DIFFERENCES BETWEEN CERTAIN OF THE NORTH AMERICAN INDIAN TRIBES

AS SHOWN BY A MICROSCOPICAL STUDY OF THEIR HEAD HAIR

By

GEORGE WOODBURY
EDNA T. WOODBURY

By Order of the Directors
of
The State Historical Society of Colorado
State Museum, Denver, Colorado

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PREFACE

When this investigation was first undertaken in November, 1930 we had no conception of what would be entailed before a suitable end could be reached. The head hair on the desiccated body of a Cliff Dweller from Mesa Verde, in the collection of The State Historical Society of Colorado, provided the original impetus. To this were added more specimens of Mesa Verde hair as well as specimens from living Indian tribes until this study reached its present proportions. More material from other tribes than are here represented remains in our files still to be examined, but it was thought best to call a halt for the moment and publish the results so far won and trust that in the near future time and opportunity might be afforded for carrying this investigation a step further; the study of the microscopic characteristics of American Indian head hair has been anything but exhausted.

The help and cooperation that we have received from so many sources has been largely responsible for whatever merit this investigation may have.

We wish to express our especial thanks and appreciation to the Directors of The State Historical Society of Colorado whose interest and encouragement have made this work possible.

For specimens of prehistoric hair we are indebted to Mr. S. J. Guernsey, Peabody Museum, Cambridge, Massachusetts; Professor Junius Henderson, University Museum, Boulder, Colorado; Professor Earnest A. Hooton, Harvard University, Cambridge, Massachusetts; Mr. E. B. Howard, University of Pennsylvania Museum, Philadelphia, Pennsylvania; and to Dr. H. Shapiro, American Museum of Natural History, New York.

We wish to express our thanks to the following who collected hair samples from the living Indian tribes for us: Mr. M. L. Burns, Cass Lake, Minnesota; Mr. S. H. Gillam, Sherman Institute, Riverside, California; Mr. O. C. Gray, Fort Totten, North Dakota; Reverend A. A. Hastings, Ethete, Wyoming; Mr. T. G. Mackey, Fort Mojave, Arizona; Mr. E. K. Miller, Keams Canyon, Arizona; Mr. C. Newell, Fort Washakie, Wyoming; Mr. G. E. Peters, Flandreau, South Dakota; Mr. W. O. Roberts, Rosebud, South Dakota; The Fort Sill Indian School, Lawton, Oklahoma; Mr. H. M. Tidwell, Fort Duchesne, Utah; Mr. F. Snyder, Stewart, Nevada; Mr. E. Stacher, Crown Point, New Mexico; Mr. R. P. Stanion, Elbowoods, North Dakota.

For the Chinese material, we wish to express our thanks to Miss Sallie Glass, of Kwangtung and Miss Lelia M. Hinkley of Peiping and, for the splendid series of Japanese hair specimens, Mrs. S. C. Bartlett of Kyoto.

Our thanks are due to Dr. A. V. Kidder, of the Carnegie Institution of Washington, D. C. for his assistance in obtaining specimens.

To Professor Earnest A. Hooton of Harvard University we tender our grateful appreciation for reading this manuscript and for helpful suggestions and criticism.

George Woodbury

Colorado State Museum
Denver, Colorado
September 25, 1932.

SECTION I

Form and Texture

AN HISTORICAL SUMMARY

"Human hair appears, to common observation, a not very important part of the animal organization of the integumentary covering of the cranium. Its chief design appears to have been to ornament and protect the head—that crowning part and finished glory of the created structure of man."
—Peter A. Browne (1860).

A short summary of the history of the study of human hair may not be out of place before embarking upon the detail of this investigation. Since the times of Herodotus and Aristotle and even before, the outward appearance of the hair has been recognized as one of the most distinctive of racial criteria. Throughout the subsequent centuries this study was limited to the outward appearance only until in the early part of the 19th century, the development of microscopic technique brought with it a better and more accurate method of investigation.

In 1822, Heusinger (16) first brought the revealing power of the microscope to bear upon the characteristics of human hair. In that year he cut and examined cross-sections of the head hair of a Negro, and was the first to recognize the characteristically kidney-shaped appearance of the head hair of this race. Weber (41), in 1826, carried the microscopic study a step further. He examined the cross-sections of hair of several of the different races of Man, and concluded that straight hair was round in section, while curly hair was elliptical. At the same time, he attempted measurements and computed the minimum diameter of hair to be 33 micra and the maximum, 100. In 1843, Henle (14) wrote the first detailed study on this subject and was the first to outline the hypothesis that the degree of waviness in hair was directly related to the degree of flattening of its cross-section. In other words, he demonstrated that the wavier a hair was the more elliptical would be its cross-section. Kölliker (23), in 1856, demonstrated that an elliptically shaped hair tended to curl toward its flatter side. In this way the hypothesis of the relation between hair form and shape of cross-section devel-

oped. This hypothesis has come down to the present time, with but slight modification by subsequent research.*

The first investigator of American Indian hair by the microscopic method appears to have been Mr. Peter A. Browne of Philadelphia. His "Examination and Description of the Head Hair of the North American Indian and its Comparison with the Other Varieties of Man," appeared as a contribution to Schoolcraft's "Archives of Aboriginal Knowledge" (1860). This investigation, undertaken, as Schoolcraft assures us "with scientific and philosophical care" is one of importance because it appears to be the first study of this kind undertaken on American Indian material. Browne examined cross-sections of Indian hair under the microscope and concluded that it was all either "Cylindrical or Cylindroidal." He added that this fact indicated that all Indian hair was naturally straight, and thereby corroborated Henle's hypothesis that the straightness or waviness of hair depended upon the shape of its cross-section. In his own words, his conclusions in their briefest form were: "The covering of the head of the American Indian is *hair;* it is in shape either cylindrical or cylindroidal." "That peculiar, *lank* appearance of the hair of the head of the American Indian is owing to its cylindrical form."

Due to the fact that these conclusions have, and for that matter still do, influence our conception of the physical character of Indian hair, it is of interest to see upon what evidence Browne based these important conclusions. The specimens of Indian hair that he examined represent ten individuals in all and were tabulated by him in the following manner:

Cylindrical specimens.

1. A Choctaw Indian.
2. "Big Water", a Texas Indian.
3. "Cap-o-co-mal", a Sac man, descendant of "Black Hawk".
4. A Mummy from Lima.

