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Plant sentience: "feeling" or biological automatism?

Commentary on **Segundo-Ortin & Calvo** on Plant sentience

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Abstract: Sentience refers to the ability of an organism to have subjective experiences such as sensations, emotions and awareness. Whereas some animals, including humans, are widely recognized as sentient, the question of whether plants are sentient is still debated among scientists, philosophers, and ethicists. Over the past 20 years, many scientists such as Trewavas, Baluška, Mancuso, Gagliano, and Calvo have reported interesting discussions about memory, behavior, communication, and intelligence in plants. However, the reported conclusions have not convinced the entire scientific community. In this commentary, I would like to focus on two critical aspects related to sentience: cognition and emotion.

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1. Cognition and biological automatisms of humans, animals, and plants. Segundo-Ortin & Calvo (2023) equate the movements of bean tendrils in search of support with cognitive processes observed in animals. They also attribute communicative properties to plants that emit volatile molecules that influence the cuscuta's ability to "choose" which plant to parasitize. Are these examples of cognition? Or are they perhaps biological responses of an organism to specific environmental stimuli?

Cognition refers to mental processes and activities related to the acquisition, processing, storage, and use of information in the brain (Taiz *et al.* 2019; Mallatt *et al.* 2021a; Mallatt *et al.* 2021b; Robinson et al. 2023). This encompasses a wide range of mental processes, including perception, attention, memory, language, problem solving, decision making, reasoning, and abstract thinking. Animals and plants may have high sensory abilities compared to humans, but they lack complex cognitive abilities. In elephant colonies, the matriarch has important mnemonic skills for locating water sources that are probably superior to those of humans, yet she will never be able to write a novel or make a movie about elephant life.

Recently, Hadany's research group published experimental work on plant communication under stress (Khait *et al.* 2023). The authors recorded ultrasound (20-150 kHz) in the laboratory on tomato and tobacco plants subjected to drought or stem cutting. Even if we were to call this phenomenon "communication" it does not involve cognition. In fact, many animals, including mice and rats, can emit ultrasonic vocalizations during courtship or to attract the attention of the mother (Premoli *et al.* 2023). This communication does involve cognition. It occurs mainly in species whose social interaction and cognition are highly developed.

In contrast, ultrasonic communication by plants could depend on cavitation phenomena (already known) and stimulating "receiving plants" to respond adaptively to possible water stress (stomata closure?). Volatile essences emitted by a plant attacked by a herbivore are molecules that can bind to receptors of neighboring plants and can trigger increased synthesis of secondary defense metabolites or increased cell wall hardening. Again, we can talk about communication in the sense that there is a sending and a receiving organism. But these are biological automatisms that do not involve cognition (Alpi *et al.* 2007; Taiz *et al.* 2019; Mallatt *et al.* 2021a; Mallatt *et al.* 2021b; Robinson et al. 2023).

The plant is not “conscious” of emitting molecules. When we approach an automatic door, it opens. We "communicate" to the door to open, it opens with an automatic response. Mancuso and colleagues observed that radical tips can orient their growth to specific sound vibrations that can be traced to water (Gagliano *et al.* 2017; Rodrigo-Moreno *et al.* 2017; Mancuso & Baluska 2018; Calvo *et al.* 2020). Sound waves (not soil moisture) determine the orientation of the root toward the source of the sound. Again, is this a matter of cognition? Or perhaps an automatic response? Could sound waves be interacting with root tip statoliths that, together with auxin hormone signals, could "guide" root growth?

The data collected by Gagliano also emphasize the effects of sound pollution on the plant world, but this is not cognition either. Similar effects can be observed in sea turtle hatchlings. Sometimes the hatchlings are attracted to the artificial lights and move toward the city instead of the ocean (Thums *et al.* 2016). The attraction to these lights is an instinctive response that requires no cognition, just an automatic response. In animals, instinct determines certain behaviors that occur without the involvement of cognition.

2. Do plants feel emotion? Animals, like humans, can experience emotions such as pain, pleasure, fear, and anger (as well as sensations like warmth or cold), and this makes animals sentient. At the same time, animals can be given molecules that alter their emotional state. Animals can be anesthetized to not feel pain. At the same time, animals in the laboratory (but also in the wild) can develop dependence on psychostimulants and they show anger and aggression during withdrawal.

These examples involve mainly mammals and birds. Reptiles and amphibians can experience pain (Lillywhite *et al.* 2017), but their behavioral response is much "simpler" than the pain symptoms of a chimpanzee. In humans, sentience reaches its highest expression through facial expressions and complex language.

According to Baluška and colleagues, plants can be anesthetized, and this phenomenon could be evidence of “plant sentience" (Yokawa *et al.* 2018). Segundo-Ortin & Calvo support this thesis, pointing out that plants produce ethanol, ethylene, and divinyl ether under stress conditions. However, this is not sufficient to establish that plants can "feel" pain or pleasure or be otherwise aware of their behavioral responses. The inhibitory and excitatory effects of GABA and glutamate on neuronal cell receptors, respectively, may be common to their effects on plant cell receptors (Weiland *et al.* 2016). However, the effects of their actions on conscious organisms are different from those on organisms responding to biological automatisms. A laboratory rat consciously pulls the lever to get its dose of narcotic. This aspect is absent in the plant kingdom.

3. Sentience: the last word has not yet been said. The lack of consensus on the issue of plant sentience is further complicated by the fact that there is no widely accepted definition of

sentience and that different criteria may be used to define it. In addition, cultural and ethical considerations may influence perspectives on this issue, as some people may place a moral value on plants, regardless of their sentience status, because of their intrinsic value or ecological importance.

In conclusion, although there is evidence that plants can exhibit complex behaviors and responses, the question of plant sentience remains unresolved and is the subject of ongoing scientific and philosophical debate (Gutfreund 2023; Harnad 2023; Milburn 2023; Pessoa 2023; Struik 2023). Further research is needed to better understand the nature of plant sentience and, if it exists, to gain a clearer understanding of its ethical implications, if any. Sentience would not add anything to the plant kingdom. The complexity and importance of photosynthetic organisms is independent of whether they are sentient.

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