vie extrautérine d'une espèce dont la taille est extrêmement réduite et dont le cerveau est tout à fait embryonnaire au moment de la naissance [1]).

4) Les éléments constitutifs de la lamina granularis primaria représentent un stade évolutif général de l'évolution de la cellule nerveuse; il semble que chaque élément constitutif du système nerveux central doit passer par le stade des „grains".

5) En passant par les grains, les distributions antérieures de la substance chromatophile du noyau sont sacrifiées, et ce n'est qu'après une fusion complète de la substance chromatophile du noyau que sa différenciation définitive et l'apparition des corpuscules de NISSL du corps protoplasmique peuvent avoir lieu.

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[1]) Il est vrai qu'on n'a encore qu'une connaissance fragmentaire des différents stades évolutifs par lesquels les éléments constitutifs des différentes régions du système nerveux central doivent passer dans des conditions physiologiques ordinaires (intrautérines), et de la rapidité avec laquelle ces étapes sont parcourus. La coexistence de formes primitives et de formes mûres dans la même région n'est cependant pas chose rare.

ADDISON (Journ. of Comp. Neur., vol. **21**, No. 5) a étudié l'évolution des différents éléments constitutifs de l'écorce cérébelleuse chez le rat, par rapport aux différentes régions de l'organe. Le cervelet du rat nouveau-né est encore embryonnaire, ce qui est en concordance avec le comportement moteur de cette espèce au moment de la naissance. Bienque la description (quelque peu sommaire) de la structure cellulaire des éléments constitutifs du cervelet en formation n'admette pas une comparaison exacte avec mes observations propres, on voit cependant aisément que la couche granuleuse externe, couche-mère de la majeure partie des éléments constitutifs des autres couches, est composée au stade évolutif le plus jeune de petits noyaux arrondis ou elliptiques mais foncés: il semble donc que les éléments constitutifs du cervelet doivent passer, eux aussi, par un stade de „grains". Sont à citer également les constatations de M. DE CRINIS (Wiener Klinische Wochenschrift, 1932, No. 39/40 et „Aufbau und Abbau der Grosshirnleistungen und ihre anatomischen Grundlagen", Berlin, S. Karger, 1934) sur l'apparition successive des dendrites dans les différentes régions de l'écorce humaine. En considérant les dendrites comme éléments essentiels de la cellule nerveuse (et en se servant d'une méthode particulière pour les rendre visibles) DE CRINIS arrive à établir une carte cérébrale traduisant la maturation successive des aires respectives, carte qui s'accorde assez bien aux cartes myélogénétiques des auteurs (FLECHSIG, VOGT). L'évolution de la fibre nerveuse *précède* celle de la cellule. Enfin, j'ai étudié moi-même le degré de maturation que la structure cellulaire atteint dans les différentes régions d'un fétus humain de 9 cm et d'une chèvre naine de 24 cm et j'ai tiré des conclusions d'ordre général de ces études par rapport aux lois de l'évolution du cerveau (v. mes publications citées p. 212).

(Laboratoire de Physiologie Générale de la Sorbonne et Laboratoire d'Ethologie des Animaux Sauvages du Muséum National d'Histoire Naturelle.)

Comparative Pathology. — *The growth curves of the dimensions and of the weight of the seeds of Phaseolus vulgaris.* By G. P. FRETS. (Communicated by Prof. J. BOEKE.)

(Communicated at the meeting of January 28, 1939.)

The results of the experiments of 1937 induced me to continue them in 1938. It has been my aim now to compile growth curves of the dimensions and of the weights. I have also extended the experiments to beans of still smaller dimensions and repeated the observations of 1937. The experiments have again been carried out with the I- and II-line [1]).

