Propagation of North American Trilliums

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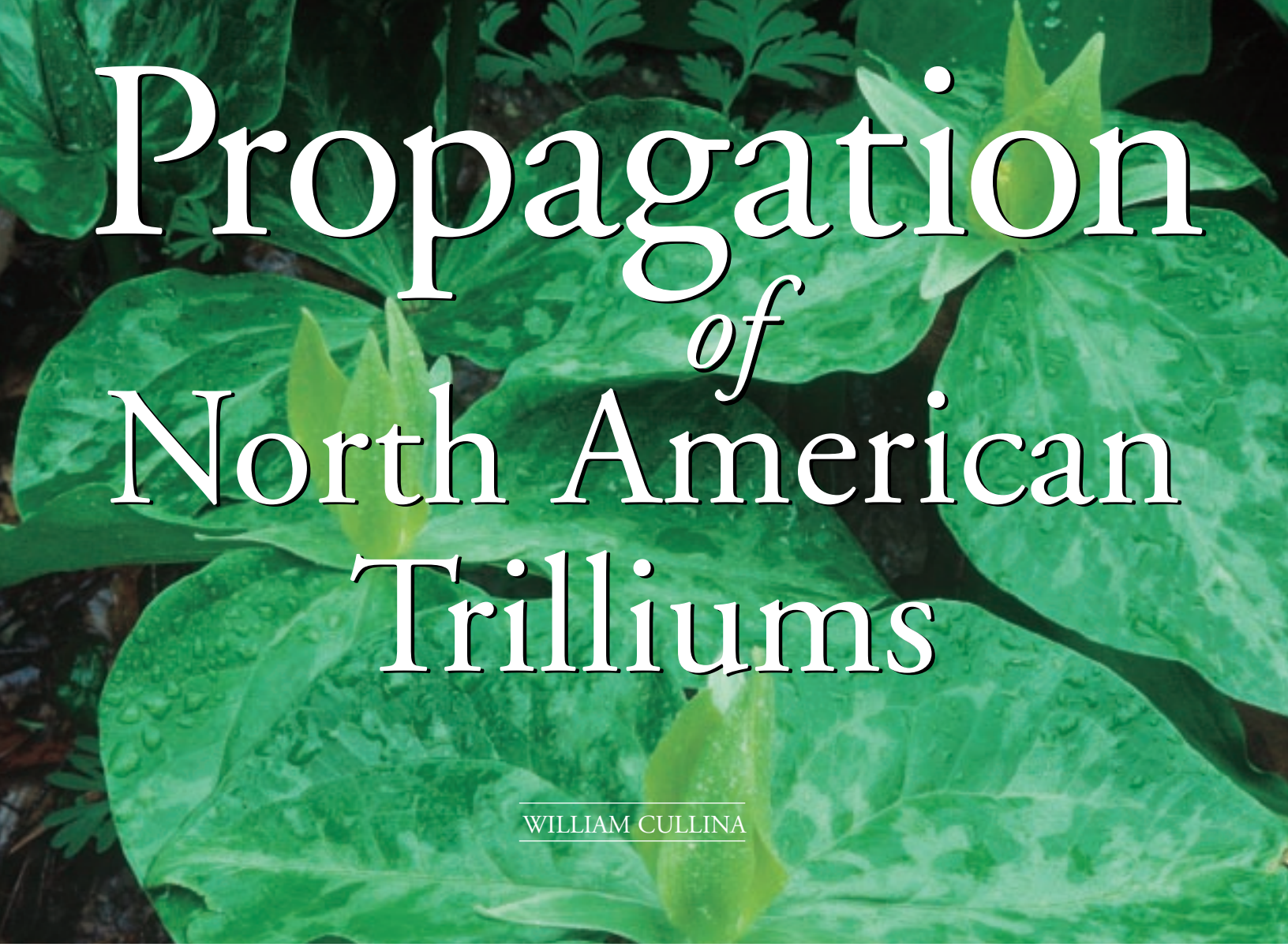

Yellow trillium (Trillium luteum)

Photo by William Cullina

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NOMENCLATURE:
Gleason and Cronquist (1991); Case and Case (1997)