*In 1929 Neuert (29) proved that a definite correlation existed between the curvature of the hair shaft and the form of its cross-section. The coefficient of correlation calculated by him for White, Negroid, Mongoloid and Composite material reached the significant value of 0.517.

5. A Mummy from Pachacamac.
6. A Mummy from Arica.
7. A Mummy from Pisco.
8. A Mummy from Mexico.
9. A Mummy from Brazil.

Cylindroidal specimens.

1. A Choctaw woman.

A few years later Pruner-Bey (1863-1864) (33) in Paris undertook a comprehensive study of the racial characteristics of hair including American Indian material. Two groups of Indians are represented in his tables; "2 Américaines du Nord" and "6 Guarani". Their index values are given as "81" and "77" respectively. Since the index value is an expression of the form of the hair cross section, we see that these two tribes were not found to be exactly alike.

In 1888 the German physical anthropologist, Gustav Fritsch examined the subject of the American Indians' head hair and announced his findings before the 7th Session of the International Congress of Americanists in Berlin (12). He stated that from his experience Indian hair was characteristically slightly wavy, dark brown in color and not at all coarse.* He further stated that there were intertribal differences to be noted among the various tribes in the United States. Fritsch's "Probe" as he termed it was admittedly inconclusive through lack of abundant material. Ehrenreich (8) pointed out in 1897 that among the Brazilian tribes that he had examined, straight, black coarse hair was by no means general.†

In 1908 Latteux appeared as collaborator in Chervin's "Anthropologie Bolivienne" (6). Latteux's contribution consisted in measuring the specimens of head hair collected from the Aymara and Quéchua tribes. His conclusions, that they were fine, black and slightly oval, were summed up by him the following laconic manner:

1er Ils sont fins. (plus fins que les cheveux des Français.)
2e Ils sont noir et droit.
3e Ils sont faiblement reniform.

*(12) " . . . dass es durchaus nicht straff, sondern leicht wellig war, dass es nur von tiefbrauner Farbe und nicht grobe war".
†(8) " . . . unsere Erfahrungen bestaetigen nun durchaus dass das grobe, straffe schwarze Haar keineswegs allgemein ist".

This brings up to date the brief sketch of the history of the study of human hair in general and of Indian hair in particular. We can see that there are two schools of thought regarding the nature of Indian hair. One holds that Indian hair is uniformly straight, black and coarse, and this is perhaps the more popular conception, and assumes that all Indian tribes are of the same race and that they are descendants of the Mongoloid peoples of Asia. The other holds that there is a non-uniformity among the Indians in general and that there are various types of Indian hair, and assumes, that because of this non-uniformity, not all Indians sprang from the same racial group. The data published on Indian hair appear to us inadequate to support either of these rival contentions.

This study of the subject is prompted by a desire to find out if American Indian head hair is of one uniform type or whether it is not. If it is not of one uniform type how many types are there and in what respects do they differ? How greatly do they differ and what is the anthropological or racial significance of this difference?

MATERIAL

The specimens used in this study represent 156 individuals from twelve Indian tribes. Ten of these tribes are present living Indians and two are prehistoric; the Mesa Verde and the Basket Maker.*

In selecting these specimens a number of precautions have been observed. In the first place all samples were cut from the *crown* of the head (cf. 24; 27; 30). In the second place they represent full-blooded individuals of adult age (i.e. over the age of puberty) (cf. 18; 24). In the third place only those tribes indigenous to the western and southwestern parts of the United States were included for the purpose of giving geographical unity to the investigation. Some of the series are numerically small but were considered to be of such intrinsic interest that they were included with the larger series and for the most part gave out statistically satisfactory results.

*Our Basket Maker material from Grand Gulch, Utah and from Canyon del Muerto, Arizona, was found to be similar to the point of identity. Both groups were therefore pooled together and treated as one tribe of Basket Makers.

The tribes used are:†

20	Navajo (New Mexico)	6	Ute (Utah, northern division)
15	Shoshoni (Wyoming)	10	Arapahoe (Wyoming)
19	Hopi (Arizona)	10	Paiute (California & Nevada)
‡10	Gros Ventre (Wyoming)	16	Basket Maker (Arizona & Utah)*
§20	Sioux (N. & S. Dakota)	11	Mesa Verde (Colorado)
7	Comanche (Oklahoma)	12	Chippewa (Minnesota)

TECHNIQUE

In examining the hair samples, we have used the technique usual in histological work for material of this character. (35). The hairs were embedded in a semi-solid preparation, sectioned by a microtome and mounted.¶

The hairs were sectioned at right angles through the mid-part of the hair shaft, avoiding both the free tip and the bulb. (27).

Ten hairs from every individual head of hair were examined on account of the variations in form and texture. From these figures a mean calculation representing each person's head of hair was obtained.‖

All measurements were made with a standardised micrometer ocular under a magnification of 385x. Micrometer readings were converted into micra (.001 m/m); the standard unit of measurement throughout this paper.

The greatest (maximum) and the least (minimum) diameters of each hair cross-section were measured and from these two figures the form and texture were computed.

*Our Basket Maker material from Grand Gulch, Utah and from Canyon del Muerto, Arizona, was found to be similar to the point of identity. Both groups were therefore pooled together and treated as one tribe of Basket Makers.

†We have been unable as yet to secure good series of material from the Pueblo Indians of New Mexico but hope that this may be possible in the near future.

‡(Hidatsa).

§(Sisseton).

¶This method of examining hair samples is attributed to Dr. Latteux. (cf. 25; 26).

‖We have calculated that the selection of ten hairs from one individual will yield approximately the following constants:

for Form: (Index)

S.D. ± p.e.	V. ± p.e.
8.867 ± 1.321	10.97 ± 1.590

for Texture:

S.D. ± p.e.	V. ± p.e.
7.994 ± 1.205	10.20 ± 1.451

No difference between the head hair of the two sexes could be determined. (24) Male and female specimens were, therefore, pooled together and whenever possible, an equal number of the two sexes were represented in each series.

FORM

In analysing the material at hand the first step has been to examine the form of the hair shaft. The form of the shaft is determined by the measurement of the two diameters of the cross-section; the maximum and the minimum. These two diameters are computed as an index which is the expression of the form of an object by means of a single figure, as follows:

$$\text{Index} = \frac{\text{Minimum diameter} \times 100}{\text{Maximum diameter.}}$$

Oval cross-sections indicate wavy hair and round sections indicate straight hair. Therefore, since a low index value represents an oval section and a high index value represents a round section, it is possible to identify wavy and straight hair by a consideration of the index values alone.