I provided myself with material for growth curves, in the middle of July, by winding threads of different colours round freshly opened flowers on two succeeding days. Especially the flowers of the 2nd day form a group which are equally old. As soon as the pods were so large that the beans could be measured with our instruments, a few pods were plucked and the beans measured and weighed. This was repeated about every other day until the beans were fully grown. There were still 3 small supplementary groups of pods. On the first day on which flowers were bound, 2 groups of very small pods were also bound; each of these groups consists of pods of the same age; of the first group the original pods are somewhat smaller than those of the second. The smallest beans measured of these groups proved to correspond with beans which were measured 10 days after the flowering of the 2 main groups. Finally, efforts were made to form a group from the 2nd bloom; another group of flowers were bound about the middle of August. Of these flowers however, only a small number formed seed and the pods had grown into unequal sizes. This group provided hardly any material for the experiment.

In this way I obtained material of which it has been possible to make a fairly good study of the growth of the dimensions and of the weights.

Of the 5 groups of beans the average dimensions and the average weight for every day of the measuringperiod (23 July—23 August) have been tabulated and the tab. 1 and 3 (p. 216 and p. 221) contain the summarising of these observations, resp. for the I- and for the II-line.

I-line.

Observations are lacking only for one day, 27th of the period of growth

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[1]) G. P. FRETS, Dimension and Form with the growth of the seeds of Phaseolus vulgaris. I and II. Proc. Kon. Ned. Akad. v. Wetensch., Amsterdam, **41**, Nr. 3 and Nr. 4, p. 324 and p. 431 (1938).

investigated, the first pods were plucked 10 days after the flowers had been bound. Of the beans of the 3 pods each containing 4 beans which were investigated, the dimensions and weights corresponded. The beans of 2 pods in the supplementary groups also had these dimensions. For each succeeding day the average dimensions and weight of the beans from the measured and weighed beans were ascertained. The discrepancies of the measured beans on one day were sometimes very significant for the various pods. The beans of pods which, for example, have only one bean also frequently differ from the beans of pods with 4 or 5 beans. The latter pods are the most representative and these excluding the last bean, which is often small. On the 19th day after the flowering a pod, containing 5 beans was measured, the average breadth being $b = 6.4$ (or $= 6.3$, if one large bean was left out). On this day a pod with only one bean which was very large ($b = 8.5$ mm) was measured. We did not include this bean. I assume that $b = 6.4$ mm is of too small a value for the 19th day, and I did not put the curve through the point which indicates the breadth on the 19th day (Fig. 1). The largest investigated beans for the end of the period of growth were very large and therefore not quite representative. They originated from the 2 supplementary groups of material; the beans of the 36th day (last) are from the first group.

TABLE 1. Beans in growth, 1938. I-line.

Number of days after the flowering	10	11	12	13	14	15	16	17	18	19	20	21	22	23
Number of beans	19	8	11	10	11	11	15	11	20	6	2	19	9	26
Length	2.9	3.5	4.4	4.9	5.2	6	6.5	8.2	10	11	12.5	12.9	13.9	14.2
Breadth	1.9	2.1	2.6	3	3.1	4	4.3	5.4	6.3	6.4	8	8.2	8.6	9
Thickness	1	1.3	1.6	1.9	1.9	2.1	2.3	3.1	3.6	3.9	5	5.1	5.6	5.8
Weight	0.5	1	1.2	1.7	1.9	3	4	6.5	13	15	27	30	37	42

Number of days ofter the flowering	24	25	26	27	28	29	30	31	32	33	34	35	36
Number of beans	12	13	50		24	18	17	34	6	9	6	12	8
Length	15.1	15.8	16		16.3	16.8	17.2	17.6	17.8	18.6	18.7	19.5	18.6
Breadth	9.5	9.7	10		9.9	10.3	10 6	10.5	10.7	11.2	11.5	11.7	11.3
Thicknets	6.2	6.5	6.8		6.7	7.3	7.3	7.4	7.7	7.9	8.2	8.4	7.9
Weight	52	57	58		64	69	76	77	78	94	98	109	90

From the material at our disposal we have as well as possible fixed the average dimensions and weight (tab. 1) and represented them by curves (Fig. 1). In all 4 curves there is a steep ascending centre part and a less steep beginning and ending. Of the length, the end part of the curve is straighter than that of the breadth and of the thickness. If we compare the curves for the length and the breadth, we find that in the first part of the curve that of the breadth runs somewhat straighter than that for the length, it is not quite parallel with that of the length. The curve of the thickness diverges already in the first part somewhat from the curve of the length. In its further course the curves of the length and breadth

