SHORT NOTE Air layering as a propagation method in glasshouse cultivation

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Abstract

The glasshouse renovation works being undertaken at the Royal Botanic Garden Edinburgh (RBGE) as part of the Edinburgh Biomes Project (2020–2027) pose a number of challenges to the horticulturists managing the plant collections. The grandeur of many of the larger specimens and the limit of available space are the most prominent of these. Air layering is a propagation method that until recently has not been used widely at RBGE. It has however proven to be a successful technique to maintain the genetic diversity of the collection while reducing both the need for space in propagation glasshouses and the level of aftercare required once propagation is complete. This Short Note explains the method used and highlights several successful propagations, illustrated with images, along with suggestions for implementing the method in the future.

Introduction

The Edinburgh Biomes Project is one of the largest renovation projects ever undertaken at the Royal Botanic Garden Edinburgh (RBGE). The project commenced in 2020 with the main body of work scheduled for completion in 2027. Many of the large trees and shrubs cultivated in the glasshouses at RBGE will prove to be challenging and/or impossible to remove from their current locations without drastic canopy pruning and root disturbance, potentially resulting in loss of plants. A number of these are therefore being propagated to maintain the taxonomic and genetic diversity of the collection.

This article will focus on the use of air layering within the arid and temperate collections in the Indoor Department at RBGE. The method has also been used on the tropical collections and on hardy plants growing outside the glasshouses. Many of the plants propagated by this method are part of RBGE's extensive collection of cultivated Chilean flora.

Numerous plants within the living collection are poorly represented in cultivation and there is little or no literature available on their propagation or cultivation. Experimentation with various treatments and propagation timings, to increase numbers of plants and knowledge of their cultivation, is required.

This article describes a standard operating procedure for air layering and provides a list of the materials required. Noteworthy successful propagations using this method include *Austrocedrus chilensis* (D.Don) Pic.Serm & Bizzarri, *Porlieria chilensis* J. Arnold Arbor, *Myrcianthes coquimbensis* (Barnéoud) Landrum & Grifo, *Schinus polygamus* (Cav.) Cabrera, *Cussonia paniculata* Eckl. & Zeyh., *Schotia afra* var. *angustifolia* (E.May) Harv. and *Prosopis* sp. L. The details of the propagations are listed later in the article.

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Method

Overview

Air layering, or marcotting, is a propagation method originating in China some 4,000 years ago (Menzel, 2002; Rafieq *et al.*, 2016). It involves wounding, sometimes even girdling, a limb of a woody plant to encourage it to produce adventitious roots while still attached to the parent plant. Once successfully rooted, the propagule can be removed from the parent plant and potted or planted out. The method is widely used by fruit producers as it allows the propagator to produce plants that are true to type and often already at a mature life stage and capable of fruiting. It has also been used as a means of propagating *Ulmus* spp. with a resistance to Dutch elm disease (Hartmann *et al.*, 2011).

Materials needed

- A sharp, sterile knife for making incisions and girdling
- Rooting hormone. While this is not essential for successful propagation, it may increase the likelihood of survival and the total root mass of completed propagations (Akoto *et al.*, 2016; Okonkwo *et al.*, 2020).
- Growing media. Sphagnum moss is primarily used at RBGE; however, other materials such as topsoil and sawdust can have successful results (Yakubu *et al.*, 2019), and species are likely to respond differently depending on the choice of medium.
- Tags to label the propagule with details of any treatments used and the date the air layering was carried out. This is not strictly necessary for successful propagation but allows the propagator to track progress and gain a better understanding of what treatments work on which species.
- An air layering pot or black plastic sheeting to wrap the layer. With prostrate shoots close to ground level, it is possible to use standard plastic pots with a groove cut into them for the propagule to rest in (Fig. 1).

