The Dignity of an Oak Leaf

Chapter from "Cell Whispers. Journeys through new realms of science"
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2005, Lenos Verlag, ISBN 3-85787-368-X
Informations (mostly in german): www.blueridge-institute.ch

Animals have an inherent value of their own, a soul perhaps or an "inner consciousness". But what about plants? Do they have an "inner consciousness" and inherent sense of dignity as well? It was this question that I was given an unexpected opportunity to explore, as a member of the Swiss Ethics Committee on Non-human Gene Technology. In the spring of 2004, the Swiss Federal Administration gave us instructions to look into what implications the Constitutional Article of 1992 pertaining to the dignity of creation might have on plants. Switzerland is the only country world-wide that has such a constitutional norm.

But how can a plant have dignity? Dignity is something humans are entitled to. The word derives from the Latin „dignitas", which relates to „worthiness". In the olden days only those who enjoyed great esteem because of their virtue or high ranking had dignity.

But now, should the neighbour's cat and the apple I bite into have dignity, too? Isn't that an exaggeration? In giving them dignity, aren't we humanising non-human creatures? We do tend to transfer human attributes to other living beings; seeing the camel as arrogant and the eagle proud based on their appearance and expression.

Or does the use of the word dignity in this context show that our view of fauna and flora has in fact changed in the last 50 years? Does it mean we are now ready to value them as living beings with qualities of their own, irrespective of our interests? This new respect for all creation can be formulated in different ways.

Since the Age of Enlightment, plants and animals have lost much of their dignity; they are treated ever more like living machines, acting or reacting as they are programmed. Today we do admit that at least more highly developed animals have a certain sensitivity and - as the Adolf Portmann, one of the greatest biologists of the last century, would have called it - an "inwardness". But plants? Do they have an "inwardness" as well?

The Ethics Committee was asked to find out how the ruling regarding respect for the dignity of plants could be implemented. We decided to look first into what modern biology knows about the essence of plants. Are plants robot-like beings or sensitive creatures with an "inwardness" of their own? What is, in fact, the difference between animals and plants? The answers to these questions would help us provide a basis for ethical arguments.

An often used criterion in differentiating between animals and plants is the assumption that animals are social beings able to communicate, whereas plants are not. I began my own investigation by questioning this assumption. While looking for research projects on plant communication, I came across Ted Turlings at the University of Neuchâtel, only two hours from where I live. This scientist has examined the dynamic interplay between a maize (corn) plant and a caterpillar and its natural enemy, the parasitoid wasp.

It is pouring rain when I arrive in Neuchâtel. The university is situated outside the city centre; the grey building complex looked gloomy. I have trouble finding office D 116 and there is no one around to ask. Finally there is D 116, at the end of a long, tubelike corridor. Ted Turlings, a native Dutchman, wears a dark blue cotton shirt and jeans that day. Stacks of paper cover

his desk and the floor. Good that I am alone, no one else would have fit in that small room.

“When a caterpillar of the *Spodoptera exigua Hübner* species attacks a maize plant and starts to feed on its leaves, its natural enemy, a parasitoid wasp of the *Cotesia margini-ventri* species, is sure to follow. The wasp lays its eggs in the caterpillar; they then feed on their host and slowly kill it”, Ted Turlings tells me.

But how do the wasps locate their prey so quickly and reliably? The caterpillars are rather inconspicuous and odourless; they could hardly attract the wasps. This would also contradict their “evolutionary interest”. It had to be the plants themselves. Ted Turlings and his team tried mechanically damaging the surface of maize leaves to see if the wasps were attracted by some reaction at the injured sites. Their results were negative. The wasps, the females in particular, were only attracted to those leaves that had really been nibbled by caterpillars. Turlings’ group found out that those leaves damaged by the caterpillars emitted a special blend of odorous substances. “The odour is actually so strong, even humans can smell it! At first you only perceive the easily recognizable odour of fresh cut grass. Then a much stronger scent follows, and that is what attracts the female wasps, regardless of whether the caterpillars are still around or not. Chemical analyses have showed that the odorous signals emitted by the maize leaves are a combination of indole and terpenoids.”

