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Art-Science Research in Botany: Reinvestigating scientific representations of trees

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Collaborations in art and science work with explorative and uncertain research methods to find new ways of knowing about nonhuman actors such as trees. Methodologies and concepts common to modern science are questioned ontologically, in part through artistic practices. The epistemological process itself, its contextual meaning and philosophical level are investigated. In this paper, I analyse two case studies on trees that gathered and measured data on their sounds and smells and question the scientific representations of plants as inert objects.

Scientific research has highly influenced our perception of nonhuman actors, mainly from an anthropocentric narrative. This knowledge is created with scientific methods and narratives. In the sociology of science, this situatedness of knowledge in human experience and expertise is analysed in how it shapes the presentation of scientific knowledge (Latour 1987, Collins 2001). For trees, which have an essential impact on our environments as a habitat for many species, in their use by human beings and their influence on climate. Yet, trees as a taxonomy cannot be completely defined in botany or in common language. It is an anthropocentric conception that has created too narrow narratives for a "woody plant with secondary growth."

Art, science and technology. Scientific constructivism. Art installation. Botany. Art history.

1. ALL THE THINGS WE NEVER KNEW ABOUT TREES

One goal of interdisciplinary projects is to ontologically question existing forms of disciplinary knowledge and research (Barry *et al*., 2008). Particularly art and science collaborations can critically reflect upon concepts and representations in science through an artistic lens. Disciplinary methods can be reinvestigated within an artistic context, and vice versa, artistic methods used in a scientific experiment to challenge the boundaries of common practices. In this paper, I analyse two art-science projects in their relation to scientific representations of trees. Both projects reinvestigate traditional methods and their underlying representations of plants as inert objects. Sound artist Markus Maeder co-developed new research approaches on tree sounds that consider them as potential communication (*trees*, 2012-15). In *One tree ID*, Agnes Meyer-Brandis reflected upon methodologies on tree scents. The artists explored trees as agents in the complex ecosystem of a forest.

Until today, a universally recognized definition for 'tree' has never been phrased. In botany and in common language, trees can be standardized by their usage, as research objects in labs, or in their co-existence in forests. Descriptions include the production of lumber or characteristics like upwards growth, woody stem, or growth rings. Any of these many attributes can also exclude one another and this diversity of trees challenges a singular definition.

Research in botany since the 2000s (Mancuso *et al*., 2002; Marder, 2016; Coccia, 2019) revealed new attributes that questioned our traditional understandings of 'tree' anew. Trees have five senses and can f. ex. hear a bee flying over their flowers (Mancuso, 2015). They also create sounds intentionally and unintentionally. As part of photosynthesis and other biochemical processes, scents are produced that communicate information from one plant to another. The sensory perception creates an awareness of their surroundings, particularly of other trees. During a drought, trees can share nutrition with smaller ones surrounding

them (Wohlleben, 2016). Sounds and scents in a forest are a system of communication where trees act as historical agents. Although much data has been gathered in botany, tree as a historical agent and living entity is only partially palpable through scientific inquiry (and, hence, otherwise).

Many phenomena in botany have often been regarded as passive by-products. Botanists knew about these phenomena but did not consider them research objects (Mishra, 2016, p. 4484).

Auditory and olfactory data has not been standardized and added to any plant taxonomy. They are not measured by common methods in plant morphology, physiology, or other fields. Sounds are often described as noise rather than phenomena of their own. Tree scents are produced by biogenic volatile organic compounds (BVOC) and analysed in their chemical composition and impact on the atmosphere, but they are not much understood in their significance for trees themselves. Botanic observation is often conducted with a one directional gaze. Consequentially, scent and sound fell through the grid of botanic research as signs of tree co-agency.

From the outer surface to the cellular level, plants are commonly understood in a cyclical life process (Kallhoff, 2002). In a paradigmatic concept of a daily cycle, any communication with other plants or insects has been neglected. Modes of action in a plant are explained in their causal chain of reactions such as the transportation of water from the roots to the leaves. Plants are examined as purely causal processes, leaving not much room for non-purposive explanations. This analytic approach has an evaluative aspect, too (Kallhoff, 2018). Guidelines for the health, vitality, or ill conditions of a plant are determined in the scientific analyses of good and bad conditions. Such evaluations are at least in part constructed through a causal narrative.

