Native Tree Series

WARNELL
SCHOOL OF FORESTRY AND NATURAL RESOURCES
THE UNIVERSITY OF GEORGIA

WSFNR11-13 June 2011

Sourwood

Oxydendrum arboreum: The Honey Tree

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Sourwood is a tree of contrasts. It's sour foliage supports many small summer flowers containing the sweetest of nectar. This nectar is collected by bees and made into one of the premium honeys of the world. Sourwood has been used for both arrows and medicines. Sourwood has little importance to most people until they see it as the earliest red color of Fall. Flower stalks and fruit hang onto the tree deep into Fall allowing sourwood to be easily identified and enjoyed as a unique specimen tree. Sourwood is one of the most stolen trees taken from the wild, but the hardest to transplant and to grow from cuttings. Sourwood is a special tree in need of care and consideration.

Naming Names

Oxydendrum arboreum is a native tree of the Eastern and Southeastern United Sates. It is the only member of its genus (*Oxydendrum*) and has no known subspecies, varieties or forms. Common names for *Oxydendrum arboreum* include sourwood, sour-wood, sorrel tree, sorrel-tree, lily-of-the-valley tree, titi, titi tree, arrowwood, elk tree, sorrel gum, sour gum, and tree andromeda. The accepted common name is "sour-wood" and will be used here. Sourwood was first scientifically described in 1739 and 1753 as *Andromeda arborea*, in 1834 as *Lyonia arborea*, and finally in 1839 as *Oxydendrum arboreum*. Sourwood was first noted in a gardening book for plant collectors in 1754.

The name *Oxydendrum* is derived from Greek for a "sour tree." The species name *arboreum* means "tree form." The "sour tree" name comes from the acidic and bitter tasting foliage caused by oxalic acid in the leaf tissues. Note sourwood's scientific name (*Oxydendrum arboreum*) is commonly mis-spelled in some of the best plant books and web sites. Common mis-spellings are "Oxydendron," "arboretum," or "arborea." There are currently few cultivars of sourwood available, principally "Chameleon" and "Mt. Charm."

The Relatives

Sourwood belongs to the heath family (*Ericaceae*). The heath family contain roughly 70 genera and about 1,800 species distributed in temperate and cooler portions of the world. Many species in this family are woody shrubs, trees, and perennial herbs. Common species in the heath family include azaleas, blueberries, cranberries, doghobble, fetterbush, heath, heather, huckleberry, Labrador tea, laurel, madrone, manzanita, rhododendrons, snowberry, and staggerbush. Genetically, sourwood's closet relatives are in the genera *Pieris* and *Lyonia*.

There are about 15 native trees and many shrubs of the heath family found in North America. In the Southern and Southeastern United States there are about 22 heath family genera including six with tree forms: *Elliottia*, *Rhododendron*, *Kalmia*, *Lyonia*, *Vaccinium*, and *Oxydendrum*. Sourwood is deciduous and can be differentiated from many of its evergreen tree-form family members. Only about 19% of the species in the heath family are deciduous.

Growth Range

The native range of sourwood is shown in Figure 1. This map provides a general range of the contiguous native population. There are several outlying populations which have been identified from herbarium samples and on maps derived from federal agency data, but not shown. Some outlying populations had specimen tree origins and are now naturalized. States with historically identified or disjunct populations of sourwood not included in Figure 1 include Illinois, Indiana, Maryland, New Jersey, New York, and Texas. Indiana lists sourwood as threatened in the state, and Maryland lists sourwood as endangered. Sourwood grows in multiple counties of Alabama, Florida, Georgia, Kentucky, Louisiana, Mississippi, North Carolina, Ohio, Pennsylvania, South Carolina, Tennessee, Virginia, and West Virginia. The Georgia range map is provided in Figure 2. The altitudinal range is from near sea level along the Gulf and Atlantic Coasts to roughly 4,600 feet (average maximum altitude from 3 sources).

Habitat

Sourwood is usually found as a single tree or rarely as a small single species stand. It requires full to partial sun and becomes less tolerant of stress as it ages. Sourwoods are common but scattered in open mixed hardwood forests on slopes and in coves. Sourwood is found in the understory and midstory of several different forest types. Over time it can attain an intermediate crown class within a closed forest, but usually occupies suppressed or shrub layer canopy positions. Sourwood rarely reaches an overstory / codominant crown position due to site disturbance, competition loss, or overstory tree blow-downs in storms.

Sourwood is associated with upland oaks, cove hardwoods, Southern yellow pines, upland hickories, and sweetgum. Associated species are not as critical to survival as stand density, where openness of the forest to light resources is critical. Open, medium to low crown density in taller trees, and lack of an aggressive shrub layer, facilitates sourwood success. If old suppressed sourwoods are released from light competition suddenly, they usually die. When it is found in bottomland areas, sourwood is always above the high water mark in well drained soils.

