# The Tuliptree Scale

# A Particularly Vile and Nasty Pest

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The tuliptree scale (*Toumeyella liriodendri*) can be a serious and damaging pest of tuliptrees (*Liriodendron tulipifera*), magnolias (*Magnolia* spp.) and other members of the Magnoliaceae, and even some non-magnolia hosts. Its gregarious nature and heavy feeding remove plant sap, reduce plant vigor, cause shoot dieback and defoliation, distort growth, and can even lead to death (**Fig. 1**). To add insult to injury, this pest produces copious amounts of honeydew, which promotes the growth of black sooty mold on leaves and stems, and coats portions of the tree and everything beneath its canopy in a severely annoying, sticky, dark to amber-colored, glossy, lacquer-like finish, making the tuliptree scale a particularly vile and nasty pest (**Fig. 2**). Here we provide a summary of its history in southern California, signs and symptoms, identification and biology, hosts and distribution, and possible management strategies.

## History

The tuliptree scale was first documented in the 1700s on tuliptree in its natural range in the eastern United States. However, it was unrecognized as a significant pest until the early to mid-1900s when it impacted tulip tree timber production (Dale 2016). The tuliptree scale was detected in California as early as 1982 in San Leandro in Alameda County in the Bay Area. The California Department of Food and Agriculture Plant Health and Prevention Services assigned it an “A” pest rating: a pest of the agricultural industry or environment that scores high and is not known to occur or be under official control in California (Papp and Tidwell 1982).

An eradication program was implemented in Alameda County but was unsuccessful (Dreistadt 2004), and the tuliptree scale was detected several times over the next 10 years in Alameda County (Gill 1983a, b; 1987; 1991a, b). It is now established in many places throughout California. Although wind can spread tuliptree scale nymphs locally, movement of infested plant material is mostly responsible for long-distance dispersal throughout the State.

Our interest in the tuliptree scale began in 2015 when co-author Michael Wallich, campus arborist at the University of Southern California, invited co-author Donald Hodel to view this pest, which was heavily infesting young and old southern magnolias (*Magnolia grandiflora*) on campus. The pest’s gregarious nature and densely packed colonies, completely covering stems for a few feet and appearing like plump kernels on a corn cob, were striking (**Figs. 3, 14, 19**), and the copious amounts of honeydew it produced were impressive.

**1.** The gregarious nature and heavy feeding of tuliptree scales remove plant sap, reduce plant vigor, and cause shoot dieback and defoliation.

**2.** Tuliptree scales produce copious amounts of honeydew, which coats everything beneath its canopy in a severely annoying, dark, sticky, glossy, lacquer-like finish, making them a particularly vile and nasty pest.

**3.** The tuliptree scale's gregarious nature and densely packed colonies completely cover stems for a few feet and appear like plump kernels on a corn cob.

In 2017 co-authors Jerry Rowland and Eliud Aguirre, city certified arborists of the City of Long Beach, showed Hodel numerous, spectacular infestations of the tuliptree scale, again on southern magnolia, in several parts of their city. We had never seen anything even remotely close to the damage and nuisance this pest was causing. At various sites many trees were damaged and dripping with honeydew and several trees were dead. The honeydew was so abundant it made nearly any type of activity beneath the tree impossible.

## Signs and Symptoms

The tuliptree scale damages the host in several ways. Feeding extracts large quantities of plant nutrients. The honeydew waste that the scales excrete causes sooty mold on leaf surfaces, which reduces photosynthesis and transpiration. The damaged leaves and stems and sooty mold reduce plant value and marketability (Borden and Dale 2016). Also, the damage and inconvenience that the honeydew causes to surfaces and objects under and near the host tree can be significant.

The first noticeable signs might be the copious honeydew that the tuliptree scale produces. Looking up into the tree, the main branches, stems, and twigs, especially their upper surfaces, appear dark and oil-stained or water-soaked, as if light-weight motor oil had been poured on them (**Fig. 4**). In especially heavy infestations, the oil-stained or water-soaked areas sometimes extend down the trunk (**Fig. 5**). Tremendous and vast amounts of sooty mold cover leaves and twigs, causing them to turn dark or even black (**Fig. 6**). Trunks and branches under long-term, heavy infestations take on a charred appearance as though they are burned (Donley and Burns 1971).

