Albinism Among Indians in Arizona and New Mexico

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STEPHENSON, in 1904 (p. 383), made reference to albinos occurring among the Zuñi Indians in New Mexico. Hrdlička (1908, pp. 192–196) also described albinos in this Indian population and in addition gave a detailed account of this disorder among the Hopi Indians living in Arizona. He estimated that the prevalence among the Hopis in 1900 was 1 in 182. Certain other writings, some appearing more recently, have made vague and sometimes misleading references to the frequency of albinos in Indian populations in Arizona and New Mexico. These references, as well as personal reports of the occurrence of albinos in the Hopi, Zuñi, and other Indian populations, led to the present study. The objectives were to document which Indian populations in these states actually have a high frequency of albinos; to determine the prevalence for each of these populations; and to formulate, if possible, a hypothesis to explain the high frequency of the autosomal recessive gene producing albinism in some of these populations.

PROCEDURE

Permission to confer with U. S. Public Health Service physicians, nurses, and social workers at the various Indian hospitals and health centers in Arizona and New Mexico was obtained from the Area Medical Officers in Charge, Indian Health Area Offices, Phoenix, Arizona, and Albuquerque, New Mexico. Sanction for this study was obtained, when requested, from the various Indian Tribal Councils. Inquiries were made as to the occurrence of albinos in the various populations. All populations were visited, except in those cases where the evidence was conclusive that no albinos were present. Experience soon demonstrated that information about albinos can best be obtained by enlisting the aid of Indian informants. Tribal council members, physicians, anthropologists, and other individuals acquainted with the various Indian groups were helpful in supplying the names of Indians who were capable and willing to serve as informants.

Albinos are so noticeable in a population of dark-skinned individuals that the number with this disorder is relatively easy to obtain for small or moderately sized populations. Physicians, nurses, and social workers who have lived on a reservation for an extended period of time are usually aware of the existence of albinos in the population, even though, in some cases, they may not know the actual number. However, Indians know of albinos in their own population, and the number can be determined by making inquiries to

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TABLE 1. PREVALENCE OF ALBINISM IN SOUTHWEST INDIAN POPULATIONS

Population	Estimated population size	Number of albinos	Estimated prevalence
Acoma, New Mexico	2,400	0	
Apache (Jicarilla), New Mexico	1,400	0	
Apache (Mescalero), New Mexico	1,500	0	
Apache, Arizona	11,000	0	
Cochiti, New Mexico	600	0	
Hopi, Arizona	5,000	22	1 in 227
Isleta, New Mexico	2,000	0	
Jemez, New Mexico	1,400	10	1 in 140
Laguna, New Mexico	4,000	2	1 in 2,000
Navajo, Arizona, New Mexico, Colorado, Utah	90,000	24	1 in 3,750
Papago, Arizona	9,000	0	
Picuris, New Mexico	150	0	
Pima, Arizona	7,000	0	
San Felipe, New Mexico	1,300	0	
San Ildefonso, New Mexico	290	0	
San Juan, New Mexico	1,000	2	1 in 500
Sandia, New Mexico	200	0	
Santa Ana, New Mexico	400	0	
Santa Clara, New Mexico	800	0	
Santo Domingo, New Mexico	1,900	0	
Taos, New Mexico	1,300	0	
Zia, New Mexico	425	0	
Zuñi, New Mexico	4,200	17	1 in 247

the right informants. What one informant does not know, or wish to give, may be obtained from another informant. An attempt was made to verify the information received from any source.

The number of individuals in each Indian population was obtained, unless stated otherwise, from data made available by the Phoenix and the Albuquerque Indian Health Area Offices of the U. S. Public Health Service. Since data on the size of southwest Indian populations are difficult to obtain, the values given in most cases are only estimates.

RESULTS

The Indian populations in Arizona and New Mexico surveyed in this study are given in Table 1. The majority of these populations have no living albinos; yet, three stand out as high prevalence populations. These are the Hopi Indians in Arizona and the Zuñi and Jemez Indians in New Mexico.

