CENTER FOR INTEGRATIVE GENOMICS (CIG) UNIVERSITY OF LAUSANNE

Focus

The main goals of our Institute are

1. The development of a first rate research program in the biological sciences.
2. The development of an outstanding teaching program.
3. The development of shared research technologies available to the local research community and beyond.
4. Outreach to main public schools and open door events.

Nouria Hernandez
Director of CIG
Christian Fankhauser
Associate Professor
Laure Allenbach
Lab technician

In Christian Fankhauser's lab <http://www.unil.ch/cig/page8391_en.html> we are interested in the role of the environment on plant growth and development. More specifically we focus on plant responses to changes in their light conditions (e.g. shading by other plants). We study the plant photoreceptors and the mechanisms by which a signal transduction cascade is initiated by their light activation. Light perception leads to specific developmental responses. This is important for the plant to optimise its growth and its reproduction in reaction to environmental parameters. We perform our work with a small plant called Arabidopsis that is particularly well suited for the molecular genetic approach that we are using. We use sophisticated microscopes and LED-incubators for our biological studies and the whole palette of molecular biology and biochemistry tools.

artist-in-lab

Sylvia Hostettler developed a project that really fits the scientific universe in which we are working. She eventually built a 'black box' in which the visitor can enter and where diverse objects were exposed. The main source of light was a window made of recycled Petri dishes, painted on the back to represent a giant stomata. Dispersed in the room, were shiny plastic objects representing undifferentiated plant tissues. The outside of the box was used to expose pictures that were inspired by Sylvia's work with the microscope and by her observations of galls.

Her overall project took into account different scientific topics, which are each embedded in one another. It covered the gene expression field by using the visual of a specialised program called Genevestigator and by creating quite astonishing homemade microarrays. The black box symbolizes the exchange between the outside and the inside (both literally and figuratively) by referring to a special plant structure: the stomata, involved in the gas exchanges during photosynthesis. The plastic shapes inside the box focus on the growth and development of plant tissues and their possible mutations in reference to calli (sort of vegetal tumours). The installation also enhances the importance of light for plants survival by playing with the different light sources. The black box was moreover a wink to our dark room where we perform all our experiments under controlled light conditions. Sylvia's own experimental manipulations are also displayed. She worked extensively

Sylvia Hostettler's art world (Photo: Laure Allenbach, 2008)

Lab world (Photo: CAOS, 2008)

with microscopy, taking images of small collages she made with parts of the plant we use to work with and parts of herself. Sylvia created her Petri window by collecting the used experimental dishes, washing them and painting them. She also tried different materials to research the undifferentiated calli and she worked in the microscope facility. Her preliminary project was presented to the scientists working in the CIG as an informal display and also on a poster during our retreat in Saas-Fee. Moreover people were freely invited to visit her in her art lab as often as they wanted.

The scientists were pleased about this new 'colleague' with whom they could experience a different universe. They were very curious about what would emerge from the interaction between Art and Science and were absolutely enthusiastic about her project. Her office was a breath of fresh air, especially when people wished to quit their benches, pipettes, computers and publications.

The artistic approach of Sylvia had some parallels with the scientific approach including hardship and perseverance. She was not stopped by the difficulties and if the idea was good she just went for it, no matter how long and repetitive it was to achieve it. Another analogy could be that an idea brings another and so the project moves on step by step. Also she works by trials and improvements as we do.

Recommendations

The time of the residence was long enough for Sylvia to develop her project, but accomplishment takes a lot more time. From this point of view, she didn't have time to finish her project during her residence, but the public presentation of her artwork actually took place in March 2009. We were able to collect enough funds for its achievement, but could more grants be available for some expensive exhibitions that could not be covered by the host institute?