The copious honeydew, which falls as a sticky, nearly syrupy, amber-colored material that sometimes darkens with age, likely from the accumulation of dust and dirt, typically covers all surfaces beneath the infested tree, such as sidewalks (**Fig. 7**), curbs and gutters, roads (**Fig. 8**), children's toys, automobiles (**Fig. 9**), and landscape plants. However, white surfaces, such as sidewalks, curbs, and gutters, sometimes appear as if they have been lacquered or varnished with shiny, amber-colored shellac (**Figs. 10-12**).

Typically the easily seen, unusually large scale insects and their gregarious nature, densely packed along twigs and stems, are sufficient for diagnosis (**Figs. 13-14**).

Host symptoms include loss of vigor, leaf chlorosis and necrosis (**Fig. 15**), premature leaf drop, distorted new growth, twig and branch dieback (**Fig. 16**), canopy thinning (**Fig. 17**), and death (Borden and Dale 2016, Donley and Burns 1971). Although old and young trees are equally susceptible to the tuliptree scale, the latter are reported to be more easily killed (Donley and

**4.**The first noticeable signs of a tuliptree scale infestation might be the copious honeydew that it produces, drenching the upper surfaces of branches, making them appear dark and oil-stained or water-soaked.

Burns 1971) (**Fig. 18**). In one instance as few as 38 tuliptree scales killed a two-year-old tree (Borden and Dale 2016) and 32 killed a three-year-old sapling (Donley and Burns 1971).

## Identification and Biology

Much of the information in this section is taken from Borden and Dale (2016) and Donley and Burns (1971), excellent summaries of the tuliptree scale. Most of the information about the tuliptree scale, especially its lifecycle, was developed from studies of the pest in cold-temperate localities in the eastern United States. Its lifecycle differs in warm-temperate and subtropical regions like Florida and coastal California, where life stages typically overlap and all stages can be found at any time of year (Donley and Burns 1971). In southern California populations of immatures and adults dip significantly during the winter months but all life stages can still be found. Similarly, honeydew production lessens but does not stop entirely in the winter. In colder areas of northern California, tuliptree scales overwinter as second instar nymphs on twigs and mature in late spring to early summer (Dreistadt 2004).

**5.** On especially heavy infestations, the oil-stained or water-soaked areas sometimes extend down the trunk.

**6.** The copious honeydew that the tuliptree scales produces causes leaves to darken or blacken with sooty mold.

**7.** Honeydew typically covers sidewalks beneath infested trees.

**8.** Honeydew typically covers roads beneath infested trees, making them appear wet and shiny.

**9.** Honeydew typically covers automobiles parked beneath infested trees.

**10.** White surfaces like sidewalks appear as if they have been lacquered or varnished with shiny, amber-colored shellac.

**11.** White surfaces like curbs and gutters appear as if they have been lacquered or varnished with shiny, amber-colored shellac.

**12.** White surfaces like curbs appear as if they have been lacquered or varnished with shiny, amber-colored shellac.

## Taxonomy

Burns and Donley (1970) and Kondo and Williams (2008) reviewed the taxonomy of the tuliptree scale. Other scientific names (synonyms) sometimes used for this pest include *Coccus liriodendri*, *Eulecanium liriodendri*, *Lecanium liriodendri*, and *L. tulipiferae*.

## Eggs

Female tuliptree scales are ovoviviparous: the eggs develop and hatch inside the female's body (Donley and Burns 1971). Newly hatched nymphs crawl out of the female and find a feeding site. One female tuliptree scale can produce over 3,000 offspring in its lifetime (as few as 45 days) (Borden and Dale 2016, Donley and Burns 1971).

## Nymphs

First instar nymphs (crawlers) are typically dark red and 0.5 mm long (**Fig. 19**). In cold-temperate areas they emerge from beneath their stationary mother from August through October. These crawlers are the only mobile female stage (adult males are mobile), and their

**13.** The large size and gregarious, densely packed nature of the tuliptree scales are usually sufficient for diagnosis.

**14.** The large size and gregarious, densely packed nature of the tuliptree scales, like plump kernels on a come cob, are usually sufficient for diagnosis.

