ANTHROPOLOGICAL OBSERVATIONS ON THE ANGLO-INDIANS OF CALCUTTA.

PART II. ANALYSIS OF ANGLO-INDIAN HEAD LENGTH.

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FOREWORD.

The first part of the present study was published in 1922 [1]. Dr. N. Annandale who had placed the material at my disposal explained its special character in an Introductory Note. The subjects were with very few exceptions men between the ages of 18 and 40, and with a few exceptions belonged to the middle-class of the so-called Anglo-Indians, mostly employed as clerks, mechanical engineers, overseers and so forth, or else fresh from school and about to take up employment of the kind. Dr. Annandale had attempted to eliminate "from the measurements analysed those of persons known to have recent Negro or Mongoloid blood, persons one of whose parents or grand-parents was a Negro or belonged to Mongoloid stock." Dr. Annandale was confident that he had been fairly successful in excluding recent Negro blood, but felt doubtful regarding Mongoloid influences, and was of opinion that probably some Mongoloid admixture was present in many individuals.

"The measurements were taken in the Zoological laboratory of the Indian Museum in the years 1916-1919. They were made..........on one system and with the same instruments. The system was that recommended in the British Association hand-book on anthropology and the instruments were the "Anthropometer" (112) and Instrumententascher (203) supplied by Harman of Zurich."

I must offer an explanation and an apology for the great delay in publishing the second part. The material for this part had been reduced in 1923, but certain unforeseen difficulties prevented its publication.

Dr. Annandale had stated that the chief aim of the investigations was "to throw some light on the question of the origin of human races by fusion." I had planned to study this problem from the statistical point of view in two ways.

(A) To test the homogeneity (or the heterogeneity) of the Anglo-Indian data.

(B) To compare quantitatively the Anglo-Indian measurements with those for Indian castes and tribes as well as for races of European origin.

My original intention was to adopt the following routine procedure for testing the homogeneity of the measurements for each character separately :—

(i) The type of the frequency distribution ;

[1] *Records of the Indian Museum*, Vol. XXIII, April, 1922.

(ii) Whether a statistical dissection into real components was practicable or not ;

(iii) An empirical comparison of the standard deviation (and the coefficient of variation) with the corresponding values for other races.

As work proceeded it became clear that with a sample of size 200 there was practically no chance of the first two tests being applied with success. In other words, in a sample of 200, the observed frequency distribution could almost invariably be graduated by a normal curve within the limits of errors of sampling. Consequently no significance could be attached to elaborate statistical dissections. I must confess that owing to my inexperience I had adopted a more ambitious programme in this direction than was justified by the size of the sample. After analysing a few characters I, however, definitely abandoned attempts at statistical dissection. Results for the few characters already analysed are being published, not because I attach much anthropological significance to them, but as numerical examples of a method of investigation which might prove more fruitful with larger samples.

The only test of homogeneity left was a comparison of the magnitude of the standard deviation and the coefficient of variation with the corresponding values for other races. I had used Risley's data for Indian castes and tribes for this purpose in my work on stature. I encountered a new difficulty as soon as I came to the indices ; I shall discuss this point in detail a little later.

In 1923-24 I approached the question of a systematic comparison of the Anglo-Indian measurements with those of other races. A little before this Prof. Karl Pearson had formulated his well-known Coefficient of Racial Likeness for judging the degree of resemblance between two races. I decided to select a suitable group of Indian castes and tribes from Risley's book and calculate the Pearsonian Coefficient of Racial Likeness (C^2) for each pair of races included in my list. A study of these coefficients would show the inter-connexion between the selected castes. I could then easily calculate the coefficients for the Anglo-Indian measurements, and thus study the relation of the Anglo-Indians to the Indian castes and tribes. I explained my plans to Dr. Annandale at Bangalore in 1924. He immediately became greatly interested in the question, and suggested that I should choose this problem for discussion in my presidential address to the Anthropological Section of the Science Congress in 1925.

As soon as I started work on this problem several difficulties however cropped up. I had a brief opportunity of discussing some of them with Dr. Annandale before his sudden death in April 1924. It was only after his passing away that I fully realised how great a stimulus had been his never-failing interest in my anthropological work, and how handicapped I was without his guidance and advice.

I shall now briefly consider the nature of the difficulties alluded to above :—

(*a*) *The Need for a Suitable Statistical Formula.*—I selected about 30 castes and tribes from Risley's data and proceeded to calculate the values of the Pearsonian Coefficient of Racial Likeness of 7 Bengal castes and the Anglo-Indian sample with respect to these 30 selected castes and tribes. The results have been fully discussed in a paper on "Analysis of Race-mixture in Bengal" which was given as the presidential address to the Anthropology Section of the Indian Science Congrees in 1925, and was published in the Journal of the Asiatic Society of Bengal (Vol. XXIII, pp. 301-333). A careful study of the values of C^2 obtained by me made me feel extremely doubtful regarding the use of the Pearsonian C^2 in such cases. Although C^2 is an adequate *test* of the existence of divergence between different samples, I could not accept it as a satisfactory *measure* of the amount of such divergence. Values of C^2 were too profoundly affected by the size factor $(\frac{n.n^1}{n+n^1})$ to make it a reliable tool for comparison. I decided to drop the size factor altogether, tentatively developed a new coefficient D§ and used it for my analysis in this paper. In 1926-27 I obtained an expression for the probable error of this new coefficient D‡. In 1928 I used the new formula for an analysis of certain Chinese data [1]. In certain papers communicated to the Indian Science Congress, 1929, I further developed the statistical theory of several coefficients of divergence[2], and finally in a second paper communicated to the Indian Science Congress, 1930, I made a detailed empirical study of the new coefficients on an exceptionally large series of anthropological measurements from Sweden[3]. The results reached in the above papers show, I think, that a particular coefficient which I have called D^2, is a suitable measure of divergence. It has all the advantages of the Pearsonian C^2 but does not suffer from any of its drawbacks. In 1927 I had discussed the question of the size-factor with Prof. Pearson in London; at that time he was unable to accept my views. I am glad to note, however, that he has recently revised his views [4] and has decided to make allowances for the size-factor in C^2. The values of his new standardised coefficients (C^2 reduced to a standard population [4]) would give practically the same results as my coefficient of divergence (D^2). But the coefficient of divergence (D^2) possesses one great advantage; the theoretical distribution of D^2 has been determined so that in actual practice the probable error of D^2 can be calculated and used for comparison. It should therefore prove distinctly more useful than the standardized coefficient of Pearson.

(*b*) *Want of Standardisation in the Measurements on the Living.*—A second difficulty was the want of standardisation in the measurements on the living. I obtained incredible results with several series of data of non-Indian origin. I utilised a short period of leave in London in 1927 to study this question carefully. I came to the astounding conclusion that more than 70% or 80% of the data collected by leading anthropologists were probably useless for comparative purposes for want of

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§ *J. A. S. B.*, Vol. XXIII, 1927, Appendix III, pp. 328-329.

‡ *Journ. As. Soc. Bengal*, Vol. XXIII, 1927, No. 3. Issued 18th September 1928. Appendix III, pp. 329-330.

[1] *Man in India*, Vol. VIII, Nos. 2 and 3, April and September, 1928, p. 113, etc.

[2] This paper on "Tests and Measures of Group Divergence" is in the press and will be shortly published.

[3] The anthropological results are being published in the *Biometrika*, Vol. XXII, 1930.

[4] *Biometrika*, Vol. XXB, 1928, pp. 376-378. (Karl Pearson, "Note on Standardization of Method of using the Coefficient of Racial Likeness".)

adequate standardisation in the technique (*Biometrika*, Vol. XXA, 1928, July, Parts I and II). I have decided therefore to abandon for the present the programme of extensive comparison of mean values.[1]

(*c*) *Difficulties in using Risley's data.*—As soon as I started working on the indices given in Risley's book I became aware that Risley's figures were full of discrepancies. Karl Pearson had noticed this in 1903 [2] and had come to the conclusion that such discrepancies rendered Risley's data practically useless. A careful scrutiny showed, however, that the discrepancies were in many cases of such a nature that they could be easily reconciled.

There were obvious printing mistakes such as Mahomedan Vertico-Cephalic Index No. 15 (Vol. I, p. 118) printed 47·9, actual 49·7 ; Malpahari Vertico-Cephalic Index No. 70 (Vol. I, p. 135) printed 75·0 for actual 70·5, etc. Almost equally obvious were mistakes due to wrong entries, *i.e.*, using an adjoining figure for the correct one in calculating the index, or taking an adjoining (wrong) value from the index-table. These also could be corrected with certainty. In many cases the same individual measurement enters in two or more indices ; in such cases mistakes could be eliminated by double or triple checking.

I felt convinced that if the clerical and printing mistakes could be eliminated from Risley's data, they would furnish splendid material for comparative purposes, for the whole series of measurements had been taken by only 3 observers and on one definite system. In 1924 I did not have sufficient leisure to undertake the heavy work of recalculation and checking of over 47,000 individual indices given by Risley. But during the last 2 years the work of recalculation and checking of. about 59,000 individual measurements and 47,000 indices given by Risley (together with 792 and 636 mean values) has been steadily pursued and is now nearly complete. I believe that with this revision of Risley's data the greater bulk of them may be used with safety for purposes of comparison.

It will be seen that all these years I have steadily kept before me the programme of a critical analysis of Dr. Annandale's measurements on the Anglo-Indians. There were grave difficulties in the way. All the work I have done in anthropology during the last few years was directed towards removing these difficulties. Some of the difficulties have been surmounted, and the work of analysis can now proceed more smoothly than before. This is my excuse for the long delay.

It will be realised that certain changes in the programme have become inevitable. I propose to publish as quickly as possible the descriptive statistics of Dr. Annandale's measurements. At the same time I shall continue to reduce the reivsed version of Risley's data, and as soon as the work of reduction is completed I hope to be able to start the actual work of comparison and analysis, following generally the method described in the preliminary paper on " Race-mixture in Bengal."§

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[1] I may note, however, that I have devised a photographic apparatus with which I believe it will be possible to take photographs of *profiles* of living persons quickly and under standardised conditions.

[2] *Biometrika*, II (1902-03), p. 348.

§ *J. A. S. B.*, Vol. XXIII, 1927, Appendix III, pp. 328-329.

Table of Individual Measurements.

Table 1 (*see* pp. 139—143) gives the individual measurements. The card number given in column 2 refers to the serial number in the original records of Dr. Annandale.

Section I.—Frequency Type.

The frequency constants [1] for Head Length were calculated with a grouping unit of 1 mm. and are given in Table 2.

Table 2.—Frequency Constants: Anglo-Indian Head Length.

N = Total number of individuals = 200. Grouping Unit = 1 mm.

Mean (M)	=	182·45 50 ± 0·41 15 mm.
Standard Deviation (σ)	=	8·62 93 ± 0·29 10 mm.
Coefficient of Variation (V)	=	4·72 95 ± 0·15 97

β_1 =	0·01 04 44	±	0·00 82 95.
β_2 =	3·71 82 06	±	0·72 90 84.
μ_2 =	74·46 42	±	5·85 49.
μ_3 =	— 65·66 72	±	115·10 97
μ_4 =	20617·38 83	±	6168·40 85.

It will be seen that neither β_1 nor β_2 differs significantly from the Gaussian values of 0 and 3 respectively. We anticipate therefore that a normal curve should give a good fit. I give in Table 3 a comparison of the observed and expected values of the frequency distribution as graduated by a normal curve.

I adopted a grouping unit of 3 mm. I also distributed the border-line frequencies in observed values, that is, divided them equally between adjoining cells. The actual comparison [2] is shown in Table 3.

Table 3.—Goodness of fit: Normal Curve.

Range.	Expected Values (m)	Observed Values (m^1)	$(m-m^1)^2$	$\frac{(m-m^1)^2}{m}$
Beyond 160	0·96	1·50	0·29 16	0·30 37
160—163	1·52	3·50	3·92 04	2·57 92
—166	3·57	3·50	0·01 69	0·00 50
—169	6·48	1·50	24·80 04	3·82 72
—172	11·05	14·00	8·70 25	0·78 75
—175	16·13	15·00	1·27 69	0·07 91
—178	22·17	13·00	84·08 89	3·79 29
—181	26·37	30·00	13·17 69	0·49 96
—184	27·00	32·50	30·25 00	1·12 04
—187	25·32	30·00	21·90 24	0·86 50
—190	21·72	21·00	0·51 84	0·02 39
—193	16·01	19·50	12·18 01	0·76 01
—196	10·46	5·00	29·81 16	2·85 01
—199	5·92	4·50	2·01 64	0·34 06
—202	3·16	2·00	1·34 56	0·42 58
—205	1·44	2·00	0·31 36	0·21 78
Beyond 205	0·92	1·50	0·33 64	0·36 56
				χ^2=18·84 55

[1] For explanation of symbols *see* Mahalanobis, 1922, pp. 15-19.
[2] *See* Mahalanobis, 1922, pp. 35-44.

Summing up column 5, I get $\chi^2 = 18{\cdot}85$ approximately. The number of cells is 17, therefore n^1 (the number of degrees of freedom) is 16. I find from Biometric Tables XII (p. 27) that corresponding to $n^1 = 16$, $\chi^2 = 18{\cdot}85$, $P = 0{\cdot}24$ approximately. That is, the fit would be as bad or worse about once in four trials. The normal curve may therefore be considered to give a satisfactory fit.

Although the normal curve gives a good fit, the observed values of β_1 and β_2 show a tendency towards a distribution of Pearsonian Type IV.. I give below the calculated constants for a Type IV curve.[1]

Table 4.—Constants for a Type IV curve.

If X = deviation from the origin, and

Y = corresponding frequency, then

$$Y = Yo\left(1 + \frac{x^2}{a^2}\right)^{-m} e^{-\nu \tan^{-1}\left(\frac{x}{a}\right)} \qquad (1)$$

where the constants are defined by the following formulæ:—

$$r = \frac{6\,(\beta_2-\beta_1-1)}{2\,\beta_2-3\,\beta_1-6} = 11{\cdot}65\ 52\ 43$$

$$m = \tfrac{1}{2}\,(r + 2) = 6{\cdot}82\ 76\ 21$$

$$\nu = \frac{r\,(r-2)\sqrt{\beta_1}}{\sqrt{\{16\,(r-1)-\beta_1\,(r-2)^2\}}} = +\ 0{\cdot}72\ 33$$

$$a = \frac{\sigma}{4}\sqrt{\{16\,(r-1)-\beta_1\,(r-2)^2\}} = 28{\cdot}14\ 53\ 70$$

The origin is at a distance $(\nu a/r)$ from the Mean, *i.e.*, in this case at 184·1317 mm, and

$$Yo = \frac{N}{a.\,F\,(r, \nu)} = 9{\cdot}6817,$$

where F (r, ν) is found from Biometric Table LIV, pp. 126-142.

It is convenient to use the following form for drawing the curve :—

$$x = a \tan \theta \qquad (2{\cdot}1)$$

$$Y = Yo.\,(\text{Cos}\,\theta)^{r+2}\,.\,e^{-\nu\theta} \qquad (2{\cdot}2)$$

[1] Elderton, pp. 64-73.

Table 5.—Calculations for Type IV curve.

	28·14537 ×(tan θ)	0·3141287 ×·0872620		13·655243 × L Cos. θ	log Yo=0·9859508	log Yo=0·9859508	log Y (+)	log Y (—)
θ	= a tan θ	= v $\log_{10}$ e × θ	Col. (3)— (1)	(r+2) log Cos. θ	Col. (4)+Col. (5).	Col. (5)—Col. (4).	log Yo+ Col. (6).	log Yo+ Col. (7).
1	2	3	4	5	6	7	8	9
5°	2·4624	·0274129	$\bar{1}$·9725871	$\bar{1}$·9773897	$\bar{1}$·9499768	$\bar{1}$·0048026	0·9359276	0·9907534
10°	4·9628	·0548258	$\bar{1}$·9451742	$\bar{1}$·9092131	$\bar{1}$·8543873	$\bar{1}$·9640389	0·8403381	0·9499897
15°	7·5415	·0822387	$\bar{1}$·9177613	$\bar{1}$·7944040	$\bar{1}$·7121653	$\bar{1}$·8766427	0·6981161	0·8625935
20°	10·2441	·1096516	$\bar{1}$·8903484	$\bar{1}$·6311146	$\bar{1}$·5214630	$\bar{1}$·7407662	0·5074138	0·7267170
25°	13·1244	·1370645	$\bar{1}$·8629355	$\bar{1}$·4165894	$\bar{1}$·2795249	$\bar{1}$·5536539	0·2654757	0·5396047
30°	16·2497	·1644775	$\bar{1}$·8355225	$\bar{1}$·1471019	$\bar{2}$·9826244	$\bar{1}$·3115794	$\bar{1}$·9685752	0·2975302
35°	19·7076	·1918904	$\bar{1}$·8081096	$\bar{2}$·8169715	2·6250811	$\bar{2}$·0088619	$\bar{1}$·6110319	$\bar{1}$·9948127
40°	23·6167	·2193033	$\bar{1}$·7806967	$\bar{2}$·4194606	2·2001573	$\bar{2}$·6387639	$\bar{1}$·1861081	$\bar{1}$·6247147
45°	28·1454	·2467162	$\bar{1}$·7532838	$\bar{3}$·9446816	3·6979654	$\bar{3}$·1913978	$\bar{2}$·6839162	$\bar{1}$·1773486
50°	33·5423	·2741291	$\bar{1}$·7258709	$\bar{3}$·3791156	3·1049865	$\bar{3}$·6532447	$\bar{2}$·0909373	$\bar{2}$·6391955

Table 6.—Ordinates for Type IV curve.

