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A Note on the Attempt to Ascertain Inbreeding through Dermatoglyphics

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SUMMARY

A study of the anatomical correlation for the fifth-finger ridge count and its ratio to the correspondent correlation of a first degree relative (i.e., between sons and fathers and daughters and fathers) has been carried out in an inbred population of German ancestry living in Northern Venezuela for the last 127 years. This study revealed a remarkable straight relationship of the logarithm of the above ratio to the probability of having both genes at the locus (or loci) identical by descent, for the trait fifth-finger ridge count, i.e., the coefficient of inbreeding. The practical consequences of this finding for the estimation of inbreeding, if confirmed for other populations, are emphasized.

The establishment of a genealogy among an inbred community with an average or even a higher degree of education is not complicated, but involves very frequently a search for records of marriages, birth dates, and so on, or of church records if the community is Catholic. Nevertheless, verbal accounts are frequently enough to obtain the right data for establishing the relationship among the members of the populations studied. If that population is inbred, crossed references are frequent and serve as internal checks of what the investigator is collecting verbally from people, for many whole names in the ancestry of several informers are the same. Even in such an easy case, the work might be cumbersome and long.

If there were quantitative variables from which differences could be demonstrated in regard to the coefficients of kinship and inbreeding between people of known genetic relationship, it might be of interest to explore the kind of influence that those coefficients would have on such a difference. This paper deals with a preliminary attempt on the inference of the coefficient of inbreeding, through the study of one dermatoglyphic variable, and its practical consequences.

Material and Methods

Palmar dermatoglyphics of the whole school children population in an inbred group of German ancestry living in northern Venezuela (Arias, 1970) were collected. A total of 212 children (125 boys and 87 girls) whose parents were both alive, and their parents (96 cou-

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ples) were chosen for study out of 270 children (from 124 kinships). Prints were obtained on absorbent white paper using printing ink.

A genealogy for the people in the sample was worked out through seven generations up to the founders-German peasants who immigrated to this country in 1843. The ascertainment of ancestors is complete for the inbred members in the sample, i.e., 75% of the studied group of children. The coefficient of inbreeding was calculated with the Fortran II program KUDO of the Department of Human Genetics of the University of Michigan, modified to accommodate a larger population, to be used in the computer IBM360/40K. The coefficients of correlation for 21 dermatoglyphic variables were calculated with the program DERMA, a modified version of a multiple correlation and regression program of the Departamento de Computación, U.C.V. de Venezuela, Caracas.

The intraindividual (anatomical) and intergroup (genetical) coefficients of correlation for fathers, mothers, sons, and daughters were calculated separately after dividing those groups into three subpopulations according to their weighted mean coefficient of inbreeding obtained with the program KUDO.

After the correlation coefficients were obtained, a preliminary study of the results led us to choose one variable in which the differences were apparently important. Next, the coefficients of correlation were divided by their standard errors, and these results (weighted coefficients of correlation), between sons and their fathers, sons and their mothers, daughters and their fathers, and daughters and their mothers, were compared dividing these quotients member to member (see Table). Finally, the logarithms of the ratios were plotted against the probability of both genes being identical by descent at any particular locus, i.e., the coefficient of inbreeding of children = coefficient of kinship of parents (Malécot, 1966), on a logit paper.

Findings

The table shows the values for the coefficients of correlation of the fifth-finger ridge count, their standard errors, the ratio of the coefficients of correlation to their standard errors, and the ratio of the above values, between boys and their fathers, and girls and their fathers. The results for daughters and their mothers and for sons and their mothers were not included, because the differences between mothers and their offspring were not so evident as between fathers and their offspring.

The relationship between the logarithm of the ratio between the weighted coefficient of correlation for ridge count on the fifth finger between boys or girls and the same weighted coefficient of their fathers has a straight relationship with the weighted mean coefficient of inbreeding in the children populations, as illustrated in the Figure. Nevertheless, this relationship holds only in the range of inbreeding coefficients of 0.007 to 0.025. For the group with no inbreeding, the relationship does not seem to hold; however, it is very difficult to really know what the inbreeding coefficient for the children in that group is, because the majority of kinships in the group were of a different ethnic origin, and the genealogies for the group were ascertained only up to the third generation, generally the last-one people had heard of.