**15.** Leaf chlorosis and necrosis are symptoms of a tuliptree scale infestation.

**16.** Twig and branch dieback is a symptom of a tuliptree scale infestation.

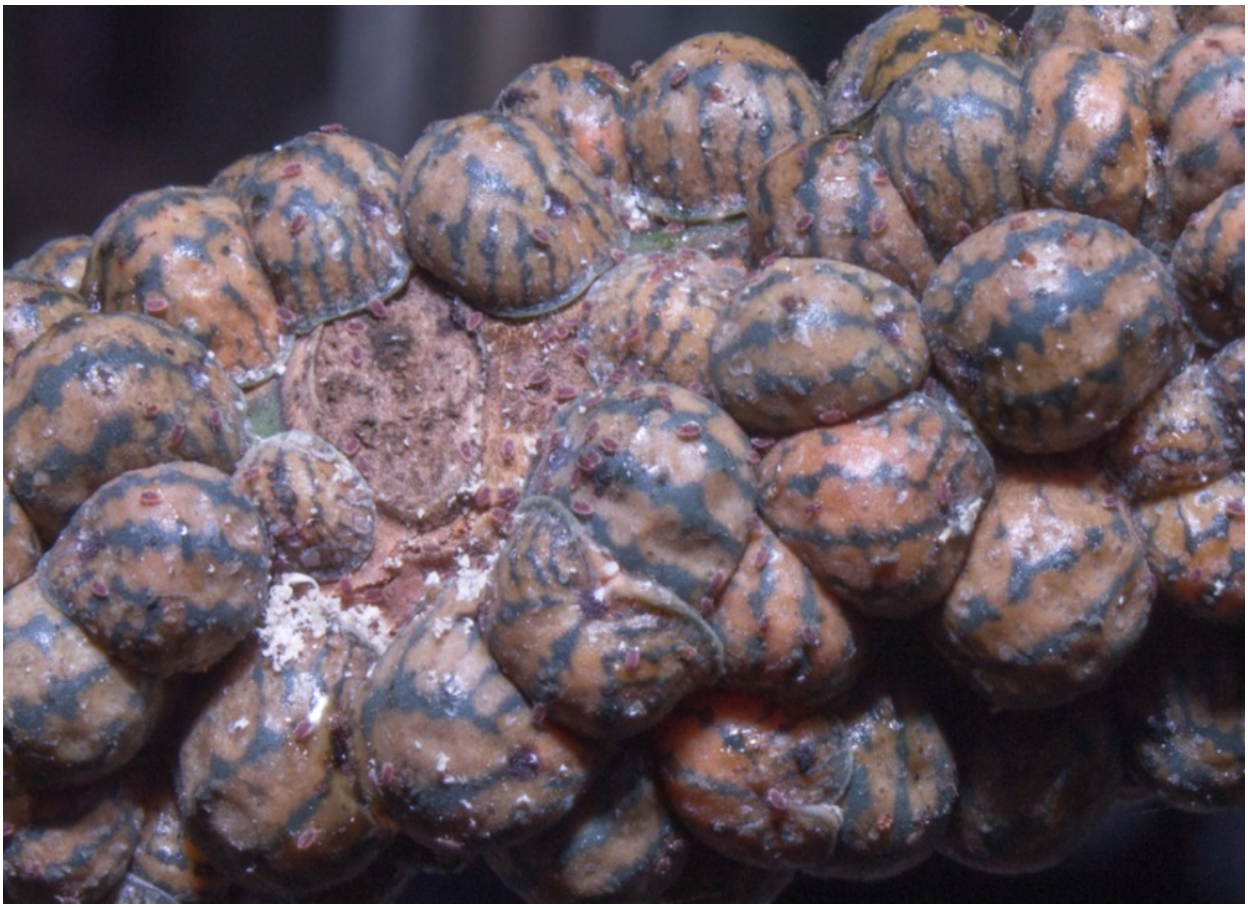
small size means that wind can easily carry them to new sites up to 30 m distant (Borden and Dale 2016, Donley and Burns 1971). Indeed, the infestation in Long Beach was first detected on a southern magnolia street tree on 3rd Street in 2016, only a few blocks inland from the coast (**Fig. 20**); however, because of prevailing westerly winds off the ocean, it has spread and fanned out inland to at least 30 blocks from the coast within two years. Once they land on a susceptible host, they crawl to find a bud or young twig, insert their mouth parts, and begin to feed (Borden and Dale 2016, Donley and Burns 1971).

