are used for comparison; Americans predominantly of English ancestry represent the white element (Hrdlicka, '25); and the Gullah are again considered for Negro. The same methods of calculations of

similarity of Seminoles to parental populations are also useful in comparing the subpopulations on the three reservations.

Robert and Hiorns ('62, '65) have contributed one method for estimating admixture. Elston (unpublished) has contributed an alternate least squares solution, a pseudo-maximum likelihood estimate using gene frequencies, and a maximum likelihood method using phenotype frequencies. All these methods view current gene frequencies of the Seminoles as a weighted average of the assumed gene frequencies in two or more ancestral groups. The weights are estimated and taken to be the contributions of the respective ancestral group. Using ABO, MN, Ss, Rh, Duffy, Kell, Hemoglobin and Haptoglobin data, the proportions of racial admixture are shown in table 8 for all Seminoles and then for the subpopulations.

If Indian and Negro were the *only* parental groups contributing genes, then various methods suggest almost 90% Indian and 10% Negro for the total Seminole sample. If *only* Indian and English are postulated, the Indian component is even higher. (And if English and Negro *only* were the ancestors, English would be over 90%.) The assumption of all three ethnic stocks as parents, which appears most in accord with the historical facts, produces negative values and thus unrealistic estimates.

Apart from sampling error, several explanations for this can be advanced. One probable factor is that, in view of the heterogeneity among American Indian, Negro and White populations, the ancestral gene frequencies used in these calculations may not be those of the actual parents. The marked fluctuation in population size over the years has produced

TABLE 8
Proportions of racial¹ admixture in all Seminole Indians and three sub-populations based on eight² serological traits

Hybrid pops.	Methods ³							
	R and H		L. S.		M.L.G.F.		M.L.P.F.	
Analysis I. Parents used: Negro and Indian								
Parents:	N	I	N	I	N	I	N	I
All Sem.	0.1362	0.8638	0.1295	0.8705	0.0796	0.9204	0.0813	0.9187
Dania	0.1216	0.8784	0.1100	0.8900	0.0522	0.9478	0.0530	0.9470
Big Cyp.	0.1540	0.8460	0.1482	0.8518	0.1103	0.8897	0.0943	0.9057
Brighton	0.1346	0.8654	0.1278	0.8722	0.0163	0.9837	0.0491	0.9509
Analysis II. Parents used: English and Indian								
Parents:	E	I	E	I	E	I	E	I
All Sem.	0.0701	0.9299	0.0711	0.9289	0.0251	0.9749	0.0196	0.9804
Dania	0.0492	0.9508	0.0387	0.9613	*	*	*	*
Big Cyp.	0.0312	0.9688	0.0424	0.9576	*	*	*	*
Brighton	0.0877	0.9123	0.0861	0.9139	0.0771	0.9229	0.0684	0.9316
Analysis III. Parents used: English and Negro								
Parents:	E	N	E	N	E	N	E	N
All Sem.	0.9572	0.0428	0.9606	0.0394	0.9255	0.0745	0.9198	0.0802
Dania	0.9726	0.0274	0.9784	0.0216	0.9470	0.0530	0.9438	0.0562
Big Cyp.	0.9025	0.0975	0.9041	0.0959	0.8515	0.1485	0.8592	0.1408
Brighton	0.9699	0.0301	0.9739	0.0261	*	*	*	*

¹ Allele frequencies of parental racial groups used for the analyses are from English, Charleston Negro and Cherokee Indian populations.

² Eight traits are: ABO, RH, MN, Ss, FY, Kell, Hemoglobin and Haptoglobin.

³ Four methods used are: Roberts and Hiorns (R & H), Least squares (L.S.), Pseudo-maximum likelihood using gene frequencies (M.L.G.F.), and Maximum likelihood using phenotype frequencies (M.L.P.F.). Roberts and Hiorns is modified to use all alleles at each locus.

* Admixture proportion negative with one parent indicating that the parental combination is unrealistic and does not fit the model. With English, Indian and Negro, admixture proportions show negative results for English.

