PHRAGMIPEDIUMS: WHAT CAN MOTHER NATURE TEACH US?

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**T**<sup>F</sup> WE CANNOT GROW our plants, taxonomic knowledge does little more than take up space in our heads and on our bookshelves. Correctly identifying species is essential for many reasons. It did not take long to realize that much of the cultural advice common in the phragmipedium community did not work for me. When I started visiting *Phragmipedium* habitats in the 1990s, I started noticing inconsistencies with what I was hearing and seeing at orchid shows, monthly society meetings, and from commercial vendors.

At the outset, we can dismiss some commonly held misconceptions about phragmipedium culture. No *Phragmipedium* species grows in standing water in a natural population, not one. There are no consistent light-level requirements across the genus. Temperatures vary and attempting to grow warm-growers next to cooler-growers will leave you with one choice: which plants do you want to kill. While most *Phragmipedium* species like high humidity, several species are partially xerophytic (adapted for growth in dry conditions) and are susceptible to overwatering.

Natural populations teach that it is a mistake to confuse one species' cultural requirements with others. There is no "one size fits all" culture for phragmipediums; this is our first mistake. Articles and chapters in books professing expertise in the standardized culture of phragmipediums are ill-informed and not consistent with the information that natural populations give us. What we need to do is to pay attention. Each species of *Phragmipedium* should be grown according to its own specific needs. The second mistake we make is that many of us grow our phragmipediums with our paphiopedilums and must water, fertilize, and care for both genera side by side.

So how do we grow phragmipediums? What Mother Nature teaches us is unique, challenging, and reward-ing.

The first step is to understand where phragmipediums grow in situ. There are primary and secondary habitats. Primary habitats are those locations such as along rivers and cliffs where, in the total absence of the influence of man, phragmipediums grow in ecosystems to which they have adapted over the millennia. Secondary habitats are areas where humans have had influence, such as roadsides and open agricultural areas, that mimic primary habitats. Each species will have its own set of unique circumstances that we need to understand. These circumstances are the first clue to understanding culture.

What is presented here is not a checklist of how we grow our plants, nor is it intended to be. What is presented here are the main cultural lessons and principles that natural populations define for each species, with the intent that each grower will adjust these principles to his or her growing conditions. A greenhouse grower in the southwestern United States will need to make different adjustments to those of a grower growing under lights in Canada. The quality of your plants and blooms will reflect modifications of your growing conditions, potting material, watering habits, and pot choice.

We start by grouping the culture requirements for the genus into a few broad categories to use as a guide. Here are four main groups and the species that are included.

#### Group One: Warm-growing and terrestrial

Phrag. caudatum Phrag. guianense Phrag. humboldtii Phrag. lindenii Phrag. lindleyanum Phrag. warscewiczianum

#### Group Two: Warm-growing, terrestrial, and wet

Phrag. longifolium Phrag. schlimii Phrag. vittatum

#### Group Three: Warm-growing, lithophytic, and humid

Phrag. boissierianum Phrag. cabrejosii Phrag. caricinum Phrag. hirtzii Phrag. klotzschianum Phrag. pearcei Phrag. richteri

#### Group Four: Cool-growing and wet

Phrag. besseae Phrag. kovachii

Although the cultural differences between species are numerous, the similarities are critical. All species, regardless of light, temperature, fertilizer, growing media, or potting requirements, will require good airflow across the roots. High humidity at the roots is another requirement. I want to differentiate between humidity at the roots and humidity around the plants. They are not meant to be the same. All species, regardless of light, temperature, fertilizer, growing medium, or potting requirements, will require good airflow across the roots and high humidity inside the pot. Good airflow will solve many problems that impact phragmipediums, such as soft rots, fungus infections, and dead roots.

I have done the "match test" a few times near the crowns of a few species in natural habitats, specifically those of besseae, longifolium, hirtzii, pearcei, and kovachii (nothing in a dry environment). This test will help you visually measure air movement without the need for scientific equipment. The match test is simple: light a match, gently blow out the flame and hold the match still. You will see a small stream of smoke coming up from the match. In natural habitats, the stream of smoke drifts noticeably from side to side and quickly disappears in the air movement. A straight line of smoke tells you that the air around the crown of your plant is not moving, or is moving too slowly to be beneficial to your phragmipedium. You want to see the smoke being dispersed and carried away by the moving air. Running water, even on a small scale, moves the air along with it.

Phragmipediums like to be fed with a weak fertilizer at every watering, with an occasional clean-water rinse across the roots. The natural world is continuously providing phragmipediums with small amounts of nutrients from the surrounding jungle and rivers, nothing accumulates. There are no constant or strong doses of nutrients feeding phragmipediums in nature. Moving water or rapidly drying conditions remove any solids that accumulate at the roots. Using reverse osmosis is strongly recommended but not necessary if your water has low dissolved solids. Clean water is critical. Remember, phragmipediums do not have kidneys to flush out the solids from dirty water or over-fertilizing. Given the moisture requirements and frequency that some of us need to water our phragmipediums, 10%–20% fertilizer is enough. Once you better understand the quality of your water, you can choose a fertilizer that provides your plants with the needed nutrients while avoiding the things that they do not need.

Phragmipediums are not paphiopedilums and do not grow on limestone or limestone hills. They prefer granite and other hard rocks, and the materials that accumulate around their roots drain well. Granite, a hard stone, does not leach minerals into the environment as quickly as limestone. It anchors plants and provides long-term physical stability. Plants growing terrestrially are found in soils that are sandy and porous.

The temperature requirements for each species, or culture group, need to be considered. Trying to cultivate *Phrag. hirtzii* in a cool environment with your *Phrag. besseae* will give you a choice: which one do you want to kill. Phragmipediums can withstand a range of temperatures; they are not picky, as long as you keep the cool-growers and the warm-growers in their respective comfort zones. To increase your plant health and flower quality, assess night and day temperatures, airconditioning, the type of heat, and sunlight levels that affect the temperature at different times of the year.

