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Cover Page Footnote
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Running Title: Winter Smoketree Surveys

Abstract

Cotinus obovatus (American smoketree) is a rare deciduous tree with a relictual distribution in southeastern North America. Efforts to map its fine-scale geographic distribution in the Ozark Mountains have been limited to the growing season when the distinctive blooming panicles and foliage facilitate detection in hardwood-cedar woodlands. I describe the physiognomic traits of leafless *C. obovatus* that permit effective population mapping in winter landscapes. Clumped growth and diagonally leaning stems facilitate detection at a distance. Bark texture, twig morphology, and sap odor confirm the identity of the tree at close range.

Introduction

Cotinus obovatus Raf. (Anacardiaceae: American smoketree), the sole member of the genus in the Western Hemisphere, has intrigued naturalists since Thomas Nuttall discovered it in 1819 on a bluff above the Grand River in eastern Oklahoma (Buckley 1881; Little 1942; Long 1970; Mohr 1882; Nuttall 1821; Palmer 1921; Sargent 1885, 1892; Weber 1990). Natural populations of this suffusively rare deciduous tree have been documented in 41 counties scattered in three disjunct regions: (1) Ozark Plateau in Arkansas and Missouri with a few scattered stations along bluffs of the Arkansas River and its tributaries in eastern Oklahoma, (2) southern Cumberland Plateau in northeastern Alabama and adjacent Tennessee and Georgia, and (3) the Edwards Plateau in west-central Texas. *Cotinus obovatus* is currently considered globally secure (G4) owing to protected populations on national forest lands in the Ozark Mountains of Arkansas and Missouri, but it is listed as threatened in Alabama (S2), Oklahoma (S2), and Tennessee (S2) and as critically imperiled (S1) in Georgia (Natureserve, 2017).

The center of abundance of *C. obovatus* on the Ozark Plateau occurs in four counties that border the Arkansas-Missouri state line (Baxter, Marion, Taney, Ozark). Factors that restrict the tree's geographic distribution are unknown, but all well-documented sites occur on soils derived from calcareous bedrock. An effort to map its fine-scale geographic distribution in relation to the soil chemistry and geology of the Ozark Plateau has been ongoing for the past decade. Population mapping has traditionally been conducted during the growing season when the distinctive blooming panicles (late April through mid-May) and foliage (April-September) are easily detectable in roadside surveys (Davis and Graves 2016). However, dense understory foliage may conceal isolated specimens of *C. obovatus* in the interior of hardwood-cedar woodlands. If the tree can be identified at modest distances (~10–40 m) in leafless winter landscapes, detection efficiency during walking surveys may actually increase relative to growing season efforts. Here I describe the physiognomic traits that facilitate winter surveys of *C. obovatus*. These can be grouped into characters that form the search image necessary to detect trees at distance (growth form) and those that confirm identity at close range (bark, twigs, sap).

Methods

Study area

Winter surveys of *C. obovatus* were conducted 28 February-14 March 2017 and 4-20 February 2018 in the Sylamore Ranger District of the Ozark National Forest, centered on the Norfork and Norfork SE topographic quadrangles (7.5-minute series, U.S. Geological Survey) in Baxter County, Arkansas. This region is topographically complex (100–429 m), dissected by deep valleys that drain into the White River and its major tributary, the Buffalo River. Current land cover in the national forest is a patchwork of secondary hardwood forest, *Juniperus virginiana* (eastern redcedar), and *Pinus echinata* (shortleaf pine). Glades are relatively

Figure 1. Typical growth form of *Cotinus obovatus* (American smoketree) in the Ozark National Forest, Baxter County, Arkansas. Multiple stems emerge from a single root crown in many specimens.

rare and those that do occur are relatively small. Old-growth trees and elevational bands of timber that exhibit no evidence of logging are found on steep, rocky slopes. Surface rocks over most of the study area are composed of interbedded limestone, dolostone, and sandy dolostone of the Everton Formation (middle Ordovician) which is overlain by thin beds of St. Peter sandstone. The highest ridges and knobs are capped by cherty limestones of the Boone formation, (Haley et al., 1993). Data reported in this study were obtained on off-road surveys aimed at documenting the geographic coordinates of witness specimens of *C. obovatus* at a 200 m grain size.