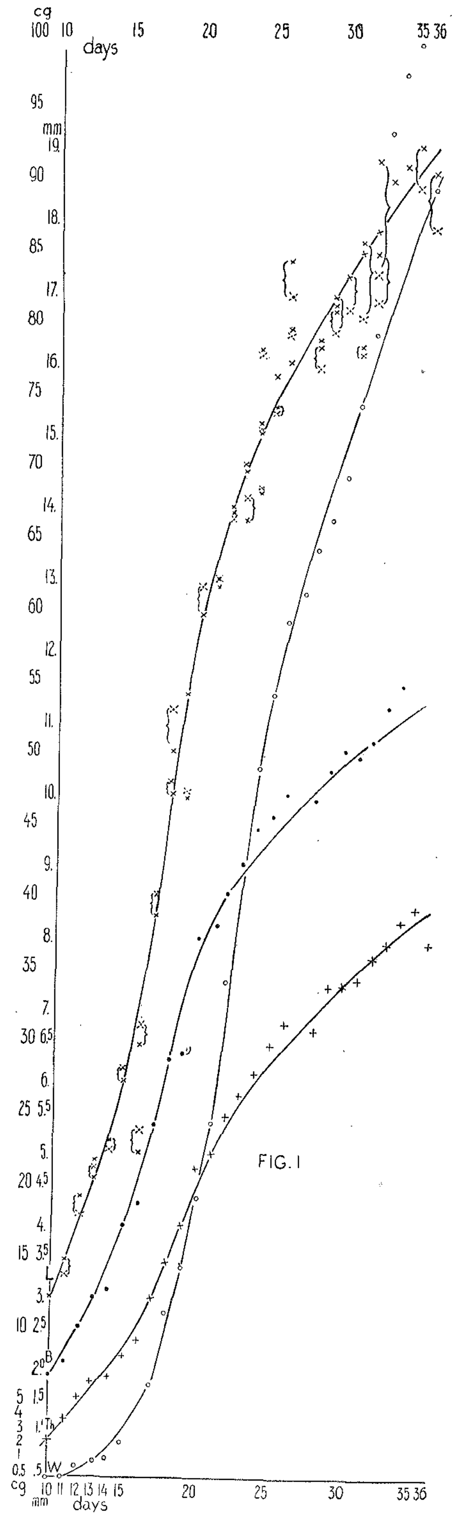

Fig. 1. Growth curves for the 3 dimensions and the weight of beans of the I-line, 1938. The dimensions L, B and D are represented by the signs ×, ● and +, the weight by the sign o. The breadths transmuted to lengths which have also been included in fig. 1, are indicated by the sign ⋎. L = length; B = breadth, Th = thickness; W = weight. Dimensions in mm; weight in cg; time of growth in days [1]).

[1]) See text.

diverge greatly, those of the length and the thickness somewhat less. In a 2nd publication the significance of the details of the curves will be proved still further.

The weightgrowthcurve, which is also illustrated in Fig. 1, cannot naturally be directly compared with those of the dimensions. After a slightly ascending first part a strongly ascending second part follows.

In the varying course of the growthcurves of the dimensions, a varying growthspeed of the dimensions is shown, also in varying periods of growth a somewhat varying rate.

We can also try in other ways viz. by transmutation, to make the growthcurves of the dimensions comparable. In doing so we must bear in mind that similar transmutations are influenced in their results by spurious correlation [1]).

GALTON [2]) transmuted the length of the body of the woman to that of the man and obtained thus a fixed factor with which he multiplied the bodylength of every woman and converted it to the bodylength of the man. The transmutationfactor is 1.08. It is clear that a small error has been made here; the proportion $\frac{Lm}{Lf}$ changes with Lf.

