



Corky Bark Disease of Rambutan

Bruce Combs¹, Mark Nickum¹, and Scot Nelson²

¹Department of Tropical Plant and Soil Sciences

²Department of Plant and Environmental Protection Sciences

Rambutan (*Nephelium lappaceum* L.) is a tropical tree in the family Sapindaceae that produces delicious fruits. It is native to Malaysia and Indonesia and is cultivated throughout Southeast Asia. It is also grown from sea level to 600 m (2,000 feet) in other tropical, humid regions with well-distributed rainfall. In its native range, rambutan flowers in response to water stress. A typical weather pattern that triggers flowering is a monsoon season followed by a dry season (Rossman et al. 2010). In some areas, including Hawai'i, rambutan may produce two crops per year. Hawai'i tends to have a short dry period during the winter and another in the spring, permitting one crop in late spring and another in early summer (Nagao 2009).

In 2008, 70 farms in Hawai'i produced 204 metric tons (450,000 pounds) of rambutan valued at US\$1,080,000. The relatively high return is due to the fact that exotic tropical specialty fruits (including rambutan, longan, and lychee) bring higher farm prices (NASS-USDA 2010).

Here we discuss the etiology and management of a fungal disease of rambutan known as "corky bark." The disease causes conspicuous and easily recognizable symptoms (Fig. 1), especially when rambutan is grown in such high-rainfall areas of Hawai'i as regions of the Hamākua coast on the island of Hawai'i. The disease also affects other host species such as lychee (*Litchi chinensis*) and pulasan (*Nephelium mutabile*).

Disease symptoms

Corky bark first appears as small to large irregular patches of raised bark on the main trunk and lateral branches of trees. As the disease develops on a tree, the pathogen

disperses from the older, previously infected stems to the younger stems, although initially the younger shoots or branches may display no symptoms as the infection incubates. As the disease spreads to twigs or young stems, the corky areas appear as roughly textured golden brown lumps that protrude from the bark (Fig. 2). As the stems and branches grow and as lesions age, the lumps enlarge and become more corky and rough in texture (Fig. 3). The bark cracks open, and stem and branch cankers form, turning black in color (Fig. 4). These symptoms may also appear on the stems of rootstocks. The cankers are slightly roughened and irregular to spherical in appearance. They are usually raised about 1 cm (0.4 inch) from the bark surface and have deep fissures in which sexual fruiting bodies (ascomata) of the pathogen develop



Corky bark disease on rambutan appears as small to large raised, irregular blackened cankers.



Fig. 2. The initial symptoms of corky bark on young twigs and stems are small, raised golden brown or beige patches of roughly textured intumescence.



Fig. 3. As the initial symptoms age on rambutan, the color of the corky tissue changes from golden brown or beige to black, and the texture becomes more rough.



Fig. 4. Cankers, which form on woody branches, are dark brown to black, slightly roughened, and irregularly spherical in appearance. Cankers are raised from the bark surface, with deep fissures.



Fig. 5. The corky, cankerous galls can protrude noticeably from stems.

(Rossman et al. 2010) (Fig. 5). In high-rainfall areas, the corky cankers absorb moisture, leading to a premature rotting of their tissues (Fig. 6). In severe cases, dieback of entire branches occurs, although it may take years for a tree to become so severely affected. Trees have not been reported killed by the disease, but severe infections (Fig. 7) reduce tree growth (Rossman et al. 2010).

In Hawai'i, corky bark is widely distributed on rambutan farms throughout the wet areas of the Hāmākua coast on the island of Hawai'i, from Hilo to Honoka'a and Waimea. On several farms, all of the rambutan trees show symptoms of the disease. Some farmers claim that the disease does not reduce yields or negatively affect the health of their trees; however, the effect of corky bark

disease on yield and plant health in Hawai'i has not been fully evaluated.

Pathogen

Dolabra nepheliae is a plant-pathogenic fungus that causes extensive bark cankers and deep fissures on stems and branches of rambutan (Rossman et al. 2010). As the sexual stage of the pathogen, *D. nepheliae* represents a new lineage within the *Eurotiomycetes* and is related to *Phaeoconiella chlamydospora*, the causal agent of Petri grapevine decline. The pathogen was first described in Malaysia, has been reported in Australia and Puerto Rico, and was first found in Hawai'i in Kīlauea, Kaua'i, in 1984. The fungus may have been in



Fig. 6. The highly corky areas of severely affected branches absorb and retain water, which can enhance the premature decay of infected branches and allow mosses and lichens to colonize the branches and become established.



Fig. 7. Infections may be present on virtually every branch of a diseased rambutan.



