



Left photo: *Paphiopedilum spicerianum* photo by Gordon Kenyon
Right Photo: *Paphiopedilum spicerianum* 'Monster' HCC photo and grown by Ramon de los Santos

Paphiopedilum spicerianum with the dorsal sepal projected forward in the photo by Kenyon is the most common. The flattening out of the dorsal sepal and the larger, rounder, and flatter shape of *Paphiopedilum spicerianum* 'Monster' HCC is an example of the direction of breeding for awarded orchid flowers. There is thought that in nature the forward projected sepal found in slipper orchids keeps water out of the pouch. Water in the pouch could drown the pollinator or make the flower too heavy for the stem. As orchid breeding for awards changes the dimensions of flower parts, there are questions about the usefulness of awarded species for conservation. Judging orchids for awards is an important part of orchid horticulture. It would be interesting to see what awarded orchids will look like 100 years from now.

The Challenges of Ex Situ Orchid Conservation

text by Mark Sullivan

What the words “ex situ orchid conservation” bring to the minds for most of us is the growing of orchid species plants in cultivation. It can also mean the gathering and saving of orchid seeds, and DNA. One goal of ex situ orchid conservation is to save a species ex situ as it disappears in situ. A further, though unrealistic goal for many species, is to reintroduce the species back into the wild. I say “unrealistic” because the underlying reasons for species extinction in the wild need to be addressed before a successful reintroduction can happen. Ex situ conservation boils down to saving genetic information and diversity.

As orchids become extinct in their natural habitats, ex situ orchid conservation takes on greater importance. The loss of natural habitat will continue as humans exploit and develop land, divert water flow, and change the environment. The continent of Europe has the most developed land. Only 15% of its land is “natural” and not changed by human activity.¹ It is likely that as the human population continues to increase all other continents are headed in the same direction. There has been no time in modern human history where habitat destruction has not happened or been reversed. In fact, habitat destruction is only accelerating. This loss of habitat is the number one reason for species extinction. Ex situ conservation is the conservation of last resort we have with any species.

The need for a conservation effort now is urgent. Many orchids border on extinction as their habitat dwindles or are already extinct in the wild. A few of these include [*Caladenia brachyscapa*](#) (extinct both in situ and ex situ, Tasmania, Australia), and [*Paphiopedilum wardii*](#) (over collected and reported to be extinct in Burma; habitat limited to SW Yunnan, China). Many orchid species have less than 100 individuals known to exist. These rare orchids include [*Platanthera holochila*](#) (less than 40, Hawaii, USA), [*Corunastylis superb*](#) (40 plants, single site by the side of a road, Australia) and [*Caladenia pumila*](#) (2 individuals, 2009, Victoria, Australia, recently rediscovered having not been seen since 1926). Most orchids species are either not cultivated in ex situ or their number in ex situ is unknown.



Paphiopedilum wardii photo by Eric Hunt © www.orchidphotos.org

Paphiopedilum wardii is said to be extinct in Burma from over collecting. The orchid with other plant species is smuggled to China and Thailand orchid markets and sold. Its in situ population is dwindling and now limited to SW Yunnan, China.

Conservation, whether in situ or ex situ, must be planned with a long time frame in mind. This is difficult to comprehend in a world of instant gratification. Three hundred years out is difficult for the mind to grapple with. In the history of earth, evolution of species, and change of habitat three hundred years is a blip in the time line. Our approach for ex situ orchid conservation should be as far out as we can think.

Right now, two important objectives of science to further species conservation are the identification of all species found on earth and the categorization of them using DNA. Orchid DNA analyses are still in the stage of DNA sequencing of all orchid species and determining relationships between species. One of the biggest hurdles scientists face in categorizing a species using DNA is making sure the DNA they are analyzing comes from a true species. Knowing definitively if a plant or animal is a true species is also a problem for ex situ conservation. Since we are still figuring out the DNA of orchid species we haven't determined what true orchid species we have in ex situ. To illustrate this problem we can look at the conservation work being done on the American bison (*Bison bison*). In 1890 the bison almost became extinct with an estimated count of 750 animals. Today that number is around 360,000 or is it? To prepare a long term conservation plan for the bison, scientists started taking DNA samples to compare against a true bison DNA sequence. They were surprised to find out that many of the bison were actually hybrids with cattle DNA. The only bison herd that appears not to have cattle DNA in its genes is the Yellow Stone National Park herd. The Wind Cave National Park herd may also be made of true species but DNA testing continues. This narrows down the number of true American bison to about 10,000. Once you create a hybrid, no matter how many subsequent generations of breeding with a species, you still have a hybrid with DNA from the initial hybridization. While a plant or animal can look like a species, it could be a genetic hybrid. One of the biggest challenges of ex situ conservation, especially with orchids where extensive hybridization has occurred, is to conserve the genetic purity of a species. There is a great risk of "genomic extinction" through hybridization. This can easily happen with orchids, especially the more popular species. People "improve" a species by hybridizing it and then still calling it a "species".