The dimensions of the smallest beans weighed, beans 10 days after the flowering, show little variation. The length measured in the morning was 2.9 (3 ex) and 3 (1 ex) mm and in the afternoon 3 (7 ex) and 3.1 (1 ex) mm; as average we find $L = 2.98$ mm, $B = 1.86$ mm, $D = 1.1$ mm. From this follows $L = \frac{2.98}{1.86} = 1.6 \times B$ and $L = \frac{2.98}{1.1} = 2.7 \times D$. In the first 4 ex we find $L = \frac{2.925}{1.85} = 1.58\,B$. With the aid of these coefficients we have made the dimensions in their growth mutually comparable. The transmutations have been made group for group. Those for the thickness of the first group and one or two others have been placed on tab. 2. In the transmutations we started from the average breadth of the bean of every day of observation. In these transmutations a few beans which for known reasons deviated from the rest (e.g. pod with only one bean; last bean in the row; bean soft and hollow) have been left out of the calculation.

Also now that we have been through the whole of the material again with a view to this transmutation, the more or less independence of the dimensions with regard to each other during the growth is shown. Also the differences in the 3 dimensions of individual beans point to the independence during the growth of the dimensions.

From the transmutation of the breadth of the beans of the various growing days of the 2 complete and 2 supplementary groups to length

[1]) FRETS, Proc. Kon. Akad. v. Wetensch., Amsterdam, **40**, 454 (1937).

[2]) Natural Inheritance 1889, p. 5. Compare, also KAPTEYN, Skew frequency curves Groningen, 1903.

we see that in the sharply ascending part of the growth curves (Fig. 1), the breadth that has been transmuted into length is mostly larger than the length, therefore is higher; on the other hand in the end part the breadth which has been converted into length lies lower than the length; also in the commencing part of the curves (Fig. 1 and tab. 2).

TABLE 2. Beans in growth, 1938. I-line. Transmutations from d to l,

Number of days	Number of beans	l_m	d_m	l_d	$l_m - l_d$	Number of days	Number of beans	l_m	d_m	l_d	$l_m - l_d$
10	4	2.93	1	2.93	0	25	4	16.28	6.95	19.11	+2.83
14	4	5.13	1.9	5.23	+0.10	26	10	16.48	7	19.38	+2.90
16	5	5.9	2	5.5	—0.4	28	23	16.34	6.94	19.09	+2.75
16	4	7.2	2.6	7.15	—0.05	29	15	16.46	7.26	19.97	+3.51
17	7	8.27	3.1	8.53	+0.26	30	13	17.92	7.57	20.8	+2.88
18	7	10.03	3.9	10.73	+0.70	31	26	17.64	7.28	20.02	+2.38
19	3	10.23	4	10.81	+0.58	32	2	17.5	7.1	19.53	+2.03
21	15	13.07	5.17	15.22	+2.15	36	8	18.56	7.96	21.89	+3.33
23	15	14.7	6.06	16.67	+1.97	33 [1])	7	19.6	8.14	22.39	+2.79
24	6	14.2	6.07	16.69	+2.49	35 [1])	2	19.9	8.4	23.10	+3.2
24	5	16.28	6.6	18.2	+1.73						

[1]) These are the largest beans of a supplementary group.

The results are otherwise for the thickness. For some smallest thicknesses, the thickness, transmuted to length is smaller than the length: in the entire remaining part of the curve, the thickness transmuted to length is considerably greater than the length.

There are probably 3 periods of growth with the dimensions. For the first period of growth we had only few records at our disposal (compare 2nd communication). In the first period of growth, breadth and thickness grow somewhat more slowly than the length, in the second period of growth the latter dimensions grow quicker than the length. The third period of growth the length grows quicker than the breadth, the thickness, on the other hand, somewhat quicker than the length [1]).

II-line.

For the II-line, I have corresponding material for the growth curves as for the I-line. Nine days after the flowering the first beans were measured. There are no records of the 12th and 33rd day. The average dimensions and average weight have been calculated as well as possible for every day (tab. 3) and the curves (Fig. 2) have been composed for the entire growth. The breadths and thicknesses have also been transmuted to lengths.