Best Sites

Sourwood can successfully grow and thrive in a variety of sites and under a wide range of climatic conditions. In keeping with its family tradition, it grows best on acid soils in the pH range of 3.7 to 6.5. It does not grow on high pH or limestone derived soils. Sourwood does well on medium to moist, well drained, coarse or gravelly soils on slopes, hillsides and ridges. New road cuts, open mineral soil, and field edges can be colonized if competition is minimal. Sourwood can handle dry sites once established, but intense heat loading and drought cause severe problems. The national heat tolerance zones for sourwood are 5-9. The national cold tolerance or hardiness zones are 5b-8b. Maximum and minimum temperatures for sourwood are 105°F to -15°F (40°C to -26°C). Select native gene sets from within 100 miles North and South of any planting site.

Growth Form

Sourwood is a slow growing, short lived, woody perennial tree with a slender (usually crooked and leaning) trunk, and a narrow to oval shaped, irregular crown with relatively dense foliage. Sourwood usually has a single leader when young, but branching develops early. Branching begins close to the ground and codominant branches form over time. Branches tend to droop near the ends. Branches and twigs can be crooked, twisted, or "zig-zag" along their longitudinal axis.

Tree Dimensions

Sourwood is a small to medium sized tree, but usually noticed as a small tree. Sourwood's average height is 45-55 feet (n=22 sources). Tree height ranges down to about 20 feet as its native range edges are approached. Tree diameter averages 14-16 inches (n=11 sources). Tree diameter ranges down to 7 inches as its native range edges are approached. Crown width averages 20-26 feet (n=5 sources). Maximum size of tree is: height of 98 feet (average value of 4 sources); diameter of 25 inches (average value of 4 sources); and, crown spread of 40 feet (average value of 3 sources).

Wood Use

Sourwood does not have sour tasting wood. Sourwood wood has no odor or taste. The wood is diffuse porous, hard, dense, heavy, and close-grained (greenwood specific gravity = 0.5). As such, it is difficult to dry properly and difficult to work. Sourwood heartwood is light brownish grey with tints of red, aging to a dull grey color. Sapwood is yellowish brown with a hint of pink. Heartwood is difficult to find as most of a cross-section of a sourwood trunk is composed of sapwood. Historic European American and Native American uses for sourwood wood was for local craftsman pieces, tool handles, sliding bearings for wheels and machine parts, paneling, butter paddles, pipe stems, arrow shafts, specialty turned items, small craft items, sled runners, and fuel wood.

Tree Use

The greatest use of the tree in modern society, and its claim to fame is a light amber colored sourwood flower honey. Spring root pressure sap can be collected and evaporated into syrup. Gummy residue can be chewed to alleviate thirst (called sourgum). The second most important use for the tree after honey is as a specimen tree in a landscape setting. It should be placed in protected sites where well-drained soils, good water availability, little compaction, and no foot traffic is present. It does not make a tough urban street or park tree.

Wildlife Use

There are few references and studies available on how various animals make use of sourwood. Sourwood is consistently listed as moderately important as deer browse, especially young shoots. Small seeds, or fruit capsules, are not usually mentioned as providing wildlife food, even though these would be available for small birds and rodents. The greatest use of sourwood is by bees which generate coveted sourwood honey. Several butterflies and moths are occasional visitors. The largest sourwoods, in intermediate crown positions within forests, have been cited as providing small cavities for animal nesting or roosting.

Medicinal Use

Sourwood has been used for millennia for different human ailments. Native Americans used leaf infusions for treating menstrual and menopause problems, diarrhea, lung and breathing problems, and as a sedative for nerves. The sap, gum, or inner bark was applied for skin irritation and chewed for mouth sores. European Americans used sourwood as a tonic, decoction, a pill made from solid tree tissues, and as a tincture. Sourwood products were used to treat urinary problems (increase urine flow / diuretic), enlarged prostrate, bowel

troubles, diarrhea, dysentery, stomach ache, and fever. Sourwood gum was chewed to alleviate thirst and treat mouth sores, and the green bark was rubbed on itchy skin.

Early colonists used sourwood in brewing "spring tonic" (like a root beer) with materials extracted in water or homemade whiskey. Sourwood whiskey tinctures used in tonics were targeted primarily at men's urinary tract problems, leg swelling, and for heart problems. The youngest new leaves have been used to act as a sorrel green (sour / acidic taste) in salads. The medicinal use of sourwood requires careful tree identification because many relatives and plants resembling sourwood have a number of serious poisons in their various plant parts. This historic medicinal use of sourwood is provided for educational purposes only and should not be tried or used in animals or humans.

