Propagation Successes, Failures and Lessons Learned

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Abstract

Information on propagation of about 80 species of Pacific Northwest native plants is presented in table form, grouped by eleven protocols, followed by details about requirements for some specific plants, and rules of thumb for propagation techniques. Propagation of natives often involves trial and error, attempting multiple techniques and keeping good records. Communication with other propagators is invaluable.

Keywords

Native plants, seed germination, stratification, dormancy, cuttings, Pacific Northwest

Introduction

I am fortunate to have access to a very good propagation facility. I do not work exclusively with native plants — they share an annual production schedule with more than 100,000 annuals and perennials for our gardeners and hundreds of ornamentals for nursery stock. Though not an expert, I am a professional, and it is my aim that my empirical, (i.e. trial and error) experience may save others time and effort. My work with about 80 native species is presented in tables, grouped under eleven protocols. I will discuss some discoveries I have made and rules of thumb which I find useful. To live up to the title of this presentation, I also list some failures. I use my more interesting failures and near misses to illustrate some of the lessons I've learned. My techniques are not the only ones, but they work for me, and the lesson of that is that by sharing experiences with others, we can make connections

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which will help us all solve our propagation problems in a variety of ways.

Successes

I could also call this section "partial successes" because some were more successful than others, and some qualify as learning from mistakes, as you will see in the discussion of lessons and rules of thumb. Most seeds will germinate when natural conditions are simulated in an artificial environment. That may seem both obvious and easy, but it is not always the case. Some seeds will germinate under a wide variety of conditions, and others will stubbornly refuse to germinate even after careful handling, and therein lies the challenge. As technical as propagation can be, it is also an intuitive art. My self-taught technique has been to find out what I can about individual plants, then apply a few standard treatments. Toogood (1999) has wonderful, easily understood information on all types of propagation, and in a smaller space than any other reference I use. Young and Young (1986) contains information on steps to follow during collection, processing, storing and germination testing and trials for plants with unknown requirements.

When I research a plant I haven't propagated, I find that references often do not cover the one I am trying to grow, or that I need to alter recommended techniques in order to succeed (this is especially true for cuttings). Because I have actually applied the techniques described, I hope to contribute something new rather than repeating what we all know from our readings.

The adventure often begins with seed collection and storage. I also purchase seeds, and I have noted which seeds were purchased and which were collected in the tables which follow. The decision path I follow is fairly simple: if I cannot find germination information, I try germinating without treatment. This serves as warm stratification for those which need it, and if they do germinate, so much the better. If not, I begin to treat the seeds, first with cold stratification for at least 90 days, often longer. If germination is not good after a warm germination period (65-70° F.) I either try a second cold period, or I might start over with a new batch treated by scarifying or heat, depending on the ecology of the plant. If refrigerator stratification was used the first time, I would try them outside. If germination occurs anywhere along the way, I keep track of the percentage, and add or stop treatment depending on success of germination.

Failures

These six species have shown a mystifying lack of germination despite best efforts and multiple treatments. I would call them complete failures, as opposed to those which yielded some information. I'm sure many people have nc trouble with these species, and I would love to hear from you!

- *Actea* rubra (have not tried second cold period)
- *Achlys triphylla* (digging and growing to divide work better)
- *Arctostaphylos ova-ursi.* Very few germinated after much treatment, (scarifying to within a few mm of embryo, warm stratification, water with vinegar, cold stratification and returning to warm). Reluctance to use sulfuric acid prevented me from using that method. Cuttings can be quite successful if taken in fall/winter.
- *Maianthemum dilatatum* (purchased seed has not germinated, have not collected). Division is successful.
- *Arctostaphylos columbiana* collected seeds were burned and given cold stratification outside, unburned seeds were given boiling water treatment and cold stratified to no avail. Fall and winter cuttings work moderately well, though not easy.
- *Trillium ovatum* (sown fresh, cold stratified).

Lessons Learned

The real interest in propagation lies in gaining a feel for handling and working with plants so that the finished product turns out well. Though it is often difficult to describe in detail the knowledge gained through experience, I will attempt to discuss some guiding principles here.

Protocol 1a.

