# Ecology and Conservation of Purple Milkweed

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**Abstract**
Purple milkweed (*Asclepias purpurascens*) is a relatively rare member of the flora of oak savannas and open oak woodlands. It is endangered in several states and has been the subject of special conservation efforts. A number of native populations of this species arose spontaneously at Pleasant Valley Conservancy State Natural Area in southcentral Wisconsin after oak savanna restoration was initiated in 1997. Ecological observations of permanently marked stands made over a ten year period have shown that growth is highly variable from year to year, and flowering and seed set are sporadic and unpredictable. Germination studies have determined that seed viability is very high. Greenhouse-raised plants have been successfully transplanted to the field and followed over a three-year period. Transplants have also been used in a forbs garden, where plants could be monitored more effectively. Pod formation and seed set are highly variable, both in the field and in the forbs garden, and may partly explain the rarity of this species.

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Purple milkweed (*Asclepias purpurascens*) is an attractive and uncommon milkweed native to the eastern United States. The plant was once a frequent member of the savannas, open oak woodlands, and deep-soil prairies of the tallgrass prairie complex (Cochrane and Iltis 2000) but today is rare and has become the focus of special conservation efforts in several states. According to the USDA Plants Database, purple milkweed is endangered in Wisconsin, threatened in Massachusetts, and of special concern in Tennessee and Connecticut. In Rhode Island, it is listed as "historical." Proposals for conservation of purple milkweed in Michigan (Vande Water Natural Resources 2003) and New England have been made (Farnsworth and DiGregorio 2001).

At Pleasant Valley Conservancy State Natural Area, in southcentral Wisconsin, populations of this species arose spontaneously following restoration of the oak savannas. Greenhouse and transplant studies, have permitted further expansion of the species at this site. These studies and our field observations are providing insights into why purple milkweeds might be rare, and offer hope for the eventual reestablishment in areas where it was historically present.

In the State Herbarium at the University of Wisconsin–Madison, the first dated record for purple milkweed in Wisconsin is 1877, although an undated collection by Increase A. Lapham is probably older. A total of 35 collections exist, and, except for two records from Winnebago County, all the records are from counties in the southern part of the state.

### Unique Characteristics of Milkweeds

The milkweed flower is an unusually complex structure, sometimes called "bizarre" because of the extreme way that the blossom is constructed. "The reproductive biology of the milkweed is rivaled only by that of the orchid in complexity" (Wyatt 1976). In addition to the petals and sepals, which project downward, the flower has a complex upward-projecting structure, unique to milkweeds, called the corona. The corona consists of five petal-like structures called "hoods" that surround the stigma. Each hood has a projection called a "horn" that bends down toward the stigma, where the nectar is stored. Associated with the corona is the female structure, called the gynostegium, which consists of parts of the stamens, anther, and stigma, all fused together.

This is where fertilization takes place.

Hidden within the gynostegium is the pollen source. The pollen is not distributed as individual powdery grains, as in other plants, but is transferred all at once in a complex packet called a "pollinium." This Y-shaped structure contains two arms, each of which has numerous pollen grains. Pollen is transferred when a leg of an insect feeding on the nectar-rich flower gets tangled in the pollinium. Upon travel by the insect to another flower, the pollinium may become deposited there, permitting fertilization to occur. Although the petals are colored and presumably aid in attracting insects, it is probably the pigmented corona which is the principal attractant for the insect. In *A. purpurascens* both petals and corona are an intense purple color.

At Pleasant Valley Conservancy, purple milkweed exists as a long-lived perennial, although it does not appear aboveground every year. Culture in the greenhouse and by transplants has indicated that the plant first produces flowers during the second or third growing season. Although some milkweed species spread clonally by underground rhizomes, growth of purple milkweed is never clonal. At a given site anywhere from one to nine stems may develop, presumably all from the same root stock. Not all of these stems produce flowers. There are no special nutrient or soil conditions required, and seed germination and growth under greenhouse conditions are usually quite good.