The curves for the II-line correspond greatly with those for the I-line

[1]) TAVČAR, who investigated the growth of beans by similar experiments as mine, mentions that the growth of the thickness of the beans follows later than that of the length and the breadth (Z. f. ind. Abst. u. Vererb.l., **40**, 87 (1926)).

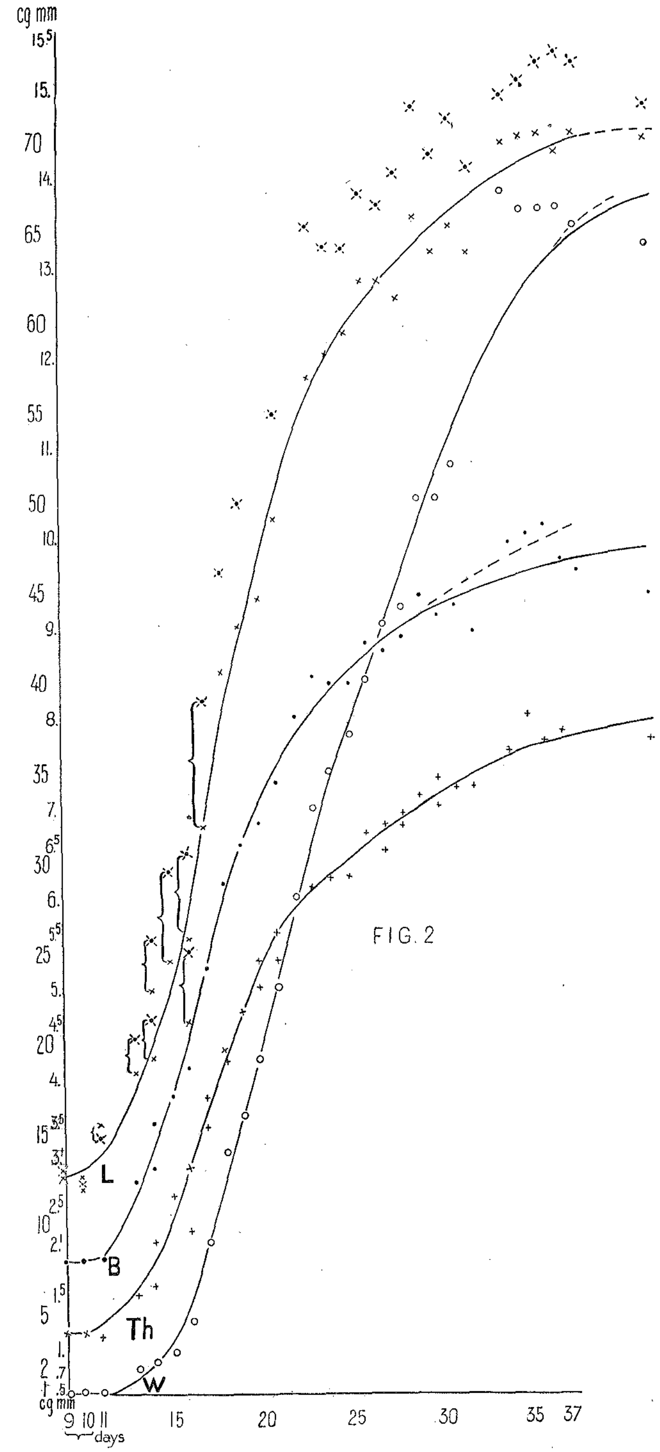

Fig. 2. Growth curves for the three dimensions and the weight of beans of the II-line. The dimensions, L, B and D are represented by the signs $\times$, ● and $+$, the weight by the sign o. The breadths transmuted to lengths, which are also included in fig. 2, are represented by the sign ⋊. Dimensions in mm; weight in cg; floweringtime in days.

(Fig. 2 and 1). The last part of the curve for the length of the II-line is less steep than that of the I-line.

The magnitude of the multiplication factor for the transmutation of the breadth and the thickness to the length of the beans of the II-line, is somewhat uncertain, which was also the case for the I-line (p. 218), if we start from the smallest beans measured. A slight difference measured

TABLE 3. Beans in growth, 1938. II-line.

