Fresh air is essential for healthy plant growth

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First published April 2021

THE SPECIES ORCHID SOCIETY OF WA

Fresh air movement is essential for healthy plant growth

Introduction

We all know that successful orchid culture requires many ingredients. Past Paphiopedilum Study Group discussion topics have covered light, humidity, heating/cooling of orchids, nutrition and media. Another important factor to which we need to pay attention to for plant health, flowering and general wellbeing is air movement. Air movement includes the movement of a constant supply of fresh air to both the plant leaves, and to a lesser extent, to the roots through open and well drained media.

As with all of our discussion topics, this this topic will inevitably involve some “do as I say, not as I do” moments for all of us. One of the most significant challenges is that we all try to keep too many orchids from too many different genera in our limited glasshouse or shadehouse space. This inevitably means that the plants are too close together, often with leaves touching one another. What this does is allow insect pests and fungal, bacterial and viral pathogens to transfer from plant to plant, while restricting the free flow of fresh air that the orchids need. Simply providing more space between plants is probably the most significant thing that we can do to improve the wellbeing of our orchid collection, but is often difficult given other constraints. Trevor Burnett grows his plants in 8 pot trays used by commercial nurseries that ensure that there is an air gap between individual plants. All that is then required is to provide the required air movement.

What do we mean by fresh air and why does it matter?

The words “fresh air” in the context of a discussion about air movement are critical. If we think back to the times when orchids were collected from the new world in the 18th and 19th centuries and transported back to Europe. Most were condemned to a slow death by culture in crudely heated glasshouses designed to replicate what were then believed to be the hot, wet tropical conditions of their natural habitat. Given what we now know, even the very best growers of those times got it wrong. The fact that any orchids survived this treatment is testament to the resilience of this group of flowering plants. During the cold winter months in Europe at that time, glasshouses were closed up, heated with wood stoves and the ingress of fresh, but cold air excluded in order to retain heat. History reveals that many, many thousands of plants perished as a result. The key message for us is that fresh, moving air is essential for orchid health throughout the year.

In the 21st century, we have made great advances in replicating our orchids’ natural environment. As hobbyist growers, the cost of sophisticated technology is often prohibitive, but automated humidification, air quality management, air movement, temperature, nutrient, water and light intensity and duration are all available to growers who have the money to invest. While systems manufactured in China are reasonably priced, they appear to lack reliability when compared with similar but considerably more expensive products sourced locally or from Europe or the USA.

The challenge for all of us therefore is how to get the best result for the least expenditure, make the best use of available space and aspect/location constraints, and to grow our plants well. Paying attention to these aspects of orchid culture will help us design and construct growing areas that provide environments in which our plants can thrive.

As a group, we meet at one-another's homes, which of itself presents opportunities to learn from others. There are almost always things we can do, and changes we can make that will help improve our orchid growing environment, although for many of us, the constraints such as lack of room to expand our glasshouse or shadehouse, or overhanging trees are actual barriers.

Where do our orchids live naturally?

So how does this topic about air movement specifically apply to some of the orchids that members of the Paphiopedilum Study Group might wish to grow? These genera are by and large, tropical or subtropical evergreen terrestrials, lithophytes or epiphytes. We principally grow them in pots in an open bark or similar media, in hothouses or shadehouses following hydroponic principles for their culture.

As Tony Budrovich demonstrated in his discussion paper on Calcicolous orchids, the way that we grow them is not how they live in their natural habitat! Those of us that have been fortunate enough to see Paphiopedilum species growing in the wild will have noticed several things. One of the most important is the constant air movement that exists in primary and secondary tropical forests. This has both a cooling effect on us, and on the plants growing there. Often, the species in these genera are found growing on cliffs where they receive constant, moving fresh air or in well-drained leaf litter over limestone or occasionally on trees as an epiphyte. Even in hot, steamy, lowland tropical and sub-tropical rainforests where these orchids are found, plant leaves, whether in the canopy, lower story or orchids, ferns and other flowering plants are constantly moving, both day and night. This air movement serves many useful purposes including keeping air temperature uniform by eliminating hot or cold areas.

Can we replicate our orchids' natural environment?