Many other species of milkweeds develop much more favorably at Pleasant Valley Conservancy than purple milkweeds. Common (*A. syriaca*), whorled (*A. verticilllata*), poke (*A. exaltata*), and swamp (*A. incarnata*) milkweeds all grow quite well. Although it was not originally present at Pleasant Valley Conservancy, butterfly milkweed (*A. tuberosa*) has also developed quite well from seed in planted prairies, as well as from greenhouse-grown transplants. Of these, only poke milkweed could be considered a savanna specialist.

## First Appearance of Purple Milkweed after Restoration

When major restoration work began at Pleasant Valley Conservancy in 1997, the oak savannas were heavily degraded by invasive shrubs (honeysuckle [*Lonicera* spp.], buckthorn [*Rhamnus cathartica*], prickly ash [*Zanthoxylum americanum*]) and undesirable trees (black walnut [*Juglans nigra*], black cherry [*Prunus serotina*], slippery elm [*Ulmus rubra*]), which were crowding out the mature open-grown savanna oaks (Brock and Brock 2006). Restoration consisted of removal of these invasive trees and shrubs (cutting followed by herbicide treatment of the cut stumps) and controlled burns.

In 1999, a year after the first clearing and two controlled burns of a 1.6 ha white oak savanna, a single population of purple milkweed appeared. Over the next two years, two more populations appeared in this same area. As further restoration work in other parts of the Conservancy occurred, more populations arose. At present, 12 separate populations are known, in both white oak and bur oak savannas, throughout about 20 hectares of restored savannas. Each population has been marked with a permanent numbered metal stake. Although most of these populations appear yearly, the extent of growth and flowering is highly variable from year to year. Also, several populations have disappeared for a year or two and then returned.

At Pleasant Valley Conservancy, purple milkweed is primarily a species of oak savanna, a habitat with widely scattered open-grown oaks. Other habitats in which it maintains populations in Wisconsin include roadsides, the edges of oak woodlands, and mesic prairies (Cochrane and Iltis 2000). At the conservancy, we measured the canopy cover for each of the stands using vertical photography with a fish-eye lens, a technique widely used to determine canopy cover in forests. The data in Table 1 show that the canopy cover varied from 34% to 75%, with an average of 54%. If only the spontaneous stands are examined, the average cover is slightly lower (52%) and the range narrower (34%-62%).

In 2001, the first seed pod was observed, a single pod at

*Native population permanently marked with a metal rebar. The AP # is inscribed on the rebar cap (Forestry Suppliers, Inc.) with a Dremel engraving tool.*

Table 1. Canopy cover for purple milkweeds as measured by vertical photography with a fish-eye lens. Canopy cover measurements were made by overlaying a grid pattern onto each digital image and counting the number of open areas and canopy areas. The transplants (T) for which canopy cover was measured are those which flowered in their third growing season. The only plant from the initial 2002 propagation effort to flower is AP-28.

| Stand | % Canopy | Type of savanna | **Spontaneous (S) or transplant (T)** |
|---|---|---|---|
| AP-8 | 64.6% | Bur oak | T |
| AP-11 | 53.7% | White oak | S |
| AP-12 | 60.0% | White oak | S |
| AP-13 | 60.6% | White oak | S |
| AP-16 | 56.3% | Bur oak | S |
| AP-17 | 61.6% | White oak | S |
| AP-18 | 34.2% | Bur oak; milkweed now gone | S |
| AP-19 | 60.4% | Bur oak | S |
| AP-28 | 50.0% | Bur oak | T |
| AP-29 | 55.0% | Bur oak | S |
| AP-30 | 53.5% | White oak | S |
| AP-31 | 37.1% | Bur oak | S |
| AP-33 | 34.4% | Black oak | S |
| AP-34 | 45.2% | White oak | T |
| AP-35 | 65.2% | Bur oak | T |
| AP-36 | 59.3% | Bur oak | T |
| AP-37 | 75.2% | Oak hickory | T |
| AP-38 | 55.1% | Bur oak | T |
| AP-39 | 53.7% | Bur oak | S |
| Average | 53.9% | | |
| Range | 34.2 to 75.2% | | |

the first site discovered. This pod provided seeds for initial propagation efforts. Plants were raised in a greenhouse and transplanted to the field in 2002. Several of these plants are still present, but only one of them has reached the flowering stage. As changes in the technique for raising and transplanting seedlings were made in response to the outcomes of early efforts, more successful results occurred.