Cold stratification: sow Nov to Jan. Place flat in cold frame. Alternatively, sow anytime and refrigerate in moist media at 38-41° F. Cold period required varies with species. Germination takes place the following spring or in the refrigerator. Flats outdoors should be shaded from sunlight. Watch for excessive warming or drying during sunbreaks and remove covers when necessary. Keep from freezing. Germination at 65-70° F. May germinate in refrigerator and should be removed immediately.

Genus	Species	Germination %	Purchased or Collected	Comments
Acer	*circinatum*	variable	C/P	Sow fresh, leave outside. Purchased seed did not germinate after repeated warm/cold cycles. Collected seed germinated moderately well.
Amelanchier	*alnifolia*	up to 75%	P	Germination better when flats are outdoors. Scarification does not seem to improve germination if stratified outside.
Aster	*chilensis*	1-5%	P	Cold stratified in refrig and outdoors. Covered and uncovered. Not sure why seeds did not germinate well. A. subspicatus slightly better. Seeds from one of these potted plants appear to have germinated in the pot where they fell during the fall with ample water. Original seed may have dried out, or needed more light, or not have been viable.
Aster	*subspicatus*	10%	P	see *A. chilensis*
Cornus	*unalaschkensis (canadensis)*	100%	P	Cold stratified in refrig 5 months
Cornus	*sericea*	90%	C	See *C. unalaschkensis* (could spend less time in cold).
Fragaria	*virginiana*	approx 80%	C	Put outdoors for cold stratification. Cover only very lightly or not at all.
Fragaria	*vesca*	approx 80%	C	If found growing with *F. virginiana* watch out for mixing of fruit and seed.
Fritillaria	*lanceolata*		P	Germinated in cold frame with warm days (60° F. in frame) and cool to cold nights (low 30's to low 40's). Continued to germinate through spring and summer. Will die back quickly and suddenly, but look for small corms and replant in deep pots. Alternatively, use very deep flats to germinate and do not repot.
Mahonia	*aquifolium*	14%	C	Low germination the first year, but seedlings may also be collected from underneath existing plants. Second winter of stratification may help.
Mahonia	*nervosa*	30%	C/P	Place flats outdoors. Keep ungerminated flats, they may germinate in larger numbers during their second winter outdoors. May be a difference between purchased and collected. Can be stratified in refrigerator.
Mahonia	*repens*	>55%	P	Cold strat indoors 1 mo. Shift to warm for 2 mo. Back to cold 5-6 mo.
Maianthemum	*racemosa*	low to moderate (no counts)	C	Outdoor stratification more successful. Seedlings may die back during summer, but resprout strongly in the following growing season. Initial warm stratification before cold period may help.
Malus	*fusca*	>70%	P	Uniform germination after 4-1/2 mo in refrig.
Oplopanax	*horridus*	10%	C	Outdoor stratification early Nov. First seedlings pricked out April. Still germinating in Sept.
Philadelphus	*lewisii*	approx 75%	C	Cold frame or refrigerator equally good. Germ within 90 days. Seedlings can sit in flat until ready to pot directly – better survival.
Physocarpus	*capitatus*	50%+	P	Cold frame or refrig strat. Easily grown from softwood cuttings.
Ribes	*bracteosum*	19%	P	Stratified outdoors Dec. Germinated in May, continuing until July. May continue to germ with second cold period.
Ribes	*sanguineum*		C	Cold frame or refrig strat. Easily grown from softwood cuttings.
Rosa	*sp.*	variable	C/P	All species need at least 10 to (preferably) 12 months of cold stratification. *R. pisocarpa* best germination rate.
Rubus	*parviflorus*	approx 85+%	C	Germination is better if flats left outside. Dec 15 sowing can be potted to 4" by first part of May.
Spiraea	*douglasii*	approx 75-80%	C	Germinates easily. Other spiraeas should be similar.
Xerophyllum	*tenax*	25%+	P	Cold stratify outdoors or in refrigerator. Seedlings are touchy and will die if they dry out. Keep quite moist, even wet, rather than letting them dry out. Slow growers. Use well-draining potting mix.

Protocol 1b.