Forest Regeneration

Regenerating populations of sourwood within forest stands or after harvest require a good number of sourwood stumps to generate sprouts. In the middle of sourwood's native range, seedlings regenerated per acre runs an average of 125 seedlings on richer and moister cove sites, and about 300 seedlings on drier, more open mixed hardwood sites. Little sourwood regeneration tends to occur in pine and oak-pine mixtures. Sourwood has been shown to be susceptible to drought loses within open forest stands. Sourwoods, once established, are stressed by the nitrogen source used in tree or stand fertilization. Only nitrate based fertilizers should be applied as ammonium based fertilizers can cause damage.

Species density of sourwood in native forest stands, in the middle of the native range, is about 2 to 4 square feet of basal area per acre. Basal area is greatest in drier, more open mixed oak forest stands. Mortality of young sourwoods inside forests (in the center of its native range) runs about 33% of stems dead by the time they reach two inches in diameter across most forest types. Mortality is ~94% in shaded and moist forest areas and ~66% in mixed oak-pine forests by the time young sourwood trees reach four inches in diameter. Note that wildlings stolen from forested landscapes and roadsides have a juvenile taproot with most of the active roots stripped away. These wildlings have >90% mortality rate.

Sourwood is susceptible to wild fires. Fire can easily kill stem tissue and girdle the tree. A single event fire usually causes a profusion of sprouts coming from the root crown area of damaged trees. Multiple fires occurring over several seasons kill back sprouts and cause death of the tree. Because of its strong sprout reproduction, rare to occasional fire events may increase the amount of sourwood in a stand.

Field Identification

Sourwood (*Oxydendrum arboreum*) is a native tree of the deep forest and forest edges. Sites which are sunny, open, well drained, and with few competitors allow sourwood to thrive. Finding mature sourwoods is easy because of their unique flowering structures and early Fall color. Sourwood attributes given here demonstrate why it is in a genus by itself. Sourwood is one of a kind.

Leaves

Sourwood leaves are arranged along the twig in an alternate or spiral form. Leaves are simple, thin, deciduous, and oblong-elliptical to oblong-lanceolate in shape. The leaf tip has a long point and the leaf base is wedge-shaped. The leaf margin can be a combination of several forms. The most common margin is finely toothed or finely toothed except near the base. Least common margin is a leaf with a smooth, untoothed edge. Leaves are sour or bitter to taste. Leaves are 4.5 - 7.5 inches long on average (n=10 sources) and 1.2 - 3.0 inches wide on average (n=5 sources). Figure 3.

The upper leaf surface is shiny, smooth, and a bright yellowish green to a darker green color, if in full sun, and a yellowish-orange tinted green color under shaded conditions. The leaf underside has a bright yellow

mid-rib which has stiff minute hairs (trichomes). These trichomes can occasionally also appear on the upper leaf surface over the midrib. The lower leaf surface is paler green than the upper leaf surface. Leaves are connected to the twig with a 0.66 to 1.0 inch long petiole covered with a few stiff small trichomes. The leaves begin senescence early and generate a bright crimson or purplish-burgundy color in early fall while most other trees are still fully green.

Flowers

Sourwood trees are cosexual (both male and female parts within each flower) with very noticeable and unique flowering structures. Individual sourwood flowers are small, regular, symmetrically shaped, fragrant, and showy. Individual flowers are bell or urn shaped with white to creamy-white colored petals. The flowers are waxy, slightly minutely hairy, and small (0.25 to 0.33 inches long). A number of people compare individual sourwood flowers with the bulb perennial herbaceous flower called "lily of the valley" in form. Petals form five short lobes. Petals are held at their base by sepals which all together form five lobes and stay attached as the fruits ripen. Each flower contains ten stamens.

Flowers are generated after the leaves have already expanded. The numerous small flowers are held on one side of long sweeping or drooping sprays, each spray (raceme) being 5.5 - 10 inches long (average of 4 sources). The end of upper branches can produce 3-8 terminal racemes of flowers around the entire crown. Lower branches may generate fewer racemes. The light colored, flower racemes and their sweeping, elongated growth form, provide a lacy or soft textured appearance to the tree. Figure 4.

Flowers are insect pollinated, primarily by bees, using rich nectar and fragrant smell for attraction. Each flower produces small amounts of pollen. Flowering occurs near mid-growing season, roughly late May to mid-July across the range. Flowers dangle downward until about ten days after fertilization when the individual flower stems begin to curl upward. The individual flower stems have fine minute trichomes.

Fruit

Sourwood fruit are small, hard, dry, oval to egg-shaped, yellowish to greenish-grey colored, pointed capsules which can split along five lines on the sides. The capsule is covered with minute hairs and the fruit stands erect on a curved, short, fruit stalk which earlier in the growing season had dangled downward to enable flower fertilization. The capsule is about 0.35 inches long (average of 4 sources). The capsule ripens by the first of October and remains attached to the tree long after splitting in late fall to release many tiny seeds. Seeds are continually released into winter. Fruit collection should be in late fall. Do not collect any fruit which hangs down. Rub the fruits together to split the capsule and release the seeds.

