This ratio is for

Jupiter	0.172
Saturn	0.374
Uranus	0.655
Neptune	1.02
Plato	1.46

The rings near the sun were flat. The smaller the ring the flatter it is. The rings of the smaller planets within the orbit of Jupiter, although the values $\varkappa$ and b have changed, all have been flat. Only those of Uranus, Neptune and Pluto attained a toruslike structure.

This, of course, will aid us to explain some features of these planets with their satellite systems. And here again we meet the 2 flat rings of Saturn, close round their primary, as living proofs of a structure, now clearly understood in its genesis by theory.

It is a stimulating aspect of the account which we have tried to give that the solar system in successive stages of evolution, could be identified with a CARTESIAN whirl, with KANT'S disc and the rings of LAPLACE. Even CHAMBERLIN and MOULTON'S planetesimals were met at a certain stage, whereas for JEANS' foreign star there might have been work to do at the moment of conception. It might have started the evolution, leaving the rest to be done spontaneously. At any rate, this beautifully ordered structure, which is our planetary system, is essentially self-made.

January 1940.

Anthropology. — *On the Increase of Stature in the Netherlands and the Possibility of its Explanation by Genetic Changes.* By W. A. MIJSBERG (Batavia).

(Communicated at the meeting of March 30, 1940.)

Since the middle of the preceding century the stature of the population of the Netherlands has considerably increased. This fact has been established by studying the measurements taken by the Boards which yearly carry out medical examinations on the male subjects that have reached the age of 19 years. As these examinations have to decide as to the fulfilment of military service they are compulsory; consequently the stature of each male of the said age is taken.

The extensive material on stature brought together in this way has been studied by BRUINSMA [1]), BOLK [2]) and VAN DEN BROEK [3]). As a result of their investigations it can be stated that in the period 1863—1925 the mean stature has continually increased, the total increase during that period being no less than 65 mm (VAN DEN BROEK).

A long time ago already it was established that at the age of 19 about 99 % of the adult stature is attained. Therefore the increase cannot be explained by assuming that nowadays the total stature is reached at an earlier time of life than was the case formerly. One is forced to admit that at present the adults are also taller. According to VAN DEN BROEK in 1921—1925 the mean stature of the conscripts was 170.77 cm. From the figures published by BENDERS (1938) [4]) it appears that since the latter period the increase has not been arrested. There is no reason to suppose that the increase should have been limited to the male part of the population.

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1) G. W. BRUINSMA, Toename in lichaamsbouw der mannelijke bevolking van Nederland. Ned. Tijdschr. v. Geneesk., p. 1495 (1906).

2) L. BOLK, Over de lichaamslengte der mannelijke bevolking van Nederland. Ned. Tijdschr. v. Geneesk., p. 1703 (1909).

L. BOLK, Over de toeneming in lichaamslengte der mannelijke bevolking van Nederland. Ned. Tijdschr. v. Geneesk., p. 650 (1910).

L. BOLK, Ueber die Körperlänge der Niederländer und deren Zunahme in den letzten Dezennien. Zeitschr. f. Morphol. u. Anthrop., **18** (1914).

3) A. J. P. VAN DEN BROEK, Over de voortzetting der toeneming van de lichaamslengte in Nederland. Proc. Kon. Akad. v. Wetensch., Amsterdam, **36** (1930).

A. J. P. VAN DEN BROEK, De anthropologische samenstelling der bevolking van Nederland. Mensch en Maatschappij (1930).

4) A. M. BENDERS, De toeneming der lichaamslengte van de bevolking in Nederland. Mensch en Maatschappij, **14** (1938).

With regard to the explanation of the increase different opinions have been expressed. In discussing them it should be borne in mind that the phenomenon is not confined to the Netherlands; it has been found in all European countries where it has been studied. Consequently the increase cannot be explained by assuming immigration of taller individuals and emigration of shorter ones. Especially for Sweden, the population of which belongs to the tallest of all, such an explanation is impossible. Yet in this country, as is proved by the extensive investigations of HULTKRANTZ (1927) [1]) and LUNDMAN (1939) [2]), an increase of at least 80 mm has occurred in the period 1840—1936. Since in the earlier years of this period the conscripts were measured at the age of 20, the increase must even be higher.

Most authors have expressed the view that improvement of external conditions has caused the increase. It is self-evident that not each individual will reach the maximal adult stature to which his hereditary factors might enable him. For the definite stature is brought about by growth, and all external influences which prevent the hereditary growth-factors from fully displaying their action will cause an adult stature that is shorter than the potential stature of the individual, i.e. the maximal stature that might have been reached on account of his hereditary factors.

