Ganoderma Butt Rot of Palms: First Report of this Lethal Disease in California

PAUL SANTOS AND DONALD R. HODEL

In November, 2024, a homeowner in Laguna Hills in southern Orange County, California contacted RPW Services, Inc., a plant pest and disease diagnostic and management company, because numerous queen palms (*Syagrus romanzoffiana*) on her property had died over the course of several years. When Chris Burk, a technician from RPW visited the site, all that remained of the most recently dead palm was a short stump. He noticed numerous, shelf- or bracket-like fungal fruiting bodies protruding from the lower part of the stump (**Figs. 1–3**). Burk sent fruiting bodies to Santos, which piqued his interest because Santos had been keenly curious about such fruiting bodies on palms for several years.

Santos suspected the fruiting bodies might be from the fungal pathogen *Ganoderma zonatum*, which causes Ganoderma butt rot of palms, a serious and lethal disease not yet reported for California. He sent samples to the Plant Pest Diagnostic Center, California Department of Food and Agriculture, Sacramento, where molecular analysis (DNA sequencing) confirmed it to be *G. zonatum*.

Here, we provide an overview of Ganoderma butt rot of palms and its causal agent, *Ganoderma zonatum*, including their history, natural history, disease symptoms and diagnosis, hosts, and management.

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1. Conk or fruiting body confirmed as *Ganoderma zonatum*, the pathogen causing Ganoderma butt rot of palms, on a queen palm stump in Laguna Hills, California. © 2025 D. R. Hodel.

2-3. Conks or fruiting bodies confirmed as *Ganoderma zonatum* removed from a queen palm stump in Laguna Hills, California. © 2025 D. R. Hodel.

Ganoderma

Ganoderma is a large, diverse genus of about 80 species of polypore fungi (having large fruiting bodies with pores or tubes on the abaxial surface) in the family Ganodermataceae (Kirk et al. 2008, Loyd et al. 2017). They are lignicolous (growing or living on or in wood), possess or lack a stipe, and are pathogenic and/or saprophytic, colonizing living or dead trees (Loyd et al. 2017). Their persistent, conspicuous, woody to leathery, hard, generally brown to reddish brown, shiny or dull cap surface, bracket- or shelf-like fruiting bodies, technically basidiocarps but commonly called conks, are attached to the outside of the host trunk and are their most easily and prominently recognizable feature (Loyd et al. 2017). Some members of this genus (e.g. *G. applanatum*) have fruiting bodies with dull surfaces (i.e. not laccate) and are in subgenus *Elfvinigia*, while those with fruiting bodies with laccate caps are in the subgenus *Ganoderma*.

Karsten (1881) named and established *Ganoderma*, basing the genus name on the laccate (lacquered-, varnished-, or polished-appearing) nature of the conk of *G. lucidum*, the one species he originally included in the genus. William Curtis, 18th-century English botanist, entomologist, and author who published *Flora Londinensis* and *The Botanical Magazine* (later *Curtis's Botanical Magazine* in his honor), had originally named and described this species as *Boletus lucidus* (Curtis 1781), basing it on material he had collected from a decaying hazel tree stump near London in 1780. The name *Ganoderma* is derived from the Greek *ganos*, meaning bright or shiny, and *derma*, meaning skin (Liddell and Scott 1980), and alludes to the nature of the conk, but not all species in the genus have a laccate conk.

Ganoderma fungi are cosmopolitan with many species from tropical regions and decay mostly the lower parts of trunks and roots. Some species are saprophytic, living on dead trees, and others more opportunistic while some are aggressive pathogens (Loyd et al. 2017). Some are generalists and found on a wide variety of host species while others are specialists and have a much narrower host range. For example, the aggressive *G. zonatum* is a pathogen that attacks only members of the palm family (Arecaceae) although a few reports indicate it might be attacking other plants like bamboo (A. Loyd, pers. comm., 24 February 2025).

