Sphyrapicus varius (Yellow-Bellied Sapsucker) Use of Cotinus obovatus (American Smoketree) in the Ozark Mountains

Author: Graves, Gary R.

Source: Southeastern Naturalist, 18(3) : 499-509

Published By: Eagle Hill Institute

URL: https://doi.org/10.1656/058.018.0315

Sphyrapicus varius (Yellow-bellied Sapsucker) use of *Cotinus obovatus* (American Smoketree) in the Ozark Mountains

Gary R. Graves*

Abstract - *Sphyrapicus varius* (Yellow-bellied Sapsucker) has been reported drilling sap wells in more than 250 species of trees and woody vines in eastern North America. Criteria for species selection and use of geographically restricted endemics are poorly understood. Here I report drilling frequencies in *Cotinus obovatus* (American Smoketree), a rare endemic whose center of abundance occurs in the wintering range of Yellow-bellied Sapsuckers in the Ozark Mountains. Horizontal bands of sap wells were present on 4.5% of specimens (DBH ≥ 7 cm; n = 402) and 12.1% of larger-diameter classes (DBH ≥ 20 cm; n = 149). Sapsuckers preferred larger trees exhibiting little cambial dieback. Latticed arrays of sap wells similar to those observed on breeding territories were present on several large specimens. This survey indicates that the Yellow-bellied Sapsucker exploits rare species that may only be encountered on their winter territories. Documentation of a yearling inspecting a preexisting array of sap wells suggests that yearlings may obtain cues for appropriate tree species selection by examining sapsucker drillings encountered on wintering grounds. Because sap wells persist for years, cultural transmission of sapping information is likely transgenerational.

Introduction

Widespread concern about the economic impact of woodpeckers on the timber and fruit industries during the late 19th century prompted the US Biological Survey to investigate woodpecker diets (Beal 1895, 1911; Beal and McAtee 1912; McAtee 1911, 1913). An unusual number of ornithological publications from that era addressed the damage inflicted on commercially valuable tree species by *Sphyrapicus varius* L. (Yellow-bellied Sapsucker), which was reported to drill sap wells in more than 250 species of native trees and woody vines in eastern North America (Beal 1911, McAtee 1911). Sapsuckers obtain a significant fraction of their caloric needs during winter and spring from tree sap and bast, a collective term that includes cambium, phloem, sieve tubes, and parenchyma extracted from sap wells (Beal 1911, Tate 1969). Sap-well scarring persists for years on bark and may result in ring shake defects, distortion and staining of grain, resin deposits, knotty growth, and other blemishes in the wood (Beal and McAtee 1912, Jorgensen and Lecznar 1964, Kessel 1986, McAtee 1911, Shigo 1963).

Yellow-bellied Sapsuckers breed in hardwood and mixed coniferous forests from Alaska east to Newfoundland and south in the Appalachian Mountains to

*Department of Vertebrate Zoology, MRC-116, National Museum of Natural History, Smithsonian Institution, PO Box 37012, Washington, DC 20013 and Center for Macroecology, Evolution and Climate, University of Copenhagen, 2100 Copenhagen Ø, Denmark; gravesg@si.edu.

Manuscript Editor: Frank Moore

western North Carolina (Walters et al. 2002). It winters widely in eastern North America from 40° N latitude south to Panama and the Greater Antilles. Quantitative studies of sapsucker foraging have concentrated on common tree species that are frequently drilled on its breeding habitats (Eberhardt 2000; Erdmann and Oberg 1974; Mancuso et al. 2014; Rushmore 1969; Savignac and Machtans 2006; Tate 1969, 1973) and wintering range (Diamond and Ross 2018, Long 2011, Rushmore 1969, Speights and Conway 2010, Varner et al. 2006, Wilkins 2001, Williams 1980). In contrast, little is known about sapsucker use of locally rare or geographically restricted tree species.

