Plant Data

Beyond our Understanding of Plant Communication

by Alice Bonnot

Published on 22.07.2021

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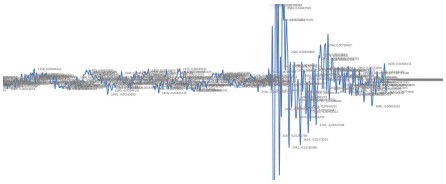

Data records from Fraxinus excelsior converted into graphs. Research by Kathy Steppe, Laboratory of Plant Ecology, Ghent University.

Study for Plant Data, 2021. Yota Ayaan in collaboration with Stefaan Van Leuven. 2–channel audio installation. Sound mixer, laptop, power cords, stands, speakers. Duration: 9 min loop. Galeria da Biodiversidade, Museu de História Natural, Porto, Portugal, 12 — 30 June 2021. Photo: Carlos Campos. Image courtesy of the artist.

As plants are subjected to dehydration, they emit sound waves imperceptible to the human ear — 'acoustic emissions' at ultrasonic frequencies. As global warming causes droughts to intensify, this process of dehydration and the stress it causes plants is expected to increase. Porto-based New Zealand artist Yota Ayaan's latest exhibition, Plant Data*, at the Galeria da Biodiversidade, Centro Ciência Viva, in Porto's Botanical garden, seeks to humanise the science behind plant sounds. In this piece, writer and curator Alice Bonnot considers the exhibition as it falls within the historic relationship between humans and plants, and the urgent lessons that can be gleaned from* Plant Data *in the current climate crisis.*

Plants have been the subject of considerable interest throughout human history, from the nomadic hunter-gatherers of the Palaeolithic period who sought wild plants for their survival, to the larger agricultural societies that rely primarily on the domestication of plants for food. Over the centuries, humans have used the benefits of plants in many nutritional, medicinal, spiritual, artistic and aesthetic ways. Considered the starting point of botanical science, the work of Theophrastus in ancient Greece and Vṛkṣăyurvĕda in ancient India greatly contributed to the expansion of plant knowledge at the time. Along with the development of herbarium, plantarum and other written texts, the wisdom of traditional folk herbal medicine was passed on from generation to generation through oral tradition. Progressively, the advancement of sophisticated scientific technology has led to increasingly revolutionary medical discoveries, including the use of bioactive components of natural plants in the prevention and treatment of cancer.[01] Although humans and plants have co-evolved[02] for hundreds of thousands of years, there is still much to learn from these sessile, yet intelligent and conscious organisms.

Homo sapiens appeared around 200,000 to 300,000 years ago, when forests had already existed for millions of years.[03] Over time, trees evolved to fit their environment, adapting to constantly

changing climatic conditions, invasive neighbours, diseases and opportunistic pests. Deprived of the ability to move, these vegetal beings had to develop a different kind of creativity to survive, including communication and cooperation through the sharing of vital information. An example often used to illustrate communication between plants is the discovery in the 1980s of a defence mechanism used by acacia trees in the South African savannah against Kudu antelopes.[04] At the time, a severe drought forced antelopes to feed exclusively on acacia leaves — the only tree species in this region capable of withstanding such extreme temperatures. Shortly afterwards, more than 2,000 Kudu antelopes were found dead for no apparent reason. A scientific investigation by South African biologist Wouter van Hoven found that the unexplained deaths were due to abnormally high levels of tannin produced by the trees as a toxic defence mechanism. They found that branches that were nibbled by animals emitted ethylene, a highly volatile compound secreted to warn neighbouring trees of the upcoming danger. This discovery was later corroborated by several scientific studies, and confirmed that one of the different ways in which plants communicate with each other is by releasing information-carrying molecules into the air.

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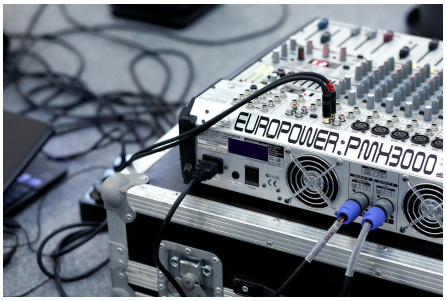