Seeds

Each capsule holds many minute, oblong shaped, pale brown to orange-yellow colored, wingless, 0.125 inch long seeds. Each seed is surrounded by a loose, thin, papery seed coat which looks like two small "wings" or points. Seeds freshly out of the capsule in late fall have no dormancy requirement and no pretreatment is needed for germination except for having at least four hours of light on the seedbed. Expected germination test rates after 30 days with alternating temperatures (86^{o}F / 68^{o}F (30^{o}C / 20^{o}C)), fungicide, and at least four hours of sunlight is ~55%. Seed production occurs every year with large variability in seed numbers. Expect 2-5 million seeds per pound.

In natural areas, sourwood seed germination can occur on thin, coarse litter and on mineral soil. Germination can occur in full sun to partial shade. A thick organic litter layer on the soil surface minimizes seed germination. It is common to see sourwood germinating and establishing in areas of open, light-saturated, forest soil along roadways and areas with tree blow-downs. Seeds are the primary way of growing sourwood as it is difficult to propagate by root cuttings.

Buds

Sourwood has no true terminal buds. A lateral bud becomes the new shoot leader for each growth flush and each new season. This lateral bud dominance gives the twigs a crooked or zig-zag appearance. The lateral buds are sparsely and minutely hairy on bud scale margins and across the inner surface. The lateral buds are small, round or globular shaped, 0.08 to 0.13 inches in diameter, and unstalked. They appear to be partially imbedded in the bark. The buds have 3-6 dark red, rounded scales terminating in a minute point at the bud top.

Twigs

Sourwood twigs are stiff but slender with a crooked or zig-zag growth pattern. First year twigs are reddish to bronze colored while older twigs range from reddish-green to reddish-orange to yellowish-brown in color. Twigs are smooth with conspicuous orange or red tinted, oblong shaped, lenticels. The leaf scars are shield or triangular shaped and raised above the twig surface, with no associated stipular scars. Each leaf scar has a single "C" or "V" shaped bundle scar. The pith is solid, white colored, round in cross-section, and has no cross walls. Sourwood is notorious as being extremely difficult to propagate from twig cuttings.

Bark

Sourwood periderm is unusual among other hardwood tree species. The periderm is shiny grey to reddish-grey-brown on the surface with a reddish-orange inner layer. Periderm is deeply creased with long furrows and short horizontal dividing fissures which yield a rectangular blocky texture (like persimmon). Mature periderm is usually 0.66 to 1.0 inches in thickness.

Roots

Sourwood roots are developed from a taproot sensing aerated soil depth and throwing out lateral roots behind its tip. This juvenile taproot soon is compartmentalized away from the tree and a mature fibrous root system is sustained. Sourwood has a shallow, high oxygen demanding root system which is not effective with too much interference (competition and allelopathy) from other species. Sourwood does not have any significant allelopathic impact of its own. Sourwood will sprout effectively from its stump and root crown area. Absorbing roots are colonized by specialized ericoid mycorrhizal fungi (an ascomycete). There is some suggestion sourwood is an obligate mycorrhizae tree requiring a specialized fungal symbiont. Sourwood is difficult to transplant from the wild because of its wide-spreading and shallow root system. It should be root pruned several times to increase the chance for success. Purchasing sourwood in containers has the greatest chance for successful establishment.

Stress & Pest Impacts

Sourwood is intolerant of (i.e. does not do well with) heavy shade, high soil salt contents, high soil pH, lime derived soils, soil compaction, flooding, poor drainage, anaerobic rooting conditions, construction damage, air pollution, and turf competition. It can handle moderate droughts for short periods but tends to quickly abscise leaves both during drought periods and after rehydration. Sourwood is moderately resistant to storm damage but is usually sheltered by other trees. It self-prunes moderately well but will keep lower branches if they are in adequate sunlight. The tree as a specimen will require strong branch training early to reach and maintain a good form.

Pest Concerns

Sourwood has many minor pests which are seldom effective in accessing and seriously damaging living tissue. By far the worst problems for sourwood are abiotic issues of soil oxygen and drainage, and soil water

availability. Some authors cite sourwood as being nearly "pest free." This notion is incorrect. Careful examination shows a number of nuisance, and some more serious, pests which can be locally damaging, especially if the tree is already having abiotic stress problems.