Woodland wildflowers are a special group of plants that have evolved to withstand the rigors of a life under trees. At Garden in the Woods, the botanic garden and headquarters for the New England Wild Flower Society, we have developed spectacular woodland gardens featuring plants native mostly to eastern North America. Every spring, the ground beneath a tall canopy of 120-y-old oaks (*Quercus* L. [Fagaceae]) and eastern white pines (*Pinus strobus* L. [Pinaceae]) is awash with violet wood phlox (*Phlox divaricata* L. [Polemoniaceae]), sky blue Virginia bluebells (*Mertensia virginica* L. [Boraginaceae]), pale pink spring beauties (*Claytonia virginica* L. [Portulacaceae]), buttercup yellow celandine poppy (*Stylophorum diphyllum* (Michx.) Nutt. [Papaveraceae]), and fresh green crosiers of ostrich fern (*Matteuccia struthiopteris* (L.) Todaro. [Onocleaceae]), but no wildflower garners more rapt attention from visitors than the various *Trillium* spp. L. [Trilliaceae] scattered here and there. Trilliums are not the most brilliantly colored or flamboyant plants in our woodlands, but they possess a certain dignity and balanced proportion that has made them a favorite of wildflower enthusiasts for generations.

Part of trillium's allure comes from their slow yet deliberate pattern of growth. Plants grow from a knobby brown rhizome set 5 to 15 cm (2 to 6 in) below the soil surface. As the spring sun warms the forest soil, a large bud at the apex of this rhizome begins to elongate rapidly. The bud is composed of a half dozen sheaths surrounding 1 or 2 stems. As the sheaths poke through the soil and duff, they wither, leaving concentric abscission scars that circle the rhizome. Dormant axillary buds formed where these sheaths attach to the rhizome can give rise to small secondary rhizomes that develop eventually into flowering stems. Consequently, species prone to this axillary bud development can form large, many-stemmed clumps after several decades. Each trillium stem

continues to expand upward after it has pushed out of the sheaths, mature ones unfurling a whorl of 3 leaves subtending a single, 3-petalled, red, pink, yellow, or white flower. Mature trilliums range in height from less than 1.2 cm (1 in [the nearly stemless decumbent *T. decumbens* Harbison]) to over 40 cm (16 in [yellow trillium, *T. luteum* (Muhlenberg) Harbison]). In all cases the whorl of oval, rhombic, or lance-shaped leaves is carried nearly parallel with the sky above, so plants can take maximum advantage of any sun that filters down through the tree canopy.

The genus *Trillium* contains approximately 48 species: 6 in Asia, 7 in western North America, and 35 in eastern North America (Case 1997). The great broadleaf forests of the southeastern US are especially rich in species, many of which are rare or fairly localized in distribution. All but a few North American species prefer a slightly acidic to neutral pH. The genus *Trillium* can be neatly divided into 2 groups: subgenus *Trillium*, bearing stalked or pedicellate flowers, and the almost completely southeastern US subgenus *Phyllantherum*, with stalkless or sessile flowers that sit between the whorl of leaves. Propagation and culture are generally the same for both groups.

Trilliums are slow growing forest species. In cultivation, plants take 5 to 8 y to reach blooming size from seeds, and I would surmise that wild plants may take up to 10 y to reach maturity under less than ideal conditions. All North American species are ant-dispersed (and occasionally water-dispersed), meaning that rates of migration are extremely slow (30 to 90 cm per y [1 to 3 ft]) and individual populations are easily fragmented and cut off from suitable habitats by road construction, land clearing, and other development. Once eliminated from a site, it is very difficult for plants to recolonize it again. Wild populations are under threat from development, mining, industrial forestry, and wild collection. Their slow growth and horticultural appeal has made them a target for large scale commercial collecting, especially in the southern Appalachian Mountains, where untold thousands of rhizomes are dug each year for sale as bare root "bulbs" in Europe and North America.

Photo by William Cullina

Figure 1 • Trillium cuneatum *stock bed at Garden in the Woods.*

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The New England Wild Flower Society is a non-profit plant conservation organization founded 100 y ago in response to uncontrolled wild collection of vulnerable native plants. Part of our mission is to seek ways to reduce collection pressures on wild populations by developing protocols to make large-scale nursery propagation feasible. Our native plant nursery raises and sells 35,000 plants annually, representing over 500 native species and cultivars. We have paid particular attention to trilliums and lady-slipper orchids, because their slow growth and desirability make them especially vulnerable to over collection.