A tag gets lost or tag markings fade on a hybrid and then it gets retagged as a “species”. These “species” then unwittingly get used in breeding. All subsequent generations are genetic hybrids even if the outer appearance may look like a species. If the two species used as parents are closely related and some taxonomists consider them one species then this may not be a problem. The basic question is what is a species?



Yellowstone Bison (*Bison bison*)
photo by Bonnie Eicher © 2008



Hybrid bison
photo Mark Sullivan

The differences between a species and a close hybrid are easier to distinguish when viewed side by side. Between the Yellowstone Bison and the hybrid bison some differences that are easier to pick out are shape and direction of horns, tails, and body shape and size. On the hybrid bison, you can really see the influence of cattle in their horns. Click on bison pictures for larger pictures.

When orchids are in ex situ, we are the pollinators. What draws us to pollinate one orchid with another is different from what draws an orchid's natural pollinator(s). Natural pollinators are drawn to an orchid because of scent, shape, visual cues that mimic food or mate and sometimes because of an actual nectar reward. Human pollinators have pollinated flowers that are pleasing to us: pleasing scent, large, round, flat, with good substance, and without what we perceive as blemishes. We are attracted to the unusual, the outliers of a species and not the plainer, everyday examples of a species. We pollinate selectively to create above “average” orchids. We hybridize.

This creates two problems from a conservation point of view. If reintroduction occurs the original pollinator may have trouble pollinating our “above average” orchids. The proportion between flower parts may have changed, allowing a pollinator to escape without the pollen attached. A sepal that once acted as a hood to keep rainwater from collecting in the pouched lip may be flattened. Rainwater collects in the pouch and drowns potential pollinators. Of course, this assumes that the pollinator exists in the orchid habitat and has not suffered the same demise as the habitat or the orchid it pollinated. Our pollination for orchids that please us skews the gene pool of an orchid species in ex situ to the unusual varieties of that species. We jeopardize the “average” genes of the orchid as would have been found in nature. We lose the genetic diversity of a species.

Saving the genetic diversity of species is a top goal of ex situ conservation. A conservation orchid breeder would breed to increase or stabilize the genetic diversity of an orchid species. Line breeding and breeding for specific traits would not be done. While award winning orchid species can be a part of any conservation effort, they should not make up a large percentage of the effort. There is more wiggle room with plants than with animals in saving genetic diversity. Plants can decrease to a smaller number of individuals than animals and still have a healthy

population.

Large number of individuals of species does not protect a species from going extinct. Many orchids are niche players with only a few individuals in unique habitats. This makes these orchids particularly vulnerable to habitat destruction and they can disappear like *Caladenia brachyscapa*. But even orchids found in relatively large numbers and over large habitat areas are vulnerable to extinction. While there are no abundant orchid species that have yet suffered this fate there are a number of cautionary tales that tell us not to leave our guard down.

The passenger pigeon (*Ectopistes migratorius*) was once said to be so great in numbers that a passing flock would be a mile wide and would darken the skies of the US Midwest for days. Before the hunting of passenger pigeons it is estimated that they were 25- 40% of the total bird population in the US. People shot the passenger pigeon for feather decoration, for food, but most were shot just for the “fun” of it. People believed that there was an endless supply. From 1900 until 1914 a concerted effort was made at ex situ conservation of the passenger pigeon. The last passenger pigeon in the world died in September 1914 at the Cincinnati Zoological Garden. Great numbers of a species does not guarantee that a species will not go extinct. When explorers from Europe found the new tropical world of Central and South America, they would often ship back to Europe things packed in crates with orchid plants used as the “Styrofoam peanuts”. Orchids were used as packing materials because they were so plentiful and easily available. While there is a little hope for conservation if an orchid species gets down to one plant, we should not be lulled into complacency because of the abundance of a species. There are many things that can go wrong and we do not want to get down to one plant or the extinction of a species. We must keep a watchful eye.



When plants and animals are interbred and not crossbred, they lose vigor, gain abnormal and often-crippling traits, and become more susceptible to disease. Orchid breeders are well aware of this risk as they line breed. The risks increase with every successive generation. Cultivated edible bananas have been so line bred that they have become very susceptible to black sigatoka, a fungus. There is concern that it could cause the collapse of the banana industry. Dog breeds suffer from genetic abnormalities that affect their hips and hearts. The importance of maintaining genetic diversity cannot be understated.

