The History of Tung Oil

by Karen Brown and William Keeler

While greatly enjoying the experience of studying local flora some years ago with the humorous yet venerable botanist, Dr. Dana Griffin of the University of Florida (now retired and birdwatching), I struggled to learn to identify the trees of Gainesville. One of my favorites was the tung oil tree, Aleurites fordii, *because of its dead giveaway clue, the two tiny glands at the top of each leaf where it joins the petiole. This was as good as an answer written in the palm of one's hand during a final exam. I later learned that tung oil trees were an invasive exotic tree listed as a FLEPPC Category II species.* Even later, I was surprised to learn there was a rich history of tung oil trees right here in my own backyard of Gainesville.*

1946. Florida State Library and Archives, The Florida Memory Project.

1932. University Archives, Department of Special and Area Studies Collections, George A. Smathers Libraries, University of Florida.

"Florida now has one of the most important opportunities which ever came South for a visit, knocking at her door."

(Dacy, 1927)

History of American tung oil production

After extensive stands of pine trees were cut for timber in the early 1900s, Gulf Coast farmers looked for a suitable cash crop for the large acreage left over. The U.S. was the primary market for Chinese tung oil, importing 12 million gallons (100 million pounds) in 1927, and almost 120 million pounds in 1933, with demand still exceeding supply. Tung oil from southern China was extracted by hand from trees growing wild throughout the country; they were not cultivated. Due to the fluctuations in cost, quality, and delivery, China was a risky source of the high-grade tung oil that was far superior to any other type of oil.

The first tung tree seed reportedly was brought to America from Hankow, China in 1905 by Dr. David Fairchild, then senior agricultural explorer for the U.S. Department of Agriculture (USDA). Resultant seedlings were distributed to experiment stations in the South. In 1912 the Bureau of Plant Industry issued a special bulletin, carrying the personal approval of Secretary of Agriculture James Wilson, which urged growers to plant tung orchards and offered a limited number of free one-year old trees. In the same year, ten trees were planted at UF's Agricultural Experiment Station in Gainesville. By 1927, there were some 400 growers and more than 10,000 acres of tung oil trees in Alachua and adjoining counties alone.

In 1928, L.P. Moore (nephew of the Benjamin Moore Paints founder) of the Alachua Tung Oil Corporation in Gainesville built the first mechanized tung oil compressing mill in the world. This began the commercial production of tung oil in the U.S. The largest of Florida's tung plantations at the end of 1937 was that of H.W. Bennett in Alachua County. Mr. Bennett studied tung trees in their native China along the Yangtze River. He returned to plant 100,000 trees on 2,000 acres from 1930-1932, establishing China Tung Oil on "Tung Acres" just outside of Gainesville.

In 1938, the USDA began an extensive research program on tung production at

**Category II - Invasive exotics that have increased in abundance or frequency but have not yet altered Florida plant communities to the extent shown by Category I species.*

laboratories in Georgia, Florida, Alabama, Louisiana and Mississippi. In 1941, just prior to the outbreak of WWII, tung oil was declared a strategic item for defense use. All tung oil produced was to be used for war efforts only. All ammunition was "coated, and all ships were painted by products using tung oil." Federal financial support programs were available, and the U.S. also helped planters in South America, particularly Argentina. Since there was an embargo on Chinese tung oil at this time, the domestic oil was profitable. The Pan American Tung Research and Development League was formed between tung oil producers in America and Argentina to work jointly on research and development and to pool tung oil from both countries to provide consistent supplies to U.S. consumers.

Tung oil as a crop

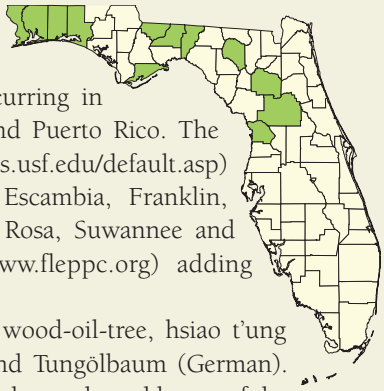
Tung oil trees thrive in moist, well-drained, slightly acid soil (Dacy). Trees begin to bear fruit in their third year and yield commercial quantities at four to five years of age. Maximum production occurs in the tenth to twelfth years of growth. Trees were expected to be commercially productive for at least 20 years after maximum production occurred.

