GROWING SLIPPER ORCHIDS

HAROLD KOOPOWITZ

THE VARIOUS GENERA that make up the slipper orchid sub-family tend to have different cultural requirements. Of the genera, *Selenipedium* does not have a history of cultivation, mainly because most of the species tend to grow too tall for most conservatories or greenhouses. *Cypripedium, Mexipedium, Phragmipedium, Selenipedium* are primarily terrestrial plants while many of the *Paphiopedilum* species are epiphytic, lithophytic or terrestrial. We will deal with *Mexipedium* first, and then *Phragmipedium* and *Paphiopedilum* together as many of their requirements are similar.

Many gardeners seem to forget that plants are living creatures and need to carry out all of the functions that animals also require. Plants must breathe, feed, drink, grow, and reproduce as well as other functions. As is the fate of higher living organisms, plants also die. Your job as a gardener is to make it as easy for the plant to continue living, growing, and flowering for as long as possible. Slipper orchids' cultural ease is attested by the fact that, for 150 years, they have been one of the most popular groups of orchids and are grown all over the world. I will not discuss cultivation of cypripediums as I have no experience with those delightful flowers.

Much of this article has been copied from my book *Tropical Slipper Orchids*, but, as it is now out of print, I will reproduce parts of the chapter on culture in this article.

Growing Mexipediums

There is only one species, *Mexipedium xerophyticum*, and it comes from arid regions in Mexico. Only a few plants have ever been found in the wild, but fortunately it has proved easy to grow, flower, and propagate. It is almost trouble-free and appears to be very resistant to the various rots that can attack other slipper orchids. Given the correct conditions, this species is a vigorous grower.

Containers: The hobbyist needs to make a decision whether to grow this plant in a small two inch (five cm) plastic rose pot (somewhat deeper than most two inch pots) or in a larger diameter container. I have grown and flowered them in both small rose pots as well as relatively larger shallow pots with a diameter approaching six inches (15cm). They seem to grow equally well in either plastic or clay containers. It is quite surprising that these small plants lend themselves so easily to growing into fine specimens with multiple growths and flower stems.

Growing medium: I have seen them succeed in a variety of different media ranging from pure bark to more complicated mixtures. I use my standard paphiopedilum mix (see below). These plants have wiry, thin roots and it seems appropriate that the potting mix should be small diameter particles in the range from 1/4 to 1/2inch (6-12 mm) in size.

Water: Mexipediums, like all slipper orchids, prefer good quality water with a low salt content. Many growers use deionized or reverse osmosis water, and it is worthwhile investing in some type of water purification system. Small handheld water testing meters are useful as they allow one to keep an eye on the water quality one is giving to the plants. Good water quality should be less than 40 ppm (parts per million) dissolved solids. Many reverse osmosis and ion exchange systems produce water with less than 10 ppm dissolved solids.

Because mexipediums are desert plants, one might be apprehensive about the amount of water the plants are able to handle. While they tolerate drier conditions than the other genera, I found that they seem able to handle the damper conditions of the greenhouse, and no provision need be made for growing them under drier conditions than paphiopedilums on the same bench.

Temperature range: This species grows well and flowers under intermediate conditions. I grow it with the same temperature regime as other tropical slipper orchids with low temperatures of 55°F (13°C) and highs of 90°F (32°C). There is usually a minimum high-low temperature oscillation of 20°F (11°C) on a daily basis, although it can be higher depending on the season.

Feeding: *Mexipedium* plants respond to a well-balanced fertilizer applied at strength of about 750 ppm applied once or twice per month.

Hygiene: As with all slipper orchids, one should maintain good hygiene. Remove all dead leaves as they occur; keep pots free of weeds; remove any leaves that might look infected, etc.; however, *Mexipedium* seems to be especially resistant to most insect and fungus problems.

Special conditions: *Mexipedium xerophyticum* produces wiry runners between their fans of leaves. These runners vary between one and six inches (2.5 – 15 cm) in length and each ends in a fan of leaves. Another runner will often be produced from the base of that fan before it produces its own roots. This often leads to an untidy mass of runners hanging over the edge of the pot. The runners can be gently bent and twisted so that the emerging fan of leaves is confined within the pot. Pieces of metal wire can be bent into an inverted "U" and the runner pinned onto the compost of the pot close to the base of the new fan leaves. Or, if you wish, an additional pot of fresh medium can be placed under the emerging fan of leaves and the fan pinned to the new pot until roots have emerged. Do not sever the rhizome until a new root system has become well developed.

Growing Paphiopedilums and Phragmipediums

Many aspects of the culture of these two genera are similar with a few distinct differences depending on which species is involved. I will start off with some general comments and then consider some of the different requirements. *Paphiopedilum* and *Phragmipedium* orchids are grown in many different parts of the world. Their popularity suggests that they are robust and easy to maintain. For the most part, both species and hybrids are quite long-lived. Some individual cultivars have probably been in continuous cultivation for well over 100 years and 75 years is not uncommon. During this time they have lost neither their popularity nor their allure. We probably grow them more successfully now than at any previous time, but their continued popularity tells us that they are, in fact, very easy to grow and even beginners can succeed with them. Of course, there are some "difficult" species that are not recommended for the beginner and these will be discussed elsewhere.

Containers: The major categories of suitable containers are clay and plastic pots. There seems to be little use of ceramic or glazed pottery. Usually clay is better for places with high humidity but plastic, being cheaper and lightweight, is now used nearly everywhere. Certain plastic pots have an inverted cone in them to allow air into the center of the pot. While some growers get good results with these, I have seen equally good results using normal pots. It does not seem to matter if one uses round or square pots, but the square shape allows one to pack the pots more tightly together on the bench. In the wild, many paphiopedilums grow directly in the humus of the forest litter. A number of species are lithophytic growing on rocks with their roots foraging in a very thin layer of mosses and humus. Other species are epiphytic. Similar habitats are also found for *Phragmipedium* species. Irrespective of their wild nature, most slippers do well in pots but are difficult to grow mounted, and this is not recommended.