Ganoderma are considered white rot fungi because during their degradation process the wood progresses through stages where it turns lighter in color and often stringy wet (Moore 2025, Sinclaire and Lyons 2005). *Ganoderma* are efficient wood-decay fungi because they possess enzymes that degrade all wood components, including lignin and cellulose (Loyd et al. 2017, Moore 2025), the structural framework of wood, and are typically tolerant of adverse environmental conditions, making them ideal for bioremedial work (Moore 2025). They occur on all woody plants, including gymnosperms (pines and cycads) and angiosperms (including palms).

The presence of *Ganoderma* conks indicates active wood decay but conks are not always present. Conks tend to form year-round in warm, humid areas but might be restricted to warmer months in cooler, more temperate regions (Loyd et al. 2017).

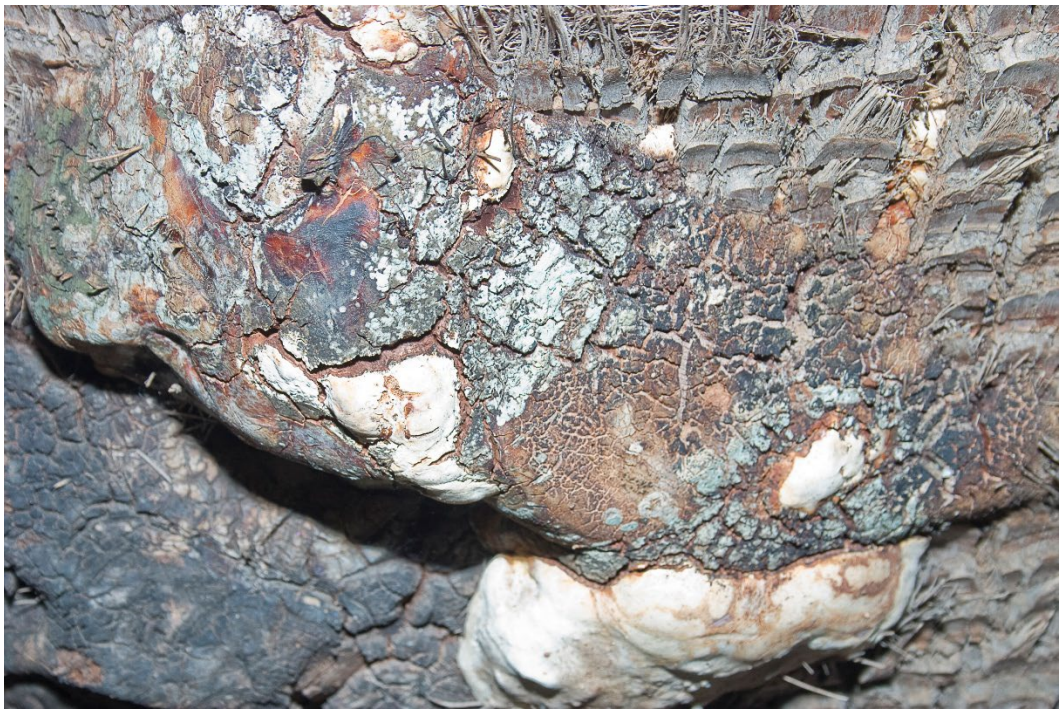
Because of the diversity and variability of *Ganoderma* conks, the lack of reliable morphological characters, and the overabundance and widespread misapplication of names, the taxonomy of the genus was confused and identification was difficult (Smith and Sivasithamparam 2003, Ryvarden 1985) until the advent of more precise and less expensive molecular analyses (DNA sequencing data) in the late 20th and early 21st centuries, which greatly enhanced our understanding of this genus (Cao et al. 2012, Moncalvo et al. 1995, Zhou et al 2015). For example, up until mostly the late 20th century, most species of laccate *Ganoderma* in the United States had been identified as *G. lucidum* (Adaskaveg and Gilbertson 1988, 1989; Gilbertson and Ryvarden 1986, Hapuarachchi et al. 2015). However, later *G. lucidum* was considered to occur naturally only in Europe and northeastern China (Cao et al. 2012, Hennicke et al 2016, Moncalvo et al. 1995), with records from Utah and northern California in the United State considered to be introductions for commercial mushroom operations that escaped into the wild (Loyd et al 2018). Similarly, many wild-collected and commercially cultivated, laccate *Ganoderma* in Asia, where they have been used medicinally for centuries and called *reishi* or *ling-zhi*, were identified as *G. lucidum* (Hennicke et al. 2016, Sissi et al. 2011, Wang at al. 2012) but many are now considered other species (Cao et al. 2012).