Fruits fall to the ground from late September through November and are left for a few weeks to dry and cure. Nuts are separated from the hard outer shell, and pressed to extract the oil. Byproducts can be used for mulch or burned for fuel but cannot be used as feed for livestock due to the fruit's toxic properties. Dried and pressed nuts yield about twenty percent oil. Under favorable conditions, an acre of tung trees will produce about two tons of nuts and eight hundred pounds (one hundred gallons) of raw tung oil annually. Late spring cold spells will kill spring growth and destroy the fruit for that year. However, the trees need from 200 to 400 hours below 45 degrees F for their dormancy period. (Moore/Davis) (Montgomery).

The demise of American tung oil production

Between 1934 and 1940, frost almost totally ruined the tung nut crop for four different years. The industry had expanded from Florida, Georgia, and Alabama, to Mississippi, Louisiana, and Texas, with Mississippi the largest producing state. Although price supports continued, Argentina could sell oil at lower prices and U.S. producers were operating at a loss. In addition, frosts were decreasing the extent and yields of tung oil groves. In the 1950s and 1960s, freezes wiped out commercial tung activities in parts of Louisiana, Mississippi, and Alabama and all of Georgia. Hurricanes Betsy (1965) and Camille (1969) dealt the final blows to the tung plantations in southern Mississippi and eastern Louisiana. Camille destroyed or damaged about half of the groves in the U.S., and destroyed the entire tung nut crop plus two thirds of the trees in Mississippi. Approximately 40,000 acres of groves were destroyed in one Mississippi county alone. Growers eligible for federal disaster compensation took it and went into other agricultural production. Unfortunately for the tung oil industry, Camille "came on the heels of what many thought would be the savior of the industry: a genetic breakthrough that produced late-blooming varieties capable of escaping late spring freezes." (Fry) It also was believed the new clones would maintain typical production but on only half the acreage. However, there was little incentive for replanting. Oil is the lone economically

Botanical Description and Distribution



Aleurites fordii (Hemsl.) is in the Euphorbiaceae (Spurge) family. The USDA Plants Database (http://plants.usda.gov/) shows the tung oil tree occurring in Florida, Georgia, Alabama, Mississippi, Louisiana, and Puerto Rico. The Atlas of Florida Vascular Plants (http://www.plantatlas.usf.edu/default.asp) lists vouchered specimens from Alachua, Citrus, Escambia, Franklin, Gadsden, Jefferson, Leon, Marion, Okaloosa, Santa Rosa, Suwannee and Walton counties, with the FLEPPC database (www.fleppc.org) adding Columbia County.

Common names include tung oil tree, Chinese wood-oil-tree, hsiao t'ung shu, t'ung shu, t'ung yu, tung yan shu (Chinese), and Tungölbaum (German). "Tung" is the Chinese word for "heart" and refers to the heart-shaped leaves of the tung tree, which is native to southern China and Indo-China.

The tung oil tree is a small deciduous tree up to 40 or more feet in height with smooth bark and a much-branched head. Branches are horizontal to semi-erect, often produced approximately in whorls. Leaves are glossy, dark green, alternate, long petioled and simple. Leaf blades are broadly ovate, 3-13 inches wide, entire with a cordate base and sharp point or with 2-5 sharp-pointed lobes. Two convex reddish-brown glands occur near the junction between the petiole and the leaf blade. The trees are monoecious (separate male and female flowers are borne on the same tree.) Flower petals are white tinged with red and yellow, darker at the base with dark red-branched lines running lengthwise. A prominent tuft of hairs occurs at the base of each petal. Flowers range from just over 1" to almost 3" in diameter. Petals range in number from 4-9. Fruits are 1-3" in diameter, dark green, turning brown upon maturity. Most are oblong to ovoid, but some are nearly spherical. Some have distinct longitudinal ridges. Fruit contains 3-7 large seeds, with 5 seeds being most common, ranging in size from 5/8" to 1-1/4" long with a brown coat and white flesh (Dickey, 1952).

