# PROPAGATION OF SHOOTING STAR, *DODECATHEON MEADIA*

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*Abstract.* Studies on the propagation of shooting star, D*odecatheon meadia*, reveal that the species requires five to six years to reach flowering from the seedling stage under normal field conditions. Laboratory and greenhouse procedures employed to shorten this long maturation include manipulation of photoperiod and application of gibberellins. Twenty-four hour illumination may circumvent the ephemerality associated with field conditions, as does the use of gibberellins applied during the seedling (cotyledon) stage. Propagation of mature plants by separating and replanting suppressed buds remains one of the most reliable—though labor intensive—means for increasing the species for small-scale grassland restorations.

## INTRODUCTION

The common and much-loved shooting star, *Dodecatheon meadia L.*, of open woodlands and plains in the upper Midwest has the reputation of a species difficult to propagate for the purposes of prairie restoration. Its small seeds, long maturation period (Figure 1), and brief period of annual growth combine to thwart the patience of workers accustomed to more hasty development typical of some species, such as the robust prairie Asteraceae. In this report, I summarize the life cycle of shooting star, review the literature on its biology, and present the results of my efforts to shorten the long period of development from seed to flower.

### Life Cycle

Shooting star belongs to the group of plants we call the spring ephemerals (Sörensen 1984). About mid-March, or later depending on latitude, the buds formed during the previous spring break dormancy as a consequence of winter cold stratification. Leaves soon appear above the soil surface in clusters of small rosettes. They continue to elongate, depending upon the amount of litter through which they must protrude, until about mid-April when the flower buds begin to show in the center of the rosette. Soon, the leafless flower stalk (the scape) begins to elongate, and the earliest flowers reach anthesis in early May. Peak of flowering in our area (northern Illinois) occurs fairly reliably by 10 May each spring. Young fruits develop by late May, coinciding with the gradual senescence of the leaves. By mid-June, the leaves have withered entirely, leaving behind only the slowly maturing, achlorophyllous fruiting scape (Figure 1), and the below-ground bud that remains dormant through the growing season and the following winter. Capsules rupture at the summit of the fruit by late July, and by mid-August, all are fully open. As the stiff peduncle is whipped about by wind and animal movements, seeds disperse through the opening of the erect capsule summit. However, one may often find seeds remaining in the capsule on scapes still standing the following spring. Crushing the dry capsule frequently produces an additional yield of undispersed seeds. Under natural conditions, seeds probably germinate in the spring, about the same time buds of established plants break dormancy, but a significant number may germinate in the fall if an early, brief cold period is followed by a warm spell. Whether such seedlings survive the rigors of winter remains unknown. The available literature lacks information on seedling survival (population recruitment) under natural conditions.

## METHODS AND RESULTS

The remarks which follow are based on experiments and observations conducted in a laboratory and greenhouse on seeds and plant parts derived from plants of two extensively cloned individuals, which have been in cultivation for many years. Seeds gathered from these plants constitute the source for germination tests, and root material from mature specimens of them have been used for additional experiments.

### Seed Germination

Moist stratification of seeds, under artificial as well as natural conditions, seems routinely essential for germination (Greene and Curtis 1950). But workers have reported different lengths of time necessary for optimum results. Following the work of Threlfall (1970), and corroborated in the present study, one may obtain satisfactory germination percentages from as few as seven days of refrigeration in a moist medium at 5.0-10.0 C. Highest germination percentages resulted from a cold stratification duration of 21 days. Turner and Quarterman (1968) reported on the use of gibberellic acid (GA) combined with cold temperatures as a method to improve germination, but my experience suggests that the 21-day treatment obviates whatever benefit the use of GA confers. Individual seed batches seem to differ somewhat in their responses to the length of cold treatment, based upon a number of variables, such as age and water content of the seeds. In all seed-related experiments, the seeds were sorted beforehand in a "fan" to eliminate empty or poorly-developed seeds.