The size of the container is important. Most beginners tend to put their plants into pots that are much too large. Many try to balance the size of the pot with the size of the leaves rather than the amount of roots and consequently select a container that is much too big. Paphiopedilums tend to have sparse roots that seem unable to drain much of the moisture from the pot. If the pot, and hence the volume of medium, is too great the medium will stay wet for too long, creating anaerobic conditions, which will cause the roots to die. One should always select a pot in which the roots will just fit comfortably. The main point about repotting is to give the plant fresh medium and not necessarily to move it into a larger pot.

If you are going to reuse pots of either plastic or clay, they will need to be thoroughly sterilized. Pots should first be scrubbed clean in soapy water and after rinsing, they must be submerged in a bucket of water to which a cup of household bleach has been added. As many pots as can be fitted comfortably in the bucket can be processed, however, resist the possibility of stacking tight-fitting pots in the solution as one need to insure that the bleach comes in contact with all surfaces. The pots should remain in this solution for about one hour, and then rinsed. The sterilizing solution is good for about a day. I prefer plastic pots because they are inexpensive so that I do not need to recycle them. When one considers that the value of a slipper orchid plant can be up to hundreds of dollars for one individual, saving half a dollar by recycling a pot is a false economy that does not make sense, and I have neither the time nor the need to devote to those activities.

Potting media recipes: There are many different potting mixes and they have changed and varied over the years. People are always anxious to try out a "better" medium. The act of repotting into any half-way reasonable mix usually initiates a growth spurt in a slipper orchid. After repotting in any new mix, many people report on how well their plants are growing and so others try this new mix. But after five to six months, the plants tend to slow down; the telling time is nine months to a year after repotting. I canvassed a number of slipper enthusiasts who are good growers. They grow under quite different growing conditions and I asked them for the recipes of their mixes. Some of these are listed below and will give the grower a feel for both the similarities and differences that occur. One common element that occurs in many of the North American mixes is Douglas fir bark. This comes in nuggets (pieces) of different size grades. Small nuggets vary between 1/4 to 5/8th inches (0.6 –1.5 cm) in diameter; medium nuggets vary from 5/8th to 3/4 inches (1.5 to 2 cm). Larger sizes are also available but normally are not used for slippers. In recent years, pine bark imported from New Zealand has been substituted for Douglas fir bark. It is said to have better lasting qualities. I have seen many fashions come and go in potting media. I find that, after a trial period, I always do back to Douglas fir bark.

The same mixes can be used for both paphiopedilums and phragmipediums. Usually if oyster shell or marble chips are used in the mix, they are omitted for the phragmipediums. Remember, if something works well for you don't change it merely because something new and fashionable comes along.

Here are a few recipes, additional ones can be found in my book *Tropical Slipper Orchids* (2008). Cindy Hill grows her plants near San Francisco in Northern California and she modifies her mix if the plants are potted into containers that are wider than four inches (10 cm).

For pots less than 4" in diameter she uses
2 parts small fir bark
1 part sponge rock

1 part horticultural charcoal
1/4 part shredded tree fern (medium)
and a handful of well-rinsed crushed oyster shell

For pots larger than 4" diameter she uses
1 part large Douglas fir bark
1 part small fir bark
1 part sponge rock
1 part horticultural charcoal
1/4 part shredded tree fern (medium)
a handful of well-rinsed crushed oyster shell

John Robertson, owner of Robertson's Orchids, in Queensland, Australia is a commercial grower with his plants accommodated in large nursery greenhouses and he sees his potting mix as being embarrassingly simple. Many parts of the world do not get Douglas fir bark and they switch to pine bark. John's mix contains

4 parts of 5-8mm pine bark
1 part of similar size charcoal
1 part medium perlite.

After the plant is potted in his mix he sprinkles shell grit on top, which then, over time, works its way down into the mix. For the larger pots, he increases the bark size to 8-18mm and changes the perlite to a super-coarse grade, but the amount of charcoal and shell grit remains the same. He adds that he has not had good luck trying to grow paphiopedilums in either pure rock wool or pure New Zealand type sphagnum moss.

The mix used by Terry Root, at his nursery in Northern California, the Orchid Zone, has produced superbly grown plants for the wholesale market. Over the years, they have modified their planting mix several times, often experimenting for a year of two with new mixes. The one I give here is an earlier mix they came up with that I used for many years.

45% washed larva rock
45% washed small grade Douglas fir bark
10% fine grade horticultural perlite.

Nick Tannaci grew in Northern California and had a reputation for being an extraordinarily fine grower of brachypetalums. He specialized in these dwarfs and grew and hybridized them for decades. His mix was as follows:

7 parts small size Douglas fir bark that is first washed in hot water,
1 part clean construction sand added to the damp bark and swirled in a "cement" mixer to coat the bark lightly with sand grains.
1 part charcoal
1 part coarse perlite

Note that he does not use shell or marble grit (usually recommended for brachypetalums) in this mix. His plants always looked robust and flowered well.

Marilyn LeDoux of Windy Hill Gardens in Labade, Missouri specializes in phragmipediums. She is renowned for her plants and uses the following mix for seedlings and plants in small pots.

9 parts fine bark (Douglas fir)
3 parts perlite
3 parts fine to extra fine horticultural charcoal (#3 or #4)
3 parts fluffed Canadian peat (sphagnum) or similar Pro-mix with peat.

For larger plants she will add some extra medium sized Douglas fir nuggets making up about 1/4 to 1/3 of the volume of the pot.

In Oregon, Steve Vinisky has a somewhat more complicated mix used for paphiopedilums.

4 Measures of fine orchid bark (Rexius)
2 Measures of medium orchid bark (Rexius)
1 Measure NZ Sphagnum rough chopped (1/4" to 1/2" pieces)
1 Measure Sponge rock
1 Measure Dyna rock
1 Measure fine charcoal
1/2 Measure Builders sand
1/2 Measure #1 grit (chick grit)

This comes to 11 measures.