The right mix and pot will solve a lot of problems and make growing your phragmipediums easier. We use Orchiata bark and add rocks or perlite depending on the species. The plants are watered often enough, so the mix is always moist, the humidity in the pots is high, with the air always flowing across the roots. This combination prevents retained solids at the roots.

I have seen collections where the owners grow phrags beside paphs. The genera are grown identically: watered on the same schedule and fertilized with the same fertilizer and the same amount. To compensate for the increased moisture requirements of their phrags, the owners put the phrags in compressed sphagnum moss or standing water. However, phrags are not paphs, neither biologically, ecologically, nor taxonomically, and need to be grown and treated as distinct from paphs.

We have developed a modified hydroponic pot system that works well for several species, but not all. While we use clay pots for most of our phragmipediums, we have had success using modified plastic pots for Phrag. hirtzii, Phrag. vittatum and Phrag. kovachii without the need for substantial investments in flood tables and special watering hoses. We start with plastic pots without holes in the bottom. We cut holes in the sides of the pot about one inch from the bottom and fill the bottom of the pot with small rocks until the holes are completely covered. We do not use pebbles or aquarium gravel because it is too small, and it falls out of the side holes. On top of the layer of rocks, we place the mix. The mix stays above the waterline. We water the sides of the pot, watering the roots and never drench the plants from above. If you water from above, it runs off the leaves and does not make it into the pot. Leaves do not need to be watered; the roots do. We water until the excess overflows from the holes. As the water evaporates, it pulls air in from the side holes and pushes the humid air up through your potting material and out the top of the pot. Water again when the mix starts to dry out.

A typical orchid pot placed in standing water has no airflow and no oxygen at the roots because the holes are on the bottom; this suffocates your plants. Compressed moss and rapidly decomposing bark also cut off all airflow inside the pot and to the roots. Having any part of your mix in standing water will cause it to decompose faster, further cutting off the air the roots need. Using clay pots, we frequently water several times a week. Remember what I said, we are growing our phragmipediums as phrags and not paphs, which need much less water, more fertilizer, and drier conditions at the roots. We check the mix and water again when it starts to dry out. What these approaches accomplish is simple. We are continually moving the air in and out of the pot. Every time you water, you move air through the pot and across the roots. We keep the humidity high inside the pots and we keep our roots breathing. That is the key.

Light requirements vary depending on the species. Some species can thrive in a wide range of light levels. I have encountered phragmipediums growing in dense shade and others growing exposed to intense light throughout the day. Blanket statements about light levels for phragmipediums are misleading and can be deadly to your plants. Putting some species in *Cattleya* levels of light will kill them quickly, while for others, low light levels are a recipe for rot and eventual death. Know your species and pay attention to the natural habitat conditions.

## **GROUP ONE SPECIES**

Let us start with the Group One species: *Phrag. caudatum, Phrag. guianense. Phrag. humboldtii, Phrag. lindenii, Phrag. lindleyanum,* and *Phrag. warscewiczianum.* These species are warm-growers and terrestrial.

I would like to start by asking the reader to be careful about how you define terrestrial for your culture. These species do not grow in what we think of as typical soil or potting mix from Home Depot or Lowes.

## Phragmipedium caudatum

*Phragmipedium caudatum* is one of the most spectacular and beautiful orchid species in any genus, and one of the most spectacular species of slipper orchids. *Paphiopedilum sanderianum* gets all the attention, however the flowers of *Phrag. caudatum* are larger, and its petals are just as long. The flower of *Phrag. caudatum* is green, yellow, and brown with a spectacular dorsal and synsepal framing the flower. There are three to four flowers on a spike, with some plants having multiple spikes. The flowers stand out and impress anyone lucky enough to see a plant in full bloom! *Phragmipedium caudatum* is faster growing than *Paph. sanderianum* and can form a specimen-sized plant in about five years with good culture. Understanding how to grow *Phrag. caudatum* successfully rewards one with years of spectacular blooms.

*Phragmipedium caudatum* grows terrestrially in decomposing organic material and occasionally epiphytically on trees. I saw a few enormous plants growing in an open pasture used for grazing; I am sure the cows enjoyed the seasoning. There have been reports of this species growing lithophytically, but I have not observed this.

Most plants are found in warm-growing areas between 1,000 to 1,700 meters (3,281 to 5,577 feet); however, there are reports of plants as high as 2,000 meters (6,562 feet) near Cusco in southern Peru. Observed populations receive moderate to intense light with only surrounding low-lying grasses and other vegetation providing some relief. One location has plants growing in accumulated pockets of loam along an almost vertical cliff surface in full sun. No populations have been observed in deep shade under dense canopy. The light requirements found *in situ* must be duplicated to grow a healthy plant, so do not be shy about giving your *Phrag. caudatum* enough light.

*Phragmipedium caudatum* is a large plant that needs space. In the habitat, leaves have been observed to reach 80 cm (31 inches). However, the vegetative characteristics vary. Plants on vertical surfaces in full sun tend to have thinner and shorter leaves, while the leaves on plants on roadside embankments tend to grow more



Phrag. caudatum growing terrestrially in Peru.

erect, stiff, and upright.

The loam, where Phrag. caudatum grows, retains moisture well, and dry conditions are rare. Plants found on trees have a pocket of loam around the base of the plant, making the immediate environment identical to the plants found in terrestrial locations. The loam is almost always moist but not wet. Humidity in the habitat is high, having been registered at 74% and 78% at two locations in Peru. I have heard that all the long-petaled phragmipediums like to be grown dry like we grow paphiopedilums; however, the natural populations teach us otherwise. We mimic the habitat conditions by growing Phrag. caudatum in clay pots in seedling Orchiata bark mixed with a small amount of small-sized perlite. We water to keep the mix moist. We fertilize at ten to twenty percent with each watering. This species can tolerate higher levels of nitrogen because this is the case in the habitat.

