

**DISTRIBUTIONS OF SKIN PIGMENTATION, DERMATOGLYPHICS,
TASTING ABILITY, AND ABO BLOOD GROUPS WITHIN
MIXED NEGRO - WHITE POPULATIONS**

by
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Populations of hybrid origin provide a tool for the detection of linkage, providing certain conditions are met. The principles involved were recently outlined (Rife, 1954). In essence, significantly higher associations between some genetic traits than between others within hybrid populations is suggestive of linkage, providing at least one of the traits showing such an association is of no assortative significance.

An investigation of 100 northern Sudanese and of 35 Negro students at The Ohio State University revealed highly significant correlations between shade of skin pigmentation and the incidence of patterns in the second interdigital area of the palm. No significant correlations were found between tasting ability for phenyl-thio-carbamide and either pigmentation or the incidence of patterns in the second interdigital area (Rife, 1954).

This report is concerned with additional data obtained from 167 Negro students at Central State College of Wilberforce, Ohio, and a summarization of the results from the Sudanese and Ohio State University data, as well as those obtained from Central State College. An expedition consisting of Dr. Elton F. Paddock, Professor William J. Brakel, Mr. and Mrs. Charles Pemberton, Dr. Chai Yoon, Mr. James Trimble, Mr. Ed Les, Mr. P. G. Nair, and the author collected the Wilberforce data.

Acknowledgments

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Types of Data

Data on shade of skin pigmentation, ability to taste phenyl-thio-carbamide, palmar dermatoglyphics, and ABO blood groups were obtained from 167 students.

Ratings of skin pigmentation were made independently by Paddock, Brakel, and

Rife. Four categories were used; black, dark brown, light brown, and very light brown. The final classification includes those where all observers agreed, as well as those upon which two agreed, where all disagreed the intermediate class was designated. The observers were in complete agreement in 54 cases, no two agreed in 11 cases, while 2 out of 3 observers were in agreement in 102 cases. In no instance did any observer disagree from both of the others by more than one category.

Ability to taste phenyl-thio-carbamide was tested by placing a few crystals of the substance on the back of the tongue by means of a tooth pick. Taste reaction was recorded after the lapse of a minute or two.

Palm prints were obtained by the Faurot inkless method.

The ABO blood groups were tested on the spot, using liquid anti-sera and whole blood.

Analysis of the Data

Tables E and F in the Appendix give the numbers in each category with respect to each of the four traits, as well as sex. Similar classifications of the Sudanese and the Ohio State University data are presented in Tables A, B, and C. Unless otherwise stated dark among Wilberforce students includes the two darkest classes; light the two lightest classes. Among Sudanese, darks include the two darkest; lights the three lightest classes. There are six types of two way comparisons of associations between four traits, and each of these shall now be considered.

1. Pigmentation and Patterns in Interdigital Area II

This is the association we are particularly interested in, as it is the only one where highly significant positive associations occurred among both the Sudanese, and the Ohio State University students. Table 1 shows the data for associations in the Wilberforce students, as well as in the other two populations. Note that the trends are essentially the same in all three populations. The Wilberforce data alone show a highly significant association, and as would be expected, the pooled data of all three populations show an even higher Chi-square value.

Table 2 shows the results when males and females are tested separately. The associations is highly significant among males and is significant but not highly so among females.

The question may be raised as to how many of these classed as dark are pure Negroes. This is an important point, as only those individuals of mixed ancestry can give valid evidence for associations suggestive of linkage. It seems reasonable to assume that those classified as "black" by the observers likely include all of those of unmixed ancestry. Among the northern Sudanese, however, none of those investigated appeared to be as dark as southern Sudanese Negroes, but the two lightest classes may have contained some individuals of pure Arab descent.