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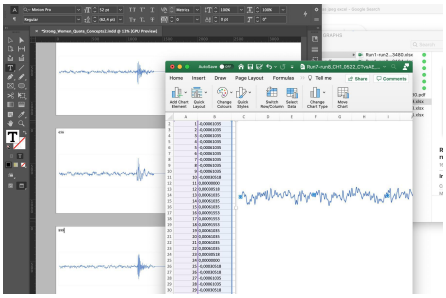
In the 2021 collaborative project and exhibition *Plant Data* at Galeria da Biodiversidade, Centro Ciência Viva, in Porto's Botanical garden, Porto-based artist Yota Ayaan and scientist Marianna Sottomayor, Professor of Cell Biology at the Faculty of Sciences of the University of Porto, studied the language of plants at the cellular level, seeking to humanise the science behind plant sounds. In their months of work, they studied the sound waves of plants, known as 'acoustic emissions' (AE). These ultrasonic frequencies, imperceptible to the human ear, are mainly recorded when plants are subjected to dehydration, a phenomenon that occurs daily in plants. In the morning, they extract water from the

soil and fill their cells with it. This water is essential to their survival as it transports nutrients, distributes carbohydrates and maintains the elasticity and firmness of soft tissues. During the day, water in cells gradually evaporates and is eventually replaced by air as the plant dries up. Using X-ray microtomography (microCT), a 3D imaging technique that uses X-rays to see inside an object, scientists were able to measure the acoustic emissions of Ash Trees (Fraxinus Excelsior) in order to provide highly accurate data on the sounds trees make as they dehydrate. In their research papers, scientists refer to this process of plant dehydration as 'stress',[05] which is expected to increase as droughts intensify due to global warming. The sound of stress is observed when a rupture of sap in the plant's conduits occurs during dehydration.

In 2020, Yota Ayaan and Marianna Sottomayor started working with Professor Kathy Steppe from the Laboratory of Plant Ecology at Ghent University, one of the most advanced laboratories for detecting AEs in plants. Steppe compares the sound data of these 'cavitation events' to the scream of trees when they are subjected to extreme thirst, which causes discomfort and stress deep within these living beings. Similarly, positive sounds have been observed in plants. When watered again, plants sing together blissfully as their cells fill with water. Artist Yota Ayaan, understanding that current available technology can only record ultrasonic frequencies represented by digital data in the form of graphs, was drawn to imagine what these sounds could be. To make plant emissions audible for human ears, Yota Ayaan collaborated with several scientists and sound experts.



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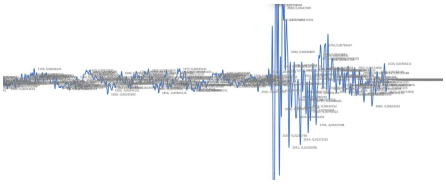

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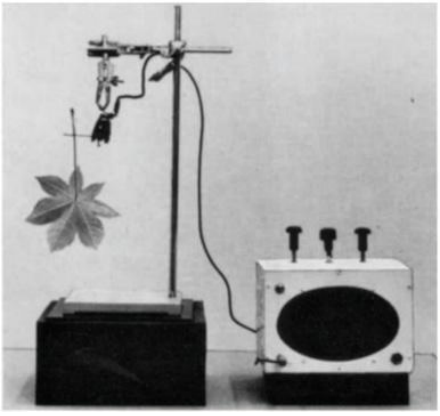
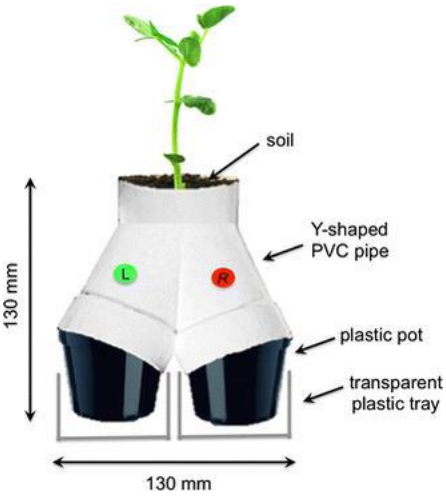


Picture of the vibration detector used by Milburn and Johnson to detect drying-induced sounds in leaf petioles, 1966. Source publication: *Acoustic Emissions to Measure Drought-Induced Cavitation in Plants*, by Linus De Roo, Lidewei L. Vergeynst, Niels De Baerdemaeker, and Kathy Steppe.



Schematic representation of the custom-designed experimental Y-maze, made of a PVC pipe filled with soil and attached to two tightly fitting small black plastic pots and two transparent rectangular plastic trays at each lower end. Source publication: *Tuned in: plant roots use sound to locate water*, by Monica Gagliano, Mavra Grimonprez, Martial Depczynski, and Michael Renton.

Preparation work for *Plant Data*. Photo courtesy of the artist.