Curly hair gives a mean index value of 50.00 to 75.00 and straight hair a mean index of 80.00 to 100.00. (27) Therefore, we may say wavy hair, being intermediate between these two extremes, will have a mean index of 75.01-79.99. This is the classification of hair form that has been used and may be tabulated as follows:

Curly hair	50.00— 75.00
Wavy hair	75.01— 79.99
Straight hair	80.00—100.00

Table I shows, in ascending order, the mean indices, appropriate constants, and the respective probable errors calculated for each of the twelve tribes under consideration. The division into wavy and straight, according to the above classification, has been made. Among these tribes no example of curly hair was found.

The range of index values shown on this table is not very great, but sufficient, when compared with the proper constants, to show that a tangible difference in form is present among these tribes. The values are found to range from wavy to straight (77.25 to 84.64) according to the classification. The

TABLE I

FORM
(expressed in indices)

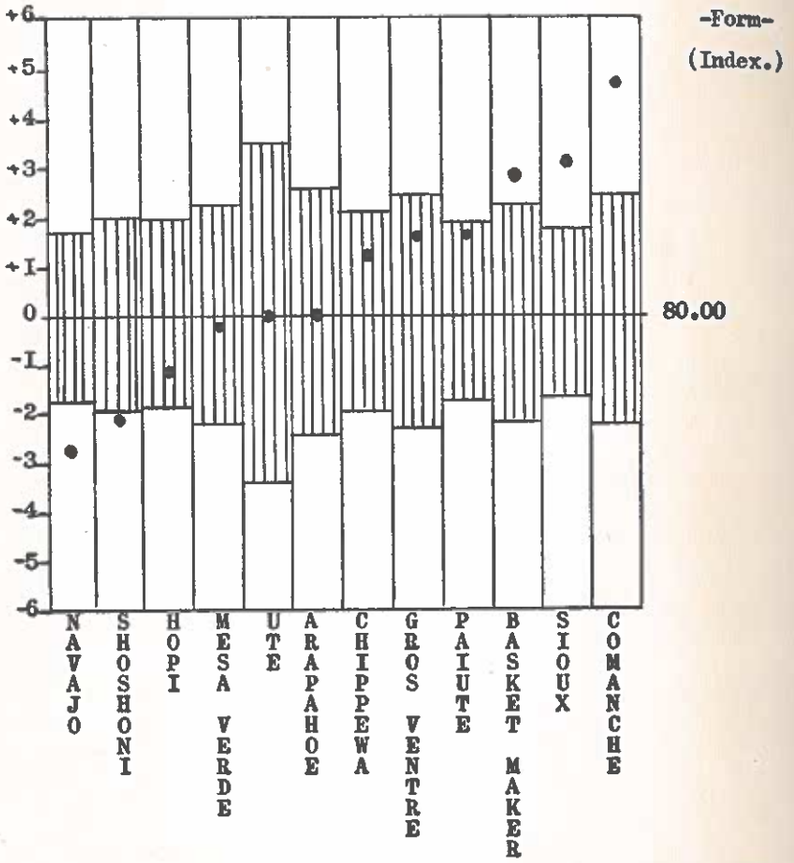
				Wavy		Straight	
TRIBE	n.	M ± pe.	Range	S.D. ± pe.	V. ± pe.		
Navajo	20	77.25 .866	67.49-86.90	5.74 .612	7.43 .750		
Shoshoni	15	77.83 .985	68.79-88.59	5.65 .696	7.26 .866		
Hopi	19	78.81 .941	64.51-86.32	6.08 .665	7.71 .769		
*Mesa Verde	11	79.77 1.113	72.39-85.97	5.47 .787	6.86 .865		
Ute	6	80.00 1.719	71.74-89.33	6.24 1.215		7.80 1.369	
Arapahoe	10	80.00 1.279	65.22-89.67	6.00 .904		7.50 1.060	
Chippewa	12	81.25 1.048	74.09-93.73	5.38 .741		6.62 .829	
Gros Ventre	10	81.50 1.243	74.41-90.24	5.83 .879		7.15 1.060	
Paiute	10	81.50 .929	74.05-89.04	4.35 .657		5.34 .755	
Basket Maker	16	82.81 1.143	67.05-92.48	6.78 .808		8.18 .959	
Sioux	20	83.00 .892	70.81-91.93	5.91 .630		7.12 .750	
Comanche	7	84.64 1.195	81.68-90.21	4.69 .845		5.54 .903	

*cf. note on p. 20.

Navajo, Shoshoni and Hopi are found in the wavy haired category, while the Mesa Verde, Ute, Arapahoe, Chippewa, Gros Ventre, Paiute, Basket Maker,* Sioux and Comanche, appear as straight haired.

The intertribal difference in hair form (index) is shown to be real and not the result of the random selection of samples, when the following test is made. The total mean

GRAPH.I.



*The statement has been made that of all the American Indian tribes the Basket Maker was characterized by wavy hair (17). This has not been our conclusion. The contradiction may be explained by a difference in the technique of examination.

index value of all the tribes put together is 80.00. If each tribe were merely a sample taken at random from a homogeneous whole, 82.% of the tribal mean indices would fall within the range of twice their probable error when marked off on either side of the total mean. This is shown in Graph I.

The straight line indicates the total mean index (80.00). On either side is laid off twice the probable error of each tribe. The tribal mean is then plotted with relation to the total mean (80.00). We see that 41.66% of the tribes fall outside the limits, and that only 58.33% fall inside. The tribes can not, then, be considered as random samples of a homogeneous whole. The intertribal difference that we have noticed in hair form is real.

TEXTURE

The next main consideration in this analysis is the hair texture typical of these tribes. Although there are various methods and formulae for calculating this quantity, the one recommended by Martin (27 p. 498) has been used throughout. It is, in brief, the average of the two diameters of the cross-section, the maximum and the minimum, and is expressed:

$$\text{Texture} = \frac{\text{Maximum} + \text{Minimum diameter}}{2}$$

No classification could be found that set the limits to what values we should consider fine and what coarse. It was, therefore, necessary to make one. The most frequent mean range in texture calculated by this formula is found to be 60.00 to 110.00 among Hominidae (27 p. 498). The classification we have used was made by bisecting this range. The smaller half has been designated as representing fine hair and the larger, coarse.

