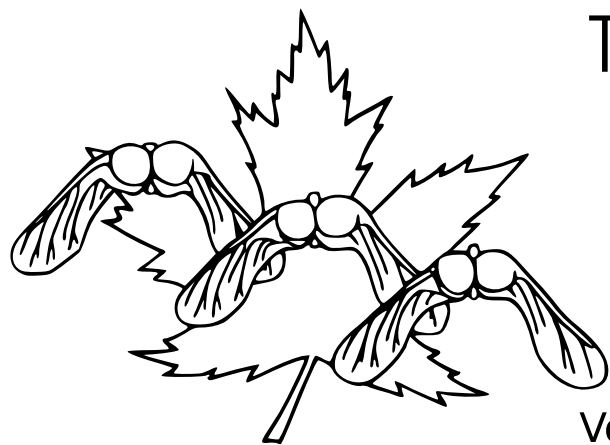




The Canadian Botanical Association Bulletin

Bulletin de l'Association Botanique du Canada

Vol. 48 Number 3 December/décembre 2015



North of Inuvik, as seen from a helicopter, ©Cory Wallace. See Cory's full report on page 83.

IN THIS ISSUE:

President's Message	78
CBA / ABC 2016 Call for Award Nominations and Applications	79
Mycology Section News	80
LAC preserves the extensive history of the CBA	81
BAC préserve la riche histoire de l'ABC	82
Laurie Consaul Northern Research Scholarship Report	83
Top Canadian Ornamental Plants: 12. Phalaenopsis	84
Tenure-track position in Plant Genomics	92

PRESIDENT'S MESSAGE

As the fall semester winds down for many of us it will soon be time to start thinking about the up coming year. I know most CBA sections have started to talk about symposia ideas for next year's meeting in Victoria. There have also been discussions about nominations for our major awards. I would encourage any of you thinking about nominating someone for an award to talk with other members of your section.

Recently, I sent out an announcement of our 2016 awards (see page 79). Please keep in mind that this year's deadlines are earlier than last year, due to the 2016 annual meeting



taking place at an earlier time. Last year we were able to support a large number of students to travel to the annual meeting. While this is a significant cost for the CBA I think it is a good investment in our future. As such, please circulate the award announcement among your colleagues who may not be CBA members. For those of you who still need to renew your membership (you are not alone) there is now an additional charitable donation you can make. As we are now involved in the Planting Science program, you can make a donation to supporting this program. Your donation will go toward producing material that will be used by schools to run plant science related activities.

I wish all of you a happy New Year,

John Markham

The Canadian Botanical Association Bulletin

The CBA Bulletin is issued three times a year (March, September and December) and is freely available on the CBA website. Hardcopy subscriptions are available for a fee.

INFORMATION FOR CONTRIBUTORS

All members are welcome to submit texts in the form of papers, reviews, comments, essays, requests, or anything related to botany or botanists. For detailed directives on text submission please contact the Editor (see below). For general information about the CBA, go to the web site: www.cba-abc.ca

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Bulletin de l'Association Botanique du Canada

Le Bulletin de l'ABC paraît trois fois par année, normalement en mars, septembre et décembre. Il est envoyé à tous les membres de l'ABC.

SOUMISSION DE TEXTES

Tous les membres de l'Association sont invités à envoyer des textes de toute nature concernant la botanique et les botanistes (articles, revues de publication, commentaires, requêtes, essais, etc.). Tous les supports de texte sont acceptés. Pour des renseignements détaillés sur la soumission de textes, veuillez consulter le rédacteur (voir ci-dessous). Infos générales sur l'ABC à l'url suivant: www.cba-abc.ca

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PROCHAIN NUMÉRO

La date de tombée des textes du prochain numéro, le no 49(1), est le 1 mars 2016

CBA / ABC 2016 CALL FOR AWARD NOMINATIONS AND APPLICATIONS

Each year the Canadian Botanical Association gives awards to botanists studying in Canada, and Canadian botanists studying abroad. Many of the awards are available to non Association members. Applications and nominations are now open for the following:

Student Awards

PUBLISHED PAPERS

These awards are given to students for a paper they have published in the last year:

Porsild-Consaul Award, \$1000: for the best paper in plant systematics or phytogeography.

Stan Rowe Award, \$500: for the best paper in plant ecology.

Taylor Steeves Award, \$500: for the best paper in plant development, or structure.

Luella Weresub Award, \$1000: for the best paper in mycology or lichenology.

Application deadline: February 1, 2016.

PRESENTATIONS AT THE ANNUAL CBA/ABC MEETING

Lionel Cinq-Mars Award, \$500: is given for best oral presentation.

Iain and Sylvia Taylor Award, \$500: is given for the best poster.

Application deadline: March 1, 2016.

FOR TRAVEL TO ATTEND THE ANNUAL CBA/ABC MEETING

These awards provide travel funds for graduate (**Macoun Award**) or undergraduate (**Winterhalder Award**) students presenting talks or posters at the annual CBA/ABC meeting. **Value: \$200-\$600**

Application deadline: March 1, 2016.

FOR RESEARCH-RELATED TRAVEL TO CANADA'S NORTH

Laurie Consaul Northern Research Scholarship, \$1000

Application deadline: March 1, 2016.

CBA/ABC Major Awards

The Mary Elliott Service Award is given to an individual for meritorious service to CBA.

The Magister Award is given for excellence in plant science teaching.

The Lawson Medal is the most prestigious award of the CBA. It recognizes excellence in the contribution of an individual to Canadian botany.

Nomination deadline: February 1, 2016.

For more information see www.cba-abc.ca

MYCOLOGY SECTION NEWS

In 2016, the annual meeting of CBA/ABC will be held in Victoria and our Weresub Lecturer will be Dr. Bryce Kendrick. Bryce is widely recognized as a terrific speaker and amazingly knowledgeable mycologist. The Weresub Lecture is open to the general public and is always a fun, informative and insightful event.

For the 2016 annual meeting, we are working on the possibility of a truffle search with trained truffle dogs; stay tuned to see if we can pull it off.

The announcement of the next Luella K. Weresub Memorial Award for the best paper in Fungal Biology will appear early in the new year, so students and supervisors can expect to hear more soon.

Stay tuned for more mycological news as it evolves rapidly in early 2016.

Respectfully submitted,

Hugues Massicotte and Shannon Berch
Co-Chairs of the Mycology Section



©Hugues Massicotte

LAC PRESERVES THE EXTENSIVE HISTORY OF THE CBA

Melody Béland¹

It is with great pleasure that I have processed the material provided by members to preserve your association's memory. Today I will be giving you an overview of some of the gems I discovered when I was reviewing the content of the Canadian Botanical Association (CBA) fonds.