Air layering pots are beneficial as they allow roots to be inspected without disturbing the growing medium, thus limiting potential damage to emerging roots (Fig. 2). These pots consist of two hemispherical cups with a groove at each end. The grooves enable the propagule to be held in a stable position in the pot, and allow for irrigation when required. Air layering pots are available in a range of sizes, and can be used on branches with a diameter of 5 mm to 40 mm. The smaller pots hold a smaller volume of growing medium and so will dry out more regularly and therefore require more irrigation in arid environments.

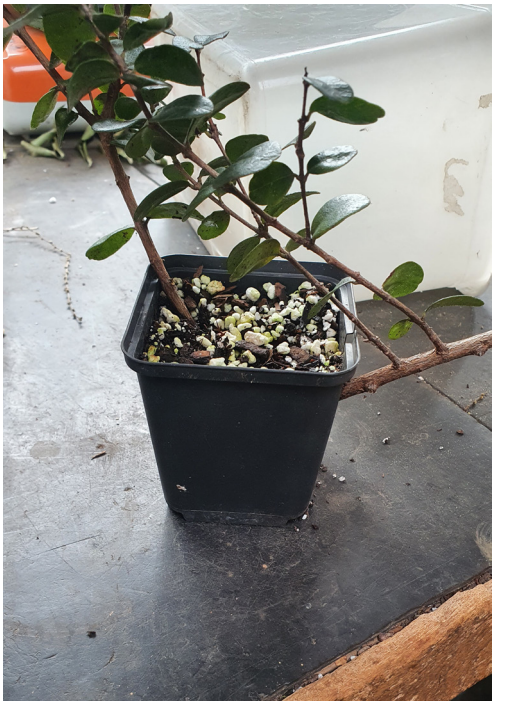

Fig. 1 *Myrcianthes coqumbensis* air layer using a standard black plastic pot. Photo: Marc Gilbert.

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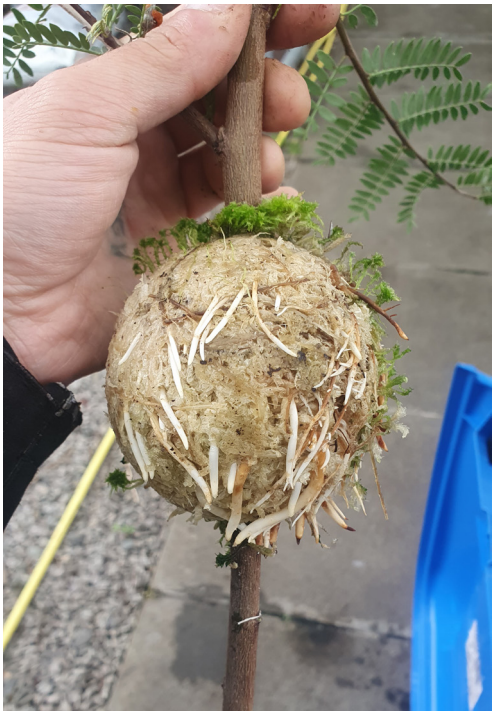

Fig. 2 Inspected air layer of *Schotia afra* var. *angustifolia* showing successful rooting. Photo: Marc Gilbert.

Process

Healthy shoots with desirable growth traits are selected for use as propagules. Vertical shoots are preferred, first because of the increased likelihood of apical dominance on the new plant, and second because irrigation is easier throughout the propagation process on a vertical shoot. The selected shoot is then stripped of any leaves and side shoots approximately 10 cm above and below the point of layering. If a horizontal shoot is selected and an air layering pot used, care must be taken when irrigating as the medium will be incapable of draining fully due to the spherical shape of the pot.

The cambium between two nodes is then removed using a sterile knife, completely girdling the shoot (Figs 3 & 4). At this point rooting hormone, if being used, should be applied.

Fig. 3 Shoot of *Juniperus excelsa* subsp. *polycarpos* before girdling. Photo: Marc Gilbert.

Fig. 4 Shoot of *Juniperus excelsa* subsp. *polycarpos* after girdling. Photo: Marc Gilbert.