Ted Turlings speaks softly, in a reserved but precise manner. He is not prone to enthusiastic outbursts. “So how does the maize plant know when it is being attacked by caterpillars and needs to call on the wasps for help? Our experiments showed us that it couldn’t be the injury itself. We tried smearing caterpillar faeces on an injured maize leaf, but the results were negative. We then dripped some caterpillar saliva onto the injured leaf, and the plant started to produce volatiles immediately. What followed was a very costly four-year search. We raised caterpillars, fed them and made them vomit and analysed the spit using modern analysis techniques. We finally isolated and identified a chemical compound from the saliva of *Spodoptera* larvae, which we named volicitin.”

Fascinating teamwork, like pieces of a puzzle falling into place: the plant “tastes” the volicitin in caterpillar saliva and starts to produce specific volatiles. These attract female wasps that lay eggs in the voracious caterpillars, which lead to the insects’ demise.

“Could one say that the maize plants call on the wasps for help?” I ask.

“No, I don’t see it that way. The plants do not call for help, and the wasps do not come to the plants’ aid. They simply want to parasitize the caterpillar. Here I am cautious with too high-sounding phrases.”

“But communication – that is, an exchange of information - does take place.”

“Yes, I agree. Plants communicate using odorous substances.”

“Does the maize plant learn to use these substances in the course of its life?”

“I wouldn’t call it ‘learning’. But they are flexible; they evolve defensive strategies to protect themselves against attacks from insects and pathogens.”

“And the wasp? Is it preconditioned? Does it recognize the odorous substance from the very beginning?” I ask. “No”, he replies, “wasps learn by association. They have an extraordinary sense of smell and can learn to link diverse odours to food or available egg-hosts in minutes. Under laboratory conditions they can also be trained to recognize novel odours like chocolate and vanilla.”

In preparing for my visit to Neuchâtel, I had read the ample scientific literature on plant communication. Tomatoes, for instance, start to produce toxins when attacked by caterpillars. In addition, they emit methyl jasmonate to warn neighbouring tomato plants that danger is approaching. These also then take steps to defend themselves. Because methyl jasmonate is often used in perfumes, researchers working in greenhouses have been asked not to wear perfume as it could confuse the plants.
Other studies show that trees can talk to each other. Oak trees talk to other oak trees, and willows, poplars and birch trees communicate too. One scientist maintains that there is a constant murmuring in the air, a babbling of smells.

Many plants use scents to attract beneficial insects, or warn each other. I ask Ted Turlings if plants can exchange other information. “I don’t believe so. Their various communication systems have yet to be fully understood.” Once again I have the feeling that Ted Turlings is not into speculation, which makes him all the more likable, actually. Obviously current knowledge of plant communication cannot yet tell us if plants function in more complicated ways than robots do. There are indications, however, that they can carry on an exchange similar to a conversation, and show flexibility, wilfulness and even determination in their actions.

I continue my search for more scientific information and speak to several botanists in Switzerland.

Apparently plants can distinguish at least seventeen different environmental variables. They “smell” chemical odours. They have a varied perception of light; they measure its strength and quality and regulate many of their most important metabolic processes such as germination, formation of buds or leaves accordingly. Plants react to excess ultraviolet radiation by producing pigments (suntan cream!) for protection.

Plants also respond to vibration and touch. We know about the mimosa and how its leaves turn downwards at the slightest touch. But there are thousands of creeping and climbing plants that respond to contact stimuli; some tendrils are more sensitive to the touch than the human skin. The tendril of a *Bryonia dionica* reacts to the stroke of a 0,00025-milligram thin thread, while the human skin does not.

Plants are susceptible to sounds, and they register gravity, temperature and water content. They show the consequences of stimulation by altering their growth, number of leaves, or thickness of their stems. Plants can pick up environmental signals, pass them on internally and then deal with them adequately, even if it means changing their behaviour. This shows flexibility, even purpose, and possibly their own form of “inwardness”.

Anthony Trewavas of the University of Edinburgh, who has investigated the flexible behaviour of plants for thirty years, writes that plants can learn and remember. If the roots of a plant are exposed to low levels of salt at an early stage, the plant will survive in normally lethal concentrations later on. The roots’ experience is transferred to the whole plant. The memory of this experience can last for months to years.