A recent account of albinism among the Hopi Indians has been given elsewhere (Woolf and Grant, 1962). The Hopi reservation is located in northeastern Arizona where it is completely surrounded by the Navajo reservation. Eleven of the twelve existing Hopi villages are located on the top or at the base of three mesas, known as First, Second, and Third Mesas. One village (Moenkopi) is located on the western range of the Navajo reservation but is

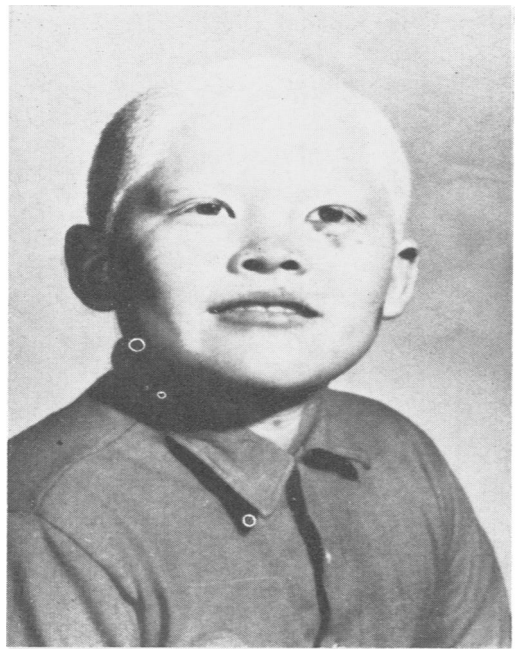

FIG. 1. Partial albino (piebald) from First Mesa, Hopi Reservation, Arizona. When he and his brother are clothed in long-sleeved shirts with high collars, they are frequently mistaken for generalized albinos.

actually an offshoot of the Third Mesa population. It is estimated by the Hopi Indian Agency, Bureau of Indian Affairs, Keams Canyon, Arizona, that the total number of Hopi Indians (1962) is about 5,000.

One of the three villages on First Mesa was established by Tewa emigrants from the Rio Grande area in New Mexico. They arrived about 1700 on the invitation of the First Mesa Hopis to help give protection from hostile Ute nomads. The Tewa and Hopi Indians on First Mesa have intermarried extensively (Hodge, 1959, Part I, pp. 560–568) so that the gene pool on First Mesa is different from these on Second Mesa and Third Mesa. This is supported by the blood group studies of Brown *et al.* (1958). The distribution and types of albinism in the Hopi population can be used perhaps as further evidence that the First Mesa population shows genetic divergence. There are 22 Hopi albinos, giving a total prevalence of 1 in 227. Yet, twenty of these albinos are from Second Mesa and Third Mesa. All twenty have generalized albinism. The total population from Second Mesa and Third Mesa is about 4,000; thus, the prevalence of generalized albinism in this population is 1 in 200 (Woolf and Grant, 1962).

The two cases from First Mesa represent a different genetic situation. These are brothers born in 1952 and 1956. Their hair and face are almost devoid of pigment; therefore, when dressed in a long-sleeved shirt with a collar, they can be mistaken for generalized albinos and were classified as such by Hopi informants (Fig. 1). A suspicion arose that they were genetically different from the twenty albinos from Second Mesa and Third Mesa when it was