Space limitations faced by orchid growers living in suburbia dictate that we generally grow our orchids in small, rather confined growing spaces, and most often, as part of a mixed collection. Glasshouse/shadehouse design and layout is always subject to cost and space constraints. However, good planning, glasshouse/shadehouse siting that maximises light and radiant heat during winter can help overcome these barriers.

In the southern hemisphere, we want to maximise sunlight in winter, and for this reason, the optimum design is to have the longest dimension facing north, and unobstructed by trees or other buildings that reduce the photoperiod or day-length. The sun provides full-spectrum light and radiant heat which in winter (when the sun's path has tracked to the north) is essential for plant health. Similarly, in the southern hemisphere, the least useful light comes from the south, and accordingly transparent material can be replaced with non-translucent, insulating material (that could be a fence or house wall) without detrimental effect. Additional summer shading can be removed during winter. Generally, as we have now discovered, Paphiopedilums require more shading in summer to reduce light intensity than most of the other genera we grow.

So, it is clear that a well-designed and sited shadehouse can help overcome air movement issues by encouraging airflow through the shadecloth, particularly from the south west and west, while it might be desirable to limit airflow from the east as this is the source of hot summer winds. Our hothouses do not afford us this luxury unless the impervious wall material is totally removable for summer. That said, during winter, we want to capture and retain as much heat as possible. Therefore, growing orchids in an impervious-walled hothouse means that we need to find ways to replicate the movement of fresh air that they would have enjoyed in their natural habitat.

In their natural habitat, the survival of orchids and many flowering plants is very dependent on continual, gentle breezes through the leafy canopy and lower stories of the rain forest. This air movement helps evaporate stagnant water trapped in leaf axils from periods of rain that would otherwise allow fungal and bacterial pathogens to breed. In the absence of fresh circulating air, orchids will die from these pathogens and will also suffer from a lack of readily available carbon dioxide that is circulated by the air movement. Effective ventilation also helps orchids tolerate intense light without leaf burn. While we seldom think about it, the distribution of carbon dioxide from plant respiration is an important factor to remember in this complex set of environmental factors, making air movement at night just as important as air movement during the day.

Moving air helps maintain leaf temperatures at desirable levels. Some plants, including orchids close the stomates on their leaves that allow transpiration of air and water from their leaves during the day, and leaves can overheat and be damaged without adequate air movement to cool them. Consistent and even air movement avoids stratification of cool moist air below the growing area and warm dry air above, where “dead spots” are minimised and damp stagnant areas, the breeding place for disease, are eliminated. In Western Australia where much of our summer is hot and dry with low relative humidity, too much air movement can reduce humidity and retard growth as the orchids are unable to take up enough moisture to offset that lost through the leaves resulting in desiccation and destruction of leaf tissue. In these instances, the supply of additional humidity is essential

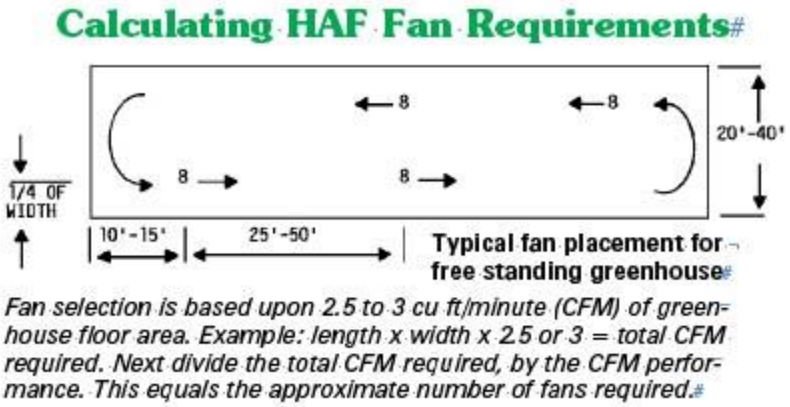
The challenge for us then is to replicate, insofar as it is possible, the natural habitat of orchids in our often cramped glasshouses. A graphic demonstration of the way that nature works occurred during the very hot days in January 2016 where some epiphytic orchids we have growing on trees in our garden were relatively unaffected by the heat with only minimal leaf burn. One of these orchids, *Cattleya aurantiaca* was in flower at the time. By comparison, several *Stanhopea* species hanging just under the roof of our shadehouse (under Solaweave) though being watered every day and misted up to 8 times a day were severely affected with the leaves badly burnt. Comparing the temperature and humidity in the leaf canopy of the trees in our garden to which orchids are attached showed a significant difference from the ambient temperature and humidity. I attribute this to the trees modifying the temperature and humidity in their immediate environment through transpiration, combined with natural air movement in the immediate vicinity.

