Herat. They do not recognise the authority of the Amir of Kabul, and should the Czar, as about title of "Emperor of Central Asia," claim the allegiance of this outlying Central Asiatic tribe, here will be a fruitful source of future complications. Their submission would at once advance the Russian frontier far into Afghan territory and up the Murgab valley to within easy distance of Herat from the north. The route in this direction is well known, and constantly traversed by traders from Khiva, Bokhara, and Samarqand. It appears to present no greater difficulties than the more westerly route crossing the Barkol ridge recently surveyed by Lessar.

There remain to be mentioned the Kataghání Usbeks, who form the bulk of the population in Afghan Turkestan. They belong to the same ethnical group as the Usbeks of the Khwarazm, and have even some settlements in Bokhara beyond the Oxus. They are mostly agriculturists and traders, Sunni Mohammedans of pure Turkic speech, and bear with reluctance the hard yoke of their Afghan masters. Their sympathies are entirely with their northern kinsmen, and as the country (Kunduz, Balkh, Maiman) belongs geographically to the Aymalo-Caspian basin, it is difficult to see how further rectifications of frontier can ultimately be prevented in this direction. Exponents of a public opinion in Russia already openly claim the whole of this region to the crest of the Hindu-Kush as properly belonging to the ruler of Central Asia, and their arguments are largely based on ethnological grounds.

### Table of the North Afghan Border Tribes

<table>
<thead>
<tr>
<th>Tribe</th>
<th>Locality</th>
<th>Population</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tadjik</td>
<td></td>
<td>150,000</td>
</tr>
<tr>
<td>Badaksh</td>
<td></td>
<td>160,000</td>
</tr>
<tr>
<td>Wakhi</td>
<td></td>
<td>300,000</td>
</tr>
<tr>
<td>Shugnání</td>
<td></td>
<td>25,000</td>
</tr>
<tr>
<td>Kohistán</td>
<td></td>
<td>20,000</td>
</tr>
<tr>
<td>Fier-Khót</td>
<td></td>
<td>2000?</td>
</tr>
<tr>
<td>Jemshidí</td>
<td></td>
<td>12,000</td>
</tr>
<tr>
<td>Tjálkí</td>
<td></td>
<td>300,000</td>
</tr>
<tr>
<td>Affghán</td>
<td></td>
<td>100,000</td>
</tr>
</tbody>
</table>

**Caucasian Stock**

**Mongolic Stock**

| Hazarahs | Házarāját | 300,000 |
| Aínak    | Ghur, Herat, Khorasan | 350,000 |
| Salor Turkoman | Maragab, Murgab | 35,000 |
| Kataghání Usbeks | Afghan Turkestan, Bokhara | 600,000 |

A. H. Keane

| ANTHROPOMETRIC PER-CENTILES |

### SEND the following Table, partly to exemplify what I trust will be found a convenient development of a statistical method that I have long advocated, and partly for its intrinsic value, whatever that may be. It will at all events interest those of the 937 persons measured in my Anthropometric Laboratory at the late International Health Exhibition, who may wish to discover their place among the rest. Its meaning is plain, and will be understood by the help of a single example, for which I will take the line referring to Strength of Squeeeze among males. We see that a discussion was made of 519 measurements in that respect, of men whose ages ranged between 23 and 26; and of whom 45 per cent. of them were not able to exert a squeeze with their strongest hand the squeeze was measured by