Plants can even plan ahead. Anthony Trewavas uses the dodder (*Cuscuta* sp.) as an example. These parasitic plants can quickly discriminate between suitable hosts of high nutritional status and hosts of poor quality. Hours in advance they “choose” the resources to devote to a particular new host plant, deciding how many coils and suckers to deploy. The dodder plant estimates expenses and yields some four days in advance - the time needed to get to the nutrients after first contact with the host.

Anthony Trewavas is convinced that this kind of foresighted planning requires flexible behaviour, which presupposes learning ability, memory and therefore intelligence.

Intelligence? A rather risky hypothesis, rejected by Ted Turlings and other experts I asked. Intelligence is a human quality and cannot be attributed to plants.

But what is intelligence? A term charged with difficulties in definition, it comes from the Latin word “interlegere”, meaning “to choose between”, and implies the ability to cope with new problems by selecting from a number of possible alternatives.

In his remarks, Anthony Trewavas always refers to David Stenhouse, a psychologist and philosopher from New Zealand. The latter defines intelligent behaviour in animals as “adaptive variable behaviour within the lifetime of an individual”. This is exactly what Anthony Trewavas observes in plants. They also show adaptive and variable behaviour, as they try to optimize their fitness in ever-changing environmental circumstances.

The experts have different opinions on whether the tomato can “communicate” or whether the dodder is “intelligent”. But they all agree that there are amazing coincidences between animals and plants on the cellular level. Cells communicate, in both fauna and flora. Cells “whisper” to each other and “converse” with cells farther away.

When harmed by caterpillars, leaf cells send out signals telling all plant parts to start their defence response, top to bottom. Messages like “water shortage” or “too much shade” circulate from cell to cell within the plant. In the last twenty years it has become increasingly evident that plant cells communicate the same information in almost the same way as animal and human nerve cells communicate. When I burn my finger, pain information is sent to my brain, bringing on a quick response. Similarly, plants react to various stimuli by activation and propagation of rapid electrical signals. Even the molecular basis for processing memories is surprisingly similar for plants and animals. Recent research has shown that plants have a molecular equivalent to what we call learning ability.

A possible explanation for this resemblance at cell level may lie in evolution. Geologically-speaking, animals and plants are young, coming on the scene only 500 million years ago. It was actually in the three billion years prior to that, when only one-celled organisms existed, that the basic forms for future feeding and metabolic processes in animals and plants developed.

Although much remains unknown, it is this similarity at the cellular level that has led some scientists and researchers to believe that plants are “intelligent” and have “the ability to learn”. Most experts I interviewed, however, balked at the notion of plant intelligence, citing fundamental differences at higher levels.

What exactly is the difference between animals and plants? There are two major aspects. The first is that a plant has neither a nervous system nor a brain. It does not need them because its body is built in a modular way. It grows by the progressive accumulation of the same or similar units, leaves, stems and roots. Each leaf is a solar collector, broad and flat to allow maximal light harvest in a changing environment. Plants are organized democratically: there is no strong control centre; leaves and roots make many decisions.

While Anthony Trewavas agrees with the above, he also points out that plants have an overall coordination. They process signals and store memories. The cell membranes or cell walls probably play a central role. Thousands of signalling molecules throng here; information is passed on, registered and coordinated. Could a plant as a whole be a brain?

The second difference: animals must flee, run, attack; they depend on quick reactions. Plants, however, are sessile. It can take days or weeks for them to show any kind of variable behaviour. According to Anthony Trewavas, this slowness makes it difficult for us to use the term intelligence when discussing plants. We associate intelligence with speed, for no real

reason. It takes up to four days from initial touch contact for the dodder to coil around a suitable host and start feeding, but that does not mean it lacks intelligence.

Plants communicate, smell and taste; they remember and may even be intelligent – how important are these new scientific findings for our discussion on the dignity of plants? I asked the philosopher, Klaus Peter Rippe, president of our Ethics Committee and also head of the private institute in Zurich “Ethik im Diskurs”. After a long and tiring day of a Committee meeting, we sit in the conference room; the air is stale, his tie loosened and I have turned the tape recorder on. My first question is: “What determines the dignity of a plant?”

“For me, sensitivity is the crucial factor. When I step on a cat’s tail, it experiences pain and suffering. I am infringing upon its dignity by causing it harm. But a plant? Can I infringe on her dignity when she is not even capable of feelings?”