Among such external influences insufficient quantity and especially insufficient quality of ingested food, moreover poor health, are of the utmost importance. The improvement of nutrition and of hygienic conditions which is still in progress, as it is spreading in all social layers of the population of the Netherlands, in my opinion [3]) largely accounts for the increasing average stature of the adults. Possibly the stimuli which nowadays in ever increasing number irritate the ears and the eyes and thus stimulate the neuro-glandular apparatus might play a certain part too (IMPERIALI, vide my paper just mentioned).

Accordingly the increase of stature depends on the fact that the mean observed stature of the population is ever more catching up with its mean potential stature.

Not all authors are of this opinion. According to them the mean potential stature has increased too; the latter change might perhaps be the more important one. Among them BENDERS [4]) has given a very definite account

[1]) J. V. HULTKRANTZ, Ueber die Zunahme der Körpergrösse in Schweden in den Jahren 1840—1926. Nova Acta Reg. Soc. Scientiarum Upsaliensis. Volumen extra ordinem editum 1927.

[2]) B. J. LUNDMAN, Ueber die fortgesetzte Zunahme der Körperhöhe in Schweden 1926 bis 1936. Zeitschr. f. Rassenkunde, **9** (1939).

[3]) W. A. MIJSBERG, Lichaamslengte als anthropologisch kenmerk. Natuurk. Tijdschr. v. Nederlandsch-Indië, **99** (1939).

[4]) A. M. BENDERS, De toeneming der lichaamslengte van de mannelijke bevolking in Nederland. Ned. Tijdschr. v. Geneesk., p. 1438 (1916).
A. M. BENDERS, De toeneming der lichaamslengte van de bevolking in Nederland. Mensch en Maatschappij, **14** (1938).

of the genetic changes which are said to have taken place. He based his explanation on BOLK's statement that the increase of stature which started in 1863 has been preceded by a decrease from 1821, the earliest year of which data are available, till 1858. If this is true the recent increase cannot be understood without first knowing the cause of the preceding decrease. According to BENDERS the decrease has resulted from the negative selection brought about by NAPOLEON's wars.

Before continuing BENDERS' reasoning I wish to lay stress on the fact that in studying all available data I reached the conclusion that during the period 1821—1858 no decrease of stature has taken place. BOLK's statement is based on part of the material only; if all the data are taken into account it appears, as I pointed out in my above-mentioned paper, that during the whole period in question the average stature of the conscripts was short. Some variability can be observed but no tendency towards greater average stature in the beginning of the said period than at its end can be detected.

Although the starting-point of BENDERS' hypothesis is erroneous I will continue his reasoning since it leads to some genetic questions which I wish to consider in this paper.

According to DAVENPORT [1]) (l.c., p. 315) CHARLES LYELL writing from France in 1828 says the French troops are "...... a stunted race. By accurate calculation of the height of men of the levy since the peace, it is found that the mean height of Frenchmen has been diminished several inches by the Revolution and NAPOLEON's wars. These are now the sons of those who were not thought by NAPOLEON strong and tall enough to fight and look well".

The same negative selection has according to BENDERS taken place in the Netherlands during the French supremacy from 1795 till 1815. In this period only the shorter men were allowed to stay at home, all of them could establish a family in mating with females of normal average potential stature (N-generation); of the taller men part was killed in the battlefields so that only part of them could marry and establish a family. Consequently the offspring (F_1-generation) of the parents during the said period had an average potential stature intermediate between the averages of the normal mothers and the negatively selected fathers.

By accepting BENDERS' suppositions regarding the age of marriage and the ages of the parents at the times of the births of their eldest and youngest children, it can be demonstrated that the individuals belonging to the F_1-generation appeared for the first time among the conscripts of the year 1820. In the following years the number of F_1-individuals increased till in 1840 all conscripts belonged to the F_1-generation. In this year the lowest average stature of the conscripts should have been observed, for

[1]) CH. B. DAVENPORT, Inheritance of Stature. Eugenics Record Office. Bulletin No. 18. (Genetics **2**) (1917).

starting in 1841 a yearly increasing number of individuals belonging to the N-generation, or after 1844, descending from at least one parent belonging to this generation, was admixed to the F_1conscripts. For further particulars I may refer to my paper "De toeneming van de lichaamslengte der bevolking van Nederland" which will shortly appear in the Journal "Mensch en Maatschappij". In that paper I am setting forth that on the base of BENDERS' hypothesis the mean potential stature of the Dutch conscripts must have been stabilized again about 1870 on a level between that of the N-generation and that of the F_1-generation. Consequently the up till recent times continuing increase of the mean actually observed stature of the conscripts cannot be explained by BENDERS' hypothesis.