# Phragmipedium humboldtii

*Phragmipedium humboldtii* can be found growing on dead and living trees, and terrestrially in poor, rocky soil mixed with clay. Plants growing on living trees have pockets of loam and are found high in the canopy where there is brighter light and more air movement. Deadwood retains moisture, and the plants send their roots deep into the rocky soil that keeps the conditions



Phrag. humboldtii growing on a dead tree.

at the roots moist and allows for excellent drainage. Terrestrial locations have been seen to be a fast-draining, rocky clay mixed with decomposing organic material. No plants have been observed in standing water or growing lithophytically.

*Phragmipedium humboldtii* can be found in both primary forest locations and on roadsides where it cohabits with *Phrag. longifolium*.

*Phragmipedium humboldtii* is a warm grower, found between 1,500 to 1,800 meters (4,921 to 5,906 feet). As with all phragmipediums, cooler night temperatures result in deeper color. Night temperatures recorded at one secondary roadside habitat registered 11.5°C (53°F). These plants exhibited very dark coloration on the pouch.

*Phragmipedium humboldtii* likes open areas where plants receive ample airflow. Light levels can vary from intermediate to direct sunlight. We fertilize *Phrag*. *humboldtii* at ten to twenty percent, but this species can probably tolerate higher levels of fertilizer.

# Phragmipedium lindenii

*Phragmipedium lindenii* is another oddity for the genus. *Phragmipedium lindenii* grows in bright, dry conditions for extended periods. *Phragmipedium lindenii* straddles the Equator, and it can be found in equal numbers from central Ecuador, north, through Colombia. *Phragmipedium lindenii* is unique in the genus in that it is only found on the slopes of volcanoes growing terrestrially in volcanic soil. After these volcanoes stop belching fire, death, and destruction, lava rock breaks down until it becomes sand, and this volcanic sand combines with volcanic ash that holds moisture to form volcanic soil.

Andosols, the scientific name for the volcanic soil, have a high organic matter content and extraordinary physical properties. It is open and porous yet has a high-water retention capacity that explains how *Phrag. lindenii* can survive in arid climates. Roots from nearby grasses and small shrubs crisscross under the plants, providing for additional drainage and moisture retention. Plants in natural habitats are partially xerophytic with leaves that are erect, stiff, thick, and reflect the dry conditions that persist between rainfalls.

I have visited the habitat in almost every month, and I have never seen wet andosols. I have dug down, and after the top two or three inches, you start to feel very moist conditions, and the plant roots do extend into this layer; however, the top inch is almost always dry. There is no reservoir of water deeper down; these are the slopes of volcanoes. *Phragmipedium lindenii*, regardless of how much rainfall the plants receive, will quickly dry out until only a layer of moist volcanic soil remains several inches below the surface. The volcano slopes, where *Phrag. lindenii* grow, are covered with grassland and mixed savannah. Grasses and low-lying shrubs are the only protection from the sun, and it is not uncommon to find plants growing in direct sunlight.



*Phrag. lindenii* in typical habitat of bright, direct sun in a very dry environment.

*Phragmipedium lindenii* is best grown in clay pots with a quick-draining and humidity-retaining medium. We use Orchiata bark that retains moisture well. We water several times a week, allowing the surface of the bark to become dry between watering. Avoid cattleya light levels, but do grow this species in bright light conditions. This species likes moisture at the roots but not on the leaves. Keep it away from wet places in your greenhouse, especially under a hanging basket or mounted plants where there will be runoff.

We feed *Phrag. lindenii* with a ten to twenty percent solution of fertilizer with each watering; however, due to the high nutrient levels of volcanic soil, especially the sulfur content, this species can probably tolerate higher fertilizer levels.

*Phragmipedium lindenii* flowers in February and March and out of season flowers are rare. It self-pollinates, an oddity of this beautiful species.

# Phragmipedium lindleyanum

*Phragmipedium lindleyanum* is a bit of an oddity as it relates to the other species. Ninety-five percent of all populations are north of the Equator. This species is quite common throughout Venezuela, Guyana, Suriname, and French Guiana in the northeast of the continent. However, a single area in Pernambuco State, Brazil is at the easternmost tip of the continent and



*Phrag. lindleyanum,* sharing a root ball with a catasetum, attesting to the xerophytic cultural conditions of this species

south of the Equator has several populations. The location in Brazil is at the easternmost tip of the continent, about 2,500 km (1,553 miles) southeast of the closest population of *Phrag. lindleyanum* in French Guiana and about 1,800 km (1,118 miles) to the northeast of the closest population of *Phrag. vittatum* near the capital of Brasilia. This location, being south of the Equator, makes *Phrag. lindleyanum* one of only three species that crosses the Equator in the primary habitat range. The habitats south of the equator in Pernambuco are the exception rather than the rule. Plants from this location are not different from the populations further north.

*Phragmipedium lindleyanum* is also an oddity because the plants are partially xerophytic, an oddity in this genus. It persists in conditions unheard of for phragmipediums, conditions that turn our preconceived ideas of *Phragmipedium* culture, as the concept of one-sizefits-all culture conditions across the genus, on its head. *Phragmipedium lindleyanum* can be found growing in moderate to bright light, with some plants growing in the tropical sunlight. Plants grow on granite outcrops and immense granite boulders in shallow mats of accumulated leaf litter and organic materials. The plants grow atop large rocks near streams, in shallow mats of accumulated leaf litter and organic material. Plants have been encountered at the edge of tree lines atop the granite outcrops but never under the canopy.

