Botany. — *On the connection between the geotropic curving and elasticity of the cell-wall.* By R. HORREÜS DE HAAS. (Communicated by Prof. F. A. F. C. WENT.)

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As the principal cause of growth and geotropic curves SACHS and DE VRIES looked upon the pressure put upon the cell-wall by the cell-contents. Though DE VRIES knew that two factors have to be considered viz. the elasticity of the wall and the osmotic value of the cell-fluid, he has laid too much weight upon the production of osmotic active matter.

It was soon proved however that at the convex side a decrease rather than an increase of the quantity of osmotic active matter took place. Moreover the curve of unicellular organs remained unexplained. Consequently the opinion was repeatedly expressed, that the cause of this curving was to be looked for not so much in the change of the quantity of osmotic active matter as in a change of the elasticity of the cell-wall.

As the suctive power of the cells at the convex side increased, although the suctive power of the contents remained constant, a lessening of the wall-pressure had to be thougt of.

From experiments made by OVERBECK (1926) it is proved that this lessening of the wall-pressure cannot be the consequence of active growth of the cell-wall, because the curving proceeds normally also by temperatures by which the active growth is absolutely eliminated. So it must be the consequence of an enhanced elasticity of the cell-wall.

I have succeeded in proving this difference in elasticity by dividing length wise into halves embryo-roots of Vicia Faba, after delivering them from the strained position in which they had been lying for twelve hours horizontally, in which position they were of course prevented from curving.

Immediately strong curving of the upper-half (convex-half) appeared, while the bottom-half (concave-half) did not curve, or even somewhat in the opposite-direction of the convex-half. Since we may believe with URSPRUNG and BLUM (1924) that the osmotic value of the cells of upper- and netherhalf is equal, we must draw the conclusion that there is a lessening of the elasticity passing from the convex- to the concave-side.

This difference in elasticity between both sides of the root could also be proved by direct measure. These experiments in ductility were made with a balance of which one scale had been removed. This scale had been replaced by a wooden catch. A similar catch had also been fixed to the bottom of the balance. If a divided root was placed between those two catches, then it was possible by burdening the remaining scale to bring about a certain stretching. The extent of this stretching was observed in m.m. movement of the balance needle.

In this way it could be ascertained whether the same load caused unequal lengthening of convex- and concave half.

As the subjoined list proves the upper half of the root possessed a much greater elasticity than the nether half. With the same load (15 gr.) the following movement of the balance needle was observed.

For upperhalf.	netherhalf.
1.5 mm.	1.0 mm.
2.0 ,,	1.5 ,,
0.9 ,,	0.7 ,,
1.0 ,,	0.5 ,,
1.1 ,,	0.9 ,,
0.9 ,,	0.6 ,,

If on the otherhand the root was divided into a left and a right half, then, as indeed might be expected, no difference in elasticity was found.

Movement of the balance needle by equal load:

For left half.	For right half.
0.5 mm.	0.5 mm.
0.75 ,,	0.7 ,,
0.7 ,,	0.7 ,,
0.7 ,,	0.65 ,,
0.7 ,,	0.7 ,,

How is the connection between the geotropic stimulus and the increased elasticity of the cell-walls to be imagined?

An indication for it is to be found in the researches of WENT JR. (1927) who furnishes the proof of the constant production of a "growing matter" in the tops of coleoptiles of Avena. Without the presence of this "growing matter" no growth. WENT JR. now pre-supposes the production of the phototropic curving the consequence of an unequal division of the normal quantity of "growing-matter" over both sides of the coleoptiles.

To prove the connection between increased elasticity of the cell-wall and the quantity of growing-matter, experiments in elasticity were made by myself with coleoptiles of Avena, after removing the first leaf, in the same way as has been described above for Vicia Faba. Some of the Avena plants with which the work was done, were decapitated, and after a lapse of two hours again decapitated. Hereby nearly all the growing-matter in these plants was removed from the coleoptile. As is evident from the subjoined list a considerably greater elasticity was found in the non-decapitated material i.e. for the coleoptiles with "growing-matter" than in the material void of growing-matter.

By burdening with 15 gr. the following movement of the balance-needle was observed.

In non-decapitated plants.		In decapitated plants.	
0.8 mm.		0.7 mm.	
0.8 ,,		0.6 ,,	
1.0 ,,		0.65 ,,	
0.7 ,,		0.7 ,,	
0.8 ,,		0.7 ,,	
1.0 ,,	average	0.7 ,,	average
1.0 ,,	0.87 mm.	0.65 ,,	0.66 mm.
0.9 ,,		0.7 ,,	
0.9 ,,		0.75 ,,	
0.9 ,,		0.6 ,,	
0.9 ,,		0.7 ,,	
0.8 ,,		0.6 ,,	
		0.65 ,,	
		0.6 ,,	

In analogy with the statement of WENT Jr. given for the phototropic curving we can form for ourselves the following idea of how the geotropic curving is brought about.

The geotropic curving depends upon the unequal division of the quantity of "growing-matter". Consequently a larger quantity reaches the convex than the concave side.

The unequal division of the quantity of growing-matter causes unequal elasticity of the wall on the opposite sides.

The turgorenergy now brings about the curving. Subsequently the curving is fixed by over-stretching or active growth.

LITERATURE.

OVERBECK, FR. 1926. Studien über die Mechanik der geotropischen Krümmung. Zeitschr. für Botanik. **18**. Heft 8.

URSPRUNG und BLUM, A. 1924. Eine Methode zur Messung des Wand- und Turgordruckes der Zelle. Jhrb. für wiss. Botan. **63**.

WENT, F. W. 1928. Wuchsstoff und Wachstum. Recueil d. Trav. bot. néerl. Vol. **25**, p. 1.