Roman Zweifel as ecophysiologist in the art-science project *trees* questioned whether alternative approaches to analysing auditory tree data existed (Zweifel *et al.*, 2008). Agnes Meyer-Brandis, too, questions our (scientific) representations of trees through viewer-tree interaction in her artwork. Explorative approaches in art-science research can potentially help to open up scientific representations to previously neglected aspects.

2. TREE AS SCIENTIFIC REPRESENTATION

In the projects, measuring scent and sound data as investigation of tree agency is a critical reflection of standard methods in botany. The collaborators ontologically questioned how trees are constructed as inert objects. The scientific representation of trees becomes palpable. Gaining knowledge is not discovering or unveiling truth but constructing it within the scientific referential and narrative system it was created in.

The difference between a plant in its natural environment and its representation as research object derives from a transformative process where plants are dissected, dehydrated, preserved, or otherwise transformed to make them analysable and comparable. Bruno Latour analysed this as “epistemological question of scientific reference”, describing that “the sciences do not speak of the world, but, rather, construct representations that seem always to push it away, but also to bring it closer” (ibid., p. 30).

Research in arts and humanities reconstructed representations and scientific narratives towards co-agency and ideas of trees as historical agents in a forest while questioning anthropocentric views (Tsing, 2015; Marder, 2016). This capacitated a re-evaluation of tree characteristics as interaction and communication. Today, we know that trees can hear, smell and taste and they actively influence the ecosystem in a forest. An explorative investigation of tree data helped to make these discoveries. In the relation between arts, humanities, and science, any questions about plant ethics and plant intelligence are intrinsically connected to scientific research and vice versa.

The interdisciplinary connections also challenge conceptions of scientific practices as fundamentally different to artistic or humanist ones. Innovative research can be compared to creativity in art since it prerequires a breaking out of learned techniques and a questioning of confirmative structures. Especially during initial research stages, experience and observation are embedded into a predefined methodology. Scientific observation is a learned and skilled technique that is based on collective practice (Daston, 2008, p. 102) and necessitates a system of standardized knowledge. No researcher can perceive her research object with impartial or undefined perception but includes a background of knowledge and a skilful observation.

Lorraine Daston has compared this perception to the aesthetic pleasure of seeing a painting (2008, p. 107). Both practices require previous knowledge and teaching. However, the study of how intuition in science is initiated is still a neglected idea. Regarding tree data and how it may be considered as communication, this may answer why tree sounds were neglected as research objects for a few centuries. A deeper investigation required a novel and creative approach. Michael Marder boldly declared the discovery of tree senses as a Kuhnian paradigm shift in botany, although the actual innovation of this research is still in the margins and only time can tell its potential influence (2016, p. 75).

3. ART-SCIENCE PROJECTS: HEARING AND SMELLING DATA

3.1. *trees*, 2012-2015

Tree sounds were discovered during an analysis of conduction and cavitation in sap (Milburn *et al.*, 1966). Botanists recreated the cavitation process to understand the water tension in plant cells. During the night and during droughts, cavitation may occur in cells that can cause them to burst. This process causes a crackling noise in ultrahigh frequency that is not audible for human ears.

The art-science project *trees* (2012-2015) was one of the first research-driven attempts to investigate tree sounds in their potential meaning for a daily life cycle as well as for communication. Eco physiologist Roman Zweifel and sound artist Markus Maeder gathered data from Scots pine trees in the Swiss Alps. A data sonification was used to explore the meanings of these sounds. The research results were used in a sound art installation. The interdisciplinary research project was a collaboration between the Swiss Federal Institute for Forest, Snow and Landscape Research and the Zurich University of the Arts.

As a sound artist and engineer, Maeder recorded, transmitted, and made the ultra-frequency sound data audible. The recordings included not only the cells bursting but other noises such as insects landing on leaves, bugs crawling on the stem, and leaves rustling from the wind. The artist and the botanist collected the data together but kept to their individual expertise in the data analysis/art installation. The challenge for a scientific use of this data was to analyse and differentiate their origins.

