

Hoptree / Wafer-Ash (*Ptelea trifoliata*): The Flat Citrus

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On moist rocky toe-slopes and well-drained gravel bars, hidden among shrubs and young trees, grows a citrus family tree. This citrus tree is the most northern growing of its family in North America, surviving in Quebec and Ontario, Canada. Instead of a plump juicy fruit, it bears a fruit which appears as a small thin papery pancake. Its natural plant oils give the entire tree a lemony kerosine smell. It contains a number of special alkaloids utilized historically for herbal medicines. People notice this unique tree when they hike into its moist, well-drained haunts and spy clusters of fruit disks. This is the hoptree (*Ptelea trifoliata*).

Names

The tree *Ptelea trifoliata* was first referenced in 1696 as a Virginia plant grown in the King's garden in England. *Ptelea trifoliata* is a scientific name derived from Greek and Latin which means a three-leaved elm. It was originally given this name (1753) because its fruit resembled large elm fruit. Other scientific names used for this species, sub-species or varieties have included: *Ptelea trifoliata* 1753; *Ptelea baldwinii* 1838; *Ptelea angustifolia* 1839; *Ptelea trifoliata mollis* 1840; *Ptelea carolina* 1880; *Ptelea serrata* 1893; *Ptelea mesochara* 1897; *Ptelea aquilina* 1906; *Ptelea pallida* 1906; *Ptelea isophylla* 1906; *Ptelea toxicodendron* 1906; *Ptelea mesochara* var *mucronata* 1912; and, *Ptelea trifoliata* var *deamiana* 1912. This tree has been known in the ornamental trade since 1724.

Common names varies by historic use and location. Here hoptree will be used. This name was derived from use of the fruit, with its bitter alkaloids and essential oils, acting as a replacement for hops in flavoring beer. Other common names used for this species have included agree bark, cola de zorrillo, common hoptree, hoptree, narrowleaf hoptree, paleleaf hoptree, prairie-grub, prickaway-anise, quinine tree, sang-tree, shrubby trefoil, skunkbush, stinking prairie-bush, stinking-ash, swamp dogwood, three-leaved hoptree, trefoil, wafer-ash, water-ash, western hoptree, wingseed, and woolly hoptree. All these common names can be found used with and without hyphens, and printed as one or two words.

Family Matters

Ptelea trifoliata belongs to the *Rutaceae* family which is composed of trees, shrubs and some herbs. Most of this family are sub-tropical and tropical plants seldom growing in temperate regions. The *Rutaceae* family contains about 150 genera which hold about 1,800 species. All species in this family are known for bitter alkaloids and volatile essential oils.

Members of the *Rutaceae* family which many people might be familiar with include key lime (*Citrus*), sour orange (*Citrus*), torchwood (*Amyris*), trifoliate orange (*Poncirus*), and pricklyash (*Zanthoxylum*). In the Southeastern United States, the family is represented by four small trees or large shrubs, two are *Zanthoxylum* (pricklyash) and one *Ptelea*. A fourth family member is an escaped and naturalized exotic species from Asia called *Poncirus trifoliata* (hardy or trifoliate orange).

The genus *Ptelea* contains two native trees in the United States (*Ptelea trifoliata* in most of the United States and *Ptelea crenulata* in California) and one native tree in Mexico (*Ptelea aptera* in Baja). *Ptelea* has a huge range, growing in many different places, and with seemingly great genetic diversity. There are many geographic variations within this species across its range. For example, depending upon the scientific paper consulted, *Ptelea trifoliata* is either a single species with many sub-species and varieties, or is composed of many species not yet examined and officially named (one author lists *Ptelea* as having 10 species in the United States and Mexico). The most common treatment of *Ptelea trifoliata* used here, is to divide the species into four sub-species (3 in the West & 1 in the East), and nine varieties (6 in the West & 3 in the East) within the United States and Canada, with an additional single sub-species and two varieties in Mexico.

Accepted Variations

The four sub-species of *Ptelea trifoliata* usually accepted in the United States are: *Ptelea trifoliata* ssp. *angustifolia* (common hoptree) found in Arkansas, New Mexico, Oklahoma, and Texas; *Ptelea trifoliata* ssp. *pallida* (pallid hoptree) from Arizona, Colorado, New Mexico, Texas, and Utah; *Ptelea trifoliata* ssp. *polyadenia* (pallid hoptree) found in the hills and mountains of Arizona, Arkansas, Colorado, New Mexico, Oklahoma, and Texas; and, *Ptelea trifoliata* ssp. *trifoliata* (hoptree) found in roughly 37 Eastern North American states and provinces. Figure 1 is an outline of these sub-species and varieties, and Figure 2 provides a map of their ranges in the United States.

Hoppy Confusion

Along with accepted varieties are some additional forms of *Ptelea trifoliata* described historically which include: *Ptelea trifoliata* var *pentaphylla* (or var *heterophylla*) a narrow leaf form; *Ptelea trifoliata* var *fastigiata* with a narrow crown and upright branches; and, *Ptelea trifoliata* var *pubescens* a variety with densely hairy leaf undersides. *Ptelea serrata* was identified early as a small, narrow-leaved form from the Stone Mountain area of Georgia and other isolated spots. Some of these forms may have been considered sub-species or varieties, but now are considered local variations.