Data collection

I photographed specimens of *C. obovatus* (n = 177) to document growth form and stem count. Selected trees met the following criteria: (*i*) the base of the tree was unobscured by undergrowth; (*ii*) the number of stems (> 5 cm DBH) emerging from the root crown could be counted in the photograph; and (*iii*) the stems were mature enough to have attained the flaky bark characteristic of older trees. I walked around each tree until the principal axis of a focal stem, usually the thickest for multi-stemmed specimens, was perpendicular to the plane of the camera. From enlarged photographs, I measured the angle of the focal stem (from ground level) along its lower side with a protractor. Landmarks for angle measurement were stem base at ground level and a point on the stem ~1.5 m from the base. Only a single stem per specimen was measured. Summary statistics (mean $\pm$ standard deviation) are presented for stem angle and stem count.

Results

Growth form

Sargent (1892:3) offered a brief description of *C. obovatus* physiognomy: “A small tree, twenty-five to thirty-five feet in height, with a straight trunk occasionally twelve or fourteen inches in diameter, usually dividing, twelve or fourteen feet from the ground, into several erect stems which separate into wide-spreading, often slightly pendulous branches.” Individuals of this diameter are rare in the Ozark Mountains, but more importantly, a majority of *C. obovatus* trees are composed of multiple stems that emerge from the root crown (Fig. 1).

In the sample of photographed trees (Fig. 2), the number of stems per root crown varied from 1 to 15 ($\bar{x}$ = 2.6 $\pm$ 2.5). Stems have a tendency to lean or sprawl diagonally from the base. Stem angle (from horizontal) varied from 9° to 90° ($\bar{x}$ = 62.7 $\pm$ 18.6°; n = 177). Solitary stems tend to be more vertical ($\bar{x}$ = 68.2 $\pm$ 16.6°; n = 77) than stems randomly chosen from multi-stemmed specimens ($\bar{x}$ = 58.4 $\pm$ 18.9°; n =100). In any event, diagonally leaning stems and clumped growth are

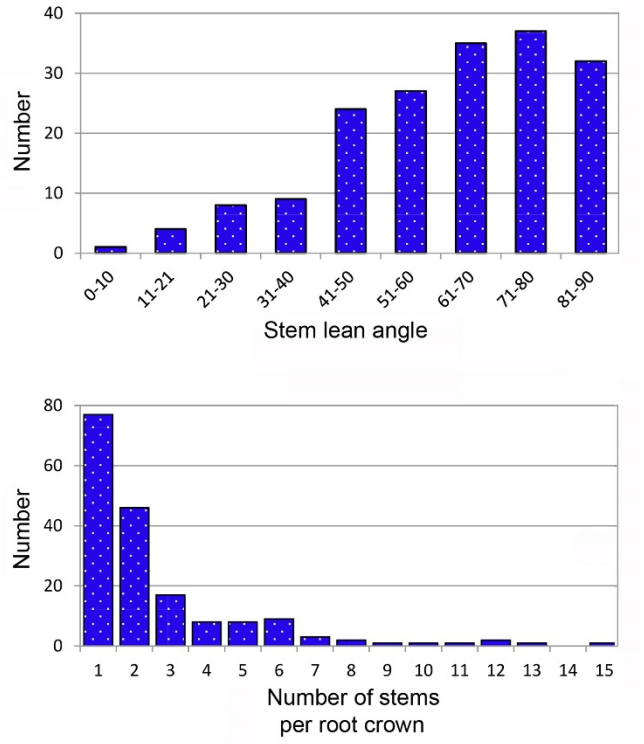

Figure 2. Histogram of stem lean angle (90° = vertical) and number of stems per root crown of *Cotinus obovatus* (American smoketree) in the Ozark National Forest, Baxter Country, Arkansas. Y-axis represents the number of specimens in each bin.

hallmarks of mature *C. obovatus* in open and closed canopy hardwood-cedar woodland in the Ozark Mountains.