BENDERS reached another result. According to him the increase of the average potential stature could not start in 1841; it was postponed till 1866 in consequence of the shortening influence exercised by the admixture of sons of parents both of which belonged to the F_1-generation. These sons, constituting the F_2-generation, according to him should have been extremely short. Now this surmise cannot be correct. For since both the parental generations had the same genetic compound with regard to factors for tallness it seems highly improbable that the average potential stature of their offspring (F_2-generation) should have differed from that of the parental-generations (F_1-generation). Still the question what changes could occur, seems interesting enough to be studied in detail.

For good reasons it may be assumed that the hereditary base of stature is due to the presence in each body-cell of a number of independent, similar and equal factors for tallness, the effect of which is cumulative. If we suppose that in the population no more than 3 pairs of factors can be present there will be seven groups, the members of one group being without factors for tallness, the members of the other groups having 1, 2, 3, 4, 5 and 6 such factors respectively in their body-cells. If we further suppose that in the Dutch population before 1795 the groups presented a normal distribution, the frequencies of the groups will be found by calculating for each group the possible combinations of its number of factors out of the total number of six. As follows from the theory of combinations the frequencies of the 7 groups will correspond with the coefficients of the terms resulting from expanding $(a + b)^6$ (vide table 1).

Since we also want to know in what frequencies different types of germ-cells in which factors up to three in number may be present, are produced by the individuals belonging to each group, it is of advantage to draw up the possible combinations for each group. Let us take as an example the group with 2 factors. Both the factors may be inherited from the father (3 possibilities) or from the mother (again 3 possibilities); but it is also possible that one factor has come from the father, yielding 3 possibilities each of which may occur in combination with the presence of each of the three possible maternal factors (3×3 combinations). The total number of combinations therefore is 15. Only in case each factor has

come from a different parent a pair of factors may be present; this occurs in three cases out of 15. In these cases all germ-cells are provided with one factor. In the other 12 combinations occurring in the body-cells the genes never form pairs; it can easily be computed that in those cases

TABLE 1.

Frequencies of groups with different numbers of factors for tallness in the body-cells in case of normal distribution the highest number of factors being six. Frequencies of germ-cell types in each group and in the population as a whole.

Factors in body-cells to the numbers of:	Frequencies of groups defined in first column	Frequencies of germ-cells with factors to the numbers of:			
		0	1	2	3
0	1 = 1.5625 %	1	—	—	—
I	6 = 9.3750 %	3	3	—	—
II	15 = 23.4375 %	3	9	3	—
III	20 = 31.2500 %	1	9	9	1
IV	15 = 23.4375 %	—	3	9	3
V	6 = 9.3750 %	—	—	3	3
VI	1 = 1.5625 %	—	—	—	1
	64	8	24	24	8

germ-cells without a factor, with one factor and with two factors are produced in the proportions of 1 : 2 : 1 or 3 : 6 : 3. It thus appears that by the group of individuals in whose body-cells two factors are present the said three types of germ-cells (0, 1 and 2) are produced in the proportions of 3 : 9 : 3. In table 1 these proportions have been set forth and the same has been done with regard to the other groups. By adding up the numbers it appears that in the whole population the four types of germ-cells are produced in the proportions of 1 : 3 : 3 : 1.

Now I do not wish to pretend that the Dutch population before 1795 should necessarily have possessed an entirely normal distribution of the seven groups in question. Probably some deviations from normal conditions were present, but, as will be understood presently, such deviations, if not too considerable, do not interfere with the general trend of our calculations.

Now according to BENDERS, during the period of the French supremacy a certain number of the taller men was killed. Consequently among the men who could form an offspring the groups with a low number of factors for tallness in their body-cells were more frequent than before. Let us suppose that all the men belonging to the groups 0 and I were too short and were therefore exempted from military service, whereas of each of the groups II to VI one third of the men was killed; then the proportions of the different groups among the men who could produce offspring were as represented in the second column of table 2.

The frequencies with which the different types of germ-cells occur in each group can be calculated in the same way as in table 1. The resulting proportions of germ-cell types in all male parents appear from table 2.

TABLE 2.

Frequencies of groups with different numbers of factors for tallness in their body-cells among males having married in the period 1795—1815. Frequencies of germ-cell types in each group and in all these males together.