The literature has used the species name *Ptelea pentaphylla*, which is considered to be the same as *Ptelea trifoliata*. A combination of *Ptelea mollis*, *Ptelea tomentosa*, and *Ptelea trifoliata glauca* have all been historically attached to a form of hoptree which grows along the Atlantic Coastal Plain from North Carolina to Florida and has very hairy leaf undersides. *Ptelea nitens* was an identified (1912) narrow leaf variant from the Colorado and Oklahoma area. *Ptelea lutescens* was an identified (1918) narrow leaf variant from Arizona. *Ptelea baldwinii* was a species form identified (1893) in Florida.

Trade Names

There are a number of historic cultivars or ornamental varieties found in the plant trade: “Aurea” cultivar is a yellow-leaved form; “Glaucua” cultivar has unique blue-green colored foliage; “fastigiata” is an old upright form; “variegata” is a variegated leaf form; “pentaphylla” and “heterophylla” are probably from the same Western sub-species (*Ptelea trifoliata* ssp. *angustifolia*) and are a five leaflet form; and, “glaucua” is an extremely hairy (i.e. many tricombs) form.

Locations

Ptelea trifoliata is found singly and in non-clonal thickets scattered across its wide range of habitats, but never abundant in any location. Depending upon the reference, *Ptelea trifoliata* can be found in 34-39 states and two Canadian provinces, plus across large areas in Mexico. In New Jersey and New York the species is considered endangered, and in Pennsylvania the species is considered threatened. A rendition of the classic federal range map usually cited for this species is Figure 3. Figure 4 shows a general range map of the species in Georgia.

It is thought humans helped expand the range of *Ptelea trifoliata* into the upper Midwest and into Northern New England. This species can be found growing from sea-level in the Southeast to 8,500 feet of elevation in the Southwestern mountains. The Western portions of the range is broken up into small pockets along mountain waterways and in isolated valleys.

Preferences

Ptelea trifoliata is a small, deciduous, tree or large shrub which survives in open understories of many forests, and along open, sunny stream and river banks. This tree is tolerant of both shade and full sun, and can handle moderate resource shortages. It is found growing in partial shade along moist forest edges, in more open forest gaps, and along first and second stream terraces. The heavier the shading, the less likely the tree will ever flower and fruit.

Most references consider it an upland species, but it is found in well-drained areas adjacent to waterways, in open woodlands along ravines, and along edges of prairies on stony ground and coarse soil areas. Its preferred location is low-lying, well-drained rocky or gravelly soil areas with some organic matter and moist conditions. The combination of requiring strong soil moisture, but great drainage, limits growth to selected areas along rivers and stream bottoms, gravel banks, and flood terraces. It is clearly a water requiring upland tree, rather than a bottomland tree, regardless of where found.

Uncommon

Ptelea trifoliata is seen infrequently, but is wide-spread through many forest types and growing conditions. It is constrained by cold and heat, depending upon the portion of its wide range examined. Figure 5 lists cold hardiness and head index zones. It grows as a well balanced, dense and broad crowned tree tending toward a crooked, low-branched, multi-stemmed habit. It is slow growing and short-lived. It is easily damaged by fire and tends to be found in the interior, moist, stream gallery areas of woodlands.

Ptelea trifoliata reproduces by seed and does not form clonal clumps. The first two years after seed germination is critical for tree survival. Quick root connection (within several weeks) to a good permanent water supply which is constantly draining and being refreshed, and is not stagnant or anaerobic, is key. In a forest setting, 5% survival of germinated seeds is normal in the first two years. Once the proportion of roots to shoots reach 2:1, with a photosynthetically viable shoot, strong juvenile growth begins. Most extension growth occurs in a short burst, 1-4 weeks in duration, in mid to late Spring.

Sizes

Average or expected tree size is usually 12 - 22 feet tall (16 sources) with a crown spread of 12 - 18 feet (3 sources) and a stem diameter (DBH) of 7.5 inches (3 sources). This tree becomes shrub-like in stature and growth from at its range edges. The largest specimens are found in more Northern parts of species range, reaching a maximum of 36 feet tall, 30 feet crown spread, and 24 inches in diameter.

Leaves

Leaves on *Ptelea trifoliata* are deciduous, alternate growing, and compound with usually three leaflets or trifoliate (rarely 5 leaflets pinnately arranged). Figure 6. Leaves are 4-7 inches long (3 sources) with a long stem (>3 inches) which is swollen at its base covering the twig's axillary bud. Individual leaflets are 2.6 - 5.1 inches long (7 sources) and 1.5 - 2.6 inches wide (3 sources). The terminal leaflet is largest of the leaflets with a short tapered attachment to other leaflets which occasionally has small wings. Leaflets are elliptical to oval in shape with prominent veins, no connecting stems, pointed tips, and smooth or slightly toothed to slightly wavy margins. The mid-veins on side leaflets can be noticeably off-center.

