

THE MIDDIGITAL HAIR GENES

Their Inheritance and Distribution among the White Race.

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DANFORTH⁵ has shown that humans vary as to the presence and distribution of hair on the middle phalanges of the fingers. He presented data on 80 families with a total of 178 children which proved that complete absence of middigital hair is a recessive trait. He has also shown that the recessive phenotype is much more frequent among colored races than among the white race. Apes and monkeys were found to have middigital hair on all four fingers. Danforth therefore concludes that there is an evolutionary tendency towards the freeing of the hand from middigital hair.

In an earlier paper¹ the author presented evidence that the distribution of middigital hair on the four fingers of the human hand is controlled by a set of five alleles of the *A* gene. These were named *A*₀, *A*₁, *A*₂, *A*₃ and *A*₄ (arranged in order of increasing dominance), the subscript corresponding to the number of fingers with middigital hair. A person lacking all middigital hair would have an *A*₀ *A*₀ genotype. The *A*₁ phenotype usually has hair on the ring finger; the *A*₂ phenotype has hair on the ring and middle fingers. In the *A*₃ phenotype the index finger usually is free from hair. Danforth⁵ has shown that other combinations and asymmetries occur in less than five percent of his cases. In the former paper of Bernstein and Burks¹ we have explained that manual work may cause hair to be rubbed off and the opening of the follicles to be obscured. It is interesting to note that in the *A*₃ phenotypes the little finger usually bears the least number of hairs and the ring finger the greatest number of hairs, even though the middle finger, being the largest in size, bears the greatest number of hairs on the proximal segment of the finger.

With the use of Cotterman's⁴ formula for testing unit factor inheritance in data

comprising but a single generation, Bernstein and Burks¹ tested the proposed allelic mode of inheritance of middigital hair on sibling pair data collected by Burks. Deviations from the expected frequencies of sibling pair combinations were found to be very small for most of the corresponding comparisons; the chi-square test indicated that deviations of the size obtained may legitimately be attributed to chance variation of sampling.

Snyder⁸ has developed formulae for testing a monomeric inheritance hypothesis involving dominance on two-generation family data. The Burks' family data used in the earlier paper¹ were not extensive enough to allow such testing for all possible parental combinations. Furthermore, Snyder's formulae presuppose random mating for many generations resulting in panmixy. The Burks' family data consisted mainly of Irish, Italian and Polish immigrant families. These data may not constitute a panmictic sample; for Bernstein and Burks¹ have shown that the average number of fingers with middigital hair differs among Italian, Irish and English subgroups.

A Survey of European Population

On the foreign student body of Syracuse University and the foreign diplomatic corps in Washington, the author carried out an anthropological study of the geographical and racial distribution of the five middigital hair phenotypes in the hope of finding a locale in the Old World where all five middigital hair phenotypes occur side by side. The population in such a locale should be panmictic with respect to middigital hair, since matings for this character are non-selective.

The results of this anthropological study are published in the form of a map. It shows the distribution of the *A*₃, *A*₂,



DISTRIBUTION OF HAIR GENE ALLELES

Figure 9

A_0 , the recessive of a series of four alleles, conditions absence of hair on the middle joint of the finger. The A_3 gene is concentrated in Protestant regions, the A_2 in Roman Catholic areas, and the A_1 gene in Greek Orthodox countries. Further exploration of the distribution of the four alleles should throw interesting light on the origin of various racial groups.

A_1 and A_0 middigital hair phenotypes for those parts which are inhabited primarily by members of the white race. Though the number of cases examined in this anthropological study has been quite small (about 200 cases) few exceptions were found to the middigital hair phenotype typical for a country or part of a country. Hence it is believed that these phenotypes are representative of those regions of the Old World for

which they are entered on the map. When we consider the non-selective nature of this character the consistency of the results is noteworthy.

We conclude: (1) that the A_3 phenotype seems centered in North Europe; (2) that A_2 phenotype seems centered in the Western Alps, spreading out to Southern Germany and Northern Italy; (3) that the A_1 phenotype seems centered in Southeastern Europe; and (4)

that A_0 phenotype, besides occurring in Ireland and Northeastern Sweden (Lapp influence?) is most frequent in the Mediterranean countries. More extensive studies in the Old World itself might reveal that the A_8 phenotype is a characteristic of the Nordic branch of the white race, that the A_2 phenotype is a characteristic of the Alpine branch of the white race and that the A_0 phenotype is a characteristic of its Mediterranean branch.