He screens the bark, Dynarock, sponge rock and charcoal to remove the fines and soaks the bark in warm water overnight. Only floating bark is used and he discards whatever gets waterlogged and sinks. To the wet bark, he adds the sphagnum and then the sand and grit. The wet bark helps the sand/grit to adhere. Then he adds the last three measures (of Dynarock, sponge rock and charcoal) and mixes it well.

Steve writes "This has been a very "forgiving" mix for me. I do think that repotting twice a year is best although I have let some things go a full year with no degradation. The sphagnum seems to encourage root growth as many roots cling to it and grow though it. My sense is that when the mix begins to break down, it seems to "go over" rather quickly. Annual repotting would be as long as I think it should go using this mix. I see NO sphagnum breakdown with my average 6 to 9 month repotting cycle."

In Japan where enthusiasts can be very intense about their slipper orchids, a number of different mixes are used. I have seen a variety of slipper plants from several sections grown in shredded cedar bark that has a consistency of coarse wool. All of the plants I examined had extensive and healthy root systems. Other recipes call for pumice chips, crushed brick, charcoal and imported small grade Douglas fir bark from the United States.

Understanding the Mixes

Examining the mix recipes above shows that potting

mixes of Douglas fir bark, charcoal and perlite appear to be the most popular, although the proportions of each ingredient can vary. This mix will break down fairly rapidly depending on local conditions including types and rates of fertilization. If plants are not repotted at least annually, it can lead to stagnant conditions and loss of roots. There are no magic mixes that last forever. If you are of the lazy persuasion then cut down on the number of plants you grow so that you can give them the attention they deserve.

If we look at all of these mixes we find that the media are mixes of organic and inorganic components. The organic components are usually a conifer bark of some sort, but over the years a series of different components have been used with varying degrees of success. Among these have been nuggets of cork-oak bark, osmunda fiber, chopped tree fern fiber, pine bark, Douglas fir bark, and cedar fir wool, chunks of coconut fiber, sphagnum moss, and sphagnum peat. Recently, coir nuggets and ground coconut husk fiber have been introduced. The main function of the organic matter is to provide an electrically charged surface that functions to hold fertilizer molecules that are also electrically charged until the orchid roots can take them up. Without these components, the fertilizer would just get washed out of the pots. The most popular components appear to be the conifer barks. The slippers do not like redwood bark and one popular bark sold under the Sequoia brand name is actually made up of a mixture of white fir, red fir and Douglas fir and is not redwood. Stay away from redwood bark.

A problem occurs when bacteria and fungi start to breakdown the organic components in the planting mix. The nitrogen provided in the fertilizers often accelerates this. Some of the organics listed above break down very rapidly while others are quite slow. Cork-oak bark nuggets, which were once a very popular medium, were very quick to deteriorate while osmunda fiber was quite slow and could last for years. The conifer barks last for only about a year to 18 months and the smaller size bark nuggets degrade much faster than the larger nuggets. However the larger sizes often do not hold enough water and can dry out too quickly.

While coconut products, both chunks and coir peat, have given good results for many kinds of orchids, at this point in time I do not recommend them for slipper orchids. In my experience, I find that the plants initially start to grow quite vigorously and make good roots, but after a few months the root tips stop growing and tend to go blind. In addition, both the chunks and the peat appear to collapse and compress upon themselves and aeration suffers. If you do decide to use these products make sure that they are soaked for several days and change the water a number of times. One needs to measure the salt in the soak water to make sure that all of it has been leached out. During processing, most coconut is soaked in seawater to rot the softer matter around the fibers and this is not always rinsed away before it is chopped up. The salt content can be quite variable, and, if there is too much salt, you will lose your plants.

Sphagnum moss is often used to wrap the roots of slipper orchids for transport. It is convenient, lightweight and holds water. In addition, it is usually acceptable for transport across international borders where regular mixes are not allowed. Some orchids, such as cattleyas and phalaenopsis, are now permanently grown in pure sphagnum and they do quite well. But slippers will not succeed if grown in pure sphagnum for any length of time. Like coconut products, use of New Zealand type sphagnum moss often initially produces good roots but within a few months the roots start to die. If you purchase plants in moss, even if they are in bud or flower they should be replanted in a regular bark mix as soon as convenient.

Because paphiopedilums growing in the wild are often associated with limestone formations, people tend to assume that they prefer a basic mix and so they add powdered dolomite, marble chips, or crushed oyster shell, etc. While these additives do not seem to harm the plants, they grow equally well without them. For years we added powdered dolomite to the mix for the paphiopedilums and swore by it. But when I stopped adding dolomite, the plants continued to grow just as well as before. Plants growing lithophytically on limestone have their roots associated with mosses, decaying leaves, and other detritus, which are usually somewhat acidic. A neutral to slightly acidic mix is probably best for the tropical slipper orchids.

The inorganic components perlite (Sponge rock), lava rock and Aliflor (expanded clay spheres) that many people add to the mix are there to try and prevent the organic components from compacting. They provide airspaces so that oxygen, which is essential for good root growth can percolate into the mix. It does not seem to matter what one uses, as long as there is something to keep the mix aerated. Aliflor comes in different sizes and some growers prefer to use 1 cm spheres with adult plants. Likewise, coarse chunks of perlite are better than the finer grades for larger plants. Ideally one should use grade #3 or even #4 if the latter is available. Perlite is produced from a natural type of glassy rock. Its components are primarily silicon, aluminum, oxygen and water. When it is heated to 1,600°F (871°C) the rock "pops" similar to the way popcorn expands when it reaches a critical temperature. When the rock cools it produces the lightweight compound called perlite. It is inert and produces a neutral pH of 7. The substance is used worldwide in horticulture soils as it holds both water and air.