We have observed that pod formation and seed set of this species are highly variable, both within a single population and across the whole range of populations. Even if a plant has many flowering stems, only a few flowers may initiate pod formation, and many of these pods abort. In several years, throughout the whole range of populations only a single pod has matured. The best pod formation has been obtained in populations raised from seed in a forbs garden, where weeding and watering can be readily done. Especially good pod formation in the forbs garden in 2007 provided hundreds of viable seeds, some of which we have distributed to other natural areas in southern Wisconsin.

## Finding and Identifying Purple Milkweeds in the Field.

If they are not in flower, purple milkweed plants are hard to locate, especially in savanna habitats where they are often hidden by taller plants. In southern Wisconsin, leaves of purple milkweed plants start to appear in late May and flowering peaks around the middle of June. Some stands do not flower and some of the individual stems in many stands do not flower. If none of the stems are flowering, discovery is difficult.

Careful surveys at the Pleasant Valley Conservancy have been made at peak flowering of all the likely sites. Also, restoration personnel are asked to report any flowering plants. However, flowering plants are easy to miss if hidden by taller species, and many of the best populations have been found accidentally. If the plant is not flowering, it cannot be positively identified as purple milkweed. Although field guides often confidently describe vegetative characteristics, most of these are variable and uncertain. Frequently they are based on the characteristics of a few herbarium specimens. According to Farnsworth and DiGregorio (2001), misidentification in the field has led to incorrect labels on at least one voucher specimen at the Gray Herbarium at Harvard University.

In the absence of flowers, the two species most difficult to tell from purple milkweed are common and poke milkweeds. Both are also found in savannas, and both have leaves that are fairly similar to those of purple milkweed. However, the flowers of purple milkweed are striking and easy to distinguish by color from those of both common and poke milkweed. In dried specimens, purple milkweed can be distinguished from common milkweed by the shape of the hood portion of the flower, that of purple milkweed surpassing the gynostegium, without lateral teeth but often somewhat widened in the middle (Gleason 1968). If pod formation occurs, the pods of common milkweed are hairy and warty, whereas those of purple milkweed are downy but without warts. Common milkweed is a clonal species and can usually be distinguished from purple milkweed because it usually has many stems distributed over a larger area. Poke milkweed leaves often resemble those of purple milkweed. However, purple milkweed leaves are hairy on the bottom, whereas poke milkweed leaves are not. If it is flowering, a poke milkweed plant can be easily identified. The pods of poke milkweed are smaller and narrower. Because of these difficulties, identification of purple milkweed should never be made without seeing the flowers.

Beginning in 2000, we made special efforts to discover purple milkweed plants at the Conservancy. Because purple milkweeds do not always flower every year, we marked each milkweed population with leaves resembling purple milkweed. When flowers finally formed, sometimes years later, some of these plants turned out to be poke milkweed and a few were common milkweed.

**Growth Form**

Purple milkweed is a perennial but does not always show aboveground every year. Although it is said not to be rhizomatous (Gleason 1968), at a single location stems often develop over a 50-100 cm radius, presumably from underground growth processes. In our forbs garden, where we transplanted a number of purple milkweeds raised from seed in our greenhouse, a new plant arose from a stem that had grown horizontally under black plastic sheeting into the next row 60 cm away. Because of its rarity, I have not attempted to examine the anatomy by digging up any plants.

At a single marked location I have found anywhere from one to nine separate stems, although there is striking year-to-year variability. Some stems at a single location may be only 25 cm tall whereas others may be 100 cm tall. The shorter ones generally do not flower. A single stem often has only a single flowering umbel, although as many as three umbels may occur on a single stem, one or two sometimes in leaf axils. The number of flowers per umbel is variable, from about 12 up to 25 to 30. Usually, individual umbels are smaller if there are multiple umbels on a single stem. Wilbur (1976) in Michigan also found that the majority of stems did not flower.