Fluctuating germination temperatures after cold stratification preferred (80 deg F Day/50 deg N)

Genus	Species	Germination %	Purchased or Collected	Comments
Vaccinium	*membranaceum*	approx 75%	C	Cold strat in refrig 3-4 months. *Vacciniums* prefer 50-50° nights and 80° days or approximation during germination period.
Vaccinium	*ovatum*	approx 75%	C	Collected seeds germinate after one cold period. Purchased seed may take second cold period. See also *Vaccinium membranaceum*
Vaccinium	*parvifolium*	approx 75%	C	Germinates well, follow same protocol as for other *Vacciniums*. Current year's seed used.

Protocol 2.

Shorter cold period is necessary. It is easier to see when seeds begin to germinate if kept in the refrigerator (38° F.). Will germinate in refrigerator in large numbers.

Genus	Species	Germination %	Purchased or Collected	Comments
Arbutus	*menziesii*	90%	C	Germinate in refrigerator in 90 days.
Holodiscus	*discolor*	>80%	C	Try to collect seeds from plants with insects – flower beetles may increase pollination. Very small seeds difficult to count for germ %, germ has been high for seed up to 2 years old. Will begin to germinate after 2 months in refrigerator.

Protocol 3.

Pretreatment unnecessary. Small seeds often need light to germinate. Germination temp varies.

Genus	Species	Germination %	Purchased or Collected	Comments
Allium	*cernuum*	>89%	C	Germ temp 65-70° F
Gaultheria	*shallon*	75%	C	Germinate at cooler indoor temp (58-65° F). Keep in flat longer than most seedlings, prick out in clumps. Slow growers. Delicate roots.
Heuchera	*micrantha*	approx >75%	P	Germinate in about 3-4 wks.
Iris	*tenax*	up to 90%	C	Keep at no more than 50° F. Old seed can be soaked in cold water, changed frequently for a week or so, or hung in toilet tank in mesh bags to pretreat with cold fresh water. All pacific coast irises similar. (Cole)
Lupinus	*polyphyllus*	75%+	C	Sow 55-65° F. Will start to germinate in 4-6 weeks, continue to germinate over next 2 or more months. Watch for stem rot.
Penstemon	*sp.*	approx 80%	C	Seed of *P. barrettiae* and probably most other Penstemons germinate in high numbers. Easy from cuttings.
Rhododendron	*macrophyllum*	high (seeds are tiny)	C	Seed several years old will germinate without treatment at 60-68° F. Best if they have light to germ.
Tellima	*grandiflora*	90%	C	Germinate in 3-4 wks
Tolmeia	*menziesii*	90%	C	Germinate in 3-4 wks
Tiarella	*trifoliata*	<50%	C/P	These probably need cold stratification. Lower germination than other saxifrages, sometimes none for many months.

Protocol 4.

Pour boiling water over seeds, soak one day and follow with cold stratification period of at least 90 days. Germinate at 65-70° F.

Genus	Species	Germination %	Purchased or Collected	Comments
Ceanothus	most species	38%	C	Cold strat in refrig Dec 15 to April 15 after boiling water soak.

Protocol 5.

Some freezing during cold stratification is beneficial, fluctuating warm days/cool nights may also be the trigger for germination. Seedlings should not be disturbed until they go dormant naturally, then dug and the bulbs replanted in deep pots where they can remain for a couple of years.

Genus	Species	Germination %	Purchased or Collected	Comments
Erythronium	*oreganum*	69%	P	Germinated with warm days/cool to cold nights in frame after 4 months. Died back early in plug tray, but bulbs had formed on many, pushing themselves out the bottom of plugs. Kruckeberg (1996) describes behavior of these seedlings and how to handle.
Lilium	*columbianum*	10%	P/C	Difficult to keep seeds below surface, if on surface difficult to keep moist. Will germinate over a long period, and may die back after germination but still have live bulb. Toogood (1999) recommends keeping flats going for at least 2 years to allow leaves to emerge after dieback and bulbs to form.

Protocol 6.

A period of warm moist stratification from 6 wks to 2 months before cold stratification of 3-4 months. Some may need scarification as well.

