xCoAx 2026
Torino, Italy
2026.xCoAx.org

Re-examining Electronic Plant Music: Ecologies, Agency and Instrumentation In More-Than-Human Musicking

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This article re-examines Electronic Plant Music (EPM) as a critical site for interrogating what it means to construct sound ecologies with more-than--human bodies. Drawing on the concept of musicking, we argue that EPM should be understood not as the revelation of plant musicality or consciousness, but as the construction of technical dispositifs that render certain physiological indices sonically perceptible. Through a historical genealogy tracing EPM from 1970s cybernetic plant imaginaries to contemporary posthumanist reactivations, we expose the continuity of galvanic sensing methods and the epistemological consequences of this technical persistence. We then present *Troisième Nature*, an artistic research project that re-examines EPM by hacking an EMG biosignal capture device for plant electrophysiology, distinguishing biological agency from the musical agency typically attributed to plants through sonification. Pedagogical workshops conducted with primary school students reveal how making technical mediation explicit can produce different modes of understanding distributed agency across human-plant-technology assemblages. We conclude by questioning what is plant temporality and how grasping this notion will be used as a framework for future EPM practice.

1 Introduction: Sound Ecologies Beyond the Human

1.1 Representation and Realism In Sound Ecology

Sound ecology emerged alongside the environmental movements of the 1960s and 1970s, when composers and sound artists began to elaborate ecological modes of thinking *through* sound, composition, and listening practices (Barbanti 2023, 147–151). Within this genealogy, Raymond Murray Schafer's acoustic ecology, developed through the World Soundscape Project, established a durable framework for approaching environments as *soundscapes*: objects to be described, documented, and, within the same movement, protected through a normative critique of "noise pollution" (Schafer 1994; Duhem 2014; Paparrigopoulos 2024). Subsequent developments such as ecoacoustics reinforced this approach by treating soundscapes as ecological indicators to be measured and analysed (Krause 2018; Sueur 2018).

This also shaped what counts as a traditional object of sound ecology: soundscape composition, grounded in the recognisability of environmental sources and contexts, and in the expectation that listening will reconstruct meanings tied to a place and its identity (Truax 1996; Westerkamp 2002). This horizon, often aligned with forms of sonic realism, tends to frame the environment as something to be captured for a human listener, privileging what can be recorded, identified and

Keywords: Electronic Plant Music, More-than-human Musicking, Sound Ecology, Biosignal Sonification, Plant Agency, Artistic Research.

DOI 10.34626/2026_xcoax_020

documented (Schafer 1994). What becomes less visible, in turn, are the conditions that configure audibility itself: the power relations embedded in regimes of attention, mostly framed in the historical and political situatedness of the «white Western-centric ear» (Wright 2022, 3), and the forms of inattention or inaudibility to more than human bodies.

More recently, critiques of these concepts have emerged through more-than-human and decolonial perspectives. They are articulated through proposals such as multi-species sonic ecology (Di Croce 2021), post-human listening (Lacey 2024), more-than-human soundscapes (Degórski 2020), and listening after Nature (Wright 2022). Together, they displace the historical frameworks of acoustic and sound ecology by questioning the position of the human recordist and the power dynamics that configure listening practices and modes of relations developed within these projects. Positioning ourselves in this perspective, we argue that moving beyond representation in sound ecology can be a methodological reorientation toward a disambiguation of the chains of mediation through which environments become audible, and toward the distributed, negotiated agencies that such mediations enact.

1.2 Making Music With Non-human Bodies?

This article investigates sound ecologies that can emerge from trying to “make music with” non-humans, such as plants. To what extent can making music-with non-human entities be understood as interaction, and how feasible is such a project? This requires apparatuses in which we reframe “making music” as a practice that does not begin from clearly bounded subjects (a performer, an instrument, an environment), but from situated couplings between bodies, signals, and technical mediations. The “body” at stake here is therefore not only the human body as an expressive source, but a heterogeneous field of corporealities and material processes (physiological, mechanical, algorithmic, environmental) through which musical events become possible and perceptible. In this perspective, the question is less “who interacts with whom?” than “what assemblage and instrumentation make certain modes of audibility possible?”

If we understand interaction in the sense of joint action, the threshold for what counts as interaction can be demanding. In models of coordinated action, interaction involves spatio-temporal coupling, mutual adjustment, and some minimal capacity to take the other into account as an intentional partner (Vesper et al. 2017, 1–2). Schütz’s analysis of “making music together” similarly presupposes a relation of co-presence: his “mutual tuning-in relationship”, in which participants share a lived time and actively “tune” to one another within a common present (Schütz 1976, 162). But many more-than-human musical situations do not meet these conditions in any straightforward way: coordination may be asymmetrical, delayed, indirect, or distributed across sensing and processing chains; mutual attunement may be enacted through thresholds, mappings, machine learning classifications, or feedback topologies rather than through reciprocal intersubjective negotiation.

Treating such situations as if they were simply dialogues between intentional partners risks importing, by default, a human-centred model of agency and musical communication.

Read through an Actor Network Theory (ANT) perspective, such practices can be described as a “knot” of agencies that are mediated and redistributed across networks of humans and non-humans (Latour 2005, 44) (Born and Barry 2018). Devices, which can be sensors, electrodes, converters, signal-processing routines, mappings, models, and performance conventions, actively shape what can occur and what can matter in the situation, by configuring thresholds of perception and conditions of response (Latour 2005, 81–82).

We mobilise the concept of musicking as a more robust framing. For Small: “musicking is an activity by means of which we bring into existence a set of relationships that model the relationships of our world” (50). Music is therefore not located in an autonomous work but in participation: “taking part in performance, in social action”, whose meaning lies in the relations established through performance (Small 1999, 9). Applied here, musicking describes the practical work through which participants (human and more than human) are provisionally brought into a shared situation of listening and/or acting. The point is to account for how relations are composed, tested, and stabilised in performance: what is made audible, what counts as a response, what becomes actionable, and what remains opaque or resistant.

1.3 Entanglements: Beyond Representationalism In Sonic Interaction

The shift from representation to musicking with more-than-human bodies requires attending not only to what becomes audible, but to how bodies, human and more-than-human, are configured as participants through technical mediation. Recent work on electromyography (EMG) in musical performance offers a model for thinking through these questions. Tanaka’s work on the notion of “sonic entanglements” (Reed et al. 2024) demonstrates how EMG-based musical systems (investigated here) cannot be reduced to either transparent measurement or expressive control. Rather, the signal itself—messy, unstable, contextually variable—becomes constitutive of the performance situation (Reed et al. 2024, 2701), highlighting how technical apparatuses actively shape what counts as bodily action, musical gesture, and intentional expression.

If even human EMG signals resist straightforward intentional control—requiring instead a cultivation of attention to “messy electricity passing across muscle fibres, skin, and sensors” (2704)—then sonic practices with plant bodies or environmental processes cannot simply adopt models of dialogical interaction. This is why we frame our case study as a dispositif for testing modes of entanglement.