Water Quality and Watering

Paphiopedilums and phragmipediums will grow in a range of water qualities but they will do much better if given good quality water. Good quality water is that which has a low salt content. There are several ways that you can supply this.

a. **Rain Water**: Collect rainwater from the roof of either your home or greenhouse. If you are in an area that has a seasonal rainy season you should not collect water from the first rain of the season as that water will also contain pollutants and dust that have accumulated on the roof during the dry season. Instead allow the first rains to wash the roof for you. If you are in an area that receives "acid" rain then using rainwater may not be a good idea. There are pH paper test strips that you can buy at nearly any nursery or pond store to test your water.

b. **Well water**: If you want to use well water you need to get it tested. Neutral to slightly acid water is preferable and brackish water with a pH of greater than 7.5 could damage your plants. Very high calcium or magnesium contents will leave stains on the leaves and make them unsightly.

c. **Reverse Osmosis water**: This system works by squeezing the water molecules through a membrane with very tiny pores so that only the water gets through and the salts are left behind. The salty water remaining is then expelled through a drain. It used to take considerable volumes of water to produce sufficient good quality water but modern units are now quite efficient. The units that do this filtering come in a variety of sizes appropriate for the gardener's needs. The good water is stored in a tank that can then be pumped to a hose or merely added to a watering can depending on the amount one requires. Reverse osmosis systems are very popular with orchid growers and are one way that growers with modestly sized collections can afford to give their plants good quality water.

d. **Deionized water**: In this system, water is passed through a series of resin beds. The resins have negative charges and absorb positively charged calcium and magnesium ions in the tap water. Depending on the water volume that one needs these units can be expensive. Water pressure coming out of the deionizing tanks is low and this can make for a problem if one wants to feed using a siphon-type system. Another problem is that the resin beds eventually get saturated with salts and then release the salts that they have accumulated. If the grower is unaware of the condition of the tanks, one can end up flooding the plants with salty water. These systems often come with indicator lights to tell one when the tanks need to be recharged or exchanged for fresh tanks. But the indicator lights are not always reliable, and one should measure the water quality frequently with a solubility meter. When the tanks are working well, water will only have 1 to 2 ppm of dissolved solutes and occasionally even less.

e. **Tap water**: Tap water is very variable depending on one's geographic position and source of the city water. It will also vary with the season and the ultimate source of the water. Some regions have extremely good quality water and others are poor. Water may by fluoridated and chlorinated using either chlorine or chloramines. Neither of these compounds appears to affect paphiopedilums but certain sensitive phragmipediums such as *P. besseae* and *P. schlimii* may be affected. Most phragmipediums, however, are also very sensitive to the salt content of water and if your tap water is high in calcium and/or magnesium, tap water should be avoided.

While slipper orchids appear to relish good quality water, one can have too much of a good thing. Excessive use of water with very low salt content will leech out both micronutrients and fertilizers. Most accounts recommend regular leeching to prevent build up of salts in the pot, especially if the grower is feeding heavily or if the water normally has a high salt content. But with frequent use of good quality water, leeching is not really necessary. I now occasionally water my slippers with regular tap water. In our area, the dissolved solids in the water are mainly calcium and magnesium carbonates and these vary between 250 and 450 ppm depending on annual rainfall. I probably water half the time with city water and half the time with deionized water. Generally when I feed my plants, I use a siphon proportioner and I need the higher pressure that the city water lines provide.

Most phragmipediums grow in moist environments. Frequently they occur on nearly vertical surfaces in thin layers of soil and moss and here the water continuously drips through the rooting layers. They appreciate continual dampness. I tested the salinity of several species growing in the wild in Ecuador. The *Phragmipedium* species *P. besseae*, *P. pearcei,* and *P. wallisii* that grew in or close to water had a salinity of no more than 10 ppm. *Phragmipedium boissserianum* plants, which grew on road cuttings, were exposed to water of about 150 ppm. This was higher than the other species were exposed to, but that was still relatively dilute. Most of the phragmipediums should be grown in standing water. This can be accomplished by putting their pots in saucers of good quality water and changing this once a week. The water must not be too deep. Approximately, half an inch (1.5 cm) is a reasonable depth. If the water is too deep then it will exclude air from the roots in the pot. If one waters frequently, there is no need for the standing water, but people who have had difficulties growing their phragmipediums report far better success when they switch to growing their plants in standing water.

Most slippers appreciate watering from above so that the entire plant is showered with water. Not only is the pot to be wetted but the leaves should be wetted as well. If the plants have open flowers, however, care must be taken not to get them wet. If the pouch gets water in it, it can start to rot. It is better to water early in the day so that the leaves get a chance to dry off before the evening.

Feeding and Fertilizers

Like most orchids, the slippers appreciate being fed. If you do not feed them, you will find that the plants slowly deteriorate: leaves will get smaller and older growths will die. Slipper orchids are normally thrifty plants and in an effort to survive, a starved plant will recycle any usable food stored in the older leaves. Food stores from the oldest leaves are redirected to the growing part of the plant. Thus a starved plant will often have yellow, older leaves and the total number of leaves on the plant will be less. There will be fewer living leaves held over from previous seasons. Normally an old growth that has flowered can be retained for many years.

There are other reasons for leaf yellowing. Often in the early fall, there will be synchronized yellowing and dying off of the older leaves; this is especially evident in collections of standard complex hybrids. Leaf yellowing can also indicate root problems. Very thin and desiccated leaves also indicate root problems. If in doubt, remove the plant from the pot and look at the roots.

All plants need an array of inorganic chemicals to carry out the functions of the living cells that make up the plant. These are roughly broken into two groups based on the quantities required. Macronutrients are those the plant needs in quantity and micronutrients are those only required in trace amounts. Normally the micronutrients don't need much attention because the amounts needed are small enough to occur nearly everywhere and a good fertilizer usually provides them. What concerns the grower is providing enough macronutrients. The major nutrients you need to provide are nitrogen (N), phosphorus (P) and potassium (K = Kalium = Potassium, otherwise the two Ps would be confused). These three are always listed in that same order numerically on the label of the fertilizer package. The three numbers indicate the proportions of N:P:K making up the fertilizer. In most fertilizers, the nutrients are in the form of soluble salts. Nitrogen in fertilizers is usually provided as a nitrate but also sometimes as soluble urea. Urea is not strictly a salt. There is some debate about how readily orchids can use urea and if that contributes to the decomposition of the bark. Other important elements that plants require such as calcium, magnesium and iron are needed in much smaller quantities.