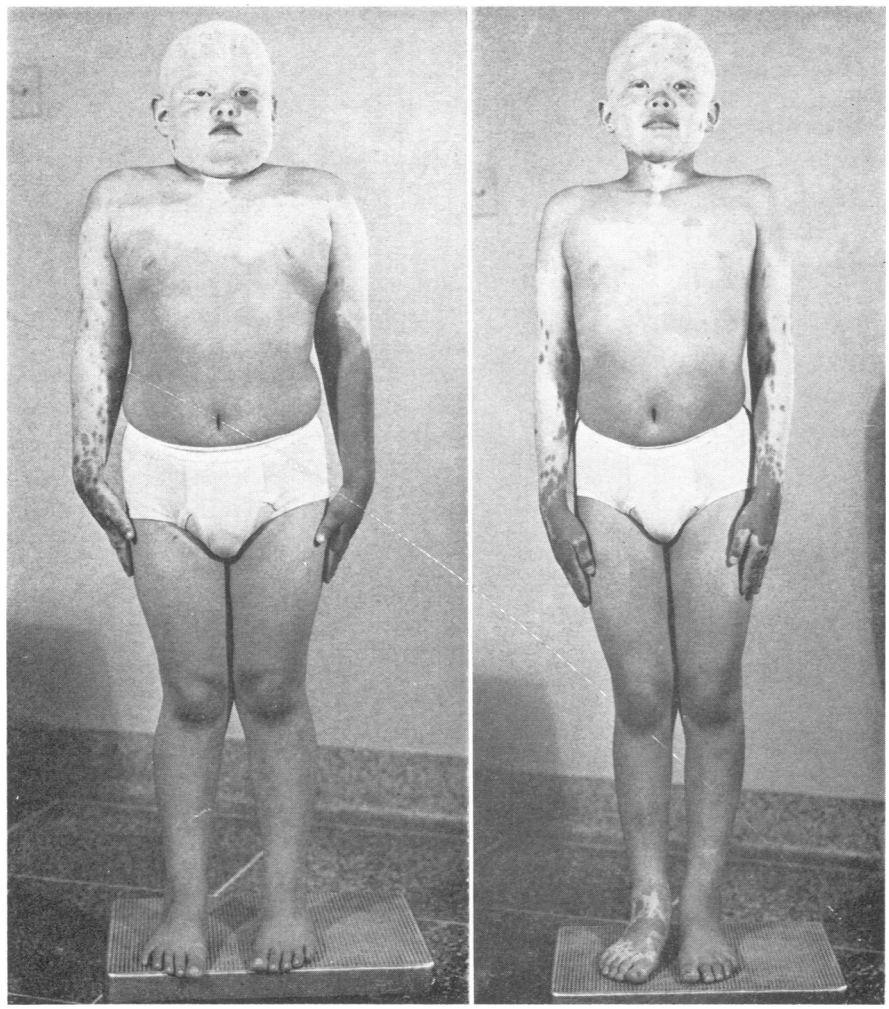

FIG. 2. Two partial albino brothers from First Mesa, Hopi Reservation, Arizona, showing a similar pattern of pigment variegation.

learned that they were enrolled in a special school for deaf children. Further investigation revealed that both show partial albinism (piebaldness) associated with congenital deafness. The pattern of variegation in the two brothers is strikingly similar (Fig. 2). The boys have one normal sibling (a male). Both parents are normal and there is no known history of this condition in any other Hopi Indian. A detailed account of the syndrome occurring in these boys will be published elsewhere.

The Jemez Pueblo is located in the Rio Grande region of New Mexico, about twenty miles northwest of Bernalillo. In 1962, there were about 1,400 Jemez Indians. When the population was surveyed in 1962, there were ten living albinos, giving a prevalence of 1 in 140. Excellent pedigrees and genealogies of Jemez albinos have been compiled by Jones (1965).

The Zuñi Reservation is located in northwestern New Mexico on the Arizona

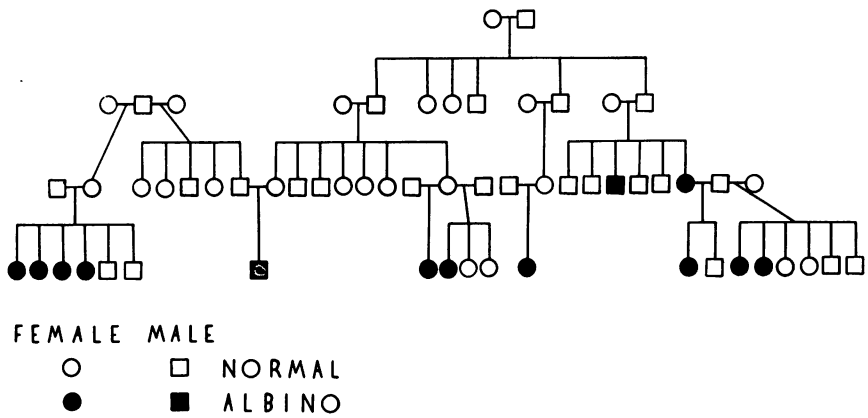

FIG. 3. Pedigree showing the relationship of many Zuñi albinos.

border. It is estimated by the Zuñi Indian Agency, Bureau of Indian Affairs, Zuñi, New Mexico, that in 1962 there were 4,200 Zuñi Indians living on or off the reservation. Seventeen of these, all living on the reservation, were albinos. The high prevalence of this disorder (1 in 247) is aptly illustrated by the experiences of the author, who spent approximately two hours walking with a colleague through the streets and passageways of the village when the reservation was first visited. During this short time, eight different albinos were observed. A pedigree showing the relationship of many of the Zuñi albinos is given in Fig. 3. In addition to sibship aggregations of cases, the pedigree gives an indication of the large number of normal individuals in the Zuñi population who carry the recessive gene.