This article takes Electronic Plant Music (EPM) as a case study to question how sound can articulate relations with more-than-human bodies. To address this, we first trace EPM’s historical genealogy from 1970s plant telepathy experiments to contemporary posthumanist reactivations, examining the continuity of technical methods alongside shifting epistemological frameworks. We then analyze how these practices have moved from demonstrating plant "communication" to constructing experimental assemblages that foreground mediation itself. After examining the persistence of certain technical instrumentation, we present the project, *Troisième Nature*, that serves as a critical dispositif for testing EPM assemblages. Historically positioned outside the acoustic ecology movement despite emerging in the same period, EPM practices have only recently been included within expanded conceptions of sound ecology through posthumanist frameworks. Our hypothesis is that carefully constructed sonic dispositifs can make perceptible aspects of vegetal agency while simultaneously revealing the technical and ethical negotiations required to render such agency audible, questioning the very notion of agency in the context of musicking with plants.

2 Electronic Plant Music: History and Regimes of Representation

2.1 Plants Making Music In the 1970's

Electronic Plant Music (EPM), defined by Miller and Cox as the use of vegetal biosignals to generate sound or music (Miller and Cox 2024), emerged from a specific historical conjuncture intertwining plant physiology, cybernetic thinking, and countercultural plant imaginaries. From nineteenth-century investigations into vegetal sensitivity like Paul Bert's experiments on anesthetized *Mimosa pudica* (Bert 1867), Charles Darwin's studies of plant movement (Darwin 1880), Jagadish Chandra Bose's electrical recordings of plant responses (Bose 1906), a genealogy developed that would culminate, during the 1970s, in the construction of the plant as sensitive, communicative, and even intelligent subject. This decade witnessed the development of plant-sound dispositifs: John Lifton's *Green Music* installation (1975), the film adaptation of *The Secret Life of Plants* (Green 1979), Tom Zahuranec's *Radio Event No. 20: Rhododendron* (1972), and the ongoing *Music of the Plants* project developed in Damanhur, Italy (1976–1980). These practices contributed to what Teresa Castro has termed the construction of the "mediated plant": a figure whose sentience and agency become perceptible only through technological scaffolding (Castro 2019, 2020).

The 1970s "plant craze" (Castro 2020) cannot be understood outside its broader cultural context. The plant became a site for reimagining human-nature relations. This reimagining was paradoxically technophilic: even eco-mystical quests to reach the plant-other depended on "bio-sensing" technologies, on the interfacing of electronic extensions that would render plants audible and knowable (Castro 2020, 175). The communicative, sentient plant was thus necessarily a mediated plant. This movement found epistemological grounding in cybernetics, which framed plants as self-regulating communication systems whose electrical and chemical responses to stimuli functioned as inputs and outputs generating feedback loops (Castro 2020, 174; Wiener 1948). The seminal moment was Cleve Backster's 1966 polygraph experiment claiming plants possessed "primary perception"— telepathic awareness of human thoughts—a thesis quickly dismissed as pseudoscience by plant physiologists (Galston and Slayman 1979) yet widely popularized through Tompkins and Bird's bestseller *The Secret Life of Plants* (1973/1989). This fusion of cybernetic systems-thinking with New Age spirituality reflected what concerned scientists described as "a wave of anti-intellectualism" sweeping the United States (Galston and Slayman 1979, 337).

This trend operated through what Castro calls a "cybernetic paroxysm": an escalation of technological mediation aimed paradoxically at dissolving the human-nature divide (Castro 2020, 184). Tom Zahuranec's experiment *Radio Event No. 20: Rhododendron* (October 18, 1972, KPFA Berkeley) is an example. Here a rhododendron wired with liquid electrode sensors normally used to measure human galvanic skin response (GSR) fed bioelectrical signals from the plant into a Buchla modular synthesizer while the radio audience was invited to "communicate mentally" with the plant (radiOM.org 2026). Drawing on Backster's discredited "primary perception" thesis, the event positioned the plant simultaneously as psychic conduit, telepathic receiver, musical performer, and participatory medium. This representational regime reveals fundamental ambiguity between acknowledging the plant's radical alterity (requiring technological mediation) and anthropomorphizing its physiological responses as intentional communication (Galston and Slayman 1979). The technical methods they established – galvanic conductance measurement, biosignal amplification, mapping to synthesis parameters – persisted. Since the 2000s, a new generation of sound artists has reactivated these experiences while seeking to displace the representational regimes and instead engaging explicitly with posthumanist and new materialist frameworks.

2.2 Musicians "Becoming With Plants" Since the 2000's

Since the 2000s, electronic plant music has been reactivated by artists who no longer present plant–sound coupling as evidence for vegetal telepathy, but who represent an experimental scene in which the plant becomes audible through a technical ecology of sensing, mapping, and listening. What is at stake is less the "revelation" of a plant interiority than the construction of an instrumentation that distributes agency across heterogeneous components. This shift from the plant as a human-like performer to the plant–machine assemblage becomes the site for testing how relations are composed. In this sense, contemporary practices are often articulated as research protocols (installation, residency, performance, publication) that make explicit the conditions under which something like "plant music" can be perceived at all.

A first axis of this shift is a move from data transparency toward aesthetic sonification, understood as a "compositional problem". Mileece

I'Anson describes using "bioelectrical signal generated by a living plant" as one possible controller that "directly animates a series of set parameters," producing timbres and cadences "in reciprocation with an organic input" (I'Anson 2018, 502). Rather than claiming to transmit a plant "message," this framing foregrounds how the musical event is co-produced by thresholds, constraints, and aesthetic decisions within the signal chain.

A second characteristic of these practices is the design of hybrid dispositifs that explicitly thematize mediation as a condition of relation. Leslie García's *Pulsu(m) Plantae* (2010) is discussed here through her later technical description of the project (García 2011), which presents it as "a self-sustainable sound device" built through "the integration of a live organism (plant) and an electronic interface (bio-sensors)" (García 2011, 2). The project does not present the plant as an autonomous musician; it constructs a system meant to "read[] the vital pulse of the plant" through "pH, Minerals and galvanic variation sensors," and to transform these micro-signals into "audible sound frequencies" so that spectators may perceive "the rhythm and arrythmia of a silent organism such as a plant" (García 2011, 3). This locates agency in an operational ecology where sensing, microcontroller programming (including granular synthesis), and sustainable energy architectures (solar power) configure what counts as audible (García 2011, 2–4).

Some of these artists are concerned with epistemological positioning: contemporary plant–sound practices frequently stage the plurality and the friction of the knowledge regimes they mobilize. For example, Christine Ödlund's *Aether & Einstein* (2016a), documented in the exhibition catalogue Aether & Einstein (Ödlund 2016b), includes *Xylem Floem*, framed as "an acoustic experiment on the root systems of the plants," explicitly "referring to research in bioacoustics and evolutionary biology" (Ödlund 2016b), while also mobilizing theosophy. Here, the dispositif does not guarantee access to a plant "truth"; it exhibits how different representational and knowledge frameworks produce different versions of what the plant can be made to signify.