It has been reported that *Phrag. lindleyanum* was found in the splash zone of waterfalls, specifically Kaieteur Falls in the Potaro-Siparuni region of Guyana. Although it grows close to the falls, the plants are found in similar conditions to the other habitats throughout the range. The splash from the falls only impacts part of the populations closest to the falls, and the water does not pass over the roots continuously, but it does raise the humidity. The presence of this population near the falls does not change the broader dynamic of the cultural conditions. Rocks near streams or in rivers still depend on rainfall to wet the organic mats, and rainfall is scarce during the dry season.



The terrestrial mat in which Phrag. lindleyanum grows.

The habitats are exposed to substantial rain and subject to drying out for long periods. The organic mats remain moist for perhaps a few days. Water quickly wets and runs off the granite immediately, keeping the plants wet only for a short time. The plants then persist in dry, bright, and warm conditions until the next rain.

*Phragmipedium lindleyanum* grows best in bright light conditions and when allowed to dry out between watering. An open medium that drains exceptionally well is critical. The mix should dry out in a day, or place your plants in a basket. Water a few times a week at most. Do not let it sit in water. Daytime temperatures in situ have been recorded at 31°C (88°F), with a relatively low humidity of 56%. *Phragmipedium lindleyanum* occurs between 700 to 2,200 meters (2,297 to 7,218 feet). However, despite the high elevation, *Phrag. lindleyanum* is not a cool-grower.

# Phragmipedium warscewiczianum

*Phragmipedium warscewiczianum* can be found growing mainly in moist terrestrial loam and rarely epiphytically or lithophytically; however, if growing lithophytically, the plants that are found on rocks are growing in accumulated organic material and not anchored to the underlying granite.

*Phragmipedium warscewiczianum* and *Phrag. caudatum* are very close in habitat growing conditions. The main differences are altitude and temperature. Although reported from 800 to 1,700 meters (2,625 to 5,577 feet) range, the primary and secondary locations, where I have encountered *caudatum*, have ranged from 1,200 to 1,800 meters (3,937 to 5,906 feet). It is not clear to me if the reports of habitat as low as 800 meters persist based on old herbarium reports or because, at one time, *Phrag. warscewiczianum*, *Phrag. caudatum*, and *Phrag. humboldtii* were lumped into one species.

I have observed a few plants of this species growing in blast holes in the granite on the side of the road, putting *Phrag. warscewiczianum* in primary and secondary habitats.



*Phrag. warszewiczianum* flowering on a roadside in southern Ecuador.

As reported in some recent literature, the natural range of this species needs to be reevaluated and verified. None of the northern herbarium data is currently supported by known natural populations. Plants are rare and widespread in southern Ecuador and northern Peru; this appears to be where the species is centered.

*Phragmipedium warscewiczianum* is very popular in the orchid trade in Colombia. It can be easily grown in pots on terraces and yards throughout that country because of their climate. There are reliable reports of truckloads of *Phrag. warscewiczianum* wiping out Central Ecuadorian populations. However, the plant can still be found far from the Colombian border in southern Ecuador and northern Peru, where I have encountered enormous plants at several primary and secondary locations.

In several secondary habitats, plants share roadsides with *Phrag. boissierianum* and *Phrag. besseae*. Several flowering plants have been encountered growing in one primary population of *Phrag. kovachii* making three species with which *Phrag. warscewiczianum* is known to cohabitate.

*Phragmipedium warscewiczianum* can be found growing terrestrially in decomposing organic material and sandy loam and, occasionally, epiphytically on trees. Terrestrial locations are fast-draining, sandy, silty loam mixed with decomposing organic material, and sometimes mud. No plants have been seen in standing water, and the soil cannot be compressed when held in your hand and squeezed; it quickly crumbles. Plants observed on cliff surfaces on roadsides grow in a terrestrial basin of the same terrestrial loam and accumulating rotting leaves. Because *Phragmipedium warscewiczianum* does not anchor itself to the underlying stone when growing vertically, it is not a true lithophyte.

The cultural requirements for *Phrag. warscewiczianum* are close to *Phrag. caudatum,* and from my perspective, culturally indistinguishable. It is not a cool grower. The temperature during the day is 25°C (78°F) and night temperatures 17°C (63°F). Based on the primary and secondary populations examined, it likes open areas where plants receive bright, yet diffuse light. No plants have been encountered in deep shade, low light conditions, or under dense canopy.

The soil that *Phrag. warscewiczianum* favors retains moisture, and the humidity around the plants is high. Dry conditions are rare as the loam retains moisture well between rainfalls, and this helps to keep the humidity immediately around the plant high. Our humidity gauge placed at ground level near the crown of one plant registered 82%.

Plants observed on trees accumulate their pocket of soil around the base of the plant, making the immediate environment identical to that of the plants that grow terrestrially. There is little runoff with the soil holding the moisture. We grow our plants in clay pots with seedling Orchiata mix and small-sized perlite. We fertilize at ten to twenty percent, but this species can probably tolerate higher levels of fertilizer.



*Phrag. longifolium* habitat with runoff over the roots that are not attached to the granite.

### **GROUP TWO SPECIES**

Group Two species include *Phrag. longifolium, Phrag. schlimii,* and *Phrag. vittatum.* These species are warm growers. Night temperatures should not fall below 13°C (55°F) for any period and, ideally, not below 15°C (60°F). I have hiked and ridden horses to and from some of the habitats. I have never, either at night or in the morning, found a temperature reading below 58°F. Day time temperatures routinely have a range from 26°C–30°C (80°F–85°F) and occasionally higher. Persistent cool temperatures should be avoided.

The terrestrial component of these species is an airy, sandy, grainy mud full of accumulated decomposing organic material and small roots from surrounding grasses. The layer of "mud" is typically fed by a water source, either seepage or runoff. Dry conditions should be avoided. As with all species in the genus, not one can be found growing in standing water. Water is always moving across the roots and through the mud.