Albinos were detected in only two other New Mexico Pueblo Indian populations. There are two sisters from the San Juan Pueblo who were 22 and 16 years of age in 1962. Two albinos are also numbered among the Laguna Indian population. One female, age 37 in 1962, lives in Albuquerque. Another female, age 31 in 1962, also lives off the reservation, allegedly in Michigan. These females are from different Laguna villages and different families.

The largest Indian population in the United States is the Navajo. They number about 90,000 and occupy an area in northeastern Arizona, northwestern New Mexico, southeastern Utah, and southwestern Colorado—larger than the combined states of Connecticut, Massachusetts, and New Hampshire (Kluckhohn and Leighton, 1962). The extensiveness of their range, inaccessibility of many regions of the reservation because of lack of roads, and nonvillage way of life makes a census of the number of albinos in this population a formidable task. Inquiries to physicians, nurses, social workers, missionaries, and traders living on or serving different sections of the reservation disclosed 24 living Navajo albinos. Undoubtedly, several were missed; thus, the prevalence of 1 in 3,750 is a minimum. This value is still relatively large when compared with that for Caucasian populations (about 1 in 20,000) in the United States and Europe (see Woolf and Grant, 1962).

No living albinos were found in any other Indian population in Arizona or New Mexico. The complete absence of living albinos in the relatively large

desert Indian populations of Arizona, such as the Pimas and Papagos, as well as the Apache Indian populations of Arizona and New Mexico, makes even more striking the high prevalence among the Hopi, Jemez, and Zuñi tribes.

DISCUSSION

For a given gene frequency, the proportion of individuals homozygous for this gene in a population is a function of the amount of inbreeding present in the population. Spuhler and Kluckhohn (1953) estimated that the mean population coefficient of inbreeding F for the Ramah Navajo population in New Mexico is 0.0080. This is the only inbreeding estimate available for any southwest Indian population. All southwest Indian populations are relatively highly inbred when compared with most Caucasians in the United States and Europe. Although different F values are expected to exist in the different southwest Indian populations, it is likely that the variance of these values is not large. Thus, the presence of high and low prevalence of albino cases in various Indian populations is a matter of high and low gene frequency values and not high and low inbreeding coefficient values.

The frequency of albinism among the Hopi, Jemez, and Zuñi Indians is of the order reported for the Cuna Indians of San Blas Province, Lower Panama. In 1925, Harris (1926) estimated that in a population of 20,000, the prevalence of albinos was 1 in 146. A lower value of 1 in 213 was given by Stout (1946) for the year 1940. Keeler (1963a) estimated that in 1962, the prevalence was more than 1 in 166, being reduced from 1 in 145 in 1925. A prevalence of about 1 in 200 results in a conspicuous number of albinos in a population of 20,000 otherwise dark-skinned individuals. Since the Hopi, Jemez, and Zuñi populations are not large, the impact of these albinos is not as great as the Cuna albinos; hence, these populations are not as well known as high prevalence populations.

The prevalence of albinism among the Hopi, Jemez, and Zuñi Indians is about 1 in 200. Using a genotypic frequency of $R = 1/200 = 0.005$, a mean population coefficient of inbreeding $F = 0.0080$ (as estimated for the Ramah Navajo), and solving for q in the equation $R = q^2 + Fpq$, gives a gene frequency $q = 0.067$. Slightly over 12%, i.e., $H = 2pq\ (1 - F) = 0.124$, of the individuals in a population with this gene frequency and inbreeding coefficient would be heterozygous for the recessive gene for albinism. The reason for the high gene frequency in a few Indian populations is unknown. Albinos appear to have a reduced reproductive fitness, as compared with nonalbinos, in all populations. Although data are lacking, Keeler (1963b) believes that the chief cause of death among the Cuna albinos is metastatic skin cancer. Myopia and lateral nystagmus are usually part of the genetic syndrome. Four of the Zuñi albino children are enrolled in a school for the blind where they are receiving special training. Neel *et al.* (1949) conclude that in European and Japanese populations at the present time the relative reproductive fitness value W for albinos is about 0.7–0.8, but in past generations it was closer to 0.4–0.5.