The laccate group of species within *Ganoderma*, which includes *G. zonatum*, the pathogen causing Ganoderma butt rot of palms, has smooth, polished- or varnished-appearing conks generally ranging from yellow to brown to reddish brown, the colors typically in a concentric banded pattern. They are woody to spongy and firm if not hard (Loyd et al. 2017). Although molecular analysis is now the preferred method of identification, morphological characters, including conk color and color pattern, stemmed or sessile morphology, tissue characters, host species, and occasionally basidiospore morphology can be helpful for identification (Loyd et al. 2017).

Ganoderma zonatum and Ganoderma Butt Rot of Palms

Ganoderma zonatum is the fungal pathogen causing the lethal disease Ganoderma butt rot of palms. Murrill (1902) named and described *G. zonatum*, basing it on a specimen that Lucien Marcus Underwood, an American botanist and mycologist, had collected on a trunk of *Sabal palmetto* palm in Florida. The undated type specimen lacking a collection number is in the herbarium of the New York Botanical Garden (specimen 00985723). The specific epithet *zonatum* alludes to the concentric color bands or zones of the conk.

4. Conk or fruiting body of suspected *Ganoderma zonatum* on a California fan palm, La Canada, California. Grid pattern made by wire mesh surrounding trunk. © 2010 D. R. Hodel.



5. Conk or fruiting body of suspected *Ganoderma zonatum* on a Mexican fan palm, Pasadena, California. © 2010 D. R. Hodel.

6. Conk or fruiting body of suspected *Ganoderma zonatum* on a queen palm, Laguna Niguel, California. © 2010 D. R. Hodel.

7. Conk or fruiting body of suspected *Ganoderma zonatum* on date palm, Santa Monica, California. © 2011 D. R. Hodel.

8. Conk or fruiting body of suspected *Ganoderma zonatum* on Senegal date palm is hard, shiny, and appears polished or lacquered, San Diego, California. © 2007 D. R. Hodel.

While we have observed *Ganoderma* on palms in southern California for about 25 years, including California fan palm (*Washingtonia filifera*) in La Canada (**Fig. 4**), Mexican fan palm (*W. robusta*) in Pasadena (**Fig. 5**), queen palm (*Syagrus romanzoffiana*) in Laguna Hills and Laguna Niguel (**Fig. 6**), date palm (*Phoenix dactylifera*) in Santa Monica (**Fig. 7**), and Senegal date palm (*Phoenix reclinata*) in San Diego (**Fig. 8**), we were unsure of the species. However, with the recent confirmation of *G. zonatum* on the queen palm in Laguna Hills, we suspect that some or all of these earlier but unidentified *Ganoderma* were likely also *G. zonatum* although some might be non-pathogenic, saprophytic species, and our highly esteemed colleague James Downer (pers. comm., 22 August 2010) suggested that at least one of these might be *G. brownii*.

Also, in 2017, a conk appeared on a queen palm (or perhaps Mexican fan palm) in Carlsbad, California and a photograph of it was posted to the on-line Mushroom Observer. It was later determined through DNA sequencing to be *Ganoderma zonatum* (Andrew Loyd pers. comm., 24 February 2025). See https://mushroomobserver.org/observations/284775?q=1zUAa for the posted photograph. This earlier detection is additional evidence that *G. zonatum* has been in California prior to our most recent detection.

The detection of this disease here raises an intriguing question: How did *Ganoderma zonatum* arrive in California? Because *G. zonatum* has a long history in Florida and the movement of containerized palms from Florida to California comprises a significant part of the nursery and landscape industry here, the pathogen likely arrived in California on containerized palms from Florida.