| a spring dynamometer that surpassed 67 lbs. of pressure; that 90 per cent. could exert one that surpassed 71; 80 per cent. one that surpassed 76; and so on. The value which 50 per cent. exceeded, and 50 per cent. fell short of, is the Median Value, or the 50th per-centile, and this is practically the same as the Mean Value; its amount is 75 lbs. This line of the Talagggan figures only presents an exact and very complete account of the distribution of strength in one respect among the middle 90 per cent. of any group of males of the tabular ages similar to those who were measured at the laboratory. The 5 per cent. lowest and the 5 per cent. highest cannot be derived directly from it, but their values may be approximately inferred from the run of the tabular figures, supplemented by such deductions as the Law of Error may encourage us to draw. Those who wish to apply this law will note that the probable error is half the difference between the 75th and the 25th per-centile, which can easily be found by interpolation, and they will draw the per-centiles that correspond respectively to the median value of their twice, three times, and three-and-a-half times the probable error, at the graduations 87, 24, 08, and those that correspond to the median value plus those amounts, at the graduations 91.5, 97.6, and 99.2. The Table is a mere statement of observed fact; there is no theory whatever involved in its construction, beyond simple interpolations between values that differ little from one another and which have been found to run in very regular series. It may be used in many ways. Suppose, for example, that a man of the tabular age, viz. above 23 and under 26, and who could exert a squeeze of 80 lbs., desired to know his rank among the rest, the Table tells him at once that his strength in this respect certainly exceeds that of 90 per cent. of those who were measured, because if it had been only 79 lbs. it would have done so. It also tells him that his strength does not exceed that of 40 per cent. of the rest, since it would have required a pressure of 81 lbs. to have done this. He therefore ranks between the 90th and the 40th per-centile, and a very simple mental sum in proportion shows his place to be about the 33rd or 34th in a class of 100.

The Table exhibits in a very striking way the differences between the two sexes. The 5th male per-centile of strength of squeeze is equal to the 90th female per-centile, which is nearly but not quite the same as saying that the man who ranks 5th from the bottom of a class of 100 males would rank 90th from the top in a class of 100 females. The small difference between the two forms of expression will be explained further on. If the male per-centiles of strength of squeeze are plotted on ruled paper, beginning with the lowest, and if the female per-centiles are plotted on the same paper, beginning with the highest, the curves joining their respective tops will be found to intersect at the 7th per-centile, which is the value that 7 of the females and 93 of the males just surpass. Therefore, if we wished to select the 100 strongest individuals out of two groups, one consisting of 100 males chosen at random, and the other of 100 females, we should take the 100 males and draft out the 7 weakest of them, and draft in the 7 strongest females. Very powerful women exist, but happily perhaps for the repute of the other sex, such gifted women are rare. Out of 1657 adult females of various ages measured at the laboratory, the strongest could only exert a squeeze of 86 lbs., or about that of a medium man. The population of England hardly contains enough material to form even a few regiments of efficient Amazon.

The various measurements of males surpass those of females in very different degrees, but in nearly every particular. A convenient way of comparing them in each case is that which I have just adopted, of finding the per-centile which has the same value when reckoned from the lower end of the male series, and from the higher end of the female series. When this has been done, the position of the
ANTHROPOMETRIC PER-CENTILES

Values surpassed, and Values unachieved, by various percentages of the persons measured at the Anthropometrical Laboratory in the late International Health Exhibition

(The value that is unachieved by $n$ per cent. of any large group of measurements, and surpassed by 100$-n$ of them, is called its $n$th percentile)