Leaflets are usually dark shiny green on the upper side and paler to whitish below, turning a yellowish-green color in Fall. When crushed, leaves produce a pungent lemon-like musky odor. Leaflets have numerous translucent oil glands which are faintly visible embedded in leaf blades. Tricomes (plant hairs) cover major veins and vein junctions on leaflets.

Flowers

Flowers of *Ptelea trifoliata* are small (0.25 - 0.5 inch diameter) and not showy. This tree has a polygamous (polygamodioecious) sexual system, but is usually functionally dioecious. Among all trees in an area, there is usually more functional males than female trees (1.5 times more functionally male). None of the female trees, and only 3% of male trees, produce functional perfect flowers (cosexual flowers). Of the few male trees with some perfect flowers, a few fruits will be present at branch ends.

Flowers have 4-5 small, narrow, greenish-white petals 1/5 of an inch long, 4-5 small sepals, and are loosely clustered on branched flower stems at the ends of twigs. Flower clusters are 2-3 inches in diameter and

bloom from late April in the South to early June in the North. Flowers are pungent and must be pollinated by carrion flies, select butterflies and moths, and a host of other insects.

Fruit

Fruit of *Ptelea trifoliata* is most unique and eye-catching. The fruit is a large, flat, round (0.75-1 inch diameter) papery samara. Two wings surrounding the central seed container are clearly netted and fused, forming a halo around the entire seed chamber. Figure 7 shows a simplified front and side view of the samara.

Each fruit usually has two single seed compartments with two fused wings, but three seed compartments and three wing configurations do occur. Most fruit (~95%) contain living seed, with 90% of fruits containing one seed. Many fruits are produced in most years. Fruit color is green in Summer changing to yellow-green and then to brown by late fall when fruit is ripe. Fruit are held on a tree late into Winter in hanging clusters. Fruit is normally wind-blown, but is sometimes carried by flood-waters.

Seeds are small (0.3 inches long and less than 1/10 inch wide) with long points, a thin blackish colored outer layer, and a reddish-brown colored inner layer. Seeds can be sowed immediately upon collection into soil after rolling to remove the samara wing structure. Seeds should be placed in contact with mineral soil, but not buried more than 1/4 inch deep into soil. Seeds have a strong dormancy process. Collected and stored seeds should be slightly dried for storage, and then stratified for three months. Warm to hot temperatures quickly destroy seed viability under moist conditions. Mid-summer cuttings can also be taken and rooted.

Twigs & Roots

Twigs on *Ptelea trifoliata* are slender, usually ascending, with smooth greenish to reddish-brown periderm, occasionally dotted with corky warts, and with no spines or spurs. Lenticels are noticeably horizontal, large and brown. Pith is large, round in cross-section, white colored, and solid. Leaf scars are deeply U-shaped with 3 bundle scars and no stipular scars. Lateral buds on *Ptelea trifoliata* are minute and sunken, usually hidden during the growing season by their leaf stem base. There is no terminal bud. Buds are light brown in color, covered with silvery fine trichomes. The tree crown is composed of low branches, occasional suckers at the trunk base and along stems, with crooked, intertwining branches. Roots are extensive in growth with a strong distinct odor and a thick, brittle, pale yellowish-brown periderm.

Bark & Wood

Mature periderm is greenish tinged, reddish-brown to dark gray-brown in color. Periderm texture is smooth with localized areas of corky ridges which flatten and become scaly over time. Periderm has a pungent odor and a bitter taste. Wood is heavy, hard, and yellowish-brown in color. It is usually tight grained, filled with brittle reaction wood, and crooked. Tree trunks are usually too small for any significant solid wood use except small crafts.

Pests

Serious pests of *Ptelea trifoliata* are few and limited by essential oils and alkaloids in all tree parts. Even deer have a low preference for this species due to its bitter taste. The common fungal leaf spot *Alternaria alternata* causes yellow or dead spots on leaves, and rarely along shoot tips and on green fruit. Arabis mosaic and Cherry leaf roll nepovirus are spread by pollen and seeds, and by nematodes, causing yellow leaf spots. Spidermites on dry sites have been cited as minor pests. Two-marked treehopper (*Enchenopa binotata*) can generate a local aesthetic nuisance where present in large numbers by making small egg-laying slits in twigs and covering these with a noticeable white foam.

Ptelea trifoliata is a larval host to a number of moths and butterflies, like Eastern tiger swallowtail (*Papilio glaucus*), Giant swallowtail (*Papilio cresphontes* / *Heraclides cresphontes*), *Agonopterix costimacula* moth, and *Agonopterix pteleae* moth. Generally, it is abiotic stress such as heat loading, soil saturation, and drought which damages this tree, not biological agents.

Uses

Ptelea trifoliata has been used historically by Native Americans and European Americans as a “tonic” tree. It is a literal cornucopia of unique alkaloids with different forms found in only one tree tissue or in many. Essential oils are found throughout the tree. Most secondary compounds have some level of antimicrobial action or other biological activity. Roots, root periderm, seeds, and leaves all have been cited as containing medicinal materials.