Most of the material consists of textual records showing the foundation and longevity of the CBA in Canada's scientific community. These records describe the CBA's activities and the influences members have had on major issues. The records reflect the extensive history of the CBA, which has endured where many others have failed.

The fonds contains correspondence, administrative documents, and documents on meetings, sections and committees. It also contains books, including a notebook, a book of accounts for memberships ("Treasurer's Record Ledger" from 1975 to 1981), as well as the "National Herbarium of Canada", produced in 1935.

Many photographs show the scale of events in which CBA members have participated over the years: excursions, annual meetings (banquets, project presentations, awards and recognition ceremonies) that show the participants' enthusiasm and their passion for botany in Canada. The fonds contains 460 black-and-white photographs, 38 colour photographs, 23 colour slides, 380 negatives and 15 snapshots (or contact sheets).

In addition to textual records and photographs, the fonds contains two works of art. The first is a poster created by the CBA in honour of the annual meeting in 1980 at the University of British Columbia in Vancouver. The second is the original template used to create the CBA pin. The three films each contain a different colour to be placed on top of one another to create the CBA logo. The template was designed by Michel St-Jean of the National Museum of Natural Sciences (now known as the Canadian Museum of Nature).

The collection also contains two original items. The first is one of the copies of the CBA pin that was produced by Athletes Wear Co. Ltd. of Winnipeg in 1986 and the second is the first model of the Mary E. Elliott Award.

The fonds was divided into 11 series to correspond to the CBA's structure and to meet varying preservation needs according to the type of material. This division will make it easier to add any new material to the fonds. The series are as follows: *Canadian Botanical Organization*; Administra-

tion; Correspondence; Sections and committees; Advocacy, public education and lobbying; Others; Newsletter; Photographs; Items; Art. You can now consult the Library and Archives Canada database to view the fonds on archives search (MIKAN #190550) at www.collectionscanada.gc.ca.

Anyone who has something to donate to LAC (photos, letters, drawings, etc...) should contact Frédérique Guinel (fguinel@wlu.ca), who is the intermediate between the CBA and the LAC. The LAC would like the fund to grow and it is the responsibility of each one of us to make it grow.



The CBA Fonds

¹Archivist, Library and Archives Canada (LAC). LAC has a mandate to maintain, preserve, exhibit and showcase Canadian heritage for current and future generations. Visit www.lac-bac.gc.ca.

BAC PRÉSERVE LA RICHE HISTOIRE DE L'ABC

Melody Béland¹

C'est avec plaisir que j'ai fait le traitement du matériel offert par des membres afin de préserver la mémoire de votre association. Je vous propose donc ici un aperçu des gemmes que j'ai eu la chance de découvrir, tout en résumant l'étendue du fonds.

La majorité du matériel conservé à Bibliothèque et Archives Canada (BAC) est constituée de documents textuels témoignant de la fondation et de la longévité de l'association au sein de la communauté scientifique du Canada. Ces documents décrivent les activités de l'ABC, mais également les influences que les membres ont eues sur des enjeux importants. Ils reflètent aussi la riche histoire d'une association qui a su perdurer là où beaucoup d'autres ont échoué.

Le fonds conservé comprend de la correspondance, des documents administratifs, des documents concernant les rencontres, les sections et les comités. On dénombre également des livres parmi lesquels un cahier de notes, un cahier des comptes pour les adhésions « Treasurer's Record Ledger » de 1975 à 1981, ainsi que le « National Herbarium of Canada », publié en 1935.

De nombreuses photographies révèlent l'envergure des événements auxquels les membres de l'association ont participé au fil des ans : excursions, congrès annuels, banquets, présentations de projet, remises de prix et honneurs qui témoignent de la passion des participants pour la botanique au Canada. Le fonds comprend : 460 photographies en noir et blanc; 38 photographies couleur; 23 diaporamas couleur; 380 négatifs; 15 planches contact (*snapshot* ou *contact sheet*).

En plus des documents textuels et photographiques, nous retrouvons deux œuvres d'art. La première est une affiche créée par l'association à l'occasion du congrès annuel de 1980 tenu à l'Université de la Colombie-Britannique, à Vancouver. La seconde est le gabarit original – trois acétates comprenant chacune une couleur différente afin de superposer le dessin du logo de l'association – qui a servi à l'élaboration d'une épinglette à l'effigie de l'ABC. Les. Le gabarit a été conçu par Michel St-Jean du Musée national des Sciences naturelles (maintenant connu sous le Musée canadien de la nature).

Le fonds contient aussi deux objets originaux : une épinglette de l'ABC produite en 1986 par la compagnie Athletes Wear Co. Ltd. (Winnipeg) et le premier modèle du prix Mary E. Elliott.

BAC a divisé le fonds en 11 séries afin de refléter la structure de l'association et satisfaire aux différents besoins de conservation, qui varient selon le type de matériel. Cette

division facilitera l'ajout potentiel de nouveau matériel au fonds. On compte les séries suivantes : *Canadian Botanical Organization*; administration; correspondance; sections et comités; défense des intérêts, éducation du public et lobbying; bulletin; photographies; objets; arts; autres. Vous pouvez dès maintenant consulter la base de données de Bibliothèque et Archives Canada afin de découvrir le fonds dans « recherche de fonds d'archives » (MIKAN # 190550) au www.collectionscanada.gc.ca.

Si vous avez des documents (photos, lettres, dessins, etc ...) qui pourraient intéresser BAC, n'hésitez pas à contacter Frédérique Guinel (fguinel@wlu.ca) qui joue les intermédiaires entre notre association et les archives. BAC aimerait voir grandir le fonds de l'ABC, et c'est la responsabilité de chacun de contribuer à ce fonds.



Le Fonds de l'ABC

¹ Archiviste à Bibliothèque et Archives Canada (BAC). Le mandat de BAC consiste à préserver le patrimoine documentaire du Canada pour les générations présentes et futures et à être une source de savoir permanent accessible à tous, contribuant ainsi à l'épanouissement culturel, social et économique du Canada. Voir www.bac-lac.gc.ca

LAURIE CONSAUL NORTHERN RESEARCH SCHOLARSHIP REPORT

Cory Wallace¹



There is something about helicopter flight that just never gets tiresome. From the first swoop off the landing pad, the unique experience of feeling like I am simultaneously in both a bubble and a roller coaster sends a jolt of excitement through me every time. It certainly doesn't hurt that the majority of the flights I have experienced take me out north of Inuvik, NT across mixed forests of black and white spruce and paper birch trees, and into the low arctic tundra east of the MacKenzie Delta, a stretch of land fascinating in its own right. The dramatic change in vegetation as you fly onto the tundra is inescapable from the air. The density of trees begins to diminish quickly as you head north, with the primary strongholds of forest remaining largely in drainage channels and low-land areas, to make way for a shrub and graminoid dominated landscape of rolling hills and small, chilly lakes. One of the more striking features of this scene is the strange, patchy distribution of the shrubby vegetation here, consisting primarily of birch, willow, and alder shrubs. These plants grow in such a clumped distribution and with such abrupt edges that you can not help but wonder, "Why do they do that?"