Pod formation is highly irregular. Even vigorously growing plants with several large flower umbels may not set seed at all. Often pod formation begins (as noted by the curled pedicel) but is aborted. Even if good pod formation begins, attack by milkweed bugs (*Lygaeus* and *Oncopeltus* spp.) or weevils (Curculionidae family) can destroy a pod. Although there is considerable literature on pollination ecology in milkweeds (Wyatt and Broyles 1994), none of it has been done with purple milkweed. However, at Pleasant Valley Conservancy, pods that do mature often produce large numbers of seeds, which agrees with the data of Wilbur (1976).

The reproductive ecology in milkweeds is notoriously complex (Wyatt and Broyles 1994). Most species are self incompatible, and outcrossing is required for seed set. Pollination is brought about by large insects (Robertson 1886), primarily Lepidoptera and Hymenoptera, which transfer pollinia from one flower to another (Wilbur 1976). Pollination requires successive visits of a pollinator insect from one plant to another. Because of the rarity of purple milkweed, the chance of successive visits by a single pollinator may be unlikely. We mapped purple milkweed distribution at Pleasant Valley Conservancy with ArcGIS software. The GPS-determined coordinates of all known populations showed two major clusters of stands, with at least 300 meters between them. Although large pollinators might pass from one cluster to the other, it seems more likely that a single pollinator would only function within one of the clusters. Since none of the pollinators are specific to milkweeds, the probability of a "hit" at a distant population seems remote.

**Year-to-Year Variability**

A striking characteristic of purple milkweed is the marked year-to-year variability of the various stands. The data summarized in Table 2 present observations on the 12 stands that have arisen spontaneously and thus could be considered to be native to the site. In stand AP-18, a vigorous population existed with excellent pod formation for one year, faded to insubstantial the next, and disappeared completely the following year. This population seems to be gone for good. In another stand (AP-16), a windstorm brought a large black oak near to, and partly on top of, the population. No plants appeared the year of the windstorm, or the following year. However, the third year after the storm, a very vigorous population with six flowering stems arose near the earlier stand. It seems likely that it is derived from the original root stock. A third stand (AP-11) was one of the original populations discovered. It flourished through 2006 and then did not appear in 2007. In 2008 this population was back with three flowering clusters.

In addition to these rather marked year-to-year changes, the data show that each population grows differently almost every year. Differences in rainfall and temperature might be responsible for some of these differences, although all stands are subject to essentially the same weather conditions. This year-to-year variability emphasizes the need for long-term observations and suggests caution against premature generalization about the species.

*Three healthy pods forming on a single stem. Pods like these commonly proceed to make good seed pods.*

*A purple milkweed pod that has been broken open, showing the arrangement of seeds. The seeds in this pod had a very high rate of germination.*

**Germination of Purple Milkweed**

Seeds collected from two different years were tested for germination efficiency. Comparisons were also made with several other milkweed species. Germination of milkweed seeds began within three days and was complete by 14 days. The results are given in the table below. All of the milkweeds tested had high germination rates, and purple milkweed had the highest.

Although pod formation is highly variable, if a pod is formed it usually provides a large number of seeds. The initial work was carried out using seeds obtained from a single pod collected in 2001. In 2002, these plants were set out at various savanna locations throughout Pleasant Valley Conservancy. The survival rate of these transplants was low, probably because insufficient knowledge had been obtained from field observations. Among other things, provision had not been made to water the transplants in the unusually dry summers of 2002 and 2003. Also, these first seedlings, grown only under fairly low intensities of artificial light, were very small. Subsequent work has led to good success in raising seedlings (plugs) in the greenhouse with much higher light intensities for transplanting to the field. The greenhouse-grown seedlings are much larger and survive transplanting well.

The growth medium for propagation in the greenhouse was a standard mixture used extensively in the University of Wisconsin–Madison. It consisted of one part compost-enriched field soil and two parts Metro-Mix potting mixture (Sun Gro Horticulture, Bellevue WA). The growth medium was autoclaved before use. Seeds were planted in rows in heavy flats (Dyna-flat, Hummert International, Earth City MO) with holes in the bottom. These were 34 × 48 × 12 cm, with a soil depth of 8 cm. The sterilized soil mixture in the flats was moistened extensively and allowed to drain overnight. The flats were wrapped in plastic and placed in a cold room at 4°C about mid-January for seed stratification.