Root periderm and inner stem periderm have been used as part of Spring tonics, as a tonic for malaria, and medicinally to aid in digestion and relief of asthma. Leaves have been used to make a poison for arrow tips. Fruit were substituted for hops used in flavoring beer (1858). This tree is usually seen in landscapes as hedges, water garden backdrops, and general ornamental use. Most common names refer either to the fruit “wafers” which look like enlarged elm fruit, or to the essential pungent oil smell of all tree parts.

Confusions

Ptelea trifoliata can be confused with bladdernut (*Staphylea trifolia*) which grows in similar areas and also has three leaflets, but bladdernut leaves grow in an opposite arrangement. Young seedlings of *Ptelea trifoliata* can be mistaken for poison ivy (*Toxicodendron radicans*) or fragrant sumac (*Rhus aromatica*). Poison ivy’s terminal leaflet has a long connecting stem to other leaflets, while hoptree has a terminal leaflet which tapers quickly to its attachment point, appearing as only a short attachment stem.

Conclusions

Ptelea trifoliata is a wonderful tree adventure growing in a small compact unit. The appearance and texture of the foliage, the unique fruit, and the curious smell of its citrus heritage makes this tree worth finding in the wild & planting in a landscape.

Selected Literature

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1. *Ptelea trifoliata* ssp *angustifolia* (4 states)

Western sub-species. Twigs green to brown color, leaves are bright green and glossy, with irregular small teeth at the margin, large glands, and with lateral leaf blades nearly equal across the mid-vein.

**1A. *Ptelea trifoliata* ssp *angustifolia* var *angustifolia* (4 states)
(*Ptelea trifoliata* var *angustifolia*)**

Pale leaves with white veins, densely hairy on underside, and a terminal leaflet with a short connecting stem.

**1B. *Ptelea trifoliata* ssp *angustifolia* var *persicifolia* (3 states)
(*Ptelea trifoliata* var *persicifolia*)**

Pale leaf, glossy on both sides, veins inconspicuous.

2. *Ptelea trifoliata* ssp *pallida* (5 states)

Western sub-species. Twigs orange to yellow colored, older branches with white bark.

**2A. *Ptelea trifoliata* ssp *pallida* var *cognata* (2 states)
(*Ptelea trifoliata* ssp *pallida* var *cognata*;**

Ptelea trifoliata var *cognata*;

Ptelea angustifolia var *cognata*)

Smooth leaf surfaces to slightly hairy, and a terminal leaflet with a short connecting stem.

2B. *Ptelea trifoliata* ssp *pallida* var *confinis* (3 states)

Twigs with fine hair, leaves hairy on bottom with a rolled leaf margin and a hairy leaf stem.

**2C. *Ptelea trifoliata* ssp *pallida* var *lutescens* (2 states)
(*Ptelea elegans*; *Ptelea neglecta*)**

Twigs and foliage smooth, leaf margin toothed & wavy.

**2D. *Ptelea trifoliata* ssp *pallida* var *pallida* (3 states)
(*Ptelea pallida*)**

Twigs with fine hairs, leaves with sparse hairs beneath especially on mid-vein and leaf stem, leaf margin wavy edged to sparsely toothed.

Figure 1: Cited sub-species and varieties of *Ptelea trifoliata* (hoptree) in the United States with numeric codes used in this publication. (after Bailey, 1962)

3. *Ptelea trifoliata* ssp *polyadenia* (6 states)

(*Ptelea monticola*)

Western sub-species. Twigs green to brown color, dull green color leaf, paler below with whitish look, leaves with many large glands, lateral leaflet blades unequal across mid-veins, wavy leaf margins.

4. *Ptelea trifoliata* ssp *trifoliata* (~37 states / prov.)

Eastern sub-species. Green to brown twigs, leaves with small glands and flat smooth margins.

4A. *Ptelea trifoliata* ssp *trifoliata* var *baldwinii* (1 state)

(*Ptelea baldwinii*; *Ptelea obcordata*)

Narrow leaf form of North Florida.

4B. *Ptelea trifoliata* ssp *trifoliata* var *molliis* (~14 states)

(*Ptelea tomentosa*; *Ptelea rhombifolia*)

Twigs and leaves hairy all over, leaves densely hairy beneath and on leaf stem.