# Phragmipedium longifolium

*Phragmipedium longifolium* is perhaps one of the most variable species of *Phragmipedium*. Both primary and secondary habitats have warm temperatures, and they are most often found along almost vertical cliff surfaces with constant runoff and seepage. The cliffs

vary in height; one roadside population of close to a thousand plants was seen on a vertical surface no more than 3 meters (10 feet) high. However, there are exceptions, and I have seen a few plants growing terrestrially in open pasture and the forest floor. This speaks to the adaptability and weedy nature of this species.

The broad range of this species stretches from Guatemala south along the Andes and into northern Ecuador. All known populations are north of the equator. Given the weedy and invasive nature of this species, this is telling.

A thin, no more than a few inches deep layer of organic material and mud accumulates along the surface, and this layer is the home of *Phrag. longifolium* roots. The roots do not go past this layer. They do not anchor to the underlying granite, nor do they seek out crevices or embed themselves in the cracks in the rocks. The organic material, roots, and mosses create a sturdy mat to support even large plants and keep them from falling to the ground.

There is a layer of water and air constantly moving under and above the roots. Regardless of where I have seen *Phrag. longifolium*, runoff and seepage have been constant. *Phragmipedium longifolium* is common and readily populates roadsides and other areas disturbed by humans, as long as there are continuous seepage and runoff.

*Phragmipedium longifolium* is a warm grower. Day temperatures have been recorded as high as 31°C (88°F) and night and early morning temperatures 17°C (63°F). The immediate environment around plants of *Phrag. longifolium* is so wet and humid that it is common to see plants with leaves covered in moss. The humidity has been recorded at 85% around the plants at two locations in northern Ecuador. Maintain your humidity as high as possible using an open, well-draining potting mix. We use clay pots with Orchiata bark and water every other day.

*Phragmipedium longifolium* can be found in natural populations growing in bright light and low light under the jungle's dense canopy. Natural plants with an overall leaf span over two meters have been seen growing a few meters from plants not bigger than thirty centimeters. You can grow this species under almost any light level.

Plant spikes can be as long as two meters (7 feet) and as short as 20 to 30 cm (10 to 12 inches), but no matter the size of the plant, the flowers are always the same size. *Phragmipedium longifolium* does not have a distinct flowering season and can bloom year-round.

# Phragmipedium schlimii

*Phragmipedium schlimii* is a weedy and opportunistic species found in large numbers in both primary and secondary habitats. Its habitat extends from the Colombian border with Venezuela in the north to the Colombian border with Ecuador in the south. It can be found on both sides of both the eastern and western cordillera



Phrag. schlimii habitat.

throughout Colombia. No natural populations have been encountered south of the equator.

*Phragmipedium schlimii* likes wet cliffs by rivers, small streams, roadsides, and other areas created by humans that mimic the wet cliff surfaces it prefers. Runoff is frequent but not constant. During interruptions in the runoff from the surrounding jungle, the roots subsist in wet mud and organic material that accumulates along the cliff surfaces and cracks.

*Phragmipedium schlimii* can be found in a wide range of light levels, from low light under overhangs and surrounding vegetation to more exposed positions with brighter light. Vegetative characteristics naturally vary depending on these cultural differences.

*Phragmipedium schlimii* grows in a warm, humid habitat with no populations found in cool-growing conditions. Plants send their roots into cracks and seepages and grow in a semi-terrestrial state despite the almost vertical cliff surfaces it prefers. The presence of rhizomes appears cultural, as the plants with longer rhizomes were seen trying to escape ever-thickening mats of moss and other small vegetation on an almost vertical cliff surface. *Phragmipedium schlimii* does not grow in rivers or below the high-water mark, even though it is close to the water in its primary habitats.

We use a mixture of seedling bark, perlite, and small

rocks for our mix and pots that allow for air movement across the roots. *Phragmipedium schlimii* will grow in almost any light level, but direct sunlight is not advised. Plants must be kept warm, with night temperatures not routinely less than 15°C (60°F). I have walked or ridden on horseback to the primary habitats, and the temperatures have always been quite warm. Fertilizer strength should be at ten to fifteen percent at each watering.

### Phragmipedium vittatum

*Phragmipedium vittatum* is an oddity for the genus because of the contrast in culture needs between the roots and the vegetative parts. This striking difference makes it a difficult species to grow and challenging, even for experienced growers.

*Phragmipedium vittatum* calls peat bogs on the Brazilian central plateau and the high mountains northwest and northeast of Rio de Janeiro home. All known populations are south of the equator.

The bogs that *Phrag. vittatum* inhabit are semi-terrestrial. There is soil present, but the roots from the surrounding grasses and other decaying organic material form a sort of wet sponge that is open and porous. Water from underground springs continuously moves through this medium. Plants do not live in standing water. The amount of water running through the bogs



Phrag. vittatum in open habitat exposed to high light levels.

is reduced during the dry season, but it is omnipresent at deeper levels. Not a single plant can be found one meter to the left or right of the water flow through these bogs.

*Phragmipedium vittatum* has a distinct growth and flowering season. Light levels are intense, so the species can tolerate cattleya light levels. A few species of *Cattleya*, as well as *Catasetum*, and *Encyclia* are found growing lithophytically nearby populations of *Phrag. vittatum*. Plants can be found in open areas and receive light from horizon to horizon. The small amount of shade these plants receive is from the surrounding grasses and low-lying vegetation. I have found day temperatures of 28°C (82°F) at elevations of 1,500 meters (4,921 feet), and the humidity to be 55%. These numbers are consistent across the several populations I have visited.

