College of Tropical Agriculture and Human Resources
University of Hawai‘i at Mānoa

Plant Disease
August 2011
PD-74

Kweilingia Rust of Bamboo in Hawai‘i

Scot Nelson[1] and Matthew Goo[2]
[1]University of Hawai‘i at Mānoa, College of Tropical Agriculture and Human Resources, Department of Plant and Environmental Protection Sciences
[2]USDA-APHIS-PPQ Plant Inspection Station, Honolulu, Hawai‘i

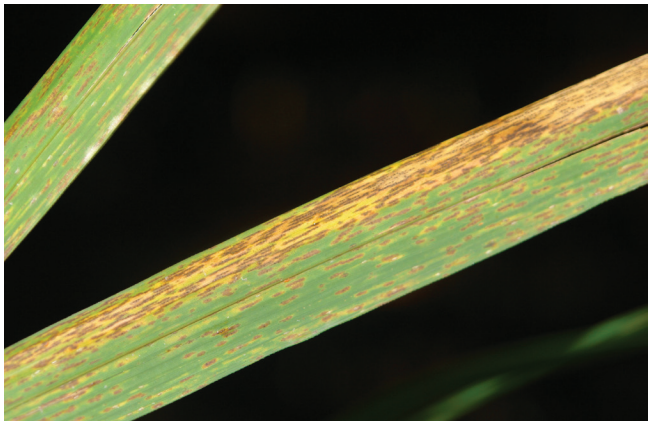
Bamboos have a wide range of societal and industrial uses as foods, building materials, crafts, and high-quality paper, as well as for landscaping and soil conservation. The Hawai‘i bamboo market includes local sales of potted bamboos, with some types priced at several hundred dollars per pot, and a burgeoning bamboo timber industry for furniture and housing construction. Bamboo plants normally require little maintenance and can live for decades without much care. In some cases, however, insect pests and plant diseases significantly diminish the growth and quality of bamboo.

A century-old stand of bamboo growing in a forest near Pahala, Hawai‘i (Photograph: Scot C. Nelson).

At least 29 rust fungi belonging to six genera (*Kweilingia, Puccinia, Uredo, Phakospora*, *Stereostratum*, and *Tunicopsora*) cause bamboo rust diseases globally. Before 2007, only two of these rust pathogens had been reported on bamboo in Hawai‘i: *Puccinia phyllostachydis* (leaf rust) and *Stereostratum corticiodes* (culm rust). In January 2007, however, a third bamboo rust caused by *Kweilingia divina* (synonym: *Dasturella divina*) was confirmed as a new disease in the state.

Kweilingia divina had not been previously reported in the United States, and the pathogen has spread to new geographical areas in recent years. After its discovery, survey results revealed the rust had already spread throughout O‘ahu, Hawai‘i, Kaua‘i, and Maui. The disease probably occurred on bamboo in Hawai‘i in 2006 or earlier, as bamboo infected with *K. divina* was discovered in Los Angeles, California, during an inspection in November 2006. This infested shipment was traced to a foliage plant producer in Hawai‘i (Blomquist et al. 2009). The exact origin of Kweilingia rust in the United States remains unclear, since the importation of bamboo plants is prohibited from all foreign countries due to the possibility of latent rust infections and other diseases. The arrival of this new bamboo rust disease illustrates the critical importance of declaring all foreign plant material on arrival into the United States.

Kweilingia divina infects many genera of bamboos in Hawai‘i. Globally, Kweilingia rust is relatively widespread within bamboo plantations and in natural stands. The rust can be an economically



Above and right: Bamboo rust lesions caused by *K. divina* on *B. vulgaris* at the bamboo court near the Department of Art and Art History, University of Hawai'i-Mānoa campus. (Photographs: Scot C. Nelson)

important disease on some species and in some locations depending on environmental conditions. Here we discuss the pathogen and symptoms of the disease, and suggest integrated management practices.