Here I present an analysis of Yellow-bellied Sapsucker foraging on *Cotinus obovatus* Raf. (American Smoketree; Table 1), the sole member of the genus in the Western Hemisphere. This rare endemic tree of the family Anacardiaceae has a fragmented distribution with populations clustered in widely separated upland regions in the southern US: (1) Edwards Plateau of south-central Texas, (2) Ozark Mountains of Arkansas and Missouri with scattered populations in the Arkansas River drainage in eastern Oklahoma, and (3) the lower Cumberland Plateau in northwestern Alabama and adjacent Tennessee and Georgia (Davis and Graves 2016; Graves 2018; Little 1942, 1977). The most extensive populations occur on rocky slopes and glades straddling the Arkansas–Missouri border in the Salem Plateau subdivision of the Ozark Mountains (Graves 2018). Sapsuckers winter throughout the geographic range of the American Smoketree, but the only report of sap wells in this species was published more than a century ago from Huntsville in Alabama (McAtee 1911). The objective of this study was to survey the prevalence of Yellow-bellied Sapsucker drilling in the most extensive American Smoketree population discovered thus far in the Ozark National Forest. The results have broad implications for tree selection behavior in sapsuckers.

Methods

Study area

The study area (Fig. 1), in the Sylamore Ranger District of the Ozark National Forest, overlapped the Norfork and Norfork SE topographic quadrangles (7.5-min series, US Geological Survey) in Baxter County in Arkansas (Davis and Graves 2016, Graves 2018). Steep knobs and connecting ridges (215–400 m above sea level) in this topographically complex region are covered in aging second growth woodland with small patches of old growth on the steepest slopes. The American Smoketree occurs patchily on rocky limestone or dolomite slopes (10–70°) and ledges, frequently in association with *Juniperus virginiana* L. (Eastern Redcedar), *Juniperus ashei* J. Buchholz (Ashe Juniper), and *Quercus muehlenbergii* Engelm. (Chinkapin Oak).

Survey methods

I searched for evidence of Yellow-bellied Sapsucker foraging along transects (79.2 km) that crisscrossed the study area in 2017–2018. Mature American Smoketrees (75–150 y old) rarely exceed 30 cm in diameter and 12 m in height. I

examined trees with stem diameters ≥7 cm and trunks with at least 3.5 m of scaly bark, which is characteristic of mature trees (see Graves 2018). I measured stem diameter 1.4 m above ground level (DBH) to the nearest 0.5 cm with a diameter tape. Mature specimens exhibit a high frequency of asymmetric radial growth caused by