60.00— 84.99.....Fine hair
85.00—110.00.....Coarse hair

TABLE II

TEXTURE

TRIBE	n.	M ± pe.		Range	S.D. ± pe.		V. ± pe.	
Fine								
Sioux	20	74.00	1.102	59.95— 93.78	7.21	.779	9.74	.967
Comanche	7	76.08	1.890	62.52— 87.72	7.41	1.336	9.74	1.635
Gros Ventre	10	78.00	1.108	65.47— 82.98	5.19	.783	6.66	.908
Navajo	20	83.00	1.365	70.69—100.95	9.05	.965	10.91	1.409
*Basket Maker	16	83.43	1.420	69.37—102.42	8.42	1.004	10.09	1.204
Coarse								
Ute	6	85.00	3.526	63.14—103.55	12.80	2.493	15.05	2.985
Chippewa	12	85.00	2.262	60.89— 98.69	11.61	1.599	13.66	1.819
Arapahoe	10	85.00	1.919	67.67— 94.95	9.00	1.357	10.58	1.523
Mesa Verde	11	86.60	2.063	68.11—104.70	10.14	1.495	11.71	1.600
Paiute	10	89.00	1.895	73.45—101.72	8.88	1.340	9.98	1.368
Shoshoni	15	89.50	1.557	66.89—102.58	8.94	1.101	9.99	1.243
Hopi	19	91.18	1.608	73.95—102.98	10.39	1.137	11.39	.769

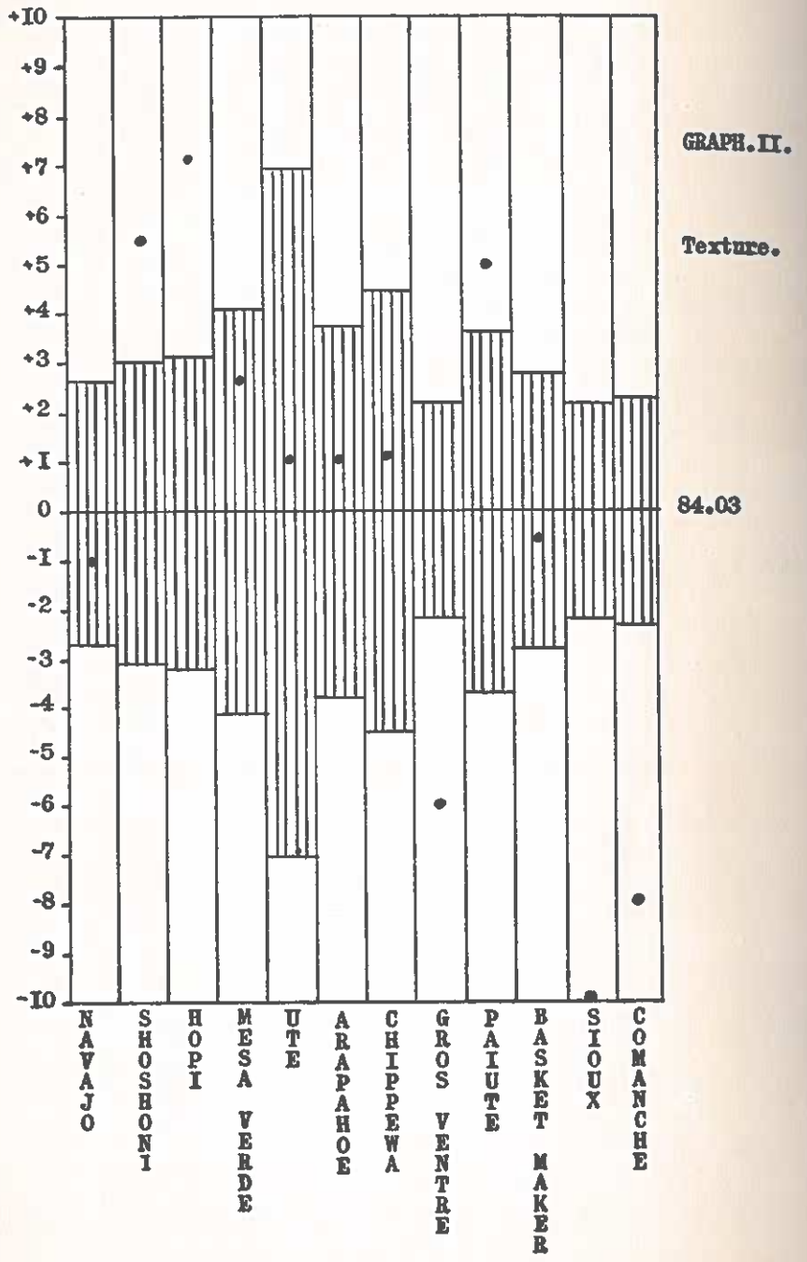
*cf. note on p. 20.

Table II shows the mean textures, constants and the respective probable errors for each of the twelve tribes, arranged in the order of ascending mean values. The above classification into fine and coarse haired tribes has been applied.

The range of mean textures shown in this table is large (74.00 to 91.18) and indicates that there is a decided non-uniformity among these tribes. The separation into fine and coarse, shows that the Sioux, Comanche, Gros Ventre, Navajo and Basket Maker* are fine haired. The Ute, Chippewa, Arapahoe, Mesa Verde, Paiute, Shoshoni and Hopi, on the other hand, are coarse haired.

In order to demonstrate that this difference in texture is not due to random sampling, Graph II has been drawn, analogous in every way to Graph I. Should 82.00% of the tribal means fall within the limit of twice their respective probable errors from the total mean of all the material (84.03) then we have random sampling to thank for this range in textures. Should this not be the case, we have real differences to deal with.

*cf note on p. 20



GRAPH. II.

Texture.

84.03

GRAPH II

We see from this graph that 50.00% of the means fall inside of the limits and 50.00% outside. Random sampling can not be held responsible for this range in textures. A definite intertribal difference can be said to exist.

CLASSIFICATION OF THE TRIBES INTO TYPES

In the analysis of these twelve Indian tribes real differences in both form and texture have been shown. We have found that both wavy and straight hair appeared as did fine and coarse. By using these four headings the tribes may all be grouped under their proper title of; wavy-fine, wavy-coarse, straight-fine or straight-coarse. Table III shows the grouping thus arranged.