About mid-March, the flats were moved to a greenhouse where the nighttime temperature was 65°C and the daytime temperature varied from 70-80°C (depending on solar insolation). Natural sunlight was supplemented as needed by artificial lights in order to achieve an illumination period of 15 h light and 9 h dark. The flats were examined daily and watered as needed. The first seedlings of purple milkweed were seen in a week, and after three weeks the seedlings were well established. When the seedlings were about 5 cm tall they were transplanted in the same soil mix to long tubes (D40 Deepots, Stewe and Sons, Corvallis OR). These tubes are 6 cm inside diameter by 24 cm deep and contain about 655 $cm^3$ of soil. They have holes at the bottom for drainage. These deep tubes were used because purple milkweed seedlings form a long taproot.

After transplanting to Deepots, the seedlings were fertilized once a week with Sun Gro Technigro (20N-9P-20K, one tablespoon per gallon of water). Without fertilization, the seedlings became chlorotic. About 45 days after transplanting to the Deepots, the seedlings were moved to an outdoor cold frame for hardening. This cold frame was covered with a screen to reduce springtime sunlight intensity and to disperse water during heavy rainfall events.

The seedlings were transplanted to the field in late May

**Table 2. Year-by-year summary of purple milkweed stands native (not transplanted) to the site. The unit numbers are management units at Pleasant Valley Conservancy.**

| Stand # | Unit # | Early notes | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | Max # umbels | Pods |
|---|---|---|---|---|---|---|---|---|---|---|
| AP-11 | 12B | Found 2000 | no details | 3 large stems; nice flowers; no pods | 3 plants; 2 flowered; no pods | 5 lush plants, 4 in flower; pods aborted | No plant in 2007! | 3 stems, 2 with flowers; no pods | 4 | 0 |
| AP-12 | 12B | Found 2000 | no details | 4 large plants; 3 flowered; 1 pod; collect seeds | 5 small plants; no flowers; 1 medium plant flowered; no pods | 5 stems, 4 with flowers; pods aborted | 6 stems, 3 with flowers; no pods | 9 stems; 5 with flowers; no pods | 5 | 1 (2004) |
| AP-13 | 12B | Found 1999 | 2 stems with flowers; no pods | 1 stem; flowers aborted | lots of plants; tall with multiple flower clusters; one pod collected seeds | 4 stems with flowers; one large pod; collected seeds | 5 stems, 4 with flowers; no pods | 4 stems, 2 with flowers, no pods | 4 | 1 (2005), 1 (2006) |
| AP-16 | 19B | Found 2001 | Did not flower | 3 stems with flowers; 9 pods formed; collected all pods | 3 stems of varying sizes with flowers; no pods | No plant; trees down on site | No plant; more trees down | North of the fallen tree; 6 stems with flowers; 3 pods | 6 | 9 (2004), 3 (2008) |
| AP-17 | 12B | | | New in 2004; 3 stems with flowers; no pods formed | 3 plants; 1 with flowers; no pods | 5 stems in flower; some weevil damage; 1 pod; collected seeds | 5 stems; 4 with flowers; no pods | 7 stems with flowers; 1 pod | 7 | 1 (2006), 1 (2008) |
| AP-18 | 11A | | | New site 2004; 4 stems; 2 with flowers; 4 pods; collected seeds | 2 tiny plants which disappeared | No plants | No plants | No plants | 2 | 4 (2004) |
| AP-19 | 19B | Near AP-29; found in 2007 | | | | | New location in 2007; 3 stems with flowers, no pods | 3 stems with flowers; no pods | 3 | |

**Table 2. Year-by-year summary of purple milkweed stands native (not transplanted) to the site. The unit numbers are management units at Pleasant Valley Conservancy.**

