VEIN

A Bio-Sonic Narrative of Forest Life through Plant Bioelectrical Signals

André Conde[1] & Celeste Santos-Silva[2]
University of Évora, 1. CHAIA - Centre for Art History and Artistic Research; 2. MED - Mediterranean Institute for Agriculture, Environment and Development & CHANGE Global Change and Sustainability Institute, Science &Technology School, Biology Department,
Évora, Portugal
1- amfc@uevora.pt; 2 – css@uevora.pt

***Abstract*—** *VEIN is an artistic research project that investigates the translation of plant bioelectrical signals into bio-sonic narratives. The system captures real-time electrical fluctuations from vegetation in a forest ecosystem (Alto de São Bento, Évora, Portugal) and transforms them into structured sound through a hybrid analog-digital workflow. Conductive sensors record variations in plant bioelectrical activity, which are amplified, digitized, and mapped onto sonic parameters such as pitch, timbre, and rhythmic density.*

Rather than treating sonification as direct representation of data, VEIN frames it as a situated interpretative process in which biological and technological systems co-produce perceptual structures. The main contribution is the proposition of narrative as an emergent property of temporal biological variability rather than a human-centered construct.

This approach is critically positioned against conventional sonification frameworks that prioritize analytical transparency and data fidelity. Instead, VEIN aligns with ecological listening and sound studies perspectives that emphasize relational perception and situated meaning-making. The project contributes to ongoing debates in bioacoustics, media art, and ecological sound practices by proposing a model of bio-sonic narration grounded in more-than-representational processes.

***Keywords*—** *Bio-sonification; plant electrophysiology; ecological listening; sound art; data sonification.*

I. Main Contributions of Our Work

VEIN introduces a real-time system utilizing the "Symbiotic Biodata" device to translate plant bioelectrical signals into sonic material through hybrid mapping strategies, focusing on perceptual emergence rather than direct data representation.

1.1. Bioelectrical-to-sonic translation system

A real-time system was developed for capturing plant bioelectrical signals using conductive sensors (Fig.1)

Fig. 1. System architecture (signal-to-sound pipeline), 2016

placed on vegetation. These signals are amplified and stabilized using the Symbiotic Biodata device and converted into digital MIDI data for sound synthesis and processing. The system enables continuous transformation of physiological plant activity into sonic material, grounded in established research in plant electrophysiology [1,2].

1.2. Hybrid sonification and mapping strategy

Bioelectrical fluctuations are translated into sonic parameters including pitch, timbre, and rhythmic density. The mapping strategy prioritizes perceptual emergence rather than direct data representation, aligning with contemporary approaches to sonification as interpretative mediation rather than transcription [3].

The system integrates audio interfaces and digital audio workstations, enabling real-time transformation of biological signals into structured sound.

1.3. Bio-sonic narrative model

VEIN proposes narrative as an emergent structure arising from temporal variation in biological systems. Instead of linear storytelling, narrative is understood as the perceptual organization of change, continuity, and repetition within sonic transformations of living processes.

This model aligns with ecological listening frameworks in which meaning emerges through situated engagement rather than representation [4,5].

1.4. Study Site and Ecological Context

The Alto de São Bento forest ecosystem (Fig. 2) (Évora, Portugal) was selected due to its ecological heterogeneity and its role as an educational and scientific field laboratory. The area consists of a Mediterranean woodland landscape shaped by variations in soil composition, humidity, and solar exposure, supporting diverse microhabitats and plant communities.

The research developed at the Macromycology Laboratory focuses on the taxonomy and ecology of fungi, with particular attention to their interactions with Mediterranean flora. This work investigates how mycorrhizal symbioses enhance the resilience of native plant species, contributing to conservation and ecosystem regeneration processes where fungi and plants coexist.

The Alto de São Bento site constitutes a granite outcrop of high geological relevance, where acidic substrate conditions and intense solar exposure shape a distinct ecological system that preserves elements of original vegetation. The site functions as a living laboratory, articulating local geodiversity with historical and cultural heritage linked to traditional milling practices.

The flora of Alto de São Bento is characterized by high resilience, comprising herbaceous and shrub communities adapted to skeletal soils and water-deficient regimes, alongside diverse assemblages of bryophytes and saxicolous lichens, as documented in regional floristic surveys [6]. The stability of this ecological niche relies on symbiotic relationships between host plants and mycorrhizal fungi, whose mycelial networks—often described as the “wood wide web”—are crucial for sustaining vegetation under xeric conditions.

Within this environment, the botanical landscape unfolds between spontaneous vegetation and cultivated ritual gardens (Fig. 3).