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Following a lineage of artworks dealing with plant communication — such as the collaborative work *The Secret Life of Plants* (SLOP), 1976, a video performance in San Francisco by artists John Lifton, Jim Wiseman, Tom Zahuranec and Richard Lowenberg — *Plant Data* offers a new perspective on what humans might hear if they were inside the cells of trees. The first room of the museum, the main hall, consists of dozens of young ash trees humming with a subtle twenty-four hour sound work. The multi-channel speaker system installed among the reconstructed forest plays two sound systems designed with musician and sound engineer Stefaan Van Leuven (Soulwax). The first transmission combines thousands of real-time sound 'events' with a 12-hour loop of the sun's path across the sky, creating a musical composition synchronised with the sun. Depending on the time of the visit, viewers will experience a different moment of plant life, coinciding with the life events of the ash trees in real time. The second transmission is composed in a much slower time, based on a single AE event. On the floor, speakers, mixers, laptops and power cables form a web-like assemblage, much like tree roots intertwining underground. On the surface, trees from small seedlings to creatures over five metres tall occupy the bright and voluminous museum's hall and, with their newly given voice, invite us to slow down and listen.

The smallest room presents *Study for Plant Data*, a 9-minute experimental sound installation consisting of four freestanding human-sized speakers facing each other. This piece is a preliminary sketch of *Plant Data*, a free interpretation of what plant sounds could be. The result is a dreamlike, cosmic and enveloping music. The sounds are slow, soft and vibrant. They mingle with the songs of birds and the wind that resonates between the branches of the trees of the Jardim Botânico. The large window, open to the outside, lets sounds and smells enter the exhibition. This intersection between natural and cultural, art and science, creates a doorway into the green world.

In the third room, *Plant Spirit* is a multimedia installation in the form of a home office, with a desk, a black office chair, two fans and some medium-sized potted plants. The scene sits within an illuminated greenhouse structure, which gives it an intimate

dimension. A laptop plays video recordings of four talks conducted on zoom in 2021 by Yota Ayaan and his friend Jackson Gore, featuring personal stories and insightful perspectives on the spirit of plants from community ritual leader Miguel Riveira, researcher and evolutionary ecologist Monica Gagliano, herbalist Mark Jensen and sculptor and indigenous food activist Roxanne Swentzell. Each speaker shares their personal encounters and relationships with plants. Dr Monica Gagliano, talking about her first communication with vegetal beings, emphasises how this experience has changed her life and research. Slowing down and listening, she says, is the key to establishing a relationship with the botanical world, stressing that 'communication can only arise from a very silent place'. She encourages viewers to move beyond the limiting idea that communication can only be verbal, using voice and words. For her, communication with plants is also about feelings, visions, dreams and a strong sense of knowing. She says that such relationships are accessible to everyone. Listening to the stillness, not rushing to get a verbal message, are the first steps. This last room brings a spiritual approach to plant cognition, in contrast with the rest of the exhibition's more scientific focus. Indigenous and ancient knowledge has replaced data. Intuition, trust and gratitude have replaced measurement and quantification.

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Science can, however, serve intuition. Ancient, traditional, shamanic and indigenous views are increasingly being recognised by the modern Western scientific world. In 2017, at the University of Western Australia, Dr Monica Gagliano conducted a study proving that plants are aware of their surroundings and have much more complex and developed senses than we think. She demonstrated, by reproducing the sound waves emitted by flowing water, that plants are able to locate a water source by sensing the vibrations generated by water moving inside pipes, even in the absence of substrate moisture and are able to direct their roots through the soil into that direction.[06] Far from being passive, trees demonstrate a great capacity to adjust to the world around them, an ability to adapt, and to deal with adversity. These abilities

become even more crucial for their survival as the effects of man-made global warming grow more substantial. To overcome high outdoor temperatures, trees use a mechanism called 'evapotranspiration' that cools them from the inside. This creates a cooling effect that keeps overall temperatures of the forest low. In addition to suffering from a lack of water, trees also face problems associated with monocultural forestry (planting and harvesting of single-species trees), including the loss of soil productivity and fertility, disruption of hydrological cycles, risks of spreading pests and diseases, increased risks of storms and fire, and negative impacts on biodiversity.[07] A study conducted in Germany by HBE Eberswalde and the Potsdam Institute for Climate Impact Research highlights the positive aspects of primary forests in the face of climate change. They show that old-growth deciduous forests are on average 8 degrees cooler than pine plantations and 12 to 15 degrees cooler than in cities. The forest canopy naturally reduces direct sunlight and wind speed, which has the effect of dampening temperatures and humidity variations. This helps to avoid extreme temperatures, with cooler below-canopy maximum temperatures and warmer minimum temperatures. Old-growth forests are also more productive in storing carbon than younger forests. Yet, these precious environments are disappearing around the world. In Europe, only 20% are older than 100 years.

This joint evolutionary history between humans and more-than-human beings is complex. Ancient forests, younger forests, flora, Plantae and nature in all its forms are very important parts of this tangled puzzle that is life. Since our arrival on earth, the plant kingdom has generously and unconditionally taken care of us. How not to feel ashamed, then, when in return the severity of forest fires caused by anthropogenic climate change destroys thousands of homes, wildlife habitats and ecosystems. Why are we not taking responsibility for the direct negative impact of our frenetic activity on nonhuman life and environments? Recognising their values, and rights, can be the first step in healing our plant blindness.[08] Ecologically sensitive exhibitions, like *Plant Data*, are there to remind us that humanity is part of nature. We are nature. When we fully realise this, we may be able to transcend the

human-plant relationship and enter a new ecological era based on mutual trust and respect.

