ORGANIC CINEMA: READING ELECTRIC POTENTIALS IN PLANTS WITH ARDUINO

Authors: Cristina Anllo Naveiras, Remedios Broceño, Judith Cano Ruiz, Margarita González del Hierro

The aim of this paper is to show the experiments held during four days at the workshop "Organic Cinema", whose objective is exploring the way local flora reacts to various inputs from their immediate environment to transfer that information to a visual experience that will be screened in September at the digital facade of Medialab Prado.

The workshop started the 30 th of June and finished the 4th of July of 2014. Organic Cinema is an interdisciplinary research platform, inspired and informed by scientific research on intelligence of plants and cutting edge development in the latest sensory technologies aiming to encourage public to have a deeper look at their immediate natural environment (and beyond) – even that invisible one. It is initiated by World Wilder Lab – an art collective set up by three artists Ivan Henriques, Erik Overmeire and Kasia Molga who share the same passion for environment, nature, living organisms, technology, data and science as main inspiration to make art in order to tell a story about the hidden beauty of this world.

The following experiments were done by interdisciplinary collaborators of the workshop: biologists, artists, urban planners, image and sound technicians and electronic developers. The assay was performed under Open Source/Open Hardware Licence. We used an Arduino connected to a computer and to two electrodes. The electrodes were punctured in the testing plants to record the alterations in electric potential that may be caused by our testings. Those alterations were fluctuating within values of 0 and 1023 points.

We did several experiments over plants, both indoors and outdoors. For the indoor experiments we used Basil (*Ocimum basilicum*) and Calanchoe (*Kalanchoe blossfeldiana)*. For the outdoor, the tests were made in the building courtyard garden Medialab Prado. We used the plants Fern, Ivy (*Hedera helix*), Acacia (*Robinia pseudoacacia L.*), Privet and Silver Ragwort (*Senecio cineraria*). This experiments were done only once, thus, the increasing and decreasing values shown at this paper should be taken just as informative data. More research must be done in this area to confirm the results.

INDOOR EXPERIMENTS

Basil

This plant has small and fine leaves that born distributed along soft branches and it loose an intense flavor when we touched it. In the following lines we are going to explain the different experiments held over the basil plant.

Touch

We tried to record what happened if the plant have had any perturbation. First of all, we touched the plant and see what happened. The levels measured with the arduino were getting higher when we touched the plant. The more we touched it, the higher it got, until it got saturated at the maximum level we were able to measure (1023).

Light

We wanted to know how light affect the electric potential plant. To isolate this factor we kept the plant covered from a day. The range of minimum and maximum values for each of the proofs done are shown in figure 1. After one night without light, the basil was exposed to red light. The values were increasing through the five minutes it was exposed to that light. After that, the plant were covered again until the values established. Then it was illuminated with blue light and the values increased in even faster than with red light. Finally, after a recovery time, the plant was exposed to white light and the values increased fast and constantly.

Figure 1: Potential values measured with different lights

Darkness: Values [342, 488] (↑)									
Red Light ON (↑)									
1’		2’		3’		4’		5’	
Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.
400	470	403	460	450	517	499	500	428	550
Red light OFF +Darkness: Values [540, 582] (↓)									
Blue Light ON (↑)									
1’		2’		3’		4’		5’	
Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.
501	602	510	616	517	632	432	627	512	648
Blue light OFF +Darkness: Values [648, 693]									
White light ON (↑)									
1’		2’		3’		4’		5’	
Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.
620	718	720	754	750	766	460	775	780	837

Herbivores

We try to simulate how the plant will react to an herbivore attack. We bite the plant and the values get lower. The values before the bite were in a range between 700-

800 and after the bite they went as low as 204 in only one minute. When we bite the plant after having had a coffee, the values get even lower, this may be caused by the caffeine.

Water drops

A common disturbance that plants are exposure is rain. We try to simulate rain by dropping water over it. The results shown an increment in the values up to 800 points and arrive to 899. This may be caused by water or by the movement of the plant (and so, the sensor) when the water hits the plant.

Wind

Other common disturbance it´s the wind. We try to simulate the effect (we simulate a wind tunnel fanning the plants), to know if there is any relation between the wind intensity and the movement of the plant. We made this test after the false rain and the range caused by the movement of the air were between 800 and 900 regardless of the force with which the fan the plant.

Calanchoe

The last day we tried to see if the electric potential of the plant were modificated by the music. We tried different kinds of music to observe and record the different answers to the rhythm and the intensity caused by the vibrations in the sound of the music. And besides it know which type of sound was more sensitive.

This plant has large, wide, stiff, fleshy leaves facing up with similar tected on both sides and then their stems.

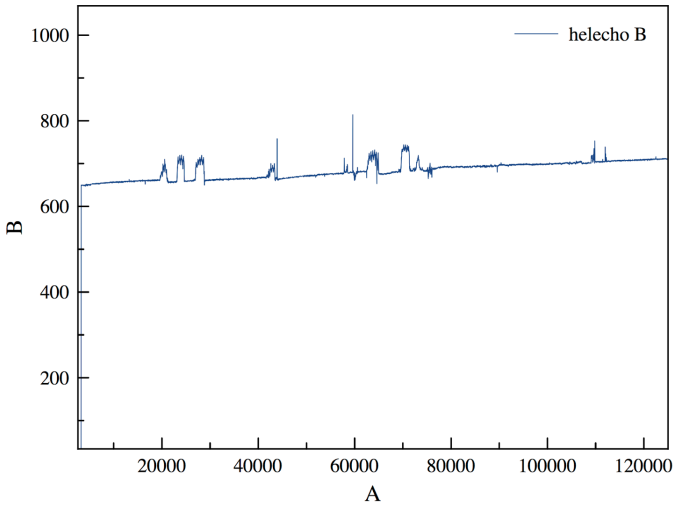
OUTSIDE (GARDEN)

The outdoor plants have more stable leaves of electricity. The charge less to any perturbation and reach earlier the normal values. In this case we decided to analyze the geometry (shape) of the graphic.