Genus	Species	Germination %	Purchased or Collected	Comments
Dicentra	*formosa*	variable	C/P	Seed may have to be sown fresh, undried. Warm stratification before cold stratification may help. Germination has not been consistently good.
Rubus	*spectabilis*	approx 80%	C	Warm stratify after scarifying, then cold stratify (outdoors works best) 4 months or more.
Sambucus	*racemosa*	75 - 80%	C	At least 6 wks warm stratification followed by cold stratification in refrigerator or outdoors (best) for 90+ days. 15% may germinate during warm stratification. High N requirement while growing on.
Sambucus	*caerulea*	15 - 50%	P	Lower germination than *S. racemosa*. Seedlings also have High N requirement.

Protocol 7.

Simulated two year cycle of 3 months warm stratification-3 months cold stratification-3 months warm stratification-3 months cold before germinating at 65-75° F.

Genus	Species	Germination %	Purchased or Collected	Comments
Symphoricarpos	*albus*	approx 85%	C	Have always used freshly collected seed cleaned and dried.

Protocol 8. Ferns

Follow standard protocols [e.g. Hardy Fern Foundation. (1998)] for ferns, keeping warm, humid and moist. Hand lens will help to observe proper moisture, germination and growth of prothalli (one month or longer), followed by fertilization and growth of sporophytes. Depending on species, a 1-gallon plant can be grown from spore in about 1 year. Use a moderately high N liquid feed through summer. Prick out in clumps for fuller plant.

Genus	Species	Germination %	Purchased or Collected	Comments
Polystichum	*munitum*	moderate	C	Grow quickly after sporophytes develop
Polystichum	*andersonii*	moderate	C	
Adiantum	*aleuticum*	high	C	Grow quickly
Adiantum	*aleuticum v. subpumilum*			Extremely slow growing.
Dryopteris	*expansa*	high	C	
Blechnum	*spicant*	moderate to high	C	
Polypodium	*glycyrrhiza*	moderate and very slow	C	Easiest propagation is by collecting dormant rhizomes from logs or trees, keep in a flat under mist until growth begins, then divide rhizome. Spores are few and bright yellow. Slow to germinate and slow growing.

Protocol 9. Trees

Leave outside in flats or pots for the winter. Fresh seed should result in good germination in spring.

Genus	Species	Germination %	Purchased or Collected	Comments
Thuja	*plicata*	Moderate to high	C	
Acer	*macrophyllum*	variable	C	
Acer	*circinatum*		C	If not fresh, may never germinate even with repeated treatment.
Alnus	*rubra*	Moderate to high	C	
Corylus	*cornuta var californica*	variable	C	Give the longest cold period possible. Nicking shells may help. Have not had any success with cuttings.
Crataegus	*douglasii*	25 - 30%	P	No difference between cold stratification outdoors or refrigerator. Stratify 4-5 mo.

Protocol 10. Wetland plants

Many will germinate without treatment at 60-65° F. Keep wet.

Genus	Species	Germination %	Purchased or Collected	Comments
Scirpus	*sp.*	Moderate (approx 50%)	C/P	
Scirpus	*tabernaemontanii (=S. validus ssp acutus)*	30%	C	This species germinates better with cold stratification. Store wet in refrigerator.
Carex	*sp.*	Moderate	C/P	
Juncus	*sp.*	Moderate to High	C/P	
Lysichiton	*americanum*	46-58%	C	DO NOT dry seed. Collect from inflorescence after it falls over and begins to disintegrate. Separate and sow fresh, store in refrigerator with natural jelly-like substance adhering. Have not tested storage life.
Mimulus	*guttatus*	High	C	Germinate readily, self sow; become weedy.

Protocol 11. Cuttings.

Dilute water-based hormone (Rhizopon ®) to 500 ppm, dip stem ends 5-8 seconds. Dilute alcohol-based concentrate (Dip & Grow ®) 3:7 or 2.5:7.5 with water. Water based hormone may be watered on periodically. Medium used is Sunshine #4 ®. Sclerophyllous species should be covered with domes to keep humidity high, and leaves dry unless watering soil. Bottom heat of 68° F.