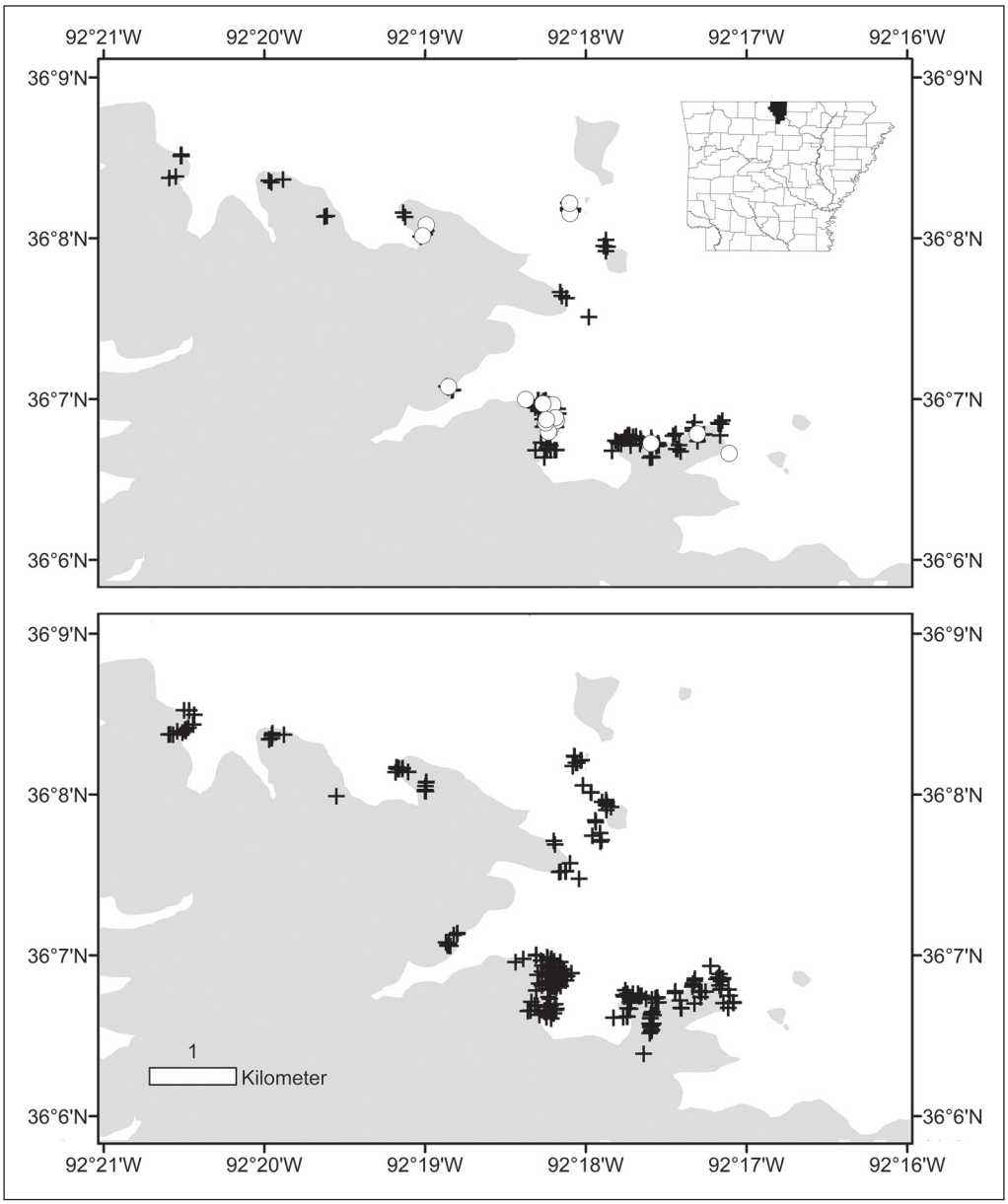

Figure 1. Spatial distribution of diameter classes of *Cotinus obovatus* (American Smoketree) surveyed for sapsucker sap wells in Baxter County (see map inset of Arkansas). Top panel: DBH ≥ 20 cm. Bottom panel: DBH < 20 cm. Gray shading represents area ≥ 275 m (above sea level), crosses = no sap wells, and circles = sap wells present. The Yellow-bellied Sapsucker winters in the study area from early October through early April.

cambial dieback of unknown origin (Fig. 2). In extreme cases, the crown may be nourished by a sinuous band of cambium on an otherwise dead stem. I quantified cambial dieback as the percentage of the measuring tape that overlapped dead wood during the diameter measurement. A majority of mature specimens in the Ozark Mountains are composed of multiple stems that emerge from a common root crown (Graves 2018). For multi-stemmed specimens, I selected the largest and healthiest stem for measurement and inspection. I recorded geographic coordinates of trees on a GPS receiver (Garmin GPSMAP® 64st, Garmin, Olathe, KS).

Horizontal bands and vertical columns of regularly spaced sap wells drilled by Yellow-bellied Sapsuckers (Fig. 3) are easily distinguished from the drillings and excavations made by other species of woodpeckers in southeastern North America (McAtee 1911). Sapsuckers also drill isolated exploratory sap wells that may be confused with drillings of other species. In this study, I attributed horizontal bands or vertical columns of sap wells to Yellow-bellied Sapsuckers. Tate (1973) and Eberhardt (2000) described subtle differences in the depth and raggedness of holes drilled for bast and sap. I did not attempt to distinguish between bast and sap drillings.