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The air layering pot should then be filled loosely with moist sphagnum moss, or another moisture-retaining substrate, and placed over the wounded shoot. If using plastic sheeting to cover the wounded area in place of an air layering pot, then sphagnum moss should be wrapped around the wounded shoot during wrapping to seal the area. Care should be taken not to overfill the pot with growing medium as it may become difficult to irrigate. Propagules will callus and root as cuttings would (Fig. 5), forming a mass of undifferentiated totipotent cells that can divide into other forms of plant tissue. Roots will then form from the callus.

Once roots are evident, the propagule should be removed from the parent plant and potted into an appropriate medium or planted out. The roots should be inspected infrequently to avoid unnecessary disturbance to any new roots that are developing. Propagules left to develop a more 'rootbound' root system before severing from the parent plant have shown improved establishment rates once potted.

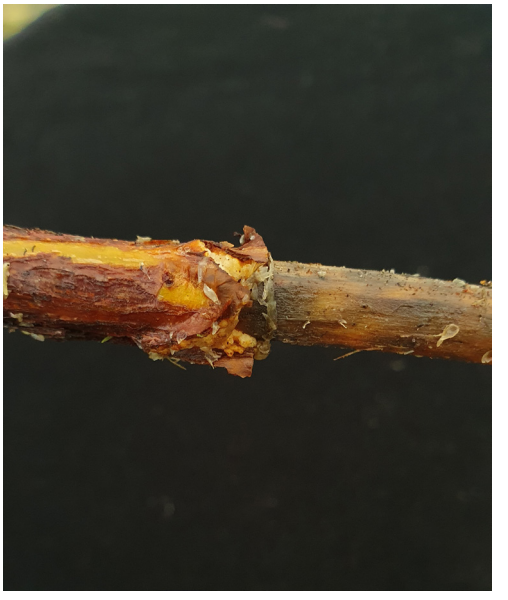

Fig. 5 *Rhododendron liliiflorum* callus forming during air layering. Photo: Marc Gilbert.

Noteworthy successful propagations

Austrocedrus chilensis – Cupressaceae

The air layering process began in July 2021 and followed the method described above, with no hormone treatment. The first sign of roots on the air layer appeared in April 2022 (Fig. 6). At this point the propagule was removed from the parent plant. The roots were rinsed to loosen any excess sphagnum moss before being potted into an inorganic growing medium. Unfortunately, in September 2022 it was observed that the shoot selected for air layering did not appear to have apical dominance. At that point, a

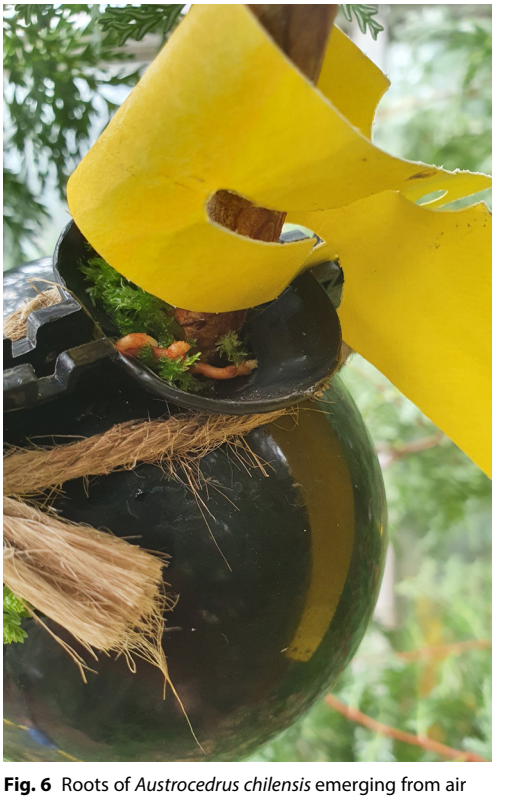

Fig. 6 Roots of *Austrocedrus chilensis* emerging from air layering pot. Photo: Marc Gilbert.

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new air layer was attempted with the aim of propagating a plant with a more desirable habit. Unfortunately this attempt was unsuccessful.