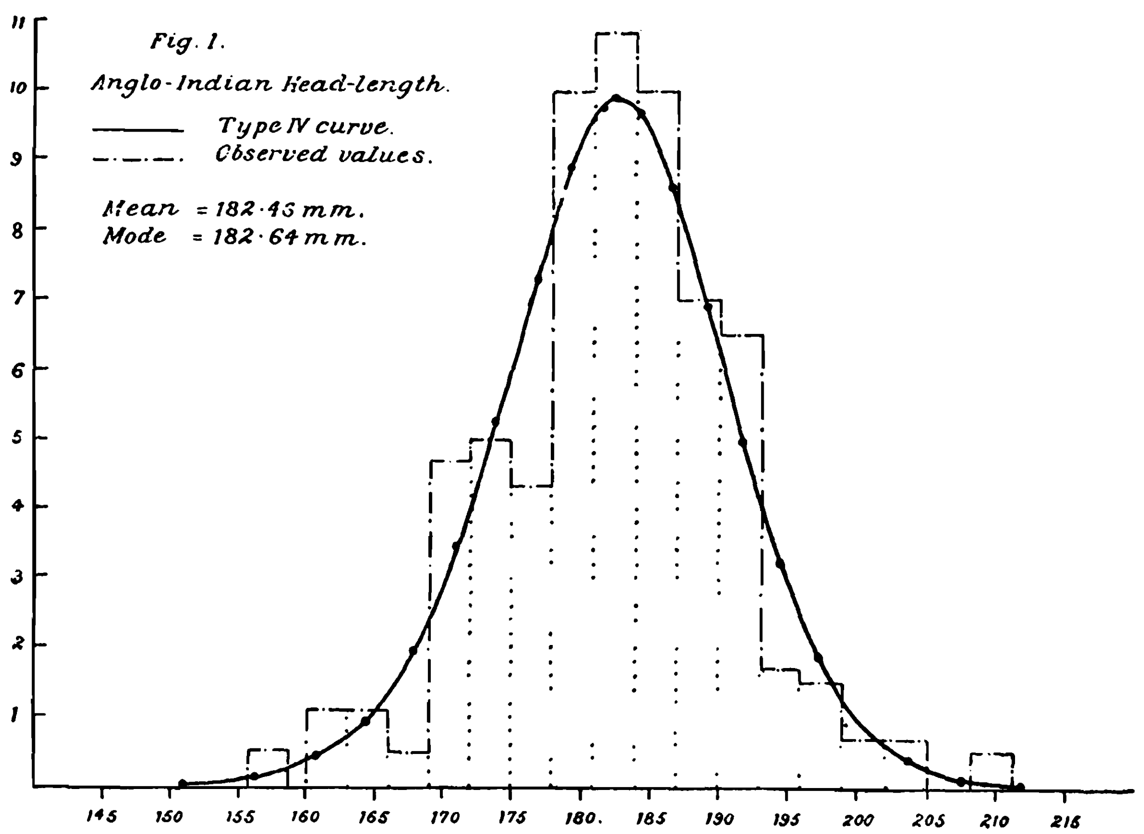
(Anglo-Indian Head Length.)

	θ°	X (in mm.)	Y		θ°	X (in mm.)	Y
—	50°	150·5894	0·0436	+	5°	186·5941	8·6283
—	45°	155·9863	0·1404		10°	189·0945	6·9237
—	40°	160·5150	0·4214		15°	191·6732	4·9902
—	35°	164·4241	0·9881		20°	194·3758	3·2167
—	30°	167·8810	1·9839		25°	197·3561	1·8428
—	25°	170·9073	3·4642		30°	200·3814	0·9302
—	20°	173·8876	5·3299		35°	203·8393	0·4084
—	15°	176·5902	7·2877		40°	207·7484	0·1535
—	10°	179·1689	8·9123		45°	212·2771	0·0483
—	5°	181·8693	9·7893	+	50°	217·6740	0·0123
	0	184·1317	9·6817	Mode	..	182·6408	9·8682

As Type IV is the most difficult curve of the Pearsonian family, I am giving below full details of the calculation in Table 5. I have used intervals of $\theta = 5°$

Column 1 gives values of θ in intervals of 5° which was sufficiently close for our purposes. Column 2 gives $x = a \tan \theta$, and is formed by putting $a = 28{\cdot}14537$ on the calculating machine and multiplying directly by successive values of (tan θ) obtained from Chamber's (or some other mathematical) tables. Column 3 gives $\nu. \log_{10}(e)$ multiplied by θ (in radians). Since in this case $\nu = 0{\cdot}723308$, and $\log e = 0{\cdot}4342945$, we have $\nu. \log_{10}(e) = 0{\cdot}3141287$. Multiplying this by the value of $\theta = 5°$ (in radians), *i.e.*, by 0·0872620, we get ·0274129 : we obtain the other figures in column 3 by successive addition. Subtracting unity from column 3, we get column 4 in the usual logarithmic form. Column 5 gives $(r+2) \log \text{Cos}\ \theta$, and is obtained directly by putting $(r+2) = 13{\cdot}655243$ on the machine, and multiplying through by (L Cos θ) taken from Chamber's tables. Column 6 is obtained simply by adding together columns 4 and 5, and column 7 by subtracting column 4 from column 5. Adding log Yo = 0·9859508 to column 6 and column 7 we get finally the values of " log Y " in column 8 and column 9 for positive and negative values of " x " respectively.

It should be remembered that the origin of the curve is at 184·13 mm. Adding or subtracting the values of x given in Table 5, column 2, we get the values of Head Length in mms. shown in Table 6, column 2. Corresponding to each value of " x " we have the value of " log Y " in columns 8 and 9 of Table 5. Values of " Y " given by the antilogarithms are shown in column 3 of Table 6. For convenience of reference I have given successive values of θ in column 1 of Table 6. The mode (Y= 9·8682) occurs at 182·6408 mms. Fig. 1 shows the observed values and the graduation by the Type IV curve.[1]



I plotted the Pearsonian Type IV curve on a graph paper on a very large scale (50 cm. × 42 cm.). The graduated values were then measured graphically from the curve with the exception of the two end-groups (" beyond 160 mm." and " beyond 204 mm."); the values for these two end-groups were obtained by dividing the total remainder proportionately. The observed and graduated values, and the calculations for the goodness of fit are shown in Table 7

[1] The type IV ordinates are given in Table 6, and the curve is shown by a continuous line in Fig. 1. The observed values are shown in the form of rectangles drawn in a broken line. The ordinates for the observed values are given by $\frac{1}{3}$ of the figures given in column (3) of Table 7. (As we are using a grouping unit of 3 mm., the frequencies are divided by 3.)

Table 7.—Anglo-Indian Head Length : Type IV curve.

Range. 1	Expected. (m). 2	Observed. (m^1). 3	$(m-m^1)^2$ 4	$\frac{(m-m^1)^2}{m}$ 5
Beyond 160	3·00	1·5	2·25 00	0·75 00
—163	1·81	3·5	2·85 61	1·57 79
—166	3·34	3·5	·02 56	·00 77
—169	6·12	1·5	21·34 41	3·48 76
—172	10·29	14·0	13·76 41	1·33 76
—175	15·81	15·0	·65 61	·04 15
—178	22·69	13·0	93·89 61	4·13 81
—181	27·81	30·0	4·79 61	·17 25
—184	29·34	32·5	9·98 56	·34 03
—187	26·42	30·0	12·81 64	·48 51
—190	20·70	21·0	·09 00	·00 43
—193	14·15	19·5	28·62 25	2·02 28
—196	8·21	5·0	10·30 41	1·25 52
—199	4·73	4·5	·05 29	·01 12
—202	2·37	2·0	·13 69	·05 78
—205	1·16	2·0	·70 56	·60 83
Beyond 205	2·05	1·5	·30 25	·14 77
				χ^2=16·44 56

For 17 cells, $n^1 = 16$, we have $\chi^2 = 16{\cdot}4$, leading to $P = {\cdot}357$. The fit is now excellent, for once in three trials the fit would be worse.

We conclude therefore that although the normal curve gives a good fit (with 3 mm. grouping) a more satisfactory fit is given by a Type IV curve.

This result is in agreement with those found by other observers. Goring[1] noted for English criminal data that " a slightly skew curve of Type IV describes our statistics of Head Length rather better than does a normal curve, although the deviation from the normal type is very slight." Tocher[2] also found that the Head Length of the Scottish insane could be graduated better by a Type IV curve than by a normal curve.

[1] Goring, p. 154.
[2] Tocher, *Biom.*, V (1906-7), pp. 304-305.

Section II.—Attempts at Statistical Dissection.

I give below the results of mathematical dissections of the frequency-curve. Owing to the smallness of the size of the sample (200) I do not attach much importance to the numerical vaules ; I am quoting them, however, as illustrations of a method of analysis which might prove more fruitful with larger samples.

(*a*) *Use of "tail" functions*[1].—Fitting a "tail" function to the shorter end I find the following distributions :—

$$m_1 = 181{\cdot}45, \qquad \sigma_1 = 7{\cdot}55$$

From the longer end I get in the same way,

$$m_2 = 184{\cdot}96, \qquad \sigma_2 = 7{\cdot}84$$

It will be noticed that these distributions do not differ significantly from the total distribution given by

$$m_0 = 182{\cdot}46, \qquad \sigma_0 = 8{\cdot}63$$

(*b*) *Asymmetrical dissection.*—Using Pearson's nonic method [2] I merely get a trivial solution with

$$\left.\begin{array}{l} m_1 = 183{\cdot}1 \text{ mm} \\ n_1 = 202{\cdot}1 \end{array}\right\} \qquad \begin{array}{l} m_2 = 251 \text{ mm} \\ n_2 = -2{\cdot}1 \end{array}$$

This solution evidently attempts to eliminate the "giant" observation at 212.

(*c*) *Symmetrical dissection.*—More promising results are given with a symmetrical dissection[3]. Using the moment-coefficients actually calculated with a grouping unit of 1 mm, but reducing them to a grouping unit of 8 mm for arithmetic convenience, we have :—

$$\begin{array}{l} \mu_3 = 1{\cdot}17\ 18\ 40 \\ \beta_2 = 3{\cdot}70\ 49\ 53 \\ \beta_4 = 23{\cdot}33\ 85\ 99 \end{array}$$

Putting $X = w/\mu_2$, the equation for x is given by

$$(\beta_2 - 3).\ X^2 + \frac{5\,\beta_2 - \beta_4}{5}.\,X - \frac{5\,\beta_2{}^2 - 3\beta_4}{15} = 0$$

Substituting numerical values we obtain

$$0{\cdot}7011\ X^2 - 0{\cdot}9627\ X + 0{\cdot}0914 = 0$$

which leads to $X = +1{\cdot}2705$, and $+0{\cdot}1026$

This gives $\left.\begin{array}{l} \sigma_1 = 9{\cdot}76 \text{ mm} \\ n_1 = 153{\cdot}68 \end{array}\right\} \quad \begin{array}{l} \sigma_2 = 2{\cdot}77 \text{ mm} \\ n_2 = 46{\cdot}32 \end{array}$

The distribution for Head Length can therefore be broken up into two normal curves with the same Means but widely different Standard Deviations. It will be remembered that we had succeeded in breaking up the Stature distribution in a similar way[4], and had obtained two components of size 150·11, and 49·89, and Standard Deviations 74·12 mm and 44·89 mm. respectively. The agreement of the analysis in these

[1] Mahalanobis, 1922, pp. 47-49.
[2] Mahalanobis, 1922, pp. 49-55.
[3] Mahalanobis, 1922, pp. 55-57.
[4] Mahalanobis, 1922, p. 57.

two cases is indeed striking. For both Stature and Head Length about a fourth of the sample appears to represent a stringently selected population.

Section III.—Change of Head-Length with Age.

I have used Pearson's method of Non-linear Regression[1] for investigating the question of growth. The relevant formulæ and constants are given below :—

Let T_p be any age-group, T_o the mean age for the whole sample, σ_1 the standard deviation for age. Let Y_p be the expected mean Head Length for the p th age-group (*i.e.*, corresponding to T_p), Y_o the observed mean value of the whole sample, and σ_2 the S. D. for Head Length. Then we write :—

$$t_p = (T_p - T_o) / \sigma_1 \ , \quad y_p = (Y_p - Y_o) / \sigma_2 \quad \ldots\ldots \qquad (1)$$

We can now express y_p as a function of t_p in the following form :—

$$y_p = b_o + b_1 \cdot t_p + b_2 \cdot t_p^2 + b_3 \cdot t_p^3 \quad \ldots \qquad (2)$$

Where b_o, b_1, b_2, and b_3 are certain constants which can be calculated from a knowledge of the moment-coefficients.

If N is the total number of observations, we define the mixed moment-coefficient $p'_{qq'}$ by the following formula :—

$$N\,p'_{qq'} = S\,(T - T_o)^{q} \cdot (Y - Y_o)^{q'} \quad \ldots \qquad (3)$$

Where T and Y are the actual age and observed Head Length for any individual, and S denotes a summation for all N individuals.

Here also we can use provisional base numbers T′, Y′ for convenience of arithmetical calculations, and then transfer to the true mean values T_o and Y_o The required formulæ for such reduction are given below :—

Let p'_{11}, p'_{21}, p'_{31}, p'_{41}, etc., be moment-coefficients referred to arbitrary axes T′, Y′ Let the distances of T′, Y′ from T_o, Y_o be p_{10}' and p_{01}', respectively.

The moment-coefficients p_{11}, p_{21}, p_{31} and p_{41} referred to true means T_o, Y_o are :—

$$Np_{11} = Np'_{11} - Np'_{10} \cdot p'_{01}$$

$$Np_{21} = Np'_{21} - 2\,p'_{10} \cdot Np'_{11} + (p'_{10})^2 \cdot Np'_{01} - p'_{01} \cdot Np_{20}$$

$$Np_{31} = Np'_{31} - 3\,p'_{10} \cdot Np'_{21} + 3\,(p'_{10})^2 \cdot Np'_{11} - (p'_{10})^3 \cdot Np'_{01} - p'_{01} \cdot Np_{30}$$

$$Np_{41} = Np'_{41} - 4\,p'_{10} \cdot Np'_{31} + 6\,(p'_{10})^2 \cdot Np'_{21} + 4\,(p'_{10})^3 \cdot Np'_{11} + (p'_{10})^4 \cdot Np'_{01} - p'_{01} \cdot Np_{40}\ .$$

We also define the following quantities (remembering that $\sqrt{\beta_1}$ must be given the same sign as μ_3 or p_{30}) :—

$$\beta_1 = \frac{p_{30}^2}{p_{20}^3},\quad \beta_2 = \frac{p_{40}}{p_{20}^2},\quad \beta_3 = \frac{p_{30} \cdot p_{50}}{p_{20}^4},\quad \beta_4 = \frac{p_{60}}{p_{20}^3}$$

$$r = \frac{p_{11}}{\sigma_1 \cdot \sigma_2},\ \bar{\varepsilon} = \frac{p_{21}\,p_{20} - p_{11}\,p_{30}}{\sigma_1^4 \cdot \sigma_2},\ \bar{\xi} = \frac{p_{31}\,p_{20} - p_{11}\,p_{40}}{\sigma_1^5 \cdot \sigma_2},\ \bar{\theta} = \frac{p_{41}\,p_{20} - p_{11}\,p_{50}}{\sigma_1^6 \cdot \sigma_2}$$

$$\varphi_2 = \beta_2 - \beta_1 - 1,\ \varphi_3 = (\beta_3 - \beta_1\,\beta_2 - \beta_1) / \sqrt{\beta_1},\quad \varphi_4 = \beta_4 - \beta_2^2 - \beta_1$$

[1] K. Pearson : Skew Correlation and Non-linear Regression, 1905.

We then find [2]

$$b_2 = (\bar{\varepsilon}.\ \varphi_4 - \bar{\xi}.\ \varphi_3) \,/\, (\varphi_2.\ \varphi_4 - \varphi_3^2)$$
$$b_3 = (\bar{\xi}.\ \varphi_2 - \bar{\varepsilon}.\ \varphi_3) \,/\, (\varphi_2.\ \varphi_4 - \varphi_3^2)$$
$$b_0 = -(b_2 + b_3\sqrt{\beta_1})$$
$$b_1 = +(r - b_2\sqrt{\beta_1} - b_3.\ \beta^1)$$

As records for age were not available for 9 subjects, all the constants had to be calculated afresh. Numerical values are given below.

For the age distribution (N = 191) we have

Mean age = 24·27 23 years	σ_1 (S. D. of age) = 6·332
p_{20} = 40·09 34 48,	p_{50} = 12 84 60·94 88
p_{30} = 3 32·05 01 90,	p_{60} = 2 60 83 02·10 05
p_{40} = 74 93·97 31,	

Leading to—

β_1 = 1·71 07,	$\sqrt{\beta_1}$ = +1·308
β_2 = 4·66 19	
β_3 = 16·50 76	β_4 = 40·4706

For Head Length we have :—

Mean = 182·1675 mm, σ_2 = 8·598 mm.