In order to provide comparative data, I measured stem diameter and noted the presence or absence of horizontal bands of sap wells in a random sample of Eastern Redcedar growing within 15 m of measured American Smoketrees. This common

Figure 2. Two views of asymmetric radial growth caused by partial cambial dieback in *Cotinus obovatus* (American Smoketree). The rope-like strip of living cambium (paler bark) comprised <10% of the stem circumference.

and geographically widespread conifer (Little 1971) is a frequent sap source for Yellow-bellied Sapsuckers on their wintering range (McAtee 1911).

I used logistic regression (Hosmer and Lemeshow 1989) to evaluate the strength of association of sap well occurrence with stem diameter (cm) and the degree (%) of cambial dieback in American Smoketrees. The dependent variable was binary (sap wells: absent = 0, present = 1). I performed analyses in SYSTAT Version 12 (SYSTAT® Software, 2007).

Results

I observed sap wells on 18 of 402 (4.5%) of the surveyed American Smoketrees (Fig. 4). Yellow-bellied Sapsuckers used larger trees (mean = 28.2 ± 8.2 cm DBH)

Figure 3. Sap wells drilled by *Sphyrapicus varius* (Yellow-bellied Sapsucker) in *Cotinus obovatus* (American Smoketree) in Baxter County in Arkansas. Oozing sap in the upper left panel was photographed on 19 February 2018.

and tended to avoid smaller trees (mean = 17.4 ± 5.8 cm DBH). By the same token, sapsuckers sapped trees with relatively little cambial dieback (mean = 13.3 ± 15.4%) and avoided trees with more cambial dieback (mean = 22.0 ± 17.5%). Sap wells were present in 18 of 149 (12.1%) specimens with DBH ≥ 20 cm. From the logistic regression (log likelihood: $\chi^2 = 51.05$, df = 2, $P < 0.00001$), the estimated probability (P) of occurrence of sap wells was Ln (P / [1 - P]) = -7.56 + 0.25 (stem diameter) - 6.60 (% cambial dieback). Sap wells were strongly associated with stem diameter ($P < 0.00001$) and cambial dieback ($P = 0.004$). This simple model

