Plant Consciousness: The Fascinating Evidence Showing Plants Have Human Level Intelligence, Feelings, Pain and More

Mountains of research have confirmed that plants have intelligence and even beyond that consciousness by many of the same measures as we do. Not only do they feel pain, but plants also perceive and interact with their environment in sophisticated ways.

The deep intelligence possessed by plants has been explored and discussed by many people of note over the past several centuries, including Goethe, Luther Burbank, George Washington Carver, Masanobu Fukuoka, Jagadis Bose, and the Nobel Prize-winner Barbara McClintock. Plants, it turns out, really are highly conscious, intelligent and yes, they do have a brain. It's just that no one ever looked in the right place.

Depth analysis of plant consciousness since the turn of the (new) millennium is finding that their brain capacity is much larger than previously supposed, that their neural systems are highly developed—in many instances as much as that of humans, and that they make and utilize neurotransmitters identical to our own. It is beginning to seem that plants are highly intelligent, feeling beings—perhaps as much or even more so than humans in some instances. (They can even perform sophisticated mathematical computations and make future plans based on extrapolations of current conditions. The mayapple, for instance, plans its growth two years in advance based on weather patterns.)

Increasing numbers of researchers, in a multiplicity of fields, are beginning to acknowledge that intelligence is an inevitable aspect of all self-organized systems—that sophisticated neural networks are a hallmark of life. Some researchers are becoming quite vocal in attacking what they call the "brain chauvinism." Kevin Warwick, a cyberneticist, observes succinctly that, "Comparisons (in intelligence) are usually made between characteristics that humans consider important; such a stance is of course biased and subjective in terms of the groups for whom it is being used." In other words, rationalists, who have long attacked the concept of plant intelligence and consciousness and awareness in nature as antirational romantic projection, have themselves been merely looking at and for their own reflection in the world around them—and, of course, finding the world wanting. But what especially activates their antirational subjectivity is whenever the organism in question appears to not have a brain, such as with bacteria, viruses, and most especially plants.

Plants and Perception

The old paradigm about plants, which is very common and (unfortunately) still believed by most people, is that plants are unconscious, "passive entities subject to environmental forces and organisms that are designed solely for accumulation of photosynthetic products." But as Baluska et al. note:

The new view, by contrast, is that plants are dynamic and highly sensitive organisms, actively and competitively foraging for limited resources both above and below ground, and that they are also organisms which accurately compute their circumstances, use sophisticated cost-benefit analysis, and that take defined actions to mitigate and control diffuse environmental conditions. Moreover, plants are also capable of a refined recognition of self and non-self and this leads to territorial behavior. This new view considers plants as conscious, information-processing organisms with complex communication throughout the individual plant, including feelings and perception of pain, among other things. Plants are as intelligent and sophisticated in behavior as animals but their potential has been masked because it operates on time scales many orders of magnitude longer than that operation in animals… Owing to this lifestyle, the only long-term response to rapidly changing environments is an equally rapid adaptation; therefore, plants have developed a very robust communication, signaling and information-processing apparatus… Besides abundant interactions with the environment, plants communicate and interact with other living systems such as other plants, fungi, nematodes, bacteria, viruses, insects, and predatory animals.

As with all self-organized systems, plants continually sense, feel and monitor their internal and external worlds for informational/functional shifts in the relevant fields. If they are focusing externally, once they note a shift, they work to identify its nature and meaning and its likely impact on their functioning. Then they craft a response.

As Trewavas amplifies, these conscious plant responses are highly intelligent. "A plant actually chooses the optimum response from a plethora of alternatives." As he says, potential "responses can be rejected; the numbers of different environments that any wild plant experiences must be almost infinite in number. Only complex computation can fashion the optimal fitness response."

Some plants, such as sundew, are so sensitive to touch, for example, that they can detect a strand of hair weighing less than one microgram (one millionth of a gram) to which they then respond. But what is more revealing is that they can determine with great specificity what is touching them—that is the plants can feel their environment. Raindrops, a common experience in the wild, produce no response. This kind of mechanosensitivity, which is, in plants, similar to what we call our felt sense of touch, is used much as we use our own: The plants consciously analyze what is touching them, determine its meaning, and craft a response. And that response many times involves rapid changes in their genetics, phenotype, and subsequent physical form. As McCormack et al. comment, "Plants intelligently perceive much more of their environment than is often apparent to the casual observer. Touch can induce profound rapid responses… in Arabidopsis changes in gene expression can be seen within minutes after the plant feels touch, and over 700 genes have altered transcript levels within 30 minutes."

Research into plant perception is showing that plants have feelings, they are sentient, they communicate with each other, feel pain and they can plan into the future.

Plants, in fact, possess a highly sophisticated neural system and while it does not look like our "brain," it really is, in actuality, a brain. In fact, once you get over brain chauvinism, it's not all that different from our own.