The mixed moment=coefficients are

p_{11} = +5·21 62,	p_{31} = — 1·76 87
p_{21} = —3·36 53,	p_{41} = —6066·20 37
r = +0·09 58 11,	$\bar{\varepsilon}$ = — 0·13 50 81
$\bar{\xi}$ = —0·44 74 75,	$\bar{\theta}$ = — 1·64 81 10
φ_1 = +1·95 12,	φ_2 = + 5·21 54, φ_3 = +17·0266

We get finally

b_3 = —0·02 79 72,	b_2 = + ·00 55 90
b_1 = +0·21 89 02,	b_0 = + ·03 10 07

The Regression of Head Length on Age may therefore be written :—

$$Y_p = +\ {\cdot}031007 + 0{\cdot}218902\ t_p + {\cdot}005590\ t_p^2 - {\cdot}027972\ t_p^3.$$

Calculated and observed values for the different age-groups are shown in Table 8. Fig. 2 exhibits the same results graphically. It will be noticed that the agreement between graduated and observed values is

[1] Equations (lv) and (liii) of Pearson (1905) p. 25. I have used Pearson's formula (xlix), p. 24.

not very satisfactory. There is a small increase up to the age of 35 years, and then a more rapid decrease.

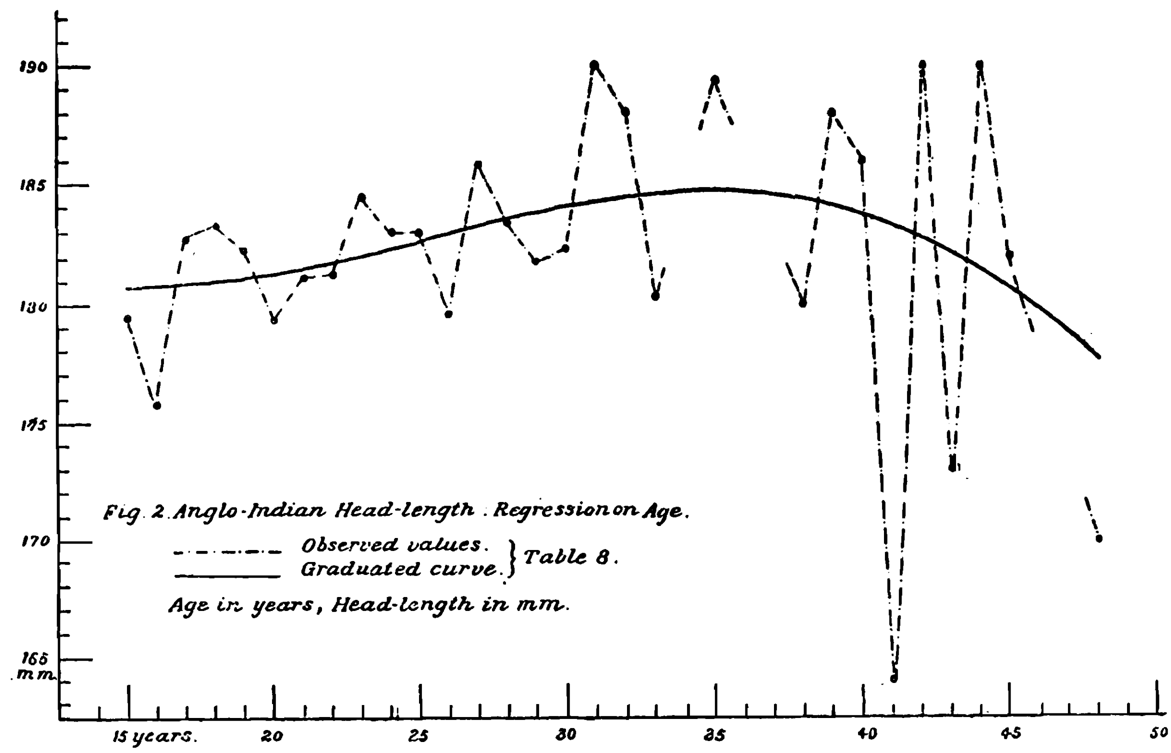


Table 8.—Regression of Head Length on Age.

Age.	n_p	Observed Values.	Graduated Values.	Age.	n_p	Observed Values.	Graduated Values.
15	1	179·50	180·54	32	6	188·00	184·37
16	4	175·75	180·60	33	3	180·33	184·49
17	8	182·63	180·70	34	—	—	184·57
18	9	183·22	180·85	35	3	189·33	184·60
19	24	182·29	181·04	36	—	—	184·57
20	19	179·27	181·26	37	—	—	—
21	16	181·12	181·51	38	1	180·00	184·29
22	19	181·32	181·78	39	2	188·00	184·05
23	8	184·50	182·06	40	1	186·00	183·72
24	11	183·00	182·35	41	1	164·00	183·31
25	6	183·00	182·65	42	2	190·00	182·81
26	8	179·50	182·95	43	1	173·00	182·20
27	9	186·44	183·23	44	1	190·00	181·49
28	5	183·40	183·51	45	1	182·00	180·68
29	8	181·88	183·77	46	—	—	—
30	12	182·33	184·00	47	—	—	—
31	1	190·00	184·20	48	1	170·00	177·51

We can test the significance of the change of Head Length with age by Fisher's method of analysis of variance.[1] In view of the importance of the method I give below full details of the calculations.

Let us consider any particular age-group, say 18. Choose a convenient base number, say 180 mm. From each individual measurement (belonging to the 18th age-group) subtract 180 mm. We then have the following series of 9 deviations for the 9 individuals :—

—8, + 16, + 2, + 4, + 12, — 6, + 3, 0, + 6.

Adding together these 9 deviations we get the total excess $e_{18} =$ +29. In the same we can form the total excess (e_p) for each age-group.

Actual calculations are shown in Table 9. Column 1 gives the age-group (p) ; column 2 gives (n_p) the total number of individuals in the age group. Columns 3 and 4 give the total excess ($+e_p$ or $\times e_p$) ; column 5 is formed by squaring the total excess and dividing by the number of individuals (e_p^2 / n_p).

Table 9.—Regression of Anglo-Indian Head Length on Age.

1	2	3		4	1	2	3		4
Age-group (p)	Number in Age-group (n_p)	Excess over 180 mm. + e_p	—	e_p^2 / n_p	Age-group (p)	Number in Age-group (n_p)	Excess over 180 mm. + e_p	—	e_p^2 / n_p
15	1	..	2	4·00	31	1	10	..	100·00
16	4	..	17	72·25	32	6	48		384·00
17	8	21		55·12	33	3	1	..	0·33
18	9	29		93·44	35	3	28		261·33
19	24	55		126·04	38	1	0		0
20	19	..	14	10·32	39	2	16	..	128·00
21	16	18		20·25	40	1	6		36·00
22	19	25	..	32·90	41	1	..	16	256·00
23	8	36	..	162·00	42	2	20		200·00
24	11	33		99·00	43	1	..	7	49·00
25	6	18	..	54·00	44	1	10		100·00
26	8	..	4	2·00	45	1	2		4·00
27	9	58	..	373·78	48	1		10	100·00
28	5	17		57·80	TOTAL	191	+494	—70	2875·01
29	8	15		28·12	Total excess = +424				—941·24
30	12	28		65·33	Total Variance between Age-groups.				=1933·77

[1] Statistical Methods, Chap. VIII.

Adding together columns 3 and 4 we get the total excess for the whole sample + 424.

Summing up column 6 we get 2875·01 which is the variance between the age-groups referred to 180. Subtracting 941·24=$(424)^2/191$, we finally get 1933·77 as the total variance between 29 age groups referred to the true mean.

By direct calculation we find that the total variance referred to the adopted base number 180 mm is 14826. Transferring to the mean value by subtracting $(424)^2/191$ =941·24, we get finally the total variance (referred to the true mean)=13884·76. The total variance 13884·76 represents 190=(191—1) degrees of freedom. The variance between age-group 1933·77 represents 28 = (29—1) degrees of freedom. Subtracting 1933·77 from 13884·76 we get 11950·99 as the total variance within the age-group with 190—28=162 degrees of freedom. We thus get the following table for the analysis of variance.

Type of variation.	Degrees of freedom.	Variance.	Mean Sq.	S. D.
Between age-groups . .	28	1933·77	69·06	8·31
Within age-groups. .	162	11950·99	73·77	8·59
TOTAL VARIANCE .	190	13884·76	73·78	8·59

It would be seen from the above Table that the variation between the age-groups is of the same order as the variation within age-groups. The change of Head Length with age cannot therefore be considered significant[1].

It will be noticed further that the variance within age-groups is 73·77, while the total variance is 73·78. The numerical value of the Standard Deviation will not therefore be reduced by applying a correction for age.

We may investigate the question of significance of the change in Head Length with age in a different way. The Pearsonian " correlation ratio " may be defined as the ratio of the variability between age-groups to the total variability[2].

$$\eta^2 = \frac{S\left\{n_p(\bar{Y}_p - \bar{Y})^2\right\}}{S(Y-\bar{Y})^2}$$

The correlation ratio η " provides an upper limit, such that no regression function can be found, the correlation of which with Y (the dependent variable) is higher than η.[3]"

[1] The observed value of the coefficient of correlation is r= +·0958±·0484. In view of the magnitude of the probable error, the correlation cannot be considered significant.

[2] Pearson (1905), p. 10.

[3] Fisher, p. 224.

In this case,

$$\eta^2 = \frac{1933 \cdot 77}{13884 \cdot 76} = 0 \cdot 129273$$

or $\eta = 0 \cdot 3732$

It is known, however, that even when the material is really uncorrelated a value of

$$(\eta)_0 = \sqrt{(K-1)/N} \pm \cdot 6745/\sqrt{N}$$

(where K is the number of arrays, and N the size of the sample) can easily arise through chances of random sampling.[1] In this case we have 29 arrays or 28 degrees of freedom, and N = 191, and hence the random value of $(\eta)_0$ will be ·3829 ± ·488. The observed value of η = ·3732 is actually less than $(\eta)_0$ = ·3829. We must conclude therefore that the observed value of η cannot be considered as indicating a significant correlation between age and Head Length.

A glance at figure 2 would show that there is a more consistent increase in Head Length up to the age of 35 years ; the irregularity comes in beyond that age.

I have therefore thought it worth while to calculate the correlation separately for all individuals up to 35 years of age. By straightforward calculation I find :—

Mean age	$= \bar{x}$	= 23·19 years.
Variance in age	$= S(x-\bar{x})^2$	= 3938·19
Mean Head Length	$= \bar{y}$	= 182·2389 mm.
Variance in Head Length	$= S(y-\bar{y})^2$	= 11584·73
	$S(y-\bar{y})(x-\bar{x})$	= +1064·64

We therefore have the coefficient of correlation

$$r = \frac{+1064 \cdot 64}{(3938 \cdot 19)(11584 \cdot 73)} = +0 \cdot 1576 \pm \cdot 0490,$$ which may be considered to be just significant.

We can now write down the linear regression equation :—

$$y = \bar{y} + b(x-\bar{x})$$

where $b = S(x-\bar{x})(y-\bar{y})/S(x-\bar{x})^2 = +0 \cdot 2703$

We have then :—

$$y = 182 \cdot 2389 + 0 \cdot 2703\,(x - 23 \cdot 1944 \text{ years}).$$

The analysis of variance is shown in the following Table :—

Type of Variation.	Degrees of freedom.	Variance.	Mean Sq.	S. D.
Between Age-groups	19	1098·09	57·7942	7·602
Within Age-groups	160	10486·64	64·2915	8·018
TOTAL	179	11584·73	64·9426	8·059

[1] Elderton, p. 197.

We again notice that variance between age-groups does not differ appreciably from the variance within age-groups.

The variance between the age-groups ($n' = 19$) consists of a portion which can be represented by a linear regression, and a portion which represents deviations from a straight line.[1] The part represented by linear regression is given by

$$\{S(x-\bar{x})(y-\bar{y})\}^2 / S(x-\bar{x})^2 = \frac{(1064 \cdot 64)^2}{3938 \cdot 19} = 385 \cdot 27$$

We thus have :—

Variance between Age-groups due to	Degrees of freedom.	Sum of Squares.	Mean Sq.	S. D.
Linear Regression	1	387·25	387·25	19·68
Deviation from Regression	18	710·84	39·49	6·28
TOTAL	19	1098·09	57·79	7·60

We can compare the S. D. of 19·68 with the S. D. for variation within age-groups =8·02 (based on 160 degrees of freedom).

Type of Variation.	S. D.	Degrees of Freedom.	$\log_e \sigma$
Linear Regression	19·68	1	2·9795
Within Age-groups	8·02	160	2·0819
			$z = 0 \cdot 8976$

From Fisher's table VI, pp. 212-214. I find that for $n_1=1$ and $n_2=160$, the 5 per cent. value of z is 0·6806, and the 1 per cent. point is ·9583. We conclude therefore that the variance due to linear regression is significantly greater than the variance within age-groups. A glance at the above table also shows that deviations from a linear regression are not significant.

The negative result for Non-linear Regression is confirmed by the value of the correlation ratio, $\eta = 0 \cdot 3079$. In this case we have 20 arrays or 19 degrees of freedom, and N=180. $(\eta)_0$ is therefore = $\cdot 3249 \pm \cdot 0503$. The observed value of $\eta = \cdot 3079$ cannot therefore be considered to be significantly different from zero, *i.e.*, it does not indicate any definite non-linear relationship between age and Head Length. The Linear Regression up to the age of 35 years is, however, probably just significant.

Finally, it is worth noting that even for the selected group of individuals up to the age of 35 years, the Standard Deviation within age-groups (*i.e.*, corrected for change with age) is about 8·02 mm. This is lower than the general value of 8·63 mm, but is still excessively high.

[1] Fisher, pp. 221-222.

Table 10.—Summary Table of Statistics of Head Length.

N.B.—Col. (2) refers to the Sub-Tables in Table 11. Col. (4)—the number (g) of sub-groups whose variances are combined together. Col. (5)—the total number (n) of individuals in the whole group; the number of degrees of freedom is given by $n'=(n-g)$. Col. (7)—gives the logarithm of the S. D. to the base "e." Cols. (8) and (9)—For combined data the simple arithmetic averages of (V) and (M) are given within brackets. Col. (10)—number refers to the bibliographical list.

Serial Number	Sub-Table Reference (Table 11).	Name of Group.	Number of Sub-groups (g).	Total Number of Individuals (n).	Standard Deviation (in mm.) σ	$\log_e \sigma$.	Coeff. of Variation V.	Mean Head Length (in mm.) M.	Reference and Remarks.
1	2	3	4	5	6	7	8	9	10
1	..	Kharga Oasis	1	150	5·05±·20	1·6194	2·67±·10	189·00±·28	Hrdlicka (18), 1912.
2	S-1	American Tribes	13	291	5·32±·15	1·6715	(2·79±·08)	(188·35±·21)	Boas and Livingston (4) 1898.
3	S-2	Borneo and Java	3	87	5·65±·29	1·7317	(3·33±·17)	(178·56±·41)	Garett (14), 1912.
4	..	Samoan	1	68	5·69±·33	1·7387	2·98±·17	190·6 ±·46	Sullivan (41), 1921.
5	..	Lycian Gypsies	1	53	5·73±·38	1·7457	3·25±·21	176·33±·53	Dudley Buxton (8), 1920 (*a*)
6	..	Aino	1	95	5·88±·29	1·7716	3·03±·15	193·78±·41	Koganei (20), 1893.
7	S-3	East African Tribes	30	1509	6·03±·07	1·7969	(3·05±·04)	(189·53±·10)	Leys and Joyce (23), 1913.
8	..	Egap (West Africa)	1	100	6·28±·29	1·8374	3·27±·18	191·48±·42	Malcolm (28), 1925.
9	..	African Tribes (combined)	31	1609	6·05±·07	1·8001	(3·06±·04)	(189·60±·10)	(7) and (8) combined.
10	S-4	Modern Egyptians	17	9436	5·98±·02	1·7884	(3·12±·02)	(190·96±·04)	Craig (7) and Orensteen (33), 1915-1917.
11	..	Egyptian Moslems	1	369	6·09±·15	1·8066	3·13±·08	194·56±·21)	Brit. Assoc. Rep. (5), 1905.

Table 10.—Summary Table of Statistics of Head Length—contd.

Serial Number	Sub-Table Reference (Table 11).	Name of Group	Number of Sub-groups (*g*).	Total Number of Individuals (*n*).	Standard Deviation (in mm.) σ	$\log_e \sigma$.	Coeff. of Variation V.	Mean Head Length (in mm.) M.	Reference and Remarks.
1	2	3	4	5	6	7	8	9	10
12	..	Egyptians Total	18	9805	5·99±·02	1·7901	(3·12±·02)	(191·16±·04)	(10) and (11) combined.
13	..	Egyptians and African Tribes.	49	11414	6·00±·02	1·7918	(3·10±·01)	(191·71±·03)	(9) and (12) combined.
14	..	English, General Sample	1	4721	6·26±·04	1·8342	3·20±·02	195·56±·06	Harmon (16), 1926.
15	..	Oxford Students	1	959	6·23±·09	1·8294	3·17±·05	196·05±·13	Schuster (40), 1911-12.
16	..	Cambridge Students	1	1000	6·16±·09	1·8181	3·18±·05	193·51±·13	Macdonell (27), 1901-2.
17	S-5	Cambridge Students	1	1011	6·12±·09	1·8116	3·15±·05	194·32±·13	Pearson (35), 1906.
18	..	English, Non-Criminal	4	7690	6·23±·03	1·8294	(3·17±·02)	(194·86±·05)	(14), (15), (16) and (17) combined.
19	..	,, Non-habitual Criminal	1	3000	6·05±·05	1·8001	3·15±·03	191·66±·08	Macdonell (27), 1901-2.
20	..	,, Habitual Criminal	1	2348	6·39±·06	1·8547	3·34±·03	192·45±·09	Goring (15), 1913.
21	..	,, Criminals (combined).	2	5348	6·20±·04	1·8245	(3·25±·02)	(192·05±·06)	(19) and (20) combined.
22	..	,, Total	3	13038	6·22±·03	1·8278	(3·20±·01)	(193·92±·04)	(18) and (21) combined.
23	S-6	Swedish, Total	17	46983	6·19±·02	1·8229	3·20±·01	193·84±·02	Lündborg and Linders (26), 1926.
24	S-7	Greeks (combined)	2	198	6·21±·21	1·8262	3·39±·11	185·34±·30	Brit. Assoc. Rep. (6), 1912 Schift (39), 1914.
25	..	Ukranians	1	249	6·02±·18	1·7951	3·27±·10	184·10±·26	Pöch (38), 1925.