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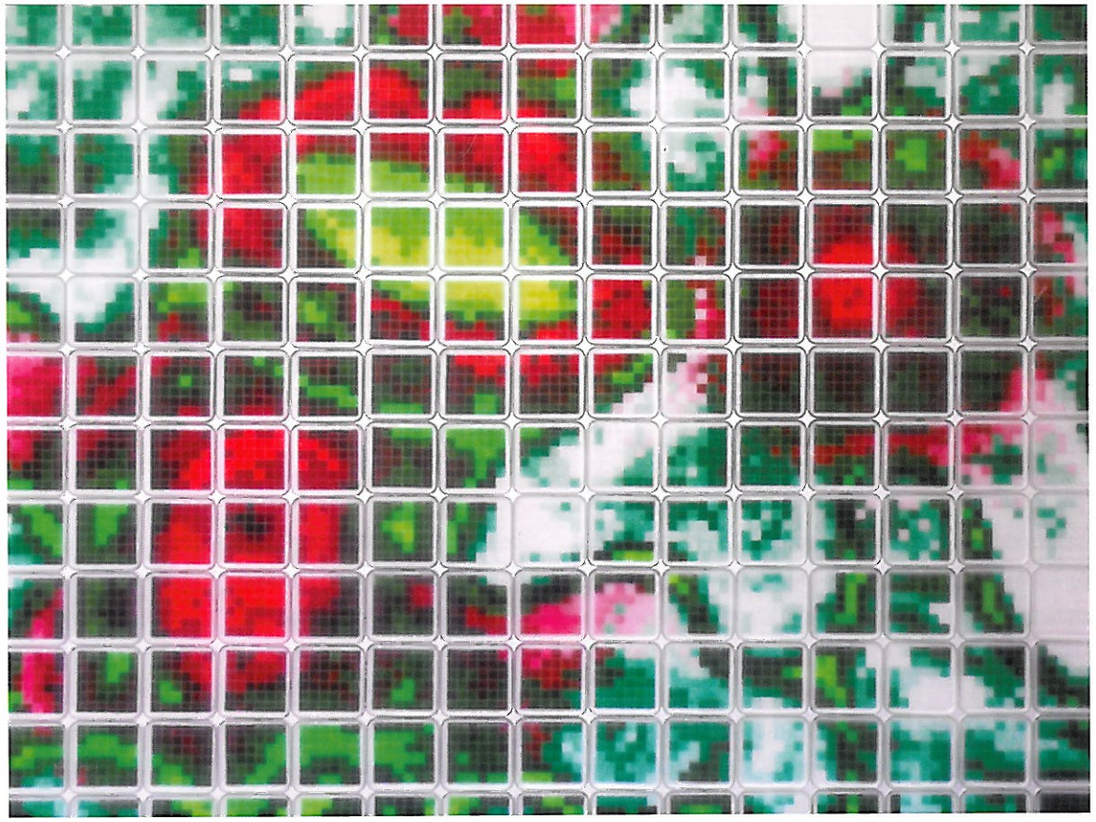


Window, construction with 294 petri dishes

Sylvia Hostettler

ARTIST IN THE CENTER FOR INTEGRATIVE GENOMICS (CIG) | UNIVERSITY OF LAUSANNE

Disciplines: Sculpture, Installation

Project title: *Light Reactions – Dimensions of Apparent Invisibility.* The aim of the residency was to work on a sculptural installation, which magnified the micro-level of nature and interpreted the behaviour of light on plant growth. Using light boxes and various light sources, works were built to highlight the experiences and observations from the residency. The following issues were important to learn about: The affects of light on the plants, their genetic mutations and manipulations and the analysis methods. The results were shown in the installation in the foyer of CIG itself and generated discussions about genetic topic in the transformation of the artist with the visiting public.

LIGHT REACTIONS – DIMENSIONS OF APPARENT INVISIBILITY

Sylvia Hostettler

University of Lausanne

Since 2005 I have been working on a serial project, *Landscapes,* which will on completion be presented in five independent chapters. It tells of unknown places – places where I have spent time and to whose influence I have exposed myself. My application for an artist-in-lab residency, and my placement at the Center for Integrative Genomics, were determined by the research character of the project and the biomorphic forms of my own sculptural work, as well as by its regular references to light. Led by Professor Christian Fankhauser, the CIG team is engaged in fundamental molecular research, in particular with the development, under specific light conditions, of 'Arabidopsis thaliana' (AT: thale cress), a plant widely used as a model in genome research. My project at CIG was the completion of chapter four of *Landscapes,* under the heading *Light Reactions – Dimensions of Apparent Invisibility.*

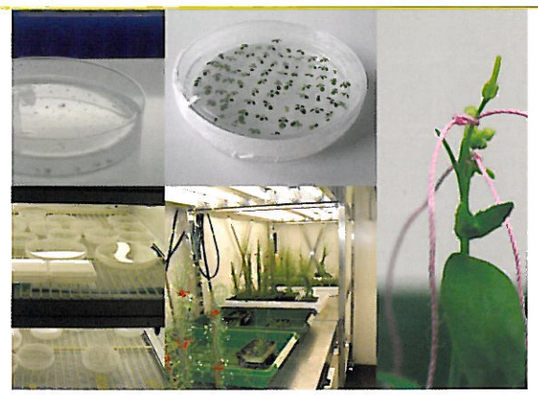
Phases

My nine month placement at CIG was divided into three phases: Learning: chaos; Conceptual development: tidying up; Realization in the lab and studio.

