Cerumen in American Indians: Genetic Implications of Sticky and Dry Types

Abstract. *Occurrence of sticky and dry cerumen was determined in 483 Indians from various tribes of the United States. The elevated frequencies of the allele for dry cerumen, found in Indians of pure ancestry, support the theory of the mongoloid origin of the American Indian. Potential application of cerumen quality as a marker for genetic and anthropological studies is discussed.*

Matsunaga (*1*) has demonstrated that human cerumen (earwax) occurs in two phenotypic forms, sticky (wet) and dry (hard), and that the quality of cerumen is controlled by a single pair of genes in which the allele for the sticky trait is dominant over the dry. The homozygous sticky type is phenotypically indistinguishable from the heterozygous form. Matsunaga found considerable racial and ethnic variation in the frequencies of these two phenotypic forms of cerumen. Frequencies ranged from a very high frequency of the allele for dry cerumen in Northern Chinese, Koreans, Tunguse, Mongols, Japanese, Southern Chinese, and Ryuku Islanders; through intermediate values in peoples of Southeast Asia and Micronesia; to very low frequencies in Caucasians and Negroes. Apart from a brief report on Chiapas Mayan Indians (*2*), no studies of cerumen type have been reported in American Indians.

During the past year 483 Indians of the Navaho, Sioux, and miscellaneous other North American tribes were examined for data on the frequencies of sticky and dry cerumen and regarding the inheritance of cerumen type in American Indians. The Indians examined were patients and non-patient visitors in wards and in outpatient clinics (*3*); additional family studies were made at well-baby clinics (*4*).

The type of cerumen was determined by simple otoscopic examination of both ears according to Matsunaga's criteria. The dry type was granular or scaly in consistency and grey-to-light tan in color, and did not adhere to the otoscope or curette; the sticky type was thick and sticky in consistency (resembling thick honey) and light-to-dark brown in color, and adhered to the otoscope and curette. In four of 483 subjects one could not classify the type of cerumen; in rare instances, classification was assisted by use of an ear curette. In addition to the quality of the cerumen, the age, sex, tribe, place of birth, and degree of known non-Indian admixture were recorded. Thirty families having a total of 109 children were available for genetic analysis.

Table 1 summarizes the data on families for which parental matings of earwax types, sticky × sticky, sticky × dry, and dry × dry, were available for study. Despite the small number of families available, our findings indicate that the inheritance of earwax in American Indians is similar to that described by Matsunaga for the Japanese, in which the sticky allele is dominant over the dry. In no instance did a parental mating of dry × dry produce children having sticky cerumen.

The observed phenotypic frequencies of dry cerumen, the estimated recessive gene frequencies for the dry allele (q), and their standard errors appear in Table 2. Of the whole group of 483 Indians, 51.3 percent (q, .716) had the dry type of cerumen. The highest frequency (63.3 percent) occurred in the Navaho (q, .796); the lowest (36.7 percent), in the Sioux (q, .606). The remaining Indians, who were grouped into a common category, included individuals from various tribes in the United States: they had an average dry-earwax frequency of 50.9 percent (q, .714).

Table 3 contains data on Indians having a known Caucasian admixture, and on Navaho and Sioux said to be full bloods.

Indians known to have Caucasian blood had a very low frequency of dry cerumen (8.9 percent). In the Navaho and Sioux full bloods, the frequencies were higher (69.7 and 46.9 percent, respectively) than in the corresponding unselected groups in Table 2. Included for comparison are the results from a small sample of Caucasians (*5*).

The family studies (Table 1) strongly suggest that dry cerumen is inherited as a simple Mendelian trait in American Indians; therefore it was considered permissible to apply this trait to studies of Indian populations. A much higher frequency of the dry allele was found in this sample of 483 Indians than is reported for Caucasians and Negroes. The high frequencies of the dry allele that we found, especially in the unmixed Navaho Indians, resemble those occurring in present-day mongoloids in Asia. Since dry cerumen is known to be a mongoloid trait, our findings seem to agree with theories of the Asiatic origin of the American Indian (*6*).

It is difficult to explain the persistence of the high frequency of this trait among mongoloid populations, since cerumen is reported to lack bactericidal, fungicidal, and insect-repellant qualities (*7*), and there is no clinical evidence to suggest that type of earwax plays a part in any disease of the ear or any other organ. Matsunaga has suggested that individuals having sticky cerumen have an associated axillary apocrine odor that may have influenced sexual selection and mating practices so as to account for the high frequencies of dry allele in Japan. However, such a potential cultural influence on genetic selection has not been suggested for American Indians.

Although drift and other unknown selective forces cannot be excluded as possibly important factors, it is interesting to speculate that the lower frequency of dry cerumen among the Sioux Indians than among the Navaho and Asian mongoloids is mainly due to Caucasian admixture. Such an assumption is supported by archeologic, linguistic, and historical information on the two tribes. According to Vogt (*8*), the Navaho are believed to be descended from Nadene-Athabascan

Table 1. Summary of family studies, illustrating inheritance of dry cerumen in American Indians.