The major pests of sourwood include twig borers, cankers, caterpillars, and leaf spots, and are listed below:

The worst pest of sourwood is considered to be twig and stem borers. These borers can damage sourwood as larvae and adults. The most commonly seen borer on sourwood is the dogwood twig borer (*Oberea tripunctata*). This borer attacks many different species of trees. They make unique chewed girdling lines on twigs and then lay eggs between the girdles in lenticel areas in or near phloem tissue. Newly hatched larvae bore to the pith at the center of the twig and feed on the living tissues of the last few growth increments. Larvae occasionally cut off dead twig segments as they eat their way downward. The larvae overwinter in twigs and adults emerge in Spring. Adults feed on the mid-veins of the leaves, causing leaves to curl downward. Borers may continue to attack the same tree, girdling tissue and killing stems and new sprouts back to the ground. The rhododendron or azalea stem borer (*Oberea myops*) is similar in its damage and life cycle within sourwood trees to the dogwood twig borer described above. Both these stem borers present similar forms of damage, except the rhododendron / azalea borer will feed into roots.

Sourwood is host (along with other trees) to a twig girdler (*Oncideres cingulata*). Adults feed on new bark and woody tissue in late summer and girdle twig tips. Dead twigs hang onto the tree, or fall from the tree, providing food for the larvae.

Young buds, shoots, and leaf petioles of sourwood are damaged by *Conotrachelus anaglypticus*, a type of cambium weevil.

Nectria canker (*Neonectria galligena*) is a slow growing fungi which generates a small dark target-shaped, perennial lesion on stems and branches, and which can girdle twigs.

Sourwood is afflicted with three bark resident, irregular canker causing fungi. *Botryosphaeria obtusa*, *Botryosphaeria dothidea*, and *Botryosphaeria ribis* are generically called "bot cankers." Bot cankers live on the bark of trees and are opportunists when injuries occur to the tree exposing internal tissues. Bot canker fungi kill tree tissues and lead to twig and branch injury and death.

Sourwood leaves are one of many hosts which several caterpillar-like larvae consume and damage. The fall webworm (*Hyphantria cunea*) is a summer web nest builder and defoliator. The hickory horned devil, larvae of the regal moth (*Citheronia regalis*), can be found on many species of trees including sourwood across its native range. Sphinx moth larvae can be found on sourwood, consuming foliage in late Spring.

Sourwood leaves are attacked and injured by a series of leaf spot fungi. *Cristulaiella depraedens* (*Grovesinia*), *Cristulaiella moricola*, and *Cristulaiella pyramidalis* initiate discolored leaf patches, blotches and lesions. As these leaf spot diseases occupy more leaf area, the tree begins a quickened senescence process and damaged leaves abscise early. These sourwood leaf spots diseases tend to occur in cool, wet weather and on understory trees. *Tubakia dryina* is another leaf spot found on sourwood leaves.

Conclusions

Sourwood is a tree deserving of attention for its landscape value. It is well-behaved, easy to care for, and petite. The foliage color of green during Spring and Summer, and the deep early red color of Fall, help present the unique flower stems for all to see. Sourwood should be more carefully conserved and shown in landscapes as a lacy contrast to a lot of bland tree foliage.

Selected References

Baldwin, J.T. 1942. Cytogeography of *Oxydendrum arboreum*. The Journal of the Torrey Botanical Society 69(2):134-136.

Barton, S.S. 1984. Factors affecting the sexual propagation of sourwood (*Oxydendrum arboreum*). Southern Nurserymen's Association Research Conference Proceedings and Annual Report 29:13-18.

Barton, S.S. & V.P. Bonaminio. 1985. Influence of light and temperature on germination of sourwood (*Oxydendrum arboreum*). Journal of Environmental Horticulture 3(3):108-111.

Bratsch, T. & R. Maleike. 1980. The effects of N (nitrogen) form and concentration on the growth of *Oxydendrum arboreum* (abstract 170, page 66). HortScience 15(3):398.

Brown, C.L. & L.K. Kirkman. 1990. Pages 222-223 in Trees of Georgia and Adjacent States. Timber Press, Portland, OR. Pp.292.

Cafferty, S. & C.E. Jarvis. 2002. Typification of Linnaean plant names in *Ericaceae*. Taxon 51(3):751-753.

Clovis, J.F. 1959. A note about *Oxydendrum*. Castanea 24(1):51-53.

Duncan, W.H. & M.B. Duncan. 1988. Page 310 in Trees of the Southeastern United States. University of Georgia Press, Athens, GA. Pp.322.

Elliott, K.J. & W.T. Swank. 1994. Impacts of drought on tree mortality and growth in a mixed hardwood forest. Journal of Vegetation Management 5(2):229-236.

Esson, J.G. 1950. The sourwood - a neglected tree. Journal of the New York Botanical Garden 51:12-15.

Gorman, N.R. & M.C. Starrett. 2003. Host range of a select isolate of the ericoid mycorrhizal fungus *Hymenoscyphus ericae*. HortScience 38(6):1163-1166.