Finally, the reorientation toward "becoming with" plants (España Keller 2024) is often articulated through explicitly posthuman vocabularies that contest interactional models inherited from human sociality. España Keller defines "intra-action" (after Barad 2007) as a way to refuse pre-established bodies and to treat agency "not [as] an inherent property of an individual or human to be exercised, but as a dynamism of forces" (España Keller 2024, 2). Her aim is "to make perceptible… the slow and subtle sonic intra-relations and other-than human sonic undulations from plant life" (España Keller 2024, 3), using modular synthesis as a milieu where "live acoustic wave signals emitted by plants" are patched into "electronic patterns of sounds designed by humans, emitted by machines" (España Keller 2024, 2). The text repeatedly returns to the problem of arrangement: what the apparatus makes audible, which modes of attention it demands, and how technicity conditions the ethics of relation (España Keller 2024, 4–7).[1]

Yet, despite this discursive shift, the technical infrastructures involved, based on resistance variation measurement remain structurally close to earlier systems. This persistence foregrounds sonification as a critical node where tensions between anthropocentrism, anthropomorphism, and attempts at critical anthropomorphism are continuously renegotiated, raising the question not only of "who speaks for non-humans" (Imhoff and Quirós 2022, 27–34), but more fundamentally: how non-humans are made to speak?

2.3 How?

Despite theoretical divergences, EPM techniques reveal remarkable continuity, primarily employing GSR measurement. From Zahuranec's 1972 Buchla-modulated rhododendron to current commercial devices, most systems employ galvanic skin response (GSR) measurement rather than recording genuine plant electrical signals. This technical persistence raises critical questions about what sonification accomplishes and obscures.

The dominant sensing method used in EPM projects measures electrical conductivity between two electrodes placed on plant tissue. Cleve Backster popularized this approach in the 1960s using polygraph equipment on *Dracaena* leaves, interpreting conductance variations as plant "primary perception" (Backster 1968). Though scientifically discredited, the method persisted because it produces continuous, measurable variation suitable for real-time sonification. As Miller and Cox specify, galvanic measurement correlates primarily with leaf water content: "these data do not necessarily represent electrical signals generated by the plant itself, but rather reflect a more-or-less accurate measure of the water content in the leaf" (Miller and Cox 2024, section 3.11). Water content fluctuates with circadian rhythms and environmental conditions, creating apparent responsiveness without representing plant signalling in the electrophysiological sense.

Electrode configurations vary by practitioner. TENS (Transcutaneous Electrical Nerve Stimulation) cables with conductive gel have become standard in commercial devices like PlantWave[2] and MIDI Sprout.[3] Zahuranec's 1972 system used liquid electrode micropipettes. García developed galvanic sensors for mosses, while Mileece combines GSR with EEG (Electroencephalogram) sensors measuring resistance and direct current. Using EEG permits the acquisition of more comprehensive or higher-resolution data, which is an exception in EPM. Davies, a molecular biology researcher, notes that surface contact electrodes avoid tissue damage but contain KCl that dries out, limiting use to "short-term

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1. The corpus mobilised here is restricted to artists publishing detailed accounts of their instrumentation. Its markedly feminine composition seems to be a gendered dimension of contemporary EPM practice to be investigated in future research.
2. https://plantwave.com/
3. https://www.midisprout.com/

(a few hours) recordings," whereas piercing electrodes (silver, platinum) remain "usable for days and perhaps weeks" without altering ionic status (Davies 2006, 414). In EPM instrumentation, plant selection also responds to technical constraints: the systems studied favour robust species with rigid leaves like snake plant (Sansevieria trifasciata), croton (Codiaeum), jade (Crassula ovata), that withstand extended electrode attachment.

In these systems, signal processing architectures transform voltage fluctuations into sound through diverse mappings. PlantWave and MIDI Sprout map conductance to MIDI notes in programmable scales. García's Max/MSP patches link multiple data streams to synthesis parameters. Mileece's modular systems use voltage fluctuations to modulate oscillator frequency and filter cutoff through algorithmically mediated processes rather than direct mapping. As Miller and Cox observe, engineering choices significantly affect sonic outcomes and creative agency (Miller and Cox 2024, section 3.3).

This technological persistence across five decades reflects structural constraints. Rigorous action potential measurement requires laboratory conditions not always compatible with exhibition contexts. Galvanic sensing offers a pragmatic compromise: continuous variation accessible through simple electrode contact. Yet this choice carries epistemological consequences. If systems primarily measure leaf water content rather than plant electrical signalling, plants function less as autonomous agents generating messages than as responsive substrates whose material properties fluctuate with environmental conditions. This reframes EPM: not as a practice accessing plant communication, but as an apparatus that brings plants, humans, and technologies into sonic relations. The instrumentation does not translate an existing plant voice but enables a sonic mode of presence.

3 Re-examining EPM: Disambiguation Through Artistic Research

Troisième Nature is an artistic research (AR) project that critically re-examines the practices and discourses of Electronic Plant Music (EPM) through two types of dispositifs: (1) a sound installation and improvised concert featuring the sonification of three terrariums planted with vegetation from the Jardins du Tiers-Paysage (Clément 2004), along with an improvised concert by a musician interacting with this system, was presented at the Festival de l'Eau from May 21-25, 2026 in the radôme of the Saint-Nazaire submarine base; and (2) a set of pedagogical workshops for primary schools we are discussing in this article.

Rather than assuming that plants possess musical agency, the project treats interspecies musicking as a site for interrogating what it means to "compose with" non-human organisms. The work problematizes the notion of agency itself: distinguishing between a plant's biological agency while questioning the idea of musical agency attributed to plants through sonification systems. By foregrounding the technical instrumentation that mediates the encounter between human and plant, we ask the questions:

What exactly are we measuring when we claim to make music "with" plants?

What does the technical infrastructure reveal or obscure about vegetal life?

3.1 What Is a Plant? What Is Agency? What Is Plant Agency?

Before examining plant agency through EPM, we must clarify what defines both plants and agency in biological systems. As Hallé observes, plants differ fundamentally from animals in their modular architecture, indeterminate growth, and existence (Hallé 1999/2024). Plants develop through continuous iteration of modular units – leaves, stems, roots – responding to environmental conditions throughout their lifespan. This architecture produces organisms capable of regeneration from fragments, exhibiting distributed rather than centralized information processing.