| Subject of measurement | Age | Unit of measurement | Sex | No. of persons in the group | 95 | 90 | 80 | 70 | 60 | 50 | 40 | 30 | 20 | 10 | 5 |
|------------------------|-----|---------------------|-----|-----------------------------|----|----|----|----|----|----|----|----|----|----|----|----|----|
| Height, standing, without shoes | 23-31 | Inches | M. | 811 | 611 | 585 | 564 | 537 | 523 | 508 | 495 | 483 | 471 | 460 | 450 | 440 | 430 |
|                           |     |                     | F. | 770 | 585 | 564 | 537 | 523 | 508 | 495 | 483 | 471 | 460 | 450 | 440 | 430 | 420 |
| Height, sitting, from seat of chair | 23-31 | Inches | M. | 1013 | 811 | 788 | 764 | 741 | 724 | 709 | 699 | 690 | 682 | 674 | 667 | 660 | 654 | 649 |
|                           |     |                     | F. | 775 | 585 | 564 | 537 | 523 | 508 | 495 | 483 | 471 | 460 | 450 | 440 | 430 | 420 | 410 |
| Span of arms | 23-31 | Inches | M. | 811 | 611 | 585 | 564 | 537 | 523 | 508 | 495 | 483 | 471 | 460 | 450 | 440 | 430 | 420 |
|                           |     |                     | F. | 770 | 585 | 564 | 537 | 523 | 508 | 495 | 483 | 471 | 460 | 450 | 440 | 430 | 420 | 410 |
| Weight in ordinary indoor clothes | 23-36 | Pounds | M. | 520 | 121 | 125 | 131 | 135 | 143 | 146 | 156 | 165 | 172 | 185 | 193 | 201 | 210 | 219 |
|                           |     |                     | F. | 276 | 102 | 105 | 110 | 114 | 118 | 122 | 129 | 136 | 142 | 149 | 156 | 162 | 168 | 175 |
| Breathing capacity | 23-36 | Cubic inches | M. | 212 | 161 | 177 | 187 | 199 | 211 | 219 | 226 | 235 | 247 | 264 | 282 | 299 | 317 | 334 |
|                           |     |                     | F. | 277 | 92 | 102 | 115 | 124 | 131 | 138 | 144 | 151 | 157 | 163 | 167 | 166 | 169 | 172 |
| Strength of pull at archer with bow | 23-36 | Pounds | M. | 519 | 56 | 60 | 64 | 68 | 74 | 87 | 95 | 104 | 108 | 110 | 113 | 114 | 116 | 119 | 120 |
|                           |     |                     | F. | 276 | 30 | 32 | 34 | 36 | 38 | 40 | 42 | 44 | 47 | 51 | 54 | 56 | 59 | 62 | 67 |
| Strength of squeeze with strongest hand | 23-36 | Pounds | M. | 219 | 67 | 71 | 76 | 79 | 82 | 85 | 88 | 91 | 95 | 100 | 104 | 109 | 113 | 117 | 121 |
|                           |     |                     | F. | 276 | 39 | 39 | 43 | 47 | 49 | 52 | 55 | 58 | 62 | 67 | 72 | 77 | 81 | 86 | 91 |
| Swiftness of blow | 23-36 | Feet per second | M. | 516 | 132 | 141 | 152 | 162 | 173 | 181 | 191 | 200 | 209 | 223 | 236 | 248 | 260 | 272 | 284 |
|                           |     |                     | F. | 271 | 92 | 101 | 113 | 121 | 128 | 134 | 140 | 145 | 151 | 156 | 162 | 169 | 176 | 183 | 190 |
| Sight, keenness of | | by distance of reading diamond test-type | | | | | | | | | | | | | | | | |
|                           | 23-36 | Inches | M. | 308 | 13 | 17 | 20 | 22 | 25 | 26 | 28 | 30 | 32 | 34 | 34 | 34 | 34 | 34 | 34 |
|                           |     |                     | F. | 433 | 10 | 12 | 16 | 19 | 22 | 24 | 26 | 28 | 30 | 32 | 34 | 34 | 34 | 34 | 34 |

per-centiles arranged in order of their magnitude are as follows:—Pull, 4; Squeeze, 7; Breathing capacity, 10; Height, 14; Weight, 26; Swiftness of blow, 26; Keenness of sight, 57. We conclude from them that the female differs from the male more conspicuously in strength than in any other particular, and therefore that the commonly used epithet of "the weaker sex," is peculiarly appropriate.

The Table was constructed as follows:—I had groups of appropriate cases extracted for me from the duplicate records by Mr. J. Henry Young, of the General Register Office. I did not care to exhaust the records, but requested him to take as many as seemed in each case to be sufficient to give a trustworthy result for these and other purposes to which I desired to apply them. The precise number was determined by accidental matters of detail that in no way implied a selection of the measurements. The summarised form in which I finally took them in hand, is shown in the two upper lines of the following specimen:—

Height, Sitting, of Female Adults, Aged 23-50, in inches

<table>
<thead>
<tr>
<th>29-30</th>
<th>31-32</th>
<th>33-34</th>
<th>35-36</th>
<th>37</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>8</td>
<td>52</td>
<td>116</td>
<td>226</td>
<td>227</td>
</tr>
<tr>
<td>2</td>
<td>10</td>
<td>62</td>
<td>178</td>
<td>404</td>
<td>631</td>
</tr>
</tbody>
</table>

Abscissae 0 to 775

1. The meaning of the two upper lines is that in a total of 775 observations there were 2 cases measuring 29 and under 30 inches, 8 cases measuring 30 and under 31 inches, and so on. The third line contains the sums of the entries in the second line reckoned from the beginning, and is to be read as follows:—2 cases under 30 inches, 10 cases (= 2 + 8) under 31 inches, 62 cases (= 2 + 8 + 52) under 32 inches, and so on.