In order to avoid the inclusion of pure Negroes or Whites we have rearranged the classification of darks and lights in Table 3. Here the darks from the Wilberforce group include only the dark browns, whereas the lights from the Sudanese include those origi-



**1. Dark brown
Northern Sudanese**



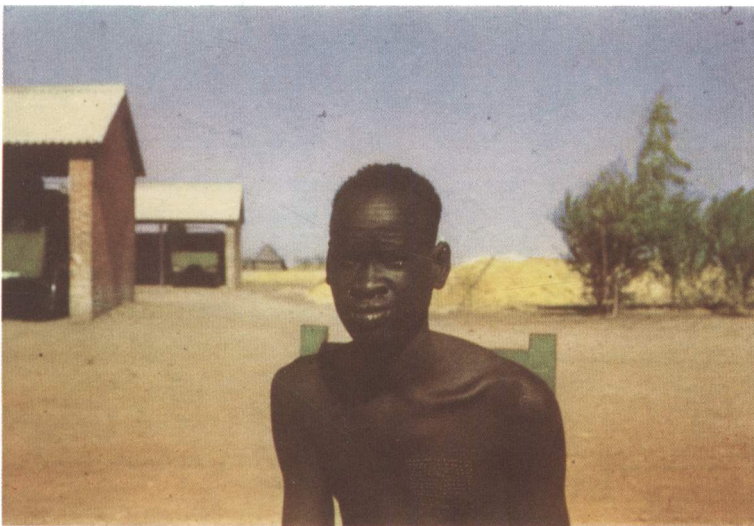
**2. Medium brown
Northern Sudanese**



3. Light brown Northern Sudanese



4. Very light Northern Sudanese



5. Black Nuer-Southern Sudanese

nally classed medium and dark. The dark Sudanese in the revision include only those classed as "blacks". Although elimination of those who may be unmixed black or unmixed white reduces the total somewhat, the trends are essentially the same.

All of the comparisons agree in showing two to three times as high frequencies of second interdigital patterns among darks as among lights.

2. Pigmentatiton and tasting ability

Table 4 shows tests for association between tasting ability and shade of pigmentation, including the pooled data from the three populations. Although there is a high incidence of non-tasters among the lights, it is of no statistical significance. Table 5 shows a comparison, in which darks and lights correspond to those in Table 3. Here again a trend towards more non-tasters among lights is indicated, but the differences are of no statistical significance. Taken separately or collectively, the three populations manifest no significant associations between pigmentation and tasting ability.

3. Pigmentation and ABO blood groups

No blood group data were obtained from the northern Sudanese, as their ancestors, African Negroes and Arabs, have similar distributions. Table 6 shows the distributions among lights and darks from the pooled Wilberforce and Ohio State data. As there is only 1 AB in the group, it was omitted from the Chi-square test, which showed no significant differences between darks and lights. Table 7 shows a similar comparison, but the "blacks" are omitted. Here again no significant difference is found.

There is a distinct trend, however, towards a higher incidence of group A among lights. This is what one might expect, among relatively new hybrid populations in which too few generations have occurred to result in equilibrium for non-linked genes. But the relatively high frequencies of O, and the rarity of AB are puzzling, as both west African Negroes and western Europeans have only 45 to 50% group AB. Inbreeding could bring about such a result, but one should expect increases in heterozygosity, rather than in homozygosity in hybrid populations.

Regardless of the cause for this peculiar trend, the data show no significant associations between pigmentation and the ABO blood groups.

4. Tasting ability and patterns in interdigital area II

Table 8 presents data on the incidence of tasting ability and patterns on the second interdigital area. No significant associations are present, nor are any trends towards an association indicated.

5. Tasting ability and the ABO blood groups

The distributions of the ABO blood groups among tasters and non-tasters are shown in Table 9. It is readily apparent that there are no trends toward associations between these two traits.

6. ABO blood groups and patterns in interdigital area II

Table 10 shows non evidence for any associations between the ABO blood groups and patterns in the second interdigital area.

Discussion

Northern Sudanese and American Negroes are both hybrid populations of Negro and Caucasian descent. The Negro ancestors of the American Negro came from western and central Africa for the most part, whereas the Negro ancestors of the northern Sudanese were from northeastern Africa, chiefly from the southern Sudan. They also differ in their White ancestors, those of the American Negro being principally of western European and British extraction, whereas those of the Northern Sudanese were Arab and Hamitic. The Negro and White ancestors of the northern Sudanese have similar distributions of the ABO blood groups, whereas the Negro and White ancestors of American Negroes show marked differences in this respect. It was for this reason that ABO blood group comparisons were made in American Negroes only (Rife, 1954).