### From Seedlings to Flowering Plants

With germination of the seed, a hypocotyl emerges to develop into a soft-tissued taproot. Concommitantly, the epicotyl arises, and the two orbicular cotyledons enlarge to a maximum diameter of about 6.0 mm. During the first season, as observed under greenhouse culture, further development takes place solely beneath the soil surface. The first organ to develop is a fleshy lateral root. A small bud forms at the juncture of the lateral root and the initial taproot. The bud enlarges to about 2.5 mm. As the season progresses, the fleshy lateral root continues its elongation to a total of about 4.0 cm, depending upon local growing conditions of light, moisture, and soil fertility. By this time (mid-June), the slender taproot and other tiny rootlets degenerate, and by late June, the only parts of the young plant remaining to carry it through until the following March are the vegetative bud and the fleshy lateral root (Figure 1, top panel).

The following year, the same sequence takes place, except that the aerial parts consist of the "young adult" or juvenile leaves that develop from the previous season's underground bud. During this second year of growth, the fleshy root system increases in size. A new bud forms, and the ephemeral, above-ground parts wither, leaving again only the fleshy roots and a bud to pass through the dormant period.

It has not been possible to observe a single plant pass through its entire developmental sequence from seedling to flowering, but from various observations, it appears that under field conditions a plant likely requires five to six years or longer of vegetative growth to reach the level of maturity necessary to produce its first inflorescence (Figure 1, bottom panel). My findings differ from those of Thompson (1953), who reports that "two or three years are required to raise flowering plants from seeds." However, he does not specify a particular species of *Dodecatheon*. Turner and Quarterman (1968) state that their experimental material failed to flower even after the