Learning: chaos (March–June)

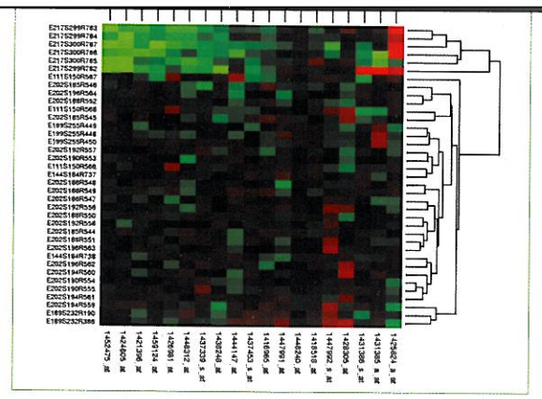
The first four months at CIG gave me the opportunity to look into many aspects of the molecular biologists' world and attempt to understand what seemed like a magician's cabinet of complexity. But all doors were open to me and I could move around the building as I pleased. I participated in lab and departmental meetings. Professor Nouria Hernandez, introduced me to the significance of DNA in private tutorials. At first I understood little: it was a language of abstract concepts and abbreviations, an international medium of scientific communication that I was hearing for the first time. I had been given an office of my own with a view over the lake, and I withdrew there to pursue my own thoughts and start my internet research. This only multiplied the questions, however, as concepts unknown to me were explained in a language equally unknown. But I received substantial help from the scientist who had been assigned to look after me, Laure Allenbach (a CIG technician), who explained her own research methods to me and supported me in mine. Thus in this first phase I was introduced to the approach and analytical methods of molecular biology, and in particular to 'Arabidopsis'. What follows is a description of molecular biological methods as I experienced them.

Petri dishes are an important piece of equipment for cultivating cells and bacteria in vitro, or for germinating seeds. In a sterile chamber clean 'Arabidopsis' seeds (either wild type or mutant) are placed in a petri dish half-filled with a sterilized nutrient, and this is then sealed to create a miniature greenhouse. The seeds are packed in tinfoil and allowed to 'hibernate' for a few days in a refrigerated room; then they are moved to an incubator which, although it looks like a refrigerator, is kept at a constant 21°C. Once they have germinated, the seedlings are used for various analyses. For instance, they are taken out of the tinfoil (where they have so far existed in darkness) and subjected to different forms of light. Some proteins, the so-called 'photoreceptors', respond to light signals in different ways, so that red, dark red and blue wavelengths impact and change certain growth conditioning factors in the plants concerned (e.g. phototropism). The early behaviour of mutants

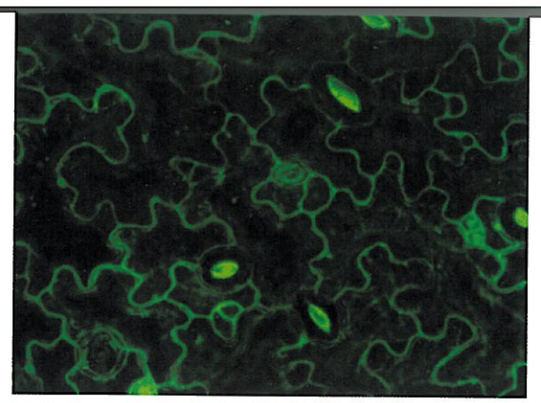


Growth of Arabidopsis thaliana in a lab situation

Petri dish with these AT seedlings



An example of a visualization software *Genevestigator,* <http://en.wikipedia.org/wiki/User:Paphrag/sandbox>



Confocal microscopy: Leaf epidermis with opened stomata

in comparison with wild-type plants in this respect was minutely observed and evaluated by the research teams. Seedlings (both wild type and mutant) are then planted in earth and kept under stable climatic conditions. Phenotypes are compared, seeds collected and different plant types are crossed. Molecular investigations are also conducted: for example, a leaf taken from a plant undergoes PCR (polymerase chain reaction) – an important analytic control method. A PCR thermo cycler is used to copy the genetic material, which is then subjected to a sequence of further steps to produce a genetic fingerprint.