The Negro and White ancestors of both northern Sudanese and American Negroes show consistent differences with respect to patterns in the second interdigital area and tasting ability, possessing significantly lower percentages of each. Thus comparisons of pigmentation, tasting ability, and patterns in the second interdigital area are applicable to both hybrid populations. Moreover, dermatoglyphics and tasting ability are of no assortative importance.

Of the six possible types of association between traits, that between shade of pigmentation and patterns in the second interdigital area was the only one of significance. The association is consistently high in the three populations investigated. This type of association strongly indicates linkage between genes responsible for skin pigmentation and patterns in the second interdigital area.

Patterns in the second interdigital area are highly heritable, and there is considerable evidence that their presence on one or both palms is due to a dominant gene with 80 to 90% penetrance. The mode of inheritance of differences between Negro and White skin pigmentation is still a matter of debate. The classical interpretation is that of Davenport (1913) who postulated two independent pairs of alleles lacking dominance and cumulative in their effects. More recently (1949) postulated three rather than two pairs. Other observers believe more than three pairs are involved. There is general agreement, however, that dominance is lacking.

If linkage is the reason for the association between pigmentation and dermatoglyphics, it is difficult to see how more than two pairs of independent pairs with equal effects could be involved in pigmentation. Yet there can be no question but that minor gradations in pigment occur. Moreover, females tend to be slightly lighter in color than males. If many pairs are involved, how could even close linkage between only one of the loci for pigmentation and one of those for dermatoglyphics produce such a marked effect.

There is a very plausible explanation for this apparent inconsistency. A single pair of alleles may be responsible for the major differences in pigment, but a number of minor

modifying pairs are responsible for the major differences in pigment, but a number of minor modifying pairs are responsible for fine gradations of color. The differences in the sex distributions are likely due to sex-linked modifiers or sex hormones. Wide differences in degrees of pigmentation among brothers and sisters occur too frequently to be accounted for on the basis of several pairs, with equal effects. I am tentatively proposing, therefore, that a single pair of autosomal alleles, lacking dominance, may be responsible for the major differences in Negro and White skin pigment. Furthermore, these alleles appear to be linked with a pair conditioning the development of patterns in the second interdigital area.

Summary

1. A highly significant association exists between dark pigmentation and patterns in the second interdigital palmar area among populations of mixed Negro-White ancestry, both in northern Sudan and in the United States.

2. No significant associations were observed between pigmentation and ABO blood groups, tasting ability and pigmentation, blood groups and tasting ability, palm patterns and blood groups, or tasting ability and palm patterns.

3. The relatively high association between pigmentation and second-interdigital palmar patterns suggests linkage between some of the genes conditioning these two traits.

References

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Table 1 - Distributions of pigmentation and patterns in second interdigital area

	Dark		Light		X ²	df	p
	Pattern*	No Pattern	Pattern	No Pattern			
Sudanese	11	29	4	56	9.46	1	<.01
Ohio State	3	16	0	16			
Central State College	22	70	8	67	4.96	1	<.05
Total	36	115	12	139	14.10	1	<.01

Table 2 - Distributions of patterns and pigmentation according to Sex

	Dark		Light		X ²	df	p
	Pattern	No Pattern	Pattern	No Pattern			
Males	22	70	5	78	14.30	1	<.01
Females	14	42	7	64	5.05	1	<.05

Table 3 - Distribution of pigmentation and patterns in second interdigital area, excluding cases of possible unmixed Negroes and Whites

Pattern	Dark		Light		X ²	df	p
	No Pattern	Pattern	No Pattern	Pattern			
22	72	13	133	10.50	1	<.01	

Table 4 - Distribution of pigmentation and tasting ability

Tasters	Dark		Light		X ²	df	p
	Non-tasters	Tasters	Non-tasters	Tasters			
136	14	124	22	1.19	1	>.05	