PROPAGATION

Trilliums can be propagated by rhizome division or by seeds, and tissue-culture shows some promise, though practical and cost-effective protocols are still being developed. We raise our plants chiefly from seeds, as rhizome division is invasive and requires large numbers of stock plants for a sustainable yield. If a sufficient number of stock plants are available, species like whippoorwill and showy trillium (*T. cuneatum* Rafinesque and *T. grandiflorum* (Michaux) Salisb.), which readily produce offsets, can be expected to furnish 2 to 6 saleable offsets per large rhizome on a 3- to 4-y rotation. The propensity to form offsets varies among individuals and populations so save and propagate your most rapidly multiplying clones.

Each pollinated trillium flower produces a fleshy, oval, pointed capsule that ripens in midsummer (approximately 65 to 90 d after anthesis, depending on species and growing conditions) atop the 3 persistent sepals. Capsules are either red, maroon, or yellow-green, depending on the species, and seeds can be collected when the seed coat has turned from green to tan or brown. We collect most of our seeds from stock beds in the nursery. Trillium seeds are 1.5 to 3 mm (0.06 to 0.12 in) in diameter, with a large, fleshy, oil-rich elaiosome designed to attract ants which carry seeds back to their nests, remove the elaiosome, and discard ("plant") the seed. Each healthy capsule contains

Photo by William Cullina

Figure 2 • Propagation area under natural tree canopy shade at the New England Wild Flower Society Native Plant Nursery. Some trillium stock beds are visible in the background.

from 10 to 40 seeds, so a cultivated stand of 1000 flowering stems may yield from 10,000 to 40,000 seeds annually (Figure 1). Trillium seeds are what I term hydrophyllic or water-loving, meaning they are completely intolerant of dry storage. Ideally, fresh seeds should be sown immediately after cleaning, but they can be stored for up to 3 y if kept in dampened vermiculite placed in a sealed, refrigerated container (I use a self-sealing plastic bag placed inside a lidded jar). Slightly unripe seeds (seed coats that are just turning tan) are easier to clean, as the capsules are less mealy at this stage. Peel off the calyx, which will expose the seeds, then pinch the capsule walls between thumb and forefinger, squeezing out seeds. Though it seems labor-intensive, this method is fairly fast, and we can clean 20,000 seeds in an afternoon.

Trillium seeds germinate in 2 stages. First, a root emerges and grows 2.5 to 5 cm (1 to 2 in), then, after a period of cold stratification (80 to 100 d), a single, lance-shaped cotyledon emerges. With the exception of snow trillium (*T. nivale* Riddle) and some forms of bent trillium (*T. flexipes* Rafinesque), all eastern species require 2 y for complete germination. The root emerges after the first winter and the cotyledon after the second. Western species as well as the exceptions among the eastern flora require only 1 y, with the root emerging in the first fall after planting and the cotyledon the following spring. Solt (1996) discovered that a percentage of *T. grandiflorum* seeds, if harvested immature about 60 d after anthesis and kept in warm, moist conditions in the lab, will germinate in the pattern of the western species such as *T. chloropetalum* (Torrey) Howell—the root emerging the first fall and cotyledons the following spring. We have tried Solt's technique, and found that although we were able to get 20% of immature seeds to germinate the first fall when we sowed them under controlled temperature and moisture, field germination was not accelerated at all. The reasons for this are unclear, but may have to do with less consistent temperature and/or moisture levels as compared to the lab.

Our technique is to sow cleaned seeds in 23 X 30 X 8 cm deep (9 X 12 X 3 in) plastic flats (Dillon Half Flat, Dillon Products, Middlefield, Ohio) filled with Metro-mix 360 (30% to 40% medium grade vermiculite, 35% to 55% sphagnum peat moss, 10% to 20% bark ash, and 1% to 15% pine bark; The Scotts Co, Marysville, Ohio). Approximately 200 seeds are distributed over the mix, then covered with 6 mm (0.25 in) of additional Metro-mix and 6 mm (0.25 in) of #1 filter sand (a washed, coarse sand sold for swimming pool filters). We place our flats outdoors in shaded cold frames open to wind and rain and the coarse sand or fine gravel holds the growing medium and seeds in place. As the seed germinates, the sand is incorporated into the top layers of the medium, providing better water drainage around the seedling's crown and discouraging damping-off diseases. We cover finished flats with floating row cover fabric (Reemay Inc, Old Hickory, Tennessee), and then a piece of half-inch hardware cloth (galvanized wire mesh) cut to make a lid that fits down over 9 flats. The row cover slows evaporation and prevents weed seeds from infiltrating the flats and the hardware cloth prevents rodent predation. (Mice and especially voles are major seed and rhizome predators in our nursery. In the wild, a colony of voles can quickly eliminate whole stands of trilliums and other woodland wildflowers.) We grow mostly *T. grandiflorum*, *T. cuneatum* and *T. erectum* L. (red trillium), as well as *T. vaseyi* Harbison (sweet Beth), *T. luteum*, *T.*