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Poisonous properties:

"Poisonous soup sickens over 100 students in Hunan"

A news report from central China's Hunan Province told of thirteen students who brought tung oil to school and put it into the breakfast soup to protest the school's food quality and price. Over 100 students were poisoned, with more than 40 sick enough to be hospitalized (www.chinaview.cn). Both the leaves and seeds of the tung tree are toxic if eaten, especially the seeds. In humans, a single tung nut can cause severe vomiting, diarrhea, cyanosis, respiratory depression, weakness, and possibly death (Everist, 1981). Effects are gastroenteritis, nausea, vomiting, abdominal cramps, diarrhea, dizziness, weakness, poor reflexes and dehydration. Onset of symptoms occurs in 30 minutes with recovery usually within 24 hours. Contact also can cause dermatitis. Two other cases of accidental poisoning occurred in November 1992 and November 1994 when elementary and high school students in Taiwan ate tung nuts, mistaking them for chestnuts. The students were hospitalized and symptoms subsided within one to two days (Lin, et al, 1996).

Uses of tung oil

The tung tree was once the principle commercial source of tung oil, used as a high-grade, quick drying oil in paint, varnish, linoleum and printer's ink (Dickey, 1952).

The Chinese have used tung oil for waterproofing masonry, cloth, shoes, clothing, and paper. The oil, mixed with lime mortar or burned tung nut residue, was one of the world's first agents for waterproofing and caulking boats. When a 600 year old shipyard was excavated recently in Nanjing, China, caches of tung oil were found. Tung nut residue also was used in the manufacture of lampblack and Chinese ink, otherwise known as "India ink" (Federal Writers' Project). One unreferenced article states that tung oil is highly regarded as a medicine in China, used as a remedy for insanity and in the treatment of burns, bruises, and swellings. Tung oil reportedly was mixed in the mortar that made the Great Wall of China, and Marco Polo is said to have brought a sample back to the western world from China. *The Book of Poetry*, Chinese folk songs compiled by Confucius, mentions that the oil was used in Chinese lacquers.

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1949. B.L. Kerce. Florida State Library and Archives, The Florida Memory Project.

significant product of tung trees; it can not be grown for fiber, meal, or fertilizer as with soybeans and flax. The climatic hazards, increasing production costs, competition from substitute synthetic products (domestic consumption declined almost 50% between 1955 and 1970), and more productive uses of land spelled the end for commercial tung oil production in the U.S. Tung orchards were abandoned or bulldozed and used for other crops, pasture or timber. Today, the major growing areas of tung trees include China, Argentina, Paraguay, and parts of Africa. The only domestic activity on tung oil is research to molecularly deconstruct its oil producing enzymes in order to convert low-cost vegetable oils to value-added drying oils. (USDA-ARS)

Spread in Natural Areas

Although tung oil can be locally abundant, it is not seen as a major player in control projects to date (Leslie, pers. comm.). However, an estimated 84 acres have been controlled since 1998 by the Florida Department of Environmental Protection's Bureau of Invasive Plant Management. Basal bark treatments of 15-20% Garlon 4 in oil work well, according to Drew Leslie of the Bureau. This is fortunate due to the lack of natural enemies that exist.

> "The tree has no enemies that we have been able to discover that in any way affect it, either fungus or insect, nor have we been able to find that there is anything in China that affects the tree."
> (Williamson, 1927)

Conclusion

It seems a sad story that a commercial crop that was so intensely researched, promoted and invested in was wiped out by the ravages of nature and the development of synthetic substitutes and products of lesser quality. There was excitement in the air when tung oil production was on the rise and offering riches to investors and farmers. But today, the tree that held so much financial promise and captured people's dreams has been relegated to a FLEPPC Category II exotic pest plant, an ignominious end for the tung oil tree.

References available from the author. Karen Brown, University of Florida, IFAS-Center for Aquatic and Invasive Plants, kpbrown@ifas.ufl.edu, (352) 392-1799.