Cuttings were also taken in December 2021 and treated by soaking in water with indole butyric acid at a concentration of 0.05 g per litre for 24 hours. These serve as a comparison between the propagation methods.

A number of these cuttings were successful, but have resulted in smaller plants than the one propagated via air layering (Fig. 7). These plants do however appear to have apical dominance, making them more useful for future planting.

Porlieria chilensis – Zygophyllaceae

Multiple attempts at propagation were made at different times of year and using various hormone treatments and different types of cutting. All attempts were unsuccessful.

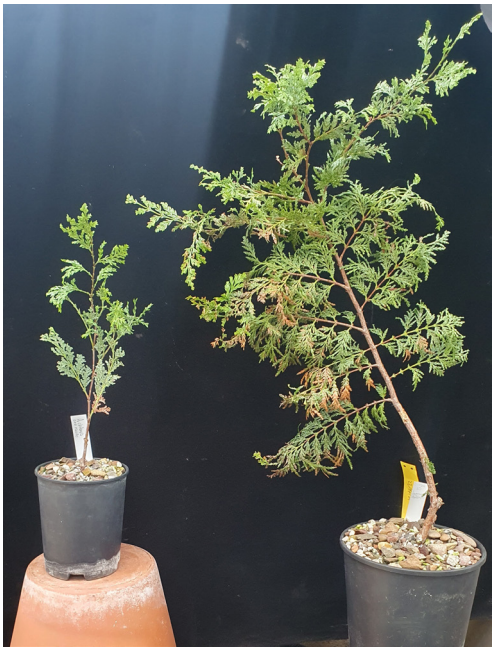

Fig. 7 Comparison between cutting (left) and air layer (right) of *Austrocedrus chilensis.* Photo: Marc Gilbert.

Air layering was carried out as described above in December 2021. A 1.2% indole butyric acid gel was applied to the wound before covering it with sphagnum and enclosing it in an air layering pot. The propagule had rooted by June 2022 and was removed from the parent plant (Figs 8 & 9). The sphagnum moss was removed from the roots and the plant was potted.

Myrcianthes coquimbensis – Myrtaceae

Air layering began in December 2021, again using the process described in this article. Standard plastic pots with a groove cut out were used instead of air layering pots (Fig. 1). Standard pots were chosen as the shoots being propagated were growing prostrate to the surrounding hard landscaping. The shoots were only partially girdled. A mix of equal parts perlite and propagation bark was chosen as the growing medium. No hormone treatment was used. The propagation was completed in April 2022 and the propagules were planted into an inorganic growing medium of sandstone gravel.

Schinus polygamus – Anacardiaceae

Unlike the other plants covered in this article, *Schinus polygamus* was planted outdoors in a sheltered position in front of a south-facing wall. Propagation was carried out in April 2022 using the air layering method. The wound was treated with indole butyric acid at a concentration of 0.05 g per litre. The air layering pots were filled with a mixture of equal parts sphagnum moss, vermiculite, perlite and propagation bark. The rooted propagule was severed from the parent plant in September 2022.

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Fig. 8 Propagule of *Porlieria chilensis* removed from parent plant. Photo: Marc Gilbert.