The vegetative parts, the leaves, and flower spikes grow out of the ever-wet peat into an environment that could not possibly be in greater contrast to what is at the root level. The challenge in growing this species is that the roots must be kept constantly moist, but not in standing water, while the vegetative organs are kept in bright, dry conditions. The plants receive little if any rainfall from April through August. Watering plants from April to September in a humid greenhouse is a sure formula for rot, and the plants will not survive.

Successful cultivation of Phrag. vittatum is possible

using special pots! We solve this challenge with modified hydroponic pots. The pots should have no holes on the bottom but about one inch from the bottom. Fill the bottom one inch with small rocks, and add an open, well-draining mix. As the water in the bottom one inch of the pot evaporates, it brings air in through the holes in the side of the pot, and moist air through the mix, across the roots, and out the top of the pot, simulating the conditions in the peat bogs. We use medium Orchiata bark mixed with large perlite. The crown of this species forms a small bowl, not unlike a bromeliad, and water will sit in the crown and quickly rot if the leaves are over-watered from a misting system or greenhouse hose.

Do not over-water when the plants are not growing, from April through August. During this time, we allow the mix to dry out between watering. *Phragmipedium vittatum* does well with reverse-osmosis water and a weak fertilizer; we use a fertilizer at ten to fifteen percent with each watering. We have been successful in growing *Phrag. vittatum* this way.

### **GROUP THREE SPECIES**

Group Three species include *Phrag. boissierianum*, *Phrag. cabrejosii, Phrag. caricinum, Phrag. hirtzii, Phrag. klotzschianum,* and *Phrag. pearcei.* These species grow in warm, humid habitats. They are lithophytes, and their roots are exposed and securely anchor the plants to the underlying stone. Rainfall quickly passes over and off the roots. Except for *Phrag. boissierianum*, these species are found below the high-water mark on rocks and boulders in rivers and are subject to periodic submersion by seasonal floodwaters.

### Phragmipedium boissierianum

*Phragmipedium boissierianum* is by far the weediest and most prolific species of *Phragmipedium*. Notwithstanding its virile nature, due in part to its obligatory self-pollinating flowers, *Phrag. boissierianum* cannot be found in any natural population north of the equator and is limited to central Ecuador south into northern Peru. It can be found in abundance in secondary locations, where it has been seen to cohabitate with *Phrag. pearcei* and *Phrag. besseae*.

*Phragmipedium boissierianum,* throughout its range, occurs naturally in the jungles and slopes around the rivers in which *Phrag. pearcei* can be found. Light levels in situ vary considerably, with plants being encountered under the dense canopy, as well as exposed to bright sunlight. It is a warm grower. The humidity ranges from 62% to 100% in both primary and secondary locations, depending on the time of year.

*Phragmipedium boissierianum* prefers disturbed areas, whether disturbed by natural forces or humans. Plants readily populate exposed areas after a landslide and continue to grow there when the surrounding jungle retakes the area. *Phrag. boissierianum* roots attach to underlying granite and extend across the rock up to two



Phrag. boisserianum

meters (7 feet). The plants are found growing terrestrially in sand or organic material mixed with a considerable amount of sand. The sandy nature of the soil is readily apparent if you ever try to climb one of these areas; it is nearly impossible. No primary or secondary populations have been found or reported on rocks in rivers or streams.

No plants have been found in standing water. Plants have been observed inundated with water and in sea-



Phrag. caricinum in situ, Bolivia.

sonal dry conditions. Runoff is present most of the time and passes underneath the plants and through the sand. Nutrients arrive with the runoff but do not accumulate at the roots. The runoff at certain times of the year can overwhelm the plants.

We have found *Phrag. boissierianum* easily rots, so it is best grown on the dry side. An open and moistureretaining potting mix is the recipe for success. We have found it is important to let the species dry between watering. Given the nature of the habitats, fertilizer should be limited to ten to twenty percent.

Plants have been observed to be in flower all year in copious numbers in the primary and secondary habitats. You will be able to see flowers any time you travel to the primary or secondary habitats!

# Phragmipedium cabrejosii

*Phragmipedium cabrejosii* is a recently described species. When this species was first collected at the site of the type population, it was thought to be *Phrag. pearcei*. The plants were not in flower and were found clinging to rocks in a river below the high-water line. Until more information is known, it is best to grow this species in the same manner as *Phrag. pearcei*.

## Phragmipedium caricinum

*Phragmipedium caricinum* is culturally and ecologically indistinguishable from *Phrag. hirtzii* and *Phrag. pearcei*. *Phragmipedium caricinum* and *Phrag. pearcei* are very closely related; however, taxonomically the three species are easily distinguished,

The plants in the primary habitat of *Phrag. caricinum* are on rocks below the high-water marks in rivers. *Phragmipedium caricinum* is found in Peru and Bolivia, and there are no known secondary habitats. *Phragmipedium caricinum* likes the tops of large boulders and rocks. Life on top of a boulder or attached to a rock below the high-water line provides constant high humidity and continuous airflow. Being below the high-water line means the onrushing water quickly removes any moss, dead leaves, grasses, or other small plants from the rocks. After it rains, plants dry quickly and retain moisture only in the small mat of organic material that clings to the roots. Roots need exposure to the air, humidity, and light. No primary population has been observed in a location fed by runoff or seepage.

*Phragmipedium caricinum* is a warm-grower and exposed to moderate to bright light and high humidity. It is not found in standing water in any habitat. Plants should be in a well-draining, moisture-retaining potting mix. We grow the plants in clay pots with seedling Orchiata Bark. Allow the mix to begin to dry before watering again. Given the exposed nature of the primary habitats and the lack of organic material around the roots, fertilizer should be limited to ten to twenty percent maximum.



Phrag. hirtzii habitat with roots exposed above the water.