The most obvious solution is fans; overhead, fixed or oscillating. Remember though that more air movement is not always better – hurricane-force winds are not beneficial air movement. The desired standard is gentle but consistent. As a simple rule of thumb, if the leaves of a hard-leaved orchid such as a *Cattleya* are moving about, you probably have more air movement than you need. The intensity of required air movement is directly related to humidity – the higher the humidity, the stronger the air movement needs to be (especially in winter where the ambient humidity makes it more difficult to evaporate and moisture on plants leaves before nightfall). Conversely, where natural humidity is low, any artificially generated air movement will serve to reduce humidity and lower the humidity around the plants. As previously explained, this can prevent roots being able take up enough moisture to balance that which is lost through the foliage potentially leading to plant mortality.

Oscillating fans such as those available from hardware stores at very reasonable prices are adequate, but need to be protected from moisture. While these cheap fans do not last long (perhaps 12-18 months before the oscillating mechanism fails), the cost is low and they are not overly expensive to operate, but their efficiency diminishes quite rapidly with the way in which we operate them. They need to be on 24 hours a day, seven days a week, ie day and night, all year round. It is worth paying more and buying fans with a higher output as they will do a better job of distributing fresh air to all points in the glasshouse.

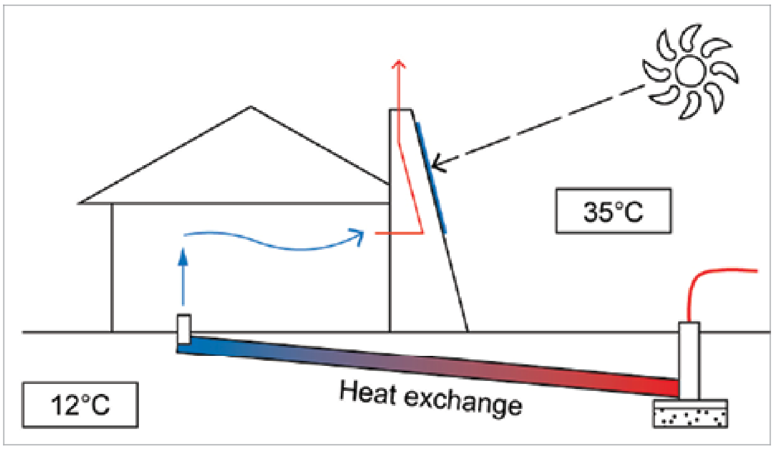
Overhead (ceiling) fans are effective in moving large volumes of air, but can leave ‘dead’ areas that do not get as much air movement, or areas with excessive air movement that dries out the plants immediately below the fan, but leaves others beyond without enough fresh air. Generally, ceiling fans need to be operated at lower speeds to avoid these problems. Fixed direction fans, unless moving air through a distribution mechanism such as a poly sock can tend to dry out the plants in their direct path unless sited over or under the plants. We have a plate fan and poly sock in our glasshouse that provides reasonable air movement throughout the glasshouse, and the air is sourced from outside so is always fresh. However, fans designed for constant operation are expensive to purchase and replace.

Horizontal air movement is different and more beneficial than air movement provided by overhead fans that tends to be downwards and circular. Horizontal air movement is parallel to the ground driven by a series of fans that combine to move all the air in the hothouse around in a coherent pattern. It is efficient as once the air is moving, it only requires a few well-placed small fans to overcome turbulence and friction to keep the air moving. Advantages are reported to be better air mixing, elimination of hot/cold spots and disease control. However, my research indicates that this technology seems better suited to large greenhouses, for example 30m x10 m rather than the small hothouses that we grow in as it is recommended that the fans are switched off when vents are open.



