Introducing… Cyborg Plants

You may be familiar with transhumanism, a movement that advocates for the augmentation of human ability through the use of technology, implants, and prostheses. Less familiar, and perhaps unknown, is that such combinations of the technological and the living are already a reality for plants! Elsa Abdoun shows us the first specimens.

Speaking of "cyborgs" we're quick to think of science-fiction characters like Robocop or the Terminator. Or perhaps our minds wander to the transhumanists who hope to boost human intellect using some sort of implant in the brain. Whatever the case, you'd probably never think of a fig tree or an orchid...

Until now. The idea of gaining completely new capabilities through the fusion of the organic and the mechanical is no longer limited to just humans: for the last couple of years it's plants that have found new superpowers! Glowing watercress, rechargeable roses, sentient spinach… cyborg plants are no longer science fiction. Stemming from work done in several pioneering laboratories, this new class of living organisms embodies the unnatural alliance of flowers and leaves with electronics and nanotechnology—all the while reframing the question of what separates the living and the artificial.

FYI

The term "cyborg", most often found in science fiction writing is a contraction of the longer form "cybernetic organism". Scientists however prefer the term "bionic", a contraction of "biology" and "electronic".

For Joseph Richardson, a researcher in Chemical Engineering at the University of Melbourne (Australia) and one of the pioneers of these bionic plants, the interest is two-fold: "Supermaterials like graphene are limited in their ability to perform certain chemical reactions—such as catalysis—that biology has mastered perfectly; while biology is limited in its control of electrons and photons, something that these supermaterials do very well." Thus this ideal of using these artificial technologies to equip plants with abilities that millions of years of evolution and decades of genetic engineering haven't been able to. As biology, either bred or genetically modified, still has its limits.

At the same time, scientists can incorporate aspects of these living systems—ones that engineers haven't yet been able to mimic—into new technologies: "plants make and store their own energy, all the while still being biodegradable" explains Michael Strano, a professor of Chemical Engineering at the Massachusetts Institute of Technology (United States). "Transforming these plants so they can replace telephone antennas or even lamps, this is a step towards sustainability". Of course he makes it know that these applications remain "futuristic" to say the least. "It's an emerging field", agrees Eleni Stavrinidou, another pioneer of "electrical plants" at the University of Linköping (Sweden).

Nature, Extremely Unnatural

There's still progress to be made on these cyborg plants though. The scientists still need to improve their creations' performance, as well as address some unanswered questions. The first of which is the long-term survival of plants loaded with nanoparticles or electrical circuits. There's also the risk of pollution

by the “artificial” components of these plants when they’re in the wild. And for that matter, if these plants ever do find their way out of the laboratory, they will no doubt be a source of discuss and controversy.

Even so, these researchers are driven, not just by the science, but also by the seeming paradoxical nature of the work: “We often think of technology as something completely synthetic, so it’s interesting when the lines between living organisms and technology blur” adds Eleni Stavrinidou. “The philosophical implications of the work is also engaging”, Joseph Richardson points out; “for example, if we incorporate a supermaterial that prevents the plant from growing and reproducing, can we still consider the plant alive?”

Forget the transhumanistes, we may well be on our way to an era of “transbotanists”—scientists so imaginative and inventive that not even science fiction can keep up.

Glowing Watercress

“We might have created the most luminescent organisms ever!” Michael Strano (MIT) should be proud of his work: making a plant produce the equivalent of half the luminescence of a 1 microwatt LED… some “several hundred times brighter than any genetic manipulation has produced up to this point.” And all that without using any electricity. His secret? A combination of different nanoparticles, particularly those that fluorescence, inserted into plants using a pressure chamber. “Even though at the beginning the light only lasted 4 hours, today it lasts several weeks.” Michael Strano has high hopes for the project, wanting to one day develop a chemical light-switch for his cyborg plant lamp. He says it’d be simple to do: sprinkle the watercress with coenzyme A to turn it on, and then dehydroluciferin to turn it back off.

Sentient Spinach

It’s not just the newer generation of humans that are becoming more connected, but plants too. At least that’s the case with the spinach unveiled in 2016 by Michael Strano’s research team (MIT). They were able to insert into its leaves, using a simple syringe, a composite of carbon nanotubes with infrared fluorescence and peptides capable of detecting nitro-aromatic chemicals (those found in certain explosives). The result: when these markers for explosives find their way to the plant’s leaves or roots, the infrared fluorescence is attenuated—something that can be detected by a smartphone placed just under a meter away. Such detection-at-a-distance systems, using plants, could be used for monitoring pollutants in the environment “and also replace the current network of detection devices made of metal and plastic that need to be to be recharged and buried in the ground to protect them from rain” Michael Strano adds.

Rechargeable Rose

In this era of cyborg plants, beautiful colors and sensual fragrances are no longer enough: even roses can be more useful. One such flower, revealed in 2017 by a team at the University of Linköping (Sweden) is even able to store electricity. To realize this feat, scientists rinsed their roses in a solution of carbon polymer, capable of conducting electricity. The polymer progressively penetrated the flower’s vasculature system, where it formed a true electrical circuit, which the researchers confirmed could conduct and store electricity. Recharge your phone with a rose, why not? “Our goal is to recover, in the future, the energy from photosynthesis”, Eleni Stavrindou, who lead the experiments, points out.

Super-Photosynthesizing Cress

Already in the history books: thale cress is the first-ever cyborg plant. Michael Strano and his team (MIT) inserted carbon nanotubes into its mouse ear shaped leaves, capable of using visible, UV, and infrared wavelengths of light that the plant doesn't absorb naturally. The result: an increase in photosynthetic efficiency of 30%! The utility of such an achievement isn't so straightforward however, because "photosynthesis isn't the limiting factor in growth for the majority of plants", explains Michael Strano. Thus such an increase in efficiency doesn't allow the cress to grow faster. None-the-less, this first-of-its-kind plant serves as a demonstration of what's possible when nature and nanotechnology work in tandem: "we succeeded in improving a biological function that took evolution millions of years to implement", and that's something to be proud of.

Radiation Resistant Chrysanthemum

The newest creation, presented only a few months ago by the team of Joseph Richardson at the University of Melbourne (Australia): a chrysanthemum whose leaves and petals are covered in a molecular layer called a "metal-organic framework", which can protect it from UVC radiation. These are wavelengths of ultraviolet light that can't reach the earth's surface, but would be incredibly harmful for any organism that finds itself in space. The team of scientists showed the efficacy of this method by comparing plants exposed to UVC rays without and without the protective coating: the flowers protected by the metal-organic framework discolored much less. "This could, one day, allow plants to grow on Mars or the moon without needing an extraterrestrial greenhouse or other protection" Joseph Richardson imagines.