I have taken this journey across the tundra into the Trail Valley Creek basin multiple times in the last two summers, each time with the goal of gaining information that may help us better answer that question. In light of recent observations of rapid, warming-driven shrub expansion in the arctic, the hope is to better understand what constrains shrub growth in order to figure out why that constraint is being lifted. Armed with measuring tapes and quadrats made of PVC pipe, we set up a series of transects which ran downhill through ten alder shrub patches along which we measured a series of abiotic and soil variables such as maximum thaw depth, soil moisture, and organic matter thickness as well as taking vegetation community composition data. These tran-

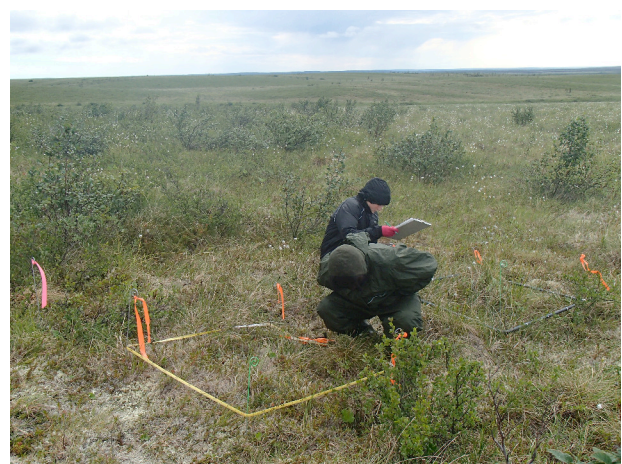
sects were paired with parallel transects running through the adjacent, open tundra. Shrub individuals were also mapped within a nine meter belt surrounding the transects with the hope of figuring out how shrub structure changes down a slope.

As the summer wore on, the ground began to change colour as the prostrate vegetation, like alpine bearberry, moved from dark greens to deep reds and purples, contrasting starkly with the white reindeer lichen that dominates much of the upland areas. This was followed shortly by oranges and reds of the birch shrubs, signaling that fall was coming fast. We finished up the last details of mapping and took down measurements of juvenile alder densities before flying back to Inuvik in mid-August after more than two months on the tundra.

All of this data is now being compiled in order to tell a story describing how shrub patches differ from neighbouring open tundra locations and how this relationship may change at the patch edge and along a slope. The hope is that this information will add to our knowledge of why shrubs grow where they do and more importantly, why that is changing. With this information, we may be able to better understand positive feedbacks between increased shrub cover and regional warming, with the goal of predicting future expansion more accurately and aiding researchers hoping to implement these feedbacks into better models of global climate change.

I would like to thank the Canadian Botanical Association profusely for their part in supporting my research and passion for northern botany and plant ecology. This summer was an incredible experience that was made possible in part with your help.

Thank you!



¹ Cory Wallace is a PhD Candidate in Jennifer Baltzer's Forest Ecology Research Group at Wilfrid Laurier University. He received the 2015 Consaul Scholarship.

TOP CANADIAN ORNAMENTAL PLANTS: 12. PHALAEOPSIS

Ernest Small¹²

MANY consider orchids to be the most beautiful and charismatic of all ornamental plants. A century ago these “living jewels” were grown primarily as opulent symbols of wealth and status of the elite classes. Today, many orchids also grace the humblest of residences, but still retain their status as the aristocrats of flowering plants. Modern phalaenopsis hybrid orchids are among the most graceful and spectacular, with blooms that last for months, superb adaptation to the low interior light and temperature conditions of homes, and tolerance of considerable maltreatment by those with very limited horticultural skills. Phalaenopsis now accounts for three-quarters of all orchids sold, and represents a mass-marketing industry with a global value of hundreds of millions of dollars annually. Aside from its economic importance, *Phalaenopsis* is of considerable botanical interest because of the remarkable adaptations of orchids, and the genus has become the subject of very extensive multidisciplinary research.

Names

Scientific Names: The genus name *Phalaenopsis* is based on Greek (*phalaína*, moth, + *opsis*, like), meaning “resembling a moth,” reflecting similarity of the white and pink flowers (at least their round, flat tepals) of many species to moths flying at twilight.

English Names: phalaenopsis (pronunciations: fayl-eh-NOP-siss; fal-en-OP-sis), phal, moth orchid.

French Names: phalaenopsis, orchidée papillon.

Official symbols

Phalaenopsis amabilis is one of the three national flowers of Indonesia, officially recognized as the “flower of charm” in 1993.

Description

Phalaenopsis species are monopodial (with a single growing stem), inflorescences arising (once per season) on alternates sides between the leaves. The leaves are commonly dark green, leathery and glossy, but some cultivars develop marbled or gray-green foliage. Modern *Phalaenopsis* hybrids produce “spikes” (technically racemes or panicles) with 12 to 20 or more flowers, and the inflorescences of larger, mature plants tend to branch. The flowers are available in virtually every colour except blue, but are usually pale pastel shades. White, pink, and striped flowers are widely marketed. The flowers of “harlequins” are usually spotted or blotched. “Multifloras” have abundant but small flowers. “Miniatures” are small plants with small flowers.

Floral structure and pollination

Orchids have elaborate flowers adapted for pollination, usually by insects. *Phalaenopsis* flowers have three outer tepals (sepals), which are more or less identical and evenly spread out. There are two lateral inner tepals (petals) and a highly modified inner median tepal (petal), the labellum or lip. The lateral petals often differ in colouration, patterning and size from the labellum, which is 3-lipped, the two side lobes raised at an angle to the front lobe. The lateral lobes in most species are usually tinged with yellow nectar guides and red



Figure 1: Orchids from the late 19th century, when only the wealthy could afford such fabulous plants. None of these gorgeous flowers is a phalaenopsis, which in those early times was too delicate to survive transportation from wild collection, and too difficult to propagate in large numbers. The 16 orchid species shown in this lithograph are identified at: commons.wikimedia.org/wiki/File:Haeckel_Orchidae.jpg. Source: Haeckel, E. 1904. *Kunstformen der Natur*. Leipzig: Bibliographische Institut, Plate 74.

splotches to attract pollinators. A raised area termed the callosus occurs at the junction of the three lobes of the labellum. The labellum is fused to the foot of the column (a fusion of the male and female parts). Tropical epiphytic orchids like *Phalaenopsis* have a single fertile anther, located at the tip of the column. A cap of tissue covers the anther. To promote

¹Science and Technology Branch, Agriculture and Agri-Food Canada, Saunders Bldg., Central Experimental Farm, Ottawa ON, K1A 0C6

²©Government of Canada. Verbatim redistribution for personal, non-commercial use is permitted.