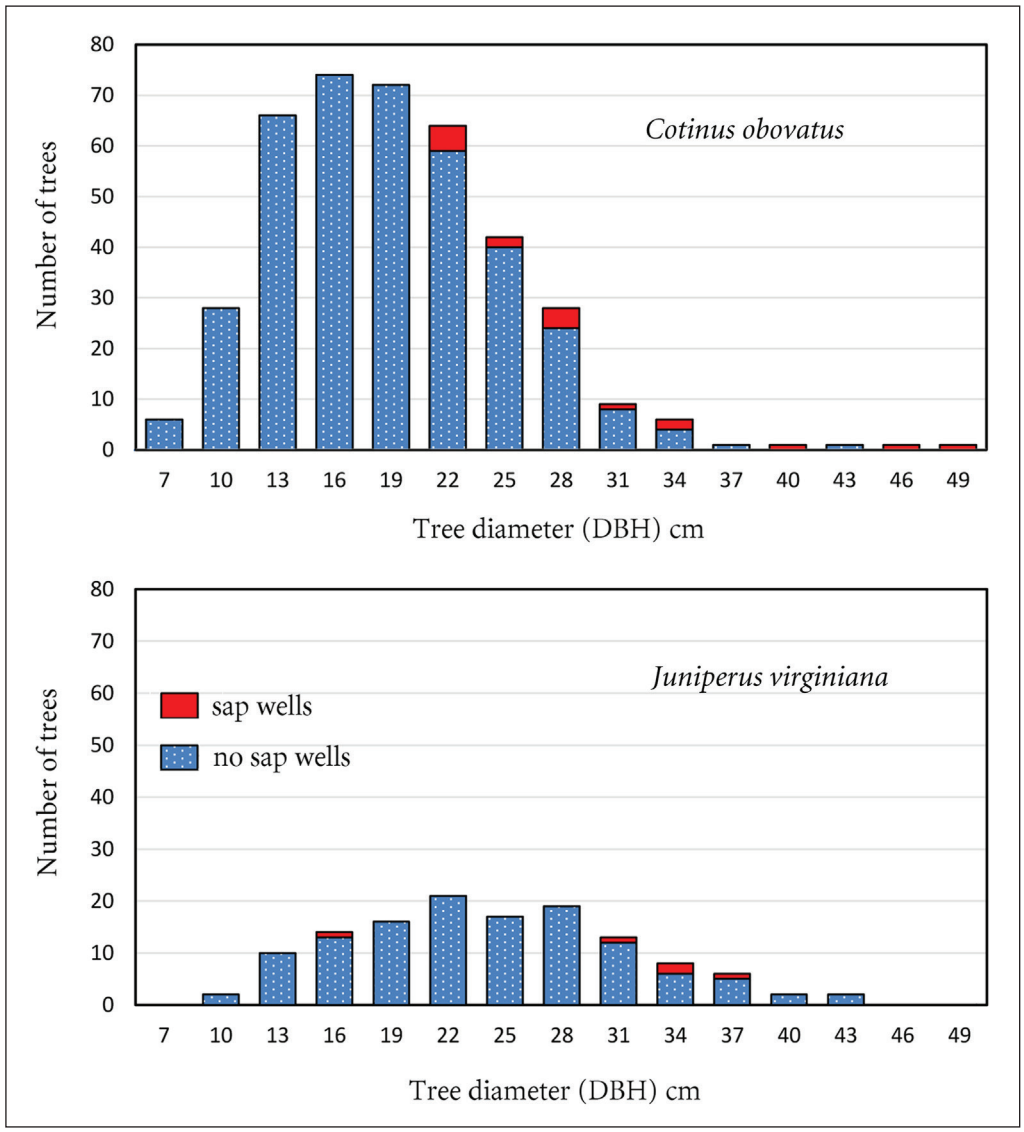

Figure 4. Histogram of occurrence of sap wells in *Cotinus obovatus* (American Smoketree; n = 402) and *Juniperus virginiana* (Eastern Redcedar; n = 133) from Baxter County in Arkansas.

explained a moderate fraction of the variance (Naglekerke's R^2 = 0.39) and correctly classified the presence of sap wells in 96% of smoketrees.

Horizontal bands of regularly spaced sap wells (3–5 mm in diameter) were drilled from 0.3 m to 5.0 m above ground level, usually on the shaded side of leaning stems. Interestingly, sap bands were drilled perpendicularly to the principal axis of leaning stems (Fig. 5). Three larger specimens exhibited a rarer type of drilling composed of parallel vertical columns of sap wells (3–13 mm in width) that varied in shape from circular to oblong and rhomboidal (Fig. 3). Bark septa

Figure 5. Immature Yellow-bellied Sapsucker visiting a latticed array of sap wells on *Cotinus obovatus* (American Smoketree) on 25 October 2017. The sap well complex was already well developed on 14 March 2017 (see upper right panel of Fig. 3).

between adjacent sap wells in these latticed arrays were as narrow as 1.5 mm. The largest array (~120 cm^2) was drilled 1.9 m above ground (Fig. 5). These trees also exhibited hundreds of smaller sap wells in horizontal bands between 0.3 m and 4.5 m above ground. Latticed arrays of sap wells are frequently observed on Yellow-bellied Sapsucker breeding territories (Eberhardt 2000, Kilham 1964, Tate 1973) but are rarely encountered on the wintering grounds in the southeastern US. Wilkins (2001) reported only a single example during a 3-y study of tree selection on winter territories in Mississippi.