flexipes (bent trillium), *T. simile* Gleason (sweet white trillium), and *T. recurvatum* Beck (prairie trillium). Seeds from these species that are sown in late summer will germinate above ground the second spring, at which point the row cover is quickly removed but the wire left in place. In its first season above ground, no additional leaves beyond the 1 cotyledon are produced from the seedling's rhizome. These first year seedlings generally continue photosynthesizing for about 60 to 70 d. Excessive sun, heat (over 29 °C [85 °F]), drought, or rain will force the seeding into early dormancy, so make every attempt to avoid these conditions. Consequently, greenhouse culture is usually not feasible unless temperature, air movement, light and humidity can be carefully controlled. Seedlings that go dormant prematurely will be smaller than normal the second year, and they are extremely vulnerable to rhizome rot diseases, especially during the heat of summer. Our plants are grown outdoors on woven weed fabric under the high, dappled shade of oaks and pines (Figure 2). Seed flats and plants are overwintered under Microfoam (Porelon, Cookeville, Tennessee) winter blankets, which are then covered with white, 6-mil polyethylene greenhouse film.

If all goes well the first year, the seedling will produce 1, nickel-sized oval leaf the following spring, its first set of 3 whorled leaves the year after, and its first flower 1 or 2 y after that (5 to 6 y from the time the seed was sown). We leave seedlings in seed flats until the nickel-sized oval leaf is seen emerging (the third spring after sowing), and transplant them into individual 6-cm square X 7.5-cm-deep pots (2.25 X 3 in) filled with a 2:1 (v:v) mix of Metro-mix 360:coarse perlite. Perlite helps prevent rhizome rot, especially after plants have gone dormant in summer. Timing is very important, and we have best survival if we transplant third year seedlings as soon as the leaf is fully expanded. If moved earlier, the leaf is easily bruised or broken, and if we wait, plants are set back and go into early dormancy. From the time seedlings germinate and as long as they are in these pots, we fertilize them 3 times each year with Peters Peat-Lite soluble fertilizer (15N:16P_2O_5:17K_2O; The Scott's Company, Marysville, Ohio) in a proportioner set to deliver 120 ppm nitrogen. We apply it when plants are beginning to emerge from the ground and twice more at 2-wk intervals thereafter. Because rhizome rot is a persistent problem for small seedlings, I have experimented with fungicide drenches (Cleary's 336 applied as directed) and coarser mixes. Everyone's microclimate is different, so if you experience rotting problems, try adding more aggregate to your mix or a fungicide drench in mid spring and again in mid summer. I have also had excellent results either direct seeding or transplanting clumps of third year seedlings from flats into raised beds filled with 2:1 (v:v) composted loam:sand. Rotting is far less of a problem and the cooler soil keeps seedlings growing longer into summer.

Photo by William Cullina

Figure 3 • Four-year-old Trillium grandiflorum *seedlings ready for transplanting to larger pots.*

Again, if all goes well, fourth year seedlings are stepped up into 11 X 11 X 13-cm-deep pots (4.25 X 5 in quart pots) filled with our standard container mix of 60% aged southern pine bark, 25% coarse perlite, and 15% peat moss adjusted to a pH of 5.8 with wetting agent and starter charge of fertilizer added (This is a custom blended mix made for us by Fafard, Agawam, Massachusetts, similar to their Fafard Mix # 52). Plants should be repotted just as they are emerging, being careful not to damage the roots. At this stage, we apply topdressing of controlled release fertilizer (Osmocote Plus 15N:9P_2O_5:12K_2O; The Scott's Company, Marysville, Ohio) at the rate of 3 g (0.5 teaspoon) per pot. Four-y-old rhizomes are large enough to handle the increased levels of fertilizer, and usually respond with a noticeable increase in lushness of the leaves (Figure 3).

By the fifth spring most of the trilliums we grow are large enough for field planting or sale, with approximately 20% bearing their first flowers and the other 80% a year from blooming. Compared to most other perennial crops, trilliums may seem unbelievably slow, but 1 wholesale nursery we are working closely with is now producing 10,000 saleable, seed-raised *T. grandiflorum* annually. The first 3 y seedlings require little attention or space, and it is only in the fourth and fifth years that they begin to occupy significant square footage in the nursery.

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