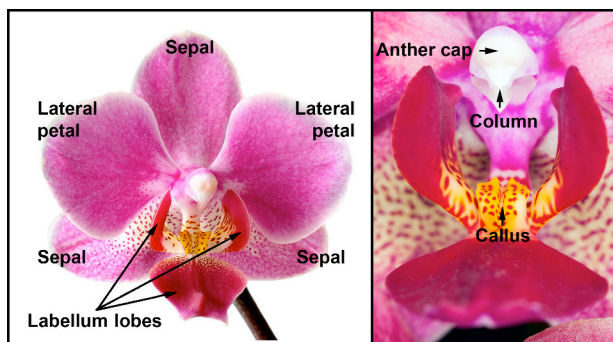


Figure 2: Parts of hybrid phalaenopsis flowers. **Left photo** by André Karwath (CC BY SA 2.5), **right photo** by Diegfo Delso (CC BY SA 3.0).

cross-fertilization, a thin flap of tissue called the rostellum separates the anther from the stigma beneath. The Orchidaceae and the Asclepiaceae are the only two families that produce pollinia — masses of pollen grains, usually in pairs (a single pair in orchids is called a pollinarium), joined to a sticky pad (called a viscidium), which adheres to pollinators. Phalaenopsis has either two or four pollinia, which are transferred as pairs among flowers. A pollinator visiting the throat of a phalaenopsis flower, positions itself on the callus, pushes back the anther cap, contacts and picks up a pollinarium while perhaps depositing a pollinarium it may have picked up previously. A single pollination results in hundreds of thousands of tiny seeds being formed, which are distributed by wind. A few phalaenopsis species are scented, but nectar is not produced and insects generally do not consume the pollen, so the flowers are rather deceitfully luring pollinators without rewarding them. Pollination is rather scarce in *Phalaenopsis* and many other orchids, and as a result the blooms are naturally very long-lived — a characteristic that makes the plants very desirable as flowering ornamentals.

Classification and distribution

Christenson's (2001) monographic treatment of *Phalaenopsis* has mostly been supported by recent chloroplast and nuclear molecular phylogenetic studies. The genus includes about 60 species, including the genera *Doritis* (which occurs in terrestrial habits) and *Kingidium* (which is montane). When *Doritis* is recognized as a separate genus, the hybrid between it and *Phalaenopsis* is called *Doritaenopsis*.

Phalaenopsis species are native from the Himalayan Mountains of India eastwards to the Philippines and northern Australia. They are commonest in the hot, moist lowlands of Asia, from Assam through Burma, the Philippines, Malaysia and Indonesia.

NOMENCLATURAL COMPLICATIONS

While most well-known cultivated plants have unique common (vernacular) names, because there are so many species of orchids, their common names are frequently based in part or completely on their scientific names (which is why "*Phalaenopsis*" in this review is virtually equivalent to "phalaenopsis"). Adding and complicating the variational pattern in orchids, hybrids can be generated not just between two (or more) species, but could involve two (or more) genera, or between grexes ("greges"), which are discussed in the next paragraph.



Figure 3: Column of a phalaenopsis flower. The white anther cap has been pushed back to reveal the pollinarium of the anther. The paired pollen masses are yellow. Photo by Rassbak (CC BY SA 3.0).

Because so many (well over 100,000) hybrids have been generated among the species by humans, cultivar names are not systematically registered for orchids, unlike other ornamental plants. To bring order to the nomenclature of hybrid orchids, a special "grex nomenclature" has been adopted for orchid horticultural hybrids (most cultivated phalaenopsis are hybrids). The term "grex" comes from Greek meaning "flock" or "group" and refers to all of the offspring as well as subsequent offspring of a hybrid cross. Grex names are chosen and registered by the breeders, and are never Latinized. A complete name for a hybrid orchid cultivar usually consists of: Genus name + Grex name + Cultivar name, for example *Phalaenopsis* Hilo Lip grex 'Lovely'. In this case, "Hilo Lip" is a collective name for many cultivars (such names can consist of up to 4 terms), and 'Lovely' (in single quotation marks) is the particular cultivar. The word "grex" in the name is often



Figure 4: Distribution of *Phalaenopsis*. Prepared by B. Brookes.



Figure 5: *Phalaenopsis amabilis* growing as an epiphyte on a tree trunk. Source: Blume, C.L. 1835–1849. Rumphia. C.G. Sulpke, Amsterdam, the Netherlands. 4 vols.

omitted in informal usage. The Royal Horticultural Society (the URL is provided later) is the International Registration Authority for grex names.

Ecology

The plants originate from tropical and subtropical areas, with relatively limited seasonal fluctuations. Reflecting their warm, usually continually moist conditions, most species have evergreen leaves. Temperatures usually range from 28°C to 35°C (82–95°F) during the day and from 20°C to 24°C (68–75°F) at night. Most species grow on the vertical trunks of trees in shady areas, in diffused light under a forest canopy. A few species (“lithophytes”) grow on rocks, and some occur in seasonally dry or cool locations. Most of the species have a single flowering time, but a few bloom twice a year or irregularly.

About 70% of all epiphytes are orchids, and this ecological niche results in many adaptive features, particularly with respect to water relations. At least in some species of *Phalaenopsis*, early growth stages exhibit conventional C3 photosynthesis. However, some (perhaps all) phalaenopsis species have developed Crassulacean Acid Metabolism (CAM) photosynthesis, which allows plants to keep their stomates closed to prevent excessive water loss during the hotter daylight hours, but to absorb CO₂ through the opened

stomates at night. This is a clever survival tactic for plants in arid environments, and although phalaenopsis generally grows in humid places its roots have very limited access to water. CAM occurs in about 7% of vascular plants, mostly epiphytes and succulent xerophytes. Orchids with thick leaves usually undergo CAM photosynthesis, while those with thin leaves (less than 1 mm thick) typically perform C3 metabolism. Thick leaves are an adaptation for reducing water loss, and it is not surprising that this is correlated with CAM, which is also an adaptation for reducing water loss.