Factors in body-cells to the numbers of:	Frequencies of groups defined in first column	Frequencies of male germ-cells with factors to the numbers of:			
		0	1	2	3
0	3	3	—	—	—
I	18	9	9	—	—
II	30	6	18	6	—
III	40	2	18	18	2
IV	30	—	6	18	6
V	12	—	—	6	6
VI	2	—	—	—	2
	135	20	51	48	16

These males married women in which the distribution of germ-cell types was normal. Male germ-cells without factors for tallness occurring in a frequency 20 out of 135 can fertilize female germ-cells of the four types in the proportions of 1 : 3 : 3 : 1. In order to avoid fractions the probabilities of such fertilizations are calculated for $8 \times 20 = 160$ male germ-cells of the 0-type out of a total number of 1080. The results are put down in table 3 (first vertical series of products), from which table the frequencies with which the other combinations occur may be seen too. By adding up the products horizontally, the frequencies with which in the F_1-generation the seven groups with different numbers of factors for tallness in their body-cells occur, can be computed (last column of table 3).

In comparison with normal distribution (vide table 1) the frequencies of the groups 0, I and II are higher in the F_1-generation, those of the other groups lower. The cause of these deviations appears from the first factors of the partial products in table 3.

It will be clear at once that the average potential stature of the F_1-generation is lower than that of the N-generation. In the latter it is equal to the potential stature of the individuals of group III. If it is supposed that to every additional factor present is due an equal increase of the potential stature by k units, the average potential stature of the F_1-generation is that of the individuals of group III minus $.055556\,k$. In table 4 this has been expressed as follows: III — $.055556\,k$.

If now one wishes to calculate the frequencies of the different groups in the F_2-generation (offspring of F_1-parents) it is necessary to compute first the proportions in which the four germ-cell types are produced in the F_1-generation. In order to do so it should be borne in mind that the individuals of the F_1-generation belonging to group III, taking these as an instance, have come into existence in four different ways with four different frequencies, as is illustrated by the partial products occurring in the corresponding horizontal row of table 3. In each case the proportions

TABLE 3.

F_1-generation. Frequencies of groups with different numbers of factors for tallness in their body-cells. These figures hold good for both sexes.

Factors in body-cells to the numbers of:	Frequencies of unions of the different types of parental germ-cells	Frequencies of groups defined in first column
0	20×1	$20 = 1.851852\,\%$
I	$20 \times 3 + 51 \times 1$	$111 = 10.277778\,\%$
II	$20 \times 3 + 51 \times 3 + 48 \times 1$	$261 = 24.166667\,\%$
III	$20 \times 1 + 51 \times 3 + 48 \times 3 + 16 \times 1$	$333 = 30.833333\,\%$
IV	$51 \times 1 + 48 \times 3 + 16 \times 3$	$243 = 22.500000\,\%$
V	$48 \times 1 + 16 \times 3$	$96 = 8.888889\,\%$
VI	16×1	$16 = 1.481481\,\%$
		1080

in which the four germ-cell types are produced have to be calculated separately. After doing this for all the partial products in table 3, the adding of the figures found gives the frequencies of the germ-cell types produced by the F_1-generation as a whole. It goes without saying that in both sexes the distribution is the same. The frequencies of the body-cell groups in the F_2-generation can now easily be found. Table 3 shows the way in which it is done. Since the distribution of germ-cell types is the same in both parental generations, some of the partial products are equal two by two, whereas of others the two factors are the same.

In order to find the distribution of body-cell groups in the F_3-generation (offspring of F_2-parents) and following generations the operations described should be repeated. Their most complicated part consists in establishing the distribution of germ-cell types in the next generation. Therefore it is of advantage to give this part of the calculations in a more generalized form as follows. If in both parental generations the 4 types of germ-cells are produced in the proportions of $p : q : r : s$, then in the next filial generation the same germ-cell types are produced in the following proportions:

$$
\begin{aligned}
0)\quad & 12p^2 + 12pq + 6pr + 3ps + 2q^2 + qr. \\
1)\quad & 12pq + 12pr + 9ps + 8q^2 + 11qr + 6qs + 2r^2. \\
2)\quad & 6pr + 9ps + 2q^2 + 11qr + 12qs + 8r^2 + 12rs. \\
3)\quad & 3ps + qr + 6qs + 2r^2 + 12rs + 12s^2.
\end{aligned}
$$

The sum of all terms is $12\,(p + q + r + s)^2$.

This formula corresponds with the one given by PHILIPTSCHENKO [1]) (p. 271). I derived the formula before knowing his, which testifies of the correctness of the two. Moreover in taking $p:q:r:s = 1:3:3:1$ the proportions in the F-generation are the same as in the parental generations, as should be the case in ideal distribution.

The formula may also be used in case the distribution of germ-cell types in one parental generation is in the proportions of $p:q:r:s$ and in the other of $a:b:c:d$; in such a case p^2 must be substituted by pa, pq by $(pb + qa):2$ etc.