Plant electrophysiology provides measurable indices of this processing. Research distinguishes several types of long-distance electrical signals (Vodeneev et al. 2015, Sukhov 2016, Li et al. 2021). Action potentials (AP) are fast, brief, all-or-nothing events triggered by non-damaging stimuli such as touch or light change. In *Dionaea muscipula*, AP typically exhibit amplitudes of 100-150 mV and durations of 1-2 seconds. AP are "self-propagating" signals transmitted primarily through phloem[4] tissue "at essentially constant velocity and amplitude" (Davies 2006, 409-410). Conduction velocities for AP range from 2-10 mm/s in most plants (Madariaga et al. 2024), though they can reach up to 20 cm/s in specialized structures like *Mimosa pudica* motor cells (Sibaoka 1962). Variation potentials (VP) are slower signals typically induced by damaging stimuli like wounding or burning. VP exhibit variable amplitudes typically ranging from 5-50 mV with durations of tens of seconds to several minutes, propagating at velocities of 0.1-1 mm/s (Zimmermann et al. 2009, Davies 2006, 411). VP amplitude decreases with distance from the stimulus site (Stahlberg and Cosgrove 1997). The amplitude and duration of VP scale with stimulus intensity and gradually decay over distance and, unlike AP, can travel through dead tissues. System potentials (SP) correspond to transient hyperpolarizations with amplitudes of 5-20 mV propagating autonomously, with mechanisms involving reactive oxygen species and photosynthetic regulation (Sukhov 2016). Taken together, AP, VP, and SP form a dynamic picture of how plants integrate and respond to environmental changes.[5]

Electrical signalling permits "very rapid systemic information transmission, so that the entire plant is informed almost instantly even

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4. The vascular tissue in plants which conducts sugars and other metabolic products downwards from the leaves.

5. See representation of AP, VP and SP in Sukhova et al. article's figures: https://www.researchgate.net/publication/318469232_Mathematical_Models_of_Electrical_Activity_in_Plants

though only one region may have been perturbed" (Davies 2006, 417). This rapidity enables coordinated defence responses: wounded cells transmit signals causing distant cells to stop cytoplasmic streaming, clog plasmodesmata, inhibit translation, and activate defence genes within minutes (Davies 2006, 417-418). Both AP and VP trigger systemic gene expression changes, with some transcripts peaking "within 2 min in a leaf 5 cm distant from the wound site" (Davies 2006, 412). These signals constitute a distributed information processing system enabling plants to integrate perturbations and mount coordinated responses across their modular bodies. These signals serve essential adaptive functions and are indices of the plant agency.

But rather than asserting a strong notion of plant agency, our project adopts a cautious perspective grounded in minimal or biological agency. Following Saint-Germier (2025) and List and Pettit (2010), agency for us involves representing environment aspects, possessing motivational states, and processing these to act when conditions mismatch. From a biological perspective, plants perceive multiple stimuli: light, gravity, nutrients, chemical signals. They integrate thess environmental cues and adjust their growth in a flexible manner oriented toward survival and reproduction. These processes, however, do not involve internal representations in the strict sense; rather, they are part of physico-chemical regulatory networks, of which electrical signals are one measurable indicator. Electrical signals are thus approached not as expressions of intention, but as measurable indices of vegetal vitality and adaptation (Selosse 2022, 2024). Thus through our artistic research experiment, the aim is not to uncover plant "language," but to construct a situated listening experience that makes perceptible clues of vegetal agency through sound and to question the notion of agency in this context.

3.2 Hacking an EMG/EEG Device for Plant Electrophysiology

For the *Troisième Nature* project, plant electrical signals are acquired using the EAVI board,[6] developed to capture human EMG and EEG for musical interaction (Tanaka et al. 2024). It features four bipolar analog inputs processed by a high-resolution analog-to-digital converter (ADS1294, 20-bit) with an internal noise of just 5 microvolts peak-to-peak, substantially below the amplitude of plant electrical signals. The system includes an STM32F427 microcontroller and transmits digital data at 8 kHz via USB. However, the EAVI's embedded firmware originally included signal conditioning designed for human biosignals: a DC filter, a 500 Hz low-pass filter, and a 50 Hz notch filter (Fig. 1.).

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6. https://github.com/RebelTechnology/BioSignals

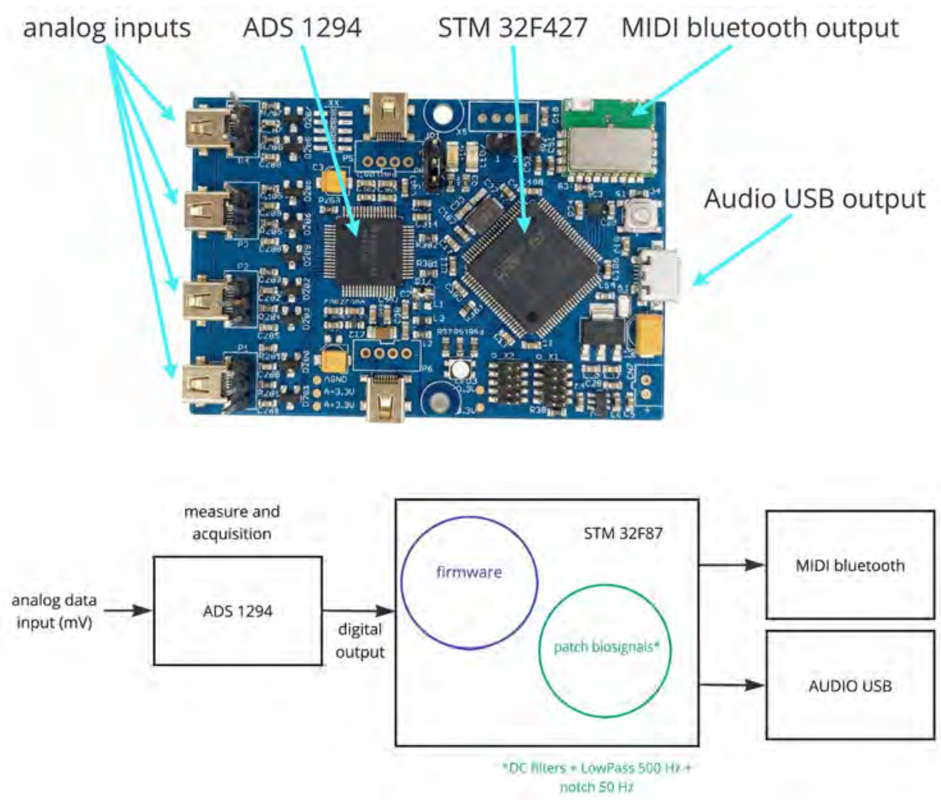

Fig. 1. Photo of the EAVI board and diagram of measurement and acquisition.

Because these filters can interfere with the slow drifts and low-frequency components characteristic of plant electrical activity, the filtering stage was removed from the EAVI boards dedicated to plant use. We conducted calibration tests using a precision voltage generator (SIGGI-2, EASYCAP) to establish the relationship between input voltage and recorded values (Schuh 2024). The calibration revealed linear relationships in specific voltage ranges, with the conversion formula: millivolt = $(x - 0.0118)/(3.8 \times 10^{-4})$, where x is the collected PCM amplitude data. This characterization confirmed that the modified EAVI board could reliably detect voltage variations at the microvolt scale typical of plant electrophysiology, supporting its use for measuring action potentials (APs), variation potentials (VPs), and system potentials (SPs) in plants.