Number of days after the flowering	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Number of beans	19	49	18		36	18	19	42	35	21	9	37	25	33	78	53
Length	2.95	2.9	3		4.2	4.7	5	5.5	7	8.5	9	9.3	10.3	11.2	11.7	12.1
Breadth	1.98	1.95	2		3	3.5	3.8	4.3	5.4	6.2	6.5	6.8	7.3	8	8.3	8.4
Thickness	1.3	1.3	1.3		2	2.2	2.4	3.4	3.8	4.3	4.6	5	5.6	5.9	6.1	6.2
Weight	0.6	0.55	0.6		1.8	2.3	2.8	4.5	9	14	16	19	23	28	33	35

Number of days after the flowering	25	26	27	28	29	30	31	32	33	34	35	36	37	38	42
Number of beans	53	88	76	90	70	68	45	13		9	4	24	11	5	9
Length	12.3	12.7	12.8	12.6	13.1	13.2	13.4	13.1		14.3	14.4	14.4	14.2	14.4	14.3
Breadth	8.4	8.8	8.8	8.8	9.1	9.2	9.2	8.9		9.9	10	10.1	9.7	9.6	9.5
Tickness	6.2	6.7	6.8	6.8	7	7.3	7.2	7.2		7.6	8	7.7	7.8	7.6	7.7
Weight	37	40	43	44	50	50	52	47		67	66	66	66	65	64

already makes a great difference in the proportions. Although the transmutation factor is somewhat arbitrary, as a constant factor it may be used to show the changes during the growth of the dimensions with regard to each other.

Of the smallest beans of the first group measured (p. 215) the length and the breadth of 6 beans are rather varied ($L = 2.7 - 3$ mm $B = 1.6 - 1.9$ mm); the thickness is still more varied ($D = 1 - 1.5$ mm). For the thickness, 1.5 mm follows on 1.2 mm; for the transmutation the specimen with $D = 1.5$ mm has been left out. We also see here, that the dimensions individually may differ e.d. be independent of each other.

As transmutation factors we find for the beans of the first group for the transmutation of the breadth to the length $\frac{Lm}{Bm} = \frac{2.9}{1.84} = 1.58$ and for the transmutation of the thickness to the length we find $\frac{Lm}{Dm} = \frac{2.9}{1.06} = 2.74$. For the second group of beans we find for 5 beans for both transmutation factors resp. $\frac{Lm}{Bm} = \frac{3.0}{1.9} = 1.58$ and $\frac{3.0}{1.15} = 2.6$. Finally we had at our disposal of the supplementary 3rd and 4th groups a large number of beans. For 20 of the smallest beans of the 3rd group measured on the 1st and 2nd day we find $\frac{Lm}{Bm} = \frac{3.2}{2.01} = 1.59$ and $\frac{Lm}{Dm} = \frac{3.2}{1.56} = 2.05$ and proceeding from 18 somewhat smaller beans we find $\frac{Lm}{Bm} = \frac{2.95}{1.99} = 1.49$ and $\frac{Lm}{Dm} = \frac{2.95}{1.38} =$

$= 2.14$. For 23 beans of the 4th group measured on the first day we find $\frac{Lm}{Bm} = \frac{2.72}{1.82} = 1.5$ and $\frac{Lm}{Bm} = \frac{2.72}{1.06} = 2.6$. The transmutation factor thus differs rather for the 4 groups; for the breadth we find successively 1.58, 1.58, 1.59, 1.49 and 1.5. We have taken 1.58 for the complete first and second groups and 1.5 for the incomplete 3rd and 4th groups. The transmutation factor for the thickness for the 4 groups resp. is 2.74, 2.6, 2.05 and 2.14 and 2.6; here, too, there is a mutual difference; for the first group we have taken 2.65 and for the second group 2.5 and 2 for the incomplete 3rd and 4th groups.