| Stand # | Unit # | Early notes | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | Max # umbels | Pods |
|---|---|---|---|---|---|---|---|---|---|---|
| AP-29 | 19B | Found in 2006 | | | | New in 2006; 5 stems in flower; big and lush; 1 pod (collected seeds) | 6 stems, 5 with flowers; 5 pods; partially eaten by milkweed bugs | Large bushy plant with 11 stems from a single point; 3 flower clusters; no pods | 5 | 1 (2006) 5 (2007 |
| AP-30 | 12B | Found in 2006 | | | | New in 2006; 1 stem with 2 flower clusters; no pods | 2 stems, 1 with few flowers, sickly, no pods | 5 stems with flowers; no pods | 5 | |
| AP-31 | 11A | Found in 2006 | | | | New in 2006; 4 stems with flowers; 1 pod; collected seeds | Lush, 3 stems with flowers, pod aborted | 7 stems with great flowers; pods aborted | 7 | 1 (2006) |
| AP-33 | 19C | Found in 2008 | | | | | | New in 2008; 5+2 stems with flowers, and 4 not flowering; pods aborted | 7 | |
| AP-39 | 19B | Found in 2008 | | | | | | New in 2008; Three separate locations in the same area; 6 stems, most with flowers; pods aborted | 6 | |
| Yearly pod totals | | One pod in 2001; no pods 2002 | No pods | 14 pods | 1 pod | 4 pods | 5 pods (plus 25 in forbs garden) | 4 plus 2 in forbs garden | | |

or early June. At the time of transplanting to the field, the seedlings were about 10-12 cm tall and had formed extensive root systems throughout the Deepots. The transplant sites chosen were in open savanna areas similar to those in which native purple milkweed plants were growing. Each seedling was marked with a numbered flag. The seedlings were watered thoroughly at the time of transplanting and whenever needed throughout the summer. When the weather was dry, the seedlings were watered at least weekly. In subsequent years, the established transplants were no longer watered.

Seedlings were planted in groups of three (spaced about 180 cm apart) to make locating for watering easier. An Excel spreadsheet served as an index, and each seedling was checked off as it was watered (a map was used to locate each trio of seedlings). The seedlings were monitored periodically throughout the summer. Over 90% of the seedlings survived well and began to senesce in late summer.

Prescribed burns are carried out every year in the savanna areas at Pleasant Valley Conservancy, including all the locations where seedlings were planted. In order to locate the seedlings after burns (which destroyed the flags), a heat-resistant electrical insulator with a unique number was placed on the wire at the base of each flag. After the burn, each insulator was found and a new flag installed. Thus transplants could be monitored over multiple years.

In early June of the year following the initial transplants, we sought out the purple milkweed sites and examined them for new growth. About 82% of plants transplanted in 2006 overwintered successfully and were found in 2007. Further, 88% of those that grew in the summer of 2007 were found again in June of 2008. Also, 25% of the three-year-old plants produced flower buds. No flower buds were produced by plants either the first or second year after transplanting.

Table 3. Germination percentages of milkweed species. Two Petri dishes were used for each species. 25 seeds were spaced out on a water-saturated filter paper sheet in the bottom of each dish. The dishes were wrapped in plastic and placed at 4° C for 45 days. The plates were then kept at room temperature (15-20° C) under fluorescent lights (16 hour light/8 hour dark), and filter papers were remoistened as needed.

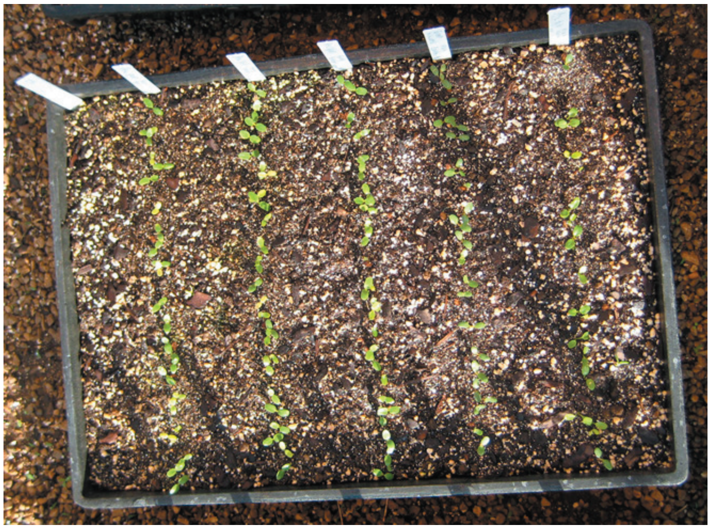
| | | Germination | | |
|---|---|---|---|---|
| **Species** | **Seed year** | **% Dish 1** | **% Dish 2** | **Average %** |
| *Asclepias purpurascens* | 2005 (stored until 2007) | 100 | 100 | 100 |
| *A. purpurascens* | 2007 | 100 | 84 | 92 |
| *A. tuberosa* | 2007 | 76 | 92 | 84 |
| *A. exalta* | 2007 | 80 | 92 | 86 |
| *A. viridiflora* | 2007 | 96 | 72 | 84 |