Disease and Pathogen Life Cycle

Spores of *Ganoderma zonatum* are soil borne. They germinate and their hyphae or fungal threads grow over palm roots without decaying them to gain access to the trunk, infecting and decaying the palm trunk at the base near or at the soil line first (**Figs. 9–10**). Initially, decay expands in diameter but then progresses up the center of the palm trunk, creating a cone-shaped pattern, widest proximally near the soil line and narrowest distally. Decay is restricted to the proximal one to two meters of palm trunks, which is the most lignified tissue. The disease is not a soft rot, so the infected portion of the palm trunk typically remains hard (Elliott and Broschat 2018) although this might not always be the case. Occasionally, a softer rot occurs and suggests a selective delignification type of decay (Andrew Loyd, pers. comm., 24 February 2025).

The conk of *Ganoderma zonatum* is diagnostic for Ganoderma butt rot of palms and is the most easily recognized and identified structure associated with the disease. Conks originate from the fungal growth inside the palm trunk (Elliott and Broschat 2018). They are initially a solid, white, relatively soft mass (**Figs. 11–12**) that often conforms to the shape of its environment. For example, in California on Mexican fan palms, we have observed them first as a white, chewing-gum-like substance crammed into the vertical furrows and cracks of the trunk cortex and pseudobark (**Figs. 13–14**).

As conks of *Ganoderma zonatum* expand outside the trunk, they become irregularly circular in shape and relatively flat. As they mature, conks become shelf- or bracket-like, half-moon shaped with the shorter, more or less straight side attached to the trunk, medium size, about 5–10 × 5–10 × 1.5–3 cm, convex adaxially and concave abaxially, smooth and glabrous, with numerous, broad, tan or chestnut-colored to chocolate brown or reddish brown, concentric, often grooved or striated bands or zones, often with a white outer margin when actively growing (Elliott and Broschat 2018, Murrill 1902) (**Figs. 1-8, 11–12, 15**). Its shiny, hard, lacquered- or varnished-appearing surface is conspicuous and adds to its visibility and distinctiveness (**Fig. 8**). At maturity, the conk will release its basidiospores, which wind, rain, and human activity can disseminate. The double-walled, truncate spores have yellow to brown inner layers and are unique in having a large length-to-width ratio, appearing “skinny” relative to other *Ganoderma* species. The time from infection to formation of a conk is unknown but is likely driven by environmental factors (Elliott and Broschat 2018). Beyond maturity, the conks age and tend to lose the smooth, bright,

9. Cross section of base of trunk of Mexican fan palm with suspected *Ganoderma zonatum* showing internal discoloration and decay (top), Pasadena, California. © 2010 D. R. Hodel.

10. Base of trunk of California fan palm with suspected *Ganoderma zonatum* showing internal discoloration and decay, La Canada, California. © 2010 D. R. Hodel.

11. White, young, developing conk or fruiting body of *Ganoderma zonatum* on queen palm, Orlando, Florida. © 2008 D. R. Hodel.

12. White, young, developing conk or fruiting body of suspected *Ganoderma zonatum* on date palm, Santa Monica, California. © 2011 D. R. Hodel.

13. Conk or fruiting body of suspected *Ganoderma zonatum* conforming to vertical crack in pseudobark and cortex of Mexican fan palm, Pasadena, California. © 2010 D. R. Hodel.

14. Cross-section of trunk of palm in Figure 13 showing conk or fruiting body of suspected *Ganoderma zonatum* emerging from decayed tissue in central cylinder out into crack in cortex and pseudobark of Mexican fan palm. © 2010 D. R. Hodel.

15. Reddish brown conks or fruiting bodies of suspected *Ganoderma zonatum* on Senegal date palm, San Diego, California. © 2007 D. R. Hodel.

colored zones and lacquered-like appearance, often becoming somewhat rough, non-descript, irregular masses.

Once infected, the pathogen *Ganoderma zonatum* might stay with that palm wherever it goes, whether it is a containerized specimen in a nursery or one that is dug, transported, and transplanted to a new site. Also, soil around an infected palm might be infested with the pathogen (Elliott and Broschat 2018).

