Fish and plant sentience: Anesthetized plants and fishes cannot respond to stimuli

Commentary on **Sneddon et al.** on *Sentience Denial*

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Abstract: Recent denial of fish sentience is at variance with the fact that all living organisms need environmental awareness in order to survive in a continuously fluctuating environment. Moreover, fish sentience – like plant sentience – is also strongly supported by the sensitivity of fishes and plants to diverse anesthetics.

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"... what is alive must sense and can be anesthetized, the rest is dead."
Claude Bernard (1878)

Anesthesia, like sentience and consciousness themselves, has long been a mysterious phenomenon in modern science (Rinaldi 2014, Koch 2018). The mechanisms that cause the loss of consciousness with diverse anesthetic compounds are still unknown.

We have recently reported that plants can be anesthetized by blocking action potentials and effects on synaptic vesicle recycling (Yokawa et al. 2018). Treatment with diethyl-ether stopped the leaf-closing movements of both *Mimosa pudica*, a sensitive plant, and the Venus flytrap, the well-known carnivorous plant. After removal of diethyl-ether from their treatment chamber, the plants immediately began recovering their action potentials; their response to touch was restored in 15 min. Leaf responses to touch disappeared even when just the root part of the *Mimosa pudica* was submerged in lidocaine (local anesthesia). In addition, seed dormancy was prolonged under anesthesia, and seeds immediately regained germination when the anesthetics were removed. Diverse anesthetics effectively affect plant cells, immobilizing the movements of plant organs under anesthesia (Yokawa et al. 2018). We have proposed that possible targets of plant anesthesia are cellular membranes, which are fundamentally important for all living organisms. This mechanism was already suggested by

French physiologist Claude Bernard in 1878, when he presented convincing anesthetic experiments using Mimosa plants (Bernard 1878; Grémiaux et al. 2014). In our study, we documented the effects of anesthetics on membranes of cells in the root apex transition zone, resulting in an excessive accumulation of reactive oxygen species (ROS) and aberrant endocytic vesicle recycling at the root synapses (Yokawa et al. 2018).

Similar high sensitivity to anesthetics has been reported for fishes (Neiffer and Stamper 2009, Sneddon 2012). Lopez-Luna demonstrated that administering analgesic drugs to fish alleviated their response to noxious chemicals (Lopez-Luna et al. 2017a) or noxious temperatures (Lopez-Luna et al. 2017b). When anesthetized, both plants and fishes lose their ability to respond to stimuli; their movements are lost too, and they are obviously devoid of environmental awareness. Removal of anesthetics results in rapid recovery. These data strongly support sentience in both plants and fishes (Trewavas and Baluška 2011, Calvo et al. 2017, Gagliano 2017, Sneddon et al. 2018).

It is still difficult to say whether fishes and plants feel pain or have nociception. However, it is known that plants respond quickly and sensitively to wounding and initiate wound-healing processes immediately. Once the plant body is physically damaged, wound-mediated cellular signaling is rapidly initiated, transferring danger information throughout the entire plant body. This 'danger' signal is also communicated to other neighboring plants by secretions and airborne chemicals. This changes the status of plant cells as well as the tissues of adjacent plants, allowing them to cope with upcoming threats. Moreover, plants endogenously produce multiple anesthetics of their own (Tsuchiya 2015, 2017) under conditions of stress or wounding (Baluška et al. 2016); these too have membranes as their targets (Tsuchiya 2015). In order to survive, all organisms need some version of a sense of pain which is perceived via their organism-specific sentience.

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