2. I plotted these 775 cases on French "sectional" paper, which is procurable in long and inexpensive rolls, ruled crossways by lines 1 millimetre apart. I counted the first line as 0° and the 775th as 775°. Supposing the measurements to have been plotted in the order of their magnitude, in succession between these lines, the first would stand between 0° and 1', the second between 1' and 2', and so on. Now we see from the Table that the second measurement was just short of 30 inches, consequently the third measurement was presumably just beyond it, therefore the abscissa whose value is 2', and which separates the second from the third measurement, may fairly be taken to represent the abscissa of the ordinate that is equal to 30 inches exactly. Similarly, the abscissa whose value is 10° divides the measurement that is just under 31 inches from that which is presumably just above it, and may be taken as the abscissa to that ordinate whose precise value is 31°, and so on for the rest. The fourth line of the Table gives the ordinates thus determined for the abscissae whose values are entered above them in the third line. I dotted the values of these ordinates in their right places on the sectional paper, and joined the dots with a line, which in every case, except the breathing capacity, fell into a strikingly regular curve. (I cannot account for this one partial exception, save on the supposition of the somewhat irre-
gular mixture of town and country folk, and of sedentary
and active professions among the persons measured, but
I have not yet verified this surmise.) Per-centiles were
then drawn to the curve corresponding to absicasse that
were respectively 5 per cent., 10 per cent., 20 per cent.
&c., of the length of the base line. As the length of the
base line was 275, these per-centiles stood at the graduations
138°, 275°, 550°, &c. Their values, as read off on the
sectional paper, are those which I have given in the
Table.

It will be understood after a little reflection that the 9th
rank in a row of 10, the 90th rank in a row of 100, and
the 900th rank in a row of 1000, are not identical, and
that none of them are identical with the 90th per-
centile. There must always be the difference of one half-
place between the post which each person occupies in a row of
π individuals, numbered from 1 to π, and that of the
graduations corresponding to the points of the πth, 90th,
and 900th man in the above example, refer to the distance
of those points from the beginning at 0 of their several base
lines, and those distances are related to the lengths of the
base lines in the proportions of 8/9, 10/9, 20/10, and 89/93,
1000, which when reckoned in per-cent of the several
base lines are 83, 89, and 89% respectively. The larger
the number of places in the series, the more insignificant
does this half-place become, and Moreover, the intrusion of
each fresh observation into the series separates its neigh-
bours by almost double that amount, and propagates a
disturbance that reaches to either end, though it is
exhausted to almost nothing by the time it has arrived
there. We may therefore ignore the existence of this
theoretically troublesome half-place in our ordinary
statistical work.

There is a latent source of error that might affect such
statistics as these, as well as many others that are drawn
up in the usual way, which has not, so far as I
know, been recognised, and deserves attention. It is due to
uncertainty as to the precise meaning of such headings as
30, 31, &c. If the measurements, no matter whether
they were made carefully or carelessly, are read off from the
instruments with great nicety, then a reading such as
30.99 would fall in the column 30-, and the mean of all
the entries in such a column might fairly be referred to a
mean value of 30.5.