Symptoms

As *Ganoderma zonatum* decays trunk tissues, the xylem, water- and mineral-conducting tissue, and phloem, carbohydrate-conducting tissue, both together in vascular bundles throughout the trunk, are destroyed. Thus, the first symptoms of Ganoderma butt rot of palms are wilting and/or general decline with yellow, off-colored leaves and slower growth (**Figs. 16–18**). An inordinate quantity of dead leaves might be in the lower part of the palm canopy (Elliott and Broschat 2018) or, in an intensely managed landscape where lower, dead leaves are frequently removed, the canopy of green leaves might be much reduced (**Fig. 19**). However, other diseases and disorders can produce similar symptoms (Hodel 2012, Broschat et al. 2014). In some cases, the proximal parts of infected trunks close to the ground exhibit dark brown staining, which is likely due to and indicates internal *Ganoderma zonatum* infection and decay **(Figs. 20–21**).

The presence of conks, though, typically confirms that these symptoms are due to Ganoderma butt rot of palms. However, sometimes conks do not appear in the presence of symptoms, even if the palm dies. In such cases, cross-sections of the proximal part of the trunk showing the darkened, decayed, central wood are confirmation of the disease (Elliott and Broschat 2018).

Host Range

Ganoderma zonatum mostly attacks palms although other woody monocots like bamboo appear to be susceptible also. All palm species are susceptible. It is not a primary pathogen of other plant families (Elliott and Broschat 2018). Until recently in the United States, *G. zonatum* was found in Florida (especially the southern half), Georgia, and South Carolina but now is reported here for California.

Other *Ganoderma* spp. are rarely found on palms and these typically are saprophytic, living on dead and decaying palm trunks killed by other agents. An exception is the African oil palm (*Elaeis guineensis*) in plantations in Africa and Asia, which, because of its economic importance, has been studied extensively, and several species of *Ganoderma* are considered pathogenic on oil palms, including *G. boninense*, a close relative of *G. zonatum* (Rakib et al. 2014, 2017; Rupaedah et. al 2024; Supramani et al. 2022; Utomo et al. 2005; Wong et al. 2012).

16. Yellowing and declining queen palm adjacent to the stump of the queen palm that died from *Ganoderma zonatum*, Laguna Hills, California. © 2025 D. R. Hodel.

17. Wilting queen palm with *Ganoderma zonatum*, Orlando, Florida. © 2008 D. R. Hodel.

18. Declining queen palms with suspected *Ganoderma zonatum*, Laguna Niguel, California. © 2010 D. R. Hodel.

19. Date palm with suspected *Ganoderma zonatum* in an intensely managed landscape showing much reduced canopy of green leaves, Santa Monica, California. © 2011 D. R. Hodel.

20. Dark staining on the basal part of this queen palm trunk might be a good early indicator of *Ganoderma zonatum*. © 2010 D. R. Hodel.

21. Base of trunk of declining queen palm adjacent to the stump of the queen palm that died from *Ganoderma zonatum* showing dark staining, a possible early indicator of Ganoderma butt rot, Laguna Hills, California. © 2025 P. Santos.

Disease Management

We adapt much of our discussion from Elliott and Broschat (2001, 2018), who provided an excellent guide to management of Ganoderma butt rot of palms. Unfortunately, environmental conditions or landscape management practices that favor disease development have mostly not been documented, which severely limits disease management options. Also, diagnosis of Ganoderma butt rot of palms is nearly impossible until a conk forms or internal discoloration is observed after felling of the trunk. However, Chakrabarti et al. (2023) showed that early molecular detection of *G. zonatum* from soil and sawdust was possible.

Ganoderma butt rot caused by *Ganoderma zonatum* occurs in natural settings, presumably throughout the range of *Sabal palmetto* and other wild palms in the southeastern United States and in intensely managed, highly maintained landscapes. Soil type, moisture levels, drainage, and

nutritional status do not appear to affect susceptibility to the disease. Wounds were once thought to predispose a palm to Ganoderma butt rot but that is not the case. All species are presumed to be susceptible. Why some palm specimens become infected, and others do not is unknown and perplexing, the etiology of this disease is still incompletely known.