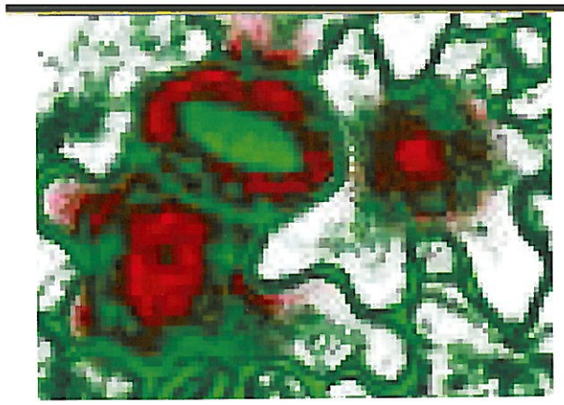
Another basic analytic process is the Western blot technique, which makes certain proteins visible and thus enables the investigator to determine whether the protein under investigation is present and in the expected place. First a fluorescent protein is docked onto the target protein; then a confocal microscope with integrated laser is used to check the presence of the protein in the plant specimen. The *Genevestigator* software, presented by Laurie Vuillet (postdoc) at a lab meeting, is an internet-based instrument-cum-database first developed in 2004 for visualizing gene expression data. It contains as complete a body of published data for various bioforms as possible. This already comprises 6000 chip data records of mice as well as all those of AT, and will soon contain the data of rats, barley and humans too. Another 4000 data records were also published, see: <http://archiv.ethlife.ethz.ch/articles/tages/genevestigator.html>.

Arnaud Paradis (microscopy technical manager) introduced me to stereo microscopy in my first month at CIG, and after that I could use the equipment on my own. The built-in digital camera and computer link-up allow a magnified image to be stored, and I spent countless hours exploring the forms and structures – invisible to the naked eye – of AT and plant galls. AT is a self-pollinating plant, and Laure showed me under the microscope how to cross a mutant with the wild type. We tried to form a callus between AT roots and a carrot, but that failed miserably: it was beyond our field of competence. A callus is a complex of undifferentiated cells that develops out of a piece of tissue or a cell taken from a living plant. The cells are cultivated in a special nutrient medium and later manipulated by the addition of specific phytohormones (plant hormones) to determine whether the callus should grow into a whole plant or merely into a plant organ. Plant galls had already excited my curiosity as a child, and from May onward I concentrated on them intensely. They could be called anomalies, mutant tissues brought about by organisms alien to the plant itself – parasites like viruses, bacteria, mites and insects. The metabolic change in the host plant, together with its own defence mechanisms, gives rise to strange and wonderful forms. Laure showed me how molecular biologists use a parasitic bacterium (Agrobacterium tumefaciens) for the production of transgenic plants. In a complex procedure they modify the bacterium with a specific gene in order to change the DNA of the plant without forming a gall. I collected many different galls and made bundles out of their branches, which I could then observe, along with their parasites, through the stereo microscope. Some other natural objects I collected served as the basis for small imaginative works of my own, for instance galls made of wax attached to buds or pine cones.

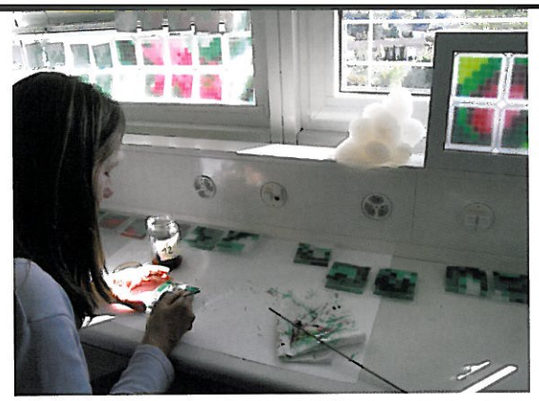
Conceptual development: tidying up (July–August)

My head was full of specialist information, observations and spontaneous ideas: I have called it chaos. In the next two months my artistic project had to take recognizable shape. I had to accept that I did not really understand the complexities of genetics, so I put a great deal of information painlessly aside. It was time to spend a week in my studio digesting the ideas I had collected and experimenting with materials, so that everything would be ready when the time came.