Sap-well frequency in Eastern Redcedar (6 of 133; 4.5%) was nearly identical to that observed in American Smoketrees (Fig. 4), even though the latter species is vastly rarer in Ozark tree assemblages. There was no significant difference in the DBH of Eastern Redcedar with sap wells (mean = 27.3 ± 8.5 cm) and those without them (mean = 23.7 ±7.6 cm; $F_{1, 125} = 1.22$, $P = 0.27$).

Discussion

The American Smoketree is one of the least probable sap sources for Yellow-bellied Sapsuckers in eastern North America owing to the tree's restricted geographic range, local rarity, and relatively small stature. The chemical constituents of its sap have yet to be analyzed, but the strongly resinous odor (Mohr 1882) and paucity of insect herbivores (Crocker and Simpson 1982, Davis and Graves 2016, Graves 2017) suggest that it contains a potent cocktail of phytochemicals. Leaves, bark, and wood of the closely related *Cotinus coggygria* Scop. (European American Smoketree) contain relatively high concentrations of phenols, flavonoids, terpenes, and tannins (Fraternale and Ricci 2014, Matić et al. 2016, Novaković et al. 2007). In any event, sapsuckers appear to be undeterred by the secondary compounds of the American Smoketree. Yellow-bellied Sapsuckers drill sap wells in *Toxicodendron radicans* (L.) Kuntze (Eastern Poison Ivy) (McAtee 1911), another member of the Anacardiaceae, and many avian species are known to consume their fruit (Martin et al. 1951).

Few comparative data on Yellow-bellied Sapsucker drilling frequency on wintering territories have been published. Varner et al. (2006) reported sap wells in 12.4% of old-growth *Pinus palustris* Mill. (Longleaf Pine) in Escambia County in Alabama. Diamond and Ross (2018:supplemental table 1) presented comprehensive data for 9270 trees and palms in suburban plantings in Miami–Dade County in Florida. Sap wells were present in 10 of 96 species represented by ≥ 5 specimens. Drilling frequencies in 11 species represented by ≥200 specimens varied from 98.7% in the introduced *Terminalia buceras* (L.) C. Wright (Black Olive) to 0 % in 6 species of native and introduced palms.

In the present study, Yellow-bellied Sapsuckers drilled the rare American Smoketrees at the same frequency as the abundant Eastern Redcedar. These data and published accounts indicate that sapsuckers likely test the sapping potential of all tree species present in winter territories, including rare native and non-native taxa that are not encountered elsewhere during their annual cycle. Heavy sapping of some locally rare species and the absence of drilling in abundant co-occurring species indicate that

sapsuckers use a complex process in tree species selection. Sugar concentration in sap is involved in tree species selection by Yellow-bellied Sapsuckers (Kilham 1964, Tate 1973, Wilkins 2001, Williams 1980), but it is unknown why many species in local floras are eschewed.

The ontogeny of sapping and tree species selection by juvenile Yellow-bellied Sapsuckers is poorly understood. Kilham (1962) and Bolles (1891) reported that recently fledged birds visited sap wells on their natal territories. Kilham (1962) observed a couple of juveniles joining an adult female at sap wells in a wintering area in Maryland. One of the juveniles later joined an adult male at sap wells. In the present study, documentation of an immature sapsucker (HY, hatching year) inspecting a pre-existing array of sap wells in American Smoketree (Fig. 5) suggests that yearlings may instinctively examine sap wells encountered during fall migration. These observations imply that naïve yearlings are cued to preferred tree species by watching adults and by the presence of abundant sapsucker drillings. Because sap wells persist for years, cultural transmission of sapping information is likely transgenerational.

Acknowledgments

I thank the anonymous reviewers for helpful comments on the manuscript, the Ozark National Forest (USDA) for issuing research permits (OZF-FW-FY17-03), Nicole Edmison and Darrin Lunde for providing the Reconyx camera, and Brian Schmidt for producing the base map. I acknowledge the continuing support of the AlexanderWetmore Fund (Smithsonian Institution) and the Smoketree Trust.