Most remarkable is the occurrence of the A_3 phenotype in Iran. The Iranians claim to be direct descendants of the legendary Indo-European Urstamm.⁶ As far as middigital hair is concerned, this claim of the Iranians seems fully supported; their middigital hair phenotypes are the same as those of North-Europeans, and quite distinct from those of their Turkish and Indian neighbors who are mostly of the A_0 or A_1 phenotypes. The above findings may lead us to assume that the legendary ancestral Indo-European, living somewhere in Central Asia, was homozygous for the A_8 middigital hair gene, and that the A_2 , A_1 and A_0 genes of some of the branches of the white race arose by mutations sometime after these subraces left Central Asia.

The anthropological data as collected by the author include only nine people with middigital hair on all four fingers, coming from five different regions of Europe: one each from Scotland, Southern France, Southern Italy, Northeastern Germany, two cases from Norway and three cases from Ireland. If a more extensive middigital hair study on the European continent substantiates these findings, we may come to conclude that the A_4 phenotype was a characteristic of the Upper Palaeolithic white man who inhabited all of Europe before the Neolithic invasions of Indo-Europeans from Asia. Coon³ has shown that racial characteristics of this ancient group may still be found in varying degrees among some of the present day inhabitants of Europe and Northern Africa especially in South Ireland and in Norway.

These anthropological findings seem to rule out existence of an indigenous Old World population panmictic for middigital hair. In view of the fact that the A_3 gene is concentrated in Protestant countries, the A_2 gene in Roman Catholic countries, the A_1 gene in Greek Orthodox countries, and the A_0 gene in Roman Catholic countries and Mohammedan countries, neither can we hope to find an area in the New World where the middigital hair genes would be panmictic.

In Biblical times the Hebrews of Palestine were in the majority a Mediterranean racial type similar to that of present-day Arabs³, who either have no middigital hair or hair only on the ring fingers. Genetic data collected by Borison and Finkel² on 68 Jewish families now living in New York City reveal that the present-day Jew may have any of the five middigital hair phenotypes. These data include 17 cases of A_4 , 147 cases of A_3 , 83 cases of A_2 , 51 cases of A_1 , and 117 persons homozygous for the A_0 gene. In 21 of the 68 families three different phenotypes were observed, i.e. the maximum number of different phenotypes possible in a system of monomeric inheritance with complete dominance. The author concludes therefore that the Borison-Finkel middigital hair data are as panmictic for middigital hair as possible. These anthropological findings on middigital hair corroborate the view held by many anthropologists⁶ that the ancestors of the present-day Jews have, since leaving Asia Minor, intermarried to a considerable extent with people belonging to the Dinaric, Nordic and Alpine branches of the white race.

If inheritance of middigital hair is controlled by the set of four multiple alleles $A_0 < A_1 < A_2 < A_3$, as we propose, then in matings of two persons with the dominant phenotype, the number of children with the recessive phenotype can be computed by Snyder's⁸ formula: $N(q/1+q)^2$ where N stands for the number of children resulting from such matings, and q is the incidence of the recessive gene, i.e. the square-root of the percentage of recessive phenotypes

in the total sample of parents and children. However, if the distribution of what we consider the recessive phenotype is random in the offspring population, then Nq^2 children should have this "recessive" phenotype.

Similarly, if N is the number of children in families where one parent shows the dominant, the other parent the recessive phenotype, then, by Snyder's⁸ formula, $N(q/1+q)$ children are expected to show the recessive phenotype. Again there would be Nq^2 children with the "recessive" phenotype if the trait were not hereditary but distributed at random in the offspring generation.

The results of the above calculations are listed in Table I, and there is close agreement between the observed number of recessive offspring and the number expected under the multiple allele hypothesis in all matings where both parents are of the dominant phenotype and correct diagnosis of the parental phenotype is unmistakable. In matings of two recessives (i.e. non-affected) no offspring should be affected; that is, they should never have more middigital hair than either parent. However, we may assume that one or two mothers in these matings had done so much washing and other housework that the middigital hair had been rubbed off and the skin had become too rough and wrinkled to allow detection of follicles. This would account for the appearance of children with more middigital hair than either parent, an occurrence much rarer in the well-collected data of Danforth,⁵ all five

of such cases being confined to only two of his families; i.e. two mothers may have been erroneously diagnosed. In human males all body hair, including middigital hair, is more abundant and individual hairs are coarser than in females and much harder to remove by mere rubbing. Nevertheless, the author is familiar with at least one case in which the man, a carpenter, had rubbed off the middigital hair at work.

The anthropological findings about the distribution of middigital hair phenotypes seem to indicate that the mutations which produced the $A_2 A_1$ and A_0 genes in the white race must have occurred some time after the ancestors of the Indo-Europeans split up. It may be that these mutations still occur and that occasionally an $A_2 A_1$ or A_0 gene reverts back to the A_3 gene. This might have been the case in the two families of Danforth described above, in which five children had more middigital hair than either parent. In view of the fact that middigital hair genes may be mutable, they should not be used in forensic medicine.