Grand, L.F. 1978. New hosts of *Cristulariella pyramidalis* in North Carolina. Plant Disease Reporter 62(10):841-842.

Hardin, J.W., D.J. Leopold, & F.M. White. 2001. Pages 404 in Textbook of Dendrology (9th edition). McGraw-Hill, New York. Pp.534.

Harrar, E.S. & J.G. Harrar. 1962. Pages 577-579 in Guide to Southern Trees (2nd edition). Dover Publications, NewYork. Pp.709.

Horn, J.C. 1985. Responses of understory tree seedlings to trenching. American Midland Naturalist 114(2):252-258.

Lewis, C.E. 1977. *Oxydendrum arboreum*. American Nurseryman 146(3):28-30.

Little, E.L. 1979. Page 182 in Checklist of United States Trees. USDA-Forest Service Agricultural Handbook 541. Pp.375.

Little, E.L. 1980. Pages 625-626 in The Audubon Society Field Guide to North American Trees – Eastern Region. Alfred A. Knopf, New York. Pp.714.

Liu, Y. & R.N. Muller. 1993. Effect of drought and frost on radial growth of overstory and understory stems in a deciduous forest. American Midland Naturalist 129:19-25.

Moerman, D.E. 1998. Page 374 in Native American Ethnobotany. Timber Press, Portland, OR. Pp.927.

Olson, D.F. & R.L. Barnes. 1974. *Oxydendrum arboreum* - sourwood. Pages 566-567 in Seeds of Woody Plants in the United States. USDA Forest Service, Agriculture Handbook 450.

Overton, R.P. 1990. *Oxydendrum arboreum* -- sourwood. Pages 497-500 in Silvics of North America - Hardwoods (volume 2). USDA-Forest Service Agricultural Handbook 654.

Radford, A.E., H.E.Ahles & C.R. Bell. 1968. Page 808 in Manual of the Vascular Flora of the Carolinas. University of North Carolina Press, Chapel Hill, NC. Pp.1183.

Swanson, R.E. 1994. Pages 318-319 in A Field Guide to the Trees and Shrubs of the Southeastern Appalachians. John Hopkins University Press, Baltimore, Maryland. Pp.399.

Figure 1: General range map for *Oxydendrum arboreum* - sourwood. Native range found within dark lines shown. Small pockets of outlying and naturalized populations are possible and do exist away from this native range.

(Range is based upon herbarium specimens, federal map sources, and personal observations.)