26	..	Austrians	1	192	6·03±·21	1·7967	3·17±·11	190·16±·29	(4) Brezina and Wastl (4), 1929.
27	..	Europe (combined	27	60660	6·20±·01	1·8245	(3·23±·01)	(192·14± 02)	(22), (23), (24), (25) and (26) combined.
28	S·8	Chinese Turkestan	25	609	6·33±·12	1·8453	(3·34±·06)	(184·74±·17)	Joyce (19), 1912
29	..	Armenians	1	75	6·30±·35	1·8406	3·38±·19	186·5 ±·49	Boas (2), 1924.
30	S-9	Scottish Insane	2	4756	6·54±·05	1·8779	..	..	Tocher (46), 1906-7.
31	S-10	Polynesians (combined)	4	449	6·85±·15	1·9242	(3·56±·08)	(189·31±·22)	Sullivan (41), (44), 1921 1922, 1923, 1929.
32	..	Malta	1	561	6·63±·13	1·8916	3·51±·07	188·70±·19	Dudley-Buxton (10), 1922.
33	..	Gozo	1	82	6·55±·34	1·8795	3·57±·19	185·38±·49	Dudley-Buxton (10), 1922.
34	..	Cyprus	1	586	7·00±·14	1·9459	3·87±·08	180·81±·20	Dudley-Buxton (9), 1920 (*b*).
35	..	Crete	1	320	7·24±·19	1·9796	3·76±·10	191·76±·52	v. Luschan (24), 1913.
36	S-11	Eastern Mediterranean	4	1549	6·91±·08	1·9315	(3·68±·04)	(86·66±·12)	(32), (33), (34) and (35) combined.
37	..	Koreans	1	552	7·10±·14	1·9601	3·91±·08	181·37±·20	Kubo (21), 1913.
38	..	Serbians	1	196	7·33±·25	1.9918	4·03±·14	181·91±·35	Lebzelter (22), 1923.
39	..	Inner Mongolia	1	52	7·57±·50	2·0242	4·00±·26	188·27±·71	Dudley-Buxton (11), 1926.
40	..	American Negroes	1	961	6·51±·10	1·8733	3·31±·05	196·50±·14	Herskovits (17), 1927.
41	S-12	Polynesian Mixed	1	122	7·47±·32	2·0109	3·98±·17	187·70±·46	Sullivan and Wissler (44), 1929.
42	..	Anglo-Indians	1	200	8·63±·29	2·1552	4·73±·16	182·45±·41	

Section IV.—Material for the comparison of Variability in Head Length.

For reasons already explained in the foreword I do not propose to compare at this stage the mean value of the Anglo-Indian Head Length with the mean values for other groups. My main object in the present section is to gain some idea regarding the homogeneity (or otherwise) of the Anglo-Indian Head Length by a comparative study of the Standard Deviation and the Coefficient of Variation. I have collected data relating to different parts of the world which were easily available in Calcutta, but have not attempted to compile an exhaustive list.

The data are given in Tables 10 and 11. I shall start in the middle of Table 10, and begin with the English groups.[1]

(14). *English, General Sample.*—The sample consists of measurements of males in Francis Galton's second Anthropometric Laboratory series of age-groups 4-7 to 70-80 years. The standard deviations were however corrected for age and reduced to a standard age of 45·5 years.[2] The value of S. D., 6·26, may therefore be considered to be a fairly reliable estimate of the general variability in English Head Length.

(15). *Oxford Students.*—The subjects were of ages between 18 to 23 and over, and were measured in the Anthropological laboratory of Oxford. Schuster was of opinion that the numbers available were not sufficient to make any definite statement regarding the changes of head measurements with age, but there was some indication that the Head Length increased during the period dealt with.[3] Owing however to the small magnitude of the change (if any), I have not thought it necessary to correct the variances for age changes, and have taken the total variance of the whole group.

(15), (16). *Cambridge Students.*—We have two different series. W. R. Macdonell[4] gave the results for a series of 1,000 male students of Cambridge. Pearson[5] gave the figures for 1,011 male Cambridge students divided into four sub-groups, 1st Class, IInd Class and IIIrd Class Honours and Poll-men. The detailed figures are given in Table 11, S-4, Nos. 71-74.

We can test the significance of the differences in Standard Deviation of the students in different classes by Fisher's method.[6]

Let σ_1 and σ_2 be the two S. D.'s based on n_1' and n_2' degrees of freedom. Let

$$Z = \log_e \sigma_1 - \log_e \sigma_2 \quad . \quad . \quad . \quad (1)$$

where natural logarithms to base " e," (and not to the base 10) are taken. Fisher states that when (n_1') and (n_2') are both large, or are moderately large but equal or nearly equal, then the distribution of Z is sufficiently normal to enable us to use the S. D. of Z which can be written :—

$$\Sigma_z = \sqrt{\tfrac{1}{2}\left(\tfrac{1}{n_1'} + \tfrac{1}{n_2'}\right)} \qquad (2)$$

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[1] The number within brackets before each group refers to the serial number in Table 10.

[2] Harmon, *Biom.* XVIII (1926), pp. 207-220.

[3] Schuster, p. 48.

[4] *Biom.* I (1901-2), p. 177.

[5] *Biom.* V (1906-7), p. 124.

[6] *Statistical Methods,* Chap. VII, p. 194.

Here n_1' and n_2' represent the numbers of degrees of freedom of the two samples respectively. The number of degrees of freedom of any S. D. can be obtained from the consideration that if n=total number of individuals, and g=number of sub-groups whose variances are pooled together, then the number of degrees of freedom is $n'=(n-g)$; usually when the S. D. refers to a single group, g=1, and $n'=(n-1)$.

Applying this test to the 1st Class and IInd Class Cambridge Students we obtain :—

Name of Group.	Degrees of Freedom.	σ	$\log_e \sigma$	$\frac{1}{2n'}$
1st Class	152	5·89±·23	1·7733	·003289
IInd Class	181	6·03±·21	1·7967	·002762
			Z=·0234	·006051

Thus Z=·0234, while the variance of Z=·006050, or Σ_z=·0828. We conclude therefore that Z is not significantly different from zero, *i.e.*, the difference in the two Standard Deviations is not significant. In this particular case this fact is apparent from the magnitude of the probable errors, and n′ being fairly large for both samples, we could have made direct use of the probable errors. But as n′ will be small in many cases, we shall be often obliged to use Fisher's method.

In the same way we find that the differences in S. D. between the other groups are practically insignificant. I have therefore used the figures for the whole groups of 1,011 students given in Table 10, No. 17

Comparing the two Cambridge series given by Macdonell and Pearson, respectively, I find Z=0·0065, with Σ_z=0·033, or the difference to be quite inappreciable. I have combined the two variances to give a value of σ=6·14, with n′=2011—2=2009. If we compare this combined Cambridge series with the Oxford students we find Z=·0146, Σ_z=·0278. The difference in S. D. is therefore negligible.

Comparing the General Sample with the Cambridge Students we have :—

	n'	σ	$\log_a \sigma$	$\frac{1}{n'}$
General Sample	4720	6·26	1·8342	·000212
Cambridge Students	2009	6·14	1·8148	·000498
			z=·0194	·000710

Z=·0194, The S. D. of Z=$\sqrt{\cdot 000355}$=·0188. The difference is again negligible.

We may therefore combine the variances for the General, the 2 Cambridge, and the 1 Oxford samples, by adding the different values of variances and dividing by the total number of degrees of freedom. We obtain in this way :—

	g	n	σ	n'
Combined English .	4	7690	6·23	7690—4=7686

The combined variance is based on 4 sub-groups and 7,690 individuals. The numbr of degrees of freedom is therefore given by 7,690—4=7,686. We may use $\sigma=6{\cdot}23$ as a reliable estimate of the variability in Head Length of a general English population.

Certain other non-criminal English data are available. For example, F. von. Luschan's [1] measurements of 84 members of the British Association. The actual value of $\sigma=6{\cdot}16$, which is in excellent agreement with the other values. The size of the sample is however, very small. Pearson [2] has given the statistics for a long series of School Boys, $n=2298$, $\sigma=6{\cdot}51$. I have not, however, used this material as it refers to young children, and would not be strictly comparable with our adult data.[3] I have also omitted Gladstone's hospital data, for Blakeman in analysing the data came to the conclusion that the hospital sample differed "in some essential features from the general population."[4]

(19), (20). *English Criminals.*—We may now consider the criminal data from England.

We have two long series. Macdonell [5] obtained the measurements of 3,000 convicts from the Central Metric Office, New Scotland Yard. The majority of the prisoners were English and Welsh, many were Irish, and only a few Scotch ; no foreigners or youths under 21 were included. The cards were drawn at random from the mass on the office shelf, and we have therefore a random sample. These subjects were prisoners whose crimes and sentences were comparatively slight and who may therefore be called "non-habitual criminals."[6]

In Goring's data [7] observations were taken consecutively on all those sentenced to Penal Servitude after the 1st June, 1902, until 3,000 individuals had been measured. Goring has divided the data into six sub-groups according to the nature of the crime. The difference in the S. D. for Head Length, were however, found to be usually negligible.

Name of Group.	n	σ	$\log_e \sigma$	$\frac{1}{2n'}$
Non-habitual Criminals	3,000	6·05	1·8001	·00016622
Criminals (Goring)	2,348	6·39	1·8547	·00021304
		z=	·0546	·00037926

[1] v. Luschan, *Zeit. f. Ethn.* 1914, pp. 58-80 (Table 11, No. 76).
[2] Pearson, *Biom.* III (1904), pp. 131-194.
[3] The lowest age among the Anglo-Indians is 15, while the average age is greater than 24 years.
[4] Blakeman, *Biom.* IV (1905), p. 125.
[5] Macdonell, *Biom.* I (1901-2), p. 177.
[6] Goring, p. 140.
[7] Goring, Preface, p. 6.

Applying Fisher's test, we find that Z=·0546, with the S. D. of Z=·0195, which indicates a just significant difference in variability between the two samples. It is necessary to remember, however, that Goring's data covers a much wider range of ages, and the greater variability can certainly be partly assigned to this cause. Goring[1] himself has shown that if a correction for age is applied (with the help of the co-efficient of correlation between age and Head Length) the S. D. becomes reduced to 6·32.

The weighted average of the combined criminal data is given below :—

	g	n	σ	v
English Criminals	2	5,348	6·20	3·25

Comparing this with the combined general English value (S. D.=6·23 n′=7,686), we find Z=·0048 with Σ_z=·0126. We conclude, therefore, that there is practically no difference in the variability of Head Length between English Criminal and Non-criminal data.

(23). *Swedish Groups.*—Detailed statistics for certain Swedish groups are given in Table 11, S-6.

The Swedish material is taken from "The Racial Characteristics of the Swedish Nation."[2] It consists of measurements of 46,983 conscripts and regular soldiers belonging to the Swedish army and navy. The subjects were all born in Sweden and were over 20 and under 22 years of age. The birth place of the persons examined was chosen as the basis of a regional grouping of the material into 5 territories :—four rural districts and the biggest cities. The material from the 4 rural territories was further classified into 4 groups on an occupational basis. In this way 17 sections were obtained altogether. There is very little difference in variability between the different territories, and a careful analysis of the original data shows that the material can be considered to be thoroughly hybridised.*

(24). *Greeks.*—Table 11, S-7 gives data for two short series of Greeks. The 99 Greek reformatory youths were measured by W L. H. Duckworth.[3] The author was of opinion that the material presented the character of a mixed stock of humanity.[4] The 99 adult males from Mani (Southern Pelponnese) were measured by Schiff.[5] There is no significant difference in the variability between the two Greek samples and the variances have been combined to give a value of σ=6·21 (n=198).

(25). *Ukranians.*—Most of the subjects were peasants and nearly 75%were illiterate.[6] The place of origin of the subjects could be deter-

[1] Goring, p. 142.

[2] Edited by H. Lündberg and F. J. Linders, Swedish Institute of Race-Biology. Upsala, 1926.

[3] Duckworth, *Brit. Assoc. Rep.* 1912, pp. 224-268.

[4] Duckworth, *ibid*, p. 260.

[5] Schiff, *Zeit. f. Ethn.* 1914, pp. 14-40.

[6] Pöch, *Mitt. d. Anthrop. Ges. Wien*, LV (1925) ,pp. 289-333.

* *See* P. C. Mahalanobis : "A Statistical Study of certain Anthropometic Measurements from Sweden." *Biometrika*, Vol. XXII, 1930, pp. 106-107.

mined with certainty in most cases, both the parents usually belonging to the same or neighbouring villages. Although 517 male individuals of all ages from 1 year to 90 years were measured, the figures given here refer to adult men only.

(26). *Austrians.*—The subjects were 192 Tramway employees of Vienna, 25 to 50 years old. Nearly two-thirds of the parents were born in German-speaking countries while the remainder belonged to the Slav-speaking districts.[1]

The differences in variability between Ukranians, Austrians and Greeks (combined) are negligible. In spite of the large values of $\mathbf{n}_1$ and $\mathbf{n}_2'$, the All-English and the Swedish values also do not differ appreciably. Although both Ukranians (6·02) and Austrians (6·03) have considerably lower values than the All-English (6·22), the Swedish total (6·19) or the Greeks (6·21), the differences are not significant in any case.

If we combine the variances of the above European groups, we obtain σ=6·20 approximately.

I think this figure, σ=6·20, may be considered to be a reliable estimate of the typical variability in Head Length for such thoroughly mixed but stable European groups as the English, the Swedish, the Greeks, the Ukranians or the Austrians.

I shall now consider values of σ less than 6·20.

(7). *East African Tribes.*—We have a fairly long series of 1,509 individuals belonging to 30 different tribes.[2] Actual values are given in Table 11, S-3.

Leys and Joyce stated that " the measurements were procured mainly at the town surgery, Mombassa, from sick who came for advice; . great care was taken in classifying the subjects according to tribe; no account was taken of a man's place of birth or residence but careful enquiries were made as regards their ancestry. It may be objected that statistics derived from measurement of the sick do not fairly represent racial types. To this it may be answered, firstly that the majority of cases were trivial; secondly that no individual was included who was suffering from a complaint which might affect head-form or stature; thirdly, about one-third were really not sick at all. Of the last mentioned about 100 were villagers seen at a mission station, another 100 or so were prisoners, chiefly political, in Mombassa gaol, and about 300 were police or applicants for admission to the police force . .. All measurements were taken on adult males. Taken as a whole therefore the data may be regarded as fairly representative."[3]

Considerable inter-mixture has taken place among the agricultural tribes. " The pastoral tribes (most of the Nilotes), however, have been less affected, since, being more mobile, they have avoided disaster by periodical migrations, according to seasons, within a more or less well-defined district. Thus there has been a greater tendency to preserve homogeneity of type within the tribe, a tendency which has some time been enforced as among the Masai, by a social system which refuses to

[1] Lebzelter, *Mitt. d. Anthrop. Ges. Wien,* LIII (1923), pp. 1-49.
[2] Leys and Joyce, *Jour. Roy. Anthropol. Inst.* XLIII (1913), pp. 195-267.
[3] Leys and Joyce, *ibid.* p. 195.

incorporate a stranger."[1] The Somali is comparatively pure but the Nilotic Kovirondo, and the Kachamega are believed to be of mixed origin.

In most cases the differences in variability are not significant. The Baganda (7·48) and the Rabai (7·25) have, however, significantly greater variabilities than the Nandi (4·06), Suk (4·24) and Lamu (4·68). Otherwise differences, although here and there suggestive of real effects, cannot be considered definitely significant. The combined weighted average S. D. of the 30 tribes is 6·03 ($n'=1479$).

(8). *West Africa.*—One short series of 100 adult males of Egap tribe is available.[2]

Egap is a small tribe belonging to the Tikar group of tribes in the grass land area of the Western Cameroon. The 100 males chosen were selected between the ages of 20 and 50 years, and no element other than age appeared in making the selection.

The S. D. of 6·28 suggests a greater variability than the East African tribes (6·03).

The author states that by reason of certain external influences such as the importation of women from other areas, and slavery, the homogeneous character of the tribes has been altered considerably even within the past few years.[3]

As the Egap variability is not however significantly different from the variability of the East African tribes, I have combined their variances to give a general African tribal variability of 6·05 ($n=1609$, $g=31$, $n'=1578$).

(10). *Modern Egyptians.*—We have splendid material for the modern Egyptians (shown in Table 11, S-4).

Craig's data [4] consist of a series of 10,000 measurements of modern Egyptian Criminals taken from the whole collection absolutely at random. Rejecting records of women and boys or youths, a total of 9,436 individuals were obtained. The subjects were classified according to their birth place.

We also have a long series of 802 male Cairo-born Egyptians (in which youths under 20 were rejected) taken from the same criminal group, and analysed by Orensteen.[5]

The variability differs very little from place to place, and only one particular district Daquahlia (6·65) appears to have a significantly higher variability than two other districts Benisuef (5·65), and Minia (5·71). Combining the variances for the 17 districts we obtain an average variability of $\sigma=5{\cdot}98$.

