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AIR LAYERING WITH POLYTHENE FILM

THE making of air layers on woody plants to induce rooting is a practice that is centuries old. Generations of Chinese did it, and undoubtedly it was introduced into America by the earlier settlers. Until comparatively recently, the method has been used chiefly in the greenhouse. It consisted of scarifying the stem of a plant and wrapping moist moss (or soil) around that injured plant part. If the wrapping material was kept moist continually, rooting often occurred. The difficulty came in keeping the wrapping material moist. Rubber or paper wrappings did not prove satisfactory, and watering of the wrapping would frequently have to be done daily and even several times a day in a hot greenhouse. This continual care was frequently more bother than it was worth.

In 1947, Colonel William R. Grove of Laurel, Florida, found that the old-fashioned method of air layering could be decidedly augmented with the use of one of the newer plastic films. He published his findings dealing with the propagation of Lychee in the 1947 "Proceedings of the Florida Horticultural Society." Colonel Grove at first used "Pliofilm" manufactured by the Goodyear Tire and Rubber Company, Inc., but he found that it disintegrated before the roots formed. Then he used "Vitafilm" this yielding much better results. On the strength of this he has used it (and other materials as well) in commercial propagation, and applied for a patent, granted four years later, covering use of plastic material in air layering process.*

In 1950 John L. Creech of the United States Department of Agriculture Station at Glenn Dale, Maryland used plastic films with good success in the propagation of evergreen rhododendron air layers, and published some of his experiences in the National Horticultural Magazine, July 1950. He used a polythene film successfully. The Arnold Arboretum, after suggestions made by Mr. Creech earlier in the year, started using polythene film around air layers in the summer

* Airwrap Products, Box 142, Sarasota, Florida.

of 1949. Results proved so interesting that additional experiments were tried in 1950, some plants showing rooting that might not ordinarily be expected to root as cuttings. During the past summer, Mr. Heman Howard of the Arnold Arboretum placed air layers on 250 species and varieties of woody plants. Some were placed early in the spring, some were placed on the current year's growth in June and July, in an attempt to determine whether this is a reliable method of rooting difficult plants. The results this year have been rather disappointing in that many of the air layers failed to root. Even with the failures, there remain enough possibilities to make this method of interest for everyone, and in order to place some of this information before ARNOLDIA readers the results accomplished in some of these experiments are recorded here.

Polythene Film

There are a confusing number of plastic films now on the market, and all do not have the same properties. The important properties of the film necessary for assisting in the proper rooting of air layers, would obviously include high permeability to gases like oxygen and carbon dioxide, and a very low permeability to water vapor.

A few years ago the Imperial Chemical Industries Ltd. of England developed a plastic known as "Polythene," a high polymer of ethylene. E. I. DuPont de Nemours & Company was licensed to manufacture this resin in the United States in 1943. Originally DuPont used the name "Polythene," but later adopted the trade name "Alathon" for this new plastic. Bakelite Corporation is also licensed to manufacture this resin, they calling their product "Polyethylene." These new plastic films are now widely used for packaging foodstuffs under such trade names as "Howard-Seal," "Pearlon," "Tralon," "Visqueen," etc. Specifically, the material used at the Arnold Arboretum was one of these, purchased from the Harwid Company of Cambridge, Massachusetts under their trade name of "Dura-Clear," manufactured from the resin "Alathon." It is unfortunate that the terms "Polythene" and "Polyethylene" have both been used as the generic name for the high polymers of ethylene since they are confusing to the layman. The point is, that the "Dura-Clear" used in our experiments, has the same properties as the "Alathon" of the DuPont Company. These properties are as follows:

Thickness of Film	*Transmission of Water Vapor* (in grams per 100 sq. inches of exposed film surface during 24 hours)
0.001″	0.95
0.002″	0.65
0.003″	0.46
0.004″	0.32
0.006″	0.21
0.008″	0.15

Permeability to Gases

Gases	*Permeability in cubic centimeters per 100 sq. inches in 24 hours*
Oxygen	175
Carbon dioxide	700 (higher if water vapor is present)
Nitrogen	72
Hydrogen	225

The thickness of the "Dura-Clear" film we used was four thousandths of an inch, but thinner material would probably have served just as well. It is these qualities relating to water vapor and permeability to certain gases that make this material ideal when wrapped about air layers. (The same properties and its transparency make it ideal in packaging perishable fruits and vegetables.)