One way of saving genetic diversity is with a seed bank. Orchid seeds are small and can be saved in a small space. The Millennium Seed Bank Project is coordinated by the Royal Botanic Gardens, Kew. It is an ex situ conservation effort to prevent the extinction of plants in the wild. There are national seed banks located around the world that participate in the Millennium Seed Bank Project. The Millennium Seed Bank stores seeds in large, -20 degree Celsius underground vaults preserving the world's largest seed collection. In 2009 they reached a banking of 10% of all wild plant species. Their next goal is to bank 25% of the world's flowering plant seeds by 2020.

The Orchid Seed Stores for Sustainable Use is a UK Darwin Initiative. Their target is to have 1000 orchid species seeds in storage. They are also gathering data on germination media, longevity of orchid seeds, seed capsule ripening time and the number of seeds per capsule. Other efforts [The Orchid Seedbank Project](#) like the sell, swap, and donate orchid seeds to researchers and conservation. [The Meyer Conservatory](#) provides another model for promoting orchid species

conservation. The business receives orchid species seeds from customers, grows them in flasks and then sells them at a low flat rate without regard to rarity.



[Meyers Conservatory](#)'s lab technician Amber Kost replating orchid plants. Photo by Troy Meyers

Growing orchid species ex situ and maintaining seed banks is expensive. Collecting, cleaning, organizing and keeping seeds in sub zero vaults is expensive. Likewise, growing and maintaining orchids in greenhouses is both time consuming and expensive. The idea of reintroducing orchids back into the wild (especially if you are rebuilding the habitat) adds greatly to the expense. It is by far more cost effective to conserve orchid species in situ and protect habitat in the first place. With about 25,000 orchid species in the world, ex situ conservation of them all is impractical. The cost alone would be staggering. There will be orchid species going extinct in the future. A great emphasis should be on the conservation of orchids in their natural habitats. For the ex situ conservation, the focus should be on orchid species where the habitat protection will likely fail or has failed.

The last challenge that ex situ orchid conservation faces is that many species are difficult or not possible to be maintained ex situ. This is specifically true of terrestrial orchids where our knowledge of their relationship with the rest of their habitat is not fully understood. While we can bank the seeds, we are at a great disadvantage of further propagating them, especially if the species goes extinct in the wild.

Right now, the state of the ex situ orchid conservation effort is fairly disorganized. The Millennium Seed Bank Project is the most organized efforts. Botanical gardens, researchers, commercial species growers, and home growers are pretty much doing their own thing with no coordination among them.

So what can be done? As scientists discover, catalog and understand species in situ, there could be a similar effort to discover the state of species ex situ. The establishment of an ex situ orchid conservation database would greatly facilitate this effort. With refinement, the database could be used for conservation breeding. With a database, we would understand our strengths and weaknesses better in terms of what species we have in ex situ and how that matches with orchid species in situ. We could then better focus our limited resources in ex situ on orchids that are threatened with extinction in situ. A “proof of concept” example of a database is the Living Orchid Collection. If and when our ex situ conservation database is established, it will require dedication from the orchid world.

The National Council for the Conservation of Plants and Gardens in the United Kingdom has a Program called the National Plant Collections, which is to be “as complete a representation of a genus or section of a genus as possible.” Some orchid genera are in this collection. A similar program could be set up with orchid societies. Orchid societies could choose to be the keepers of as complete a representation of a genus or section of a genus as possible. The collective members of the society would maintain the genus representation in their various growing situations. They could help guarantee the genetic diversity of species in the genus. Societies could choose to be the keepers of several genera. If different societies overlap by keeping the same genus, this would be beneficial. It could promote interaction between societies. An easy way to begin would

be for orchid societies to assess which species their members grow. This would be an indication of the genus the society could become involved in with an ex situ conservation effort. Then orchid society members would become direct participants in orchid conservation. The effort would give orchid societies another dimension of interest in keeping and attracting new members.

Orchid conservation is going to take a concerted effort by the people who love orchids. A few scientists and conservationists cannot do this alone. The more people involved, the better the chance for success. Not only will the participation in orchid conservation open a new aspect to this great hobby of ours, but our success will help safeguard orchid species for future generations

¹ **Primack, R. B.** 2006. Essentials of Conservation Biology. 4th Ed. Habitat destruction, pages 177-188. Sinauer Associates, Sunderland, MA.

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More photos to go with this article:

<http://www.orchidconservationcoalition.org/pr/exsitucon.html>

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The Millennium Seed Bank Project: <http://www.kew.org/science-conservation/conservation-climate-change/millennium-seed-bank/index.htm>

Orchid Seed Stores for Sustainable Use: <http://www.ossu.org/index.html>

Orchid Seedbank Project: <http://members.cox.net/ahicks51/osp/>

Troy Meyer Conservatory: <https://lab.troymeyers.com/flasking/home.php>

Living Orchid Collection: <http://livingorchidcollection.org>

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