Before I feed, I water the plants, wetting down the leaves and then after a few hours apply the fertilizer. A good dictum is feed often but feed weakly. I usually feed at half the recommended strength which is approximately 800 ppm (parts per million) for all dissolved solutes (this includes the 250 ppm already in the tap water). Small handheld salinity meters that measure dissolved salts are inexpensive and readily available from gardening and pool supply houses. The strength of fertilizer I use is equivalent to one level tablespoon of fertilizer in two gallons of water. I always foliar feed, wetting the leaves as well as the mix. During the late spring, summer and early fall, I feed a well balanced water-soluble fertilizer. Many orchid fertilizers have nutrient ratios of 20-20-20 and those seem to work well. One fertilizer that I use is Miracle-Gro® which is 24-8-16 and has some micronutrients, but nearly any well-balanced orchid fertilizer will do equally.

Repotting

One cannot get around the fact that repotting is a chore and if you do not like to repot then perhaps you should limit the number of plants that you grow. If you have an enormous collection, repotting can take on Herculean dimensions and one can spend most of the year repotting. Ideally, all slippers should be repotted once a year and some might prefer even shorter time periods between repotting. There are, however, a large proportion of slipper orchid growers who only repot every two to five years. Many of the slippers are robust enough to take this abuse, but if one wants to grow them well, they should be repotted each year. The reasons for repotting are several. The most important reason is that with time the bark in the medium decays and compacts excluding air from the roots; repotting allows one to refresh the medium at the root level. Repotting also gives one the opportunity to divide overly large plants or move plants that have outgrown their containers into bigger and more suitable ones. Repotting seems to act as a stimulant and plants often put on a growth spurt just after repotting. Plants can be repotted at anytime of the year, but I usually avoid repotting if obvious buds are present or the flowers are freshly opened. Once a flower has set then one can safely repot or divide the plant even though it is in bloom.

The first step for repotting is to knock the plant out of the container and examine the medium and the roots. If the roots have actively growing tips then extra care should be exercised so that they are not damaged. The old bark should be removed but if bark firmly adheres to the roots it can be left attached. All old, dead, and partially decayed roots need to be removed back to clean tissue and the roots then washed with a gentle jet of water to remove as much of the decayed compost as is easily feasible. There is no need to scrub the roots. One usually finds that with large plants the central roots have died and decayed and the center portion has often become anoxic. Yves Aubry has a trick to get and keep air in the center of the pot. He inverts a smaller empty pot and places it on the bottom of the new pot. The roots are then spread around the cone made by the small pot and the larger pot is then filled with fresh mix. A few holes drilled into the side of the central pot increase the airflow. Some growers design their own pots with slits in the side to admit more air. Plastic pots with inverted cones in their bases are made for orchids and many growers prefer to use these. It is a good idea to keep a second label with the repotting date together with the name label in each pot in case one cannot get around to yearly repotting. I always use new pots when I repot. Modern plastic pots are cheap and almost sterile. It makes more sense to use a new 50-

cent pot for a $50 plant than to chance introducing some disease or pest by using a dirty or old container in order to save a few cents.

Repotting time is also an opportunity to divide plants. If you have a special plant of which you are very fond, it is useful to grow several pieces in case some catastrophe befalls your special plant. Extra pieces of particularly fine plants are also useful to trade or sell. Do not succumb to the temptation to overly divide your plant. Except for standard complex paphiopedilums, all divisions need a minimum of three growths. If you have less than that, it can take the division several years to return to its normal flowering performance. With standard-complex types, a single mature growth with roots will make it on its own and even an older single back growth will usually put out new shoots from the base if it is separated from the rest of the plant. I am not suggesting that one should always divide standard-complex hybrids to single growths. A multi-growth plant will normally produce larger and finer flowers. Many growers only make divisions when their plants normally fall apart during repotting. If you cut through the rhizome it is a good idea to dress the fresh wound with powdered sulfur, Bordeaux mix or other agent such as Rootone® that has fungicidal properties.

Extra care is needed when repotting brachypetalums as they seem to be particularly susceptible to rot. They should only be divided when they become too big able to be handled easily. Special care is also needed to avoid breaking or injuring their succulent, brittle leaves.

Growing in Your Home

While greenhouses seem to be the ideal place for growing slipper orchids, they can also be grown to perfection as houseplants. Most hobbyists grow their orchids in their homes. Fortunately, the temperature requirements of these orchids are fairly similar to those that most people find comfortable. Because most of the species in the background of modern slipper hybrids are plants of forest floors or ledges sheltered by rocks, they have very modest light requirements. This is one reason why they often succeed so well indoors. They can be grown in apartments on windowsills or on tables near windows. But with the use of artificial lights, they can also be grown in basements and cellars. I have seen great orchid plants growing on shelves in closets designed for clothing. With a small amount of effort, their requirements can be supplied almost anywhere.

Growing Under Lights

I have seen closets and even wardrobes converted to growing areas for lady slippers and I even know of people who grew their orchids under the stairs. Many people convert their cellars into orchid growing rooms. In fact if you can provide adequate lighting, slippers can be grown just about anywhere. They are "low light" plants and it is easy to provide sufficient light for their needs. Nearly all species need to receive between 2,000 and 2,500 ft. candles at their leaves.

Yves Aubry grows his slippers in his cellar and does a fine job, regularly flowering even the strap leaved multiflorals, such as *Paphiopedilum rothschildianum*, a majestic species that has a reputation for being a recalcitrant bloomer, as well as many other species such as *P. lowii* and *P.* Saint Swithin. He lives in the harsh climate of Charlesbourg, near Quebec City, yet his slipper orchids regularly gain quality awards from the American Orchid Society. He also breeds slipper orchids and has produced some fine grexes. At one stage, he had eight thousand plants in his cellar. So how does he do it?