Source: https://www.hummert.com/product-details/31726/schaefer-horizontal-air-flow-fan-haf

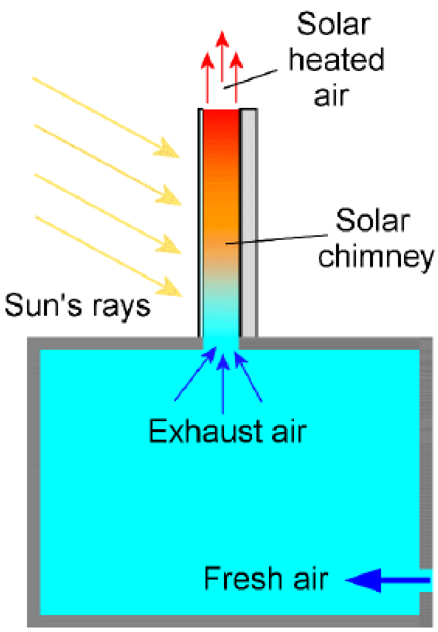
Fresh air can be introduced to the hothouse through ground level vents, making use of natural convection by allowing the air inside the glasshouse to heat up and exit via vents at the highest point of the glasshouse. While this can be detrimental to maintaining the high humidity that we want in summer, a supply of fresh air is the principal objective and we can address humidity concerns by other means. There may also be some benefit in running piping underground to introduce fresh air as in our extreme summer heat, if the piping is buried well below the surface of the soil, some degree of cooling will be achieved as shown in the following diagram.



Source: http://www.yourhome.gov.au/sites/prod.yourhome.gov.au/files/images/PD-PC-SolarChimneyDiagram-01_fmt.png

Installation of a wet wall at one end of the hothouse and a large exhaust fan at the other end can provide cooling, humidity and fresh air movement. A wet wall uses evaporation to cool and humidify air being sucked into the hothouse. These systems are often used in large scale commercial hothouses (see http://www.argosee.com.au/products/ventilation-cooling-heating/649/), but require all vents to be closed to operate effectively, for example Kevin Butler uses wet-wall systems to cool and humidify his glasshouse spaces at Ezi Gro Orchids.

Another option is to run an exhaust fan, again close to ground level so that it blows fresh air into the glasshouse and another in the roof that exhausts the hot air (for maximum result, use exhaust fans that do not have to overcome louvres on the air entry/exit side of the fan as these can result in up to 20% reduction in efficiency). While these fans are relatively economical to run, they are now available powered by photovoltaic cells, that will not be affected by power failures. My research indicates that they are relatively inexpensive (less than $100 on e-Bay) but I did not find much information about their efficiency and volume of air discharged. Wind-powered extractor fans (whirly birds) are also readily available from hardware stores and while requiring some wind action, are unaffected by power failures.



A means of adding to air movement using natural convection is a heat or solar chimney. A solar chimney is simply a length of flue pipe, painted matt black that draws air from the highest point in the glasshouse roof. As the sun heats the flue, the hot air inside rises and is replaced by air from inside the glasshouse. If air entry to the glasshouse only occurs through low level vents, then this exhaust of air will result in some fresh air being sucked in to the glasshouse. Within reason, the taller the heat chimney, the more air is heated and exhausted leading to more fresh air drawn into the glasshouse. Solar chimneys are good insurance for power failures that cause mains electric fans to cease operating.

Diagram source: https://www.researchgate.net/profile/Pavel_Charvat/publication/264882993/viewer/AS:134778674225152@1409145148752/background/1.png

How do we know whether we have sufficient air movement and humidity?

A simple test for air movement is to light Sandalwood mosquito stick and see where the air movement takes the smoke. We should see the smoke trail widely distributed with no dead areas where the air is stale and still. However, the best test is to observe our plants. Leaves (including mature leaves) should be uniformly green, with a full glossy surface rather than wrinkled or limp and desiccated. Roots should be uniformly coloured and active. The presence of insect pests such as cotton scale, hard scale and mealy bug are also indicators of poor culture, often as a result of inadequate air movement!

References

Horizontal Air Flow Bartok J Jnr