Conclusions

Danforth⁵ has shown that humans vary as to the presence and distribution of hair on the middle segment of the fingers. The A_0 phenotype (no middigital hair at all) was observed by the author most frequently among persons born in the Mediterranean countries and Ireland; the A_1 phenotype (middigital hair on the ring fingers only) was found

TABLE II.—Parental Combinations*

Affected have hair on fingers:	Both parents affected			One parent affected			No parent affected			q† =
	Aff.	Offspring		Aff.	Offspring		Aff.	Offspring		
		Non-aff.—	Expt'd†		Non-aff.—	Expt'd		Non-aff.—	Expt'd	
		Obs.			Obs.			Obs.		
2, 3, 4, 5, or 3, 4, 5	34	6	{ 8.2 T 27.6 R	36	45	{ 36.8 T 55.9 R	5	128	{ 133 T 91.8 R	$A_2 A_1 A_0$ 8307
		(11 families)			(22 families)			(32 families)		
2, 3, 4, 5, or 3, 4, 5, or 3, 4	48	11	{ 10.3 T 30.4 R	52	43	{ 39.7 T 49.0 R	11	64	{ 75 T 38.7 R	A_1 or A_0 .7180
		(16 families)			(28 families)			(18 families)		
2, 3, 4, 5, or 3, 4, 5, or 3, 4 or 4 only	114	14	{ 18.3 T 47.4 R	46	33	{ 29.9 T 29.3 R	9	51	{ 60 T 22.0 R	A_0 only .6086
		(31 families)			(24 families)			(14 families)		

* Data are a combination of B. S. Burks and Finkel-Borison data.
† Under expected are two values: T = Theoretical, according to polyallele theory; R = Random, an assumption of random distribution. See page 129 for explanation.
‡ Estimated combined incidence of genes for non-affected phenotype.

most frequently among persons from Southeastern Europe; the A_2 phenotype (middigital hair on the ring and middle fingers) was found most frequently among persons from the Alpine region of Europe; and the A_3 phenotype (middigital hair on all but the index fingers) was found most frequently among people from Northern Europe and Iran. The A_4 phenotype (middigital hair on all fingers) is much rarer than the other three phenotypes. Its bearers come from all parts of Europe; thus the A_4 phenotype was assumed to have been a characteristic of the white man who inhabited Europe during the Upper Palaeolithic era before the Neolithic invasions of Indo-European tribes from Asia, possibly from Iran.

The author¹ previously advanced the theory that five allelic genes A_0 , A_1 , A_2 , A_3 and A_4 control the inheritance and distribution of middigital hair involving but a single gene substitution (the sub-

script denoting the number of fingers affected with middigital hair), and that the genes for the more affected phenotypes are dominant over the genes for less affected phenotypes. In the present paper this hypothesis was tested on two-generation family data constituting a more or less panmictic sample.

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DICTIONARY OF GENETIC TERMS

A Review

THIS book* is billed as a "Dictionary," and in its preface the author makes a stirring plea for helping "coiners of new words to avoid putting an entirely new meaning on an old established word. . . . Genetic literature would be more readily understood if writers had, where possible, used an existing term instead of coining a new one."

The difficulty with this worthy aim is that the book is hardly a dictionary, but rather a book-size glossary. Even a rather elementary dictionary hints at derivations, but this Knight fails to do. For example, take "Monogenic.—(i) Producing offspring of only one sex. (ii) Hemizygous. (iii) Controlled by a single gene; monofactorial. N. monogeny." We are not told who used the word in the two strange senses given preference over "(iii) controlled by a single gene, monofactorial," which is in the only sense this reviewer ever remembers seeing the word used. One would like to be able to get back to the basic source of these definitions, and see where the priorities lie. But this book helps not at all to do this.

The 162 pages devoted to the glossary in-

clude over 3,000 terms. In this parade of the vocabulary of genetics all the old standbys seem to be in line. In such a compilation there is always a problem of where to put the boundary. Knight seems to have included too much. There are many words used in genetics which have only their usual meaning. Examples of four such inclusions are: "Sex reversal," "Finalism," "Quadruplets," "Fallopian tube." Such needless inclusions of routine vocabulary might run as high as one word in five. There are also a good many fantastic terms that geneticists, cytologists, and most evolutionists would gladly be spared. "Chiropterophilous" means "pollinated by means of bats," which seems to this reviewer interesting but borderline genetics-evolution. "Megaheterochromatic" which means "A species or individual which differs from its group in having more heterochromatin. Opp. Microheterochromatic" probably should be included, but one cannot avoid a shudder.

There are a few inconsistencies. The "Sewal Wright Effect" is also listed under the "Wright, Sewall, Effect." If we were talking

*KNIGHT, R. L. *Dictionary of Genetics*. Stechert-Hafner, New York, 1948. \$4.50.

Chronica Botanica, Waltham, Massachusetts.