In addition to natural selection against albinos, social selection against them can be documented in Indian groups. Cuna albinos are not allowed to marry

each other; in fact, few do marry (Keeler, 1950). There is no evidence that infanticide was ever practiced against albinos in the Hopi, Jemez, or Zuñi populations; yet, it is apparent that they have difficulty in obtaining marriage partners. Examples of this type of discrimination are known for the Hopi albinos (Woolf and Grant, 1962). Zuñi albino bachelors are known. However, in spite of social selection against them in regard to obtaining marriage partners, albinos appear to be well integrated into Hopi, Jemez, and Zuñi cultures. They participate in religious ceremonies. Hopi albino chiefs and priests are known. The author only heard one discriminating comment towards an albino from an Indian informant involving a village function. One Jemez albino was of concern to some fellow villagers because of his position as drummer in the corn dance. They were worried that unknowing spectators would conclude a white man had to be imported to fill this assignment.

Hopi, Jemez, and Zuñi Indians do not understand the origin of albinos and a variety of explanations are given, such as the breaking of a taboo by one of the marriage partners or the mother having sexual relationships with a white person. The difficulties of being an albino in a dark-skinned population have taken their toll. Keeler and MacKinnon (1963) conclude that Cuna albinos may develop anxieties and repressions because of their weaknesses and rejection. A Zuñi female albino remained secluded for most of her adult life. One albino girl from a New Mexico pueblo is presently receiving psychotherapy at a Public Health Service Indian Hospital.

The publications of Stephenson (1904) and Hrdlička (1908) contain the evidence that the high frequency of albinos in the Hopi and Zuñi populations observed in this study was present in previous generations. Other reports of Hopi albinos who lived during the nineteenth and the turn of the present century have been reviewed by Woolf and Grant (1962). A photograph of a group of Hopis containing three albinos was taken in 1885 at Shungopovi on Second Mesa (Fig. 4). The description of nineteenth century Zuñi albinos given by Matilda Coxe Stevenson (1904) is as follows:

> In 1879 seven albinos were found among the Zuñis. Mr. Stevenson with difficulty gathered six of the albinos in a group and secured a photograph of them. The mother of an infant albino could not be prevailed upon to allow her child to be photographed. Indeed, these people are so sensitive of their condition that they avoid the presence of strangers, and while the men may stand their ground, the women and children, especially the latter, flee from the "Americano." The writer has seen several of the children grow to girlhood and womanhood. A birth of an albino child occurred in 1896. These people have light decidedly yellowish hair and complexions of decided delicacy. They all have weak eyes, and their vision is so affected by the absence of choroid pigment that they are obliged to protect their eyes which always become inflamed from ordinary daylight. When out of doors the albino men wear hats, when they can be secured, and the women cover their faces with blankets and peep through the smallest openings. The statement that albinos are compelled to live apart from the others of the tribe is erroneous, and none of them are debarred from religious or social privileges. In no instance has an albino parent an albino child, and no two of them belong to the same family. The adults are each married to a dark haired Indian, and they have healthy offspring.

The photograph of the six Zuñi albinos which appears on page 382 of the monograph by Stevenson is reproduced in Fig. 5.

One explanation for the persistence of the albino gene in certain Indian populations is selection for the heterozygote. In a large random mating pop-

FIG. 4. Photograph of three Hopi albinos taken at Shungopavi, Second Mesa, Hopi Reservation, in 1885. Reproduced here with the permission of the Smithsonian Institution, Bureau of American Ethnology (S.I. Negative #48,429-C).

ulation, where the relative reproductive fitness of heterozygotes and albinos are set at 1.00 and 0.5, respectively, it can be shown that the relative fitness of homozygous normals would be 0.962 in order to maintain the frequency of albinos in the population at $R = 1/200$ (Woolf and Grant, 1962). This slight reproductive advantage of heterozygotes over homozygous normals would be difficult to detect in a practical situation. A possible argument against the heterozygote advantage hypothesis is that environmental conditions are not too different at the present time among the various Indian groups in Northern Arizona and New Mexico, especially those in the Rio Grande area in New Mexico, even though large differences exist in the frequency of the albino gene in these groups. A heterozygote advantage in one population should be found in all other populations with similar environmental conditions. Yet, it is clear that relative fitness values can be influenced by genetic background (Woolf and Knowles, 1964) and that gene frequencies presently found in a population were determined by selective pressures working in previous generations. An advantage of the heterozygote in the past may not exist at the present.