(11). We have a further series of *Egyptian Moslems.*[6] The subjects consist of " the Moslem Egyptians whose parents had been born in like regions of Egypt or the Sudan. All the subjects belonged to the native Egyptian army."[7]

[1] Leys and Joyce, p. 198.
[2] Malcolm, *M.d. Anth. Ges. Wien*, 1925, pp. 5-45.
[3] Malcolm, *ibid.* p. 43.
[4] Craig, *Biom.* VIII (1911-12), pp. 66-78.
[5] Orensteen, *Biom.* XI (1915-17), pp. 67-81.
[6] *Brit. Assoc. Rep.* 1905, pp. 207-208.
[7] *Brit. Assoc. Rep.* 1905, p. 207.

There is no significant difference in variability between the Moslem Egyptian soldiers (6·09, n′=368) and the other Egyptians (5·98, n′= 9,419) for Z=·038, with the S. D. of Z=·038.

Combining the variances we obtain an average variability of 5·99 for 18 groups of Modern Egyptians, (n=9,805, n′=9,787).

I give below the results of comparison of the Modern Egyptians with several other groups.

Name of Group.	g	n	σ	Z	Σ
Egyptians (combined) . .	18	9,805	5·99	..	..
English (Non-criminals) . .	3	6,680	6·24	·0409	·0140
„ (Criminals)	2	5,348	6·20	·0344	·0124
All-English (combined) .	6	13,038	6·22	·0377	·0095
Swedish (combined) .	17	46,983	6·19	·0328	·0079
African Tribes (combined)	31	1,609	6·05	·0100	·0192

It is clear that the Modern Egyptian variability is definitely lower than the variability of such stable (although highly mixed) European groups as the English or the Swedish.

On the other hand there is no significant differentiation in variability between the Egyptians and the African tribes. Combining the variances of the African tribes and the Modern Egyptians we obtain a Total African variability of σ=6·00 (g=49, n=11,414, n′=11,365).

I shall now consider a few primitive groups with observed S. D.'s less than 6·00. The actual values are given in Table 10.

(6). *Aino.*—A short series of 95 individuals was fully described by Koganei.[1] The Ainos are supposed to form a very homogeneous group, and it is interesting to note that the S. D. (5·88) is comparatively low. Owing to the smallness of the size of the sample we are, however, unable to assert that the variability is definitely lower than the European combined (6·20) or the African combined (6·00) values.

(5). *Gypsies.*—We have a short series of Lycian Gypsies described by Dudley Buxton[2] who says "Lycian Gypsies form a small indigenous religious community which claims to keep itself free from inter-mixture with Christian Greeks or Moslems. ... The purity of the Lycian Gypsies will be seen to be specially striking because they live amongst an unusually mixed population" The value of the S. D., 5·73, cannot be asserted to be significantly different from 6·00 owing to the very small size of the sample, but is probably really lower.

(3). *Borneo and Java.*—We have three short series of Banjerese (33), Sundanese (37) and Javanese (17) given by Garett.[3] The num-

[1] Koganei, 1893.

[2] Dudley Buxton, *Biom.* XIII (1920-21), p. 96.

[3] Garett, *Journ. Roy. Anthropol. Inst.* XLII (1912), pp. 60-66. Details given in Table 11, S-2.

bers are of course much too small to yield many significant differences. Owing to the isolated nature of the groups, and their possible connexions with India I have, however, thought it worth while to include them. Differences between the three groups are; of course, insignificant on account of the very small size of the samples. Combining the variances we obtain a S. D.=5·65, with n′=87—3=84.

The difference with the European combined (6·20) although suggestive of a real effect (Z=·0928 against a S. D. of Z=·0772) cannot be called significant.

(4). *Samoan.*—Sullivan [1] has given a short series of 68 adult male natives of the Islands of Savaii and Upolu of the Samoan group. All persons with known intermixture with European or with other races were excluded. The author notes : " our series is noteworthy for its homogeneity. Taken character for character the variability is very small. As compared with a series of pure Sioux Indians and another series of Sioux-White half-bloods, the co-efficient of variation for nearly every character is apparently smaller than that of either of these groups."[2] Although owing to the smallness of the size of the sample significant differences cannot be asserted in many cases, it is probable that the Samoans are more homogeneous than the Modern Egyptians or African tribes.

(2). *American Tribes.*—We have an interesting series of 13 Red Indian Tribes with a total number of 291 individuals from British Columbia.[3] The actual values of the S. D. were calculated by me from the original records. There are no significant differences in the variability between the different tribes, and the combined S. D. 5·32, (n′= 278) has been given in Table 10.

The variability is now definitely and significantly lower than the combined European value (6·20), Z being 0·1530 with a S. D. of Z= ·0425, and also from the combined African value (6·00) with Z=·1203 and Σ_z=·0429. The difference with Aino (Z=·1001, S. D. of Z=·0845) is suggestive without being definitely significant.

(1). *Kharga Oasis.*—The inhabitants of Kharga Oasis in Egypt form one of the most isolated communities in the whole world. Hrdlicka [4] is of opinion that " the bulk of the population maintained or renewed itself principally through natural augmentation "[5] and that " the majority of the people are as yet but little mixed with the Negro. "[6] In fact he goes so far as to assert that "the type of the Kharga natives is substantially the same as that of the population of the Oasis during the first part of the Christian Era."[7] It is therefore not at all surprising that the S. D. (5·05) comes out to be extremely small.

The differences from combined European (Z=·2051 Σ_z=·0567) and combined African (Z=·1724, Σ_z=·0583) are definitely significant

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[1] Sullivan, *Mem. Bern. P. Bish. Mus.* VIII (1921-23), pp. 81-98.

[2] Sullivan, *ibid.* p. 82.

[3] Boas and Livingston, *Brit. Assoc. Rep.* 1898, pp. 628-644. Details quoted in Table 11, S-1.

[4] Hrdlicka, *Smith. Miscell. Coll.* Vol. 59 (1912).

[5] Hrdlicka, p. 7.

[6] Hrdlicka, p. 102.

[7] Hrdlicka, p. 103.

and from the Aino group ($Z=0\cdot1522$, $\Sigma_z=\cdot0931$) a little more than suggestive.

We find therefore that Aino, Lycian Gypsies and the Java and Borneo combined groups probably have a variability less than 6·00. The Red Indian tribes have a still lower variability (5·32), and the inhabitants of Samoa and Kharga Oasis come at the bottom with the extremely low values of 5·25 and 5·05 respectively.

We have now got a rough scale or levels towards the lower end. Highly mixed but stable European groups apparently have a variability of the order of 6·20, still more homogeneous groups like modern Egyptians and African tribes of the order of 6·00; then come such groups as Aino or the samples from Java and Borneo with a S. D. of the order of say 5·75. The Red Indian tribes, Samoans or the inhabitants of Kharga Oasis very likely have a variability lower than 5·50.

We can now consider variabilities greater than 6·20 mm.

(28). *Chinese Turkestan.*—Joyce [1] has discussed a fairly long series of 609 male adults belonging to 25 different tribes and localities.

The material was collected by Sir Aurel Stein and represents the inhabitants of most of the towns and villages round the deserts at Khotan, Pamir, etc. and also certain tribes of the mountaneous countries to the West and South-West.[2]

The relevant statistics are given in Table 11, S-8. The numbers in the sub-groups are in many cases extremely small, and it is no longer possible to use the general formula for the S. D. of Z given by equation (2), p. 118. We must now use one of the Tables given by Fisher.[3] For example, let us take the case of Charklik ($\sigma=9\cdot11$, $n=12$) and Nissa ($\sigma=4\cdot62$, $n=9$). In the usual way we find $Z=0\cdot6790$. Looking up Fisher's table on p. 212 (for $P=\cdot05$), I find that for $n_1'=8$ and $n_2'=11$, $Z=0\cdot5406$; but the observed value (0·6790) is considerably greater. We conclude that the probability is less than ·05 that Z is not different from zero. That is, chances are greater than 20 to 1 against the difference between the two variabilities being negligible. As a matter of fact using the Table on p. 214 ($P=\cdot01$), we find that chances are of the order of 60 to 1 in favour of their being different.

In the same way we find that the Charklik and Karanghu-tagh have significantly higher variabilities than the Nissa, Hami, Sarikoli and Turfan; otherwise differences are not significant. The combined variability for 25 tribes is 6·33 ($g=25$, $n=609$).

The combined variability of the inhabitants of Chinese Turkestan (6·33) is just significantly greater than 6·00, but is not significantly different from the stable European variability of 6·20. The balance of evidence is therefore in favour of the view that the tribes of Chinese Turkestan are definitely more heterogenous in their composition than the modern Egyptians, and possibly more so than stable European groups.

[1] Joyce, *Jour. Roy. Anthropol. Inst.* XLII (1912), pp. 450-484.
[2] Joyce, p. 450.
[3] Statistical Methods for Research Workers, pp. 212-215.

(29). *Armenians.*—Boas.[1] has given a short series of 75 Armenians who were born in Asia but had immigrated to the U. S. A., and were measured in New York. The S. D. (6·3) is of the same order as the general European variability (6·20), but is possibly slightly greater.

(30). *Scottish Samples.*—One long series of insane, one short series of insane convicts, and one short series of students are available (details given in Table 11, S-9.)

Tocher[2] analysed the insane data, and was of opinion that the 4381 males represented substantially what may be termed the ordinary, normal asylum, or general insane population, *i.e.*, those mentally affected but not suffering from other specific diseases. The subjects were all adults and came from different asylums in Scotland. The differences in the variability of Head Length between the different asylums are usually negligible, but the differences in mean values are in many cases significant. In fact Tocher commenting on the variation of the mean value from asylum to asylum came to the conclusion that " individual asylum groups as a whole cannot be said to form part of a general insane population *of a homogeneous character* ".[3] The same author gives the figures for 375 habitual criminals in Scottish asylums. The composition of the Non-criminal Insane and Criminal Insane were not identical; the latter contained about 35 per cent. of subjects of Irish extraction, while the former had a much smaller proportion. The data for the Aberdeen University students are also quoted from Tocher's[4] paper. The Scottish figures are given in sub-table 9 of Table 11.

There is no significant difference in the variability of the Non-criminal and the Criminal Insane data. The Aberdeen students however have a significantly lower variability than either of the other two samples (for Criminal Insane $Z=0{\cdot}1168$, with $\Sigma_z=\cdot0485$, and for Non-criminal Insane, $Z=0{\cdot}1338$, with $\Sigma_z=\cdot0336$). This lower variability may be partly due to the lower range of age or some kind of selection in the student data ; without access to the original material it is difficult to say anything further. The greater variability of the other two samples may on the other hand be a real characteristic of all insane data, or may be due to the existence of a real heterogeneity among the inhabitants of Scotland.

Let us compare the Scottish Insane (combined Criminals and Non-criminals) with the All-English :—

	n'	$\log_e \sigma$	$\frac{1}{2}\cdot\frac{1}{n'}$
Scottish Insane (combined)	4,756	1·8779	·00010517
English, Total	13,038	1·8278	·00003831
	Z=	0·0501	·00014348

[1] Boas, *Zeit. f. Ethn.* 1924, pp. 74-82.
[2] Tocher, *Biom.* V (1906-07), pp. 298-350
[3] Author's italics, p. 327.
[4] I have not had access to the original paper referred to by Tocher : Anthropological Proceedings of the Aberdeen University.

We have Z=·0501, with Σ_z=·012. There cannot be any doubt regarding the significance of the difference.

In this case we can definitely assert that owing either to racial heterogeneity of the Scottish people or to some peculiarity of the insane data the Scottish group is significantly more variable than stable European groups.

(31). *Polynesians.*—The researches of Sullivan[1] have made available a good deal of valuable data relating to Samoa, Tonga, Marquesas, and Hawaii. (Table 11, S-10.)

Tongan.—Sullivan[2] states " the material consists of complete description and measurements of 225 persons, 121 men and 104 women. Of these 10 were of mixed descent and were discarded. Of the remaining 215, 184 were adults more than twenty years of age and 31 adolescents. The averages. .of all measurements except stature are based on persons of eighteen years old and upwards. The material was not consciously selected and represents persons of all social classes and occupations. It may be regarded as a fair qualitative sample of the Tongan people."

The Tongan sample is considerably more variable than the Samoan. Owing to the small size of the Samoan sample the Z—test is not definitely significant (Z=0·1914, Σ_z·1085), although strongly suggestive of a positive effect. Sullivan ascribes the greater variability to Melanesian intermixture of comparatively recent origin.[3]

Marquesan.—Sullivan[4] gives the following description of the material: " when the admitted mixed-bloods, senile and adolescent individuals were eliminated there remained two series consisting of 84 adult men and 74 adult women. Three persons with a small amount of Hawaiian blood were included in the analysis. .. .. The material was not selected and represents persons of all social classes and occupations. It may be regarded as a fair qualitative sample of the Marquesan people of to-day. Incidentally the 201 persons represent about 11 per cent. of the total population." The Marquesan and Tongan samples do not show any appreciable difference in S. D., both being nearly equally heterogeneous. Sullivan[5] is of opinion that both are mixed peoples, and he believed that he could recognise two distinct types, and possibly a third type also.

Hawaiian.—The material was collected by Sullivan and analysed by Wissler after Sullivan's death with the help of Sullivan's notes. The first group of 206 Hawaiian adult males consist of persons " whose parentage gave every assurance of true Hawaiian descent " In the smaller group of 47 were included " those concerning whom Sullivan entertained doubts. From his notes it seems that he considers the chances as favouring the pure descent of this group in contrast to the segregated mixed group. "[6] All the subjects considered here were 20

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[1] Sullivan, *Mem. Ber. P. Bish. Mus.*, Vols. VIII and IX (1921, 1922, 1923 and 1927).
[2] Sullivan, *ibid.*, VIII (1922), p. 233.
[3] Sullivan, *ibid.*, VIII (1922), p. 257.
[4] Sullivan, *ibid.*, IX (1923), p. 141.
[5] Sullivan, 1923, p. 233.
[6] Sullivan and Wissler, 1927, p. 271.

to 59 years old. A sample of older men was available, but I have not taken it into consideration.

It will be noticed that the smaller group actually shows a lower variability (6·37) than the larger one (6·78). I think this may be interpreted as definitely confirming Sullivan's belief that the former also consists of persons of pure descent. Pooling the variances we get a Hawaiian variability of 6·72 (n=253).

The Hawaiian sample (6·72) is not significantly differentiated from the Tongan (6·89) or the Marquesan (7·00) in S. D. The difference between Hawaiian (6·72) and Samoan (5·69) is however strongly suggestive of a real effect (Z=·1664, Σ_z=·0972). Omitting Samoans, we may combine the Tongan, Marquesan, and Hawaiian groups together and obtain a S. D. of 6·85 (n=449, g=4).

This combined Polynesian S. D. (6·85) shows a just significant difference from Samoan (5·96), Z being 0·1855 with Σ_z=·0927 The difference with the Scottish Insane falls a little short of significance, but the excess over the stable European groups (6·20) is definitely significant (Z=·0997, Σ_z=·0337).

(36). *Eastern Mediterranean.*—We have several rather heterogeneous groups from the Eastern Mediterranean countries.

(32), (33). *Malta and Gozo.*—Dudley Buxton has collected and fully described the material.[1] The individuals measured included among the men representatives of all social classes (professional men, gunners, militia, government messengers, men doing short sentences, paupers, and by far the largest number, men in the street). All those who were either born of Maltese parents abroad or although born in Malta were not of pure Maltese parentage were rejected.[2] The author gives a brief review of the history of the islands, and notes that the population of the urban districts (including as it does a very large proportion of the total inhabitants of the island) is completely new to its present surroundings.[3] The author gives separate figures for Malta Urban (σ=6·60, n=237), Malta Rural (6·68, n=157), Siggewe (6·33, n=80) and Zurrico (6·51, n=87). As there are no significant differences in variability between these geographical sub-groups I have used the variability of the total sample of 561 Maltese as a whole.

(34). *Cyprus.*—These measurements were also taken by Dudley Buxton.[4] The population is highly mixed. The author says : " today one man in every 5 is a Turk. .some of the villagers are pure Turkish, some mixed, some pure Greek "[5] and also that " it would appear probable that there has been a considerable influx of Negro blood at least since 1591 and possibly before." [6]

(35). *Crete.*—The material was collected by F. von Luschan.[7] The 320 adult males belonged to 19 different Eparchies (geographical

[1] Dudley Buxton, *Jour. Roy. Anthropol. Inst.*, LII (1922), pp. 164-211.
[2] Dudley Buxton, p. 195.
[3] Dudley Buxton, p. 101.
[4] Dudley Buxton, *Jour. Roy. Authropol. Inst.*, L (1920), pp. 183—235.
[5] Dudley Buxton, p. 192.
[6] Dudley Buxton, p. 200.
[7] Luschan, *Zeit. f. Ethn.*, 1913, pp. 307—393.

division in Crete) and were of all classes : gendarmes, soldiers, tailors, workmen, shop-keepers, lawyers, and men in the street.

There are no significant differences in variability between Malta, Gozo, Crete and Cyprus. Although there is no question of these samples belonging to the same race, I have combined the variances of the 4 groups in order to obtain a typical figure for the variability of Head Length in the Eastern Mediterranean. I may note that this combined variability (6·91) is significantly greater than the variability of a neighbouring group, the Greeks (6·21).