TABLE III

CLASSIFICATION ACCORDING TO THE FORM AND TEXTURE OF THE HAIR

Form		Texture	
Wavy hair	75.01— 79.99	Fine	60.00— 84.99
Straight	80.00—100.00	Coarse	85.00—110.00

Wavy-Fine	Wavy-Coarse	Straight-Fine	Straight-Coarse
Navajo	Shoshoni	Gros Ventre	Ute
	Hopi	Sioux	Arapahoe
		Comanche	Paiute
			Basket Maker
			Mesa Verde
			Chippewa

In the classification given in Table III we see that under the heading of wavy-fine the Navajo is found alone. The Shoshoni and the Hopi come together under the designation of wavy-coarse. The Gros Ventre, Sioux and Comanche fall in the category of straight-fine. The largest group of all,

consisting of the Ute, Arapahoe, Paiute, Basket Maker, Mesa Verde and Chippewa, is found under the heading of the straight-coarse type.* The twelve tribes of Indians that form the material of this study can then be grouped into four types according to the form and texture of their head hair.

THE MEAN TYPE DIFFERENCE OR DEGREE OF DIFFERENCE

Although it is clear that these four types differ significantly from each other, the quantitative question now arises: how great and how significant are these differences?

In order to give a numerical expression to the differences between these four types we have resorted to the mean type difference formula (Poniatowsky's modification)†. This has first been calculated between each tribe separately and the results tabulated on Table IV. The smaller the value of the mean type difference the smaller the degree of difference between the two tribes compared. Conversely, the greater the value, the greater the difference; by this method a scale of the degree of difference between these twelve tribes has been set up.

On Table IV the twelve tribes have been arranged according to the four types described.

*An interesting item is noticeable in the behavior of the two prehistoric tribes in this classification.

The Basket Maker hair falls into the category of the straight-coarse. It has, however, a distinct tendency toward the straight-fine since its texture is so near the border line between the fine and coarse.

The Mesa Verde hair falls into the category of the straight-coarse also, but has a tendency toward the wavy-coarse, its form being almost exactly between the divisions of straight and wavy.

Both of these prehistoric tribes, therefore, straddle the classification as regards one feature and do not fit as neatly as do the present living tribes. Is it not conceivable that we may have in the Basket Maker and the Mesa Verde prototypes that may have become altered in the passage of time?

†For Poniatowsky's modification of the type difference formula see Martin, "Lehrbuch der Anthropologie" (2te Aufl.) S. 108-109.

The formulae are:

For the type difference (T)

$$T = 100 \cdot (M - M') \cdot \frac{(sd) + (sd)'}{(sd) \cdot (sd)'}$$

For the Mean type difference (Tm)

$$Tm = 1/p \cdot (T + T' + T'' \ldots\ldots)$$

or

$$Tm = 1/p \cdot \Sigma^p T$$

where "p" is the number of the type differences (T) used.

TABLE IV

MEAN TYPE DIFFERENCE

Tm

	Nav.	Shosh.	Hopi.	Gros. V.	Sioux.	Coman	Ute.	Paiute.	B.M.	M.V.	Arap.	Chipp.
(Wavy-fine) Navajo	.....	142.07	111.32	149.28	210.87	228.09	64.87	151.59	94.37	82.63	69.03	91.68
(Wavy-coarse) Shoshoni	142.07	.....	34.21	239.11	283.69	298.52	79.23	80.29	151.15	65.42	83.86	106.66
Hopi	111.32	34.21	.....	140.31	271.06	284.04	73.21	75.82	145.14	61.29	83.77	99.08
(Straight-fine) Gros Ventre	149.28	239.11	140.31	.....	88.31	91.86	118.92	168.13	89.89	153.77	131.68	100.39
Sioux	210.87	283.69	271.06	88.31	.....	59.82	213.85	218.43	165.03	205.07	200.41	154.78
Comanche	228.09	298.52	284.04	91.86	59.82	.....	181.70	229.49	124.65	222.73	195.62	166.25
(Straight-coarse) Ute	64.87	79.23	73.21	118.92	213.85	181.70	.....	67.40	59.03	18.08	.25	15.01
Paiute	151.59	80.29	75.82	168.13	218.43	229.49	67.40	.....	89.16	61.05	73.85	49.94
Basket Maker	94.37	151.15	145.14	89.89	165.03	124.65	59.03	89.16	.....	84.67	62.18	42.09
Mesa Verde	83.63	65.42	61.29	153.77	205.70	222.73	18.08	61.05	84.67	.....	20.89	42.62
Arapahoe	69.03	86.83	83.77	131.68	200.41	195.62	.25	73.85	62.18	20.89	.....	31.89
Chippewa	91.68	106.66	99.08	100.39	154.78	166.25	15.01	49.94	42.09	42.62	31.89	.....
		Wavy-fine	Wavy-coarse	Straight-fine			Straight-coarse					

In order to arrive at a set of figures representing the degree of difference between the four types, the values found on Table IV have been averaged and set down in the form of another table, Table V. Here, expressed by a single figure, are the mean type difference values representing the degree of difference between the four types of Indian tribes.

TABLE V

	wavy-fine	wavy-coarse	straight-fine	straight-coarse
Wavy-fine	——	126.94	196.08	92.36
Wavy-coarse	126.94	34.21	252.78	92.07
Straight-fine	196.08	252.78	79.99	168.93
Straight-coarse	92.36	92.07	168.93	47.87

The smallest values found on this table are where a type is compared with itself (underlined), such as the comparison of wavy-coarse type with wavy-coarse type (34.21) etc. This does not come out as zero for the reason that the component tribes of each type are similar but not identical.

In this comparison of the four different types we see that the values range from 92.07 (wavy-coarse with straight-coarse) to 252.78 (wavy-coarse with straight-fine).

What does a degree of difference of this magnitude between these types imply?

THE ANTHROPOLOGICAL MEANING OF THE TYPE DIFFERENCES

The differences between these four types of Indian tribes have been demonstrated and the degree of these differences has been assigned definite numerical values. The question now to be answered is, whether these differences are of the magnitude of group differences or whether they are of the magnitude of racial differences under the same group.*

In order to accomplish this, we have had to resort to a comparison with non-Indian material. Two races from different groups have been examined and compared. The

*In this paper the term "group" denotes one of the four largest divisions of mankind; White (European), Negroid, Mongoloid and Composite. "Race" designates one of the subdivisions within a group.

Mongoloid group is represented by a series of eleven Chinese from Kwangtung, South China. The White (European) group is represented by a series of thirteen white Americans from Denver, Colorado. These two series have been selected, examined and studied in exactly the same way as the Indian series. They are strictly comparable in every way.