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Table - Data for the inbreeding coefficient of children and for fifth-finger ridge count anatomical correlations in offspring and fathers

	Group I	Group II	Group III	Total
Weighted mean coefficient of inbreeding of children	<0.0010	0.0072	0.0250	0.0114
No. of boys in the sample	33	51	41	125
No. of girls in the sample	19	35	33	87
No. of fathers in each group	25	38	33	96
$r_b \pm \text{SE}_b$	0.811 ± 0.060	0.853 ± 0.038	0.842 ± 0.045	0.832 ± 0.028
$r_g \pm \text{SE}_g$	0.743 ± 0.103	0.788 ± 0.064	0.784 ± 0.067	0.776 ± 0.043
$r_f \pm \text{SE}_f$	0.511 ± 0.148	0.629 ± 0.098	0.793 ± 0.065	0.671 ± 0.056
r_b / SE_b	13.5160	22.4470	18.711	29.714
r_g / SE_g	7.2136	12.3130	11.701	18.047
r_f / SE_f	3.4527	6.4184	13.217	11.982
$(r_b/\text{SE}_b) / (r_f/\text{SE}_f)$	3.9146	3.4973	1.416	2.480
$(r_g/\text{SE}_g) / (r_f/\text{SE}_f)$	2.0893	1.9184	0.885	1.506

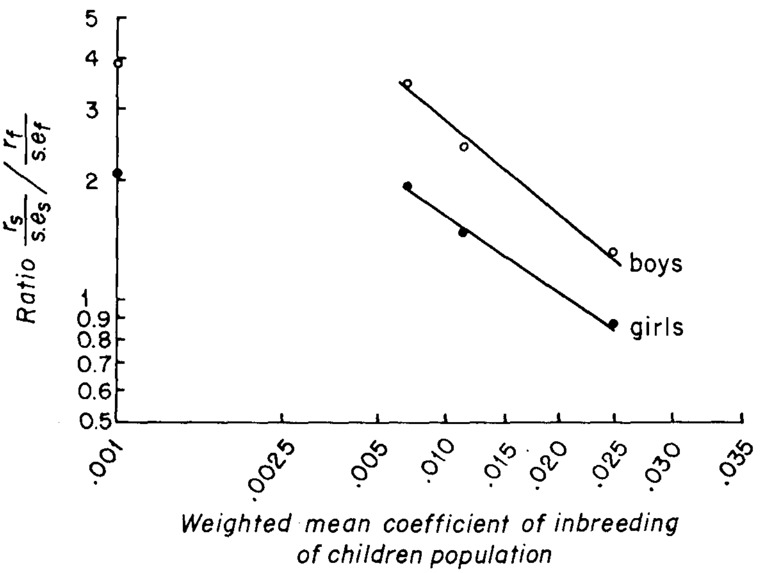

Figure - Logarithm of ratio of the anatomical weighted correlation coefficient between offsprings' (r_s/SE_s) and fathers' (r_f/SE_f) fifth-finger ridge count, against the weighted mean inbreeding coefficient of the school children population (in logit paper).

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Discussion

Very recently, F. G. Smith (1969, pp. 179-183) has pointed out the differences between an anatomical and a genetical correlation, and, although he admits that both measure hereditary influence, according to his opinion only genetical correlations can give some information about heredity. This might not be the case in the present situation, because apparently striking relationships seem to hold between the mean coefficient of inbreeding on the one hand, and the logarithm of the ratio of anatomical correlations of one individual and the same coefficient of another individual genetically related to the former, on the other.

Relatively very few data on genetical correlations between parents and offspring for the fifth-finger ridge count have been published. Only anatomical correlation matrices are known from the literature (Brehme et al, 1966; Knussmann, 1967). Holt (1951, 1952) gave figures for anatomical and genetical correlations which made clear the heritability of that character. The correlation coefficients between parents and children or between fathers or mothers and offspring were the highest for fingers, with the exception of the fourth finger, which was a little higher in mother-children pairs. To our knowledge, separate figures for each hand, however, have not been published.[1] In our sample, correlations in daughter-mother and son-mother pairs have been high, around 0.45, being higher for left than for right fifth finger but not significantly. The correlations have instead been very low both for daughter-father and son-father pairs, not reaching the level of significance between the right fingers; they reach the 1% level in daughter-father pairs ($r = 0.28$), and the 5% level ($r = 0.25$) in left daughters' against left fathers' fifth finger. In the case of son-father pairs, only right finger of sons against left fifth finger of fathers reached the 5% level of significance ($r = 0.22$). The coefficient of correlation for fifth-finger ridge count in brother-brother pairs does not reach the 5% level. Sister-sister pairs show a coefficient of correlation significant at the 5% level but not at the 1% level. Furthermore, the distribution of ridge count in the fifth finger is normal in males and females with the exception that in the latter leptokurtosis almost reached the 5% level of significance. Conflicting as these results might seem, they show heritability for ridge count in the fifth finger.