Once feeding begins, crawlers are unable to remove their mouthparts and they remain at the initial feeding site for the remainder of their lives (Burns and Donley 1970, Donley and Burns 1971). After a few weeks male and female nymphs molt into their second and final instar and lose their legs. They overwinter in this instar on twigs and evergreen leaves in cold-temperate regions, and are small, oval, and black (Borden and Dale 2016, Donley and Burns 1971).

In cold-temperate regions as weather warms in late spring, typically in May, second instars enter a pre-pupa stage and gender differentiation begins. Females become circular and begin rapid growth while males become long and slim. After a few weeks, typically in late May, males

**17.** Canopy thinning is a symptom of a tuliptree scale infestation.

**18.** Although old and young trees are equally susceptible to the tuliptree scale, young trees are more easily killed.



**19.** First instar nymphs (crawlers) of tuliptree scales are typically dark red and 0.5 mm long. Here they can be seen crawling over densely packed adult females.

pupate. The tan, elongate-oval pupae appear white because of a conspicuous opaque covering (Borden and Dale 2016, Donley and Burns 1971) (**Fig. 21**).

**Adults**

In late May immature females become hemispherical and develop a distinctive, flange-like lip around the lower part of their waxy covering. They also begin a rapid period of growth and produce copious amounts of honeydew. Adult females are conspicuous because of their large size, convex or helmet-like shape, and densely packed, gregarious nature (**Fig. 19**). They are typically so densely packed that they are often angled from mutual pressure (Dreistadt 2004). Varying in color but typically orange or brown to gray to pink with gray to black, orange, pink, red, or yellow speckling or banding (Dreistadt 2004), they are 2.6 to 7(-11) mm (nearly 0.5 inch) wide or long (Borden and Dale 2016, Donley and Burns 1971) (**Figs. 14, 19**). During the summer they fill with eggs and their bodies swell, flattening out even more the flange-like lip. Adult females die in the fall, turn brown, but remain attached to the twigs (Borden and Dale 2016).


**20.** The tuliptree scale was first detected in Long Beach in 2016 on this southern magnolia a few blocks from the ocean. Within two years, this tree was nearly dead and the infestation had spread over 30 city blocks inland.

**21.** Male pupae of the tuliptree scale are tan, elongate-oval, and have a conspicuous opaque, white covering that remains after the adult has emerged.

Female tuliptree scales are similar to the magnolia scale (*Neolecanium cornuparnum*), which is an even larger scale that lacks the distinctive flared flange on its covering (Borden and Dale 2016). Also, adult female tuliptree scales are alive in the summer and "bleed" when crushed while those of magnolia scales mature earlier and are dead and dried out by June (Dreistadt 2004).

Adult males, which emerge in mid-June, have one pair of wings and can easily be confused with parasitoid wasps. They mate with females and die shortly thereafter (Borden and Dale 2016, Donley and Burns 1971).

## Hosts

The tuliptree scale has been reported on at least 20 host species in 12 genera in 8 families (Dietz 1916, Gill 1988, Hamon and Williams 1984, Kondo and Williams 2008, Miller and Williams 1995, Novoa et al. 2011, Williams and Kosztarab 1972). Scalenet (2018) provides a detailed summary of the hosts of the tuliptree scale. Magnoliaceae is a family that has many hosts, including *Liriodendron tulipifera*, *Magnolia acuminata*, *M. figo*, *M. grandiflora*, *M. ×*

*soulangeana*, and *M. stellata*), which are considered primary hosts in Florida (Borden and Dale 2016). In southern California the primary host of tuliptree scales appears to be *M. grandiflora*.

## Distribution

The tuliptree scale occurs in 19 states and the District of Columbia, all except for Texas and California are east of the Mississippi River (Ben-Dov 1993, Hamon and Williams 1984, Kondo and Williams 2008). It occurs from Michigan and New York in the north to Florida and the Gulf states in the south. It has not yet been found in Wisconsin and the New England states. Its distribution more or less coincides with that of its namesake, the tuliptree. The tuliptree scale perhaps is introduced in Texas, but is certainly introduced in California. It has also recently been found in Cuba (Novoa et al. 2011). Scalenet (2018) provides a detailed summary of the states and countries where the tuliptree scale is found.

## Management

Once established, tuliptree scales are difficult to control and a combination of measures will likely work best.