Genus	Species	Rooting %	Purchased or Collected	Comments
Arctostaphylos	*uva-ursi*	50-75% (cuttings)		Take cuttings in fall or early winter. At other will not root easily.
Arctostaphylos	*nevadensis*			same as *A. uva-ursi*
Arctostaphylos	*columbiana*			same as *A. uva-ursi*
Ceanothus	*sp.*		C	Well expanded soft tip cuttings root well. Xeric species (*C. prostratus*) should not be misted.
Cornus	*sericea*	approx 80%+	C	Must be collected before lenticels form on stem. See Toogood (1999)
Garrya	*elliptica*	75%+	C	Root well ripened soft tip cuttings with as little mist as possible, but never allow to dry out.
Grindelia	*integrifolia*	100%	C	Root quickly from summer soft tip cuttings. Seeds have not been tried.
Lonicera	*sp.*	90%	C	Cuttings of *L. hispidula, L. ciliosa, L. involucrata* root easily from soft tip cuttings and water-based liquid hormone at rate of 500 ppm.
Mahonia	*nervosa*	56%	C	Cuttings can be taken in Fall or late Winter before new growth begins, using young plants and soft tip growth. Propagate by leaf bud cuttings. Water on hormone during rooting.
Myrica	*californica*	85-90%	C	Greenwood cuttings in mid-late summer.
Pachistima	*myrsinites*	approx 75%+	C	Have not tried from seed. Well expanded soft tip cuttings Mid-late summer root well.
Penstemon	*sp.*	90%+	C	Soft tip cuttings root easily.
Philadelphus	*Lewisii*	75%+	C	Do not use pithy, fast growing stems. Early summer, well-expanded soft tip cuttings.
Physocarpus	*capitatus*	85-90%	C	Root easily from fully expanded soft tip cuttings.
Potentilla	*fruticosa*	50-75%	C	Ornamental species root well from greenwood cuttings in mid summer.
Ribes	*sp.*	75-90%	C	All *Ribes* species tried have rooted easily from soft tip cuttings.
Salix	*sp.*	90%	C	All species will root at almost any time. Hardwood cuttings the easiest to handle.
Sambucus	*racemosa*	50%+	C	Green wood to semi-ripe cuttings with thicker stems root easily, could be put out as stakes?
Sedum	*sp.*	99%	C	All root easily if laid on surface of soil and kept humid.
Spiraea	*sp.*	varies	C	Dormant hardwood cuttings have done better than summer soft tip.

Don't assume anything

Two examples will illustrate this important point. It appeared from rumor and my own reading that *Holodiscus discolor* was difficult to propagate. One reference suggested that seeds needed a very long period of cold stratification. I had not had any luck with cuttings, and decided to forge ahead and try seeds. After they had been in the refrigerator only two months, I discovered that they were germinating in huge numbers. This very useful plant and can be grown to gallon or two gallon size in one year including stratification time.

I also had a chance to experiment with *Lysichiton americanum* and make a mid-course correction. Seeds were collected, cleaned and dried as usual but when dried, they shriveled alarmingly. Another gardener and I had noticed a clear jelly attached to the ripe seeds, and I realized I should be seeing that it had a purpose. I collected a second batch and saved the sinkers separately from the floaters when cleaning them. The usual cleaning method is to discard the seeds which float in water and save the sinkers which have heavier and therefore viable embryos). In this case, the floaters may have had more of the jelly attached. I then sowed the dried seeds, 100 sinkers, and 1_00 floaters in separate flats. The dried seeds never did plump up, even after a lot of soaking. The floaters had a 60% germination rate, the sinkers a 50% rate initially, and over a few months all 200 of the non-dried seeds germinated. No doubt the jelly keeps the seeds moist until they germinate, even as water levels drop during the late spring and summer.

Don't give up too soon

Some seeds either have a variable germination time or take an extremely long time to germinate, independently of the natural variation one would expect when working with wild collected seed. For example, I have had *Mahonia nervosa* germinate readily the first year, and a different batch of the same species fail to germinate until their second cold stratification period the next year. I have speculated that the slow germination might be because of age, lower moisture content in the dried seed, or other variables. The slow germinators were purchased, the faster ones I collected, however I have had the same thing happen with my collected seeds. Whatever the reason, for low germinators, a second winter of cold is often helpful. As can be seen from my examples of *Mahonia* flats, it is often worth it because you get enough plants to make it worthwhile, and you preserve some genetic variability by not throwing out the seeds too soon. The moss cover can obscure, but does not ruin your seedling crop. Try to get the liverworts out before they take over the flat.