Fig. 8. Pulasan branch with symptoms of corky bark disease.



Fig. 9. Lychee with symptoms of corky bark.

Hawai'i for some time before that, though, most likely in residential gardens (Rossman et al. 2010). In 2001, *D. nepheliae* was observed as growth on twigs and branches of rambutan trees in a commercial orchard in the Papa'ikou area of the South Hilo district on the Big Island. In 2007, it was isolated from cankers on rambutan in a USDA greenhouse in Hilo (Rossman et al. 2010). The pathogen and disease also occur on pulasan (Fig. 8) and lychee (Fig. 9) outside of Hawai'i, and have also been detected on these species as well as on related *Nephelium* species in Hawai'i. The characteristic appearance of the disease on the stems and the symptom severity can differ noticeably among varieties of lychee.

Pathogen life cycle

Dolabra nepheliae belongs to the Ascomycota, the largest phylum in the Kingdom Fungi. The defining feature of the ascomycetes is a microscopic structure called the ascus, in which the fungus forms sexual spores called ascospores. However, the asexual stage of fungi in the Ascomycota is usually the form responsible for repeated infection cycles and epidemics. The asexual stage of *D. nepheliae*, the form most commonly found, was described as *Rhabdospora nepheliae* sp. nov (Zalasky et al. 1971). The asexual spores of this fungus, the conidia, form in flask-shaped structures called pycnidia, at the tips of specialized hyphae (Rossman et al. 2010). These spe-

cialized hyphae, or conidiophores, are branched filaments of the fungus that grow from the inner walls of pycnidia.

How this fungus survives and spreads has yet to be determined. In general, parasitic fungi can coexist with their perennial hosts for years as resting spores, reproductive structures, or hyphae. Some fungi, known as facultative parasites, can live as saprophytes in plant debris or in the soil and then are able to infect their host plants in favorable environments defined by optimum temperature and moisture levels (Schumann and D'Arcy 2010). The thickened, dark brown to black cell walls of the ascomata and pycnidia of *D. nepheliae* are adaptations that protect them from drought, UV radiation, and microbial enzymes.

Air movement and splashing or wind-driven rain commonly distribute fungal spores. They are also vectored by insects and spread by contact with humans, machinery, or tools. Asci that contain the sexual spores of *D. nepheliae* are capable of forcibly discharging these spores into the moving air surrounding them. It is also possible that ascospores discharged from plant debris in the soil could directly infect trees.

Disease management

No management practices have been published for this disease specifically, and no fungicides have been identified to control it. Efforts are reportedly underway to study the potential damage of the disease and mechanisms to control it. This includes the introduction of disease-resistant clones (Rossman et al. 2007).

In rambutan variety trials in Puerto Rico, the cultivar 'Gula Batu' was found to have some tolerance to stem cankers caused by *D. nepheliae*. This would offer farmers an alternative to treatment in areas where the fungus is a serious problem (Goenaga and Jenkins 2011), but to date it has not been grown or evaluated in Hawai'i. Currently it is unknown if corky bark disease has a significant negative impact on overall tree health or fruit yields. Therefore we do not advocate destroying symptomatic trees. Rather, some simple sanitation procedures may be able to suppress the disease.

Greater knowledge of the disease cycle on rambutan is essential for deciding on a species-specific management plan. The following are general methods used to manage fungal diseases:

- **Exclusion.** Protect trees that are free from the fungus. Do not introduce young trees or propagative material from areas or farms in which the fungus is present. Do not intercrop rambutan with lychee or pulasan.
- **Sanitation.** Removal of affected trees is not necessary. Complete eradication of trees, if it were possible, would probably require the cooperation of all growers in an area in order to eradicate the disease. However, pruning branches with severe symptoms to reduce the spread of spores to new infection sites can help to manage the disease. After pruning rambutan trees, practice sanitation by removing crop debris from the field. Removing infested debris may significantly reduce the pathogen population.
- **Avoidance.** Choose planting sites where corky bark is absent or not known to be severe. Avoid environmental conditions favoring fungal diseases, especially rainy locations where diseases tend to occur. Plant tree rows parallel to prevailing winds and choose a planting density (number of plants per acre) that will allow the orchard to dry more quickly after a rainfall. As trees mature, prune them to increase air circulation in the canopy. Control weeds to reduce relative humidity in the plant canopy.
- **Protection.** Disinfect pruning equipment between cuts in a solution of 10% bleach to decrease spread of the pathogen during pruning operations. Keep work in orchards to a minimum when diseased trees are wet. This will reduce the chance of spreading spores of the fungus within and among moist trees.

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