The calculated form and texture for these two test series are as follows:

FORM (Index)

	M.±pe.	S.D.±pe.	V.±pe.
(13) White American	66.35±1.374	7.34±.972	11.07±1.472
(11) South Chinese	78.86±1.132	5.56±.800	7.06±1.011

TEXTURE

	M.±pe.	S.D.±pe.	V.±pe.
(13) White American	74.03±1.530	8.18±1.082	11.05±1.472
(11) South Chinese	90.69±1.076	5.29± .760	5.83± .720

The degree of difference between these two groups is obviously great. Since we can, however, calculate this quantity, it is better to rely on the mean type difference method, and then draw our conclusions from that.

The mean type difference between these two groups is 457.02.

When this is computed we see at a glance that a figure of the magnitude of 457.02 is far in excess of any that we have yet found for mean type differences. It is larger than any intertribal difference we have found and also larger than any difference between the Indian types. (cf. Table V).

It appears from this that although the four types of Indian tribes do differ materially from one another, they do not differ to as great an extent as the Mongoloid and White (European) groups. If these types of Indian tribes were really from wholly different groups we might expect to have found a degree of difference amounting to 457.02 or thereabouts. This has not been the case. We must, therefore, consider that these Indian types are more intimately related to each other.

The other possibility is that they may be related to one another as races under the same group. This might be said

to follow logically, when it has been demonstrated that the degree of difference is not as large as between groups. An estimate of what figure constitutes a racial difference can be calculated and will be of interest in this connection.

The two test races used are the series of South Chinese, that were used in the preceding case and a series of fourteen Japanese from Kyoto. These two peoples are considered races within the same, Mongoloid, group.

Their respective form and texture are calculated as:

FORM (Index)

	M.±pe.	S.D.±pe.	V.±pe.
(11) South Chinese	78.86±1.132	5.56±.800	7.06±1.011
(14) Japanese	81.43± .698	3.87±.493	4.75± .510

TEXTURE

	M.±pe.	S.D.±pe.	V.±pe.
(11) South Chinese	90.69±1.076	5.29±.760	5.83± .720
(14) Japanese	87.85±1.168	6.48±.826	7.36± .896

The mean type difference between these two races is calculated as, 102.77.

This figure of 102.77 is approximately the size of the degree of difference value arrived at for the differences between the types of Indian tribes. (cf. Table V). If anything it would appear that the Japanese differ less from the South Chinese than the four Indian types differ from one another. It seems to be clear, however, that the difference between these Indian types is of the nature of racial differences under the same group and not as group differences.

CONCLUSIONS ON FORM AND TEXTURE

There have been two principal theories prevalent regarding the American Indian in which the consideration of their head hair has played an important part. One theory held that all American Indians were intimately related and this theory was supported to a great extent by the assumption that the head hair was very similar among all tribes. The other and less popular theory held that the various tribes of Indians sprang from wholly different groups and in support of this it was stated that there were definite intertribal

differences in their head hair. The hair, although not the only item that has been used to support these two theories, has never-the-less played a conspicuous part. As a matter of fact, there has been very little published data on American Indian head hair that could be used to support either of these rival claims.

We have accordingly studied several series of Indian hair samples for the purpose of finding out which of these theories had the better claim. In other words is all Indian hair uniform or are there differences? If there are differences in what do they consist, how great are they and what do they imply anthropologically?

The result of this investigation has been to show that there are definite differences between certain of the Indian tribes in both the form and the texture of their head hair. Of the twelve tribes examined it was possible to divide them into four categories in this respect; wavy-fine, wavy-coarse, straight-fine and straight-coarse. The differences between these four categories or types were definite and have been proved. The magnitude of this difference was calculated and found to be of the degree one would expect to find among four races of the same group. It was not sufficiently great to indicate a group difference. The Indian types as far as we have examined them are closely related but are not identical. They appear to be related to one another as separate races within the same group and not as of separate groups.

SECTION II

Other Aspects of the Hair Analysis

OBSERVATIONS ON THE HAIR COLOR

The prevailing opinion seems to be that all American Indian hair is black in color. (17; 18; 19; 20; 21). There are, however, some dissenting opinions to this and the statement is often met with that brown and even reddish-brown hair has been observed among full-blooded Indians. (8; 36) This has been answered, usually, in two ways. One answer that has been offered is that the presence of anything but black hair is proof, *ipso facto,* that the individual in question is not a full-blooded Indian. This would, it seems, rather beg the question. The other answer generally brought forward is that the action of direct sunlight tends to bleach naturally black hair to a rusty brown. (18) Experiments in the matter of bleaching were carried on here, and although dark brown hair could readily be bleached in this way to a lighter brown, naturally black hair could not be made to bleach to a brown color. This may, never-the-less, be possible, with more adequate laboratory facilities than were at our disposal. We can only add this item for what it may prove to be worth on further investigation.

Perhaps the greatest factor producing this disagreement of opinion is the lack of any method of measuring hair color that renders negligible the personal equation of the observer. It is understood that research into this technical phase is now being undertaken, but as yet the results have not been published. Another factor that may play a role in this uncertainty is the question of whether the hair was observed by reflected or transmitted light. This is a matter of considerable importance. In the anatomy of a hair, the outer sheath of the hair shaft is composed of a semi-transparent keratin-like substance. When this is coated with oil, either natural or artificial, which is usually the case among Indian specimens, a reflecting surface is established and the hair appears darker than it really is. When, on the other hand, a beam of light is transmitted through the hair, this element of reflection is substantially modified and the true pigment

color may be observed. Although it may seem a trite precaution to suggest, washing is essential toward obtaining a true picture of hair color in either event.

In investigating the hair color of the specimens at our disposal, a few interesting items may be commented upon. For one thing, the specimens from the present living Indian tribes were sent us in individual envelopes. Frequently the entire envelope would be so saturated with oil from the specimen contained in it as to be completely opaque. In washing these specimens preparatory to making observations on their color, it was often noticeable that locks of hair which were at first apparently quite black, appeared, after washing, to be perceptibly browner. In these cases a considerable residue in the bottom of the watch glass provided a logical explanation. The hair from the prehistoric specimens was found to be much browner in color than was the case with specimens from the present living tribes. It was noticeable, also, that they were not oily. Doubtless, any oil that might once have covered them had long since disappeared. The prehistoric hairs may have faded through time and conditions of burial, but of this point there exists no data that we are aware of.