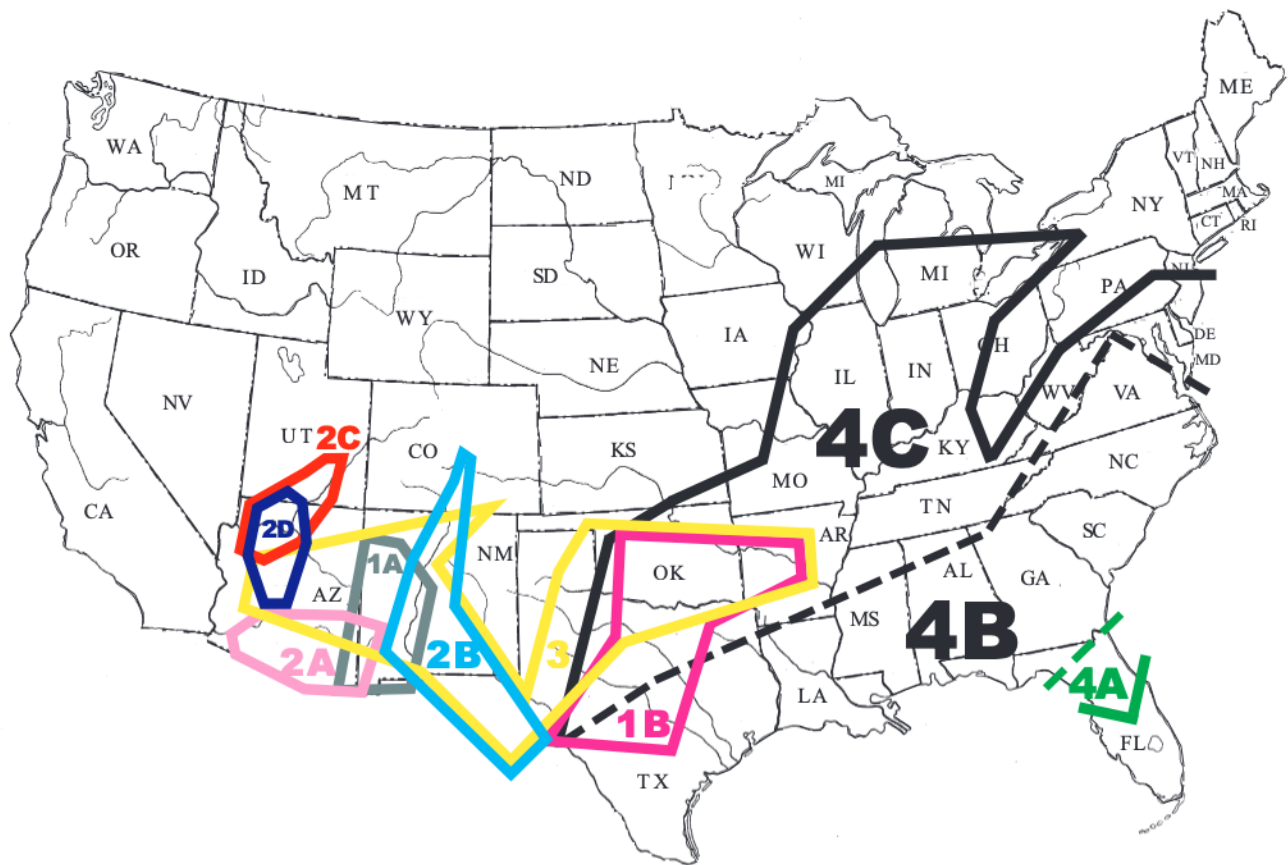
4C. *Ptelea trifoliata* ssp *trifoliata* var *trifoliata* (~36 states / prov.)

(*Ptelea microcarpa*; *Ptelea serrata* – small leafed form; *Ptelea trifoliata* var *deamiana*)

Twig and leaves smooth, margins smooth and flat, when present fine hairs are barely visible on bottom of some leaf stems, leaves, and along veins on leaf upper sides.

Figure 1: Cited sub-species and varieties of *Ptelea trifoliata* (hoptree) in the United States with numeric codes used in this publication. (continued)
(after Bailey, 1962)

Figure 2: General geographic range of sub-species and varieties of *Ptelea trifoliata*.
(derived from Bailey, 1962; Ward, 2001)



1A *Ptelea trifoliata* ssp *angustifolia* var *angustifolia*
1B *Ptelea trifoliata* ssp *angustifolia* var *persicifolia*

2A *Ptelea trifoliata* ssp *pallida* var *cognata*
2B *Ptelea trifoliata* ssp *pallida* var *confinis*
2C *Ptelea trifoliata* ssp *pallida* var *lutescens*
2D *Ptelea trifoliata* ssp *pallida* var *pallida*

3 *Ptelea trifoliata* ssp *polyadenia*

4A *Ptelea trifoliata* ssp *trifoliata* var *baldwinii*
4B *Ptelea trifoliata* ssp *trifoliata* var *mollis*
4C *Ptelea trifoliata* ssp *trifoliata* var *trifoliata*

Note: variety *trifoliata* (4C) occurs across 4A & 4B ranges.