Causal organism

The bamboo rust pathogen is *Kweilingia divina* (Syd.) Buriticá (= *Dasturella divina* (Syd.) Mundk. & Khesw.). This organism was the type species for the fungal genus *Dasturella*, named in 1943 from infected leaf samples of bamboo (*Bambusa* sp.) (Mundkur and Kheswalla 1943). In 1998, *Dasturella divina* Mundk. & Khesw. was renamed *Kweilingia divina* (Syd.) Buriticá. *Kweilingia divina* is heteroecious, producing uredinia and telia on bamboo and pycnia and aecia on the alternate host, *Catunaregam spinosa* (Thunberg) Tirvengadum (Syn. *Randia dumetorum* (Retzius) Poiret; *R. spinosa* (Thunberg) Blume). Uredinia are yellowish-brown with hyaline or yellowish incurved, thick-walled paraphyses. Spores are ellipsoid, obovoid, or nearly globoid. Telia are black to brown, erumpent, pulvinate, crustose with mostly cuboid or oblong spores in chains of 3–6 (Cummins 1971).

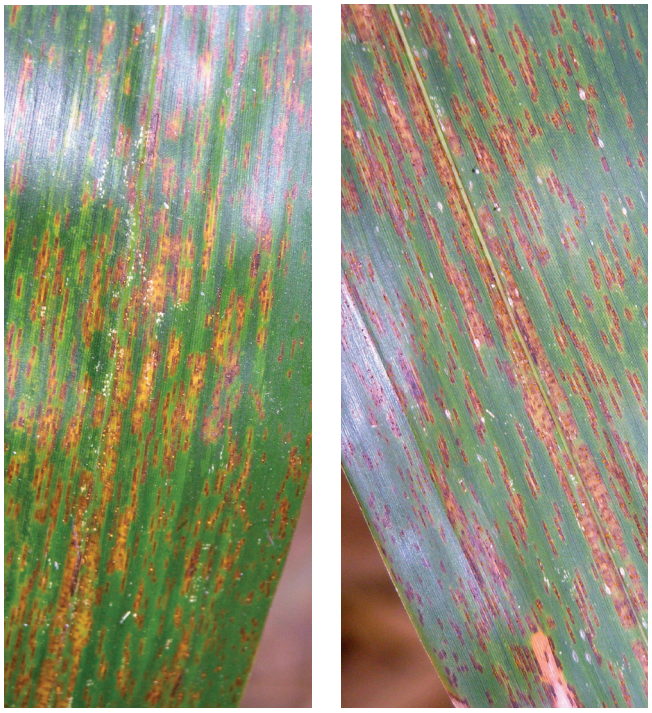
Disease symptoms and signs

Water-soaked, pinhead-sized flecks appear initially on the lower surface of bamboo leaves. Within these flecks, yellowish-orange to rust-brown, linearly aligned, spore-filled urediniosori develop. On the upper leaf surface, grayish-brown to dark brown rectilinear lesions with yellowish or yellowish-orange halos form along the parallel veins and in

correspondence with the opposing flecks on leaf undersides. Numerous rust lesions can develop on a single leaf and later coalesce into larger areas of tan-colored necrotic blight. Darkly pigmented teliosori develop in linear arrays within lesions on lower leaf surfaces, either in the degenerating urediniosori or separately. Severely infected leaves defoliate prematurely. Pycnia and aecia do not form on bamboo. Infections on the alternate host, *C. spinosa*, progress systemically to produce hypertophy and witches' brooms. Only the pycnial and aecial stages of *K. divina* appear on *C. spinosa*.

Host range of *Kweilingia divina*

Bamboo rust has been recovered in Hawai'i on *Bambusa vulgaris*, *Gigantochloa apus*, and *Bambusa* sp. Many other bamboo species are susceptible. Host species for *K. divina* are listed in Table 1 (Cummins 1971; Mohanan 1990, 1994a, b). Additional bamboo species not listed here may also be susceptible.