The Eastern Mediterranean groups (6·91) are definitely more heterogeneous than either the Scottish Insane (σ=6·54, Z=·0836, Σ_z=·0207), or the Chinese Turkestan tribes (σ=6·33, Z=·0862, Σ_z=·0329).

Going beyond σ=7·00, we have the following groups.

(37). *Koreans.*—A long series of measurements on both the Cavalry and Infantry sections of the Korean army has been described by Kubo.[1] The great variability (7·10) of the data may be partly ascribed to the fact that a considerable amount of inter-mixture has probably taken place between the Koreans and the Chinese in recent years owing to the rapid penetration of the latter into the Northern territories. I have shown elsewhere from a study of an ensemblage of 16 head characters that " the Koreans show very great resemblance with the Chinese of Manchuria, and moderate but quite appreciable association with the Northern and Eastern Chinese." [2] I also found that the variation within the Chinese provinces was higher in Head Length than in many other characters.[3] This would also partly explain the greater variability of the Koreans, in case, as we have very little doubt, intermixture with the Chinese of different provinces has actually occurred.

(38). *Serbians.*—Lebzelter[4] gives the measurements of 196 Serbians mostly belonging to North-West Serbia, who were taken war prisoners and were measured in Cracow in 1916.

(39). *Inner Mongolia.*—Dudley Buxton [5] has given a short series of measurements on 52 adult males. " Most of the people measured came from the neighbourhood of Halong Osso (a small part of the country lying on the trade route to Urga immediate North of the wall at Kalgan) and were measured in the mission (in May 1922). All those who were not of full Mongolian blood have been excluded from the final count." Buxton explained that by Mongol he meant simply the inhabitants of Mongolia.

White and Coloured Inter-mixtures.—I have been able to collect two series representing White and Coloured inter-mixtures.

(40). *American Negroes.*—Herskovits[6] has recently published an important paper on the American Negro. The author says, " the word Negro is, biologically, a misnomer, for the African Negroes, brought

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[1] Kubo, 1913.
[2] Mahalanobis, 1928, pp. 117—118.
[3] Mahalanobis, 1928, p. 122.
[4] Lebzelter, *Mit. d. Anth. Ges. Wien.*, CLIII (1923), pp. 1—49.
[5] Dudley Buxton, *Jour. Roy. Anthropol. Inst.*, LVI (1926), pp. 143—161.
[6] Herskovits, *Anthrop. Anzeig.*, IV (1927), pp. 293—316.

to the United States as slaves, have crossed in breeding with the dominant white population, as well as with the aboriginal American Indian types with whom they came into contact, so that there is today, a small percentage of the American Negroes who may be considered to be Negro in the ordinary sense of the term." [1] He states that " through the use of genealogies which were checked by Anthropometrical measurements ",[3] it has been found that only about 20 per cent.—25 per cent. of the American Negroes are of unmixed African stock. The remainder have varying amounts of mixture with White, American Indian, or both types. According to the genealogies, about one-quarter to one-third of the American Negroes claim partial American Indian ancestry, and most of the individuals who make this claim are also mixed with White. However, it is the White mixture which is more important from our point of view, for whatever Indian mixture occurred, as far as this series is concerned, took place so long ago, and was of such small quantity when compared with the amount of White crossing which took place, that it is biologically of small moment.

The present group represents, therefore, a people in which intermixture has been going on for several generations. It is, therefore, not surprising to find that the variability in Head Length is comparatively low, 6·51, which is of the same order as (in fact slightly less than) the variability of the Eastern Mediterranean or Polynesian groups. It may also be partly due to a similarity in the size of the Head Length between the White and the Negro populations of America.

(41). *Polynesian-White Inter-mixture.*—Sullivan and Wissler[3] have given a small number of cases of Hawaiian and Asiatic, Hawaiian and South European, and Hawaiian and North-American crosses. Wissler remarks that the term Asiatic was used by Dr. Sullivan, apparently because one or two Japanese crosses were included, most of the individuals tested being Chinese. In reality the group should be designated Hawaiian-Chinese. The South European Group, males only, contain 10 Portuguese, 5 Spaniards, 1 Italian, and 3 Portuguese-Negroid ancestry. The North European group represent crosses between Hawaiians, White American English, a few Germans, and one or two Frenchmen, in which the English (Irish, Scotch, and English) predominate. To facilitate comparison the various sub groups have also been combined in different ways in Table 11, S-12.

The values for the various Hawaiian mixtures are given in Table 11, S-12. The numbers are too small to give any significant differences in variability between the sub-groups. The Hawaiian All-mixture variability (7·47) is, however, quite high. It is significantly greater than the variabilities of American Negroes, Tribes of Chinese Turkestan, Scotch Insane, and stable European groups. Owing to the smallness of the size of the sample we are unable to assert significant difference from Serbians, Inner Mongolia, Armenians, or the Eastern Mediterranean groups.

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[1] Herskovits, p. 293.
[2] Herskovits, p. 294.
[3] Sullivan and Wissler, *Mem. Ber. P. Bishop Mus.*, IX (1927).

Scale of Variability.

I think we may now attempt to construct a scale of variability for Head Length, or rather, in view of the paucity of materials, a rough division into different levels or orders of variability.

Below $\sigma=5{\cdot}50$ we have such exceptionally homogeneous groups as the inhabitants of Kharga Oasis (5·05) or American Indian tribes (5·32). Between 5·50 and 6·00 occur isolated groups like the inhabitants of Borneo and Java (5·65), Samoan (5·69), Lycian Gypsies (5·65), or Aino (5·88). The modern Egyptians and African tribes are represented by a fairly reliable level of $\sigma=6{\cdot}00$. A little higher up we have another reliable level at $\sigma=6{\cdot}20$ which represents the variability of stable European groups like the English or the Swedish. Between 6·25 and 6·50 we have such groups as the tribes of Chinese Turkestan (6·33), Armenians (6·3) and the Scottish Insane (6·54), the latter owing its comparatively greater variability either to the existence of a real heterogeneity (in Head Length) among the Scottish peoples or to some kind of peculiarity of an Insane population. Between 6·50 and 7·00, but nearer the upper end, we have the Polynesian (6·85) or Eastern Mediterranean groups (6·91). In these cases it is practically certain that the groups are affected by recent inter-mixture or are communities of comparative recent settlement and growth. The Koreans (7·10), Serbians (7·33) or the inhabitants of Inner Mongolia (7·57) all show S. D.'s greater than 7·00. It is probable that each of these groups is really heterogeneous to some extent or have been subjected to considerable inter-mixture in recent years. As far as may be judged from the present material, the upper limit of the variability of samples which would be ordinarily considered to form distinct groups probably exists somewhere near $\sigma=7{\cdot}50$.

The Co-efficient of Variation.—In the main Tables 10 and 11 the Co-efficient of Variation ($V=100\ \sigma/M$) is given in Col. (8) and Col. (9) respectively. In the case of combined data I have merely given the simple arithmetic average of the different values of V, and have not thought it worth while to calculate the weighted average.

The serial order for σ and V, although not exactly identical, are generally in agreement. For the most homogeneous groups such as Kharga Oasis, American Tribes, Samoan, etc., V is usually slightly greater than 3·00, the combined African value being 3·10 (1·01). For stable European groups V is of the order of 3·20, the average value for Europe being 3·23. For the more mixed groups like the tribes of Chinese Turkestan or Scottish Insane, V lies between 3·30 and 3·50. For the Polynesian groups or the races of the Eastern Mediterranean, individual values of V usually vary between 3·50 and 3·75, average values for Polynesian and Eastern Mediterranean groups being 3·56 and 3·68 respectively. In the case of the Koreans, the Serbians, and the inhabitants of Inner Mongolia, the Co-efficient is of the order of 4. The American Negroes show a value of $V=3{\cdot}31$, which is slightly greater than the value for stable European groups. The Polynesian mixture on the other hand has a value $V=3{\cdot}98$. We may therefore consider $V=4$ to constitute a kind of upper limit for groups with definite claims to homogeneity.

Inter-racial Variation.

The material in Table II represents data from different parts of the world and covers a wide field. We may use it for gaining some idea regarding the nature of the inter-racial variation. For this purpose I used 92 groups for which N was 25 or more. The frequency distributions for Standard Deviation (σ), the Co-efficient of variation (V), and the Mean Head Length (M), are shown below.

Standard Deviation. (σ)		Co-efficient of Variation. (V)		Mean Head Length. (M)	
Range.	Frequency.	Range.	Frequency.	Range.	Frequency.
Less than 4·50	1	2·375—2·500	3	176—177	2
—4·75	4	—2·625	2	178—179	1
—5·00	1	—2·750	3	180—181	6
—5·25	3	—2·875	3	182—183	4
—5·50	3	—3·000	6	184—185	5
—5·75	9	—3·125	11	186—187	7
—6·00	11	—3·250	32	188—189	10
—6·25	29	—3·375	10	189—191	27
—6·50	13	—3·5ɔ0	8	192—193	17
—6·75	6	—3·625	5	194—195	11
—7·00	6	—3·750	1	196—197	2
—7·25	3	—3·875	3	Total	=92
—7·50	3	—4·000	4		
Total	= 92	—4·125	1		
		Total	= 92		

The frequency constants for the different statistics are given below.

Inter-racial Constants.	Standard Deviation. (σ)	Co-efficient of Variation. (V)	Mean Head Length. (M)
Mean value .	6·08± ·035	3·21± ·16	189·35± ·32
Standard Deviation	0·59± ·029	0·33± ·016	4·55± ·23
Co-efficient of Variation .	9·70	10·28	2·40

The mean value of σ, *i.e.*, the intra-racial variability, is 6·08 mm. This represents the average degree of variation within a homogeneous group. The value of Σ, the inter-racial variability, is 4·55 mm. This represents the variation of the Mean values of the different groups. It will be noticed therefore that the variation in Mean Head Length from group to group is actually less than the average variation of individual Head Lengths within a single group.

I must note, however, that owing to the preponderance of the stable European and the relatively more homogeneous African and Egyptian samples, the observed value of the inter-racial variability (4·55 mm.) is likely to be an under-estimate. As far as we can judge from the present material, we may conclude therefore that the inter-racial variability in Head Length is of the same order as, or a little less than, the intra-racial variability. I think this result is more in keeping with the monogenetic, rather than with the polygenetic, view of the origin of the human species.

Further, allowing a deviation of roughly twice the standard deviation on either side of the mean, we find that for the intra-racial variability the normal range of fluctuation is approximately from 5·00 to 7·25, and for the Co-efficient of variation from 2·50 to 4·00 for ordinary homogeneous samples.

Section V.—Anglo-Indian Variability.

Standard Deviation.—Compared to the values of the S. D. discussed above there is no doubt that the Anglo-Indian variability (σ=8·63) is excessive. In actual magnitude it is greater than any variability we have come across in the present material based on a sample of 25 or more. The differences between the Anglo-Indian variability and the variabilities given in the main Tables 10 and 11 are in every case statistically significant with only two exceptions : Hawaiian All-mixture (7·47) and the Inner Mongolian sample (7·57). In both these cases the size of the sample is small, and the statistical insignificance may very well be due to the large errors of sampling.

We must conclude, therefore, that the Anglo-Indian sample shows an abnormally high variability in Head Length and definitely indicates recent inter-mixture. It may also be partly due to Head Length being one of the characters in which its racial constituents are more dissimilar and heterogeneous.

Co-efficient of Variation.—The Anglo-Indian value, V=4·73 $\pm$ ·16 is definitely and significantly higher than 4, thus confirming the results obtained by a comparison of the absolute variability.

The excessive variability of the Anglo-Indian Head Length may be due to great dissimilarity in the Head Length of the European and the Indian parent groups. It may also be partly due to a greater variability in Head Length among the parents on the Indian side. I shall discuss this point in greater detail when I shall have occasion to consider the Indian Caste data.

In spite of the excessive variability it is, however, remarkable that the frequency distribution of Anglo-Indian Head Length can be graduated satisfactorily by a continuous normal curve or by a curve of Type IV. We failed to find the slightest evidence of a Bi—or Multi—

Modal distribution. We conclude, therefore, that so far as Head Length is concerned, variation is continuous even in such a recently hybridised group as the Anglo-Indians. Either there is no Mendelian segregation in Head Length, or, if there is, the factors involved must be sufficiently complex and numerous to produce a practically continuous variation.

Section VI.—Summary of Conclusions.

(A) *Descriptive.*

(1) The sample of 200 Anglo-Indian Head Lengths can be graduated fairly well by a normal curve.

(2) The graduation is, however, improved appreciably by the use of a Pearsonian Type IV curve. This is in accordance with the results found by other observers.

(3) The normal frequency curve can be split up into two component normal curves with the same Mean value but widely different Standard Deviations. This is in agreement with the analysis of Stature obtained before. For both Stature and Head Length about a fourth of the sample appears to represent a stringently selected population.

(4) Apparently there is a small increase in Head Length between the ages of 15 and 35 which is probably significant. This is followed by a sharp decrease after 35 years. The change of Head Length with age can be represented by a cubic equation. Analysis of the variance shows, however, that owing to the smallness of the number of individuals in the different age-groups no definite significance can be attached to the Non-Linear Regression.

(B) *Comparative.*

(5) A study of material collected from different parts of the world suggests the possibility of constructing the following provisional standards for the comparison of homogeneity.

A Provisional Scale for Variability in Head Length.

Grade of Variability.	Value of S. D. (σ)	Value of Co-efficient of Variation. (V)	Typical Groups.
I. Exceptionally Pure	Less than 5·50	Less than 2·75	Kharga Oasis, American Indian Tribes.
II. Very Homogeneous	5·50—6·00	2·75—3·00	Aino, Modern Egyptians, African Tribes.
III. Homogeneous	6·00—6·25	3·00—3·25	English, Swedish groups.
IV. Slightly Mixed	6·25—6·50	3·25—3·50	Chinese Turkestan, Scottish Insane.
V. Moderately Mixed	6·50—7·00	3·50—3·75	Polynesian groups, Cyprus, Crete, Malta.
VI. Highly Mixed	7·00—7·50	3·75—4·00	Koreans, Serbians, Inner Mongolia.

(6) The observed variabilities for the different groups discussed in section IV fit in fairly satisfactory in the above scale and have values of the order of magnitude one would expect them to have in view of the antecedents of the respective groups.

(7) There are only a few exceptions. The greater variability of the Scottish Insane is either due to the existence of a real heterogeneity among the inhabitants of Scotland, or is due to some peculiarity of the Insane population. The American Negroes show quite normal variability $\sigma=6{\cdot}51$, $V=3$, only slightly greater than that of stable European groups like the English or Swedish. This indicates that the American Negroes are already approximating to a homogeneous group so far as Head Length is concerned. The excessive variability of the Koreans may be ascribed to recent inter-mixture with the Chinese.

(8) For the present material the mean value of intra-racial variability (within the group) is $\sigma=6{\cdot}08$ mm, while the inter-racial variability (from group to group) is $\Sigma=4{\cdot}55$ mm. That is, the individuals within a single homogeneous group show greater variation than the mean values for different groups. This result is in accordance with a monogenetic view of the origin of the human species.

(C) *Anglo-Indian Variation.*

(9) Anglo-Indian variability in Head Length as judged by the actual value of the Standard Deviation ($8{\cdot}63 \pm {\cdot}29$) or by the Co-efficient of Variation ($4{\cdot}73 \pm {\cdot}16$) is definitely and significantly greater than the variability of the other groups. This indicates recent intermixture between parent groups with widely dissimilar values of Mean Head Length.

(10) In spite of the excessive variability, the Anglo-Indian sample shows a continuous variation in Head Length. This indicates either the absence of Mendalian segregation in Head Length, or in case Mendalian segregation does occur, the existence of complex and numerous factors which serve to produce practically a continuous variation in Head Length.

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LIST OF ABBREVIATIONS.

1. *Anthrop. Anz.* Anthropologische Anzeiger (*Leipzig*).
2. *Biom.* Biometrika (*London*).
3. *J. A. S. B.* Journal of the Asiatic Society of Bengal (*Calcutta*).
4. *J. R. A. I.* Journal of the Royal Anthropological Institute (*London*).
5. *M. d. Anthrop. G. Wien.* Mitteilungen der Anthropologische Gesellschaft in Wien (*Vienna*).
6. *M. d. K. Univ. Tokio.* Mitteilungen der medizinische Fakultat der Kaiserliche Universität, Tokio. (*Tokio*).
7. *Mem. B. P. B. Mus.* Memoirs of the Bernice Puahi Bishop Museum (*Honolulu*).
8. *Rec. Ind. Mus.* Records of the Indian Museum (*Calcutta*).
9. *Z. f. Ethn.* Zeitschrift für Ethnologie (*Berlin*).

TABLE I.—INDIVIDUAL MEASUREMENTS FOR ANGLO-INDIANS.