In Table VI the record of the observed hair color has been tabulated, and the percentages and the number of both

TABLE VI

PERCENTAGE FREQUENCIES OF BLACK AND BROWN HAIR

Tribe	Black	Brown
Arapahoe	88.8% (8)	11.1% (1)
Sioux	85.0% (17)	15.0% (3)
Hopi	68.4% (13)	31.5% (6)
Shoshoni	66.6% (10)	33.2% (5)
Ute	50.0% (3)	50.0% (3)
Gros Ventre	50.0% (5)	50.0% (5)
Chippewa	50.0% (6)	50.0% (6)
Paiute	40.0% (4)	60.0% (6)
*Basket Maker	12.5% (2)	87.5% (14)
Navajo	4.5% (1)	95.5% (19)
Comanche	0.0% (0)	100.0% (7)
*Mesa Verde	0.0% (0)	100.0% (11)

*These are prehistoric specimens and their color may have faded through time and condition of burial.

black and brown specimens set down. These observations were made on specimens that had previously been washed in dilute alcohol and were then examined by transmitted light.

It is interesting to note the considerable variety in percentages here recorded, and that even in the series having the blackest hair, there are to be found some brown specimens.

OBSERVATIONS ON THE PIGMENT DISTRIBUTION

The hair, when seen in cross-section, shows clearly how the granules of pigment are distributed throughout the body of the hair shaft. In the samples examined two types of pigment distribution were visible. One type showed the pigment granules distributed uniformly throughout the body of the cross-section, giving the appearance of a dense compact mass. The other type showed the pigment granules distributed more compactly at the periphery of the cross-section, while the center contained only a few scattered grains. The first type has been called dense; and the second diffused types of pigment distribution.

From the researches of Minakow (28), it seems clear that time and the conditions of burial do not affect the pigment distribution and this seems all the more probable when we

TABLE VII

PERCENTAGE FREQUENCIES OF PIGMENT DISTRIBUTION

Tribe	Dense	Diffused
Hopi	100.0% (19)	0.0% (0)
Comanche	100.0% (7)	0.0% (0)
Gros Ventre	100.0% (10)	0.0% (0)
Paiute	100.0% (10)	0.0% (0)
Shoshoni	93.2% (14)	6.6% (1)
Chippewa	91.6% (11)	8.3% (1)
Sioux	90.0% (18)	10.0% (2)
Arapahoe	77.7% (7)	22.2% (2)
Ute	66.6% (4)	33.3% (2)
Navajo	45.5% (9)	54.5% (11)
Basket Maker	37.5% (6)	62.5% (10)
Mesa Verde	18.1% (2)	81.8% (9)

consider the chemical inertness of melanine, which forms one of the chief constituents of pigment. (9)

In the material as a whole, a considerable range in percentages of the two types was visible; although there is a tendency to favor the densely pigmented variety. In Table VII the percentages and the number of individuals of the various tribes showing the dense and the diffused types are recorded.

Observations on color and relative density, although controlled as carefully as may be, can not presume to an important role in an investigation of this character, due to the fact that so much depends upon the eyesight, color sense and personal equation in general of the observer. These observations are, however, included and are given out for what they may be worth. It is most ardently hoped that in the near future, a technique may be forthcoming which will measure these qualities with impersonal accuracy.

NOTE ON THE POSSIBLE GROUP AFFINITY OF THE AMERICAN INDIAN AS SHOWN BY THE HEAD HAIR

So much has been said and written concerning the Mongoloid affinity of the American Indian that we have been tempted to go into the matter ourselves, at least to the extent that the study of the head hair alone will permit. Our material is admittedly insufficient to base any categorical statement upon, but we have data upon the hair of twelve Indian tribes and for comparative material we may use a series of white American specimens representing the White (European) group and series of South Chinese and Japanese, representing the Mongoloid group. There is a temptation to experiment with this material to see what light it may shed on the affinity of the American Indian as a whole with either the White (European) or the Mongoloid group.

The comparison of the twelve Indian tribes with the white American, South Chinese and the Japanese series has been effected by the mean type difference method. (cf. p. 20) The resulting numerical values have been tabulated in Table VIII. The larger the mean type difference is in any comparison the greater the difference between the two peoples

compared. Conversely, the smaller the mean type difference the smaller the difference.

Table VIII shows that the Indian tribes, generally speaking, are quite different from the White (European) group as represented by the white American material. They are *far less different,* also generally speaking, from the Mongoloids (represented by the South Chinese and the Japanese.) That is to say, the mean type difference values are smaller for the Indian tribes when compared with the Mongoloid group than they are when compared with the White (European). Put in another way, this would indicate that as far as the hair is concerned these American Indian tribes resemble the Mongoloid group of Asia more closely than they do the White (European).

When we compare the Indian tribes with the two Mongoloid races alone (South Chinese and Japanese) we see

TABLE VIII

COMPARISON OF INDIAN AND NON-INDIAN MATERIAL

	White American	South Chinese	Japanese
Navajo	273.59	142.64	154.65
Shoshoni	365.89	36.27	98.01
Hopi	373.14	31.18	92.88
Gros Ventre	295.15	289.06	172.41
Sioux	293.48	345.77	234.03
Comanche	354.98	350.35	245.95
Ute	311.56	95.39	63.06
Paiute	452.99	57.02	17.05
Basket Maker	346.82	176.39	88.36
Mesa Verde	352.95	75.32	52.46
Arapahoe	334.72	28.18	65.20
Chippewa	353.89	120.37	38.26

that certain tribes are more Mongoloid than others, as regards their hair. The Navajo, while resembling the Mongoloid more closely than the White (European), do not resemble either very closely. The Shoshoni and Hopi are far more similar to the Mongoloid. The group consisting of the Gros Ventre, Sioux and Comanche differ widely from both the Mongoloid and the White (European) but tend, if one can draw so fine a distinction, to show a greater similarity to the Mongoloid. The Ute, Paiute, Basket Maker, Mesa Verde, Arapahoe and Chippewa, are distinctly more Mongoloid* than White.

If a statement must be made as to the group affinity of the American Indian, it seems *more probable* that the American Indian is related more closely to the Mongoloid group than to the White (European). There is nothing unique in this concept, as many students have reached this conclusion by consideration of features other than hair.