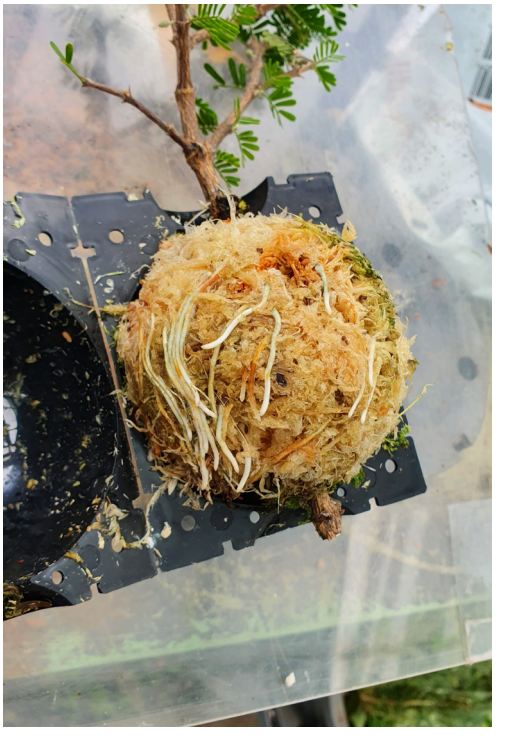

Fig. 9 Air layered roots of *Porlieria chilensis*. Photo: Marc Gilbert.

It should be noted that air layering was also attempted on *Schinus patagonicus* growing alongside *S. polygamus* using the same method and treatment on the same dates, but was unsuccessful.

Cussonia paniculata – Araliaceae

Propagation began in April 2022 using the air layering process described above. The propagation was completed in August 2022. The propagule was considerably larger than others mentioned in this article (over 100 cm tall with a diameter of > 4 cm) so was supported with stakes when planted. The size of the propagule may be a factor in its success as propagules with larger diameters have been shown to produce a greater root mass in *Balanites aegyptiaca* (Massaoudou *et al.*, 2022).

Cussonia paniculata has previously been successfully propagated via nodal cuttings. Air layering was chosen as a propagation method because of the lack of side shoots available for use as cuttings and as it would produce a larger propagule.

Schotia afra var. *angustifolia* – Fabaceae

Propagation started in April 2022 and was complete by July 2022 (Fig. 2). It was carried out using the method described in this article with no hormone treatment. Sphagnum moss was removed from the roots as much as possible before the propagule was potted into an inorganic growing medium with a small amount of organic material.

Prosopis sp. – Fabaceae

The individual being propagated was grown from seed collected in Antofagasta, Chile, in 2008 and is yet to be verified to species

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level. Multiple propagation attempts have been made with cuttings, all of which have been unsuccessful. Air layering was started in June 2022 following the method described in this article. The propagules were treated with 1.2% indole butyric acid gel. Two attempts were made at air layering; one was unsuccessful, while roots had formed on the other plant by January 2023.

Discussion

The primary advantage of air layering is that it has enabled the propagation of plants that have proven difficult to propagate through other vegetative methods. It also allows for larger and more mature propagules to be taken from the parent plant, with these often quickly developing large and strong root systems. Large plants with strong root systems need less detailed aftercare when compared with other vegetative propagation methods and produce new plants which are almost immediately more suitable for display plantings. Air layering also reduces the space needed for propagation in closed cases or on mist benches as the process is carried out *in situ*. It is also fairly easy to set up multiple air layers in one day once all the materials have been assembled.

However, there are disadvantages to air layering: if it is unsuccessful, a large amount of plant material is wasted that may otherwise have been used to produce dozens of cuttings, given that the shoot that is being air layered is likely to desiccate. Often, a considerable amount of irrigation is required to keep the growing medium moist throughout the propagation process, particularly on plants in the arid collection where the growing environment is maintained to a low relative humidity. It has been noted that when the growing medium has been allowed to dry out, the newly forming callus also dries out, resulting in the propagule dehydrating and eventually failing.

Other applications for air layering

Following the success stories described here, air layering is now also being attempted on a range of plants in the potted temperate collection at RBGE. If successful, it will free up space in the back-up glasshouses and allow for the larger – often overgrown and rootbound – trees and shrubs to be replaced with their smaller propagules. Plants in the tropical display glasshouses that have proven difficult to propagate by other vegetative methods are also being air layered. Early signs of success include *Bulnesia arborea* (Zygophyllaceae), *Derris elliptica* (Fabaceae) and *Litchi chinensis* (Sapindaceae).

Air layering may also prove useful in the field, particularly in mesic habitats such as temperate and tropical rainforests, and cloud forests where moisture is plentiful, and where the need for manual irrigation of the propagule throughout the process is reduced.

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