(1) Serial No.	(2) Card No.	(3) Age.	(4) Stature.	(5) Head Length.	(6) Head Breadth.	(7) Ceph. Index.	(8) Nasal Length.	(9) Nasal Breadth	(10) Nasal Index.	(11) Zygo. Breadth.	(12) Upper Face Length.
1	87	15	1446	178	144	80·9	44	38	86·4	124	56
2	166	16	1624	162	142	87·6	47	27	57·4	102	57
3	186	16	1588	179	150	83·8	49	39	79·6	110	69
4	147	16	1666	174	142	81·6	50	36	72·0	118	63
5	144	16	1726	188	144	76·6	56	37	66·1	122	69
6	250	17	1656	178	134	75·3	50	34	68·0	118	65
7	175	17	1588	171	130	76·0	47	30	63·8	101	66
8	145	17	1588	196	146	74·5	44	38	86·4	130	60
9	289	17	1544	190	144	75·8	47	28	59·6	115	64
10	76	17	1642	182	138	75·8	49	37	75·5	112	62
11	120	17	1610	176	150	85·2	57	33	57·9	110	66
12	143	17	1662	186	136	73·1	44	34	77·3	118	57
13	44	17	1708	182	140	76·9	47	33	70·2	112	63
14	253	18	1746	172	140	81·4	53	34	64·1	134	65
15	141	18	1768	196	146	74·5	46	35	76·1	118	63
16	132	18	1610	182	148	81·3	45	35	77·8	110	60
17	258	18	1602	184	138	75·0	49	28	57·1	114	66
18	86	18	1636	192	140	72·9	50	39	78·0	118	64
19	191	18	1660	174	150	86·2	53	34	64·1	114	71
20	160	18	1570	183	145	79·2	39	34	87·2	121	51
21	251	18	1574	180	138	76·7	52	37	71·1	116	64
22	94	18	1580	186	146	78·5	40	40	100·0	126	57
23	288	19	1638	190	140	73·7	50	37	74·0	120	69
24	277	19	1636	174	132	75·9	43	33	76·7	117	62
25	294	19	1634	185	149	80·5	50	36	72·0	120	68
26	66	19	1630	186	144	77·4	51	34	66·7	108	64
27	286	19	1626	170	136	80·0	44	32	72·7	122	62
28	298	19	1614	184	142	77·2	51	37	72·5	111	68
29	53	19	1604	180	142	78·9	44	35	79·5	110	58
30	75	19	1586	184	140	76·1	50	36	72·0	114	65
31	238	19	1458	174	138	79·3	51	33	64·7	109	68
32	226	19	1768	190	148	77·9	51	35	68·6	125	68
33	4	19	1768	188	144	76·6	47	33	70·2	122	58
34	151	19	1760	190	132	69·5	47	38	80·8	122	64
35	295	19	1744	183	142	77·6	50	33	66·0	120	69
36	174	19	1718	180	141	78·3	50	31	62·0	112	72
37	299	19	1705	202	146	72·3	49	39	79·6	134	69
38	6	19	1706	180	140	77·8	50	38	76·0	118	62
39	56	19	1780	189	134	70·9	45	35	77·8	126	58
40	146	19	1674	188	150	79·8	51	34	66·7	110	66

TABLE I.—INDIVIDUAL MEASUREMENTS FOR ANGLO-INDIANS—*contd.*

(1) Serial No.	(2) Card No.	(3) Age.	(4) Stature.	(5) Head Length.	(6) Head Breadth.	(7) Ceph. Index.	(8) Nasal Length.	(9) Nasal Breadth.	(10) Nasal Index.	(11) Zygo. Breadth.	(12) Upper Face Length.
41	176	19	1686	172	152	88·4	57	35	61·4	108	67
42	73	19	1666	184	136	73·9	46	37	80·4	114	64
43	246	19	1550	176	148	84·1	52	80	57·7	120	67
44	26	19	1646	162	151	93·2	54	33	61·1	122	66
45	140	19	1644	166	146	87·9	51	34	66·7	118	70
46	91	19	1640	198	144	72·7	43	35	81·4	124	55
47	46	20	1716	192	142	74·0	53	34	64·1	118	65
48	110	20	1712	188	148	78·7	56	37	66·1	118	66
49	142	20	1710	182	152	83·5	46	34	73·9	115	64
50	235	20	1700	182	138	75·8	49	34	69·4	125	70
51	8	20	1680	182	143	78·6	46	33	71·7	109	63
52	175	20	1670	179	140	78·2	52	36	69·2	110	67
53	14B	20	1673	178	145	81·5	46	37	80·4	129	69
54	168	20	1664	174	138	79·3	51	34	66·7	128	67
55	241	20	1638	186	148	79·6	58	35	60·3	122	74
56	156	20	1622	192	141	73·4	49	34	69·4	104	51
57	280	20	1622	178	144	80·9	54	30	55·6	120	63
58	248	20	1562	164	138	84·1	46	29	63·0	111	58
59	65	20	1500	178	144	80·9	48	37	77·1	114	62
60	275	20	1510	164	128	78·0	44	33	75·0	107	62
61	217	20	1514	170	138	81·2	49	33	67·3	116	69
62	152	20	1610	181	140	77·3	45	33	73·3	111	69
63	67	20	1650	190	136	71·6	51	37	72·5	120	59
64	219	20	1620	176	140	79·5	53	35	66·0	115	67
65	172	20	1658	170	143	84·1	48	34	70·8	120	65
66	107	21	1626	168	146	86·9	49	34	69·4	114	64
67	102	21	1636	182	132	72·5	46	38	82·6	110	58
68	111	21	1650	174	148	85·0	48	35	72·9	122	62
69	287	21	1654	180	146	81·1	49	40	81·6	120	72
70	234	21	1656	186	130	69·9	52	30	57·7	117	73
71	99	21	1708	178	134	75·3	49	38	77·5	126	64
72	133	21	1730	186	150	80·6	50	37	74·0	118	63
73	101	21	1768	187	152	81·3	50	34	68·0	120	59
74	51	21	1768	182	152	83·5	50	36	72·0	126	67
75	106	21	1704	179	146	81·6	51	39	76·3	124	66
76	10	21	1694	182	140	76·9	49	36	73·5	119	65
77	281	21	1696	180	140	77·8	52	32	61·5	125	69
78	28	21	1672	184	136	73·9	53	36	67·9	120	63
79	227	21	1678	186	128	68·8	54	41	75·9	126	64
80	267	21	1624	180	134	74·4	53	31	58·5	122	36

TABLE I.—INDIVIDUAL MEASUREMENTS FOR ANGLO-INDIANS—*contd.*

(1) Serial No.	(2) Card No.	(3) Age.	(4) Stature.	(5) Head Length.	(6) Head Breadth.	(7) Ceph. Index.	(8) Nasal Length.	(9) Nasal Breadth.	(10) Nasal Index.	(11) Zygo. Breadth.	(12) Upper Face Length.
81	88	21	1628	184	148	80·4	45	40	88·9	126	58
82	9	22	1730	181	140	77·3	49	36	73·5	122	65
83	148	22	1726	162	140	86·4	50	39	78·0	112	67
84	74	22	1716	190	148	77·9	52	34	65·4	136	64
85	180	22	1700	186	140	75·3	51	35	68·6	109	63
86	149	22	1700	180	149	82·8	50	36	72·0	112	65
87	108	22	1684	184	142	77·2	54	41	75·9	118	73
88	103	22	1688	184	146	79·3	48	33	68·7	120	63
89	170	22	1677	182	135	74·2	49	33	67·3	124	66
90	72	22	1650	184	140	76·1	50	42	84·0	118	67
91	96	22	1568	182	142	78·0	45	40	88·9	120	57
92	43	22	1576	178	148	83·1	56	35	62·5	134	70
93	177	22	1608	180	143	79·4	45	31	68·9	100	57
94	25	22	1644	170	140	82·3	47	34	72·3	112	57
95	68	22	1644	184	142	77·2	54	37	68·5	118	69
96	7	22	1636	174	134	77·0	50	37	74·0	111	67
97	136	22	1636	190	142	74·7	48	35	72·9	108	67
98	134	22	1616	182	152	83·5	58	35	60·3	120	67
99	243	22	1654	190	150	78·9	55	34	61·8	122	75
100	62	22	1658	182	136	74·7	50	42	84·0	124	64
101	40	23	1692	186	146	78·5	49	34	69·4	128	68
102	11	23	1692	184	142	77·2	45	34	75·6	116	68
103	265	23	1680	174	142	81·6	49	37	75·5	119	68
104	12B	23	1775	202	131	64·8	51	36	70·6	126	74
105	64	23	1472	160	132	82·5	45	31	68·9	92	56
106	61	23	1572	188	146	77·7	45	39	86·7	118	56
107	269	23	1624	192	140	72·9	55	34	61·8	125	72
108	42	23	1646	190	134	70·5	48	38	79·2	114	67
109	224	24	1592	181	130	71·8	45	42	93·3	127	61
110	45	24	1610	180	148	82·2	44	45	102·3	120	59
111	54	24	1620	170	146	85 9	48	37	77·1	122	58
112	297	24	1690	172	142	82·6	52	36	69·2	126	73
113	50	24	1670	182	142	78·0	48	37	77·1	114	64
114	1	24	1684	192	151	78·6	50	37	74·0	129	63
115	13	24	1696	184	142	77·2	53	33	62·3	124	65
116	230	24	1634	192	138	71·9	55	38	69·1	122	71
117	284	24	1596	184	156	84·8	50	34	68·0	118	64
118	276	24	1636	184	140	76·1	54	41	75·0	124	64
119	47	24	1644	192	142	74·0	48	38	7 ·2	124	65
120	57	25	1738	186	152	81·7	57	37	64·9	122	74

TABLE I.—INDIVIDUAL MEASUREMENTS FOR ANGLO-INDIANS—*contd.*

(1) Serial No.	(2) Card No.	(3) Age.	(4) Stature.	(5) Head Length.	(6) Head Breadth.	(7) Ceph. Index.	(8) Nasal Length.	(9) Nasal Breadth.	(10) Nasal Index.	(11) Zygo. Breadth.	(12) Upper Face Length.
121	262	25	1513	178	140	78·6	54	33	61·1	114	68
122	54	25	1580	186	146	78·5	54	35	64·8	120	62
123	285	25	1619	186	140	75·3	49	35	71·4	123	64
124	48	25	1630	190	154	81·0	53	36	67·9	124	63
125	3	25	1634	172	150	87·2	52	37	71·1	120	63
126	293	26	1644	171	142	83·0	59	36	61·0	114	80
127	240	26	1638	178	134	75·3	49	32	65·3	119	65
128	282	26	1656	180	136	75·6	49	42	85·7	126	70
129	263	26	1730	199	146	73·4	60	38	63·3	134	82
130	2	26	1710	180	142	78·9	40	37	92·5	110	60
131	60	26	1604	182	148	81·3	48	37	77·1	130	66
132	58	26	1628	174	148	85·1	56	33	58·9	130	64
133	231	26	1616	172	144	83·7	56	31	55·4	129	71
134	63	27	1522	180	142	78·9	46	34	73·9	122	54
135	27	27	1700	194	142	73·2	50	34	68·0	126	64
136	119	27	1692	173	140	80·9	51	35	68·6	121	66
137	38	27	1770	190	138	72·6	50	39	78·0	120	66
138	39	27	1776	212	152	71·7	51	39	76·5	128	69
139	29	27	1796	184	142	77·2	48	36	75·0	114	67
140	137	27	1840	184	156	84·8	48	39	81·2	125	67
141	20	27	1656	180	150	83·3	60	34	56·7	109	64
142	14	27	1650	181	140	77·3	42	27	64·3	110	59
143	31	28	1610	178	148	83·1	49	41	83·7	122	68
144	232	28	1636	174	144	82·8	54	30	55·6	125	70
145	223	28	1754	180	146	81·1	59	36	61·0	124	77
146	32	28	1662	196	152	77·5	49	36	73·5	118	60
147	78	28	1662	189	134	70·9	48	33	68·7	130	60
148	271	29	1780	192	146	76·0	57	35	61·4	133	75
149	268	29	1584	156	138	88·5	52	35	67·3	118	62
150	36	29	1730	186	146	78·5	54	33	61·1	119	67
151	278	29	1722	181	134	74·0	53	41	77·4	120	70
152	247	29	1620	170	144	84·7	56	38	67·9	127	71
153	33	29	1608	190	146	76·8	52	33	63·5	120	67
154	279	29	1562	186	140	75·3	46	35	76·1	121	67
155	55	29	1578	194	148	76·3	50	35	70·0	134	64
156	35	30	1656	178	142	79·8	50	39	78·0	120	67
157	135	30	1712	184	138	75·0	49	32	65·3	114	68
158	22	30	1734	180	154	85·6	49	38	77·5	134	67
159	34	30	1760	192	144	75·0	45	37	82·2	124	61
160	260	30	1708	176	144	81·8	62	37	59·7	115	71

TABLE I.—INDIVIDUAL MEASUREMENTS FOR ANGLO-INDIANS—*concld.*

(1) Serial No.	(2) Card No.	(3) Age.	(4) Stature.	(5) Head Length.	(6) Head Breadth.	(7) Ceph. Index.	(8) Nasal Length.	(9) Nasal Breadth.	(10) Nasal Index.	(11) Zygo. Breadth.	(12) Upper Face Length.
161	216	30	1684	188	138	73·4	68	34	50·0	120	75
162	232	30	1640	190	140	73·7	56	36	64·3	125	71
163	229	30	1628	172	136	79·1	53	35	66·0	121	67
164	77	30	1614	184	144	78·3	48	35	72·9	124	65
165	18	30	1572	186	139	74·7	44	36	81·8	120	63
166	266	30	1694	176	140	79·5	58	35	60·3	115	80
167	37	30	1698	182	139	76·4	48	34	70·8	120	65
168	283	31	1716	190	143	75·3	56	35	62·5	131	75
169	220	32	1640	188	140	74·5	50	34	68·0	128	68
170	97	32	1606	182	138	75·8	47	40	85·1	120	59
171	105	32	1592	180	142	78·9	50	37	74·0	120	63
172	19	32	1714	189	142	75·1	45	38	84·4	120	61
173	201	32	1720	191	142	74·3	46	40	86·9	122	64
174	70	32	1734	198	154	77·8	59	44	74·6	124	72
175	159	33	1617	181	152	84·0	54	34	63·0	104	66
176	264	33	1624	170	150	88·2	51	32	62·7	130	70
177	93	33	1788	190	148	77·9	48	30	62·5	124	62
178	79	35	1704	184	144	78·2	49	35	71·4	134	64
179	155	35	1722	190	153	80·5	50	35	70·0	123	69
180	17	35	1670	194	144	74·2	44	38	86·4	120	62
181	71	38	1644	180	139	77·2	52	37	71·1	120	65
182	82	39	1610	190	142	74·7	50	37	74·0	128	63
183	92	39	1714	186	140	75·3	50	40	80·0	118	67
184	252	40	1848	186	154	82·8	52	35	67·3	127	70
185	131	41	1638	164	142	86·6	50	35	70·0	120	62
186	49	42	1704	202	154	76·2	54	39	72·2	126	74
187	52	42	1756	178	140	78·6	52	35	67·3	114	66
188	165	43	1540	173	132	76·3	43	35	81·4	110	65
189	15	44	1610	190	150	78·9	52	36	69·2	122	71
190	5	45	1598	170	144	84·7	55	36	65·4	116	66
191	95	48	1574	182	138	75·8	47	35	74·5	126	62
192	98	..	1554	176	142	80·7	47	37	78·7	134	60
193	16	..	1586	185	140	75·7	52	40	76·9	120	62
194	228	..	1632	176	138	78·4	59	34	57·6	111	65
195	30	..	1654	186	146	78·5	46	39	84·8	126	66
196	12	..	1670	191	143	74·9	45	35	77·8	127	62
197	150	..	1690	170	140	82·3	51	36	70·6	120	67
198	118	..	1694	189	136	71·9	49	35	71·4	120	62
199	112	..	1700	189	142	75·1	54	37	68·5	118	72
200	6B	..	1711	205	150	73·2	53	36	67·9	130	70

TABLE II.—STATISTICS OF HEAD LENGTH.