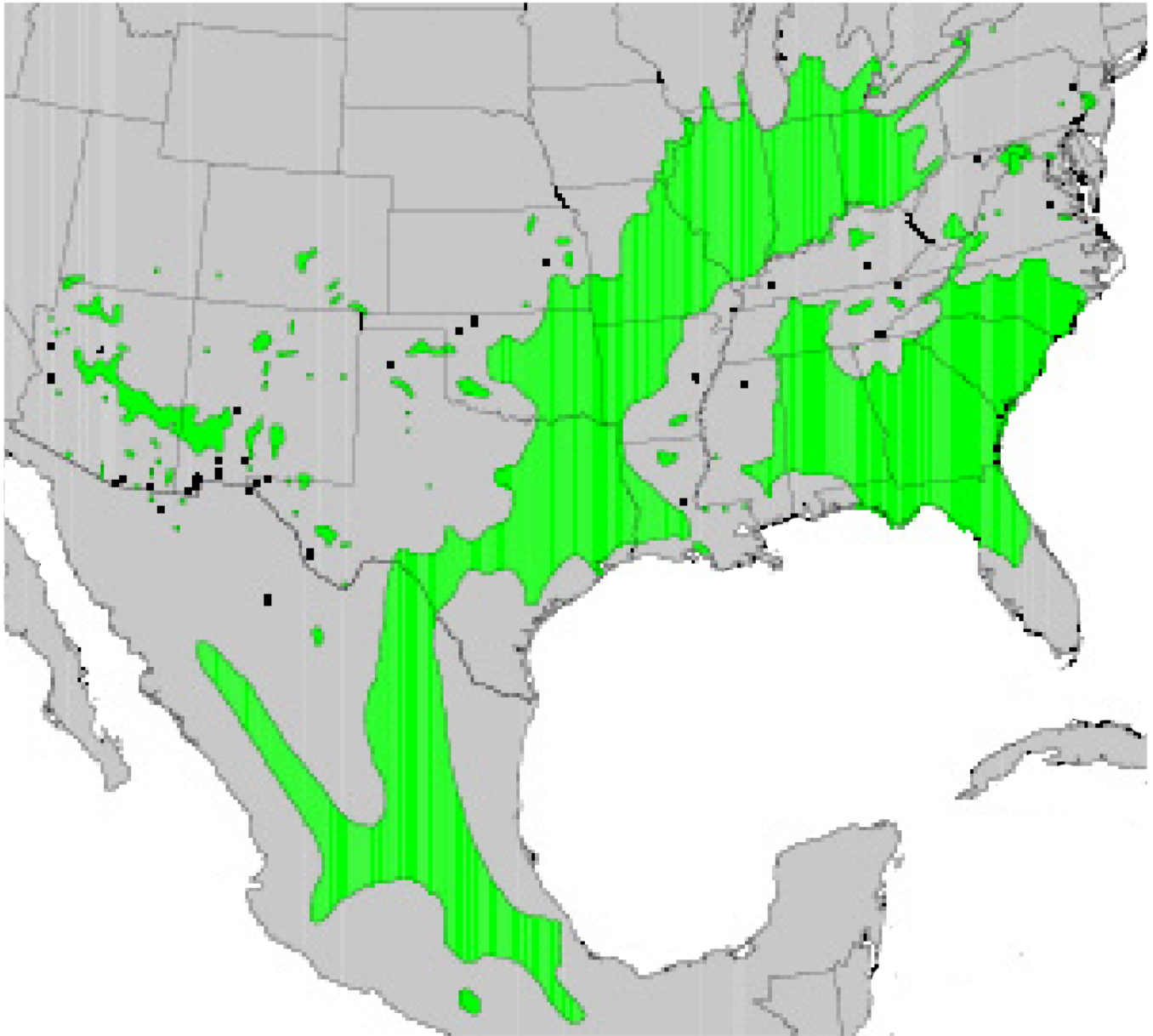
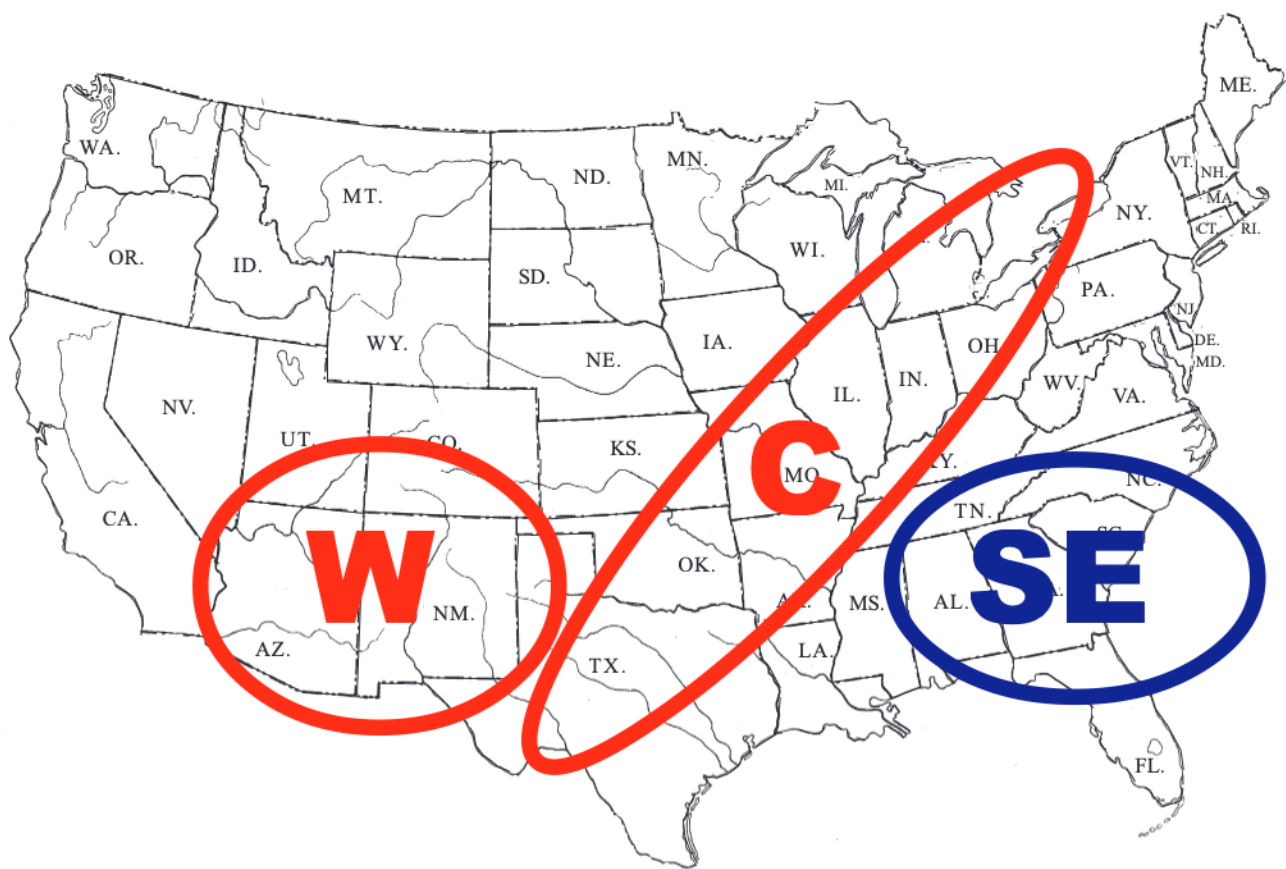


