Florianne Koechlin

PLANT WHISPERING

In recent years researchers have repeatedly discovered new, amazing properties of plants that nobody would have imagined. Scientists have known for several years that plants are ingenious communicators; they register and interpret environmental signals and can respond to them. For example, lima beans are known to have in their vocabulary over **100 frangrance ‚words'** with which they can warn neighbours of danger or specifically attract beneficial insects. It can "taste" in the spittle of its enemy what is attacking it, and then produce a scent with which it can attract a suitable bodyguard. All plants do this. This means that there is a constant **whispering** among plants, an undertone of fragrances.
What is new is the knowledge that plants also lead an active social life. **YELLOW JEWELWEED**S recognize which plants are part of their family and which do not belong to it. If a **YELLOW JEWELWEED** is growing in a pot with a family member, the plant forms long roots that do **HARDLY** branch out, while next to one it is not related to its roots branch out and encroach into the area of the neighbouring plant. In other words, the **YELLOW JEWELWEED** spares relatives but competes with strangers. Evidently it "knows" its place in the plant community.

Extended network of connections in the soil. Plants also create a highly diverse network of connections in the soil. Under natural conditions practically all land plants live in a symbiosis with subterranean networks of fungi or so-called mycorrhizal networks. Fossil finds indicate that this symbiosis was probably a precondition for plants making the move from the water to the land around 500 million years ago. "Mycorrhiza" means "fungus root" in Greek. It is an "organ" produced from a symbiosis – a product of the interaction of plant roots and fungus threads.
A group of researchers led by Andres Wiemken at the University of Basel examined such mycorrhizal networks. During my visit he points at a photo lying in front of us on the table. It depicts two pots, each one with a flax and a millet plant growing together. In the right-hand pot the flax plant is more than twice the size of the one in the left-hand pot. The millet is also a little larger. This occurred even though the plants in both pots grew in the same soil and received the same amount of water and nutrients. The reason for the difference is mycelia. The pot on the right contains mycorrhizal fungi in the soil, whereas the pot on the left does not.
Though the plants in the right-hand pot **are not related at all**, their roots are connected by a dense mass of fungal strands. The mycorrhizal fungi feed the flax and the millet nutrients from the soil; primarily phosphate, but also nitrogen and other minerals. As for the plants, they supply the fungi with carbohydrates such as sugar that they produce via photosynthesis. Wiemken's team wanted to find out which plant the fungi threads get the carbohydrates from: the millet or the flax? Because photosynthesis in the millet is slightly different to that in the flax, the team was able to distinguish the carbohydrate molecules produced by the flax from those produced by the millet using a special technique – the isotope examination. The surprising result: Some 80 per cent of the carbohydrates in the fungal biomass come from the millet. In other words, millet feeds the flax, a plant that is unrelated to it. Thanks to this cooperation a flax plant alongside a millet plant will grow almost twice as big. Thanks to the fungal threads the millet also receives nutrients from the soil. It is not known what else it derives from this cooperation.

Wiemken's experiment with millet and flax would suggest that plants in suitable mixed cultures maintain a kind of dynamic marketplace underground, where the plants involved are organized in networks and where every plant contributes its special abilities towards maintaining the fungal network. Bean plants can contribute nitrogen, removing it from the air with the help of a symbiosis with bacteria and making it usable for plants. In dry periods plants with long roots such as lupines or trees and bushes can obtain water from deep underground. Other plants are especially good at acquiring phosphates. There are also plants like millet whose photosynthesis is especially efficient when there is ample sunlight and that can invest more carbohydrates in the network than other plants. All of them can contribute with special skills to cultivating and maintaining the mycorrhizal network as a common infrastructure for absorbing nutrients from the soil.

Evidently, however, not only nutrients but also information can be exchanged via the mycorrhizal network. This was proven by a group headed by Ren Sen Zang at Guangzhou University in southern China. Two tomato plants were placed so far apart from each other that their roots would not touch, but they were connected by the mycorrhizal networks under the soil's surface. Then they were packed in airtight bags to prevent the tomatoes from communicating via fragrance. One tomato plant was infected with mildew. 65 hours later the team infected the other plant and observed that this plant could defend itself better and more quickly against the fungus, activating defence genes and enzymes more quickly and more frequently. Seemingly, the tomato infected first had warned its neighbour via the fungal web in the soil. Ren Sen Zang calls the mycorrhizal network the "Internet of plant communities". It is not yet clear how this communication works.

Similarly, in a forest trees are connected to one another by a huge subterranean web, a network of roots and fungal threads. The specialist term for this network is the WWW – the wood-wide web. The fungal threads in the forest differ from those of herbs. They tend to be larger and usually function somewhat differently. But in principle they do the same thing: They link up totally different trees and are used to exchange nutrients, water and carbohydrates. The WWW includes many familiar edible mushrooms, such as porcini mushrooms, chanterelles, larch boletes, russula paludosa and morels – to name just a few.

Forest trees also ensure that their descendants get off to a good start. For example, old Douglas-fir trees "feed" their seedlings with carbohydrates via the subterranean fungal threads. This means the small Douglas firs can also thrive in dark spots that do not get much sunlight. What is most important is that they are linked to the web and can be nourished by the mother. The seedlings with the best access to this web are the healthiest. This emerged from tests conducted by Suzanne Simard, Professor of Forest Sciences at the University of British Columbia in Canada. For this reason, old trees should not be removed from the forest too quickly.

The traditional opinion that plants are nothing more than bio-robots that go through their genetic programme and can only respond by reflexes is outdated. Today, plants are emerging as communicative, highly distinct and autonomous beings, which protect their own and harass plants unknown to them, enter into alliances, have friends and enemies and organize underground networks via which nutrients as well as information are exchanged.

In other words, plants are not machines without a soul that function according to mechanical concepts and **can be explained** using **only** physics and chemistry. This leaves scope for alternative approaches. I visited farmers in Austria and India who really get involved with their plants and reap bountiful harvests. I spoke to people

who intuitively open up to plants and enter into a dialogue with them. In my case, painting opens up the means of re-discovering plants.
But above all, does not this new totally new view of plants mean that we must respect them for their own sake, and that we have obligations toward them as we do toward animals? And are there not also limits to their total instrumentalization? But where do they lie? Questions upon questions. Together with a group of dedicated experts (farmers, philosophers, botanists, cell biologists, and gardeners) I drew up the "Rheinauer Hypotheses on the Rights of Plants", in which **WE** tried to approach the topic of plants carefully and to derive rights from this. For example, the right not to be patented like a machine or chemical.

The rapidly multiplying insights into co-evolutionary processes, mutually influencing cycles and communication networks in nature that are usually invisible to us offer more than enough material for a new view of the world.