### Plant Selection and Cultivation

Provide proper cultivation for optimal plant health. Select the right plant for the right spot, and plant and care for it correctly. Appropriate irrigation, nutrition, pruning, mulch, and root zone management are especially critical. Avoid stressing plants. Plant stress can lead to an increase in scale infestations. We have observed that southern magnolia trees lacking adequate water, growing in compacted soils (**Fig. 22**), and/or subject to root disturbance, such as root pruning to protect hardscape (**Fig. 23**), all conditions that stress plants, seem to show more damage and are more likely to die from tuliptree scales than unstressed trees. While tuliptree scales will attack healthy trees, such trees will recover more quickly when promptly treated.

### Exclusion and Sanitation

Be vigilant and practice exclusion and sanitation. Inspect all new plant material thoroughly, preferably at the nursery, before introducing it to the site. Reject all infested material. In some instances new, early infestations on small trees can be hand removed or, with deciduous species, dislodged with high-pressure water sprays when leafless. Twigs and stems with small, isolated infestations can be pruned off, securely bagged, and properly disposed (Borden and Dale 2016).

**22.** Compacted soils, often from excessive pedestrian traffic, stress southern magnolias, enhancing tuliptree scale infestations.

**23.** Root disturbance, such as root pruning to protect hardscape, enhance tuliptree scale infestations. Note the honeydew on the sidewalk.

## Ant Control

As with all scales and other sap-sucking insect pests, ants are typically associated with tuliptree scales and their control is critical to achieving overall management of this pest. In a mutualistic relationship, ants tend or “farm” scales, protecting them from natural enemies in exchange for accessing the sugary honeydew that the scales produce. Some ants actually construct protective structures of soil, grass, and even mud over scales (Borden and Dale 2016). Ants tending scale populations can increase scale survival up to 50% (Burns and Donley 1970). Ants can cause up to a 98% reduction in parasitism of soft scale species (Bartlett 1961).

Sometimes the presence of ants is a good indicator that scales are present even before twig and leaf damage and honeydew are noticed. Monitor ants on trunks, branches, and leaves. Control ants with appropriate baits.

## Natural Enemies

Encourage natural pests of the tuliptree scale, which include predaceous moths, ladybird beetles, parasitoid flies and wasps, and pathogenic fungi. The predacious moth larvae is *Laetilia*

**24.** This young southern magnolia was heavily infested with tuliptree scales in 2015.

**25.** This young southern magnolia, adjacent to and appearing in a similar condition to the one shown in Figure 24, was responding positively after two years of treatment.

*coccidivora* (Lepidoptera: Pyralidae); ladybird beetles include *Hyperaspis proba* and *H. signata*, *Chilocorus stigma*, and *Adalia bipunctata* (Coleoptera: Coccinellidae); and the parasitoid syrphid fly is *Pelecinobaccha costata* (Diptera: Syrphidae) (Borden and Dale 2016).

Parasitoid wasps include three genera in two families (Myartseva et al. 2016). These are *Anicetus toumeyellae* and *Metaphycus flavus* (Hymenoptera: Encyrtidae) and *Coccophagus bivittatus*, *C. flavifrons*, and *C. lycimnia* (Hymenoptera: Aphelinidae).

Some pathogenic fungi, including *Aschersonia cubensis*, have killed tuliptree scales in Florida (Donley and Burns 1971).

**Chemical Control**

Contact sprays can be ineffective because of the protective waxy covering the scale has for most of its life. If using such sprays, timing is critical to target crawlers or early second instars that have emerged and are active in mid to late summer (Borden and Dale 2016, Dreistadt 2004). In some instances insecticidal oils have been effective on overwintering nymphs (Borden and Dale 2016, Donley and Burns 1971, Dreistadt 2004). The most effective chemical control is likely a combination of contact sprays and one or more of the new systemic materials.

Although it took two years and multiple applications, the University of Southern California has made significant progress against severe tuliptree scale infestations on southern magnolia (**Figs. 24-25**). They used a combination of bifenthrin contact sprays, dinotefuran trunk sprays, and imidacloprid soil applications. They also used insecticidal soap and, to remediate soil compaction from excessive pedestrian and vehicular traffic, vertical mulching. The city of Long Beach is contemplating a similar approach to combatting their equally severe and even more widespread infestation.

Consider the damage that pesticides can do to the environment, and make an informed, educated decision about their use.

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