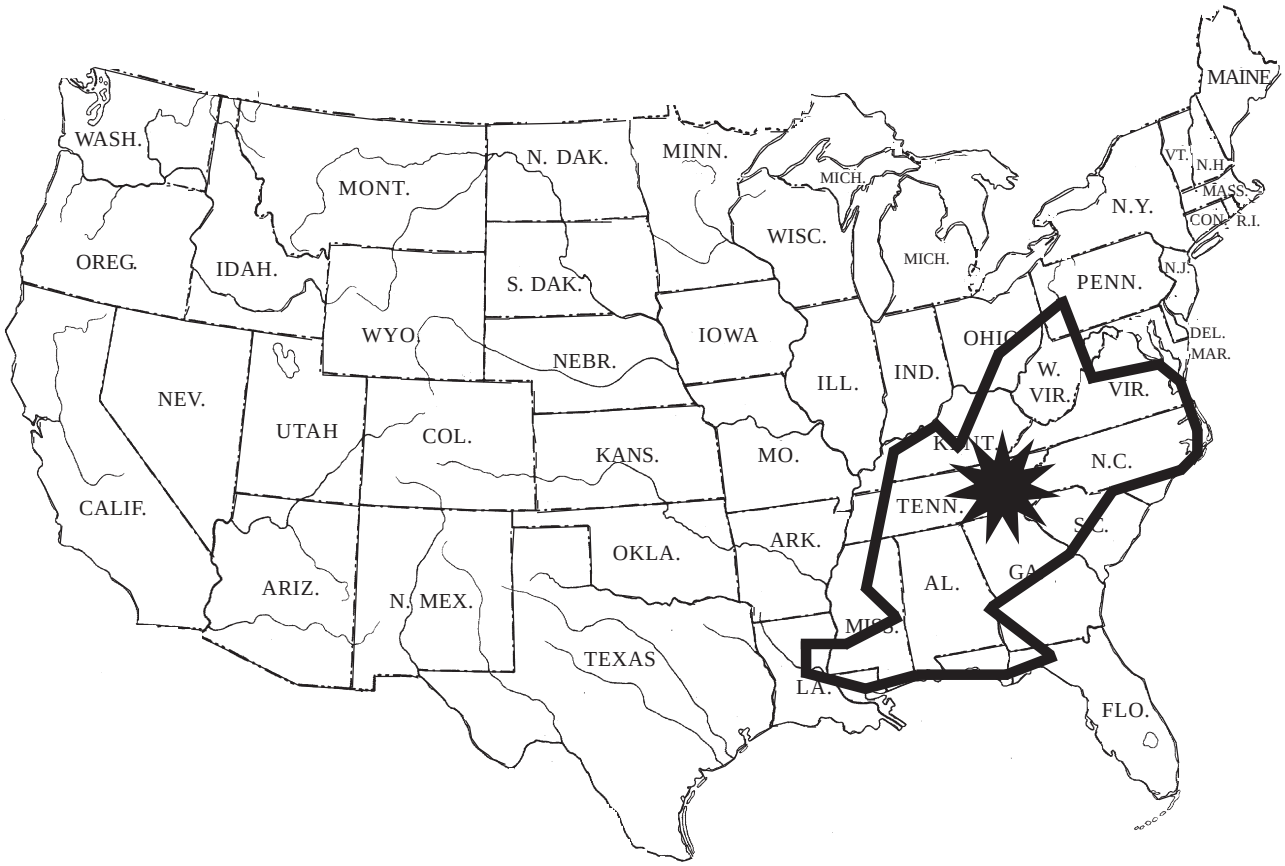

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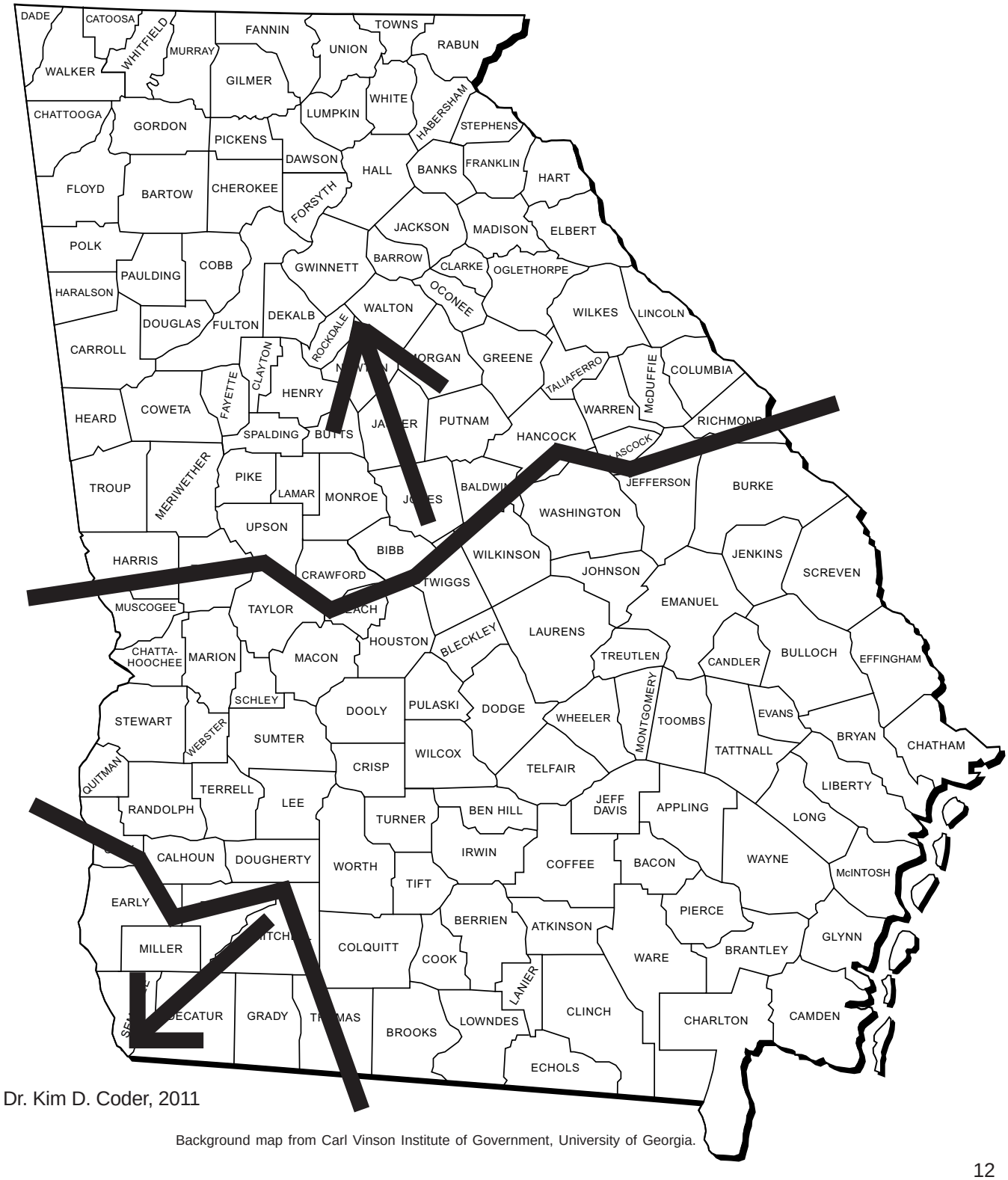
Figure 2: *Oxydendrum arboreum* - sourwood native range in Georgia.