3.3. Recording Plant Activity: Behaviours and Time Scales

Before embarking on the project proper, a series of exploratory tests was conducted to evaluate signal stability, sensitivity to environmental conditions, and the effects of different technical parameters. These tests were carried out in different environments (with and without Faraday cage), with different electrode types (steel, Ag/AgCl, and platinum), and on several plant species with known AP, VP, and SP potentials (Boston fern *Nephrolepis exaltata, Dionaea muscipula, Mimosa pudica*). These experiments documented electrode configurations, positioning, environmental conditions, and signal characteristics.

To better understand what is actually measured when recording plant electrical activity, a series of tests was conducted in collaboration with Benedikt Kaiser-Lasalle at the ITODYS laboratory (Interfaces, Treatments, Organization and Dynamics of Systems, Université Paris Cité).[7] Using a potentiostat, we compared electrode types on *Dionaea muscipula*.

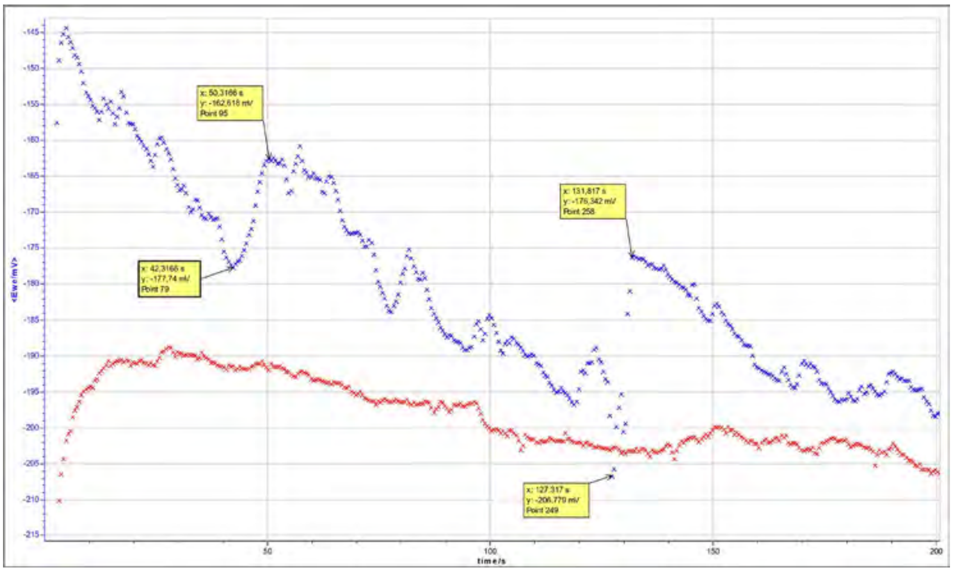

Fig. 2. Data visualisation of electrical signal on *Dionaea muscipula* with platinum electrodes. In blue: on the plant's traps, in red: on the plant's stem (11/12/2025 at ITODYS laboratory - Electrochemical Imaging).

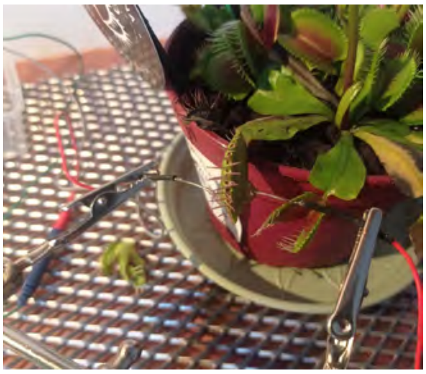

Fig. 3. Data visualisation of electrical signal on *Dionaea muscipula* with platinum electrodes. In blue: on the plant's traps, in red: on the plant's stem (11/12/2025 at ITODYS laboratory - Electrochemical Imaging).

These tests revealed that electrode positioning is critical: only placement on *Dionaea* traps captures signals corresponding to true action potentials during closure (Fig. 2.). When electrodes are placed on the stem, the recorded signal is different and does not correspond to the expected electrophysiological event. Following these preliminary tests, a protocol with reproducible manipulations was constructed to verify what is recorded with the tools and environment used for this project (Ag/AgCl electrodes, EAVI board, computer with power supply).

Two experimental series were conducted to evaluate the signal-acquisition performance of the EAVI board using homemade Ag/AgCl surface electrodes[8] and conductive gel.[9] Signals were recorded in Audacity on battery-powered laptops to reduce mains-related interference. Thirteen recording sessions on *Dionaea muscipula* tested electrode placement and environmental conditions. In Session 13, electrodes were positioned on an open trap that closed spontaneously during acquisition (Fig. 3), allowing us to document electrical activity across the trapping sequence. The recording exhibited a train of stereotyped biphasic transients, temporally associated with the closure and early post-closure period. On this basis, and given the known excitability of *Dionaea* traps, these events were interpreted as action-potential-like signals. During the first 5 minutes, the largest events occurred at intervals of approximately 20–30 s (Fig. 4). Over the following 15 minutes, both event amplitude and occurrence rate decreased, consistent with a transition toward the post-closure narrowing phase described in the literature.

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7. https://itodys.u-paris.fr/
8. Silver wire (Ag) dipped in in a sodium hypochlorite solution (bleach). The AgCl layer forms by soaking the wire for about 30 min in the solution. Then it is soldered to a din 42802 electrode cable.
9. Parker Laboratories Signa Gel.

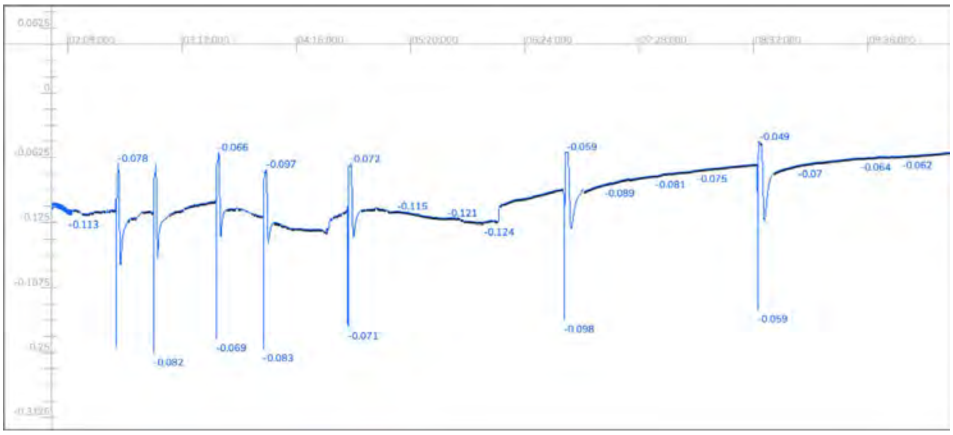

Fig. 4. Visualisation with the Partiels[10] software of the AP-like morphology acquired through Audacity. *X* axis represents the PCM amplitude and y axis the time in 00m:00s:000ms.

