ThymelaeaceaeCMezereum family

Dirca palustris L.

eastern leatherwood

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Growth habit, occurrence, and use. Eastern leatherwoodC*Dirca palustris* L.Cis also known as moosewood, rope-bark, and wicopy. Its natural distribution extends from New Brunswick to Ontario in the north and from northern Florida to Louisiana in the south (Fernald 1950). Within this range, the distribution is restricted to very specific site conditions. It is found almost exclusively in mesic, relatively rich hardwood forests or mixed coniferBhardwood forests (Alban and others 1991; Curtis 1959; Fernald 1950; Ferrari 1993; Jones 2000; Kotar and others 1988; Meeker and others 1993; Neveling 1962; Rooney 1996; Soper and Heimberger 1982; Voss 1985; Weir-Koetter 1996). In aspen ecosystems across the upper Great Lakes region, leatherwood is present in stands with a relatively high aspen site index and a significant northern hardwood component (Alban and others 1991). In Ontario, the northern limit of distribution is similar to that of beech and sugar maple (Soper and Heimberger 1982). The distribution of plants on a particular site can vary from apparently random to aggregated (Jones 2000). Forests in which leatherwood is common are characterized by a dense overstory that permits relatively little light to reach the forest floor during the growing season. It is often the only true understory shrub in these stands; the other woody understory species are tolerant to mid-tolerant treesCfor example, sugar maple (*Acer saccharum* Marsh.), ironwood (*Ostrya virginiana* (Mill.) K. Koch.), white ash (*Fraxina americana* L.), eastern hemlock (*Tsuga canadensis* (L.) Carr.), and balsam fir (*Abies balsamea* (L.) Mill.)Chaving the capacity to grow into the overstory (Alban and others 1991; Buckley 1996; Ferrari 1993; Jones 2000).

Western leatherwoodC*D. occidentalis* GrayCis very similar to eastern leatherwood (Neveling 1962). Its distribution is limited to the wooded hills of the San Francisco Bay region (Vogelman 1953). Flower descriptions and morphological comparisons of the 2 species are provided by Vogelman (1953). A related species in the ThymelaeaceaeC*Daphne mezereum* L.Cis an introduced species that has become established in some areas. The information presented here is for eastern leatherwood; some of it may also apply to western leatherwood.

In its natural habitat, eastern leatherwood reaches a height of 3 to 4 m and basal diameters of 5 to 10 cm. Crown width and depth of larger plants can be as much as 2 to 3 m; the largest crown volumes that we have measured are in the range of 15 to 25 m^3. Crown architecture can be fairly complex, with frequent branching and numerous apical growing points (figure 1). The largest individuals that we have observed are in old-growth northern hardwood forests where logging is prohibited and in older hardwood stands managed under a single-tree selection system. The maximum age attained by leatherwood is not known, but 30- to 50-year-old plants occur in older hardwood forests.

Annual height growth varies considerably (Jones 2000). On mature plants, elongation of an individual apical meristem ranges from 1 to 25 cm, but cumulative annual growth over the many apical meristems comprising the crown may be 0.5 to 1 m or more. Complete removal or reduction of canopy cover to less than 50% seems to reduce the frequency of leatherwood, but more work is needed to understand effects of disturbance on the survival, growth, and reproduction of leatherwood. This reduction, however, may be more the result of physical damage during harvesting than to the change in the physical environment resulting from harvesting. In plants that have had branches completely or partially separated, callus growth covers the wound relatively quickly, giving wounded stems a distinct appearance. The flexible nature of the stem and branches is the result of a relatively low level of lignification in the wood (Neveling 1962). The specific gravity of the wood is 0.41, ranking it among the least dense woods of deciduous broadleafed species, comparable to poplar and basswood species (Alden 1995; Neveling 1962).

There is poor sprouting in leatherwood after the main stem is cut or broken. Layering of branches has been observed, but usually it does not occur, even on branches in good contact with an apparently suitable substrate layer. Seedling regeneration seems to be the most common way that the species is maintained in forests.

