# JUMP-STARTING NATURE

## Using Science to Save an Endangered Species

**by Katherine Duan**

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**NATIVE TO THE NORTHEASTERN UNITED STATES AND SOUTHEASTERN REGIONS OF CANADA, THE SHOWY LADY'S SLIPPER ORCHID (*CYPRIPEDIUM REGINAE*) IS PRIZED FOR ITS ELEGANT BEAUTY BY ORCHID AFICIONADOS AND NATURE LOVERS ALIKE. UNFORTUNATELY, DUE TO HABITAT LOSS AND DEGRADATION, A LOW GERMINATION AND SURVIVAL RATE, AND, TO A LESSER EXTENT, ILLEGAL COLLECTION, THERE ARE ONLY A FEW LOCATIONS IN NEW HAMPSHIRE WHERE IT IS THRIVING IN THE WILD. I AM WORKING TO CHANGE THAT.**

When I was in third grade, a very cool science teacher joined the faculty at our school. Dr. Peter Faletra had a Ph.D. in stem cell research and had published numerous scientific papers. More important to the students, however, was that he created a fun-sounding after-school research program for middle school students. Club members focused on repopulating the showy lady's slipper, but, as I learned later, their efforts could have much bigger repercussions.

When I was in fifth grade, Dr. Faletra taught our class to do sterile tissue culture on that flower—research that he, along with students from his previous school, had begun 20 years earlier. This was my first lesson: that real science takes a very long time.

### A Red-Flag Organism

Right now, we're facing what many scientists believe is the sixth mass extinction, the "Holocene Extinction," due mainly to human activity. Because of their sensitivity to environmental change, orchids are often considered indicators of habitat and biodiversity decline.

With over 25,000 species, *Orchidaceae* is the most diverse family of flowering plants. They're frequently found in biodiversity hotspots and, for complex reasons, are very sensitive to habitat changes. Unlike plants that encase their seeds in a fruit, which provides a built-in food supply for the germinating seed, orchids lack a built-in food supply. Not having to invest much energy in their seeds allows them to produce thousands of tiny seeds—each about the size of a dust particle—but it also means the seeds must depend on something else for nutrients. In the wild, orchid seeds have coevolved with a fungus, mycorrhizae, to supply them with food. In exchange, the mycorrhiza benefit from the carbohydrates formed from photosynthesis.

Orchids also differ from other plants in that many have only a single pollinator. If the environment changes rapidly, the pollinator—or the mycorrhiza—might disappear, leading to extinction of the orchid. This entangled relationship of orchids with their environment makes them a prime subject for modeling the extinction of many species. It also makes them a model for global conservation efforts.

### Helping Nature Take Root

As a sixth grader, I was eager to join the club, where students propagate showy lady's slippers using the same method developed by Dr. Faletra 20 years ago. First, we germinate the seeds in a sterile gelatin medium in test tubes or baby food jars and supplement the medium with the salts and nutrients the plant needs to grow. Once the plants have well-developed roots and shoots, we vernalize them, or mimic their cold dormancy, in the refrigerator for at least three months. We then plant them in a manmade fen—a version of the orchid's natural habitat.

Over the past three years, I've tested various methods of vernalization to find the most effective one. I've also helped design and build ideal fens, controlled environments where the lady's slippers can safely reach maturity. Our research has shown that a suitable location provides four to six hours of sunlight a day and a soil pH of about seven. In building fens, we look for property owners who are

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Katherine's sketches and watercolor painting of the showy lady's slipper. In 2014, she earned first-place awards for Water Color Painting and Best New Artist from the New Hampshire Orchid Society for her painting, right.

genuinely interested in our cause and willing to commit to protecting our lady's slippers. This means covering the fens with two inches of straw each fall, removing it in early spring, and making sure the fens never dry out and that wild animals don't disturb them. We've built around a dozen such sanctuaries in the Upper Valley region of New Hampshire and Vermont. Every year, we check on the fens and track how many plant shoots emerge and when they blossom.

When grown from seed in the wild, it takes the showy lady's slipper eight to ten years to reach maturity. This year, the first batch of plants we germinated in the school lab when I was in fifth grade flowered for the first time, having reached maturity in half the time it takes in the wild. But four years is still a long time.

### A Different Approach

Micropropagation, also called cloning, is a radically different approach that can be used to supplement traditional propagation methods. Using a piece of root tip or shoot tip and a specific balance of hormones particular to a given plant, micropropagation can produce millions of identical plants in a single year. This method is commonly used for crop plants, such as potatoes, in which uniformity is desirable. In other plant populations, however, cloning comes at a cost.

Traditionally, plants receive the genetic contributions of two "parents," ensuring genetic diversity. This is evolutionarily advantageous, since genetically diverse populations can adapt more quickly to environmental changes. But in cases where a population is crashing, having a population with little genetic diversity is better than having no population at all.

Over the past half-century, micropropagation methods have been developed for many crop plants and hundreds of different orchids. While micropropagation typically requires a delicate balance of at least two hormones, the lady's slipper requires at least 25 different natural and synthetic plant hormones—meaning there are almost endless combinations of hormones and hormone concentrations that could be tried. Despite many attempts, no one has been able to micropropagate any of the estimated 50 species of lady's slippers.

Based on previous research on orchids in the same family as lady's slippers, my research partner and I have tried 16 different combinations. Each attempt takes two to three months to yield results, but we are motivated to keep trying: If we can come up with a standard procedure for others to culture this plant in their own labs, we may be able to remove the showy lady's slipper from the endangered species list.

My partner and I presented our research at the 2015 New England Orchid Show, and later at the 2015 Native Orchid Conference. Impressed by our research, the conference organizer invited Dr. Faletra to submit a paper on the topic. Since I had drafted the presentation, Dr. Faletra encouraged me to take on the challenge. With support from him and his wife, who is also a scientist, I condensed my 21-page paper into 6 pages. In 2015, I published "Conservation of New England's Lady's Slippers" in *The Native Orchid Conference Journal*.

Participating in research has shown me that solving big problems requires many people working together. I know it may take a long time, but I also know that if our efforts succeed, our model may be used to help preserve other endangered plant species worldwide. ■

**Katherine Duan**, a 2015 Caroline D. Bradley Scholar, is a high school freshman from Hanover, NH. Her abstract, "Improved Propagation of the Showy Lady's Slipper to Support a Restoration Program," was published in the 2016 online meeting records for the Annual Symposium of the American Association for the Advancement of Science.