Fig. 2. Study site (Alto de São Bento ecosystem, Évora), 2016

Fig. 3. Top left: Mediterranean Mustard; Down left: Black Salsify; Right: Sage and System architecture

Species such as Mediterranean Mustard *(Hirschfeldia* incana) demonstrate ecological independence by thriving without mycorrhizal associations, while others, including Sage (*Salvia officinalis*), rely on fungal symbionts that enhance biochemical processes such as essential oil production (Fig. 3). The botanical narrative continues with Pomegranate (*Punica granatum*) and Rue (*Ruta graveolens*), which bridge the gap between medicinal utility and magical folklore, alongside Lemon Verbena (*Aloysia citrodora*) and Black Salsify (*Scorzonera hispanica*) (Fig. 3), whose historical use in infusions and traditional confectionery illustrates the refinement of wild resources [6,7]. This ecological survey culminates with the Cork Oak (*Quercus suber*), the sentinel of the Portuguese landscape. Beyond its economic value, the tree sustains the ecosystem through an invisible "symphony" of underground mycelial networks, where symbiotic relationships between roots and fungi ensure life's continuity in challenging soils.

This ecological framework provides a critical foundation for VEIN, grounding the bio-sonic translation of plant electrophysiological activity in a context of interconnected biological processes and environmental responsiveness [1,2]

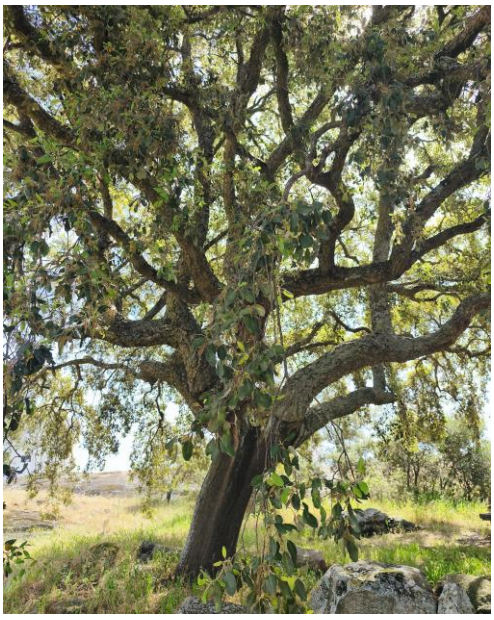

Fig. 4. Cork oak, National Tree of Portugal

II. Critical discussion

VEIN critically departs from conventional sonification frameworks, which prioritize faithful data representation, transparency, and analytical interpretability [3]. Rather than treating bioelectrical signals as stable carriers of pre-defined meaning, the project frames sonification as a situated and interpretative process in which perception emerges through the interaction between biological variability, technological mediation, and listening practices.

Research in plant electrophysiology has demonstrated that plants produce measurable electrical signals associated with environmental stimuli and internal regulatory processes [1,2]. These signals are typically approached as physiological indicators within scientific paradigms. VEIN, however, shifts this perspective by treating bioelectrical activity not as data to be decoded, but as generative material for perceptual and narrative formation.

This shift becomes more significant when considered within the ecological context of Alto de São Bento. The plant signals captured by the system do not originate from isolated organisms, but from species embedded in a dense network of ecological relations. Mycorrhizal symbioses, extensively documented in Mediterranean ecosystems, establish underground connections between plants and fungi, enabling nutrient exchange, signaling processes, and adaptive resilience. These distributed networks—often described as the "wood wide web"—challenge individualistic models of biological agency and suggest instead a relational ontology of life processes.

Within this framework, the signals sonified in VEIN can be understood as expressions of a broader ecological field rather than discrete biological events. The variability detected in plant electrophysiology may reflect not only individual responses but also indirect interactions mediated through soil composition, microclimatic fluctuations, and symbiotic exchanges. As such, the resulting sonic structures are not representations of singular entities, but emergent articulations of interconnected ecological dynamics.

This perspective aligns with ecological approaches to listening, in which sound is not treated as an object but as a relational event unfolding between environment, medium, and listener [4,5]. VEIN extends this understanding by embedding ecological relationality within the technical system itself: the mapping strategies, signal instabilities, and temporal modulations all contribute to shaping a perceptual field where meaning is co-produced rather than transmitted.

Furthermore, the concept of narrative proposed in VEIN resonates with this ecological paradigm. Instead of linear storytelling or symbolic encoding, narrative emerges as the perceptual organization of temporal variation—patterns of intensity, continuity, disruption, and repetition—arising from the ongoing activity of living systems. In this sense, narrative is not imposed onto the data but unfolds through the listener's engagement with dynamic processes that exceed human-centered structures of meaning.

By integrating plant electrophysiology, mycorrhizal ecology, and sound studies, VEIN proposes a model of bio-sonic narration grounded in more-than-representational processes. The project challenges the epistemological assumptions of both scientific sonification and narrative theory, suggesting that meaning does not reside in data or organisms alone, but emerges through distributed relations across biological, technological, and perceptual domains.

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