The only current documented use of eastern leatherwood is for landscaping. Even for this, it is not used to the extent possible, particularly in more northern areas (for example, in the northern Great Lakes region and northern New England), where the choice of plants is limited by climate. Although leatherwood provides a very early flowering, medium-sized shrub for these northern areas (Esson 1949), its leaves are often infected by a rust and leaf miners in mid-summer, turning yellow prematurely and falling early. It can be planted and does best in moist, shaded areas. If the plant is naturally present in areas where development is planned, efforts should be made to protect it and provide conditions that favor growth, as older plants provide interesting form and structure to managed landscapes such as yards and gardens (del Tredici 1991; Dirr 1990). The plant appears to be browsed very little by deer, even in forests where other woody plants are repeatedly and severely browsed throughout the year (Weir-Koetter 1996). The lack of browsing could be due to the plants= diuretic qualities (Meeker and others 1993); the stem also contains large quantities of calcium oxalate crystals (Holm 1921). Ramsewak and others (1999) have described novel phenolic glycosides in leatherwood. The strong pliable bark (the source of the common name) was used by Ojibwa for making bowstrings, baskets, and fishing lines (Holm 1921; Meeker and others 1993; Weir-Koetter 1996). The wood is very easy to slice with a sharp knife.

Flowering and fruiting. Leatherwood is monoecious. The pale yellow, fragrant flowers are perfect and borne in clusters of 2 to 7 (figures 1 and 2) (Neveling 1962; Soper and Heimberger 1982; Vogelman 1953; Zasada and others 1996). The buds from which flowers develop are small and conical, with 4 distinct dark, silky scales that persist after flowering (figure 1). Clusters of 3 flowers are most common in northern WisconsinBMichigan; clusters of 4 are somewhat less common, and clusters of 5 to 7 uncommon or rare. Mature plants commonly produce 300 to 1,500 flowers; the greatest number we observed on a plant was about 4,500 flowers (Zasada and others 1996). [Note: in the following discussion, we refer to unpublished data on fruits and seeds collected on or in the vicinity of the Ottawa National Forest in Michigan's Upper Peninsula and the Nicolet and Chequamegon National Forests in northern Wisconsin.]

Flowering occurs in AprilBMay, 2 to 3 weeks before the overstory leafs out and generally before the spring ephemeral species flower. In 1994 and 1995 in northern WisconsinBMichigan, fairly average years in terms of spring weather, pollination was mostly completed by May 11B15. In 1996, a relatively cold, wet spring, flowering began on May 14 on warm, south-facing aspects and several days later on north aspects. Flower buds opened as late as May 25 and some anthers still contained pollen in early June. Flower parts drop quickly if pollination/fertilization is not successful but remain attached to developing fruits for a longer period (figure 3). Fruits ripen in June and July, with one report of ripening as late as SeptemberBOctober (Vogelman 1953). About 1 month (mid-June) after the first flowers appear in northern WisconsinBMichigan, 75% of seeds contained embryos that filled 80% or more of the seed; 5% of the seeds were less than 50% filled. When fully ripe, the endosperm is a minor component of the seed (figure 4) (Neveling 1962; Zasada and others 1996). The outermost fleshy portion of the fruit cannot be separated easily from the seed coat until mid-late June.

Immature fruits are green and change to a very light green; some fruits are almost white, when they fall from the plant. There are some reports that fruits turn reddish when mature (McVaugh 1941; Meeker and others 1993; Neveling 1962). However, McVaugh (1941) summarized the literature and concluded that although the reddish fruit color can be observed in dried herbarium specimens, his own and other=s observations led to the conclusion that mature fruits are light to yellowish green. We found no evidence in the 8 stands studied in Wisconsin and Michigan that fruits were reddish in color when mature. The fleshy outer fruit wall (figure 5) of naturally dispersed fruits turns black within about 24 hours in some fruits, but in others it remains light green for several days.

Each flower has the potential to produce 1 single-seeded fruit, and hence fruits can be in clusters of 3 to 7 if all flowers produce fruits. Fruits with 2 seeds were observed, but they were very rare. Clusters with 1 to 3 fruits were most common, as many flowers do not produce fruits. Clusters of more than 4 fruits are uncommon or rare. Number of flowers, fruit set, and number of fruits per cluster varies annually and among stands in the same year (table 1).