"bottlenecks" which probably altered gene frequencies. The presence of G-6-PD A and the high frequency of Hgb S is indicative of Negro ancestry, but the absence of the R^o gene indicates that the number of Negroes entering the Seminoles must have been small. Selection pressure, mediated by resistance to malaria, may have maintained the abnormal hemoglobin gene at the high level noted; but the G-6-PD deficiency, also believed to be favored by malaria, has not been as elevated as expected on this assumption. Deviations from Hardy-Weinberg equilibrium at certain loci have also been noted. Thus reasonable explanations of these gene frequency observations are the influence of the founder effect, genetic drift and selection. Yet the gene frequencies in general still reflect what is suspected from the historical evidence and from the physical findings, concerning both the relative racial contributions to the Seminoles as a whole

and the degree of similarity between the Dania and Big Cypress subpopulations.

The loci which deviate most significantly from the admixture model for all Seminoles are MN, Duffy, and Haptoglobin in that order. However, when analyzed separately, Brighton and Big Cypress do not have MN deviating significantly from the model.

In considering the reservations, Big Cypress appears to be less Indian than the other two on the basis of most gene frequencies. The above methods are utilized for estimating the contribution of each of the hypothetical ancestors to the three subpopulations. Where Negro and Indian are assumed to be the only parents, Big Cypress shows slightly higher negroid admixture than the other two reservations. Where English and Indian are the assumed parents, both Big Cypress and Dania look more Indian. Where English and Negro are considered parental, the Negroid

component appears higher at Big Cypress. Assuming all three parental groups again produces unrealistic estimates for the three subpopulations.

Significance of the statistic used to test for Hardy-Weinberg equilibrium has been noted for several loci, a phenomenon which could be due to the collection of blood samples by families. To obviate this difficulty and obtain individuals not closely related a subsample of 155 people were selected, omitting children whose parents were tested and including only one member of each sibship. Gene frequencies were recalculated for the loci which showed significant deviation: Hp, Rh, MNS, and Gc. Only haptoglobin showed significant deviation at the 0.05 level in the subsample with homozygous classes still in excess. If inbreeding were responsible for homozygosity it should affect all loci. While the deviation from Hardy-Weinberg in haptoglobin among all Seminoles is probably due in large measure to heterogeneity, it is noteworthy that the Brighton reservation also shows a significant increase in homozygous classes at this locus. While chance alone may account for the haptoglobin disturbance, it is possible that some selective factor is operating. The ad-

vantage of Hp¹ where there is malaria, hemolysis, or iron deficiency has been noted (Curtain et al., '65); the advantage of Hp² in the presence of typhoid and similar bacterial infections has also been noted (Nevo and Sutton, '68). Conceivably some complex interaction between parents is decreasing the heterozygotes in this population. Mating types yielding information on segregation ratios are too few to permit reliable segregation analysis at the Hp locus. This revision makes no difference in the estimation of admixture; therefore estimates based on the total sample were used.

Mahalanobis et al. ('49) contributed a method for estimating the "distance" or degree of dissimilarity between populations on the basis of morphologic characteristics. This D² calculation using the age-corrected means and covariance matrix (within subpopulations) of height, head length, head width, face length, face width, nose length and nose width has been utilized to estimate the relationship between the Sioux Indians of the Plains (Sullivan, '20), American Whites (Hrdlicka, '25), Negroes (Pollitzer, '58) and the Seminoles, and their three subpopulations. These results are summarized in table 9 and in

TABLE 9
Generalized distance in mean ¹ units pooled for both sexes among
Seminoles and parental populations

	Sioux Indian	American White	American Negro
1. American White	1.303	—	—
American Negro	0.991	0.958	—
All Seminoles	0.701	1.283	0.764
2a. American White	1.259	—	—
American Negro	0.957	0.925	—
Dania	0.859	1.276	0.724
b. American White	1.307	—	—
American Negro	0.992	0.962	—
Big Cypress	0.754	1.271	0.714
c. American White	1.259	—	—
American Negro	0.955	0.926	—
Brighton	0.725	1.240	0.895
	Dania	Big Cypress	Brighton
3. Big Cypress	0.694	—	—
Brighton	1.223	1.083	—

¹ If d_i is the distance between the i^{th} pair of populations and if there are n such pairs of populations in a set, Mean $D_i = \frac{\sum_{i=1}^n d_i}{n}$, so that the mean distance for each set equals unity.