By means of this formula I calculated the procentual frequencies of the seven groups which can be distinguished after the number of factors for tallness in the body-cells, in the F_2-, F_3- and F_4-generations. In table 4 these data have been given together with the corresponding data already known regarding the N- and F_1-generations.

TABLE 4.

Factors in body-cells to the numbers of:	Procentual frequencies of groups defined in first column				
	N	F_1	F_2	F_3	F_4
0	1.562500	1.851852	1.799448	1.771268	1.757653
I	9.375000	10.277778	10.181866	10.134001	10.109829
II	23.437500	24.166667	24.230955	24.265451	24.281572
III	31.250000	30.833333	31.024729	31.120814	31.169216
IV	23.437500	22.500000	22.529084	22.544258	22.552802
V	9.375000	8.888889	8.793362	8.745180	8.720954
VI	1.562500	1.481481	1.440556	1.419028	1.407974
Mean potential Stature	III	III — .055556 k	III — .055556 k	III — .055556 k	III — .055556 k

It appears from table 4 that in the generations which come after the F_1-generation, the frequencies of the extreme groups (0, I, V and VI) decrease, whereas those of the more central groups show an increase. The changes are greatest in passing from F_1 to F_2; in passing to younger generations they become smaller at every turn. *Notwithstanding these changes the mean potential stature remains the same in all generations succeeding the F_1-generation.*

The correctness of the latter important conclusion can be more directly proved in the following way. It was supposed that in the paternal and in the maternal generations the four types of germ-cells are produced in the proportions of $p:q:r:s$; consequently the average number of factors for tallness present in the germ-cells is $(q + 2r + 3s):(p + q + r + s)$.

[1]) J. PHILIPTSCHENKO, Ueber Spaltungsprozesse innerhalb einer Population bei Panmixie. Zschr. f. indukt. Abstamm. und Vererb.lehre, **35** (1924).

Since fertilization occurs according to chance the average number of factors present in the body-cells of the members of the F_1-generation will be twice as high. In the production of germ-cells the number of factors is divided into halves; therefore the mean number of factors present in the germ-cells of the F_1-generation must be equal to that of the parental generations. Thus it is evident that no change of the mean potential stature can occur in following generations.

In order to check the results obtained I repeated the calculations, starting from the assumption that the maximal number of factors for tallness to be found in the body-cells may be 5 pairs. In case of normal distribution the frequencies of the 11 groups comprising individuals with 0—XI factors in the body-cells respectively are given by the coefficients of the terms resulting from developing $(a + b)^{10}$, i.e.: 1, 10, 45, 120, 210, 252, 210, 120, 45, 10, 1. If it is supposed that during the French supremacy all male individuals of the groups 0—III could establish a family and produce offspring, whereas only half the male representants of the other groups could do so, the said eleven groups will have occurred in the male parental generations of that period in the proportions of $2:20:90:240:210:252:210:120:45:10:1$. In the same way as before the frequencies of the six male germ-cell types can be calculated; in the female generations the latter types are produced in the proportions of $1:5:10:10:5:1$ (normal distribution).

Again it is useful to derive a formula giving the frequencies of the six germ-cell types in the F_1-generation in case these frequencies in both parental generations are in the proportions of $p:q:r:s:t:u$. In this case the six types of germ-cells are produced in the F_1-generation in the following proportions:

0) $160\,p^2 + 160\,pq + 80\,pr + 40\,ps + 20\,pt + 10\,pu + 32\,q^2 + 24\,qr + 8\,qs + 2\,qt + 3\,r^2 + rs.$

1) $160\,pq + 160\,pr + 120\,ps + 80\,pt + 50\,pu + 96\,q^2 + 136\,qr + 80\,qs + 42\,qt + 20\,qu + 36\,r^2 + 29\,rs + 8\,rt + 3\,s^2.$

2) $80\,pr + 120\,ps + 120\,pt + 100\,pu + 32\,q^2 + 136\,qr + 144\,qs + 116\,qt + 80\,qu + 82\,r^2 + 130\,rs + 80\,rt + 40\,ru + 36\,s^2 + 24\,st.$

3) $40\,ps + 80\,pt + 100\,pu + 24\,qr + 80\,qs + 116\,qt + 120\,qu + 36\,r^2 + 130\,rs + 144\,rt + 120\,ru + 82\,s^2 + 136\,st + 80\,su + 32\,t^2.$

4) $20\,pt + 50\,pu + 8\,qs + 42\,qt + 80\,qu + 3\,r^2 + 29\,rs + 80\,rt + 120\,ru + 36\,s^2 + 136\,st + 160\,su + 96\,t^2 + 160\,tu.$

5) $10\,pu + 2\,qt + 20\,qu + rs + 8\,rt + 40\,ru + 3\,s^2 + 24\,st + 80\,su + 32\,t^2 + 160\,tu + 160\,u^2.$

The sum of these terms is $160\,(p + q + r + s + t + u)^2$.