The fruit (figure 3) is a drupe and described as "bilaterally symmetrical, somewhat spindle-shaped....circular in cross-section at the widest point...and (having) a narrow, slightly elevated ridge...from the base of the style down the whole length of the fruit" (McVaugh 1941). Fruits are reported as 9 to 12 mm long for Ontario populations (Soper and Heimberger 1982), 12 to 15 mm long by 7 mm wide (Vogelman 1953) for Michigan and Indiana populations, and 12.5 to 15 mm long (McVaugh 1941) for New York populations. Average dimensions for fruits from 6 northern WisconsinBMichigan populations were 8.5 to 9.5 mm long by 5.5 to 6.5 mm wide. Range in length was from 6.5 to 15.0 mm and width 4.5 to 7.5 mm for these latter populations (Zasada and others 1996). The fresh weight of individual fruits containing fully developed seeds varied from 0.08 to 0.23 g. Moisture content of whole fruits was 100 to 175% (dry weight basis) for dispersed fruits and those about to be dispersed.

Individual seeds, with their fleshy coats removed (figure 4), were 5.5 to 8.5 mm long and 3.5 to 5.0 mm wide for northern WisconsinBMichigan populations. Fresh seed weight varied from 0.04 to 0.08 g and percentage moisture content was 40 to 55% (dry weight basis; seeds dried to a constant weight at 65 ˚C) for seeds collected from the ground shortly after dispersal; individual seeds on plants from which seeds were being dispersed but still firmly attached to the peduncle had moisture contents of 100 to 125% (Zasada and others 1996). Mature seeds are dark brown-black with a well-developed lighter longitudinal strip (figure 4). The strip is the point of attachment of the seed to the fruit wall in the area of the elevated ridge, which is a noticeable aspect of the shape of the fruit; the ovular trace is attached to the seed in this strip (figures 3 to 6) (McVaugh 1941; Neveling 1962).

Embryo length varied from 4 to 6 mm and from 2 to 4 mm in width in the WisconsinBMichigan populations. At maturity, the embryo fills 95% or more of the seed; a small cavity develops at both poles of the seed (figure 5). Multiple embryos, all poorly developed, occurred in less than 0.5% of the seeds (Zasada and others 1996).

The general anatomical features of the seed are illustrated in figure 5. The ovular trace and the pore through which it passes are an interesting feature of the seed (Neveling 1962). The pore appears filled with a fibrous material in seeds that have fallen from the plant. The black, stony seed coat does not appear to completely seal the pore, even at maturity.

Collection of fruits; extraction and storage of seeds. Fruits ripen in June and July. McVaugh (1941) observed that dispersal for plants in New York was completed by the following dates during a 3-year periodCJune 20, July 1B3, and later than July 7. In northern WisconsinBMichigan populations, fruits have been observed on plants as late as July 16, but as observed by McVaugh (1941), dispersal was completed by July 1 in some years. The seeds disappear fairly quickly once they are fully mature but are fairly obvious on the soil surface for several days after dispersal (Dirr and Heuser 1987; McVaugh 1941; Nevling 1962; Soper and Heimberger 1982). During windy periods, deposition rates were as high as 27 fruits/m^2/hr under 1 shrub. Timing of fruit abscission and fruit drop varies among plants in a stand, among branches within a plant and among fruits in a cluster (Zasada and others 1996). In an area where dispersal was followed on a daily basis, seeds from the entire population were dispersed over about a 2-week period; some plants shed all of their seeds in 2 to 3 days, whereas others dispersed seeds over a 6- to 8-day period.

Birds do not seem to be a critical factor in seed removal, but they do use some seeds and may be more important than our observations suggest. They may remove entire fruits, but, in some cases, they remove only the seed, leaving the fleshy fruit coat attached to the plant. Although the level of fruit use by rodents after dispersal is not known, it seems that this might be an important way in which seeds are removed from the seed pool. Remnants of the black, stony seed coat are fairly common under plants about 1 month after dispersal.

If seeds are needed, we recommend keeping a close watch on shrubs with fruits and collecting the fruits soon as they are ripe. Once some fruits fall naturally, all fruits have fully developed seeds. Embryo development is easily checked by cutting the seed longitudinally; fully developed seeds will appear as in figure 5.