(1) Reference.	(2) Serial No.	(3) Name of Sub-Group.	(4) Total No. of Individuals. (n)	(5) Standard Deviation. (σ)	(6) $Log_e\ \sigma$.	(7) Co-efficient of Variation. (V)	(8) Mean Head Length (M)
Hrdlicka (18), 1912.	1	Kharga Oasis	150	5·05± ·20	1·6194	2·67± ·10	189·0± ·28
		S—1. AMERICAN TRIBES.					
Boas and Livingston (4), 1898.	2	Nass River Indians.	27	6·18± ·57	1·8213	3·17± ·29	195·26± ·80
	3	Haida	9	5·30± ·84	1·6677	2·72± ·43	194·78±1·19
	4	Tsimshian	15	4·69± ·58	1·5454	2·43± ·30	193·40± ·82
	5	Nkamtcinemq	23	5·27± ·52	1·6620	2·79± ·28	188·78± ·74
	6	Bilqula	26	6·05± ·57	1·8001	3·20± ·30	188·73± ·80
	7	Spuzzum	12	6·94± ·96	1·9373	3·68± ·51	188·33± 1·35
	8	Lilloet (Fraser River).	17	4·98± ·58	1·6054	2·65± ·31	188·12± ·82
	9	Ntlakyapamuqoe	27	4·69± ·43	1·5454	2·51± ·23	186·89± ·61
	10	Utamkt	18	4·96± ·56	1·6014	2·67± ·30	186·72± ·79
	11	Chilcotin	36	4·59± ·37	1·5238	2·46± ·20	186·58± ·52
	12	Stlemqolequmq	48	4·45± ·31	1·4929	2·39± ·17	186·07± ·44
	13	Harrison Lake	15	4·77± ·59	1·5623	2·61± ·32	183·13± ·83
	14	Lilloet (Anderson Lake).	20	5·48± ·58	1·7011	3·01± ·32	181·75± ·83
		S—2. BORNEO AND JAVA (3).					
Garett (14), 1912	15	Sundanese	37	5·28± ·42	1·6639	3·93± ·33	176·9 ± ·59
	16	Javanese	17	4·68± ·42	1·5433	2·63± ·32	177·6 ± ·77
	17	Banjerese	33	6·22± ·52	1·8278	3·44± ·29	181·2 ± ·73
	18	Lycian Gypsies	53	5·73± ·38	1·7457	3·25± ·21	176·33± ·53
Dudley Buxton (8), 1920(*a*).	19	Aino	95	5·88± ·29	1·7716	3·03± ·15	193·78± ·41
		S—3. EAST AFRICAN TRIBES.					
Leys and Joyce (23), 1913.	20	Somali	27	4·75± ·44	1·5581	2·48± ·23	191·81± ·62
	21	Masai	91	5·28± ·26	1·6639	2·71± ·14	194·67± ·37
	22	Njemps	11	4·90± ·70	1·5892	2·57± ·37	191·27±1·00
	23	Kamasia	20	6·66± ·71	1·8961	3·46± ·37	192·70±1·00
	24	Suk	15	4·24± ·52	1·4446	2·34± ·29	185·80± ·74
	25	Nandi	14	4·06± ·52	1·4012	2·15± ·27	189·29± ·73
	26	Turkama	9	4·46± ·71	1·4953	2·36± ·38	189·00±1·00
	27	Nilotic Kavirondo.	37	6·31± ·49	1·8421	3·35± ·26	188·38± ·70
	28	Bantu Kavirondo.	24	5·04± ·49	1·6174	2·65± ·26	189·88± ·69
	29	Baganda	44	7·48± ·54	2·0109	3·91± ·28	191·30± ·76
	30	Kaseri	12	6·06± ·83	1·8017	3·19± ·46	190·08±1·19
	31	Sukuma	21	6·46± ·67	1·8656	3·37± ·35	191·43± ·95

TABLE II.—STATISTICS OF HEAD LENGTH—*contd.*

(1) Reference.	(2) Serial No.	(3) Name of Sub-Group.	(4) Total No. of Individuals. (n)	(5) Standard Deviation. (σ)	(6) Loge σ.	(7) Co-efficient of Variation. (V)	(8) Mean Head Length. (M)
		S—3. EAST AFRICAN TRIBES—*contd.*					
Leys and Joyce (23), 1913.—*contd.*	32	Manyema	42	6·85± ·50	1·7664	3·63± ·27	188·62± ·71
	33	Nyasa	21	5·87± ·61	1·7699	3·10± ·32	189·57± ·86
	34	Segeju	36	5·29± ·43	1·5872	2·76± ·23	191·91± ·61
	35	Ajawa	16	4·89± ·58	1·6658	2·53± ·30	192·94± ·82
	36	Segua	12	6·49± ·89	1·8703	3·36± ·46	192·92±1·27
	37	Swahili	53	7·22± ·47	1·9769	3·81± ·25	189·38± ·67
	38	Lamu	26	4·68± ·44	1·5433	2·51± ·23	186·65± ·61
	39	Rabai	13	7·25± ·96	1·9810	3·84± ·51	188·69±1·35
	40	Digo	15	6·75± ·83	1·9095	3·59± ·44	188·13±1·18
	41	Duruma	67	5·90± ·35	1·7901	3·18± 19	188·39± ·49
	42	Giriama	24	5·90± ·57	1·7750	3·15± ·31	187·13± ·81
	43	Nyika	18	5·75± ·65	1·7492	3·06± ·34	188·06± ·91
	44	Chaga	18	5·08± ·57	1·6253	2·71± ·30	187·33± ·81
	45	Kikuyu	384	6·13± ·14	1·8132	3·25± ·08	188·72± ·21
	46	Kamba	128	5·24± ·22	1·6563	2·79± ·12	187·80± ·31
	47	Embu	110	6·52± ·41	1·8749	3·45± ·31	189·08± ·44
	48	Wanyamwezi	101	5·67± ·27	1·7352	2·97± ·14	191·01± ·38
	49	Kachamega	100	6·19± ·30	1·8229	3·36± ·16	184·22± ·42
Malcolm (28), 1925.	50	Egap (W. Africa).	100	6·28± ·29	1·8374	3·27± ·18	191·48± ·42
		S—4. MODERN EGYPTIANS.					
Orensteen (33)	51	Alexandria	643	5·99± ·11	1·7901	3·16± ·06	189·74± ·16
Craig(7),1915-1917.	52	Cairo	802	5·96± ·10	1·7851	3·13± ·05	190·46± ·14
	53	Canal	127	5·74± ·24	1·7475	3·01± ·13	190·61± ·34
	54	Beheira	526	5·89± ·12	1·7732	3·08± ·06	191·18± ·17
	55	Gharbia	1104	6·01± ·09	1·7934	3·15± ·05	190·97± ·12
	56	Menufia	717	6·04± ·11	1·7984	3·16± ·06	191·06± ·15
	57	Daquahlia	504	6·65± ·14	1·8946	3·49± ·07	190·35± ·20
	58	Sharqia	515	6·16± ·13	1·8180	3·23± ·07	190·79± ·18
	59	Qualiubia	295	5·90± ·16	1·7749	3·09± ·09	190·82± ·23
	60	Giza	326	5·75± ·15	1·7492	3·00± ·08	191·66± ·22
	61	Fayum	413	5·92± ·14	1·7783	3·09± ·07	191·20± ·20
	62	Benisuef	384	5·65± ·14	1·7317	2·95± ·07	191·70± ·19
	63	Minia	491	5·71± ·12	1·7422	2·98± ·06	191·73± ·17
	64	Assiut	887	5·84± ·09	1·7647	3·06± ·05	190·91± ·13
	65	Girga	610	6·03± ·12	1·7967	3·15± ·06	191·51± ·16
	66	Qena	824	6·01± ·10	1·7934	3·15± ·05	191·19± ·14
	67	Aswan	262	6·00± ·18	1·7918	3·15± ·09	190·44± ·25

TABLE II.—STATISTICS OF HEAD LENGTH—*contd.*

(1) Reference.	(2) Serial No.	(3) Name of Sub-Group.	(4) Total No. of Individuals. (n)	(5) Standard Deviation. (σ)	(6) Log_e σ.	(7) Co-efficient of Variation. (V)	(8) Mean Head Length. (M)
		S—4. MODERN EGYPTIONS—*contd.*					
Brit. Assoc. Rep. (5), 1905.	68	Egyptian Moslems.	369	6·09± ·15	1·8066	3·13± ·08	194·56± ·21
Harmon (16), 1926.	69	English, General Sample.	4721	6·26± ·04	1·8342	3·20± ·02	195·56± ·0
Macdonell (27), 1901-02.	70	Cambridge Students.	1000	6·16± ·09	1·8181	3·18± ·05	193·51± ·13
		S—5. CAMBRIDGE STUDENTS.					
Pearson (35), 1906.	71	1st Class Hons.	153	5·89± ·23	1·7733	3·02± ·12	195·07± ·32
	72	2nd Class Hons.	182	6·03± ·21	1·7967	3·10± ·11	194·51± ·30
	73	3rd Class Hons.	189	6·21± ·22	1·8262	3·20± ·11	194·38± ·30
	74	Poll-men	487	6·11± ·13	1·8099	3·16± ·07	193·33± ·19
Schuster (40), 1911-12.	75	Oxford Students	959	6·23± ·09	1·8294	3·17± ·05	196·05± ·13
v. Luschan, E. and F. (25), 1914.	76	English (Brit. Association).	84	6·16± ·32	1·8181	3·20± ·17	198·51± ·45
Macdonell (27), 1901-02.	77	English, Non-habitual Criminals.	3000	6·05± ·05	1·8001	3·15± ·03	191·66± ·08
Goring (15), 1913	78	English, Habitual Criminals.	2348	6·39± ·06	1·8547	3·34± ·03	192·45± ·09
		S—6. SWEDISH GROUPS.					
Lündborg and Linders (26), 1926.	79	Swedish North, Agricultural.	2,993	6·05± ·08	1·8001	3·12± ·03	193·74± ·07
	80	Swedish North Mixed.	1,059	6·10± ·13	1·8083	3·16± ·05	192·95± ·13
	81	Swedish North, Industrial.	406	6·05± ·21	1·8001	3·15± ·07	191·90± ·20
	82	Swedish North, Urban.	337	6·35± ·24	1·8485	3·30± ·09	192·61± ·23
	83	Swedish West, Agricultural.	7054	6·00± ·05	1·7918	3·08± ·02	194·69± ·05
	84	Swedish West, Mixed.	3,200	6·10± ·08	1·8083	3·14± ·03	194·54± ·07
	85	Swedish West Industrial.	1,245	6·41± ·13	1·8579	3·30± ·04	194·36± ·12
	86	Swedish West, Urban.	1,723	6·02± ·10	1·7951	3·10± ·04	193·91± ·10
	87	Swedish East, Agricultural.	6,496	6·23± ·05	1·8294	3·21± ·02	194·12± ·05
	88	Swedish East, Mixed.	4,642	6·27± ·07	1·8358	3·24± ·02	193·74± ·06
	89	Swedish East, Industrial.	1,894	6·28± ·10	1·8374	3·24± ·04	193·59± ·10
	90	Swedish East, Urban.	2,465	6·20± ·09	1·8245	3·20± ·03	193·54± ·08

TABLE II.—STATISTICS OF HEAD LENGTH—*contd.*

(1) Reference.	(2) Serial No.	(3) Name of Sub-Group.	(4) Total No. of Indivi-duals. (n)	(5) Standard Deviation. (σ)	(6) $\log_e \sigma$	(7) Co-efficient of Variation. (V)	(8) Mean Head Length. (M)
		S—6. SWEDISH GROUPS—*contd.*					
Lundborg and Linders (26), 1926—*contd.*	91	Swedish South, Agricultural.	3,687	6·06 ± ·07	1·8017	3·13 ± ·02	193·62 ± ·07
	92	Swedish South, Mixed.	2,665	6·04 ± ·08	1·7984	3·13 ± ·03	193·01 ± ·08
	93	Swedish South, Industrial.	625	6·02 ± ·17	1·7951	3·12 ± ·06	193·13 ± ·16
	94	Swedish South, Urban.	1,737	6·00 ± ·10	1·7918	3·10 ± ·04	193·20 ± ·10
	95	Swedish Four Big Cities.	4,755	6·27 ± ·06	1·8358	3·24 ± ·02	193·31 ± ·06
		S—6. GREEK (COMBINED) (2).					
Schiff (39), 1914	96	Greeks from Mani.	99	6·01 ± ·29	1·7934	3·32 ± ·16	187·09 ± ·41
Brit. Assoc. Rep. (6), 1912.	97	Greek Youths	99	6·35 ± ·31	1·8485	3·45 ± ·17	183·60 ± ·43
Pöch (38), 1925	98	Ukranians	249	6·02 ± ·18	1·7951	3·27 ± ·10	184·10 ± ·26
Brezina & Wastl (4), 1929.	99	Austrians	192	6·03 ± ·21	1·7967	3·17 ± ·11	190·16 ± ·29
		S—7. CHINESE TURKESTAN.					
Joyce (19), 1912	100	Kafir	18	5·48 ± ·61	1·7011	2·87 ± ·32	190·72 ± ·87
	101	Chitrali	22	6·42 ± ·65	1·8594	3·51 ± ·36	1[illegible]8·64 ± ·92
	102	Mastuji	28	6·50 ± ·59	1·8718	3·50 ± ·32	185·64 ± ·83
	103	Sarikoli	40	4·85 ± ·37	1·5790	2·65 ± ·20	188·23 ± ·52
	104	Bagh-Jigda	12	6·38 ± ·89	1·8532	3·46 ± ·48	184·42 ± 1·24
	105	Pakhpo	5	5·72 ± 1·22	1·7440	3·06 ± ·65	186·88 ± 1·73
	106	Nissa	9	4·62 ± ·73	1·5304	2·44 ± ·39	189·56 ± 1·04
	107	Kökyar	37	5·69 ± ·45	1·7387	3·18 ± ·25	179·19 ± ·63
	108	Karanghu-tagh	21	8·72 ± ·91	2·1656	4·55 ± ·47	191·67 ± 1·07
	109	Korla	14	5·06 ± ·64	1·6213	2·74 ± ·35	184·21 ± ·91
	110	Wakhi	9	6·15 ± ·98	1·8164	3·33 ± ·53	184·74 ± 1·38
	111	Turfan	72	5·13 ± ·29	1·6351	2·79 ± ·16	183·64 ± ·41
	112	Khotan	67	6·24 ± ·36	1·8310	3·42 ± ·20	180·50 ± ·52
	113	Hami	21	4·80 ± ·50	1·5686	2·56 ± ·38	187·70 ± ·72
	114	Charklik	12	9·11 ± 1·25	2·2093	4·78 ± ·66	190·67 ± 1·78
	115	Loplik	38	6·78 ± ·52	1·9139	3·50 ± ·27	193·97 ± ·74
	116	Chinese	20	5·18 ± ·55	1·6448	2·17 ± ·23	192·45 ± ·78
	117	Keriya	21	7·25 ± ·75	1·9810	4·03 ± ·42	179·95 ± 1·07
	118	Niya	18	4·96 ± ·56	1·6014	2·78 ± ·31	178·44 ± ·79
	119	Polu	31	6·83 ± ·59	1·9213	3·14 ± ·38	185·45 ± ·83

TABLE II.—STATISTICS OF HEAD LENGTH—*contd.*

(1) Reference.	(2) Serial No.	(3) Name of Sub-Group.	(4) Total No. of Individuals. (n)	(5) Standard Deviation. (σ)	(6) $\log_e \sigma$	(7) Co-efficient Variation. (V)	(8) Mean Head Length. (M)
		S—7. CHINESE TURKESTAN—*contd.*					
Joyce (19), 1912 —*contd.*	120	Aksu	13	7·25± ·96	1·9801	4·17± ·55	173·92±1·35
	121	Faizabad	12	6·30± ·87	1·8406	3·46± ·48	181·92±1·23
	122	Kelpin	15	7·58± ·93	2·0255	4·20± ·52	180·47±1·32
	123	Dolan	16	6·24± ·74	1·8310	3·52± ·44	182·20±1·12
	124	Kirghiz	38	6·48± ·50	1·8687	3·59± ·28	180·50± ·70
Boas (2), 1924	125	Armenians	75	6·30± ·35	1·8406	3·38± ·19	186·5 ± ·49
		S—8. SCOTTISH INSANE.					
Tocher (46), 1906-07.	126	Scottish, General Insane.	4,381	6·55± ·05	1·8795	3·55± ·03	195·44± ·07
	127	Stottish, Insane Criminals.	..	.. ..	..	..	..
	128	Scottish, Aberdeen Students.	493	5·73± ·12	1·7457	2·94± ·06	194·80± ·17
		S—9. POLYNESIAN.					
Sullivan (41), 1921.	129	Samoan	68	5·69± ·33	1·7387	2·98± ·17	190·6 ± ·46
Sullivan (42), 1922.	130	Marquesas	79	7·00± ·38	1·9459	3·60± ·19	193·2 ± ·53
Sullivan (43), 1923.	131	Tongan	117	6·89± ·30	1·9301	3·60± ·16	191·0 ± ·43
Sullivan and Wissler (44), 1929.	132	Hawaiian (29-50).	206	6·78± ·23	1·9140	3·61± ·12	187·85± ·32
Sullivan and Wessler (44), 1929.	133	Hawsiian ? (29-50).	47	6·37± ·44	1·8516	3·42± ·24	186·00± ·63
		S—10. EASTERN MEDITERRANEAN.					
Dudley Buxton (10), 1922.	134	Malta	561	6·63± ·13	1·8916	3·51± ·07	188·70± ·19
Dudley Buxton (10), 1922.	135	Gozo	82	6·55± ·34	1·8795	3·57± ·09	185·38± ·49
Dudley Buxton (9), 1920(*b*).	136	Cyprus	586	7·00± ·14	1·9459	3·87± ·08	180·81± ·20
v. Luschan (24) 1913.	137	Crete	320	7·24± ·19	1·9756	3·78± ·10	191·76± ·52
Kubo (21), 1913	138	Koreans .	552	7·10± ·14	1·9601	3·91± ·08	181·37± ·20
Libzelter (22), 1923.	139	Serbians .	196	7·33± ·20	1·9918	4·03± ·14	181·91± ·35

TABLE II.—STATISTICS OF HEAD LENGTH—*concld.*

(1) Reference.	(2) Serial No.	(3) Name of Sub-Group.	(4) Total No. of Indivi-duals. (n)	(5) Standard Deviation. (σ)	(6) Log_e σ	(7) Co-efficient of Variation. (V)	(8) Mean Head Length. (M)
		S—10. EASTERN MEDITERANEAN—*contd.*					
Dudley Buxton (11), 1926.	140	Inner Mongolia	52	7·57± ·50	2·0242	4·00± ·26	188·27± ·71
Herskovits (17), 1927.	141	American Negroes.	961	6·51± ·10	1·8733	3·31± ·05	196·50± ·14
		S—11. POLYNESIAN MIXED.					
Sullivan and Wessler (44), 1929.	142	Hawaiian—Asiatic.	33	6·61± ·55	1·8886	3·59± ·29	183·91± ·78
Sullivan and Wessler (44), 1929.	143	Hawaiian, South European.	19	8·69± ·95	2·1622	4·86± ·53	187·16±1·34
Sullivan and Wessler (44) 1929.	144	Hawaiian, North European.	70	6·76± ·39	1·9110	3·56± ·20	189·63 + ·54
Sullivan and Wessler (44), 1929.	145	Hawaiian, All European.	89	7·29± ·37	1·9865	3·85± ·19	189·10± ·52
	146	Anglo-Indians	200	8·63± ·29	2·1552	4·73± ·16	182·45± ·41

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