The majority of *Phalaenopsis* species (indeed the majority of all orchids) grow as epiphytes on the trunks and limbs of trees, anchoring to the bark by aerial roots (hence the suitability of bark as a growth medium). As noted elsewhere in this review, *Phalaenopsis* roots often grow out of the substrate contained in their pots, and these are often termed “air roots.” About 300 species of orchids rely exclusively on photosynthesis that occurs in their roots, not their foliage. Air roots of phalaenopsis are somewhat photosynthetic, as revealed by the development of green colouration, and it has recently been shown that they develop chemicals that protect the exposed surfaces from ultraviolet radiation (Chomicki et al. 2015). The roots of epiphytic orchids absorb moisture, and a spongy, absorbent, hydrophilic coating of hollow thick-walled cells, termed velamen, aids in this role as well as in reducing water loss. Velamen cells of old roots are dead at maturity, resulting in a whitish or silvery appearance when dry (reflecting their high content of air; when wet, the velamen can be almost transparent). Young roots appear white when dry, green when moist. Photosynthetic cells are often present underneath the dead velamen, and in the root tips, which are not covered with velamen.

History of commercial orchid production

During the Victorian era, orchids were “parlour plants,” particularly desired by the wealthy of England. However, central heating was not well developed, and the wide fluctuation in temperature and humidity led to species of *Cattleya* and *Dendrobium*, resistant to such changes, becoming quite popular. Until the early 20th century, growing orchids from seeds was very difficult, most seedlings succumbing to fungal diseases, ironic because orchids in nature require infection by a fungal symbiont to survive. Accordingly, most orchids were collected from the wild, and few survived the journey back to civilization. *Phalaenopsis* species proved too delicate, either to survive wild collection or growth in most homes, but became prized specimens that only the very rich could grow in special conservatories. After it was discovered in the early 20th century that orchid seeds germinated only in the presence of a symbiotic fungus, “symbiotic germination technology,” involving inoculation of a sterilized growth medium with the fungus, made it easier to reproduce orchids sexually, and to produce hybrids. However, large-scale production was still not possible because of continuing fungal infections. In 1922, it was discovered that, even in the absence of the fungal symbiont, orchid seeds could produce viable seedlings if sown on agar with appropriate salts and sugars (so-called “asymbiotic germination technology”). This technique allowed thousands of plants to be established from

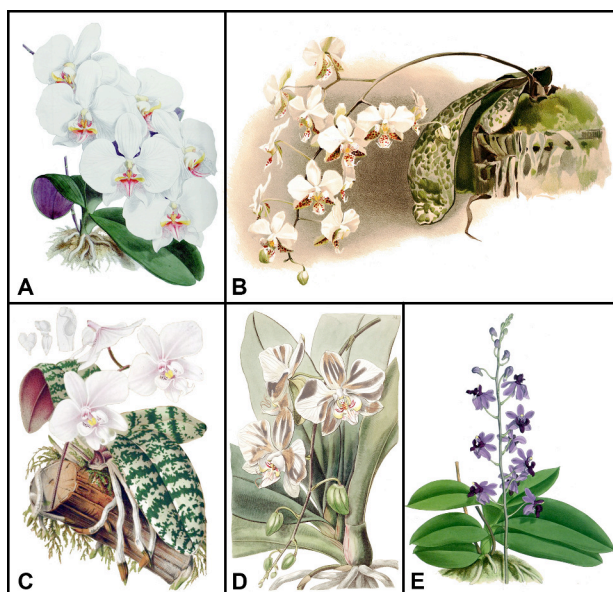


Figure 6: Some of the species from subgenus *Phalaenopsis*, which includes the parents of most of the commercial hybrids. **A:** *P. amabilis* (source: Warner, R. and Williams, B.S. 1882. The orchid album. Williams, London, U.K.). **B:** *P. stuartiana* (source: Sander, F. 1888–1894. Reichenbachia, H. Sotheran & Co., London, U.K.). **C:** *P. schilleriana* (source: Lemaire, C.A. 1860. L'illustration horticole. Vol. 10). **D:** *P. aphrodite* (source: Lindley, J. ed. 1838. Edward's botanical register. Vol. 24). **E:** *P. pulcherrima* (source: Warner, R. and Williams, B.S. 1888. The orchid album. B.S. Williams, London, U.K.). *Phalaenopsis amabilis* and *P. aphrodite* are the most significant parents of modern phalaenopsis hybrids.

a single fruit, greatly stimulated the orchid industry, and led to the present domination of the orchid world by phalaenopsis.

There has been extensive research into the technology of orchid production, with emphasis on phalaenopsis. Orchids were the first plants to be propagated in large numbers by tissue culture, and micropropagation has become a standard method for mass production. Mericlone of orchids, referring to tissue culture of apical meristems (usually stem apices but sometimes also the growing points of roots), began in the 1960s and has become a very widely employed technique. The meristem is sliced into small segments which are cultivated in sterile nutrient culture in flasks until plantlets are developed to an appropriate size, and these are transferred like seedlings to pots.

Origin of cultivated phalaenopsis

Today, most phalaenopsis orchids in the marketplace are hybrids, selected for beauty, rapid growth, prolific blooming and ease of culture.

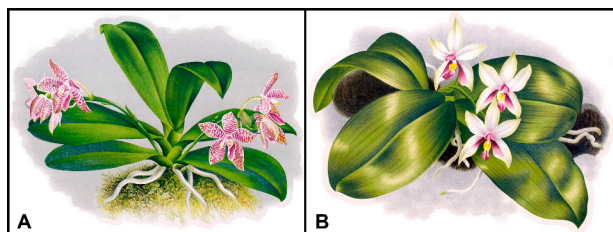


Figure 7: Some of the species from subgenus *Polychilos*, which includes the parents of several commercial hybrids. **A:** *P. lueddemanniana* (source: Linden, L. and Rodigas, E. 1887. Lindenia iconographie des orchidées. F. Meyer-van Loo, Gand, Belgium). **B:** *P. violacea* (source: Linden, L. and Rodigas, E. 1892. Lindenia iconographie des orchidées. F. Meyer-van Loo, Gand, Belgium).

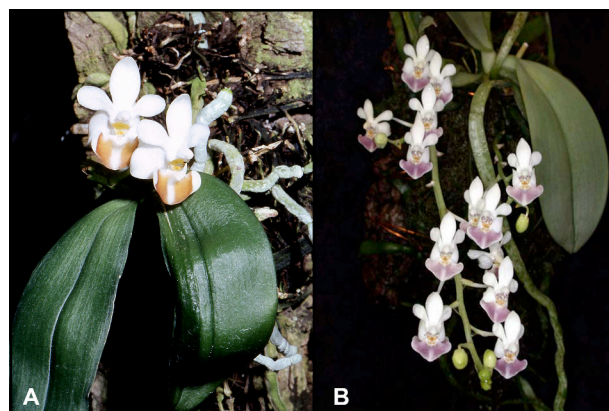


Figure 8: Examples of miniature *Phalaenopsis* species. **A:** *P. lobbii* (photo by Orchi, CC BY SA 3.0). **B:** *P. parishii* (photo by Wolfgang Apel, CC BY SA 3.0).