It is obvious, from the above, that the polythene film should be conducive to rooting. It should be noted that air layers have been kept perfectly moist by this film, when the wrapping of the film is done tightly, for periods of up to one year in length. Sometimes the sphagnum moss in the wrap actually grows, and grass seeds germinate and grow vigorously when included in the moss mixture. Because the film is fairly transparent, the rooting of the twig inside can sometimes be noted without even opening the wrapping.

This polythene film (the term used here to include all such trade-named products as mentioned on page 50) is ideal for packaging plants also. Mr. Richard Fillmore, the Propagator at the Arnold Arboretum, has merely wrapped dormant scions of roses in polythene with very little sphagnum moss, sent them by ordinary mail to England where they arrived five weeks later in perfect condition. He also wrapped scions of roses (*Rosa hugonis*) without packing material and placed them in the refrigerator for about 12 months with no bad effects, after which they were grafted and some grew successfully. Some azalea plants (3′ tall) were dug last spring at the Case Estates, the roots washed free of all soil and then wrapped tightly in polythene film. Some were kept outside, others were kept at room temperatures for a full month, then were planted out, and all grew normally thereafter.

The Air Layer

The making of the air layer itself is very simple and the principle is over a thousand years old. A longitudinal cut of about two inches upward is made on the young twig, the cut going nearly to the center of the twig. (An adaptation of this is to remove a complete circle of bark one half inch wide around the stem.) Then both cut surfaces are dusted with some hormone rooting powder which may (or may not) aid in the rooting. We have used Hormodin #3, but undoubtedly other materials are just as good. Moist sphagnum moss — about a handful — is packed *between* the cut surfaces and then all around the entire cut, fully covering it. Polythene film is wrapped carefully and tightly about it, then tied top and bottom.

Rubber bands used in grafting have not proved satisfactory for tying. Mr. James M. Rooney of Attleboro, Massachusetts, suggested the use of Scotch Electrical Tape #33, and this has proved most satisfactory.

The wrapping and tying of the film should be done in such a way that the moss is well contained and that no opening in the film is left for the evaporation of the moisture from the moss.

Mr. Fillmore has pointed out that the overlap of the film wrapping should be on the underside of the air layer so rain water will not seep in. Also he has pointed out the very important fact that in taping the top end of the wrap the tape should be started on the bare twig and gradually spiral down to completely close the top end of the wrap in order that rain water will not seep down the twig and into the moss inside. In Plate XIII this is not done properly. Many of the air layers we made in 1951 may have failed to root because this was not done, water seeped into the moss packing, pushing out much of the air and creating a soggy condition decidedly unfavorable to rooting. If properly done, the air layer will remain moist for months (we have had some remain moist for a year) and rooting may take place in a few months' time.

This is all there is to the operation. The time it is done, the size of twig used, the amount of hormone powder used and the amount of moisture in the moss are variables with which one has to contend for proper rooting. We have placed air layers in early spring on wood that is dormant, and again in June and July on twigs that grew the current year. As far as our results have been concerned, there seems to be a considerable variation and one would expect that rooting might easily vary with the species. Many plants are propagated from both "hard wood" or dormant cuttings, and "soft wood" cuttings made of wood grown the current year; others may root better from one or the other type of cutting. Consequently one would expect the time these layers are applied might well vary with the species, for best rooting.

Twigs have been rooted that were a half inch in diameter, although usually one might expect normal rooting from the twigs about the size of a lead pencil. We have undoubtedly been over-generous with our applications of the rooting powders, and Mr. Fillmore has suggested that, from the appearances of some of the layers later, too much has been applied, for some have shown what appears to be hormone injury. This also is something what will have to be worked out later. Because so very little moisture passes through the film, one should be extremely careful not to have too much moisture in the sphagnum moss at the time it is applied about the cut. The moss should be squeezed prior to application, so it will be moist — not wet.