Although prophylactic treatments or cures are unknown for Ganoderma butt rot of palms, a fair amount of research exploring the potential of several biological agents, including various species and strains of the fungus *Trichoderma* and the bacteria *Pseudomonas*, *Serratia*, and *Streptomyces*, to suppress or parasitize *Ganoderma* species that cause disease on oil palms in nursery settings is on-going (Rupaedah et al. 2024). Additional work of this nature on landscape palms might be beneficial. In the absence of a widely available and effective commercial product, though, prevention through exclusion and sanitation procedures is currently the best management option for Ganoderma butt rot of palms.

Because Ganoderma butt rot is restricted to the lower or proximal 1 to 2 m of palm trunk, chipping or griding this portion of the trunk and returning it to the landscape as mulch might not be advisable. Doing so can spread spores around the landscape site and might lead to new infections on other palms. Instead, securely wrap the infected, lower part of the trunk in 6 mil (ca. 0.15 mm) thick plastic sheeting and send it to a landfill. The remaining, uninfected upper or distal part of the trunk can be chipped or ground and returned to the landscape as mulch.

Because conks, which produce spores that spread Ganoderma butt rot of palms, typically appear on infected palm trunks, judiciously monitor palm trunks for conks, especially in the vicinity where palms have died for any reason. The disease can also infect palm stumps remaining after a palm has died and the trunk was cut and removed; thus, stumps should be monitored, also. If the site has a history of Ganoderma butt rot or if a palm died for an unexplained reason, monitor trunks and stumps monthly; otherwise, monitor every six months.

If conks of Ganoderma butt rot are found on palm trunks or stumps, remove them as quickly as possible, before they mature and release spores, potentially spreading the disease farther in the landscape (**Fig. 22**). However, conk removal does not stop the disease on the palm upon which it was detected, and that palm should still be removed. The conk is an aide to tree-risk assessors, helping them arrive at the appropriate mitigation step. Wrap the conk securely in 6 mil plastic and send it to a landfill; do not dispose of it in the green waste stream for recycling, composting, or mulching. If an infected palm is not removed immediately, a tree risk assessment, including sounding to determine extent of decay, following International Society of Arboriculture guidelines (Dunster et al. 2014), would be prudent.

The presence of conks of Ganoderma butt rot of palms indicates that significant trunk decay has already occurred. Thus, palms with conks should be removed for safety reasons, especially when

22. This Senegal date palm died from suspected *Ganoderma zonatum* but the stump was not removed, and conks or fruiting bodies still form that can release spores and spread the pathogen around the landscape, San Diego, California. © 2007 D. R. Hodel.

windy conditions are present or expected. During removal, after the trunk is properly processed, remove as much of the remaining stump and root system as possible so they do not serve as new infection sites and produce conks and spores. If removal is not possible, consider grinding the palm stump and adjacent roots to make the pieces as small as possible, which can help decrease conk formation. Because cutting and grinding of infected palm trunks and remaining stumps can spread spores, consider laying out 6 mil plastic over the ground around the work site and erecting plywood barriers to trap and collect debris that can then be securely wrapped and sent to a landfill.

Replanting with another palm, regardless of the species, at the same location where one died from Ganoderma butt rot is risky. The fungus might be able to survive in the soil for extended periods. Thus, it is best to consider an appropriate non-palm tree or shrub to replace a palm that died from Ganoderma butt rot (Elliott and Broschat 2018).

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Paul Santos is the plant pathologist and plant diagnostician at Plant Pulse Diagnostics in Anaheim, California. paul@plantpulsediagnostics.com

Donald R. Hodel is the Emeritus Landscape Horticulture Advisor for the University of California Cooperative Extension in Los Angeles County and specializes in the taxonomy, selection, and management of palms and trees. drhodel@ucanr.edu

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