# Phragmipedium hirtzii

*Phragmipedium hirtzii* has a unique ecology. All known populations are on boulders in or facing rivers in northern Ecuador and Colombia. There are no known populations south of the Equator. No secondary habitat populations are currently known. Plants have been observed on both sides of rivers; however, facing the moving water is required. Within its range, *Phrag. hirtzii* can be found in several locations in large numbers.

Phragmipedium hirtzii is subject to periodic submersion during periods of heavy rain, and all populations observed are found below the high-water mark. These plants are anchored so solidly to the granite they can withstand days of high-speed, high-pressure water rushing over them, surviving with little more than damaged leaves. Given the periodic submersion, little more than moss accumulates around the roots. The majority of plants have their roots exposed to the light and air. These plants grow in high levels of humidity, bright light, and continually moving air. After it rains, the plants dry quickly. Although not xerophytic, this species does dry out for weeks between rainfalls, and the humidity is the only moisture. High humidity levels, recorded as 88% and 90% at two locations in northern Ecuador, allow these plants to thrive.

Nutrients sporadically arrive as rainwater flows

down into the rivers, and plants are submerged. No population has been observed in a location fed by runoff or seepage. Underlying rocks have been touched and are dry and warm.

*Phrag. hirtzii* is a warm-grower, and we struggle with our plants every winter as the temperature starts to drop in the Northern Hemisphere. It is not a good candidate for a poorly ventilated pot or standing water. The potting mix should be open and drain well, and allow these plants to begin to dry out before watering again. Fertilize at ten to twenty percent maximum.

# Phragmipedium klotzschianum

*Phragmipedium klotzschianum* is culturally close to the three other species that grow on rocks in rivers below the high-water line, *Phrag. hirtzii, Phrag. caricinum,* and *Phrag. pearcei. Phragmipedium klotzschianum* has a more restricted range than the other Group Three species. It is the only one of these species that is found outside the Andes Mountains. *Phragmipedium klotzschianum* is found in Venezuela, Guyana, and Brazil, on the edges of large and small rivers across the Gran Sabana (part of the Guianan savanna ecoregion). *Phragmipedium klotzschianum* is not currently known from secondary locations and is limited in its range to populations north of the equator. The habitat of *Phrag. klotzschianum* overlaps with the range of *Phrag. lindleyanum*.



Phrag. klotzschianum

This species is warm growing, with most populations found between 500 to 1,000 meters (1,640 to 3,281 feet). These plants, almost indistinguishable from *Phrag. pearcei* when not in flower, adhere tenaciously to the rocks along the edges of these waterways, forming dense mats. The roots do not run down the sides of the river rocks and into the water. Because of the plants' exposed positions atop the rocks, there are copious amounts of bright light and, occasionally, direct sunlight. Small quantities of mosses and sand cover the roots, but it is not terrestrial. Nutrients arrive with rain and floodwater but do not linger or accumulate at the roots. The humidity is continuously high and registered at 88% at one location in Brazil. No primary population has been observed in an area fed by runoff or seepage. The airflow is noticeable, with plants bobbing back and forth in the breeze.

We grow Phrag. klotzschianum in clay pots with seedling Orchiata bark. We keep the plants warm year-round and do not allow the temperature to drop at night.

# Phragmipedium pearcei

Although taxonomically Phrag. pearcei and Phrag. hirtzii are easily recognizable, they are culturally and ecologically indistinguishable. Based on what is known, Phrag. pearcei cannot be found in any natural population north of the equator and Phrag. hirtzii cannot be found in any natural population south of the equator. Given how common these species are in rivers throughout their natural range, this is odd.

In the primary habitats, Phrag. pearcei grows on boulders in rivers ranging from north-central Ecuador south into Central Peru. It can be found in secondary habitats; two have been confirmed. These roadside embankments are exact copies of primary habitats. In its primary habitats, the plants are firmly and tenaciously attached to boulders and stones along the embankments of rivers, always below the high-water mark. They are subject to periodic submersion during periods of heavy rain.

Roots grow across the rock's surface, with the majority the roots continuously exposed to the light and air. Some plants have a small amount of accumulated river sand covering the roots. No plants are found in the surrounding jungle or under dense canopy. The plants grow in an atmosphere of high humidity, bright light, and continuously moving air. After it rains, the plants dry quickly. Nutrients sporadically arrive as rainwater flows, and plants are submerged. No primary population has been observed in a location fed by runoff or seepage. Underlying rocks have been touched and are dry and warm (when not submerged). Phragmipedium pearcei should be considered warm growing.

Rot is a problem with *Phrag. pearcei*. Years ago, after I abandoned the saucer of water and sphagnum moss, my plants started to thrive. You should frequently water a well-drained and moisture-retaining potting mix and allow the mix to begin to dry before watering



Phrag. pearcei



*Phrag. besseae* in situ.

again. Given the exposed nature of the primary habitats and the lack of organic material around the roots, fertilizer should be limited to ten to twenty percent. This is the recipe for success with this little species.

# **GROUP 4 SPECIES**

Lastly, we will look at the only two species in the genus that like consistently cooler temperatures. Group Four species are cool, wet growers. They need cooler night temperatures in the 10°C to 12°C (50°F to 55°F) range and cannot survive in consistently warm temperatures. The biggest challenge to growing these species is how to keep the roots moist without rotting the plants.

# Phragmipedium besseae

*Phragmipedium besseae* is a weedy, opportunistic species found in substantial numbers in both its primary and secondary habitats throughout its natural range that extends from northern Peru through to central Ecuador. No natural populations have been encountered north of the equator.

*Phragmipedium besseae* is found in abundance in secondary locations, especially in Ecuador. Flowers have been observed in all months of the year: however, March is the primary flowering season in situ.