Following Zweifel's general research, one of his main approaches is to investigate the meaning of climate change for forest trees. Since drought is a possible symptom of climate change, the investigation of conduction sap could lead to new research results. Due to the sonification, he could hear tree sounds that are not from sap but seem to be from trees growing at night. An idea that in the paradigmatic concept of a daily life cycle had not been considered (Zweifel *et al.*, 2021). Collaborating with a sound artist offered him the possibility for data sonification. Maeder's recordings were much more precise in differentiating between several sound types (Huber, 2014). In this sense, the artist collaboration was about sonification, mainly, rather than an exchange of work practices or knowledge. Although Maeder acquired the expertise of sound recordings for his artistic practice, his part in the collaboration centred around technical knowledge more than an artistic one.

As an art and science project, another goal was to make research in eco physiology more relatable to a wider audience. The public outreach was extensive with several newspaper articles and radio and TV documentaries. The data sonification also resulted in an art installation that was exhibited at Ars Electronica and other festivals (Maeder *et al.*, 2013) and during the climate conference in Paris 2015. Visitors saw a video from the Scots pines and an auditory display while listening to the sonification. Maeder portrayed the many sounds as a network rather than dissecting the different origins. It showed the connections between co-agents in a forest through the sound narrative.

Figure 1: *Markus Maeder/Roman Zweifel, tree lab, 2017, installation at Ars Electronica. © Florian Voggeneder*

The initial idea in the project proposal was to re-examine tree sounds as more than a by-product of conduction sap and to question whether this could be a form of communication as much as whether they can tell us something about how trees respond to drought. The questions were formulated broadly, and the results were different form the initial outset. The execution of the project was highly experimental since a data sonification is not a standard method in botany and results could not be accepted as new research outcome. It is difficult to think of *trees* outside of an art-science framework. The project methodology does not fit into a scientific narrative, and the results cannot be made into a "proper" scientific construct. The results show the importance of art-science for innovative research in general.

The approach of a network of interaction resulted from interdisciplinary thinking by embracing an understanding of tree co-agency. The sound recordings showed the many interactions between plant and insect life in a forest. Although the scientific and artistic practices are mainly separated, their combined method challenges the botanic representation of trees. However, although this change of perspective may have influenced his research approach, Zweifel as eco physiologist follows traditional representations. Whereas *trees* was initiated from a scientific observation, the second case is situated in arts-based research.

3.2. *One tree ID*, 2019

The project *One tree ID-How to be a tree for another tree* reflects on trees as scientific representations, invisible data, and tree scents. Agnes Meyer-Brandis' art-science project examined BVOCs as tree communication. In the art installation, visitors see a Himalaya cedar encapsulated by a table. Three glass bottles stand on it, each containing a tree perfume. In the installation, ideally, visitors will walk to the glass bottle, choose a perfume, and walk over to the tree. They can turn on a microphone and record a message as exchange. The cedar is placed in a hole in the table and around its stem is an analytic tool that measures BVOC data live shown on a computer screen next to it.

The perfumes were created during the artist's interdisciplinary research. At the Institute for Bio Science (University of Rostock), Meyer-Brandis together with biochemists Birgit Piechulla and Uta Effmert conducted biochemical analyses of BVOCs from the roots, stem, and needles of the cedar to create three perfumes identical to the tree scents. Perfumer Marc vom Ende from the company "Symrise" compared the original scents from the tree to the synthetic versions to make them as identical as possible. Since BVOCs are fragile due to their chemical compound, the artist and the scientists could not be sure that they could recreate the scents solely as reconstruction and relied on the perfumer to detect differences.

Figure 2: *Agnes Meyer-Brandis, One tree ID, 2019 art installation. © A. Meyer-Brandis, CC BY-NC-ND 2.0*

Meyer-Brandis created a new artistic narrative and performative installation for her research. The elements of her artistic-scientific practice—biochemistry, environmental science, posthumanism, performance—are all intricately connected. Although she applied a standardized analysis to create the perfumes, she changed the paradigmatic concept from a passive chemical process to a communication method. The art installation portrays how much scientific innovation depends on its underlying concepts. By creating an artistic narrative and an installation, the biochemist results can be recontextualised towards an alternative approach to their research object.