Bamboo rust lesions caused by *K. divina* on the upper leaf surface (left) and the lower surface (right) of *B. vulgaris* at the bamboo court near the Department of Art and Art History, University of Hawai'i-Mānoa campus (Photographs: Scot C. Nelson).

Table 1. Reported hosts of *Kweilingia divina*.

Bambusa	***Dendrocalamus***	***Ischurochloa***	***Ochlandra***	***Oxytenanthera***
B. balcooa Roxburgh	*D. brandisii* (Munro) Kurz	*I. stenostachya* (Hack.) Nakai	*O. scriptoria* (Dennst.) Fisch	*Oxytenanthera* sp.
B. bambos L.[1]	*D. hamiltonii* Nees et Arn. ex Munro		*O. travancorica* Benth.	
B. multiplex Raeusch	*D. latiflorus* Munro[2]			
B. oldhamii (Munro) Nakai[2]	*D. longispathus* (Kurz) Kurz			
B. polymorpha Munro	*D. strictus* Nees[1]			
B. tulda Roxb.				
B. shimadai Hayata		***Pseudoxytenanthera***	***Thyrsostachys***	***Catunaregam***
B. tuldoides Munro		*P. ritcheyi* (Munro) Naithani	*T. oliveri* Gamble	*C. spinosa** [3]
B. vulgaris Schrad			*T. siamensis* Gamble	*(syn: *Randia dumetorum* Lam.)

[1]*B. bambos* and *D. strictus* were very susceptible to the disease among nurseries in Kerala, India.
[2]*B. oldhamii* and *D. latiflorus* were severely affected by the disease in a bamboo plantation in Taiwan.
[3]*Catunaregam spinosa* is a non-bamboo alternate host.

Damage

Although Kweilingia leaf rust may be widespread in bamboo plantations and natural stands, control measures are not usually required, as the disease is generally of low economic importance. Nevertheless, severe outbreaks on economically important bamboo species can negatively affect stand productivity and shoot quality. For example, in plantations of green bamboo (*B. oldhamii*) and ma bamboo (*D. latiflorus*) in Taiwan, Kweilingia rust diminishes photosynthesis, reduces the growth and vigor of the infected plants, and decreases the productivity of bamboo stands (Mohanan 1997). These two bamboo species are economically important sources of bamboo shoots and pulp, respectively. Epidemics of Kweilingia rust in bamboo nurseries can pose significant production problems by defoliating young plants. In landscapes, infected leaves are unsightly and discolored, and they fall prematurely.

Management

Effective management of Kweilingia rust is difficult, as infected leaves continually produce an abundance of wind-dispersible spores. Destroy alternate host plants near bamboo production areas. Employ integrated pest control measures such as plant thinning, pruning, and fungicide sprays. Disease in nurseries can be minimized by avoiding sprinkler irrigation (use drip emitters) and by adequate plant nutrition, increased plant spacing, removal and disposal of dead plant leaves and other debris (sanitation), good aeration in production areas, and application of fungicides.

Fungicides

Compass® O 50 WDG (trifloxystrobin) is labeled for bamboo in Hawai'i to manage rusts, but *K. divina* (*D. divina*) does not appear on the label. However, the pest does not need to be listed on the label, as long as the crop, site, or object is. This fungicide has systemic activity; therefore, complete coverage of large bamboo plants during spraying is not necessary.