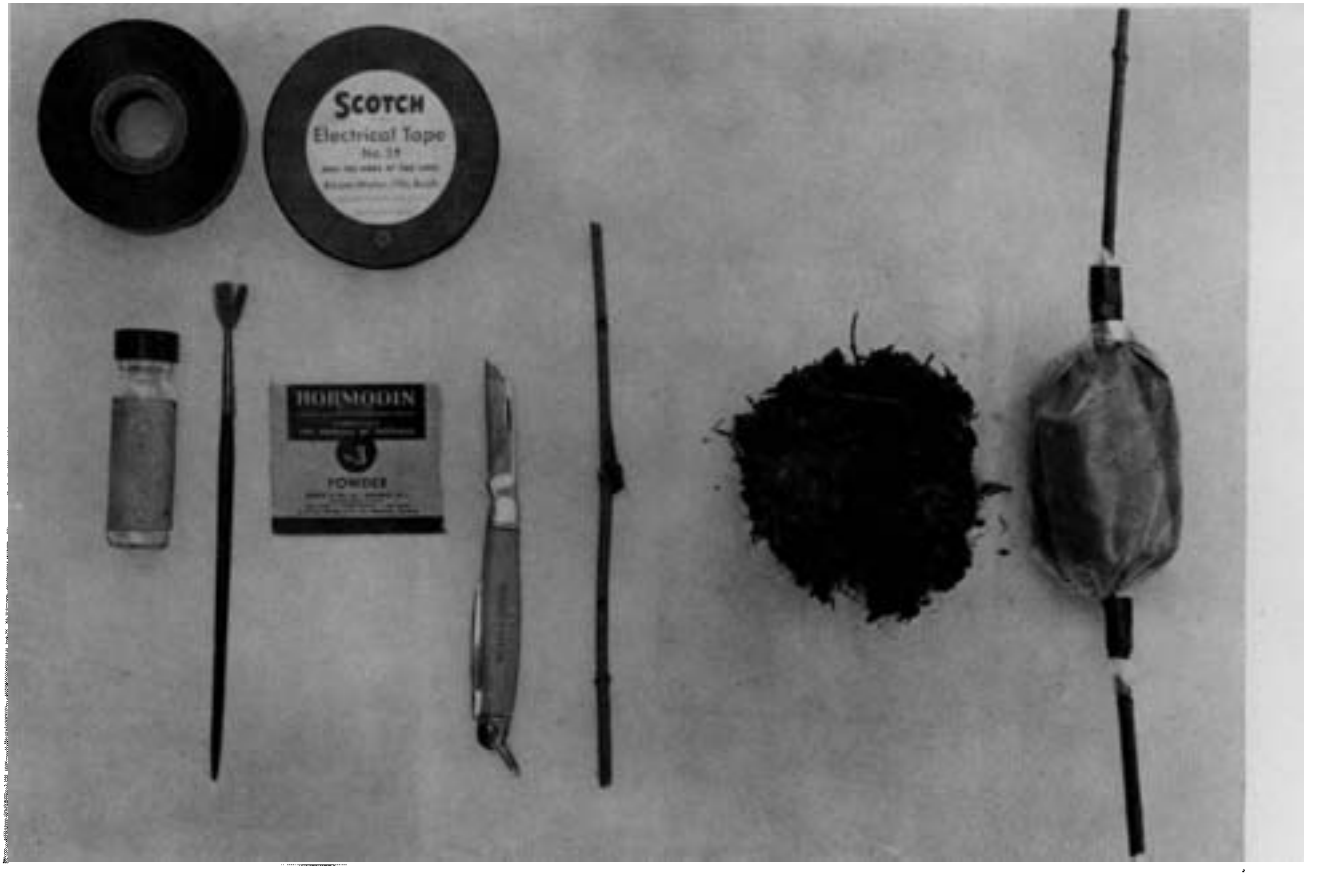

PLATE XIII. Materials used in air layer experiments at the Arnold Arboretum. Note comments on making a proper seal at the top of the layer, page 52.

Plants which Rooted by Air Layering

	Number Tried	*Number Rooted*
*Abeliophyllum distichum	1	1
"	4	2
Acer barbinerve	6	4
" callipes	3	2
" circinatum	5	3
" cissifolium	1	1
" duretti	3	1
" ginnala	2	1
* " griseum	3	1
" "	3	1
" grosseri hessi	4	3
" palmatum dissectum	4	1
" pensylvanicum	6	6
* " platanoides	6	4
" "	4	1
" " globosum	4	3
" " nanum	2	2
" " var.	4	4
" saccharum monumentale	8	1
Aesculus carnea	4	2
" hippocastanum	6	2
" " umbraculifera	4	1
*Albizzia julibrissin rosea	10	5
Betula aurata	3	1
" fontinalis	4	2
Carya tomentosa	6	1
Castanea mollissima	10	1
Catalpa bignonioides	4	4
" bungei	4	1
" speciosa	4	2
Cercis chinensis	4	2
Cladrastis platycarpa	3	2
Clethra barbinervis	3	2
*Cornus alba sibirica	3	3
Cornus florida rubra	9	8
Corylopsis glabrescens	4	3
" spicata	4	3
Corylus chinensis	4	1

*Layers made in 1950, all others in 1951.