The Plant Brain

It is common for people to view plants, for example a tree, as having a "head" and "feet," the head being the tree or its canopy, the feet being the root system. But it turns out that our orientation is incorrect.

In complex, conscious organisms like humans and most animals, the head, or anterior pole of the body, is the part that processes information, the posterior pole the part that engages in sexual reproduction and excretion of waste. From that orientation, plants live with their heads in the earth, their asses in the air.

If you take the cutting of a plant from one location and plant it in another, as the neural system of the plant intelligence develops in the soil, analyzing and feeling its surroundings all the while, it alters, as it learns, the shape and formation of emerging neural net and the plant body it develops. This, more effectively, fits it into the environment in which it is now growing. In short, plants possess a highly developed, conscious root brain that works much as ours does to analyze incoming data and generate sophisticated responses. But what is more, the plant brain that emerges always fits its functional shape to the environment in which it appears. The plant neural net, or brain, is highly plastic when compared to ours.

A unique part of the plant root, the root apex (or apices, which are the pointed ends of the root system) is a combination sensitive finger, perceiving sensory organ, and brain neuron. Each root hair, rootlet, and root section contains an apex; every root mass millions, even billions, of them. For example, a single rye plant has more than 13 million rootlets, with a combined length of 680 miles. Each of the rootlets are covered with root hairs, over 14 billion of them, with a combined length of 6,600 miles. Every rootlet, every root hair, has at its end a root apex. Every root apex acts as a neuronal organ in the root system. In contrast, the human brain has approximately 86 billion neurons, about 16 billion of which are in the cerebral cortex. Plants with larger root systems, and more root hairs, can have considerably more brain neurons than the 14 billion contained in rye plants; they can even rival the human brain in the number of neurons. And when you look at the interconnected network of plant roots and micorrhizal mycelia in any discrete ecosystem, you are looking at a neural network much larger than any individual human has ever possessed. And some people still wonder whether plants are conscious or demonstrate intelligence…

While humans and many other animals, for example, have a specific organ, the brain, which houses its neuronal tree, plants use the soil as the stratum for the neural net; they have no need for a specific organ to house their neuronal system. The numerous root apices act as one whole, synchronized, self-organized system, much as the neurons in our brains do. Our brain matter is, in fact, merely the soil that contains the neural net we use to process and store information. Plants consciously use the soil itself to house their neuronal nets. This allows the root system to continue to expand outward, adding new neural extensions for as long as the plant grows.

In addition, the leaf canopy also acts as a synchronized, self-organized perceptual organ, which is highly attuned to electromagnetic fields. It can be viewed, in fact, as a crucial subcortical portion of the plant brain.

For their neural networks to function and demonstrate consciousness, plants use virtually the same neurotransmitters we do, including the two most important: glutamate and GABA (gamma aminobutyric acid). They also utilize, as do we, acetylcholine, dopamine, serotonin, melatonin, epinephrine, norepinephrine, levodopa, indole-3-acetic acid, 5-hydroxyindole acetic acid, testosterone (and other androgens), estradiol (and other estrogens), nicotine, and a number of other neuroactive compounds. They also make use of their plant-specific neurotransmitter, auxin, which, like serotonin, for example, is synthesized from tryptophan. These plant intelligence transmitters are used, as they are in us, for communication within the plant organism and to enhance brain function.

The similarity of human and plant neural systems and the presence of identical chemical messengers within them illustrate just why the same molecular structures (e.g., morphine, cocaine, alcohol) that affect our neural nets also affect plant consciousness. Jagadis Bose, who developed some of the earliest work on plant neurobiology and plant intelligence in the early 1900s, treated plants with a wide variety of chemicals to see what would happen. In one instance, he covered large, mature trees with a tent, then chloroformed them. (The plants breathed in the chloroform through their stomata, just as they would normally breathe in air.) Once anesthetized, the trees could be uprooted and moved without going into shock—the pain perception of the plants diminished. He found that morphine had the same effects on plant consciousness as that of humans, reducing the plant pain perception and pulse proportionally to the dose given. Too much took the plant to the point of death, but the administration of atropine, as it would in humans, revived it. Alcohol, he found, did indeed get a plant drunk. It, as in us, induced a state of high excitation early on, but as intake progressed the plant began to get depressed, and with too much it passed out. The plant felt drunk.

Irrespective of the chemical he used, Bose found that the plant responded identically to the human; the chemicals had the same effect on the plant's consciousness and nervous system as it did the human. This really should not be surprising. The neurochemicals in our bodies were used in every life-form on the planet long before we showed up. They predate the emergence of the human species by hundreds of millions of years. They must have been doing something all that time, you know, besides waiting for us to appear. Like, for example, giving plants the ability to feel, perceive and sense pain, among countless other things.