Literature Cited

Beal, F.E.L. 1895. Preliminary report on the food of woodpeckers. USDA Division of Ornithology and Mammalogy Bulletin 7:7–33.

Beal, F.E.L. 1911. Food of the woodpeckers of the United States. USDA Biological Survey Bulletin 37:1–64.

Beal, F.E.L., and W.L. McAtee. 1912. Food of some well-known birds of forest, farm, and garden. US Department of Agriculture Farmers' Bulletin 506:1–35.

Bolles, F. 1891. Yellow–bellied Woodpeckers and their uninvited guests. Auk 8:256–270.

Crocker, R.L., and B.J. Simpson. 1982. *Datana perspicua* (Lepidoptera: Notodontidae) attacks *Cotinus obovatus,* a native woody ornamental. Florida Entomologist 65:375–376.

Davis, D.R., and G.R. Graves. 2016. A new leafmining moth (*Cameraria cotinivora,* Lepidoptera: Gracillariidae) of the American Smoketree (*Cotinus obovatus*). Proceedings of the Entomological Society of Washington 118:244–253.

Diamond, J.M., and M.S. Ross. 2018. Tree selection and foraging height of wintering Yellow–bellied Sapsuckers (*Sphyrapicus varius*) in an urban environment. Wilson Journal of Ornithology 130:932–939.

Eberhardt, L.S. 2000. Use and selection of sap trees by Yellow-bellied Sapsuckers. Auk 117:41–51.

Erdmann, G.G., and R.R. Oberg. 1974. Sapsucker feeding damages crown-released Yellow Birch trees. Journal of Forestry 72:760–763.

Fraternale, D., and D. Ricci. 2014. Chemical composition and antimicrobial activity of the essential oil of *Cotinus coggygria* Scop. from Italy. Journal of Essential Oil Bearing Plants 17:366–370.

Graves, G.R. 2017. First record of *Citheronia regalis* (Lepidoptera: Saturniidae) feeding on *Cotinus obovatus* (Anacardiaceae). Florida Entomologist 100:474–475.

Graves, G.R. 2018. Winter surveys of *Cotinus obovatus* (American Smoketree) in the Ozark Mountains. Journal of the Arkansas Academy of Science 72:81–86.

Hosmer, D.W., and S. Lemeshow. 1989. Applied Logistic Regression. John Wiley and Sons, New York, NY. 307 pp.

Jorgensen, R.N., and S.L. Lecznar. 1964. Anatomy of hemlock ring shake associated with sapsucker injury. US Forest Service Research Paper NE–21. Northeastern Forest Experiment Station, Upper Darby, PA. 11 pp.

Kessel, B. 1986. Yellow-bellied Sapsucker, *Sphyrapicus varius*, in Alaska. Journal of Field Ornithology 57:42–47.

Kilham, L. 1962. Breeding behavior of Yellow-Bellied Sapsuckers. Auk 79:31–43.

Kilham, L. 1964. The relations of breeding Yellow-bellied Sapsuckers to wounded birches and other trees. Auk 81:520–527.

Little, E.L. 1942. American Smoketree (*Cotinus obovatus* Raf.), one of Oklahoma's rarest tree species. Proceedings of the Oklahoma Academy of Sciences 23:21–23.

Little, E.L. 1971. Atlas of United States Trees. Volume 1, Conifers and Important Hardwoods. US Department of Agriculture, Forest Service, Washington, DC. Available online at https://www.biodiversitylibrary.org/item/225461#page/3/mode/1up.

Little, E.L. 1977. Atlas of United States Trees. Volume 4. Minor Eastern Hardwoods. Miscellaneous Publication Number 1342. US Department of Agriculture, Washington, DC. Available online at https://www.biodiversitylibrary.org/item/132195#page/3/mode/1up.

Long, A.M. 2011. Orietation of sap wells excavated by Yellow-bellied Sapsuckers. Wilson Journal of Ornithology 124:164–167.