Recontextualising standardized practices creates tensions between 'normal' science, artistic narrative and trees as research object which become visible in the performative aspects of the installation. The interaction between human and tree is not a real communication and any attempt is bound to fail. We smell the perfume, aware that this is how trees send information to each other, and we then communicate with them in our own language. We can interpret this as a critical reflection of how a "true" understanding of what a tree is, cannot be reached with scientific methods and through scientific representations of trees. The failed communication can also be a contemplation of all the things we may never know about trees. Like any good artwork, the artwork is subjective, contemplative, and open for interpretation.

The installation view is reminiscent of the traditional botanical perspective of dissecting and standardizing trees rather than trees as co-actors. It shows the histories of a scientific discipline and challenges us through the performative aspects to consider alternative approaches on how to regard trees.

4. CONCLUSION: QUESTIONING AND REAFFIRMING SCIENTIFIC REPRESENTATIONS

One tree ID reapplied a traditional scientific method to question its epistemological assumptions. Meyer-Brandis' installation is in many aspects an artistic expression of scientific knowledge. *Trees* produced two types of outcomes: an artwork and a data analysis. The approach nevertheless relies on a questioning of the scientific representation of plants in their ontological status. It is exploratory and can become functional as basic knowledge. This highly explorative approach is difficult to imagine outside of an art-science framework.

Markus Maeder's installation disseminated the subject of drought through climate change to a wider audience and is based upon an idea of true knowledge in science. The aesthetic in the installation depends on the reality of tree sounds. Viewers would perceive it radically different had it not been a data sonification but an artistic creation. Maeder also did not create an artistic narrative like Meyer-Brandis, or otherwise re-worked the data artistically. The aesthetic is focused on the idea that we can hear genuine tree sounds. By relying on a concept of scientific truth, any possibility of an artistic exploration was neglected. In comparison to his other sound installations, there are not as many artistic components in the installation.

Agnes Meyer-Brandis was less concerned with truth values for her installation. *One tree ID* investigates scientific understanding itself in how the viewer's experience critically reflects upon the botanical concept of trees as research objects. The installation questions the transformative process into a scientific construct. The tree is not the research object on display, but something hidden from us because we cannot (yet) understand its language and signs.

5. REFERENCES

Albert, B. (2019). *Trees*. Fondation Cartier pour l'art contemporain.

Anderson, E. (2004). Uses of Value Judgments in Science: A General Argument, with Lessons from a Case Study of Feminist Research on Divorce. *Hypatia*, 19(1), 1-24. https://doi.org/10.1111/j.1527-2001.2004.tb01266.x

Bailer-Jones, D. (2009). *Scientific Models in Philosophy of Science*. University of Pittsburgh Press.

Barry, A., Born, G., & Weszkalnys, G. (2008). Logics of interdisciplinarity. *Economy and society*, 37(1), 20-49. https://doi.org/10.1080/03085140701760841

Brooks, H. (1965). Scientific Concepts and Cultural Change. *Daedalus*, 94(1), 66-83. http://www.jstor.org/stable/20026896

Coccia, E. (2019). *The life of plants: a metaphysics of mixture*. Wiley Publishing.

Daston, L. (2008). *Things that talk: object lessons from art and science* (1st paperback ed. ed.). Zone Books, MIT Press.

Daston, L., & Lunbeck, E. (2011). *Histories of scientific observation*. University of Chicago Press.

Derrida, J., Porter, C., & Morris, E. P. (1983). The Principle of Reason: The University in the Eyes of Its Pupils. *Diacritics*, 13(3), 2. https://doi.org/10.2307/464997

Di Paola, M., Kallhoff, A., Schörgenhumer, M., Taylor, & Francis. (2018). *Plant ethics: : concepts and applications*. Routledge, an imprint of Taylor and Francis.

Eller, A. S. D., Young, L. L., Trowbridge, A. M., & Monson, R. K. (2016, 2016/02/01). Differential controls by climate and physiology over the emission rates of biogenic volatile organic compounds from mature trees in a semi-arid pine forest. *Oecologia*, 180(2), 345-358. https://doi.org/10.1007/s00442-015-3474-4

Gagliano, M., Mancuso, S., & Robert, D. (2012). Towards understanding plant bioacoustics. *Trends Plant Sci*, 17, 325. https://doi.org/10.1016/j.tplants.2012.03.002

Gibbs, P. (2020). *Contemporary Thinking on Transdisciplinary Knowledge: What Those Who Know, Know* (1st ed. 2020. ed.). Springer International Publishing: Imprint: Springer.