Are these transplants permanent? Successful establishment will depend upon the sites chosen, the weather, and a variety of unforeseen variables (disturbance by animals, competition by other plants, etc.). The one indication of permanence is the following: two seedlings raised from the seeds of a single pod were planted in spring 2002 and became established and have bloomed well through 2008. A number of other transplants from 2002 still appear as small plants (around 10 cm tall) each year but have not developed into flowering plants. Several other seedlings from more recent plantings are also persisting.

## Forbs Garden

In 2004, outstanding seed set occurred in the natural populations and 14 pods were obtained. Germination tests showed high viability. In 2005, we used some of these seeds to create a milkweed forbs garden, including purple milkweed and other milkweeds (butterfly, short green [*A. viridflora*], swamp, and whorled) from Pleasant Valley Conservancy and nearby prairie remnants. A former lawn area was treated once in the fall and again in the early spring with glyphosate. The resulting dry thatch was burned off and the plot tilled with a powered Rototiller. After two weeks it was Rototilled again. The plot was fenced to reduce rodent predation. This essentially weed-free plot was covered with a weed barrier of black plastic sheeting and the sheet cut to make rows. Although most of the garden was in full sun, one end was partially shaded by a large black cherry tree. It was in this area that the purple milkweeds were planted. A sprinkler watering system was set up and the whole garden watered whenever conditions were dry. (The goal here was to keep the plants in an unwilted condition.)

We transplanted some of the plants raised from seed in the greenhouse to this forbs garden. Of the 21 separate purple milkweed transplants in 2005, 18 (85%) survived and grew through the summer. None flowered during the first year. In early October 2005, 57% were still alive and were about 10-15 cm tall. The purple milkweed plants overwintered well and 12 plants were present the following year. Growth was noticeably better than in the previous year. By the middle of June 2006, there were seven plants with flowers, mostly still in bud but showing color. On 27 June, there were five plants without flowers and seven with flowers. By 3 July, the purple milkweeds were mostly finished flowering, and one



*Seedlings after 10 days of growth in a flat.*

*The extensive purple milkweed root system makes it possible to remove the whole soil plug fromthe Deepot tube.*

*Purple milkweed plants growing in Deepot tubes. These plants were about 30 days old.*

plant formed a pod.

In 2007, both growth and pod formation were much better than they had been the previous year. The purple milkweed plants from the 2005 seedlings that were closest to the shade of the cherry tree grew extremely well. Many of these third-year plants were over 90-100 cm tall, and over 30 vigorously growing stems were present. (Because of the large number of plants available, two flowering stems were collected for deposit in the University of Wisconsin–Madison Herbarium.) At least 25 pods formed on these third-year plants. Seeds from these pods were used to raise more seedlings. Also, seeds were planted in savanna areas at Pleasant Valley Conservancy, and some seeds were donated to other conservancies in southern Wisconsin. In addition to successful pod formation in third-year plants, two second-year plants that had flowered also formed pods.

Unfortunately, in 2008 purple milkweed growth in this forbs garden was much poorer than it had been in 2007. Only four flowering plants appeared in the fourth-year plants and only one pod formed. Also, only a single flowering plant formed in the third-year plants and no pod formed. In contrast, the two other milkweed species in adjacent rows, butterfly and swamp milkweed, grew very vigorously and made many pods. The explanation for this reduced vigor of purple milkweed is unknown, but the month of June 2008 was extremely rainy. Although the forbs garden never flooded, it is possible that the excess soil moisture affected the growth of these plants.