With the help of the formula the frequencies of the 11 groups characterized by the number of factors for tallness in their body-cells have been calculated in case of normal distribution (N), in the sons and daughters of N-mothers and War-fathers (F_1), in the F_2-generation (offspring of F_1-parents) etc. The results have been laid down in table 5. From its

TABLE 5.

Factors in body-cells to the numbers of:	Procentual frequencies of groups defined in first column				
	N	F_1	F_2	F_3	F_4
0	.097656	.151042	.148020	.143361	.140647
I	.9765625	1.380208	1.344186	1.315598	1.300278
II	4.394531	5.625000	5.511122	5.449975	5.419483
III	11.718750	13.567708	13.458859	13.425304	13.411081
IV	20.5078125	21.614583	21.712964	21.784201	21.821805
V	24.609375	23.932292	24.206068	24.334278	24.396863
VI	20.5078125	18.750000	18.899491	18.955219	18.980493
VII	11.718750	10.286458	10.209534	10.168141	10.146921
VIII	4.394531	3.776042	3.652546	3.595257	3.567434
IX	.9765625	.833333	.781352	.756679	.744857
X	.097656	.083333	.075858	.071987	.070138
Mean potential Stature	V	V — .175000 k	V — .175000 k	V — .175000 k	V — .175000 k

figures it appears that a decrease of the frequencies of the extreme groups (0, I, II, III, VII, VIII, IX and X) occurs in the generations succeeding the F_1-generation; in passing to younger generations the changes gradually grow less considerable. The mean potential stature however remains fixed at the same distance below the potential stature of the individuals bearing 5 factors in their body-cells. The difference is .175000 k, the latter constant being the increase of potential stature due to the presence of each additional factor in the body-cells.

From his calculations PHILIPTSCHENKO has drawn the conclusion that as a result of the mixture of two different populations or of two layers of the same population which formerly did not mix, in the following generations increase or decrease of the numbers of individuals which in certain respects are far below or above the average may be expected to occur. This conclusion, which is of great importance in questions regarding race-crossing, has been affirmed by my own calculations. In my examples a decrease of the frequencies of the extreme groups occurred, but PHILIPTSCHENKO has demonstrated that in case the initial frequencies differ in other directions from normal distribution other changes may be seen. He even deduced formulas from which the changes to occur in following generations may be predicted.

In the course of his conclusions PHILIPTSCHENKO also stated (l.c., p. 277) that the decrease or the increase of the mean stature of the population which has been found in some countries, may be explained in the same way. This is the only reference to the problem of the increase of stature as well as to changes occurring in mean values to be found in his paper. Therefore one would be inclined to pass it over in silence if it had not found its way into the literature on the subject. Thus I am obliged to lay stress on the fact that PHILIPTSCHENKO did not give any proof whatever of the correctness of this statement, whereas it appears from my own calculations that although the frequencies of the different groups change in following generations, the mean potential stature remains fixed at the value it has in the F_1-generation.

It is HULTKRANTZ that felt inclined to attach much value to PHILIPTSCHENKO's explanation of the increase of stature in consequence of genetic changes brought about by mixture and BENDERS (1938) also mentioned it on HULTKRANTZ' authority. Both these authors lay stress on the mathematical base of PHILIPTSCHENKO's deductions, but unfortunately the latter author omitted the mathematic probing of only this one statement.

Another genetic explanation of the increase of the average stature of a population might possibly consist in the occurrence of heterosis resulting from mixture of different parts or layers of the population which previously did not mix. According to HULTKRANTZ (l.c., p. 50) WAALER, in a study on the Norwegian population, mentioned this possibility. HULTKRANTZ thinks its foundation insufficient, but according to LUNDMAN (l.c., p. 269) it is on the whole accepted by the Swedish geneticists.

By heterosis (= hybrid vigor = "Luxurieren der Bastarde") the well-known fact is expressed that crosses between different strains or races of plants or animals may produce offspring more vigorous in many respects than either parent type. It is most markedly in evidence when two highly inbred strains, i.e. strains consisting mainly of homozygous individuals, are crossed.

The explanation seems to be that the character in question (in our case stature) is the result of a number of cumulative factors present in both parental generations with the exception of at least one pair which is dissimilar in the two parental generations or is present in one of them only. Now all the individuals of the F_1-generation will be heterozygous with regard to the factors occurring in homozygous conditions in one of the parents only. If it is further assumed that the presence of one factor of the pair has the same effect on the phenotype as the pair of them has, it is evident that the main stature of the F_1-generation will exceed either of the parental generations in case each of them possesses at least one pair of factors not present in the other.