In the English sample of Holt (1951) the coefficients of correlation in males are higher than in females, but the opposite is true in the German material of Brehme et al (1966) and in ours, in the case of fathers but not in the case of sons. Therefore, although the differences are not significant, a large variance is present in the anatomical correlation of fifth-finger ridge count between different sexes, and different populations.

Knussmann (1967, 1969), has recently postulated the existence of a factor con-

[1] Dr. Parisi has kindly reminded me of the following paper showing such data:
Parisi P., Di Bacco M. (1968). Fingerprints and the diagnosis of zygosity in twins. Acta Genet. Med. Gemellol., **17:** 333-358.

trolling ridge count and pattern type (*Kleinfingerfaktor*) and consistently most researchers in this field have found a very high anatomical correlation for ridge count in these fingers. The finding of a normal distribution in males and an almost normal distribution, at least a symmetrical one, in females, make more probable the hypothesis that more than one factor is responsible for the trait. The striking difference found in this sample taken in a very special homogeneous population between fathers and sons (and in a lesser degree daughters) regarding the ratios between the anatomical correlations of the different groups according to the coefficient of inbreeding of sons (and daughters) is somewhat unexpected, but evident and enough to investigate it systematically. This finding might be due to a random phenomenon or be more or less characteristic of the alleles controlling the trait, fifth-finger ridge count, in the population under study; but, if it has an actual genetical basis, it must be confirmed in other populations as well.

The logarithm of the ratio for the anatomical correlations, as mentioned above, does not have the same straight relationship with the inbreeding coefficient when the latter is lower than 0.005. The explanation for this finding is not self-evident but two reasons might shed some light on its origin: either the group of " nonrelated parents " has actually a mean coefficient higher than 0.001 as assumed, or simply the relationship exists only for inbreeding coefficients higher than 0.005 or 0.007. Nothing can be said about the coefficients higher than 0.025 because of lack of data. It might be worthwhile to undertake studies on this variable in inbred groups with coefficients of inbreeding higher than the last figure (Amish and Hutterites, in the Unites States, or the inbred villages in Switzerland for instance).

The practical consequences of this finding, if confirmed in other populations, are obvious because it would permit to have a very approximate and objective estimation of the mean coefficient of inbreeding in a particular situation. Before attempting the elaboration of a genealogy of the whole population, (which is a time consuming task, subjected to the sampling error of incomplete ascertainment of ancestors and of the involuntary errors of the informers), the approach presented in this paper, on the contrary, is as objective as any other, or even more, because the genes would be " speaking by themselves ".

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Riassunto

È stato condotto uno studio sulla correlazione anatomica del conteggio delle creste del quinto dito e sul suo rapporto con la correlazione corrispondente di un parente di primo grado (cioè tra padri e figli), in una popolazione consanguinea di origine tedesca vivente nel Venezuela Settentrionale da 127 anni. Questo studio ha rivelato una relazione diretta tra il logaritmo di tale rapporto e la probabilità di avere identici i due geni, o gruppi di geni, responsabili di tale carattere (cioè il coefficiente di consanguineità). Vengono sottolineate le conseguenze pratiche di questo reperto, se confermato per altre popolazioni, per la stima della consanguineità.

Résumé

Une étude sur la corrélation anatomique du numéro des crêtes du cinquième doigt et son rapport avec la corrélation correspondante d'un parent de premier degré (c'est-à-dire entre pères et fils) a été conduite chez une population consanguine d'origine allemande vivant dans le Vénézuela Septentrional depuis 127 années. Cette étude a démontré une relation directe entre le logarithme de ce rapport et la probabilité d'avoir identiques les deux gènes, ou groupes de gènes, responsables de ce caractère (c'est-à-dire le coefficient de consanguinité). Les conséquences pratiques de ce rapport, si confirmé chez d'autres populations, pour l'évaluation de la consanguinité, sont soulignées.

Zusammenfassung

Bei einer blutsverwandten Bevölkerung deutschen Ursprungs, die seit 127 Jahren in Venezuela lebt, wurde die anatomische Korrelation der Berechnung der Kleinfingerhautleisten und deren Verhältnis zur entsprechenden Korrelation eines Verwandten ersten Grades (d.h. zwischen Vätern und Kindern) untersucht. Es ergab sich daraus eine direkte Beziehung zwischen dem Logarithmus dieses Verhältnisses und der Wahrscheinlichkeit einer Identität der beiden für dieses Merkmal verantwortlichen Gene oder Gen-Gruppen (d.h. der Blutsverwandtschaftskoeffizienten). Wenn sich dieser Befund auch bei anderen Bevölkerungen bestätigen lässt, so wäre er für die Bewertung der Blutsverwandtschaft von grosser praktischer Bedeutung.

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