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



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Background map from Carl Vinson Institute of Government, University of Georgia.

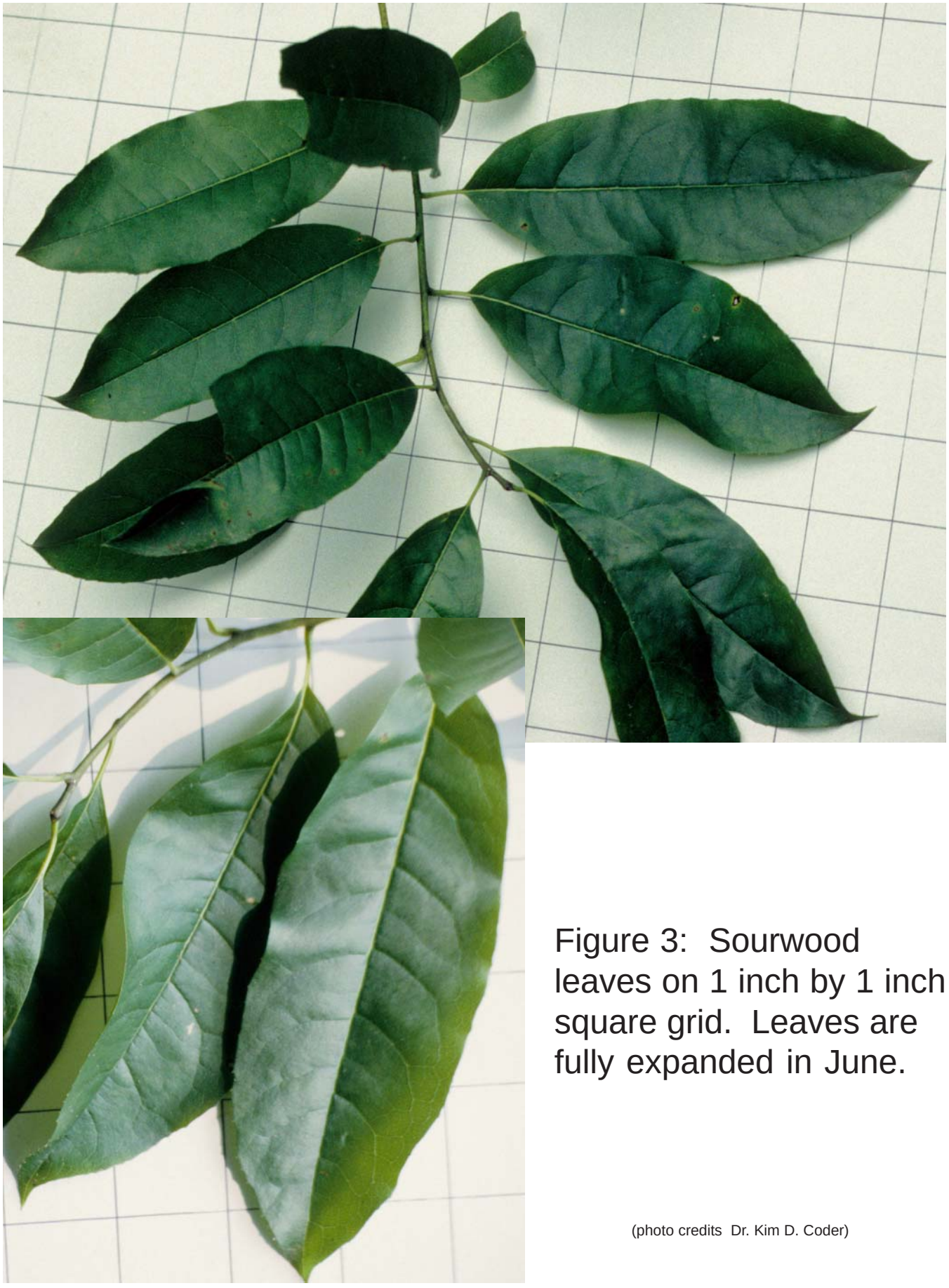

Figure 3: Sourwood leaves on 1 inch by 1 inch square grid. Leaves are fully expanded in June.

(photo credits Dr. Kim D. Coder)

Figure 4: Sourwood flowers.

(photo credits Dr. Kim D. Coder)