We have done the transmutations in this manner. We see (tab. 4) that

TABLE 4. Beans in growth, 1938. II-line. Transmutations from *b* to *l* and from *d* to *l*. Most even days are omitted.

Number of days	Number of beans	l_m	b_m	d_m	l_b	l_d	$l_m - l_b$	$l_m - l_d$
10	5	3	1.9	1.15	3	3	0	0
11	6	2.9	1.84	1.06	2.9	2.81	0	−0.09
13	8	4.08	2.83	1.96	4.47	4.90	+0.39	+0.82
14	3	4.27	2.97	1.97	4.69	5.22	+0.42	+0.95
15	4	5.3	4	2.7	6.32	6.75	+1.02	+1.45
17	10	6.8	5.18	3.49	8.18	9.15	+1.38	+2.35
19	9	9.06	6.57	4.68	10.38	12.40	+1.32	+3.34
21	20	10.18	7.26	5.28	11.47	13.99	+1.29	+3.81
23	33	11.74	8.48	6.14	13.40	16.27	+1.66	+4.53
25	28	12.25	8.33	6.14	13.16	16.27	+0.91	+4.02
27	32	12.8	8.7	6.5	13.74	17 23	+0.84	+4.33
29	21	13.5	9.33	7.1	14.74	18.72	+1.24	+5 22
31	21	13.4	9.25	7.15	14.61	18.95	+1.21	+5.55
35	3	14.4	10	8	15	20.8	+0.6	+6.4
37	5	14.2	9.7	7.8	15.33	19.50	+1.13	+5.3

the breadth transmuted to length is to an increasing degree greater than the length, but that for the highest length classes the magnitude of the breadths transmuted to lengths falls. We found analogous results for the I-line (p. 219); there, however, the breadths transmuted to lengths decreased more for the highest length classes and finally became smaller than the corresponding lengths. From this we see that in the I-line the length continues growing more than in the II-line; of full grown beans the average length for the beans of the I-line is considerably greater than that of the II-line [1]).

The thickness transmuted to length increases more for all length classes than the corresponding lengths; in the largest length classes the increase is also very strong. For the I-line we also find this increase, but not to the same degree as in the II-line. This corresponds with the fact that for

[1]) FRETS, Genetica, **16**, 46 (1934).

full grown beans the average thickness for the II-line beans is considerable greater than for the I-line.

In the curves for the thickness of the I- and II-line this difference is not indicated. The second part of the curve for the thickness for the beans of the II-line is not steeper than that for the I-line (Fig. 1 and 2). Neither is the curve for the thickness visibly steeper than that for the breadth for the beans of the II-line (Fig. 2). With regard to the curves for the I-line it is noticible that whereas the average thickness of full grown beans of the beans of the I-line is considerably smaller than those of the II-line, with the growing beans the greatest thickness of the beans measured of the I-line is greater than that of the II-line. With the growing beans very large weigths occur, 100 cg, whilst the average weight of full grown beans is 60 cg. Here, too, the large percentage of water of the fresh beans is shown.

It also appears from these transmutations for the beans of the I- and II-line from the breadth and the thickness to length and the comparison with the length that the 3 dimensions have a certain independence in their growth. In the comparison of the transmuted breadths and lengths (as well as in the transmuted thicknesses), we find a confirmation of the suggestion that, with the growth, in the mutual proportion of the dimensions something is continually changing; because B grows according to the size of B, L according to the size of L and D according to the size of D and these measurements are not all the same; B is smaller than L, D is smaller than B. There is also a difference in various periods of growth and each, moreover, has probably its own character. In the middle period of the growth the breadth and the thickness grow more quickly than the length. The dimensions, therefore, are independent and oscillate round about each other, thus producing the variations of the indices (compare 2nd communication). The growth of the dimensions is directed to what is aimed at, e.d. to the magnitude of the dimensions of the fullgrown beans.

In a recent article on the growth of babies the geneticist CHAS. DAVENPORT [1]) deals with similar questions.

[1]) Contributions to Embryology, Nr. 169; Public. Nr. 496 of Carnegie Institution of Washington (1938).