Huber, M. (2014), Bäume wachsen hören. *Zentralschweiz am Sonntag*, 09.11.2014, 47.

Kallhoff, A. (2002). *Prinzipien der Pflanzenethik: die Bewertung pflanzlichen Lebens in Biologie und Philosophie*. Campus-Verl.

Kesselmeier, J., & Staudt, M. (1999, 1999/05/01). Biogenic Volatile Organic Compounds (VOC): An Overview on Emission, Physiology and Ecology. *Journal of Atmospheric Chemistry*, 33(1), 23-88. https://doi.org/10.1023/A:1006127516791

Latour, B. (1999). *Pandora's hope: essays on the reality of science studies*. Cambridge, Mass. [u.a.]: Harvard Univ. Press.

Latour, B., & Woolgar, S. (2013). *Laboratory Life: The Construction of Scientific Facts*. Princeton University Press.

Machamer, P. K., & Silberstein, M. (2002). *The Blackwell guide to the philosophy of science*. Blackwell Publishers.

Maeder, M., & Zweifel, R. (2013). Downy Oak: Rendering Ecophysiological Processes In *Plants Audible. 10th Sound and Music Computing Conference*, Stockholm, Sweden.

Mancuso, S. (2015). *Brilliant green : the surprising history and science of plant intelligence*. Island Press.

Marder, M. (2016). *Grafts*. University of Minnesota Press.

Meyer-Brandis, A., & Voropai, L. (2020, 2020/04/02). Exploring the Aesthetic Potential of AMB's MOC and AAM. *Performance Research*, 25(3), 74-76. https://doi.org/10.1080/13528165.2020.1807761

Milburn, J. A. (1966). The Conduction of Sap: I. Water Conduction and Cavitation in water stressed Leaves. *Planta*, 69(1), 34-42.

Milburn, J. A., & Johnson, R. P. C. (1966). The Conduction of Sap: II. Detection of Vibrations produced by sap cavitation in Ricinus xylem. *Planta*, 69(1), 43-52.

Mishra, R. C., Ghosh, R., & Bae, H. (2016). Plant acoustics: in the search of a sound mechanism for sound signaling in plants. *Journal of Experimental Botany*, 67(15), 4483-4494. https://doi.org/10.1093/jxb/erw235

Nowotny, H. (2001). *Re-thinking science: knowledge and the public in an age of uncertainty*. Polity Press.

Petit, R. J., & Hampe, A. (2006). Some Evolutionary Consequences of Being a Tree. *Annual Review of Ecology, Evolution, and Systematics*, 37(1), 187-214. https://doi.org/10.1146/annurev.ecolsys.37.091305.110215

Shapin, S. (2008). *The scientific life : a moral history of a late modern vocation*. University of Chicago Press.

Song, X., Lv, X., Yu, D., & Wu, Q. (2018, 2018/01/01/). Spatial-temporal change analysis of plant soundscapes and their design methods. *Urban Forestry & Urban Greening*, 29, 96-105. https://doi.org/https://doi.org/10.1016/j.ufug.2017.11.002

Tsing, A. L. (2015). *The mushroom at the end of the world: on the possibility of life in capitalist ruins*. Princeton University Press.

Vivaldo, G., Masi, E., Taiti, C., Caldarelli, G., & Mancuso, S. (2017). The network of plants volatile organic compounds. *Sci Rep*, 7, 18. https://doi.org/10.1038/s41598-017-10975-x

Wohlleben, P. (2016). *The hidden life of trees : what they feel, how they communicate. discoveries from a secret world*. Greystone Books Ltd.

Zweifel, R., & Zeugin, F. (2008). Ultrasonic acoustic emissions in drought-stressed trees - more than signals from cavitation. *New Phytologist*, 179(4), 1070-1079. https://doi.org/https://doi.org/10.1111/j.1469-8137.2008.02521.x

Zweifel, R.; Sterck, F.; Braun, S.; Buchmann, N.; Eugster, W.; Gessler, A.; Häni, M.; Peters, R.L.; Walthert, L.; Wilhelm, M.; Ziemińska, K.; Etzold, S., 2021: Why trees grow at night. *New Phytologist*, 231, 6: 2174-2185. doi: 10.1111/nph.17552