Fern

We tried to record the way the fern was affected by touch. Every time the plant was touched we registered peaks in a graph with constant and continuous trajectory, as can saw in figure 2.

Figure 2: Variation in electric potential of the fern



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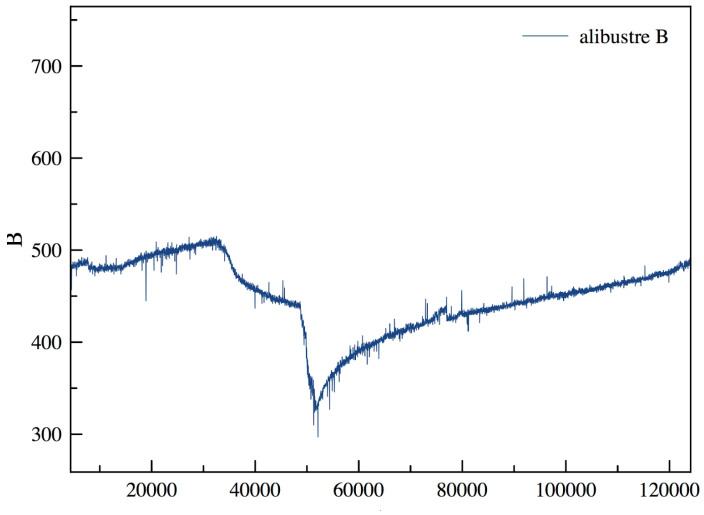
Privet

Different experiments were held with this plant. The result are shown in figure 3. The electricity levels went down when we taked off a leave by the stem (300-500). We waited for the values to recover. Then we recorded a small jump when we hugged the trunk of tree (700-800) and we we register peaks in the graph when we touched the leaves of this tree.

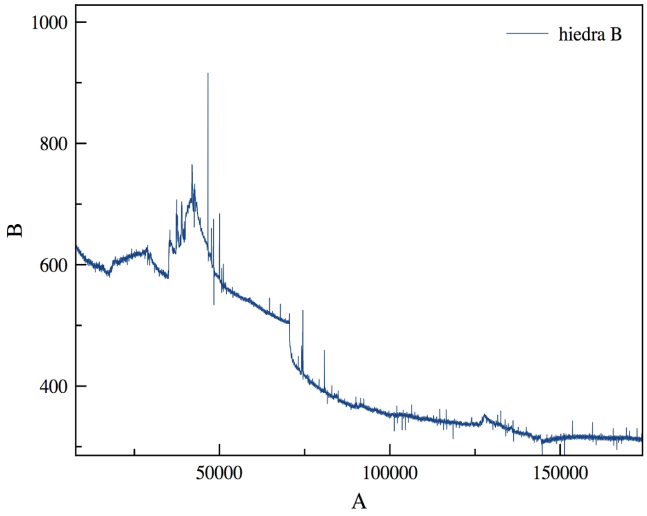
Figure 3: Variation in electric potential of the privet during the experiment.



Ivy

The graph shown in figure 4 describes the way the potential of the Ivy was altered with the movement of the edge of the plant (not only the branch with the sensor) with a foot (not direct skin). We registered high and low peaks with descending trajectory, whistle they were low when we taked off some leaves.

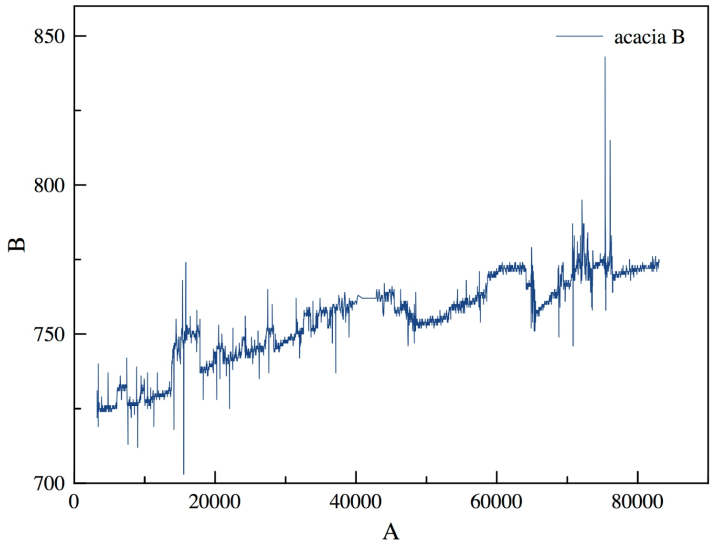
Figure 4: Variation in electric potential of the Ivy during the experiment.



Acacia

Figure 5 shows the variations registered with the acacia experiments. Longer and higher peaks appeared with ascending trajectory when we touched the leaves and leafs were started (600-700 points).

Figure 5: Variation in electric potential of the Acacia during the experiment.



CONCLUSIONS

All the experiments held over the plants showed changes in the values we were measuring. We still not so sure if the values measured are the electric potential of the plant or just the result of the plant acting as a capacitor. The way the plant increased the levels when measuring; and the way they decreased when in contact with a new source of ground (like contact with mouth), made us think about the possibility of the plant becoming a big capacitor. Further experiments should be done over the plants in order to check that the data obtained is the result of a change in the electric potential of the plant. Whether the plant acts as a capacitor or if the plant is showing electrical potential, we believe that this project may have important and spectacular artistic applications.