Fruits can be picked by hand from the plant. However, when fully ripened, they readily fall when the plant is shaken and could be collected from the ground. Because each fruit contains only 1 seed, the number of seedlings desired (plus additional seeds as insurance against poor germination) will determine the number of fruits required. Based on cutting tests, 90 to 100% of developed fruits contained seeds with apparently viable embryos.

The pulp can be removed by hand or mechanically. When the seeds are fully mature, a cavity, with the exception of the attachment between the ovular trace and fruit wall, develops between the fleshy fruit wall and the hard inner seed coat, making it fairly easy to hand-clean small quantities of seeds. The stony seed coat is easily broken with the pressure of a fingernail and the seed can be squashed by squeezing between the thumb and forefinger with moderate pressure. Consequently, care should be taken in any type of mechanical cleaning.

No information was found on the best ways to handle fruits or store seeds. Seeds remain viable in the forest floor from the time of dispersal until they germinate in the spring (del Tredici 1984), suggesting that storage for at least 8 to 10 months is possible. Seeds are exposed to a fairly wide range of temperature and moisture conditions between dispersal and germination.

Germination. Detailed information on the effects of environmental conditions on germination was not found. del Tredici (1984) used a number of standard methods to stimulate gemination, but untreated seeds planted in a nursery bed soon after they were collected were the only ones that produced seedlings (67% germination). Dirr and Heuser (1987) reported that both cleaned and uncleaned (fleshy fruit wall removed) seeds produced seedlings. In controlled environment studies, a seedlot was observed to produce germinants over at least a 3-year period (Zasada and others 1996).

Nursery. Based on the limited information available, we recommend planting seeds soon after collection with and without the fleshy fruit wall in order to provide the range of conditions under which seeds appear to germinate naturally; seeds sown this way will germinate the next spring (del Tredici 1984; Dirr and Heuser 1987). Dirr and Heuser (1987) reported finding a number of young plants under a mature plant growing in a landscaped area, indicating that it might be possible to obtain some small seedlings from these situations. The growth rate of seedlings under open conditions is not documented. In its natural habitat, seedlings grow to a height of 20 to 30 cm in 5 to 10 years.

There has been little or no success in stimulating rooting in stem cuttings (Dirr and Heuser 1987). Layering occurs under natural conditions, suggesting that air-layering is a potential option for propagating leatherwood. However, Hendricks (1985) reported that air-layered stems did not produce roots or callus during an 8-week period. Our observations of layering of branches and the main stem under natural conditions suggest that it might take longer than 8 weeks for rooting to occur.

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Figure 1C*Dirca palustris*, eastern leatherwood: mature forest-grown plant in full flower, with plant about 1.3 m tall.

Figure 2C*Dirca palustris*, eastern leatherwood: 3-flower cluster, subtending structures are silky, bud scales.

Figure 3C*Dirca palustris*, eastern leatherwood: fully developed but immature fruits. Flower parts are still attached to some fruits. Fruit length varies from 6.5 to 15 mm in the northern WisconsinBMichigan area where fruits were collected.

Figure 4C*Dirca palustris*, eastern leatherwood: ripe fruits collected shortly after dispersal.

Figure 5C*Dirca palustris*, eastern leatherwood: seeds with fleshy outer fruit wall removed. All seeds have a light-colored area along which the ovular trace is located; only 2 of the seeds are positioned to show this area.

Figure 6C*Dirca palustris*, eastern leatherwood: generalized longitudinal section of mature seed, based on Neveling (1962) and Buckley (1996).

Table 1C*Dirca palustris,* eastern leatherwood: flowering and fruit production in 2 forest types in northern Wisconsin

Stand type*	No. 3-flower clusters/shrubH Mean	Range	% cluster w/1B3 fruits	% of all clusters with fruits 1 fpc	2 fpc	3 fpc	No. fruits/plant Mean	Range
Hardwood								
1995	153	5B515	23	22	48	30	40	0B386
	198	21B695	C	C	C	C	194	13B840
1996	C	C	55	20	41	19	C	
Pine								
1995	59	0B255	2	0	77	23	3	0B45
	85	0B325	C	14	57	29	C	
1996	C	C	23	C	C	C	36	0B260

Note: fpc = fruits per cluster; these populations did not have 4-flower or 4-fruit clusters in the 2 years of observation.

* Based on 15 randomly selected shrubs in each stand.

H To obtain total number of flowers, multiply by 3.