The vascular strands that support the plant body, giving it its rigid structure, also act as the peripheral nerve system for the plant—that is the felt sensory organ of the plant. The plant's neurotransmitters travel along the nerve system carrying information to the periphery, just as they do in our bodies. The plant roots engage in finely detailed analysis of their environment and communicate with the rest of the plant via neurotransmitters. The leaf canopy, as well, is taking in considerable data about the exterior world above ground. That data is sent to the root brain system, again via neurotransmitters for analysis. Is this not demonstrating sophisticated plant intelligence of the highest order?

The neuronal plant cells in the root exist in what is called the transition zone of the root apex. Baluska et al. note that "as cells of the transition zone are not engaged in any demanding activities, such as mitotic divisions or rapid cell elongation, they are free to focus all their resources on the acquisition, processing, and storing of information." Storing of information, that means memory. As they continue: "Smart, intelligent plants can memorize stressful environmental experiences and can call upon this information to take decisions about their future activities."

That is, plants consciously plan ahead.

Plant Social Communication

Roots of plants are exquisitely conscious and aware of self and not-self and engage in sophisticated interactions with a wide range of living organisms. The plant roots enter into symbiotic relationships with bacteria, fungi, and communicate with other plants that are highly sophisticated.

Bacteria form colonies on root systems and produce nitrogen nodules, which the plant can then intelligently use as a nitrogen source, something the plants cannot do on their own. And, in exchange, the bacteria gain nutrients they need to survive.

Roots also form close attachments with fungal mycelia. In fact, most plant roots are part of a sophisticated root/fungus communal network that can extend over miles. This highly developed mycelial/plant root system connects all the plants in a particular ecorange into one self-organized whole that, itself, possesses capacities not perceivable in any of the parts. In essence, a large, self-organized neural network develops in which plant to plant communication is abundant and robust. This leads to the emergence of a unique identity in every identifiable ecorange on Earth. What we are seeing is mass plant consciousness in action.

The emergence of self-organized ecoranges generates the potential for highly adaptable responses to environmental perturbations that might affect that ecorange. Within that system, all the plants are consciously and continually communicating with each other, sending chemical communications along the mycelial network to other plants in the community. (Plants also speak using auditory signals through a complex sound-based language that is far more ancient than the human, though it exists in a much subtler sound spectrum than our own.)

If plants in the system detect that another plant in the mycelial network is ill, unique compounds are intelligently generated by the plants most able to do so and sent through the mycelial network to where they are needed. The medicinal compounds in plants have been consciously used for millennia to heal the individual plant, other plants in the ecorange network, and the insects and other animals that make that ecorange home. This kind of conscious plant cooperation, while irritating to kill-or-be-killed reductionists, produces an ecorange much more adaptable to environmental perturbations than would occur if each organism were constantly fighting each other (as neo-Darwinists would have us believe). The old lie that nature is red in tooth and claw, that life is a constant struggle for survival in an implacably hostile environment, just doesn’t bear up under close examination, Life-forms die, yes, but they also help other members of their family, and other members of their species, and the members of other species off and on throughout their lifetimes. Just as we do, except they are conscious, intelligent plants.

Within ecoranges, there is a continual exchange of information that flows as volatile chemicals through the air. These chemical exchanges are in fact a highly complex form of plant communication, a language, that is taken in through plant stomata, analyzed, and responded to. There is also a highly complex communication that moves through the soil community, also quite often through the release of volatiles into the immediate rhizosphere surrounding the plant roots. And many chemicals are released into the mycelial network for travel throughout the ecorange. These interactions are highly intelligent and individually generated out of each self-organized plant entity. “The underground roots are,” as Baluska et al. comment, “engaged in social activities that require self-awareness.” Like bacteria, plants consciously form social communities that are tightly coupled together. And similarly to bacteria, plants show just the same sorts of complex and sophisticated behaviors that humans do, from language, to sentience, to intelligence, to the creation of cities, to cooperation in groups, to complex adaptation to their environment, to protection of offspring, to species memory that is consciously handed down through the generations of plants. And, if the definition of tool is extended, as it should be, to the creation of chemicals that are designed to produce specific impacts on environment, plants capacities include intelligent tool making.

Older plants intelligently send out volatiles to younger plants that contain within them information about chemical responses to predation. A bean plant, being fed upon by a spider mite, can analyze from its saliva just what type of spider mite is feeding on it. It then will craft a specific pheromone, releasing it from its leaf stomata as a volatile chemical into the air. That pheromone will call to the plant the exact predator that feeds on that particular spider mite. Older plants consciously store this information as a kind of cultural learning that is then passed on to younger generations. Old growth plants are repositories of the acquired learning of the species. Cultural learning and transmission is, in reality, common throughout the Gaian system. Chimpanzees teach their young to collect termites with a stick, and how to make the stick—which is harder than it sounds; the stick must be shaped exactly. Scientists who tried to do so, failed… continuously.

The world is made up of a series of highly conscious nested self-organized systems within other nested self-organized systems within other self-organized systems. They, together, make up the much larger system we know as Earth, the living, self-organized biological organism that James Lovelock named Gaia. And all of them are intelligent.