1. Distance between Seminoles and parent populations.
2. Distance between each sub-population and parental population.
3. Distance between the three sub-populations.

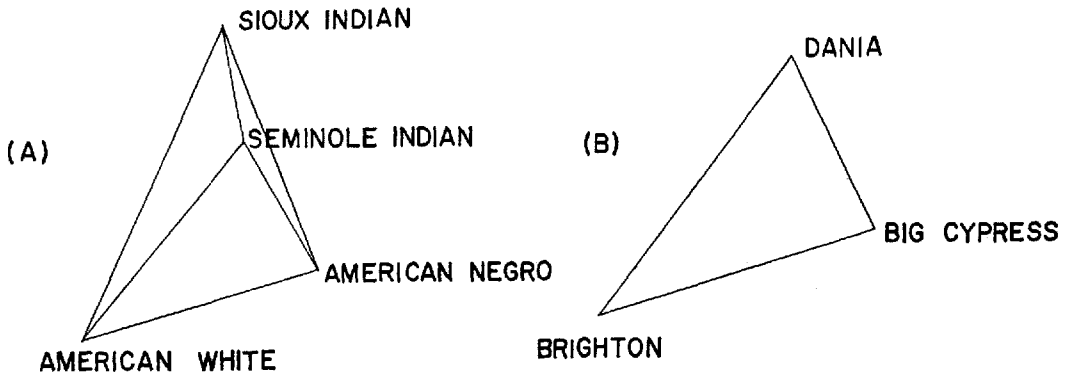


Fig. 1 Schematic representation of generalized distance in mean units (A) between parental populations and Seminole Indians and (B) between Seminole sub-populations.

figure 1, in which all distances have been expressed as mean units, the smaller number indicates closer similarity, and the calculations for the two sexes have been averaged. They show the Seminoles to be closest to the Sioux, a little less close to the Negroes, and still farther from the Whites. Of the three reservations of Seminoles, Dania and Big Cypress are closer together, with Brighton somewhat removed.

Another method of comparison of the different populations uses in addition to the pooled covariance matrix within the subpopulations, W , the covariance matrix among subpopulations, A , to determine the two largest latent roots and vectors of the matrix AW^{-1} (Rao, '52). This facilitates the projection of the populations in terms of their age-corrected means in a plane along two new and independent dimensions. The analysis uses height, head length and width, face length and width, and nose length and width. The largest latent root λ_1 and the second largest latent root λ_2 and the corresponding vectors are calculated from the matrix AW^{-1} , in which A and W are obtained from the two sexes pooled. λ_1 accounts for 65%, and λ_1 and λ_2 together account for 87%, of the total variation.

Figure 2 is a graphic representation of the Seminoles, their approximate parental populations, and their three subpopulations along the two independent axes corresponding to the characteristic vectors of λ_1 and λ_2 . The females in all populations are nearer the origin than the males. For

each sex all Seminoles (pooled) fall within the triangle of the three "parental populations," but the Seminole males are more similar to their Sioux counterparts than the Seminole females are to theirs. Among the three subpopulations Dania and Big Cypress are most similar and removed from Brighton; this is apparent for females but striking for males.

By multiplying each element of the vector by the standard deviation of the trait, it is possible to find the contribution of each trait in terms of its standard deviation, to each λ ; nose width contributes most to λ_1 (followed by head width and face width in that order of importance), and face width contributes most to λ_2 (followed by head width and face length). The age-corrected F values for head and face widths in females were significant at the 0.01 level in comparison of the three reservations.