For *Mentha spicata*, eight sessions investigated wound-induced electrical responses through systematic stem cutting.[11] In Session 4, the initial cut elicited a slow transient characterized by an approximately 45-second rise time and a 3–4 minutes decay. This morphology—slow depolarization followed by prolonged recovery—is consistent with descriptions of wound-induced variation potentials in the plant electrophysiology literature (Libiaková et al. 2014, Davies 2006). However, subsequent cuts produced progressively weaker responses. This attenuation may reflect electrode-interface instability or conductive gel desiccation, a known practical limitation in surface electrophysiology recordings over multi-hour sessions (Davies 2006). While the temporal profile of the initial response aligns with reported variation potentials, definitive identification will require additional controls.

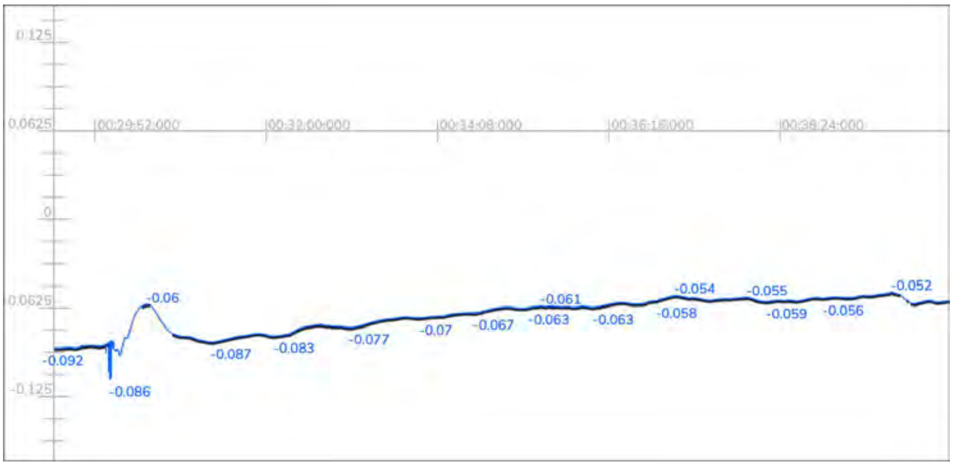

Fig. 5. Ag/AgCl electrode placed on *Mentha spicata* stem, visualisation with the Partiels software of the of the VP-like morphology acquired through Audacity. X axis represent the PCM amplitude and y axis the time in 00m:00s:000ms.

In *Dionaea*, the recorded fast transients exhibited durations on the order of 1–2 seconds, which fall within the range commonly reported for Venus flytrap action potentials. The waveform morphology (rapid depolarization, repolarization, and transient undershoot) is compatible

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10. https://forum.ircam.fr/projects/detail/partiels/

11. *Mentha spicata* was selected precisely because stem cutting is a commonplace horticultural and culinary gesture (harvesting mint for cooking). This familiar context allowed wound-induced electrical responses to be documented using a stimulus that falls within the plant's ordinary ecological experience. Nevertheless, wound-induced protocols were conducted exclusively during the experimental validation phase and will not be replicated during public presentations or pedagogical workshops, where only non-damaging stimuli are used.

with published descriptions of electrically excitable events in *Dionaea*. Because recordings were obtained using surface Ag/AgCl electrodes, measured amplitudes represent extracellular potentials and therefore cannot be directly equated with intracellular membrane potential values. The progressive reduction of transient amplitudes during closure sequences may relate to the electrical counting mechanism described in *Dionaea*, in which successive action potentials contribute to trap activation (Böhm et al. 2016);[12] however, direct confirmation in our setup will require controlled stimulation protocols.

Fig. 6. Array of Three Ag/AgCl electrode placed on each side of a *Dionaea muscipula* trap and secured with medical tape in order to prevent artefacts caused by movements.

Since the original submission, we have implemented a multi-electrode recording protocol on a single *Dionaea muscipula* trap (Fig. 6.), designed to distinguish true action potential propagation from recording artefacts. The underlying rationale is that an artefact would appear simultaneously across all channels, whereas a propagating AP would arrive at each electrode with a measurable delay reflecting its conduction velocity through the tissue. Across all documented AP events (Fig. 7), we observed consistent sequential activation of the three surface electrodes with inter-electrode delays yielding propagation speeds of approximately 0.52–1.64 cm/s.[13] These values fall below the reference range most commonly cited in the literature for *Dionaea muscipula* action potential propagation: typically 6–20 cm/s (Bakker et al. 2021), up to 10 cm/s (Hedrich and Kreuzer 2023), and from 0.82 to 11.22 cm/s for first-stimulus responses measured with a NeuroGrid MEA (Armada-Moreira et al. 2023). This discrepancy is likely methodological rather than physiological: our surface Ag/AgCl electrodes measure extracellular potentials across a 0.15–0.50 cm span, whereas published values derive from intracellular or high-density array recordings across larger tissue distances. The propagation order we observed is consistent across all documented events and the measured velocities are physiologically plausible (i.e. they do not exceed known upper bounds), a point confirmed by Stephen Whitmarsh's expert review.[14]

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12. https://www.cell.com/cms/10.1016/j.cub.2015.11.057/asset/2daac841-09e9-4e1c-8f71-ffc45aba3c89/main.assets/gr1_lrg.jpg
13. All data available on demand to the authors.
14. Stephen Whitmarsh (Institut du Cerveau, Paris) is a neuroscientist and BBDMI member.