“There are at least seventeen environmental signals to which plants are sensitive”, I counter. “They show a great flexibility in their reaction to these signals. They can change their growth habits, for instance.”

“But the problem is: Are these reflexive responses or decisions made by the whole plant? Are plants just living machines? Today, we would no longer say that animals behave like robots. They have a subjective perception of the world as well as individual preferences, they can assimilate sense-data; this all falls within the scope of sensitivity. And when we use the word “sensitive”, we automatically think of a central nervous system that receives sensory input and…”

“Why?”

“Good question.”

“Why is the brain a prerequisite for sensitivity and perception? When maize is attacked by a caterpillar, it emits an odour that attracts the caterpillar’s natural enemies, parasitic wasps. This means the maize plant senses impending herbivore damage. Why is there the need for a centrally controlled consciousness?”

“We do not know.”

“Aha, that is what I wanted to hear.”

“No, no, we cannot seriously say that plants do not have a consciousness. We can only say that we do not know. Just as we cannot really say that animals have a consciousness, although there are plausible reasons to believe so, because what happened to the cat and the way it reacted are very similar to what our own experiences and behaviour would be under the same circumstances. Plants and humans have less in common. That is what we mean.”

I say nothing and let Klaus Peter Rippe’s words go through my head. Do I agree with his caution? Ted Turlings probably would. Or do I favour Anthony Trewavas’ side with his plant intelligence theory? I am no longer sure.

Klaus Peter Rippe must have been reading my mind. “We philosophers are always cautious in such cases”, he says. “We shy away from attributing human characteristics to non-human beings. We still know too little about the subject. Does a plant feel pain? Is it actually possible to feel pain without a brain? To always explain plants in animal language is a delicate matter.”

“But we consider plants in robot terms,” I reply.

He says if you upgrade a plant, you compare it to an animal. A downgraded plant is likened to a robot.

I ask him what he personally thought the consequence would be if plants were to have dignity. Certainly not the prohibition of green-stuff consumption! Man and beast feed on plants, either directly as herbivores or indirectly as carnivores. Man and beast would not exist without plants. One scientist even told me it could be the plants’ ethical duty to be eaten…

“Yes, but the arbitrary dealing with plants would no longer be possible. We would not be taking their dignity seriously if we were to pull plants out of the earth, roots and all, or to mow the lawn for purely aesthetic reasons.”

“Mow the lawn? The grass will grow back. That is the unique thing about plants. I can break a branch off a tree but I cannot tear a leg off a cat. In this respect, plants and animals are completely different. I think the limits lie elsewhere. In my eyes to patent a plant is to violate its dignity. This also applies to the so-called terminator technique, which consists of introducing a killer transgene that prevents the germ of the harvested grain from developing. In other words the grain becomes biologically sterile. I am also sceptical of gene-technical changes in plants on an industrial scale.”

“I agree with your terminator-technique point. Plants should not be patented because breeding should be kept patent-free. However, I do not think your argument about plant dignity fits in here.”

I object that by patenting a plant we are degrading it and using it as an instrument for our own interests. I am also having trouble accepting the eternal “we don’t know” argument. It is just an excuse for not dealing with progressive ideas.

Klaus Peter Rippe agrees at least partially. “We must take the plunge, but that requires new definitions. For example, what does consciousness mean? This is difficult to say for animals, let alone plants. Animals realize that something harmful is happening to them, and this we interpret as a weaker form of consciousness. And plant consciousness? Wouldn’t that have to be an even weaker than weak form? The same applies to intelligence and sensitivity. Actually, moral vocabulary should be rethought; when we talk about the dignity of plants, what should it pertain to, the individual tree or the whole forest?”

“This is a complex question that even botanists cannot answer unanimously. Most of those I asked thought that the decisive factor for the dignity of a plant was the individual behaviour found at the lowest level; in the leaves, for instance. The tree as a whole plays but a small role in the overall coordination.”

“Then I am all for the dignity of the oak leaf.”

“Not necessarily. Each tree - just think of the giant, old oak tree, gnarled with age! - has a personality of its own.”

Once again I realize that we are only beginning to understand what it means to be a plant. As much as there are amazing similarities with humans on the cellular level, there are great differences on the next higher level. We still lack the language to describe plants and we do not even know who should receive that title of dignity: the leaf , the tree or the whole forest?