The parents of most of the hybrids are in subgenus *Phalaenopsis*, including *P. amabilis*, *P. aphrodite*, *P. equestris*, *P. lindenii*, *P. philippinensis*, *P. pulcherrima*, *P. sanderiana*, *P. schilleriana*, and *P. stuartiana*. These are native to warm and humid habitats and are the easiest to grow.

Subgenus *Polychilos* includes *P. amboinensis*, *P. bellina*, *P. gigantea*, *P. lueddemanniana*, *P. venosa*, and *P. violacea*. These also originate from warm humid habitats and are the parents of some commercial hybrids.

Miniature *Phalaenopsis* species from the subgenera *Parishinae* and *Aphyllae*, such as *P. gibbosa*, *P. lobbii*, *P. parishii*, and *P. wilsonii*, originate from seasonally cool and dry areas or relatively high elevations. They require cooler, dryer conditions than most phalaenopsis, and are best suited to cultivation by specialists.

Horticultural value

As a houseplant, many species and hybrids of *Phalaenopsis* offer many advantages: they are relatively easy to grow, are adapted to household temperatures, thrive in low light, bloom for long periods (often for months), and produce elegant sprays of beautiful flowers in a dazzling array of colours. Some cultivars are attractively scented (although most are not fragrant) and many produce interesting glossy green or marbled foliage. Plants are usually inexpensive and are very widely available – from grocery and big-box stores, garden centres, and mail-order suppliers. Although they may be so cheap that they can simply be discarded after flowering, phalaenopsis plants can live for many years. Unlike many of the most attractive plants that demand greenhouse culture, these beauties thrive on windowsills.

Economic value

The global trade in orchids is estimated to be about US\$500 million annually, most of this in cut rather than potted orchids. The flowering stems of phalaenopsis often are long-lasting, and so suitable for the cut flower industry. The cut orchid trade is dominated by eastern Asia, with Japan being the largest importer. The flowers of phalaenopsis orchids are so attractive they are often used in flower arrangements and corsages, although cattles are considered to be the most desirable corsage orchid, and *Cymbidium* and *Paphiopedium* have also been popular. Orchids are estimated to make up

about 10% of the international fresh cut flower trade, with more than 40 countries exporting orchids and 60 importing them. Although the Orchidaceae is perhaps the largest plant family with at least 25,000 species (representing about 10% of all flowering plant species), it has relatively few species that are commercially significant as ornamentals. *Phalaenopsis* represents the majority of orchid sales, although other important ornamental orchids include *Cymbidium*, *Dendrobium*, *Oncidium* and *Vanda*.

In Canada and indeed in most of the Western world, orchids are grown primarily as indoor potted ornamentals, and in the horticultural trade they are often classified as “tropical flowers” (most but not all in fact originate from the tropics). This horticultural category is also dominated by species of *Anthurium* (anthuriums), *Alpinia* (gingers), *Heliconia* (heliconias), *Strelitzia* (birds-of-paradise), and members of the Musaceae (banana), Bromeliaceae (pineapple) and Proteaceae (protea) families. Tropical flowers are grown in greenhouses in temperate areas (particularly the Netherlands), and in the open in tropical and subtropical countries (particularly in Africa, Hawaii, central and South America, Southeast Asia, New Zealand, and Australia). Europe, Japan and the U.S. are major importers. Importation of tropical flowers to cold-climate markets like Canada is usually more economical than growing them in the country, but it is often possible to ship young plants into Canada for “finishing” in local greenhouses prior to marketing. Production value of greenhouse orchids in Canada in 2013 amounted to a modest \$3 million, down from \$6 million in 2009. By contrast, geraniums, poinsettias, chrysanthemums, roses, and other ornamental plants grown in Canadian greenhouses are much more valuable. Statistics are unavailable for orchids imported into Canada and subsequently sold in retail outlets.

Taiwan is the world’s largest producer of commercial orchids (although the Netherlands makes more revenue from its orchid crop). In 2012, Taiwan exported more than \$100 million worth of orchids, representing more than half of its total floral exports. The value of U.S. imports of orchids was \$65 million in 2012, mostly from Taiwan, followed by the Netherlands and Thailand. There has been concern about the sanitary status of the substrate (“soil”) of imported orchids, but in 2005 both the U.S. and Canada allowed transportation of orchids in seaweed from Taiwan, and this subsequently increased imports substantially. Indeed, in the U.S. orchids have become the best-selling potted flowering plant, exceeding the poinsettia in annual sales.

Cultivation notes

Although phalaenopsis is relatively easy to grow, there is a vast amount of information about how to grow it and other orchids well (see the literature and websites mentioned later). The following is a brief synopsis.

PURCHASING

Acquiring plants from orchid specialists, either at shows or by mail-order, is a relatively reliable way of ensuring quality. However, most phalaenopsis are cheapest at flower shops, garden centres, and especially from supermarkets.



Figure 9: A plantlet (“keiki”) produced on a flowering stem of phalaenopsis (photo by Tangopaso, released into the public domain).

PROPAGATION

Although some orchids are still propagated from seeds (an ambitious undertaking best left to specialists), commercial orchids are mostly grown from cultured meristems (as noted earlier). The cost of phalaenopsis orchids is frequently as low as that of cut flowers, so some consumers simply discard them after blooming. Because it is single-stemmed, phalaenopsis cannot be divided like clump-forming orchids. However, a mature vertical stem that has grown to a reasonable length can be divided to produce new plants (so-called “stem propagation”). The old, remaining original plant is then usually discarded. For detailed instructions on the subject, see Greaves (2007) and the websites listed later. Many species and cultivars produce plantlets (“keikis;” keiki is the Hawaiian word for “baby”) with their own roots on the flowering stem, and these can be cut off and potted.

CONTAINERS

The thick, succulent roots that arise from the base of the stem or lower nodes of phalaenopsis function mainly to adhere epiphytic plants to trees, although they also absorb some water and nutrients, and carry out some photosynthesis. However, roots that contact a substrate (in contrast to aerial roots) are much more significant in absorbing water and nutrients and conducting photosynthesis, and so commercial growers prefer plants to dedicate their roots to growth in substrates. Some of the roots of phalaenopsis tend to grow out of their pots, especially evident with old plants. However, it has been shown that when the plants are grown in pots with a suitable medium, they tend to develop more roots in the substrate rather than out of it (i.e. aerially). Plants grown in bark develop more roots outside of the container than plants grown in sphagnum.