Mancuso, K., E. Nol, D. Burke, and K. Elliott. 2014. Effect of selection logging on Yellow-bellied Sapsucker sap-feeding habits in Algonquin Provincial Park, Ontario. Canadian Journal of Forest Research 44:1236–1243.

Martin, A.C., H.S. Zim, and A.L. Nelson. 1951. American Wildlife and Plants, a Guide to Wildlife Food Habits: The Use of Trees, Shrubs, Weeds, and Herbs by Birds and Mammals of the United States. Dover Publications, New York, NY. 500 pp.

Matić, S., S. Stanić, M. Mihailović, and D. Bogojević. 2016. *Cotinus coggygria* Scop.: An overview of its chemical constituents, pharmacological and toxicological potential. Saudi Journal of Biological Sciences 23:452–461.

McAtee, W.L. 1911. Woodpeckers in relation to trees and wood products. USDA Biological Survey Bulletin 39:1–99.

McAtee, W.L. 1913. Destruction of sapsuckers. Auk 30:154–157.

Mohr, C. 1882. *Rhus Cotinoides*, Nutt. Proceedings of the Academy of Natural Sciences of Philadelphia 34:217–220.

Novaković, M., I. Vučković, A. Janaćković, M. Soković, A. Filipović, V. Tešević, and S. Milosavljević. 2007. Chemical composition, antibacterial, and antifungal activity of the essential oils of *Cotinus coggygria* from Serbia. Journal of the Serbian Chemical Society 72:1045–1051.

Rushmore, J.M. 1969. Sapsucker damage varies with tree species and seasons. USDA Forest Service Research Paper NE-136:1–19. Northeast Forest Experiment Station, Upper Darby, PA. Available online at https://www.fs.fed.us/ne/newtown_square/publications/research_papers/pdfs/scanned/OCR/ne_rp136.pdf.

Savignac, C., and C.S. Machtans. 2006. Habitat requirements of the Yellow-bellied Sapsucker, *Sphyrapicus varius,* in boreal mixedwood forests of northwestern Canada. Canadian Journal of Zoology 84:1230–1239.

Shigo, A.L. 1963. Ring shake associated with sapsucker injury. USDA Forest Service Research Paper NE-8:1–10. Northeast Forest Experiment Station, Upper Darby, PA. Available online at https://www.fs.fed.us/ne/newtown_square/publications/research_papers/pdfs/scanned/rp8.pdf.

Speights, J.R., and W.C. Conway. 2010. Habitat and host-tree selection by wintering Yellow-bellied Sapsuckers in east Texas. American Midland Naturalist 164:107–118.

Tate, J. 1969. Foraging behavior of the eastern Yellow-bellied Sapsucker (*Sphyrapicus varius varius*). Ph.D. University of Nebraska, Lincoln, NE.

Tate, J. 1973. Methods and annual sequence of foraging by the sapsucker. Auk 104:328–334.

Varner, J.M., J.S. Kush, and R.S. Meldahl. 2006. Characteristics of sap trees used by overwintering *Sphyrapicus varius* (Yellow-bellied Sapsuckers) in an old-growth pine forest. Southeastern Naturalist 5:127–134.

Walters, E.L., E.H. Miller, and P.E. Lowther. 2002. Yellow-bellied Sapsucker (*Sphyrapicus varius*). No 662, *In* P.G. Rodewald (Ed.). The Birds of North America. Cornell Laboratory of Ornithology, Ithaca, NY. Available online at https://birdsna.org/Species–Account/bna/species/yebsap. DOI: 10.2173/bna.662.

Wilkins, H.D. 2001. The winter foraging ecology of Yellow-bellied Sapsuckers, *Sphyrapicus varius*, in east-central Mississippi. Ph.D. Dissertation. Mississippi State University, Starkville, MS.

Williams, J.B. 1980. Foraging by Yellow-bellied Sapsuckers in central Illinois during spring migration. Wilson Bulletin 92:519–523.