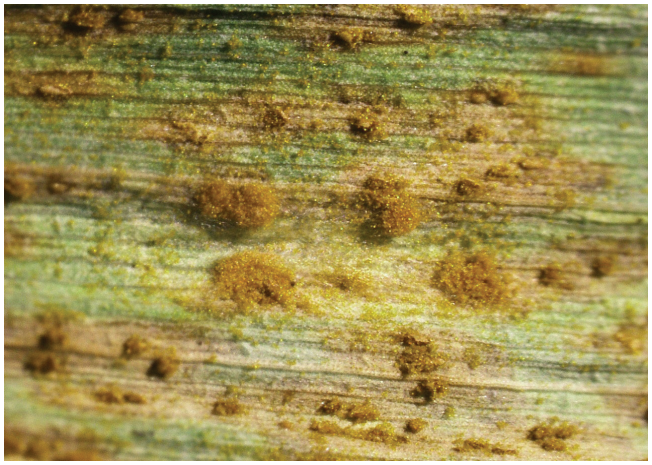
Acknowledgements

The authors thank Fred Brooks (UH-CTAHR) and Ken Ching (APHIS) for reviewing this manuscript.

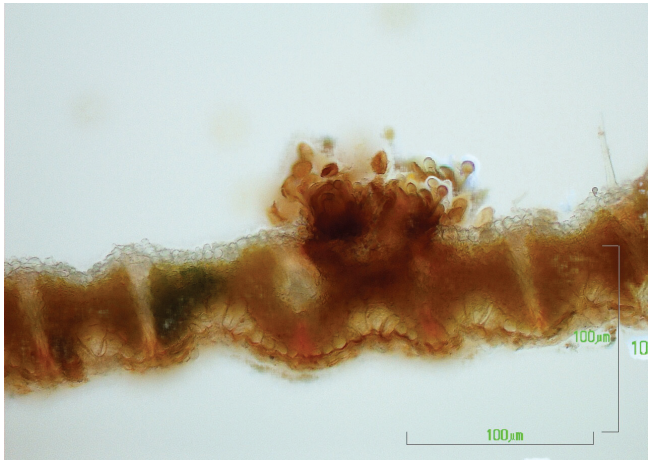
References

Blomquist, C.L., McKemy, J.M., Aime, M.C., Orsburn, R.W., and Kinnee, S.A. 2009. First report of bamboo rust caused by *Kweilingia divina* on *Bambusa domestica* in Los Angeles County, California. *Plant Disease* 93:201.

Cummins, G.B. 1971. The rust fungi of cereals, grasses and bamboos. Springer Verlag, New York. 570 pp.



Sporulating uredinia of *K. divina* on a leaf of bamboo (magnified). (Photograph: Matthew Goo)



Sporulating uredinium of *K. divina* on a bamboo leaf (cross section, magnified). (Photograph: Matthew Goo)

Dasturella leaf rust. http://www.inbar.int/publication/txt/tr10/dasturella.htm (accessed 16 March 2011)

Johnson, G.I. 1985. Rust (*Dasturella divina*) of *Bambusa* spp. in Australia. *Australasian Plant Pathology* 14:54–55.

Lee, M-J. 1995. The occurrence and distribution of *Dasturella divina* and its influence on leaf characteristics of green and ma bamboos. Paper presented at the XX IUFRO World Congress, Tampere, Finland, 7–12 August 1995.

Mohanan, C. 1990. Diseases of bamboo in Kerala. *In:* Ramanuja Rao, I.V.,Gnanaharan, R. and Sastry, C.B., eds. Bamboos: current research. Proceedings of the International Bamboo Workshop, Cochin, India, 14–18 November 1988. Kerala Forest Research Institute, Kerala, India. International Development Research Centre, Ottawa, Canada. pp. 173–183.