There are, however, many objections to explaining the increase of stature of a human population in this way.

1. Stature is a character which in the population presents a high variability similar to that of normal distribution. The genetic base of such variability is the presence of multiple factors which have a cumulative effect even when present as a pair. The assumption of genes which in heterozygous and in homozygous conditions have the same effect on the phenotype does not fit in with this kind of variability.

2. In case of heterosis in the F_2-generation (offspring of heterozygous F_1-parents) and following ones, the homozygous conditions will be partially restored which will cause a decrease of the mean stature; this result is well-known in plant breeding. Of course for the time being this decrease could be overcompensated by increase due to heterosis resulting from new hybridizations. Still very short individuals would continue to occur in younger generations as well as they did before. Now according to BOLK (l.c.) the minimal stature of 2000 non-Jewish conscripts in the town of Amsterdam was 120 cm in 1850, whereas in 1900 it was 144 cm. Among the Jewish population of this town (750 individuals examined) the lower limit of the range of variability rose during the same period from 126 cm to 144 cm!

3. If heterosis should occur in man it ought to be most clearly seen in crossings between individuals of two widely different races of mankind. It was FISCHER [1]) who, in studying the Rehobother Bastards, reached the conclusion that in some respects, especially in stature, the average of the hybrids surpassed those of both the European paternal and the Hottentot maternal ancestors. He ascribed this result to heterosis and expressed the view that BOAS' finds in North-American hybrids descending from European fathers and Indian mothers were due to the same cause. The great trouble with such investigations is that nothing definite is known of the average stature of the male ancestors. The investigator is therefore compelled to assume that their mean stature corresponded with that of the population from which they had emigrated. But it is of course quite possible that the emigrants belonged to the taller part of the population. The same holds good with regard to the female ancestors.

More recently FISCHER appears to be not so sure of the occurrence of heterosis in man as he was before. In 1930 he wrote [2]) (p. 184): "Man darf keinesfalls aus der Feststellung eines Luxurierens in zwei Fällen (BOAS und FISCHER—einmal angenommen, dass es wirklich ein Luxurieren ist) den Schluss ziehen, es müsse jede Rassenkreuzung zu Luxurieren führen". The latter warning refers to the circumstance that in other cases of race-crossing no signs of heterosis could be detected. But even in case a bastardpopulation should be taller than expected, FISCHER gives the following warning (l.c., p. 183): "Dabei möchte ich aber heute viel mehr als seiner Zeit bei meinen Bastarduntersuchungen betonen, dass man mit der Annahme echten Luxurierens sehr viel zurückhaltender sein muss. Einmal erklären uns die Annahme von Allelen und von Siebungsvorgängen (SCHEIDT) manche Fälle, die zuerst ein Luxurieren andeuten könnten..... etc.".

All in all the occurrence of heterosis in man seems far from being proved; moreover as explained before, with regard to the problem of the increase of stature, it does not seem a very successful hypothesis.

In the foregoing quotation FISCHER refers to two publications by SCHEIDT. In the first [1]), p. 134, SCHEIDT describes as "Luxurieren der Mischlinge" the fact that in a family some of the children may exceed either parent in some respects or fall behind them. Such a fact can be easily explained by multiple factors ("Allelen"). Only these individual variations do not explain the problem we are interested in, viz. the excess shown by the bastard population as a whole, as apparent from its average stature. It seems that FISCHER overlooked this difference.

In the second paper [2]) SCHEIDT emphasizes the onset of puberty as the event which puts an end towards growth. If in a population puberty sets in at a rather early time of life the population will stop growing early, before its members have reached their entire potential stature; consequently the average adult stature will be rather short. Here SCHEIDT is in accordance with DAVENPORT's earlier statement.

BOLK [3]) however found 1923 that in Dutch women the onset of puberty in the younger generation of his time occurred about $1\frac{1}{2}$ years earlier than it did in the preceding generation. According to FISCHER (l.c., p. 196) similar anticipation was found by STEIN in Germany (Freiburg) and by SCHREINER in Norway.

Still it may be safely accepted that the younger generation of Dutch women is on an average not shorter than the preceding one; on the contrary the continuous increase of stature proved in males seems to have occurred in the females as well. Consequently the onset of puberty must not be regarded as the important event which controls the extent to which the potential stature can be realized. It seems more probable that in the younger generation a more rapid growth occurred which permitted puberty to set in at an earlier time of life.

Thus SCHEIDT's efforts to explain the skewness of the frequency-

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[1]) E. FISCHER, Die Rehobother Bastards und das Bastardierungsproblem beim Menschen. Jena (1913).