Plants which Rooted by Air Layering (Cont.)

	Number Tried	*Number Rooted*
*Cotinus coggygria purpureus	4	4
" " "	11	3
Cotoneaster foveolata	4	4
" horizontalis	4	4
Crataegus monogyna stricta	6	1
" pinnatifida major	6	1
Cytisus praecox	4	1
" supinus	4	4
Davidia involucrata vilmorini	15	5
Diospyros lotus	4	2
Enkianthus campanulatus	5	3
*Forsythia "Arnold Dwarf"	3	3
Franklinia alatamaha	4	4
Ginkgo biloba	1	1
Halesia carolina	6	6
" monticola rosea	4	4
Hedera helix baltica	4	4
*Hibiscus syriacus rosea	1	1
Hippophae rhamnoides	6	3
Ilex crenata convexa	4	4
" glabra	6	6
" montana macropoda	1	1
" verticillata	3	1
Indigofera amblyantha	4	3
Koelreuteria paniculata	8	3
Laburnum anagyroides	4	3
" watereri	8	4
*Ligustrum ibota aureum	3	3
* " ovalifolium	4	4
" vulgare buxifolium	4	4
Lonicera maacki	4	2
Maackia amurensis	4	4
Magnolia denudata	10	1
" soulangeana "Alexandrina"	4	1
Malus astracanica	4	1
" atrosanguinea	5	4
" "Dorothea"	5	5
" floribunda	6	1
" halliana spontanea	5	1

Plants which Rooted by Air Layering (Cont.)

	Number Tried	*Number Rooted*
Malus "McIntosh"	3	2
" micromalus	7	2
" prunifolia rinki	6	3
" purpurea	4	3
" sargenti rosea	6	3
" spectabilis	6	5
" sublobata	6	6
" "Wabiskaw"	4	2
Morus alba pendula	4	2
Orixa japonica	4	4
Osmaronia cerasiformis	4	2
*Populus alba nivea	2	2
Prunus juddi	1	1
" maacki	2	2
" serrulata "Amanogawa"	4	3
" " "Gyoiko"	2	1
" " "Kwanzan"	6	2
" yedoensis "Taizanfukun"	4	4
Ptelea trifoliata aurea	6	2
*Rhododendron "Dr. Charles Baumann"	7	5
* " "Josephine Klinger"	9	8
Salix caprea	7	7
Styrax japonica	7	2
Symplocos paniculata	6	3
Syringa amurensis japonica	6	1
" prestoniae "Lucetta"	4	3
" " "Paulina"	5	3
" villosa	5	3
" vulgaris vars.	35	9
Tamarix pentandra	2	2
Taxus cuspidata nana	3	1
Tilia cordata	5	3
" platyphyllos fastigiata	8	2
Tsuga canadensis	3	3
Ulmus carpinifolia koopmanni	6	1
" " sarniensis	4	1
" glabra	4	1
Vaccinium corymbosum "Jersey"	3	2
Viburnum carlesi	4	1

Plants which Rooted by Air Layering (Cont.)

	Number Tried	*Number Rooted*
*Viburnum dilatatum	4	1
" juddi	4	1
* " opulus	2	2
" rhytidophyllum	4	1
" rufidulum	6	1
* " sargenti	6	5
" "	3	3
" " flavum	4	4
" setigerum aurantiacum	8	3
" sieboldi	4	1
Wisteria floribunda violacea-plena	4	2
" " longissima alba	4	2
" " "Naga Noda"	4	4
" formosa	4	2
" macrostachya	4	4
" sinensis	15	1
" " hybrid	2	2
" venusta	3	1
Zelkova serrata	6	6
" sinica	6	3

Plants which Failed to Root

	Number of Layers Tried
Abies homolepis umbellata	6
Acer campstre	6
" palmatum atropurpureum	1
" " lutescens	2
" platanoides	6
" shirasawanum	3
" tataricum	6
Aesculus carnea plantierensis	5
" discolor mollis	4
" glabra leucodermis	4
Albizzia julibrissin rosea	16
Amelanchier canadensis	2
Amelasorbus jacki	4
Betula jacquemontiana	3
Carpinus cordata	4
" orientalis	4

Plants which Failed to Root (Cont.)