An alternative and perhaps more plausible hypothesis to explain the distribution and frequency of the albino gene in Indian populations involves the action of cultural selection, gene flow from one group to another, and genetic drift. It is conceivable, although conclusive evidence is lacking, that during some period in past generations there was cultural selection for albinos, i.e., albinos were protected and therefore reproductively favored.

Albinos are an oddity, especially in a population of dark-skinned individuals. Bourke (1892) states, "Among many savage or barbarous people of the world albinos have been reserved for the priestly office." It is believed by their fel-

FIG. 5. Six Zuñi albinos in 1879. Originally published on page 382 of the Twenty-third Annual Report of the Bureau of American Ethnology, by Matilda Coxe Stevenson. Reproduced here by permission of the Smithsonian Institution, Bureau of American Ethnology.

low men that Cuna Indians will inhabit a better place in heaven, and to see that place, a non-albino Cuna Indian must make friends with eight albinos while he is on earth. They are considered to be special charges of God, particularly free of sin, and the only Cuna Indians able to scare off the demon who devours the sun and moon during eclipses (Stout, 1947).

In Prescott's account (p. 320) of Montezuma's royal household at the time of the conquest of Mexico, the following is found:

> I must not omit to notice a strange collection of human monsters, dwarfs, and other unfortunate persons, in whose organization Nature had capriciously deviated from her regular laws. Such hideous anomalies were regarded by the Aztecs as a suitable appendage of state. It is even said, they were in some cases the results of artificial means, employed by unnatural parents desirous to secure a provision for their offspring by thus qualifying them for a place in the royal museum!

Numbered in quantity among the "unfortunate persons" under Montezuma's protection were albinos (Orazco y Berra, 1880):

> There was in this house a room in which there were men, women and children, white at birth in the face, body, hair, eyebrows and eyelashes.

The protection of albino males in some early American cultures, while non-albino males went off to fight the wars or even work in the fields where there was a danger of attack, might have favored the propagation of the albino gene in certain segments of the population. Gene flow and genetic drift (or founder principle) might then explain the divergent prevalence in the various populations. Indian populations in the southwest, even in historic times, have been plagued by epidemics, periodic starvation conditions, and raids by hostile groups. This is attested by the number of archeological ruins throughout the area. It is evident that these populations have often consisted

of a small number of individuals and therefore a large variance has existed in gene frequency values from one generation to the next. If the albino gene were present in one of these populations, the frequency would fluctuate and might rise by chance to a relatively high value. Furthermore, it is also likely that many, if not most, of the present southwest populations were founded originally by a small group of migrants. The frequency of the albino gene could be high in a present population if one or more of the founders were heterozygous for the gene.

Even though the Hopi, Jemez, and Zuñi Indians belong to different linguistic families, they show strong cultural similarities, demonstrating cultural exchange in past centuries. With cultural exchange there is an opportunity for gene flow. Parsons (1933) quotes from the journal of Stephen of 1892, who describes kachina dances at First Mesa by 46 Zuñi visitors. Parsons states that interchange visits by Zuñi and Hopis for kachina dances are of long standing. The literature contains further evidence that gene flow could have occurred among the various Indian populations of northern Arizona and New Mexico in historic and prehistoric times. The Hopis (Uto-Aztecan linguistic family) were at one time much more widely distributed in the southwest than at present, as evidenced by archeological findings and their own legends (Hodge, 1959, Part I, pp. 560–568). Following the Pueblo revolt against Spanish authority during the latter part of the seventeenth century, certain groups of Jemez, Zuñi, Acoma, and Navajo Indians united as allies (Hodge, 1959, Part I, p. 630), and some of the Zuñis (Zuñian linguistic family) took refuge among the Hopis (Stephenson, 1904, p. 285). At the time of the revolt, a large proportion of the populations from Isleta and Sandia (Tanoan linguistic family from the Rio Grande area) also fled to Hopi country. The Isleta Indians returned to New Mexico in about 1709 or 1719, but the Sandia Indians appear to have remained with the Hopis until 1742 (Hodge, 1959, Part II, p. 749). It is of interest that a mother and two sons with albinism were reported in the Isleta population in relatively recent times by Parsons (1932). Remains of Keresan pueblos are situated on Antelope Mesa in Hopi country. The Keresan linguistic family is represented presently by the populations at Acoma, Laguna, San Felipe, Santa Ana, Santo Domingo, and Sia, all in New Mexico. Near the Keresan ruins on Antelope Mesa are the ruins of a pueblo once occupied by the Wood clan, originally from Jemez (Hodge, 1959, Part I, pp. 560–568). Jones (1965) concludes that the albino gene may have been introduced into the Jemez population by the Pecos Indians, since known carriers of the recessive gene in previous generations are known to be of Pecos descent. The Pecos Indians (Tanoan linguistic family) were a populous group at the time of the Pueblo revolt, but their number was reduced by Commanche raids and epidemics. In 1838, the Pecos pueblo was abandoned and the 17 survivors moved to Jemez. These Indians shared a common language, with dialectal variation (Hodge, 1959, Part II, p. 221).