Bark

Standard floras (Mohr 1901; Steyermark 1963) of states that harbor populations of *C. obovatus* omit descriptions of bark, and the accounts and illustrations in field guides (Leopold *et al.* 1998; Samuelson and Hogan 2003; Sibley 2009; Simpson 1988) are too brief or idiosyncratic to be useful for distinguishing the bark of *C. obovatus* from that of other small forest trees with rough bark. Buckley (1881: 125) observed, "…trunks and larger limbs [of *C. obovatus*] coated with light gray and deeply-furrowed bark resembling the bark of the larger trees of the common sassafras (*S. officinale*)." Perhaps the most accurate description was penned soon after the rediscovery of the tree in Alabama in 1881 (Mohr 1882: 218), "The bark is rough, covered with a whitish gray epidermis of a deep chestnut-brown underneath, and exfoliating in oblong square scales of uniform size."

In the Ozark Mountains, the smooth gray bark of young *C. obovatus* begins to crack and crenellate when the stems reach a diameter of 4–7 cm, although some sprouts as large as 10 cm have immature bark. The bark of mature stems is relatively thin and fractured into rounded rectangular or oval scales that are usually 1.8–3.5 times longer than wide (Fig. 3). Scale tips are frequently curled or curved away from the stem. Some specimens possess imbricated bark scales with curved tips pointing downward. Scale size and shape tend to be relatively uniform within individuals but vary significantly among trees. The bark is pale to medium gray when dry and dark gray to black when wet. The diagnostic combination of bark texture and color distinguishes *C. obovatus* from other small trees with craquelure bark in the Ozark Mountains (e.g., eastern redbud, *Cercis canadensis*; flowering dogwood, *Cornus florida*; sassafras, S*assafras albidum*; and gum bumelia, *Sideroxylon lanuginosum*). Large specimens of *C. obovatus* frequently exhibit cambial dieback, which can affect as much as 80% of the stem girth. Exposed wood weathers to grayish black. The crown foliage of many older specimens is nourished by a meandering band of cambium and phloem winding up the stem. The cause of cambial dieback is unknown.

Twigs

Sargent (1892: 3) provided a concise description of the twigs of *C. obovatus*, "The young shoots are purple at first, but soon become green; during the first winter they are bright red-brown and are covered with small white lenticular spots and marked by large prominent leaf-scars…The winter-buds are acuminate and an eighth of an inch long, and are covered with thin dark red-brown scales." During the late winter in the Ozark Mountains, the reddish-brown color, moderate diameter (3-5 mm), and absence of knobby or obliquely projecting buds give twigs a smooth silhouette and distinctive appearance (Fig. 4) that help confirm the identity of *C. obovatus* at moderate distances.

Sap

Buckley (1881:3) noted that broken branches of *C. obovatus*, "emitted a yellowish sap, the odor of which was highly aromatic; to me very unpleasant." Mohr (1882: 218) observed that the bark, when bruised, exuded "a resinous sap of a heavy, disagreeable terebinthinous odor."

I found the pungent odor to be reminiscent of thesap of *Rhus copallinum* (winged sumac) and *R. glabra* (smooth sumac), both of which are widespread in the Ozarks, and nearly identical to that of *Cotinus coggygria* (Eurasian smoketree), which is occasionally used in urban landscaping in the Ozark region. Broken

twigs of *C. obovatus* are odorous, even in cool or cold weather (0–5° C). The odor persists for years in dead twigs. The aromatic constituents of *C. obovatus* sap have not been analyzed but intensive analyses of *C. coggygria* have revealed that the wood and bark are rich in monoterpenes, sesquiterpenes, and phenols *(Matić et al*. 2016). As a matter of practice, all witness trees encountered during winter surveys in areas where *C. obovatus* trees occurred at low density were confirmed through the examination of growth form, bark, twigs, and sap odor.

Figure 3. Bark of mature stems of *Cotinus obovatus* (American smoketree).

Figure 4. Twigs of the American smoketree (*Cotinus obovatus*).

Discussion

Winter survey efficiency has not been quantified although it certainly varies with topography, understory visibility, and the density of *Cotinus obovatus* trees. Once the search image has been formed, observers should be able to detect most if not all mature specimens within 20 m of the survey path at slow walking speed (1-3 km/hr). In relatively open understories, the clustered, leaning stems of *C. obovatus* may be apparent to the unaided eye at distances as great at 50 m. Binoculars are indispensable for scanning prospective specimens, and I never attempted a cross-country survey without them.

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