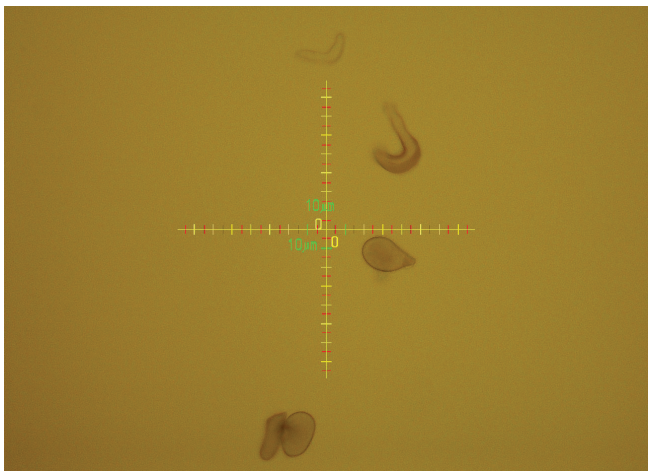
Mohanan, C. 1994a. Diseases of bamboos and rattans in Kerala. KFRI Research Report 98. Kerala Forest Research Institute, Kerala, India. 120 pp.

Mohanan, C. 1994b. Studies on diseases of bamboo and nursery management of Rhizoctonia Web Blight in Kerala. Ph.D. thesis. Cochin University of Science & Technology, Kerala, India. 316 pp.

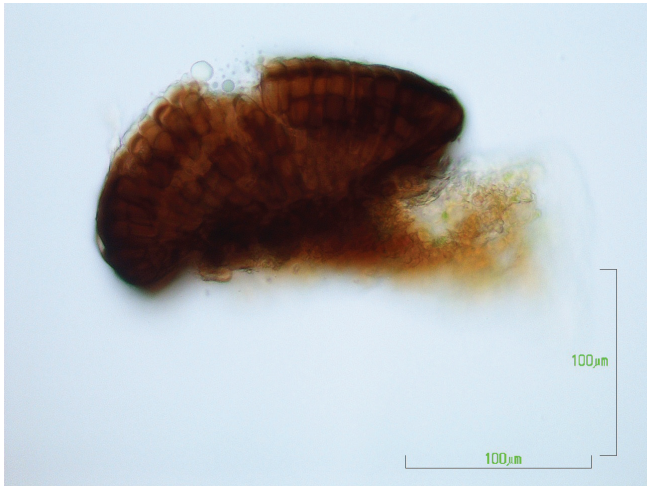
Mohanan, C. 1997. Diseases of bamboos in Asia. International Network for Bamboo and Rattan, New Delhi. 228 pp.

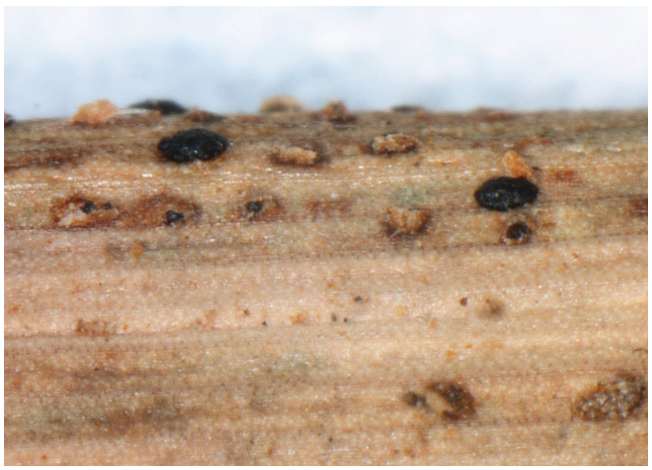
Mundkur, B.B. and Kheswalla, K.F. 1943. *Dasturella*: A New Genus of Uredinales. *Mycologia* 35:201–206.

Widely prevalent fungi of the United States. http://www.prevalentfungi.org/subject.cfm?id=56309



Urediniospore of *K. divina* (center) are yellowish-brown with hyaline or yellowish incurved, thick-walled paraphyses (upper right) (magnified). (Photograph: Matthew Goo)





Above: Telium of *K. divina* containing rows of maturing teliospores (magnified). Below: Black-colored telia of *K. divina* on a bamboo leaf surface (magnified). (Photographs: Matthew Goo and Eloise Killgore, Hawaii State Department of Agriculture).