The plant, the unknown. To fathom its secret, that is the objective of the SystemsX.ch project «Plant Growth in a Changing Environment».

Thomas Müller

Bern. A plant is very different from us. It keeps growing until it dies. It cannot run away, and for this reason, it has developed defense mechanisms completely different from those of mobile multicellular organisms. The plants are the most successful products of evolution, at least in terms of mass, representing 99% of the biosphere. They are frugal, they need nothing, but light, air, water and a few minerals. And last, but not least, we human beings live from the plants and breathe the oxygen they produce.

«The genes cannot ignore physics.»

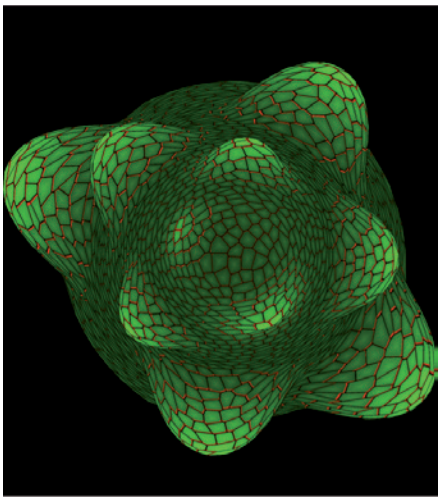
Plants are among the «creatures» mentioned in the Swiss Constitution which confers them a certain dignity. How do they function in fact? How do they grow and develop in an ever-changing environment? How does nature, this engineer, manage to create a cell wall which is, at the same time, scaffold, support, protection envelope, filter, pressure container and many more other things, all this growing at the same time? In comparison, our «functional tissue» is a simplistic affair.

Modellers refute biologists

These are the questions among others addressed by 18 research groups in the whole of Switzerland within the framework of the SystemsX.ch project «Plant Growth in a Changing Environment». «We intend to study the nature of the plant at many systemic levels», explains the director of the project, Cris Kuhlemeier, professor at the University of Bern and director of the Institute of Phytobiology affiliated at this university.

In this project, computer simulation will play a central role. Kuhlemeier explains his expectations with the following example: how does a plant trigger the construction of a leaf? Under the cold light of mathematical formulas generated by modellers, the explanation attempts, so dear to the «classical» biologists, were found to be insufficient. Kuhlemeier explains his strategy: «We expect to make other discoveries also in other fields through the interplay between computer simulations and practical experiments». The project «Plant Growth» will involve other systemic levels such as the plant cell and the plant as a whole in its environment.

Cris Kuhlemeier presents his experiment subject, the thale cress. Photo Thomas Müller



Computer simulation of a meristem, the highest point of a shoot. Photo Richard Smith

To reduce the number of variables, «Plant Growth» limits itself to the biologists' preferred plant, the thale cress, (arabidopsis thaliana) which has a short generation cycle and a small genome composed of only five chromosomes.

The objective, is it to develop a virtual plant, an «iPlant» so to say? «That's the latest hype, but it does not mean very much», he says. However this name cannot be so wrong as it is the name of an American research project pursuing similar goals.

From architecture to construction

Kuhlemeier is keen to know how a plant organ, whether a leaf or a flower, is actually constructed. Just as the architect's plan does not say very much about how masons, carpenters, joiners, painters, plasterers and plumbers will construct a house, so the genetic construction plant does not allow to understand how the plant is constructed. «Thus, we want to know how a plant sets scaffolds for itself, generates the cell wall and determines the angel at which the shoots and the stems will grow upwards to the sky. One thing is certain: it is not written in the genes that many plants arrange their leaves at an angle of 137,5 degrees».

Mechanics and statics will thus play an important role in «Plant Growth». «The genes cannot ignore physics» remarks Kuhlemeier with a smile. Thus, the forces involved in the construction of the plant are to be measured, and this on the living subject for the first time. For this task, the project will collaborate with the firm Femto-Tools which constructs the necessary sensors (s. box: «Delicate Force Measurements on Shoots and Stems»).

«We will try to link our plant models to the climate models»

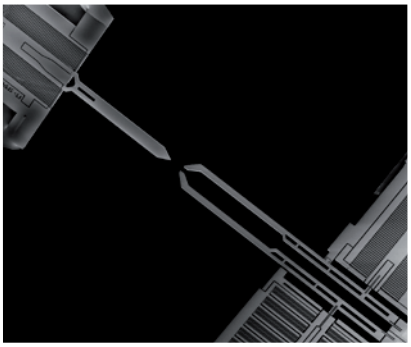
The global aspects will be addressed in a second phase. Kuhlemeier's dream is to give the plant the place they deserve in the climate discussion. «Often, plants play only a minor role in this discussion whereas they are much more important than the animals in the composition of the atmosphere» explains Kuhlemeier, somewhat worked up.

Naturally, it is about extrapolating from one plant-model to the whole biosphere. Nevertheless, a good model could give us a good idea of what is going on at the global level. «That's why we will try to link our plant models to the climate models of the atmosphere physicists». At the moment, their models take only the atmosphere and the oceans into account. «Plant Growth» intends to inject a bit of life into them.

Delicate Force Measurements on Shoots and Stems

Zurich. Femtotools, that is the name of the company which provides assistance in measuring the forces involved in cell growth or cell division. Counting four employees, the company is a spin-off of ETH professor Bradley Nelson. that specializes in the development of sensors capable of measuring tiny forces. They can measure forces as small as those exerted by a grain of dust of one tenth of a milligram on a piece of paper.

As sensors, it uses a flexible piece of silicon embedded directly in a chip. With this technology, the company hopes to fill the «measurement gap» between the large scanning microscopes and the usual meters. «With our participation in «Plant Growth», we want to demonstrate that our sensors can be used not only in engineering, but also in biology», with these words, the company director, Felix Beyeler, describes the reason for the company's participation to «Plant Growth». thm



A silicon force sensor with pincers to grab objects of a size between 0.001 and 0.1 mm. Photo Femtotools

«Plant Growth in a Changing Environment» at a glance

Plant Growth
in a Changing
Environment

Principal investigaor:	Prof. Cris Kuhlemeier, University of Bern
Participating institutions:	University of Bern, University of Zurich, ETH Zurich, University of Basel, University of Fribourg, University of Genf, EPF Lausanne, University of Neuchâtel, University of Lausanne, Swiss Institut of Bioinformtics
Industriy partners:	Femtotools GmbH, Zurich.
Number of research groups:	18
ressearcher / administrators:	74 / 1
Ratio biologists - non-biologists =	3:1
Total budget (2008-2011):	14, 778 342 Mio. Fr.
from SystemsX.ch:	5, 87 Mio. Fr.