The Brighton population also have a higher frequency of hypothenar patterns on the palms than the Dania and Big Cypress populations have (Rife, '68). Thus morphologic, dermatoglyphic and serologic methods appear to agree fairly well with each other and with history and linguistics on the nature of the Seminoles and their subpopulations. The divergences of the subpopulations may indicate different directions of microevolution.

The apparent assortative mating for skin color, plus the differential fertility by color, provide an interesting speculation for the future. If skin color should continue to be a basis for matings and darker per-

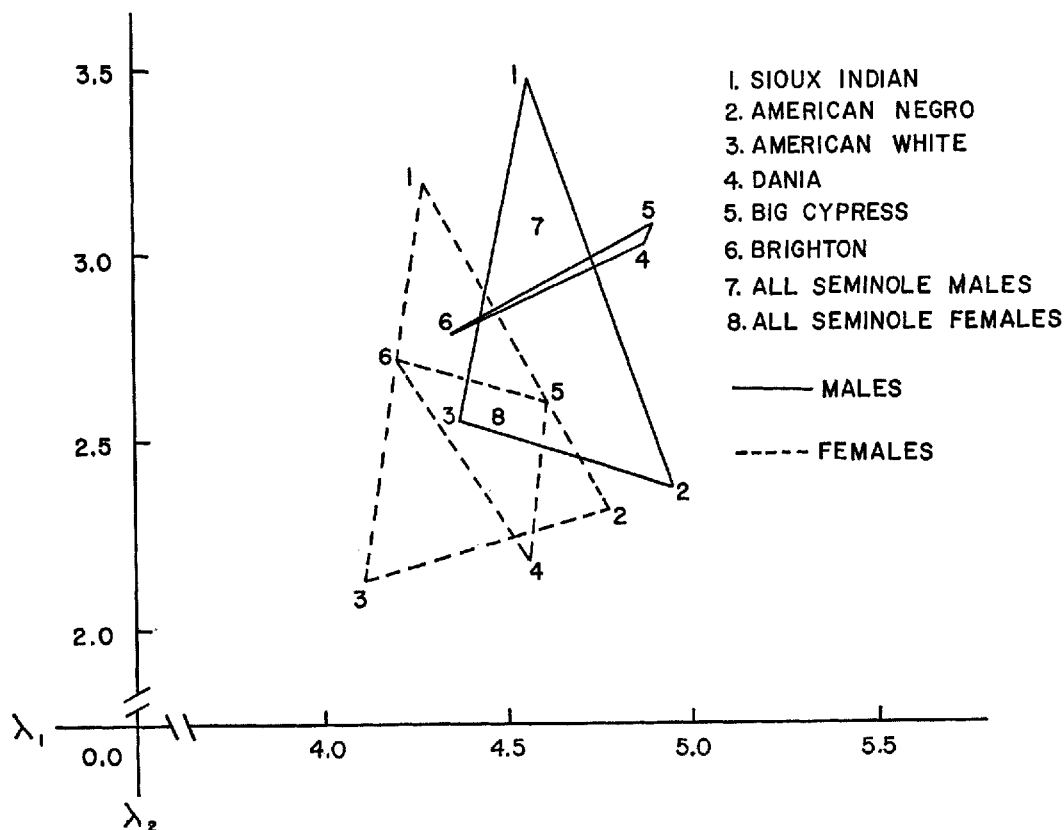


Fig. 2 Graphic representation of the three Seminole sub-populations and parent populations (sexes separate) in terms of their means for physical traits along two independent axes obtained by an analysis of among and within sub-population variance.

sons have more offspring, a trend toward increased pigmentation should result in this population. It is noteworthy that the apparent trend is in the opposite direction from that of a North Carolina tri-racial isolate (Pollitzer et al., '66) where the more Indian or less Negroid phenotypes had a higher fertility. But the sample size is small, and the trend is always subject to modification by changing attitudes and by migration.

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