I began to collect used petri dishes, washing them and piling them up on my office shelf. I returned to plant galls and continued to observe AT through the microscope. I had the idea of using it to create 'microscopic constellations'. And the recycled petri dishes suggested a sort of window. The back of the dishes formed a relief-like design with 36 divisions that I could paint with part of a Photoshop-adapted image of a stoma from the confocal microscope. Stomata are tissue structures, pores that open and close in the leaf and stem epidermis of plants and are used for gas exchange; for me they represented the transition from the inside to the outside of the living plant. I wanted to use a pixel image to create a reference to the *Genevestigator:* when the red lips of the stoma opened, the colour showed that the gene was active. Around my window, made of 294 petri dishes, a walk-in black box took shape whose interior was bathed in a sacral light entering through the coloured window. Inside the room stood objects made of transparent plastic that radiated a luminosity of their own – symbolic representations of undifferentiated cells or meristems, the embryonic tissue of plant and callus, galls, the imaginative creation of the artist. The exterior walls of the black box bore pictures that showed two further dimensions of manipulation and mutation: anomalies and microscopic constellations.



Sylvia Hostettler's draft of the *Window* inspired by stomata



Sylvia Hostettler constructing the *Window* (Photo: Laure Allenbach)

Realization: in the lab and in the studio (September–November)

Like a scientist in her research hypothesis I was immersed in my work on the installation *Light Reactions – Dimensions of Apparent Invisibility*. I spent most of my time on the window, but before the end of November I also had to finish my research in the microscopy department. Four microscopic constellations took shape: *Crossing*, *Leaf-root*, *Expression_C8*, and *Expression_C9*. I had devised a medium for the two Expression pieces composed of some strands of my own hair fixed with sticky strips onto a lamella to form a sort of 'tissue' – a word I heard repeatedly over the months of my placement. Selecting a petri dish from the window, I painted its colours onto the tissue and completed the construct under the microscope with AT. I was so pleased with the result that I decided to repeat the process with a symbolic analysis of the window on 294 lamellae that I would set as a light table into a niche in the black box.

Conclusion

I was happy to return to my studio and complete the complex, many-sided project there. Nine months are an ideal time span for acquainting oneself thoroughly with an unknown world and embarking on a major installation. The final project was shown in the main hall at CIG, and they funded it. The CIG itself, as well as Lausanne's FBM (Faculté de biologie et de médecine), provided generous support. The scientists, too, had enough time to see how in the language of the artist a work of art can grow out of their own familiar material. Although at the presentation in April I could say nothing precise about the form my project would finally take, they could see in the following weeks and months how my office gradually filled up, first with the Internet printouts I pinned to the white walls of the room, then with my own small pieces – singular objects that occasioned a number of conversations. At the beginning of October I showed the current state of the project at one of the weekly 'apéros' in the main hall. I was also present at the retreat in Saas-Fee, where I improvised a 'Postdoc Poster', and at the end of my placement I held an open door day. The CIG people were interested in everything, and I really made friends.

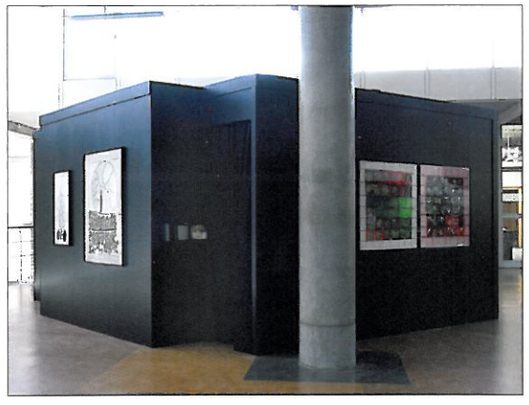
My presence did not change the way molecular biologists go about their work, but it can be seen as a significant widening of horizons. Scientists focus for years on problems of a very small compass; I tried to create something broader and more comprehensive. It was an extremely fruitful education, on which I shall continue to draw in the future. My experience at CIG will interconnect with new experiences, mutating and surfacing into different forms in the years to come. One concrete idea remains, however: to contact scientists again for a new field research project.

Detail, *Expression_C8*, pigment print on paper, 84,5 x 84,5 cm

Detail, *Anomalie 3*, pigment print on paper, 57 x 42,5 cm

Special thanks to

Laure Allenbach, Christian Fankhauser and his research team, Nouria Hernandez, Nicole Vouilloz, Gilles Boss, Arnaud Paradis. The installation *Light-reaction – Dimensions of apparent invisibility* was made possible by: UNIL/Université de Lausanne; UNIL/Centre Intégratif de Génomique (CIG); UNIL/Faculté de biologie et de médecine; Fondation Leenards; Fondation Fern Moffat/Société Académique Vaudoise; sc/nat, Swiss Academy of Sciences; KulturStadtBern; Erziehungsdirektion des Kantons Bern.



Exterior view of the installation *Light Reactions* at the Center for Integrative Genomics in Lausanne