**Discussion**

The year-to-year variability of a single plant group is obviously a major concern in the successful establishment of purple milkweeds. Weather may be a major factor, especially during the critical growth and flowering period in June (in southern Wisconsin). We have no explanation for

*Above: Layout of the forbs garden. The soil was covered with a weed barrier of black plastic and was fenced to reduce access by rodents. The milkweed plugs were planted in slits in the pastic. Watering was done with a conventional lawn sprinkler.*

*Below: Vigorously growing purple milkweed plants after two years growth. These plants formed a large number of pods and seed set was very good.*

the disappearance of purple milkweeds from permanently marked stations and their reappearance several years later.

Although purple milkweed grows well from seed and can be readily transplanted to the field, its long-term survival depends on its spreading without help. Pod formation and seed set are highly variable and very inefficient, and this may be a critical factor in the poor establishment or retention of the species. In some years, only one or a few pods with viable seeds have formed among all 12 sites. If purple milkweed's pollination ecology resembles that of other milkweeds, pod formation and seed set depend on cross-pollination. With populations of low density, the probability of cross-pollination is low. It is perhaps as a result of this that purple milkweed plants at Pleasant Valley Conservancy are clustered in two areas, so that pollinators picking up pollen at one plant will find another nearby plant where the pollen might become deposited.

One approach to obtaining higher seed set would be the use of artificial pollination, a technique that has been used for pollination and genetic work in other milkweed species. Because of the complex nature of the milkweed flower, this requires considerable skill and has been carried out only with greenhouse-raised plants. A review of the hand pollination process (as described in several web sites) indicates that this would be very difficult to accomplish in the field. Descriptions of the technique assume pot-grown plants that can be manipulated under a dissecting microscope in a laboratory setting (Wyatt 1976).

At Pleasant Valley Conservancy, restoration of the oak savanna habitat led to the appearance of purple milkweed at 12 separate sites. However, this result obviously depended on the preexistence of seeds or plants in the area. If a good supply of seed is available, reseeding an area after savanna restoration could be carried out. However, no data are available on the success of such a seeding effort. In small untracked efforts, we have not observed any plants arising from seeds sown on the land. We had greater success raising seedlings in the greenhouse and transplanting them into the field. The success rate in our transplantation studies has been high, considerably greater than 70% after the first winter (second growing season) and over 50% after the second winter (third growing season). A number of these plants flowered in their third growing season, offering hope that these populations might become permanently established. Two transplants from 2002 have also developed into thriving plants and formed pods in 2008.

The most likely success for purple milkweed conservation will be the restoration of the savanna habitat, followed by transplanting seedlings into suitable sites. However, this procedure requires availability of a suitable seed source. Since seed set is so inefficient, collecting seed in the field is uncertain. We have had the best success by raising plants under relatively controlled conditions in a forbs garden. Although even here, there is considerable variability in seed production, but the chances of obtaining significant amounts of seed are higher than by any other means. Commercial seed sources are very expensive. Prairie Moon Nursery lists purple milkweeds at $2.00 for a packet of 25 seeds. However, this species is currently out of stock. JF New lists plants at $1.75 each, and seeds at $65 per ounce, around 5,000 seeds. Agrecol and Taylor Creek Nurseries do not list this species.

*Monarch butterfly on purple milkweeds. In the forbs garden, where there were five different species of milkweeds, the Monarchs laid eggs preferentially on this species. The caterpillars were removed daily and transferred to a nearby clone of common milkweed (A. syriaca). If not removed, the caterpillars sometimes killed a milkweed stem by girdling it or by eating all or most of the leaves.*

One biological threat to purple milkweeds is the monarch butterfly (*Danaus plexippus*). The data from our forbs garden suggest that monarch butterflies deposit eggs preferentially on purple milkweed. Five species of milkweed were present in the forbs garden, but we observed that monarch caterpillars prefer purple milkweed plants. The monarch caterpillars growing on purple milkweeds often girdle the stems, resulting in death of that stem. To protect the purple milkweed plants, we removed caterpillars and transported them to a large patch of common milkweeds about 15 m away.

Wilbur (1974) found that 23% of the purple milkweed plants at his study site near Ann Arbor, Michigan were damaged from herbivory by deer or other mammals. I have seen no evidence of herbivory at Pleasant Valley Conservancy, although in a garden in Madison, four vigorously growing purple milkweed transplants were completely eaten.

In general, my results provide encouragement for conservation efforts on this attractive species, although much more extensive research is needed.

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