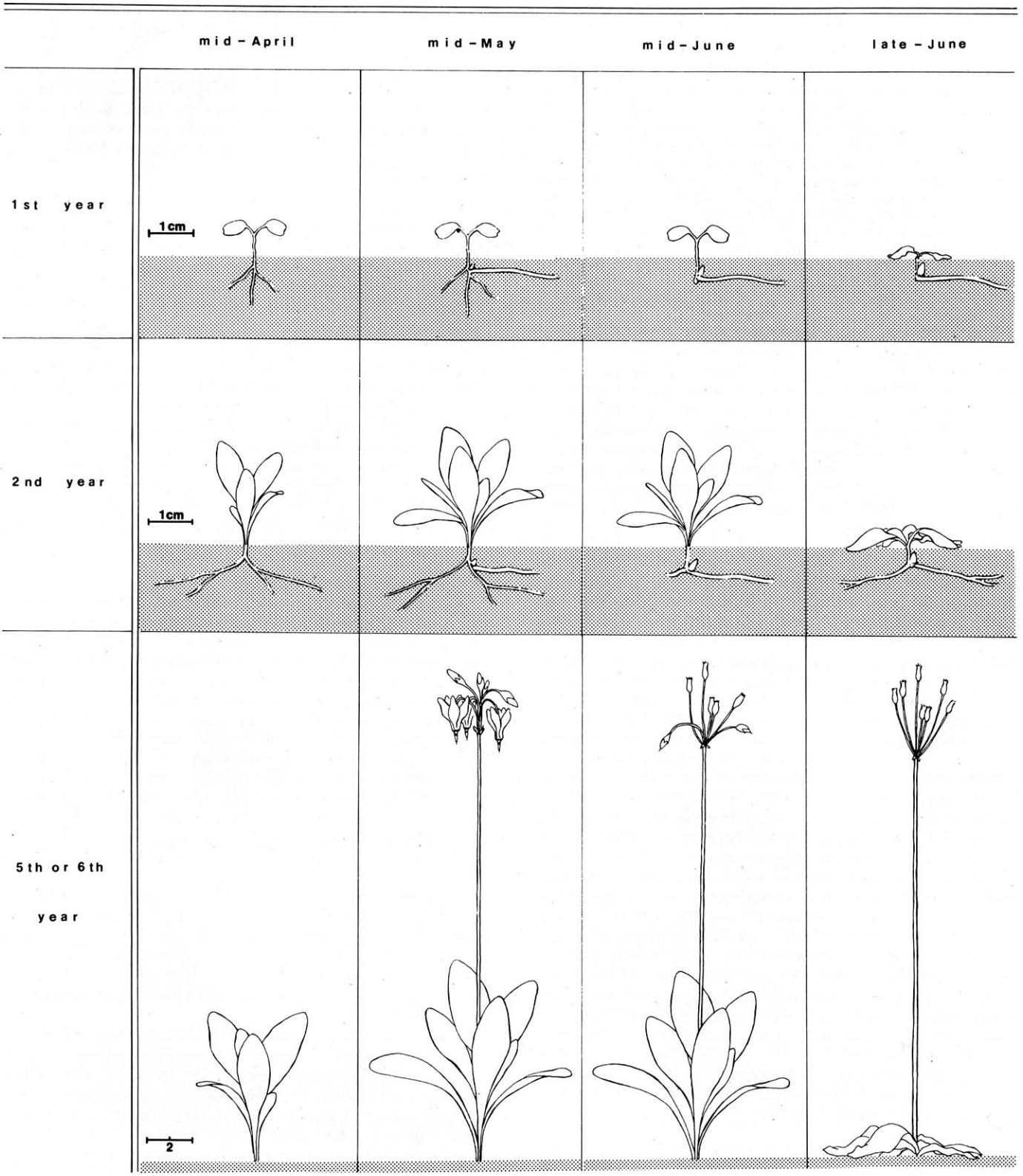


**Figure 1. The life cycle of Shooting Star. Note that after a brief period of growth in the spring of the year, the leaves wither, leaving behind only the oversummering and wintering subterranean bud with a fleshy root attached.**

second year, but they do not indicate whether the observation period extended beyond a third season. As I have intimated, one will doubtlessly observe considerable variation in the length of the maturation period as a function of local environmental conditions.

Propagation of Mature Plants

The most reliable method for increasing the number of flowering plants, whether in a garden or in a prairie restoration, is the simple division of what I call the "root-crown" system (Figures 2 and 3). A mature plant that has reached maturity and remained in place for a number of years will have developed a dense clump of interconnected buds and fleshy roots that can be divided into as many individuals as there are buds. My experience suggests the best time for this is in late summer, about the end of July or early August, after all of the developing capsules have ripened and one can gather the seeds for further sowing. An essential exercise when replanting the buds with a few of their fleshy roots attached involves copious watering to reestablish the soil capillarity. Failing this, the newly placed underground parts are subject to drying and frost heaving. Even with watering, the transplants benefit greatly from adding a substantial layer of mulch.

Under outdoor garden conditions, where individual plants lack competition for space, one can expect at least one, large, new bud to form each growing season. This allows further division of a root-crown system to take place rather soon. The root crown-system shown in Figure 2 has resulted from about six years of growth, starting with a single bud. I have not observed whether more than one bud can develop in a single season.

Use of Giberrellins to Accelerate Maturation

Seedlings in the coytledon stage can be made to bypass the normal dormant period (from July to March) by advancing their development to the juvenile leaf stage, the equivalent of their second year's growth (Figure 1), with the application of GA at a concentration of 500 ppm in an aqueous spray. I have found the most satisfactory product to be Pro-Gibb marketed by Abbott Laboratories. It comes in an alcoholic concentrate of 3.91%. Adding 12.78 ml of the concentrate to 1.0 liter of water yields a 500 ppm solution that should be stored at cold temperatures and used within one month. A drop of surfactant, such as Kodak Foto-flo or even ordinary dishwashing liquid detergent, added to a liter of the 500 ppm solution will reduce surface tension on the leaves of the plants when sprayed with the GA. Application of the GA to the cotyledons should take place as soon as they have reached full expansion. The sprayed