Matings		Children				
Cerumen combinations	No.	Cerumen (No.)		Dry cerumen, proportion		
		Sticky	Dry	Obs.	Calc.	S.D.
Sticky × sticky	10	32	6	.15	.18	.012
Sticky × dry	8	20	9	.31	.42	.014
Dry × dry	12	0	42	1.0	1.0	

Table 2. Occurrence of dry cerumen among American Indians, and estimated recessive gene frequencies (q); estimates based on two phenotypes [after C. C. Li, *Human Genetics* (McGraw-Hill, New York, 1961)]. Matsunaga (*1*) found q to range between .978 and .790 for Northern Chinese, Koreans, Tunguse, Mongols, Japanese, Southern Chinese, and Ruyuku Islanders; to be .176 and .069 for Caucasians and Negroes, respectively. "All other tribes" include Walapai, Pauite, Omaha, Winnebago, Chumibec, Tlingit, Apache, Chicasaw, Quinault, Chippewa, Cowicham, Arapaho, Mescalero, Flathead, Aleut, Yurak, Cheyenne, Tiowa, Comanche, Chuckchanci, Mono, Washo, Nez-Perce, Creek, Mohave, Delaware, Choctaw, Shoshone, Papago, Blackfoot, and Yakima. Numbers of subjects examined appear in parentheses; standard errors, in square brackets.

Peoples	Dry cerumen		
	No.	Percentage	q
Navaho (all) (183)	116	63.3	.796 [.022]
Sioux (all) (147)	54	36.7	.606 [.031]
All other tribes (153)	78	50.9	.714 [.028]

groups that migrated to the New World from Asia about 3000 years ago. The present-day Navaho arose from subsequent southerly migrations of Athabascans (as "Apacheans") to the Southwest about 400 to 500 years ago. It is known that the Navaho have maintained their scattered encampments and nomadic culture unchanged, and that historically they experienced no contact with large numbers of Caucasians until relatively recently. There has been little mixture of the Navaho with Spanish and Anglo-American settlers (*8, 9*).

The Siouan tribes are believed to be descended from early paleolithic mongoloids who first settled in the Upper Mississippi Valley before migrating to the Dakotas, Nebraska, Wyoming, and Montana (*10, 11*). In contrast to the Navaho and other Southwestern tribes, the Dakota (Sioux) and other Plains Indians experienced extensive and sustained contact with French trappers and traders from as early as 1700, and, over the last 150 years, with American traders, soldiers, and settlers. Extensive intermarriage is recorded between the Dakota and Caucasians (*11*). Undoubtedly, flow of White genes into these tribes was further accentuated by the extremely severe reductions in populations that resulted from epidemics of smallpox and cholera, famines, and military campaigns (*9, 12*) during this period.

Table 3. Occurrence of dry cerumen among American Indians of full and mixed blood, and their recessive gene frequencies (q). "All Southwest Indians" include all full-blooded Navaho, Walapai, Paiute, Apache, Papago, and Mohave. Numbers of subjects examined appear in parentheses; standard errors, in square brackets.

Peoples	Dry cerumen		
	No.	Percentage	q
Navaho, full blooded (162)	113	69.7	.835 [.020]
All Southwest Indians (251)	168	66.9	.818 [.017]
Sioux, full blooded (113)	53	46.9	.685 [.033]
Indians with white blood (78)	7	8.9	.299 [.053]
White Americans (45)	2	4.4	.210 [.072]

Certain blood-group findings may reflect these historical influences on the Navaho and Sioux also. It is acknowledged that the presence in American Indians of blood groups A_2 and B indicates non-Indian admixture (*13*). Several reports show the complete absence of blood groups A_2 and B among the Navaho (*14*), whereas up to 4.2 percent of blood group B has been found in Sioux Indians and been attributed to mixture of blood with Caucasians (*15*).

The findings in Chiapas Mayan Indians are unexpectedly at variance with what would be anticipated from reported present-day cerumen frequencies in mongoloids of Asia, and from our findings in Indians of the United States. Since the Chiapas Mayans are stated to have remained almost completely isolated from the Spaniards throughout the centuries (*16*), it is conceivable that the high frequency of sticky cerumen in these people is the result of early genetic drift, or possibly of mixture with prehistoric non-mongoloid immigrants (*17*). It seems prudent to suspend judgment pending further information.

Our findings indicate that determination of the type of cerumen can provide a useful and simple genetic marker for population studies of the American Indian. More extensive anthropologic studies will be needed to establish the hypothesis that the presence of high frequencies of the sticky allele in American Indian tribes results from Caucasian admixture.

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Lymphocytic Choriomeningitis: Production of Antibody by "Tolerant" Infected Mice

Abstract. *Newborn mice infected with lymphocytic choriomeningitis virus are not immunologically tolerant to the agent but, rather, appear to make antibody to the virus. This antibody was detectable only in the kidneys, where presumably it had been deposited in the glomeruli in the form of complexes of antibody, virus, and complement.*

Traub, more than 30 years ago, reported the occurrence in mice of a lifelong, symptomless, lymphocytic choriomeningitis (LCM) viral-carrier state induced by *in utero* or neonatal infection (see *1*). This state was characterized by persistently high titers of virus in blood and organs throughout