Yves provides the light in either of two ways: fluorescent tubes or high-pressure sodium lights. In the first case, he uses pairs of four-foot fluorescent tubes, one of which is a cool white tube and the other a daylight spectrum tube. The tube holders and their ballast are mounted on chains above the bench so that they can be raised or lowered depending on needs. A four-foot wide bench requires two sets of lights, i.e., four tubes. Normally the tubes are suspended 8-15 inches (20-38cm) above the foliage. When buds start to elongate, the tubes need to be raised so that the flower stems have enough room to elongate. After flowering, the tubes are again dropped lower. The high-pressure sodium lights (250 watts) work particularly well for the multifloral species and hybrids. They are held two to three feet (660 to 1,000 cm) above the foliage but also need to be raised when the tall flowers spikes elongate. He uses two of these lamps to illuminate a bench area of six feet (two meters) long by four feet (1.3m) wide. These plants do not get fluorescent illumination.

One of the nice things about growing under lights is the fact that one can use stacked shelves and so can increase the available growing area. There are, however, a few problems. As each shelf needs its own lights, one must be careful that lights on the lower shelves do not get wet when the upper shelves are watered. This can be ensured by building a watertight shelf and a drainage system to lead the excess water away. There is less maneuverability for raising and lowering the lights for the lower shelves, so one may need to confine seedlings and dwarf types to the lower shelves or else move plants in bud to the higher shelves as necessary.

Another problem with double or triple shelves is that the light fixtures heat up the benches above them and pots tend dry out more rapidly. One needs to monitor watering carefully. Some growers like to grow their plants on trays of pebbles to increase humidity around the plants but Yves has found that to be unnecessary.

During the winter months, plants are on a 13 hour light and 11 hour dark cycle; during the summer, they are on a 16 hour light and 8 hour dark cycle. In May, they are given an extra 90 minutes light and 90 minutes less dark and then in June the light cycle is again increased by another 90 minutes and the dark reduced

an additional 90 minutes. In November, light is reduced by 90 minutes again and then in December it is reduced once more by another 90 minutes with the dark period increased by the same amounts.

Temperature regimes are important for slipper orchids. Most of them (*Paphiopedilum primulinum* is the exception) need a substantial drop in temperature to set flower buds. If one keeps the home temperature at a minimum of 72°F (22.2°C) one may have difficulties setting buds. Be aware that the cellars' temperatures can end up even higher because of the heat given off by the lights. An oscillating day–night temperature between 85°F (29.4°C) in the day and down to 65°F (18.3°C) or even slightly lower at night is desired.

Because of the heating effects of the lights, adequate ventilation is very important and there must be air movement below as well as above the shelves. Yves has an elaborate system of fans and ducts perforated with holes to produce air circulation both at floor and ceiling level, as well as a series of smaller fans that cause air movement over the shelves when the lights are on. It is important not to develop pockets of cold or hot air. The main fans run 24 hours a day and are supplemented with smaller fans that operate when the lights are on. However, one wants a gentle breeze not a gale, so it may take some experimentation to get the right levels of air movement. Yves grows small seedlings under acrylic domes to prevent them from drying out too much.

Plants grown in cellars and other places are not immune to insects and other pests. New plants should be quarantined until you are sure that they are pest-free but some of the smaller almost microscopic pests will eventually find their way into your cellar or other growing space. Two problems for those growing under lights are false spider mites and thrips that will damage leaves if given the chance. See the section on pests and problems below.

Pests and Diseases

There are a variety of insects and other pests, as well as bacterial and fungal diseases that can attack any plant–orchid or otherwise. Unfortunately, slipper orchids are not considered agriculturally important crops and little research has been done on either understanding their pests and diseases, or on controlling them. The trick is to be vigilant and not let any trouble spread and get well established before it is recognized. It usually takes very little trouble to deal with a small infestation but when a large proportion of the plants get infected it can be very difficult, expensive, and a real pain. It is at this point that many amateurs give up and switch to growing zinnias and pansies in their gardens. Frequent inspection is the key to easy maintenance.

The major pests that infect slipper orchids are relatively few. I would rank the main one to be mealy bugs. These are white woolly insects, related to scale, but much more mobile. Mealy bugs are often carried by ants and moved from plant to plant. The young larvae are so tiny and light; they can float on air currents and can find their way to other plants. As mealy bugs drink the sap of your plants, you can consider them plant "bloodsuckers." They occur mainly on the undersides of leaves, in the growing crotches of young leaves, inside flower sheaths and even on the developing scapes and flower buds. Fortunately, they are susceptible to both contact sprays as well as systemic insecticides. If you have only a few mealy bugs, use 70 percent ethanol or isopropyl alcohol. Either spray the mealy bugs or dab them with a cotton bud soaked in the alcohol. This is non-toxic to the plant as well as to the person applying it and has much to recommend it. If you use chemical insecticides then you must take proper precautions, especially if you are spraying them in a confined space such as a closet or cellar. I have not had good success with some of the "organic" products that are often touted, such as light mineral oils and neem oil. I routinely spray my collection every three months and this seems to keep pests under control.

If one grows under very dry conditions, there are two groups of pests that can work their way through a collection. The first group includes the red spider mite and the false spider mite. These very tiny tick relatives prefer the under surface of the leaves. They produce rusty markings on the leaves. The red spider mites will also produce very fine silken threads. It needs a good hand lens or magnifying glass to see these pests in all their glory. They will eventually also be noticeable on the upper surfaces of leaves when the infestation gets heavy enough. The damage can be seen on the upper leaf surface as pits and grooves that sometime seem filled with a rusty stain. Once established, an infestation can spread rapidly through your collection. Fortunately, you can easily deal with false spider mites. A thorough spraying of soapy water on all of the surfaces of the leaf and into the growing crotch will take care of them. Insecticidal soap works well and this is non-toxic to humans. Unfortunately, the damaged leaves will remain pitted, scared, and tinged with rust, but your plant will eventually outgrow the damage. If you have repeated infestations, you might try increasing the humidity around your plants.