Stratification

Seeds must be moist for stratification. Tiny seeds will do better in the refrigerator where you can check often. They can be mixed with damp sand in a plastic carton or sow them in flats and put the flat in the refrigerator. Larger seeds can be folded into wet paper towels or peat moss and put in a plastic carton or plastic bags. If placed outdoors, it is a good idea to put plastic domes on the flats. Outdoor flats will need more water, they may need to be protected from freezing, although some freezing is recommended for some seeds, and they will need to be vented.

All stratification is not equal. For certain plants, there appears to be a difference in germination success between refrigeration and natural outdoor stratification. Alternating day/night temperatures may induce faster and better germination, or the length of time in cold, or possibly a light freeze. If I was able to compare the two methods, I have noted it in my tables.

Pay careful attention

This may be obvious, but it is easy to forget to check your seeds often. Seeds will dry out in the refrigerator, and keeping moisture and temperature within limits is crucial. It is not easy to do this for seeds which are in a flat for months, and it's essential to check daily during periods of sunny weather. Once seeds imbibe moisture, it may take only one episode of drying to destroy the flat.

Scarification

My favorite mechanical method is to put seeds in a rock tumbler with granite grit; even more abrasive products used in rock polishing could be used. *Rubus spectabilis* has very hard seeds and seems to benefit from the rock tumbler technique.

Afterripening and/or warm stratification

I've noted the species which need some warm stratification before a cold period. This can also be used as a backup technique when seeds don't germinate well.

Sowing media

Granite chicken grit, available in feed stores, is useful for covering seeds which tend to damp off. It also has the added effect of making the surface easier to water and prevents puddles. It will allow some light in if sown thinly, and grit can also be added to the soil mix to increase drainage in the medium without adding a lot of weight.

Don't be afraid to fail

If there is a message in my presentation it is that failure equals learning. If you fail, try again and try something new. Don't avoid doing something because it might not work (see the part about not assuming anything). Intuition is extremely helpful in propagation, which is a lot like baking. You never know how it will turn out until you open the oven, and it sometimes involves minute adjustments during the preparation phase.

A few species' idiosyncrasies

Arbutus menziesii

While it may be considered hard to transplant, Pacific Madrone is quite easy to grow in containers. Germination is high, and will occur in the refrigerator after three months. Seedlings are temperamental in needing very little water and no liquid fertilizer (leaves will burn). It is not recommended to transplant Madrone in the fall (Date. pers. comm) Spring is a better time for salvaging other Ericaceae, like Salal, and repotting Madrone.

Sambucus sp., *Rubus spectabilis*, *Dicentra Formosa*

Both *S. racemosa* and *S. caerulea* will germinate sporadically during warm stratification but the main germination comes after cold stratification. and prefer a period of warm stratification before cold.

Rosa sp.

These very hard seeds need an inordinately long cold period of nine to twelve months.

Scirpus tabernaemontanii (= *S. lacustris* ssp.

Following recommendations in Baskin and Baskin (1998) I will be storing my collected seed refrigerated in water. I have had only 10%-20% germination rates with seed stored dry and cold stratified.

Saxifrages in general

With the exception of *Tiarella trifoliata,* saxifrages appear to have similar germination requirements. They will germinate at about 65 degrees F. without any treatment in about a month. They may germinate better with light.

"I Try All Things; I Achieve What I Can." (Herman Melville in Moby Dick)

Herman Melville explored whales and human nature. Plants may seem more humble, but the discovery process is no less thrilling and metaphysical. The important thing is to keep an open and adventurous mind. My goals have been to share some practical information I have discovered. Besides propagation experience with 80 or so species, I have tried to extract lessons from the time I've spent observing and working with seeds and plants. I invite others to contact me and establish a network of knowledge from which we can all benefit. By maintaining connections I believe we can increase our personal effectiveness, save time and improve our success rate.

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