But if the instruments are roughly read, say, to the
nearest half inch, the reading of a real instrumental
value of 30.99, and even that of a real value of 30.76, would
both be entered in the column 31. The column 30-
would then contain measurements whose real instrumental
values ranged between 30.75 and 30.75; and the column
31- would contain those that ranged between 30.75 and
31.75; consequently, the means of all the entries in those
columns respectively should be referred, not to 30.5 and
31.5, but to 30.25 and to 31.25. An error of a quarter
of an inch in the final results might easily be occasioned
by the neglect to note the degree of minuteness with which
the instruments were read, and I strongly suspect that
many statistical tables are affected by this generally un-
recognised cause of error. The measurements at my
laboratory were read to the nearest tenth of an inch and
a fraction of a pound, so I can afford to disregard this
consideration. There was, however, a slight bias in
favour of entering round numbers, which should have
been, but were not (because I neglected to give the neces-
sary instructions), rateably divided between the columns
on either side.

A fuller description of the results of the measurements
at the laboratory will appear next February or March in
the forthcoming number of the Journal of the Anthro-

ological Institute, at which place the original data will
ultimately be deposited.

FRANCIS GALTON

NOTES

It having become known to some of the friends of the late
Mr. Henry Watts, the well-known chemist, whose death
had occurred very suddenly on the 30th of last June, that his
widow and family are in very straitened circumstances,
informal meetings was recently held at the Royal Institution.
Those present resolved to form themselves into a committee,
with power to add to their number, in order to collect a fund
for the benefit of Mrs. Watts and those of her children, who are
not of an age to provide for their own support. Dr. Atkinson
consigned to act as secretary; and Dr. Perkin, President of the
Chemical Society, as treasurer. Among the names on the com-
mittee are those of Sir F. A. Abel, Prof. H. E. Armstrong,
Mr. William Crookes, Dr. Warren De La Rue, Prof. James
Dewar, Prof. G. C. Foster, Dr. J. H. Gladstone, Prof. A. G.
Harcourt, Dr. Hugo Müller, Dr. William Odlng, Dr. W.
H. Perkin, Dr. B. W. Richardson, Prof. W. Chandler Roberts,
S. H. E. Roscoe, Dr. W. J. Russell and Prof. A. W.
Williamson. Mr. Watts's public labours for the advancement
of chemical science may be said to have begun with the transla-
tion of Gmelin's "Handbook of Chemistry," the admirable
English edition of which was prepared and edited for the
Cavendish Society by him. This work occupied eighteen large
octavo volumes, of which the first appeared in 1849, and the
second in 1851. A work scarcely, if at all, inferior to this in
magnitude, and one which has perhaps been of even greater
service to English chemists, both scientific and industrial, is
Watts's great "Dictionary of Chemistry," which appeared from
1863 to 1881, in eight volumes, containing nearly
9700 pages. Mr. Watts also edited and largely added to the
second volume of the late Prof. Graham's "Elements of
Chemistry," published in 1858; he prepared several editions of
Fownes's well-known "Manual of Chemistry," which he almost
entirely rewrote and made into a virtually new work; and in
conjunction with Mr. Ronalds and Dr. Richardson, he prepared
for Messrs. Bailliére an elaborate treatise on chemical tech-
nology. Up to the time of his death, and for about thirty years
previously, Mr. Watts was editor of the Journal of the
Chemical Society, and in this capacity, as well as in that of librarian
for the Chemical Society, he became personally known to
and gained the friendship of very many among the Fellows of the
Society. But although Mr. Watts's life was one of unmitting
labour, the money return for his work was barely sufficient to
enable him to provide for the daily wants of a delicate wife and
a numerous family. It was not possible for him to provide for
their future needs. But if he could not leave behind him
any pecuniary resources, he accumulated esteem and affection among
all who knew him, which, it is confidently hoped, will prove a
valuable legacy for those who are dependent on him. The
facts of the case show that there is a great need of whatever
practical proof of their regard for him and appreciation of his
labours Mr. Watts's friends, and English chemists generally,
may be willing to make. For many years Mrs. Watts has been
ill-health, so that she cannot do anything for her own support
and that of her family. One son is a permanent invalid, and
the four youngest children have still to be educated. A consider-
able expenditure is therefore unavoidable for a good many years
to come, if the children are to have a fair chance of a start in
life. A considerable sum has already been promised in the way
of subscriptions, but much more will have to be done in order
that any substantial benefit may accrue to Mrs. Watts and her
young family. Subscriptions will be received and acknowledged