[2]) E. FISCHER, Versuch einer Genanalyse des Menschen, mit besonderer Berücksichtigung der anthropologischen Systemrassen. Zschr. f. indukt. Abst. u. Vererb.lehre, **54** (1930).

[1]) W. SCHEIDT, Allgemeine Rassenkunde. München (1925).

[2]) W. SCHEIDT, Die Asymmetrie der Körpergröszenkurven und die Annahme der Poymerie. Arch. f. Rass.- u. Gesellsch.biol., **16** (1925).

[3]) L. BOLK, De Menarche bij de Nederlandsche vrouw en de vervroeging ervan bij de jongste generatie. Proc. Kon. Akad. v. Wetensch., Amsterdam, **32**, No. 7 (1923).
L. BOLK, Statistisch onderzoek over de Menarche bij de Nederlandsche bevolking. Geneesk. Bladen, **24**, No. 6 (1925).

curves of stature present in many populations and the increase of the average stature of the same by assuming recessive factors which stop growth before the individuals have reached their ultimate potential stature, are fruitless.

DAVENPORT's statement according to which persons of similar stature tend to marry each other interferes with the results of my calculations thus far, that the relative frequencies of the different groups of potential stature in following generations may differ from the figures given by me in the tables 4 and 5, since I supposed matings to occur according to chance only (panmixia). But it does not interfere with the principal result of my calculations, viz. the constancy of the mean potential stature in following generations. The more direct proof I gave of it remains valid. I emphasize this fact since SCHEIDT, by combining his hypothesis of recessive genes putting an untimely end to growth with DAVENPORT's selective matings, tried to prove the opposite.

I may conclude by saying that up till now the increase of the average stature of populations has not been satisfactorily explained from a genetic point of view. In my opinion such an explanation could only be given by proving that short individuals on an average produce less offspring than tall ones do. But I do not know of investigations indicating that bachelors and single women on the whole should be shorter than heads of families and married women, or that short parents on an average should get fewer children than tall parents.

Physics. — *Structure and* ZEEMAN-*effect of doubly ionized Thorium, Th. III.* By T. L. DE BRUIN and P. F. A. KLINKENBERG. (Communicated by Prof. P. ZEEMAN.)

(Communicated at the meeting of April 27, 1940.)

Introduction.

The work concerning the structure of the spectra of Thorium was begun in the laboratory "Physica" in 1935. At that time nothing was known about the spectral structure and even the separation between the lines belonging to the different stages of ionization was never investigated. Since we have made a new description of the spectra of thorium. New measurements of wavelengths have been made. An investigation concerning the absorption spectra with the under water spark method and the method of explosion of wires have been completed [1]. Farther extensive data of ZEEMAN-effects have been obtained [2].

In Th. III a scheme of levels was detected giving the j and g values. However it was not possible to identify the multiplets because the lines of Th. III mainly are in the ultra violet and the ZEEMAN-effects obtained with the grating mounting, are not sufficiently resolved. LANG has found independently many important $\Delta\nu$ differences however without indicating j values [3].

By means of new data obtained with a LUMMER plate it was possible to identify the terms originating from the most important electron configurations of the doubly ionized atom.

Spectrum of Thorium III.

The thorium III atom is an example of a two electron spectrum and terms of the configurations fd, fs, fp, ds, pd, d^2 etc. can be expected. It was however uncertain if the spectrum would have a structure similar to La. II [4]) and Ce. III [5]) or to Ti. III [6]) and Zr. III [7]). This was one of the

1) T. L. DE BRUIN and J. N. LIER, Proc. Kon. Ned. Akad. v. Wetensch., Amsterdam, **41**, 956 (1938).

2) J. N. LIER, Thoriumspectra en hun ZEEMAN-effect. Thesis, Amsterdam, June 1939.

3) R. J. LANG, Phys. Rev. **56**, 272. August 1939.

4) RUSSELL and MEGGERS, Nat. Bur. Stand. J. Research, **9**, 664 (1932).

5) T. L. DE BRUIN, J. N. LIER and H. J. v. D. VLIET, Proc. Kon. Akad. v. Wetensch., Amsterdam, **40**, 334 (1937).

H. N. RUSSELL, R. B. KING and R. J. LANG, Phys. Rev. **52**, 456 (1937).

H. J. v. D. VLIET, Het ZEEMAN-effect van de spectraallijnen van Cerium en Neodymium. Thesis, Amsterdam, Januari 1939.

6) RUSSELL and LANG, Astr. J. **66**, 13 (1927).

7) C. C. KIESS and R. J. LANG, Nat. Bur. Stand. J. Res. **5**, 305 (1930).