



Hooked on Plants

Building Microbots to Preserve Plant Ecosystems

Have you ever walked through a grassy field and returned home with burrs stuck to your clothing? Burrs are plant seeds or dried fruits covered with tiny hooks. The function of these tiny hooks is to catch onto an animal's fur—or, in your case, socks and pants. Doing so helps scatter the seeds to a new location where they might sprout. Biotechnologist Dr. Isabella Fiorello is using this same concept to develop microdevices. The tiny devices can harmlessly attach to leaves to perform tasks such as delivering nutrients or monitoring plant health.

Fiorello's work was inspired by a plant called *Galium aparine*, commonly called catchweed. The plant's leaves and stems have tiny hook-like hairs that stick to clothing and other materials. The catchweed uses the hooks to attach itself to host plants. Once anchored, the catchweed grows upward.

"What I did was to mimic the adhesion and anchoring mechanism of this plant to create robotic devices capable of attaching themselves to the surfaces of the leaves, just like the plant does," she explains.

Fiorello and a team of researchers used a high-resolution 3D printer and raw materials made from a sugar-like substance called isomalt in their device design. Once attached to a leaf, the device's microhooks can puncture the leaf's outermost layer. The hooks then connect to the plant's vascular system. This lets the device deliver substances, such as nutrients, pesticides, or other treatments, directly into the plant.

All of this happens without any damage to the plant.

In a second application, Fiorello and her team designed microhook devices made from light-sensitive resin and sensors for humidity, light, and temperature. When clipped onto a leaf, these devices can wirelessly transmit data about the plant's health.

In a final prototype test, Fiorello and her team developed a microrobot based on catchweed's ability to climb over host plants. The microrobot can move over the surface of a leaf by taking tiny steps forward. This movement mimics the gear-like forward motion of catchweed. ■

Thinking Critically

Science and Society How can using nature as a source for design inspiration lead to better engineering solutions?



Top A clip with sensors attached to a leaf can monitor plant health. | **Bottom left** Tiny hooks on the leaves and stems of catchweed inspired Fiorello's designs. | **Middle right** Dissolvable microhook-based machines can be used to treat plant disease. | **Bottom right** A prototype microrobot takes steps across a leaf.

▶ Watch our interview with Fiorello and learn more about her career and research.