The date of arrival of the Navajos into the southwestern part of the United States is unknown; one estimate is about 1000 A.D. (Kluckhohn and Leighton, 1962). The Navajos have long been antagonists of the Hopis and Zuñis. The presence of the albino gene in the Navajo population at an increased fre-

quency is explainable, even if they did not bring it with them, by the close proximity of the Navajo reservation to the Hopi and Zuñi reservations and by Navajo raids in the past on the Hopis and Zuñis for the purpose of obtaining food, women, livestock, and other booty. Several of the Navajo families with albinos are presently living adjacent to the Hopi reservation.

A cultural selection–gene flow–genetic drift hypothesis to explain the high prevalence of albinism in the Cuna, Hopi, Jemez, and Zuñi Indians has the corollary that natural selection is tending to rid the Indian populations of this gene. Selection would be expected to be more effective in some areas, such as the desert populations of southern Arizona, than in the more temperate climates of Northern Arizona and New Mexico where the Pueblo Indians presently reside. Inquiries made by Russell (1908) to an Indian informant concerning the possible existence of albinos in the large Pima population in southern Arizona was met with the reply, "There never were any." Possibly aiding natural selection in the Pima populations was the practice of infanticide. Russell states that the Pimas had such a strong feeling against the abnormal that attempts were made on the life of an adult male because he had six toes; hence, it is doubtful that an albino infant would have been allowed to survive in past years.

Evidence is lacking that generalized albino cases in the Cuna, Hopi, Jemez, and Zuñi populations are all due to the same allele. The Trevor-Roper (1952) pedigree of two albino parents producing normally pigmented offspring is evidence for at least two different types of recessive albinism in man. Witkop, Van Scott, and Jacoby (1961) obtained experimental evidence for at least two different forms of autosomal recessive albinism by placing unfixed albino hair bulbs into a solution of L-tyrosine, 50 mg/100 ml, pH 6.8. They observed that the hair from some albinos formed pigment but the hair from others did not. It would be informative to run similar tests on Indian albinos from the different ethnic groups. The detection of inter- and intrapopulation differences would put gene origin and gene flow hypotheses on a firmer basis.

The cultural selection–gene flow–genetic drift hypothesis also has the corollary that the prevalence of albinism will decrease in future years because of the gradual trend towards exogamy in southwest Indian groups. Better transportation facilities, schools on and off the reservations where members of different ethnic groups associate, and increasing economic pressures forcing young people to seek employment off the reservations are all lessening inbreeding and decreasing the probability of homozygosity for the gene resulting in this inborn error of metabolism.

SUMMARY

A survey for albinos was made among the Indian populations of Arizona and New Mexico. None was found in the majority of these populations, but there are three high frequency populations. The prevalence among the Hopi Indians of Arizona is 1 in 227. Among the Jemez Indians of New Mexico (Rio Grande region), the prevalence is 1 in 140; among the Zuñi Indians of New Mexico, it is 1 in 247. The Hopi, Jemez, and Zuñi are related culturally but not linguistically.

The prevalence among the large Navajo population in southwestern United States is greater than 1 in 3,750, a value which is relatively large when compared with that in the Caucasian population in the United States. Albinos also occur at the present time in the San Juan and Laguna Indians of New Mexico.

One explanation for the high frequency of the albino gene in certain Indian populations is selection for the heterozygote under certain environmental conditions. An alternative hypothesis entails cultural selection in past generations, gene flow from one population to another, and genetic drift (or the founder principle).

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