Footnotes

01. Wang, H., Khor, T. O., Shu, L., Su, Z. Y., Fuentes, F., Lee, J. H., & Kong, A. N. (2012) “Plants vs. cancer: a review on natural phytochemicals in preventing and treating cancers and their druggability”, *Anti-cancer agents in medicinal chemistry*, 12(10), pp. 1281–1305. www.ncbi.nlm.nih.gov/pmc/articles/PMC4017674/

02. The term ‘coevolution’ was coined by Peter Raven and Paul R. Ehrlich in 1964. It is the process by which species interact with and respond evolutionarily to each other. Ehrlich, P. R., & Raven, P. H. (1964) ”Butterflies and plants: A study in coevolution”, *Evolution*, 18(4), pp. 586–608’.

03. The oldest forest in the Catskills region of the United States is estimated to be around 385,000 million years old.

04. Beardsley, T. (1990). Clearing the Airways. Scientific American, 263(6), 28-33. Retrieved July 14, 2021, from www.jstor.org/stable/24997007

05. In this context, stress in plants is seen as “the state of a plant under the condition of a force applied”. De Roo, L. D. R., Vergeynst, L. L. V., Baerdemaeker, N. D. B., & Steppe, K. S. (April 2016) “Acoustic Emissions to Measure Drought-Induced Cavitation in Plants”, *Research Gate*, www.researchgate.net/publication/296701459_Acoustic_Emissions_to_Measure_Drought-Induced_Cavitation_in_Plants

06. Gagliano, M. G., Grimonprez, M. G., Depczynski, M. D., & Renton, M. R. (May 2017) “Tuned in: Plant roots use sound to locate water”, *Research Gate*, www.researchgate.net/publication/315811492_Tuned_in_plant_roots_use_sound_to_locate_water

07. Liu, C. L. C. L., Kuchma, O. K., & Krutovsky, K. V. K. (2018, July). *Mixed-species versus monocultures in plantation forestry: Development, benefits, ecosystem services and perspectives for the future*. Research Gate. www.researchgate.net/publication/326677444_Mixed-species_versus_monocultures_in_plantation_forestry_Development_benefits_ecosystem_services_and_perspectives_for_the_future

08. Plant Blindness is a term coined by the botanists and biology educators J. H. Wandersee and E. E. Schussler in their 1999 publication ”Preventing Plant Blindness”. It refers to a human tendency to ignore plant species. Wandersee, J., & Schussler, E. (1999). Preventing Plant Blindness. The American Biology Teacher, 61(2), 82-86. doi:10.2307/4450624

Biographies

Yota Ayaan is an artist from New Zealand based in Porto, Portugal. He studied architecture at Victoria University in Wellington, several fine arts courses at Central Saint Martins University of the Arts in London and sculpture at Faculdade de Belas Artes da Universidade in Porto. His practice draws upon various media in hybrid forms including research, writing, installation, sound, video, web, sculpture, painting and drawing.

Yota Ayaan is currently completing a one year artist in residence at the Faculdade de Ciências da Universidade do Porto, researching the subject of plant intelligence and acoustic emissions with Professor of plant biology Dr Mariana Sottomayor. This residency has led to the exhibition entitled Plant Data at the Galeria da Biodiversidade, Museu de História Natural, Porto in June 2021.

Recent solo exhibitions include *Xerox publica* in a forest in Couce, Portugal in 2021; respublica.tube, an online exhibition available on Ayaan's website and screened at CCC, Porto in 2020; *Continuity forum* at Galeria do Sol in 2019; *Omega* at Artes, Porto in 2019; *Learning without language*, screened at RDC516 in 2019; and *Sponsored Content* at Century, London in 2017.

Alice Bonnot is an independent curator, writer and speaker interested in the development of environmentally sustainable curatorial and artistic practices with a drive towards eco solutions. She is the founding director of VILLA VILLA, a sustainable art residency programme in the countryside of Lisbon.

Alice is interested in developing exhibitions that address socio-political issues and environmental issues, as well as broader concerns relating to society. Her current curatorial research deals with subjects such as contemporary sustainability, intersectional environmentalism and ecofeminisms.

Upcoming exhibition: *Chasseurs de Tempêtes*, CAC Passerelle, France, 2022—2023. Recent exhibitions include: *Triple Point*, Belo Campo, Lisbon, 2021, *Podium Sales*, Picnic, London, 2019, *Out Of Office*, PADA, Lisbon, 2019 and *Hyper Mesh*, Assembly Point, London, 2019.

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