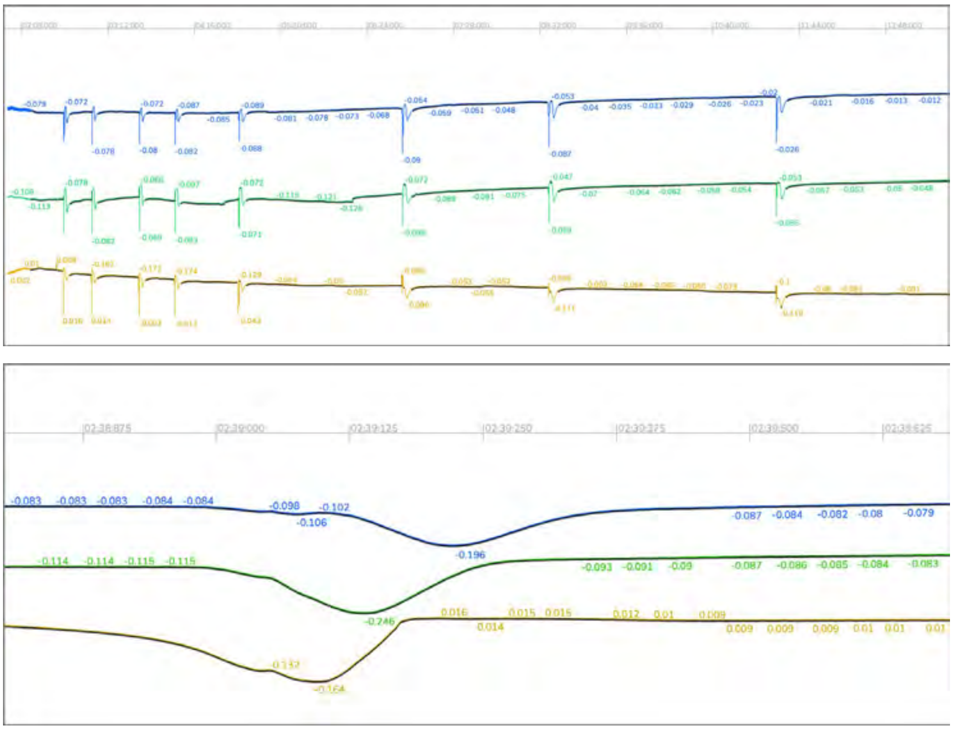

Fig. 7. Visualisation with the Partiels software of the of the AP-like morphology acquired through Audacity. PCM amplitude is indicated on each channel and y axis the time in 00m:00s:000ms. The first image shows the first 8 events, the second image is a zoom of the first event. The orange channel corresponds to the electrode placed the furthest from the stem and Blue channel is the closest, this representation shows the propagation of the signal from the trap's hair to the stem. These experiments indicate that the EAVI board coupled with homemade Ag/AgCl electrodes is capable of detecting reproducible plant bioelectrical transients in both *Dionaea* and *Mentha*. Under conditions of careful electrode placement, fresh conductive gel, battery operation, and recording durations below approximately 2–3 hours, the observed temporal characteristics are compatible with published electrophysiological reports.

4 Re-examining EPM: Electronic Plant Musicking

4.1 EPM as a Pedagogical Experience, a Case Study

A pedagogical dispositif emerging from the project was developed within a Parcours d'Éducation Artistique et Culturelle (PEAC)[15] residency at a public elementary school in Saint-Nazaire, involving two classes: a CE2 class (approximately 20 students aged 8-9) and an Unité Locale pour l'Inclusion Scolaire (Ulis, 12 students with disabilities aged 6-12).[16] The school's particular context proved significant for this experimental inquiry into EPM intelligibility. Unlike most urban schools, this institution maintains several "nature spaces" in its courtyard, including a vegetable garden with outdoor classroom spaces. This existing ecological socialization—constructed through institutional pedagogy and enriched by family contexts (Vitores 2025)—meant students already possessed substantial botanical knowledge before encountering the plant-sound assemblage.

The pedagogical project comprises four workshop sequences culminating in a public presentation. The workshops aimed to sensitize students to ecological questions through listening and musical experience, following a progressive pedagogy from soundscape listening to technical mediations. The January 15, 2026 sequence – the focus of this analysis – divided each half-class session into two parts: first, collective soundscape listening activities reconnecting to field recordings students had made in October; second, small-group testing of the plant sonification system after pedagogical framing about plant electrophysiology.

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15. https://www.education.gouv.fr/bo/15/Hebdo28/MENE1514630A.htm
16. https://www.education.gouv.fr/bo/15/Hebdo31/MENE1504950C.htm

Before testing the interactive system, students participated in discussions establishing necessary background: distinguishing plants from animals, understanding cellular electrical activity in both kingdoms, and learning the three types of plant electrical signals (AP, VP, SP). These exchanges revealed students' existing representations, ranging from associating life with movement to sophisticated knowledge of mycorrhizal networks. This baseline understanding allowed the technical system explanation to proceed, with students following the signal chain from electrodes through the ADC card to computer software and sound output.

The pedagogical context thus constituted what Hejoaka et al. (2022) term an "a priori difficult" test case for dispositif intelligibility: young students, some with disabilities requiring adapted pedagogical supports, encountering a technically complex assemblage mediating between plant electrophysiology, signal processing, EMG sensing, and algorithmic sonification. Yet this very difficulty rendered the case study methodologically valuable: if the system could produce forms of understanding and engagement in this context, it might suggest something about EPM's potential as more than mystification or anthropomorphic projection.

4.2 Constructing Interactivity With Plant Temporality

The sonification system developed for this pedagogical context—and subsequently adapted for the exhibition installation—embodies the attempt to construct what we term "interactivity" rather than "interaction" with plant temporality,[17] since plant-human musicking cannot meet the criteria of straightforward interaction. Rather than projecting interactional capacities onto the plant, the system localizes "interactivity" in the technical apparatus itself: the Max/MSP patch functions as a rule-based system that constructs an "ear" for the plant—a chain of thresholds, decisions, and transformations that makes certain plant-human relations audible and actionable.

The system architecture operates through two interacting modalities: sonification of the plant signal, and transformation of this sonification through human gesture (signal measured via the plant biosignal), with human actions triggering processes that are always conducted by parameters derived from the plant signal. Both signals are normalized and interact through threshold logic and dependencies: the human gesture acts as trigger while the plant signal determines precise parameters of sonic evolution. This creates an asymmetrical dialogue where the human initiates processes but the plant guides their unfolding.

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17. By "plant temporality" we refer to several concrete features of vegetal electrical dynamics: event durations on the order of seconds rather than milliseconds (as compared to human neural APs), inter-event intervals of 20–30 seconds during active phases, progressive attenuation over minutes, and propagation speeds orders of magnitude slower than human neural conduction. These temporal scales, too slow for rhythmic musical patterning, too fast for perceptible growth, constitute a specific temporal regime that challenges conventional sonification mappings.

The sonification system maps plant electrical signal amplitude directly to the pitch of a sustained drone tone.[18] Different signal tracking modes produced varying perceptual effects of the plant's "liveness." The choice of tracking mode proved determining: more precise tracking makes the plant seem more active and responsive.

The human EMG signal intervenes through three transformation modalities triggered by muscle tension thresholds. Continuous muscle force creates proportional "blurring" of the plant drone.[19] Strong contraction (sustained above threshold) triggers harmonic multiplication, generating polyphony through chord structures selected according to the plant signal value at trigger moment.[20] Conversely, muscle relaxation (sustained below threshold) activates rhythmic sound objects—pre-recorded samples from the students' garden recordings—whose tempo, echo subdivisions, and feedback parameters all derive from plant signal amplitude at trigger crossing. Common to all these mappings is the plant signal amplitude: thus beyond diverse transformation types and gestures, the general sonic impression relates to vegetal signal amplitude.