*Phragmipedium besseae* occurs on cliffs next to rivers with constant runoff from the surrounding jungle; secondary habitats mimic this ecology. As wet as the cliff surfaces are, the plants tend to sit above the cliff surface, using the rhizome to keep the plants slightly above the moss and moving water. Plants have been observed inundated with water, as if showering, in the substantial runoff. Some habitats in primary locations have been so inundated with water that approaching the cliff surfaces is impossible. Humidity near the crowns varies from 85% to 100% in both primary and secondary locations. *Phragmipedium besseae* shares secondary habitats with *Phrag. boissierianum*. The range also overlaps with *Phrag. pearcei* and *Phrag. warscewiczianum*. No natural hybrids have been observed.

*Phragmipedium besseae* is a cool-grower. It attaches to the underlying granite, and it is rare to encounter plants with the roots covered in anything other than occasional moss. The roots ramble across the surface of the underlying rock and do not embed in cracks and crevices. Unlike the closely related *Phrag. schlimii, Phrag. besseae* likes its roots exposed and is not terrestrial. I have not seen any plant growing on trees.



Phrag. kovachii in situ.

*Phragmipedium besseae* tolerates a wide range of light levels, varying from almost full exposure on secondary habitat roadsides to light levels so low as to confound logic. Plants growing in differing light levels produce flowers with only the vegetative characteristics showing variations. I am aware of one location with many plants growing inside a notch in the side of a cliff, a groove that extended back almost three meters with dozens of plants that produce some of the largest and deepest-colored flowers of *Phrag. besseae* that I have seen. Natural light is very low at this location, and neither the sun nor the rain ever touch the plants. The plants are sustained by runoff from the rock at the back end of the notch with plants rambling across an almost horizontal surface devoid of other plant life.

In natural populations, *Phrag. besseae* roots are subject to ever-moving water and air across the roots. There is a misconception that *Phrag. besseae* should be grown in standing water. This is contrary to how the plants grow in situ and suffocates the roots and allows for a buildup of solids in the tissues. Tightly packed moss or bark material that has started to break down almost immediately suffocates the roots. Placing pots in standing water only accelerates this process.

This species likes cool temperatures, constant mois-

ture, air movement at the roots, and high humidity. This is the key to the best flowers. Dry conditions adversely impact both flower quality and plant health. The potting material must be open and allow for the retention of humidity and airflow. Using a mixture of seedling bark, perlite, small rocks, and loose moss in clay pots allows for air movement across the roots. Growers must tailor the ecological requirements to their growing area. Remember, watering not only moves water through the pot but also moves the air. Depending on what medium you use, frequent watering through a well-draining mix will cure much of what ails *Phrag. besseae* in cultivation.

*Phragmipedium besseae* will grow in almost any light levels except direct sunlight but must be kept cool, with day temperatures seldom exceeding 24°C (75°F). Cooler night temperatures produce deeper red colors.

Fertilizer should be at ten to fifteen percent strength with each watering. Cool temperatures, the quality of your water, and the ability of the roots to constantly breathe are essential to successfully grow what has proven to be a tricky species to cultivate.

# Phragmipedium kovachii

*Phragmipedium kovachii* is currently found in a restricted area in San Martin, Peru. A few years ago, two more locations were located several days on horseback ride further into the jungle from the original site. These habitats, however, do not substantially increase the known range of this species. The first two plants, one of which was the infamous plant brought to the United States and used as the type plant for the description, are known to have come from the side of the road. However, this seems to be the exception rather than the rule. Currently, all plants known are from the primary habitats.

*Phragmipedium kovachii* shares one location with several plants of *Phrag. warscewiczianum*, and both *Phrag. boissierianum* and *Phrag. pearcei* are known from nearby primary and secondary habitats. No natural hybrids have been observed.

*Phragmipedium kovachii* can be found on granite cliffs along rivers and granite hills close to rivers. I have read reports that this species grows on limestone, but I have not seen that. The habitats and ecology are most closely related to *Phrag. longifolium* with two significant differences. One, *Phragmipedium kovachii* does not get continuous runoff. On the contrary, locations appear to have little runoff outside of the period immediately following rain. Two, *Phrag. kovachii* is a cool-grower. While day temperatures have some overlap with *Phrag. longifolium*, it is the night temperatures that make *Phrag. kovachii* a distinct cool-grower. Night temperatures in nearby towns and roadsides have been found to range from 10°C to 12°C (50°F to 55°F).

I have seen one plant in flower in March and several in flower in nearby nurseries in November. However, in situ, the vast majority of plants flower in December, so that is the time to go if you want to get some impressive photos.

Plants form enormous clumps when left undisturbed, and most are in exposed locations open in the surrounding jungle rather than under the dense canopy or low-light conditions. However, direct sunlight is not typical. *Phragmipedium kovachii* is terrestrial. Plants persist in a layer of mud, perhaps 2.5cm (1 inch) thick in most places. The roots ramble through this layer and do not anchor to the underlying granite. This layer of organic material mixed with mud is continuously moist, and I have never found the plants in dry conditions. Rainwater quickly passes through the layer of mud and runs down the granite's surface, so there is never an accumulation of water.

Nutrients arrive with rain, and because of the terrestrial nature of the layer of mud, nutrients can accumulate. This species can probably tolerate higher levels of fertilizer given the nature of the habitats. However, we keep the fertilizer routine consistent at ten to twenty percent each watering.

## CONCLUSION

There are several points I hope readers take away from what Mother Nature teaches us about *Phragmipedium* culture. Each species inhabits its specific ecological niche. There is no one-size-fits-all culture. The cultural specificities of each species must be respected if we are to grow *Phragmipedium* successfully. Although some species are highly opportunistic and weedy, there are firm boundaries around the broader geographic range of each species that must be respected. Give a phragmipedium the correct culture, and there is almost no limit to the size and quality of the plants you grow.\*

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