A second problem is thrips. These are tiny elongated black insects that are bigger than the mites and can be seen with the naked eye. Thrips damage tends to be confined initially to the lower surface of the leaf. They chew the epidermis and produce a white scar. Individual insects create circular white patches that can merge if there are enough of the pests. With time, the damage to the under surface of the leaf can be seen through the leaf from the upper surface. Thrips must be dealt with using contact and systemic insecticides. Unfortunately, the undersides of leaves are difficult to check and by the time one is aware of the problem the invasion of these insects will be well underway. Thrips are attracted to the color blue and one can sometimes get blue cards coated with a sticky substance that can capture these insects. The cards need to be hung among the plants. It is easy to inspect the card for the presence

of the black specks signifying trapped insects. One needs to catch the infestation as soon as possible to avoid the unsightly damage that thrips can produce.

Aphids are small sap-sucking insects that are also carried about by ants, but the adults do have wings and a single female can infest an entire bench of plants. Normally one does not get aphids on the adult leaves, but they will suck sap from the leaves of young seedlings. On adult plants, they are usually on the petals and sepals and can cause distortions of the blossom. Aphid damage on seedling leaves usually manifests itself as a small circular yellow spot if there is a single aphid or achlorotic blotches if there are heavier infestations. By the time one notices the disfigurement considerable damage has been done. Actually, many paphiopedilums have an unusual relationship with aphids. The major pollinators of paphiopedilums are female syrphid flies. The flies feed on aphids and also look for aphid infestations where they will lay eggs. A number of slippers have markings, small warts and spots that mimic aphid infestations. Perhaps the most obvious of these are the clusters of warts seen on the petals of *Paphiopedilum viniferum* and the spots of *P. sukhakulii*. The umbo (small protuberance) in the middle of the staminode of *P. insigne* and its relatives is also thought to be an aphid mimic. Despite this, one does not want aphid infestations because they spoil and distort the flowers. Once again, routine inspection is the key and they are easy to control with a mild insecticide.

There are few other insect pests on slipper orchids. Luckily we do not appear to have scale on slippers in North America although I have seen it on paphiopedilums in Australia. Slugs and snails can cause damage to flower buds but there are good molluskicides available and they need to be applied if slime trails are noticed. Mice can also cause damage to flowers by tearing holes in them. Mice also seem to like eating pollen. Special cookies containing poisons can take care of that problem.

The reader will notice that I have not recommended any specific insecticides by brand name. Types of permissible insecticides vary from area to area. It is best to contact your local agriculture department or nursery and ask them for recommendations. If you have a large collection, you might want to contract with a competent and professional pesticide applicator who will routinely spray your collection three or four times a year. Many growers incorporate Enstar® II, an insect growth regulator, with their insecticides. This is a non-toxic juvenile hormone analog that causes the insects to moult prematurely and die. Remember that with any insecticide that you use, you need to pay careful attention to the printed instructions on the labels. Not all phytochemicals will agree with your plants and some can damage them. Oil based chemicals can burn the leaves, especially those of the *Brachypetalum* group. Spraying some insecticides during hot weather may damage developing flower buds.

Diseases

The most difficult problems with which one has to deal are those caused by bacteria and fungi. Controlling these problems is usually a matter of hygiene. Vigilance is the key. It is easier to deal with a problem at its outset than after it has become established in your collection.

Leaf tip die-back: This is the easiest problem to analyse and deal with. It starts with the tip of the leaf turning a dark black-brown if it is a paphiopedilum or a translucent, watery brown if it is a phragmipedium. The leaf die-back progresses from the leaf tip down to the base. Normally when a leaf dies, it turns yellow first and then becomes brown. With leaf tip die-back, the leaf goes from green directly to brown. This is usually a response to over fertilizing or salt build-up. Individual plants will vary in their sensitivity to dissolved salts and fertilizers and some plants are more susceptible than others. *Phragmipedium schlimii* is very sensitive to even moderate salt concentration. Another sensitive plant is *P. bellatulum*. If only one leaf has the problem then that should be removed by tearing it away at the base. If many leaves have symptoms, the tips can be cut off some distance behind the dead area, but once a leaf starts to die back it can be difficult to reverse the trend. Good quality water with no or very low dissolved salt concentrations (20 ppm) should be used for plants that have these problems and fertilizer concentrations should be reduced in strength and frequency of application. There are some disease organisms that can cause leaf tip die-back as well. The fungus *Glomerella cingulata* is one of these. Fortunately, this is not a very serious problem and is more unsightly than anything else.

The rots: There are a number of diseases caused by different organisms which all produce similar symptoms, and the causal agents are difficult to determine unless one is a trained pathologist. The details of the kinds of rots can also vary depending on the position of the infection on the plant and the individual plant as well. Good air movement and scrupulous hygiene will go a long way towards avoiding outbreaks of these nasty diseases.

a. **Soft rot**: This is a pernicious problem where a patch of leaf becomes a glassy brown that then proceeds to spread both towards the base and the tip of the leaf. If left on the plant, the brown region spreads to infect other leaves and growths of the plant. This is caused by a bacterium *Pseudomonas cypripedii*, and the rot is usually noticed on the upper surface of the leaf or at the very base of the leaf. The way of dealing with the problem is to remove the entire leaf being careful not to touch the infected area and do not let the infected area touch other leaves of the same or nearby plants. If the spot is near the tip of the leaf that part can be cut off with a clean razor blade, once again being careful not to touch the actual spot itself or bring that into contact with another

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Crown rot is caused by one of several bacteria. It is highly infectious–spread by splashing water or handling the rotted areas before touching a clean plant. Infected plants should be destroyed, there is no cure.

part of the plant. If several leaves on a growth are infected then you need to remove the entire growth. When several growths are infected, the entire pot, plant and all should be removed from the growing area and destroyed. As with other bacterial diseases, good hygiene is the key. You can spread the disease with cutting instruments, physical contact and water splashes. After handing an infected plant, you should scrub your hands with a good bacterial soap before touching another plant. Once again, vigilance is the key and it is very important to deal with the problem as soon as it is noticed. There seem to be no antibacterial agents for treating this disease in paphiopedilums.