4.3 Experiencing the Device: What Is the Plant Really Doing?

Testing the dispositif with students revealed both ludic potential and fundamental intelligibility challenges: this session was a first test. After the technical chain explanation, students listened to three sonification versions of the same plant signal corresponding to the tracking modes described above. After this introduction, students experimented human/plant sonic interactivity by group of two.

We present these observations as preliminary findings from a first test session, not as a systematically analyzed case study, which will be conducted in future research-projects. Student responses revealed varied comprehension levels. Some provided precise observations of gesture-sound correlations, also identifying counter-intuitive mapping creating inversion between gesture intensity and perceived amplitude (more muscle tension = less sound). Recording analysis revealed that during unguided experimentation, some children successfully discovered the system's logic through play.

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18. One drone used in the patch : https://drive.google.com/file/d/1u_tbgAFWmi3rJl-VS1PgTIiK1s6Hn7gl/view?usp=sharing ; and its decorrelation ("blurring effect"): https://drive.google.com/file/d/1gbUg9UV8pz1Q79Ej2g3zEkCO_2hFkD03/view?usp=sharing

19. The same drone with several examples of the harmonic transformation: https://drive.google.com/file/d/19y8EWvAyYcwozpKpDaWzwlrBjCyVq_yw/view?usp=sharing

20. Example of a rythmic sound object triggerd by relaxing muscle: https://drive.google.com/file/d/1vuhXYftcXoEMvSrpi9JRBUmUdcuKxHHe/view?usp=sharing

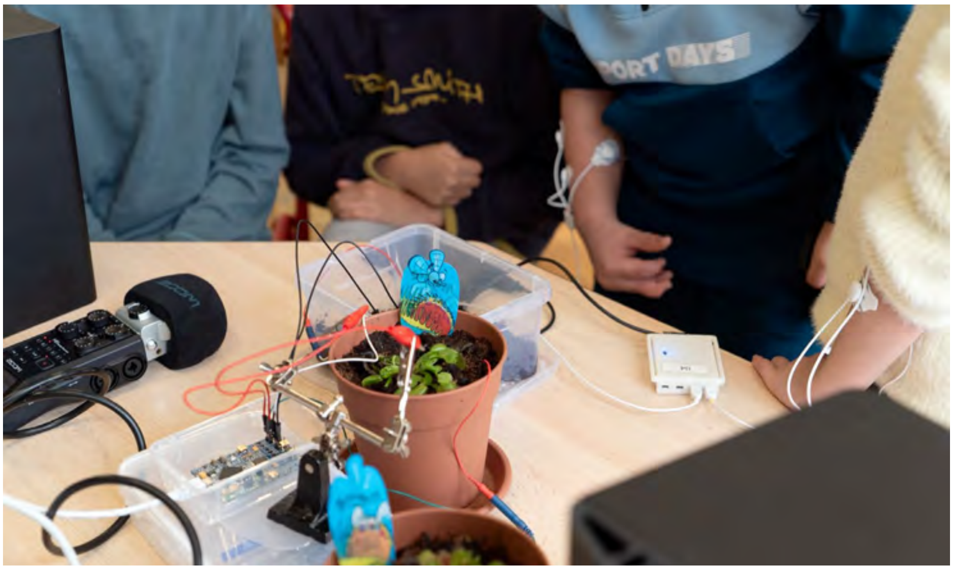

Fig. 8. Students experimenting musicking with gesture (EMG) and plant sonification.

Yet the central question—"what does the plant do?"—revealed comprehension difficulties. Some responses demonstrated general ecological understanding without grasping the specific sonic dispositif. Students expressed confusion distinguishing plant sonification from gesture-induced transformations. The afternoon group better grasped the sonification principle, correctly identifying electricity, technical mediation, and the computer as necessary components, and recognizing that without this apparatus plants make no music.

Teachers' feedback testified to positive impact, particularly for the Ulis students. The teacher noted remarkable concentration levels, suggesting this kind of sonic practice can open different pathways to knowledge than conventional pedagogical supports.

These tests identified required improvements for the next sessions: addressing latency, mapping issues, cognitive overload, and technical friction. Yet despite these limitations, the dispositif succeeded in making perceptible the fundamental strangeness of plant-human temporal mismatch, the necessity of technical mediation, and the distributed character of agency across this assemblage. This experience of Electronic Plant Musicking did not function as transparent demonstration of plant musicality but a constructed scene for testing what modes of relation become possible when vegetal electrical activity is rendered audible.

5 Conclusion: Toward Plant Timescales

This investigation has disambiguated several fundamental aspects of Electronic Plant Music previously elusive in historical and contemporary practices. First, what EPM actually is: not the revelation of plant musicality or consciousness, but the construction of a technical apparatus that renders certain physiological indices sonically perceptible. Most EPM systems do not measure genuine plant electrical signals but rather galvanic response reflecting leaf water content—a crucial distinction that reframes these practices from epistemological (revealing plant communication) to ontological (producing new plant-human-technology assemblages).

Second, what the plant actually "does" in these dispositifs: it functions as a responsive material whose physiological processes provide measurable indices of vegetal vitality and adaptive behavior. Hacking the EAVI from human EMG to non-human biosignal capture demonstrated that when technical conditions align the apparatus can extract data represented by these electrical signals, providing indices of plants' temporal patterns.

Third, by distinguishing biological agency (the plant's capacity to perceive and respond) from musical agency (often anthropomorphically projected), this research exposed how distributed agency operates across heterogeneous assemblages. The pedagogical experiments revealed that students could grasp this distributed character when the technical mediation was made explicit, recognizing that "without this apparatus plants make no music."

EPM builds sound ecologies through constructed modes of relation that localize decision-making in the technical apparatus itself, creating an "ear" for the plant while acknowledging fundamental temporal mismatches. The sonification system's asymmetrical structure (human gesture as trigger, plant signal as parameter source) refuses both anthropocentric dismissal and anthropomorphic projection. The *Troisième Nature* project departs from prior EPM practice by trying to technically capture both vegetal potentials (AP, VP, SP) while reconsidering the encoding paradigm: rather than translating bioelectrical signals into MIDI, the system operates on what can be termed "plant temporality," forms built by plant time.

This raises questions for future experiments: if we measure biological plant processes with sufficient precision and maintain fidelity to their inherent temporal characteristics in our encoding systems, how accurately can sonification reflect the plant's own time rather than converting it to ours? What does plant time do to our human musical aesthetics?

Acknowledgments. This work received government funding managed by the French National Research Agency under the Investments for the Future program, reference number ANR-17-EURE-008. This work is also supported by Athénor – Centre National de Création Musicale (CNCM), the Ville de Saint-Nazaire, and the Agence Nationale de la Recherche (ANR) through the Brain Body Digital Musical Instrument (BBDMI) project (ANR-21-CE38-0018). LLM generative AI was not used in the writing of this paper. Schuh's native language is French, and Tanaka is a native English speaker. Some elements were written in French and machine translated by Schuh, and then human edited by Tanaka.

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