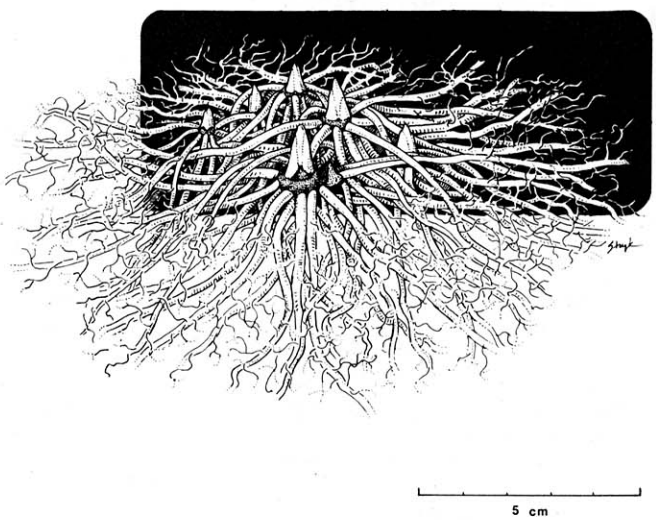


**Figure 2. An intact "root-crown" system lifted in late July from an outdoor garden location. See also Figure 3.**

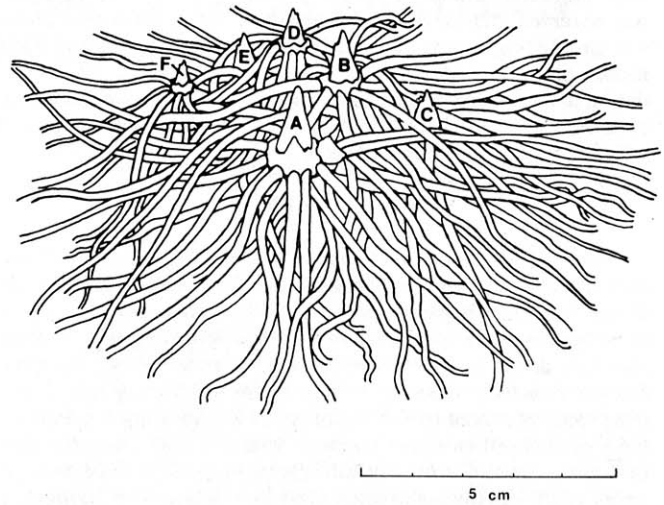


**Figure 3. Tracing of the root-crown system pictured in Figure 2 without the tender rootlets and with the buds (crowns) labeled in descending order of size. Separating each of the buds from the network permits vegetative propagation. Under garden conditions, at least one new bud is added to the root-crown annually.**

plants should be removed from sunlight or from a bright greenhouse for a few hours to allow absorption of the hormone. The procedure has not been totally satisfactory. About half of the plants respond as expected. Circumventing the normal first dormant period following the cotyledon stage is the chief benefit to be derived from this method. The action of the hormone is to induce continuous growth and thereby invest the seedling with a greater chance of survival when placed outdoors.

Continuous illumination with artifical lighting over a period of not less than 30 days following the full development of the cotyledons has, in one instance, produced the same results as the application of GA; that is, the young plants began to produce juvenile leaves without first passing through the dormant period. Attempts to repeat this, which was a consequence of a serendipitous malfunction in the lighting timer of a growth chamber, have not been successful. Experiments are underway to try again.

Propagation of Mature Plants with Gibberellins

Success in the use of GA on seedlings led to the question of whether mature plants could be treated in the same way. Root-crown systems of a single genotype (numbered 9096A-H below), more or less identical to that shown in Figure 3, were lifted on 26 July 1990, cleaned, separated into eight individual buds with attached fleshy roots, numbered, and submerged in varying concentrations and durations of GA as follows:

9096 A & B - 100 ppm GA, 2 hours

9096 C & D - 100 ppm GA, 12 hours

9096 E & F - 500 ppm GA, 2 hours

9096 G & H - 500 ppm GA, 12 hours.

Potting in a mixture of Pro-Mix, loam, and sand (4:1:1) took place immediately after the GA treatment. The pots were then placed in a greenhouse with normal daylight. Developing leaves were visible by 31 July on 9096 E and 9096 F, and by 6 August, buds in all eight pots had begun to sprout. Owing to the inability to prevent excessively high temperatures in the greenhouse, the pots

were moved to an outdoor frame. While preparing this report, it was observed that growth of the newly-sprouted, off-season plants was proceeding slowly; the quality of growth suggested that the treated plants lacked the vigor associated with plants developing during the normal spring season. This could be attributed to a temperature factor: perhaps shooting star benefits from a cool soil which cannot be provided in August.

## SUMMARY

The common shooting star possesses the spring ephemeral habit and, consequently, has only a brief period of growth each spring. The ephemerality begins even in the seedling stage; only the cotyledons appear in the first season of growth following germination. As many as six years of development intervene before the plant reaches flowering maturity. Propagation of shooting star plants from seed is fostered by GA treatment of the seedlings that induces the equivalent of two year's growth within a single season. This invests the young plants with sufficient robustness to cope with the rigors of the environment when placed outdoors. The application of an aqueous spray of GA onto the cotyledons serves as an effective method of causing the young plants to bypass their normal prolonged dormant period. So far, the GA treatment seems most effective on young plants.

## ACKNOWLEDGMENTS

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