When exposed to light the roots are often greenish, reflecting the occurrence of some photosynthesis, although often they are whitish with age. The roots in transparent containers can also become quite green, although it is unclear how significant this is to the vigour of their growth. Commercial growers of phalaenopsis frequently employ translucent or clear containers, because their use has been shown to promote development of roots into, rather than out of pots.

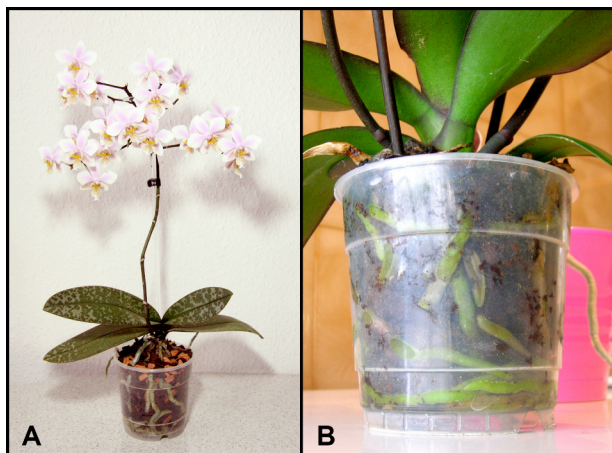


Figure 10: Phalaenopsis in transparent containers. **A:** *Phalaenopsis schilleriana* × *P. stuartiana*. Photo by Maja Dumat (CC BY 2.0). **B:** Photo by Javier Mediavilla Ezquibela (CC BY SA 3.0).

The roots of retail potted plants are also more resistant to damage if they are inside, not outside of the pots, so growers try to restrict growth of roots outside of the pots.

Store-bought plants are usually in plastic pots. These are less preferable than terra cotta pots, which dry faster and promote aeration. However, mass-produced clay pots are often relatively impervious, despite their reputation for porosity and not holding water excessively, and specialists often drill extra drainage holes. Pots designed for orchids have large holes at the bottom and slits (elongated holes) on the sides, and are often referred to as “azalea pots” because azaleas, like phalaenopsis, prefer well-draining containers. Orchid specialists also employ other alternatives to promote root aeration, including the use of containers made with wickerwork or cloth. Shallower pots and hanging pots are other ways of promoting aeration. Repotting may be required every 1–3 years when the plant become root bound or the medium needs to be replenished.

SUBSTRATES & FERTILIZATION

Genuine “soil” is rarely employed in orchid compost. The media used to root phalaenopsis are very porous and coarse compared to the soil-like mixes used for conventional houseplants. Until the Second World War, peat was the commonest growth medium. For a period after the war, osmunda fibre (the root of *Osmunda*, especially the royal fern, *O. regalis*) was adopted, and later, bark-based media. Peat-based, soil-less media have regained popularity today, although many specialists remain loyal to bark. While a very wide variety of potting media have been employed for phalaenopsis, store-bought plants are usually in peat moss, which requires much less watering than bark, a preferable medium. Commercial orchid potting media, formulated for good drainage, are usually ideal. These may be based on bark chips, hardwood charcoal, coarse peat moss, perlite, or other materials.

Bark-based media can be fertilized with a high-nitrogen fertilizer (because decomposition of the bark by bacteria is thought to use up nitrogen rapidly), while a balanced fertilizer is recommended for other substrates. A high-phosphorus fertilizer may be applied to promote flowering, but the merit of this has been disputed. A weaker strength

fertilization is preferable for cooler, more overcast seasons when the plants grow less vigorously (although phalaenopsis tends to grow well year-round). Water-soluble commercial orchid formulations are available. To avoid burning roots, the substrate should be somewhat moist before applying fertilizers. Because of the possibility of harming the rather exposed roots, orchid specialists strongly recommend the application of dilute levels of fertilizer, generally quarter-strength. Slow-release fertilizers are also sometimes used. Potting media often show signs of decomposition within 1 year, and if this appears to be the case the old medium should be removed from the roots and the new medium carefully placed among the roots.

LIGHT REGIME

Because phalaenopsis mostly exhibits Crassulacean Acid metabolism (CAM) photosynthesis, there can be complicated interactions between photoperiodic regime (number of hours of light per day), light intensity, relative humidity and stage of maturity. These interactions can be important to commercial growers, who need to budget for control of climate and light intensity, but the hobbyist grower need not be concerned.

Greenhouses typically require 70 to 85% shading. For the hobbyist, a light intensity of between 1000 and 1500 foot candles (photosynthetic photon flux between 200 and 300 $\mu\text{mol}/\text{m}^2/\text{s}$) usually suffices. Depending on location and time, this can represent between 10% and 15% of full sunlight. In homes, phalaenopsis grows well on a window-sill provided with bright light but not direct sunlight, which can cause leaf scorch. However, in winter in northern climates, a full southern exposure may be best. Alternatively, broad-spectrum fluorescent lights can be employed, placed 15–30 cm (6–12 inches) above the leaves.

Phalaenopsis is considered to be a non-photoperiodic plant, although some varieties seem to require short days to induce flowering. For the orchid hobbyist, ambient seasonal light regimes usually suffice, although supplemental lighting during winter can be beneficial.

TEMPERATURES

Phalaenopsis has a relatively long juvenile phase to allow it to grow to a sufficient size to reproduce. Temperature is the primary environmental factor initiating flowering. It is widely and incorrectly believed that low nighttime temperatures induce flowering, but it has been shown that low daytime temperatures are the main stimulus. Commercial greenhouse producers commonly grow phalaenopsis for 1 to 2 years in a day/night temperature fluctuation of 28/26°C to promote vegetative growth; and stimulate flowering with a chilling treatment of 30 to 60 days at 21/19°C. In the home, night temperature should not be lower than 15.5°C (60°F). The recommended day range is 24–29.5°C (75–85°F). The high temperatures employed by commercial growers produce faster growth but require closer control of humidity and air movement.

WATERING

Orchids like cattleyas have pseudobulbs (enlarged stems) which store water and so can tolerate periods of drought. However, phalaenopsis species are intolerant of substantial

drying out as they have limited means of storing water (just the succulent leaves) and are mostly adapted to areas that are rainy and misty. Larger pots require less watering, so oversize pots can be helpful (provided they are not overwatered). A bark-based medium dries out rapidly and should be watered every few days. By contrast, sphagnum moss is very water-retentive and does not require watering for at least a week. However, sphagnum tends to produce overly wet conditions, leading to fungal infection and decay. As noted above, orchid specialists often add extra drainage holes or expand the drainage holes of standard pots to promote drying. Salt-softened and distilled water should be avoided. Tepid water is recommended, although a frequent practice (sometimes criticized by specialists) is to simply put some ice cubes in the pot (to provide for meltwater over an extended time). Misting the plants can be somewhat helpful, but doing so with hard water can result in deposition of a mineral crust on the foliage. Watering in the morning is preferable and the foliage should not be moist overnight, to prevent encouraging rot. Potting mixes should be kept evenly moist but allowed to dry out slightly between irrigations.