THE MONGOLOID TYPE OF HEAD HAIR

Anthropological literature refers repeatedly to the Mongoloid type of head hair describing it as straight, coarse and black. In the course of this investigation of American Indian material we have had recourse to comparisons with two races which happened to be members of the Mongoloid group: the South Chinese (Kwangtung) and the Japanese (Kyoto). In using this material for comparative purposes we have calculated the form and texture of their hair. It is not at all the purpose of this investigation to cross over and work with Asiatic material, but since it has come to our attention perhaps a note on the characteristics of Mongoloid type hair as represented by these two races, might not be

*In connection with this it is interesting to recall the classification made on p. 19 of these twelve tribes into four types. This classification based on both the form and texture of the hair was:

Wavy-fine	Wavy-coarse	Straight-fine	Straight-coarse
NAVAJO	SHOSHONI	GROS VENTRE	UTE
	HOPI	SIOUX	PAIUTE
		COMANCHE	BASKET MAKER
			MESA VERDE
			ARAPAHOE
			CHIPPEWA

The behavior of these four types in relation to the comparative series shows that this classification may be more than fortuitous.

out of place. The digression may be considered as merely a by-product of the main substance of this article.

FORM

The Mongoloid type of hair is usually described as being especially distinguished by its straightness. Sometimes this feature is further described by reference to the extreme roundness of the hair cross-section. The following calculations of the form of South Chinese and Japanese hair already given on page 24 of the text and may be here abstracted for convenience.

	M.±pe.
South Chinese	78.86 ± 1.132
Japanese	81.43 ± .698

Bearing in mind that a perfectly round cross-section has an index of 100.00 we see that neither of these samples are perfectly round, but tend toward a perceptibly oval form. This would indicate a slight degree of waviness.

TEXTURE

The Mongoloid type of hair is often described as coarse in texture. The calculations of the texture as calculated on the South Chinese and Japanese are:

	M.±pe.
South Chinese	90.69 ± 1.076
Japanese	87.85 ± 1.168

The highest mean texture that we have found quoted (cf. p. 15) is 110.00. These two Mongoloid peoples do not have hair as coarse as that but we can readily see that their hair does merit the adjective coarse.

COLOR

Mongoloid hair by definition should be black. We have examined this feature on the South Chinese and Japanese by the method previously described. The results obtained are,

	Black	Brown
(11) South Chinese	72.7% (8)	27.2% (3)
(14) Japanese	28.5% (4)	71.4% (10)

It is interesting here to note that a certain amount of brown haired specimens are found among these Mongoloid peoples, especially the Japanese. The brown is a very deep nuance resembling what is commonly described as chestnut.

This digression on the subject of the Mongoloid type of head hair as represented by our series of South Chinese and Japanese has the following conclusions:

1) Mongoloid head hair may be moderately wavy in form, that is, it is not always perfectly straight.

2) It is coarse in texture.

3) The color is dark and may be either black or a deep nuance of brown.

4) The differences noted above between these two races of Mongoloid peoples in the form, texture and color of their head hair shows that if a Mongoloid type must be described as such, the definition must be broad enough to cover a considerable range. In other words, the definition must be sufficiently flexible to include the ranges in form, texture and color of hair found among the various Mongoloid races. In the nature of things Mongoloid type of hair can not be very specific.

A COMPARISON OF THE CLASSIFICATION BY THE HAIR WITH THE CLASSIFICATION BY LINGUISTIC STOCKS

It is not without interest to see how these two classifications of the Indian tribes compare, one classification being based on the form and texture of the head hair and the other on linguistics.

The Navajo who are in a separate category by themselves as being of the wavy-fine hair type, are the sole representatives of the Athapascan linguistic stock in this material.

The Shoshoni and the Hopi, who are both in the wavy-coarse category, are both members of the Shoshonean stock.

In the straight-fine type there are the Gros Ventre, Sioux and the Comanche. The Gros Ventre and the Sioux both belong to the same linguistic family, the Siouan, but the Comanche belong to the Shoshonean. At this point the two classifications fail to coincide.

In the straight-coarse category are the Arapahoe and the Chippewa, who are both Algonkin. Also in the same category are the Ute and the Paiute who are both of the Shoshonean stock. There are naturally no data on the linguistic stock of the two prehistoric tribes and so they will have to be left out of this consideration.

As far as this material allows us to go we see that the classification by hair and the classification by linguistics coincide except in the case of the Shoshonean linguistic stock.

Two members of the Shoshonean stock, the Shoshoni and the Hopi are found together under the heading of wavy-coarse haired. One member, the Comanche, is found to be in with the Siouan stock under the heading of straight-fine. Two more members, Ute and Paiute, are found to be with the Algonkin under the heading of straight-coarse.

It is conceivable that the members of the Shoshonean linguistic stock may not be as genetically closely related as their language might imply.

SECTION III

General Conclusions

From the microscopical study of the head hair of the twelve tribes of North American Indians we have drawn the following conclusions:

1.) There are distinct and definite intertribal differences in both the form and texture of the head hair.

2.) The differences in form and texture permitted a classification of these twelve tribes into four distinct types; wavy-fine, wavy-coarse, straight-fine and straight-coarse.

3.) These four types of Indian tribes show that as far as the head hair is concerned we are dealing with four races of Indians. The differences between these types are of the magnitude of racial and not group differences. *(In this paper we have used "groups" as the largest divisions of mankind; Mongoloid, Negroid, White (European) and Composite, and "races" as subdivisions of these.)*

4.) Observations on the hair color show that not all North American Indian head hair is black. On the contrary, there is a decided element of dark brown as shown in these twelve tribes.

5.) Two types of pigment distribution have been observed among these twelve Indian tribes; dense and diffused.

6.) When these North American Indian hair specimens were compared with Mongoloid and White (European) hair specimens, it appears that the Indian exhibits a stronger affinity toward the Mongoloid group.

7.) The Mongoloid type of head hair is shown by a study of South Chinese and Japanese specimens to be non-uniform. The hair of these two Mongoloid races is not identical. The definition of the Mongoloid type of head hair must, therefore, be made sufficiently flexible to include some degree of waviness, a small range in texture and a color ranging from black to dark brown.

8.) A comparison of the classification by hair with the classification of these same twelve tribes by their linguistic stocks shows a complete agreement, except in the case of the Shoshonean stock. Among the tribes of Shoshonean linguistic stock were found tribes having three distinct types of head hair; wavy-coarse, straight-fine and straight-coarse.

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