Figure 3: Native range of Ptelea trifoliata (hoptree).
Range map from USGS-GECS 2016.



Figure 4: *Ptelea trifoliata* - hoptree
generalized native range in Georgia.

Range based upon herbarium records, federal agency maps, and personal observations.



temperature scale	West range	Central range	Southeast range
Heat Zones	6 - 10	5 - 10	7 - 10
Hardiness Zones	6b - 8a	5a - 8b	6b - 9b

Figure 5: Temperature limiting zones for three primary range areas of *Ptelea trifoliata*.

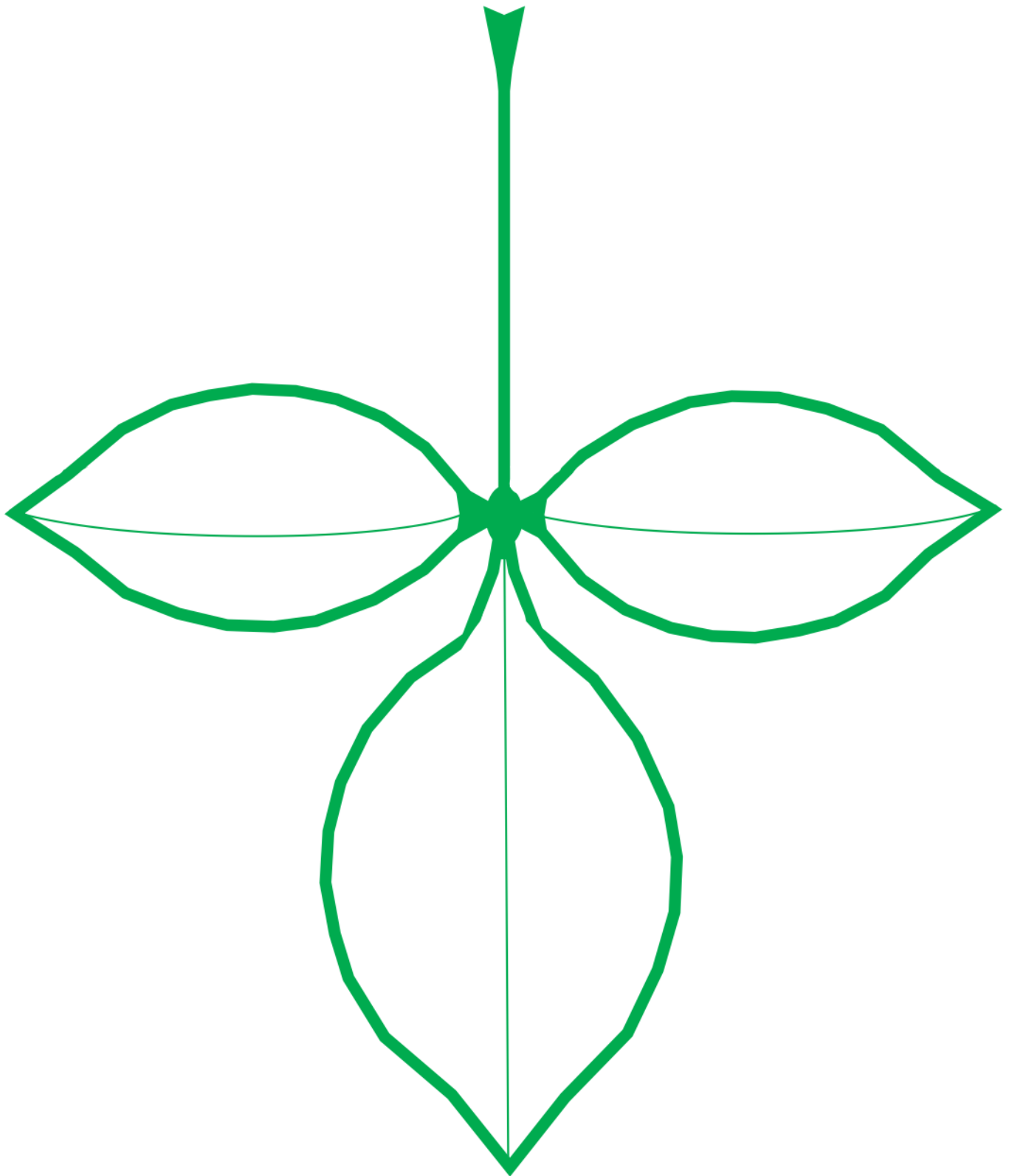


Figure 6: Outline view of Ptelea trifoliata compound leaf.

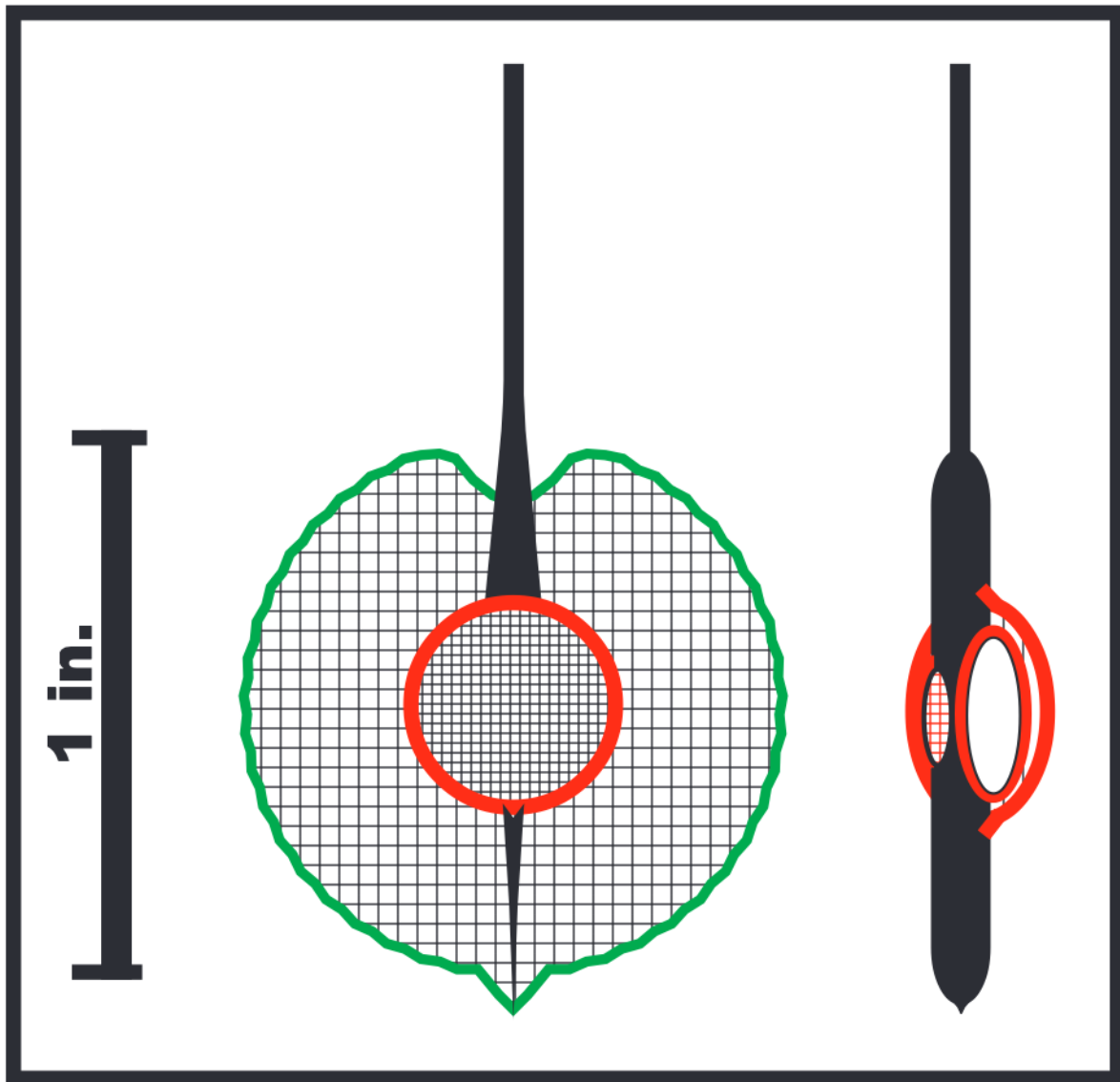


Figure 7: Fruit / samara of Ptelea trifoliata with one seed.
(front and side view)



Outreach

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