Table 5 - Tasting ability and pigmentation Black and White excluded

Dark		Light		X ²	df	p
Tasters	Non-tasters	Tasters	Non-tasters			
86	8	123	22	2.28	1	<.05

Table 6 - Distribution of ABO blood groups and pigmentation

	0	A	B	AB	Totals	X'	df	p
Darks	70-62.5%	23-20.55%	18-16.07%	1-0.89%	112	4.51	2	>.05
Lights	45-50.0	31-34.4	14-15.55	0-00.90	90			
Totals	115	54	32	1	202			

Table 7 - Distribution of ABO blood groups and pigmentation
(Blacks from Central State College excluded)

	0	A	B	AB	X'	df	p
Dark	45	12	14	0			
Light	36	25	14	0	3.20	2	>.05
Total	81	37	28	0			

Table 8 - Tasting ability and pattern in second interdigital area

Tasters		Non-tasters		X ²	df	p
Pattern	No Pattern	Pattern	No Pattern			
52	246	7	33	0.001	1	>.05

Table 9 - Tasting ability and ABO blood groups

	0	A	B	AB	*X ²	df	p
Tasters	119	53	33	2			
Non-tasters	15	13	9	0	0.04	1	>.05

* Only groups A and B tasted for significance, as this is where differences would be most likely to appear associated with pigmentation.

Table 10 - Patterns in second interdigital area and ABO blood groups

	0	A	B	AB	*X ²	df	p
Patterns	24	13	8	1			
No Patterns	120	56	36	3	0.001	1	>05

* Only groups A and B tested for significance, as this is where differences would be most likely to appear associated with pigmentation.

APPENDIX

DISTRIBUTIONS OF TRAITS AMONG EACH OF THE POPULATIONS

Table A - 100 Northern Sudanese Males

Pigmentation	+ *	—	Total
Dark Brown			
Tasters	7	16	23
Non-tasters	0	0	0
Medium			
Tasters	2	13	15
Non-tasters	0	2	2
Light Brown			
Tasters	3	46	49
Non-tasters	0	4	4
Very Light Brown			
Tasters	0	6	6
Non-tasters	0	0	0
Tasters	1	0	1
Non-tasters	0	0	0
Totals	13	87	100

* denotes individuals who possess pattern in the second interdigital area of one or both palms, — those who lack patterns in both.

Table B - 47 Ohio State University Males

Pigmentation	Blood groups					Total
	0 + —	A + —	B + —	AB + —	Unclassified + —	
Dark						
Tasters	1 4	1 1	0 1	0 0	0 0	8
Non-tasters	0 0	0 1	0 2	0 0	0 0	3
Unclassified	1 0	0 0	0 0	0 0	0 0	1
Light						
Tasters	0 3	0 0	0 0	0 0	0 0	3
Non-tasters	0 0	0 0	0 0	0 0	0 0	0
Unclassified	0 0	0 1	0 0	0 0	0 0	1
Unclassified						
Tasters	2 8	0 4	2 2	0 1	0 0	19
Non-tasters	2 2	0 2	0 0	0 0	0 0	6
Unclassified	0 4	0 0	0 2	0 0	0 0	6
Total	6 21	1 9	2 7	0 1	0 0	47

Table C - 53 Ohio State University Females

Pigmentation	Blood Groups					Total
	0 + —	A + —	B + —	AB + —	Unclassified + —	
Dark						
Tasters	2 3	0 0	0 1	0 0	0 0	6
Non-tasters	0 1	0 0	0 0	0 0	0 0	1
Unclassified	0 0	0 0	0 0	0 0	0 0	0
Light						
Tasters	0 4	0 4	0 0	0 0	0 0	8
Non-tasters	0 0	0 0	0 0	0 0	0 0	0
Unclassified	0 3	0 1	0 0	0 0	0 0	4
Unclassified						
Tasters	1 7	2 6	1 5	0 0	2 4	2 8
Non-tasters	0 1	0 0	0 0	0 0	0 0	1
Unclassified	0 2	0 1	0 0	1 1	0 0	5
Total	3 21	2 12	1 6	1 1	2 4	5 3