	Number of Layers Tried
Carya glabra	6
" laneyi	2
" ovata	4
" schnecki	4
Castanea dentata	4
Catalpa fargesi	6
Cercis canadensis alba	8
Chaenomeles sinensis	4
Chionanthus retusa	4
" virginicus	2
Cladrastis lutea	4
Cornus florida	4
" mas elegantissima	8
" officinalis	4
Corylus avellana fusco-rubra	4
" " contorta	3
" colurna	5
Cotinus americanus	5
Crataegus arnoldiana	4
" coccinioides	6
" lavallei	4
" monogyna inermis	2
" " versicolor	3
" nitida	5
" pruinosa	6
" punctata	6
" succulenta	3
Diospyros virginiana	4
Eucommia ulmoides	4
Evodia danielli	4
Fagus grandifolia	2
" sylvatica atropunicea	3
" " pendula	4
Fothergilla monticola	2
Fraxinus chinensis	6
" pennsylvanicum	4
Gleditsia triacanthos	6
" " inermis	4
Hamamelis mollis	8

Plants which Failed to Root (Cont.)

	Number of Layers Tried
*Hamamelis mollis	3
Juglans cinerea	6
" nigra	9
* " " laciniata	4
" " "	5
Kalmia latifolia	5
" " polypetala	7
Kalopanax pictus	4
Lindera benzoin	3
Magnolia fraseri	6
" loebneri	6
* " stellata rosea	4
" " "	6
" virginiana	4
Malus "Arrow"	3
" baccata	5
" "Bob White"	4
" brevipes	1
" coronaria charlottae	3
" florentina	5
" glabrata	4
" hupehensis	5
" ioensis plena	1
" robusta	4
" sargenti	6
Parrotia persica	4
Phellodendron amurense	9
" chinensis	4
" sachalinensis	6
Photinia villosa	4
Pinus bungeana	5
Prunus maritima "Eastham"	4
" " "Raribank"	4
" serrula	5
Pseudolarix amabilis	4
Quercus bebbiana	4
" bicolor	6
" dentata	4

* Layers made in 1950, all others in 1951.

PLATE XIV

Showing the rooting of Malus "Dorothea" in September 1950, three months after the air layer was made.

Plants which Failed to Root (Cont.)

	Number of Layers Tried
Quercus falcata	3
" marilandica	5
" mongolica	5
" robur	6
" " argenteo marginata	4
" runcinata	6
" stellata	5
" variabilis	4
Rhododendron "Mrs. C. S. Sargent"	4
" "Purpureum grandiflorum"	2
" "Watereri"	3
Robinia longiloba	3
Sophora japonica	4
Sorbus alnifolia	4
" aria	4
" aucuparia	8
" latifolia	6
" matsumarana	4
" pratti	3
" thuringiaca	4
Syringa pubescens	4
Taxus cuspidata expansa	4
Thuja standishi	5
Tilia americana fastigiata	4
" platyphyllos	4
Tsuga caroliniana	6
Ulmus carpinifolia dampieri	4
" " umbraculifera	6
" " wredi	4
" plotti	4
Vaccinium corymbosum "Harding"	2
Wisteria "Jako"	2

Results

It will be noted from the results that only a few plants were tried that are easy to root from cuttings. The process was merely checked at first to ascertain whether easily rooting plants like *Forsythia*, *Ligustrum*, *Syringa prestoniae*, *Populus*, the Siberian Dogwood, Tamarix and some of the Viburnums would root this way as well. Although the other materials (listed as rooted) may be rooted from

cuttings, most can be considered as "difficult" when handled in this way. The purpose of these reported experiments was to ascertain which of these difficult-to-root plants, would respond to the air layer technique, possibly saving a time-consuming grafting operation.

It must be admitted that after the roots are formed, the matter of cutting the potential plant from the parent is not simple. Only a few attempts were made to pot these plants. Mr. Lewis Lipp rooted twigs of the McIntosh apple, but was unsuccessful in getting the plants to grow after they were potted. Some of the other plants are in the same group. It may well be that cutting the rooted twig from the parent plant should best be done at a certain time, or gradually, or that the moss in the air layer might be taken from it and soil substituted before the plant is cut off. These first experiments have to do only with the formation of visible roots during one growing season.

Most of the layers were put on either in late April or July 1951 and were removed in early October. The majority of those that did not root were well callused, some much more so than others. Air layers that were opened by vandals, that broke off in high winds, or that died because of improper cuts, do not enter into the figures given.

This age-old subject of air layering now appears to be given a great impetus due to the properties of these new plastic films. If these results can be repeated, the percentage of rooting increased, and the young plants removed from the parent satisfactorily, this method of propagation will be a highly valued one in any garden where rare and difficult-to-propagate plants are grown.

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