Soft rot in phragmipediums does respond to powdered cinnamon. Fresh confectioner's powdered cinnamon liberally sprinkled onto small soft rot spots does seem to dry them out and stop the rot as long as it is caught early enough. Cinnamon does not work in the same way on paphiopedilums but see later in this chapter.

b. **Brown-Black rot**: Another bacterium, *Pectobacterium cypripedii* (syn. *Erwinia cypripedii*) produces brown to dark brown or even black spots on the leaves. The spots increase in diameter and, if they get into the crotch of the growth will cause the entire growth to die. This disease is also spread by splashing water and direct contact, and once it becomes established, it is extremely difficult to eradicate. Lance Birk (2004) considers this to be the single "most serious threat to *Paphiopedilum* growers and it is responsible for more losses than any other single disease." Isolate a plant as soon as an infection is discovered, and remove all infected parts and destroy them. After handling these plants, it is important to disinfect your hands. If you cut away infected leaves, use a fresh single edge disposable razor blade for each cut, and properly dispose the used blades. If the infection has spread into the rhizome, a pinkish or beige area will be seen. That means the infection has gotten into the vascular system. Cut away until only clean white tissue is seen. You must use a new blade for each cut. There are a number of different strains of this disease; some cause the rotted portions to be fragrant while others seem to have no fragrance.

Yet another bacterium, *Pseudomonas aeruginosa*, also produces moist brown rots and like the others is difficult to treat. The best thing for all these rots is to maintain scrupulous hygiene, be vigilant and ruthless about cutting away infected leaves and shoots and discard plants that are too far-gone.

Fungal problems: There are a couple of fungal prob-

lems that one will also eventually encounter.

a. **Flower Blight**: These are unsightly light brown spots that can develop on flowers; the fungus *Botrytis cinerea* causes this. The spots occur when the fungi kill a group of cells, which collapse leaving a circular indentation of dead, brownish tissue. The spots develop if night temperatures drop too low and humidity is very high. Getting flowers wet by watering too late in the day often leads to flower blight. It is possible to spray against flower blight but one usually does not notice it until it is too late. Keeping evening temperatures at 65°F (18.3°C), watering in the morning, and having good air circulation minimize or prevent the occurrence of this problem.

b. **Root Fungi**: The most common fungal root infection is called fusarium wilt. *Fusarium oxysporum* attacks the roots of slipper orchids and kills the roots. Without functioning roots, the leaves can live but fusarium may also invade the rhizome and can get into the leaves so that they dehydrate, become thinner, and eventually curl inwards and die. The leaves will also discolor and at this stage there is little hope of saving the plant. Another fungus is *Rhizoctonia solani*, which can also cause leaf wilting, rather like fusarium. The fungus appears as white webbing associated with the roots. It is relatively rare and not as common as fusarium. Other fungi such as *Pythium* and *Phytopthora* infect seedlings and community pots but it would take a trained pathologist to identify them. There are several fungicides on the market that one might try, but these diseases are better treated by prevention than trying to cure them. Many of the fungi succeed because conditions are too wet and soggy.

   One of the results of fungal infestations is loss of all the roots but that does not always result in loss of the plant. Plants can still take up water and nutrients through their leaves. It is necessary to anchor these plants firmly in the pot so they are not battered when watering which will damage newly emerging root tips. One can make "artificial roots" to help anchor the plant. One of the best ways of making these anchors is by tying two twistems together. Twistems are paper-enclosed lengths of wire that are often used in supermarkets to close plastic bags. A length of twistem is tied around the rhizome between two growths or around the base of a single growth making two longish pieces of "root" from the free ends. If these are bent back and forth to make a series of zig-zags, the bark and mix lodged against the anchors will hold the growth quite firmly.

   There are also fungi that attack Douglas fir bark. This is to be expected, but one of these fungi makes small white fruiting bodies about the size of a pinhead. The fruiting bodies can become very numerous and, in extreme cases, the surface of the pot will be peppered with the tiny fungus. Some growers call this "snow mold" but that term is normally used for a variety of different fungal infections in lawns. The mold accelerates breakdown of the bark and seems to cause the demise of the plant as well. Snow mold can spread from pot to pot. No one knows for sure if the snow mold is a direct pathogen or not. The fungus might be releasing a toxin. Plants in pots with snow mold need to be repotted right away. The roots should be washed and all traces of the mold removed. This usually takes care of the problem.

Viruses: Slipper orchids seem relatively resistant to virus diseases and although they do get them, they rarely show any symptoms. Both CMV (cymbidium mosaic virus) and ORSV (odontoglossum ring spot virus) have been found in paphiopedilums. Usually the virus is present in older cultivars that have been around for nearly a century and have been divided many times and shared with friends. Some acquaintances that had a good collection of antique slippers were dismayed to find that nearly all their plants were infected. On the whole, however, viruses are relatively benign in slippers and do not cause the kinds of color break and flower deterioration problems one often encounters in other types of orchids.

Cinnamon, a Helpful Hint

Cinnamon is the spice made by grinding up the bark of the cinnamon tree. Some time ago phragmipedium growers found that fresh powdered cinnamon was useful in drying out some of the soft rots found on the leaves of those plants. The powder was also found to be useful in dealing with some of the infections encountered with phalaenopsis. It made sense to try cinnamon on various paphiopedilum rots also. Sometimes it helped, but at other times it did not. What I did notice was that following an application of cinnamon dust in the crotch of the leaves that the leaves seemed to put on a growth spurt. Then I tried regular applications of cinnamon to the growing areas in the crowns of plants that were slow growers or just did not seem to be doing much of anything, and in nearly every case I got growth. Usually the day after dusting quite heavily with cinnamon, I water the plants and the cinnamon forms a crust. One can monitor the growth of new leaves by observing the crust moving away from the center of the crown as the leaves elongate. I now use cinnamon as a routine "tonic" for plants that appear to be growing poorly and have a number of plants that are growing robustly when I had previously despaired of saving them. I use fresh cinnamon and keep it tightly stopped and in the freezer when it is not needed. I also tend to buy it in small bottles so that it gets renewed fairly often. Visitors to the greenhouse are often puzzled by the bakery smells coming out of the house until I explain what it is all about.✾