Table D - 60 Central State College Males

Pigmentation	Blood Groups				Total
	0	A	B	AB	
	+ -	+ -	+ -	+ -	
Black					
Tasters	2 4	3 1	0 0	0 1	11
Non-tasters	0 0	0 0	0 0	0 0	0
Dark Brown					
Tasters	3 17	0 4	2 2	0 0	28
Non-tasters	0 3	0 1	0 0	0 0	4
Light Brown					
Tasters	0 5	1 3	0 2	0 0	11
Non-tasters	0 0	0 4	0 0	0 0	4
Very Light Brown					
Tasters	0 1	0 0	0 0	0 0	1
Non-taster	0 0	0 0	0 1	0 0	1
Total	5 30	4 13	2 5	0 1	60

Table E - 107 Central State College Females

Pigmentation	Blood Groups				Total
	0	A	B	AB	
	+ -	+ -	+ -	+ -	
Black					
Tasters	0 6	2 2	0 0	0 0	10
Non-tasters	0 0	0 0	0 0	0 0	0
Dark Brown					
Tasters	5 16	2 4	2 6	0 0	35
Non-tasters	0 1	0 1	1 1	0 0	4
Light Brown					
Tasters	2 15	1 10	0 5	0 0	33
Non-tasters	2 2	0 3	0 4	0 0	11
Very Light Brown					
Tasters	1 8	0 2	0 2	0 0	13
Non-tasters	0 0	1 0	0 0	0 0	1
Total	10 48	6 22	3 18	0 0	107

RÉSUMÉ

1. Il existe un rapport très significatif entre la pigmentation foncée et les motifs qui se manifestent dans le deuxième territoire interdigital palmaire parmi les populations d'origine mixte nègre-blanc, dans le nord du Soudan et aux Etats-Unis.

2. Aucun rapport n'a été observé entre la pigmentation et les groupes sanguins ABO, le développement du sens du goût et la pigmentation, les groupes sanguins et le développement du sens du goût, les motifs palmaires et les groupes sanguins, ou le développement du sens du goût et les motifs palmaires.

3. Le rapport relativement étroit entre la pigmentation et les motifs du deuxième territoire interdigital palmaire suggère une liaison entre quelques-uns des déterminants qui conditionnent ces deux traits.

ZUSAMMENFASSUNG

1. Eine zwischen dunkler Pigmentation und Handdermatoglyphen des zweiten Zwischenfingerraums höchst bezeichnende Verwandtschaft findet sich unter den in Nord-Sudan und Vereinigten Staaten Populationen von vermischt weiss-negerischer Herkunft statt.

2. Keine bezeichnende Verwandtschaften wurden zwischen Pigmentation und ABO Blutgruppen, Geschmäcksfähigkeit und Pigmentation, Blutgruppen und Geschmäcksfähigkeit, Handdermatoglyphen und Blutgruppen, oder Geschmäcksfähigkeit und Handdermatoglyphen beobachtet.

3. Die zwischen Pigmentation und anddermatoglyphen des zweiten Zwischenfingerraums bezüglich hohe Verwandtschaft weist Verkettung zwischen einigen der diese Züge bedingenden Genen hin.

RIASSUNTO

1. Esiste un rapporto molto significativo fra la pigmentazione scura e il disegno papillare del secondo territorio interdigitale palmare nelle popolazioni di origine mista negro-bianca, nel nord del Sudan e negli Stati Uniti.

2. Nessun rapporto fu rilevato fra la pigmentazione e i gruppi sanguigni ABO, lo sviluppo del senso del gusto e la pigmentazione, i gruppi sanguigni e lo sviluppo del senso del gusto, i disegni palmari e i gruppi sanguigni, oppure fra lo sviluppo del senso del gusto e i disegni palmari.

3. Il rapporto relativamente stretto fra la pigmentazione e i disegni del secondo territorio interdigitale palmare suggerisce un legame fra qualcuno dei fattori determinanti che condizionano questi due caratteri.