HUMIDITY

A humidity of 50–70% is suitable for most hybrid phalaenopsis. Humidifiers or misters are beneficial in dry situations, especially during the winter season when it is very difficult to maintain suitably high humidity indoors. Nevertheless, the plants are usually just kept on a wet pebble tray with 2.5–5 cm (1–2 inches) of water, taking care to keep the water level in the tray above the pebbles (and so below the bottom of the pot) to prevent wicking of water to the roots. A disinfectant added to the water will discourage buildup of algae. Air movement is also beneficial. At higher humidities (such as in moist climates), air movement is strongly recommended. Some hobbyists keep plants in a transparent plastic tent in order to maintain humidity, and in this situation it is especially important to provide air circulation.



Figure 11: Examples of floral displays of hybrid *Phalaenopsis* cultivars. A: 'Elegant Deborah' (credit: Pressebereich Dehner Garten Center, CC BY ND 2.0). B: 'Pandora' (photo by Roger Fenton, CC BY 2.0). C: Unidentified cultivar (photo by B. Brookes). D: 'Mino Lightning' (credit: Pressebereich Dehner Garten Center, CC BY ND 2.0).

REBLOOMING

Phalaenopsis tends to produce flowers in the late winter and early spring, but may produce some flowers year-round. After the flowers senesce, the plant can be encouraged to rebloom by cutting the flowering stem 1.3 cm (0.5 inch) above the first or second node with disinfected pruners. Only large and healthy plants should be stimulated to rebloom repeatedly. An excellent video on the subject is at www.youtube.com/watch?v=ABXOpzwe3Wo.

Curiosities of Science and Technology

- Orchids have a very long erotic reputation. The root word of "orchid" is the Greek *orkhis*, testis, a reference to tubers (tuberous roots are present in a few species). The ancient Greeks viewed the plants as the incarnation of Orchis, the lustful son of a satyr and a nymph, who had attempted to rape a priestess, and was turned into a flower after his death. Ancient Greek parents believed a man would father sons if he ate large, new orchid tubers, while a woman would give birth to daughters if she ate small tubers. The beauty and exotic nature of orchids led to their being associated with sensuality in the literature and mythology of various cultures. Orchid tubers have long been used as an aphrodisiac to boost a man's libido and, in parallel, the flowers have been employed as an enhancement to the formal attire of women to make them more attractive.
- Orchids vary tremendously in size. The smallest is likely *Platystele jungermannioides*, which is less than 7 mm (1/4 inch) long. Several *Vanilla* species are longer than 30 m (100 feet). *Grammatophyllum speciosum*, thought to be the largest orchid, produces clumps weighing as much as 2 tons.
- During the Victorian era, orchids were ostentatious symbols of wealth, flagrantly displayed by the rich. The astronomical prices paid to orchid poachers sometimes led to orchid collectors killing their competitors (Orleans 1998). More seriously, immense damage was done to orchid habitats. Some early collectors picked every plant in sight, and burned the land to corner the market for a given species. To this day, illegal orchid poaching and smuggling represent dire threats to the survival of numerous species.
- Some species of *Phalaenopsis*, such as *P. violacea*, are unique with respect to petal development following fertilization of the flowers. In almost all plant species, petals senesce after pollination, but in certain *phalaenopsis* they rejuvenate, becoming fleshy and green, and apparently producing enough chloroplasts to contribute to photosynthetic production.
- Orchid Island (Lanyu) is a tiny Taiwanese island with a population of about 4,000, named for its local species of *Phalaenopsis*, on the southeastern coast of Taiwan. Unfortunately, most of the native flora has been decimated, and the location has become a dump for nuclear waste despite the protests of the mostly indigenous Tao people. Lesser Orchid Island, a nearby unin-

habited volcanic islet, is the refuge of a critically endangered endemic form of *P. equestris*. Military aircraft have used the site for target practice.

- Most orchids require regular attention, and orchid owners who have built up large and valuable collections often find themselves tied down to their “babies.” In recent times, the profession of “orchid sitting” has appeared to allow orchid enthusiasts to be away from home. Similarly, some nurseries offer a “boarding service,” reminiscent of parents who send their children to camp while they vacation.

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Key Websites

There are hundreds of orchid societies and clubs worldwide, and most of these are interested in phalaenopsis orchids since these are the principal commercial forms. There are also thousands of firms supplying orchids. Accordingly, there are numerous websites providing information on phalaenopsis. The following sites are particularly informative.

AMERICAN ORCHID SOCIETY

www.aos.org [particularly note the AOS video library at www.aos.org/Default.aspx?id=95]

CANADIAN ORCHID CONGRESS

canadianorchidcongress.ca [has links to many Canadian orchid organizations]

ORCHID MALL

www.orchidmall.com/society.htm [links to orchid societies around the world]

ORCHID RESOURCES IN CANADA

www.orchidwire.com/Earth/1/Canada.html?v=343 [lists commercial firms and non-profit organizations]

ROYAL HORTICULTURAL SOCIETY

www.rhs.org.uk [has numerous documents dealing with orchids]

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Department of Biological Sciences

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Applicants must hold a PhD in the biological sciences or related field, with postdoctoral experience in a discipline relevant to plant biology and functional genomics. The successful candidate will have a strong publication record demonstrating exceptional research expertise in plant biology and genomics, and show the ability or potential to obtain external funding from different programmes or sources to develop a strong research programme. The successful candidate will have the ability to teach courses in topics such as plant biology, biochemistry, molecular biology, and genomics. Prior experience in teaching and mentorship is highly desirable. An outstanding candidate will be invited by the Dean, Faculty of Science, to apply for a Canada Research Chair at the Tier II level. (www.chairs-chaire.gc.ca)

Candidates should electronically submit a curriculum vitae, a two-page summary of research interests, a one-page statement of teaching interests, and reprints of their three most significant publications to recruitment1@biology.ualberta.ca. Please arrange for three letters of reference to be sent to the attention of the Chair to recruitment1@biology.ualberta.ca

All correspondence should be addressed to:

Dr. Michael Caldwell, Chair
Department of Biological Sciences
CW405 Biological Sciences Building
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