Pathogens linked to the decline of *Casuarina equisetifolia* (ironwood) on the Western Pacific tropical island of Guam

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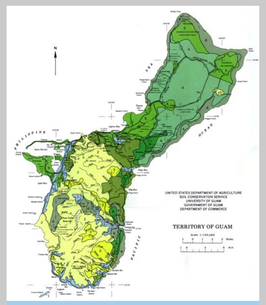
GUAM

With a landmass of 212 square miles, Guam is the largest island in the Western Pacific geographic region known as Micronesia. Guam has a tropical marine climate moderated by seasonal easterly trade winds. The mean high temperature is 86 °F (30 °C) and mean low is 76 °F (24 °C). It has an average annual rainfall of 96 inches (2,180 mm) of which 60% occurs during the wet season July through November. Published on February 2017.

HISTORY

Likely native to the island of Guam, ironwood is considered an integral member of the natural landscape. It is propagated for windbreaks, urban landscapes, erosion control and soil restoration projects. Farmers use its foliage as mulch.

HABITAT AND DISTRIBUTION



In Guam, ironwood grows in low pH volcanic and bottomland soils and high pH limestone and beach soils. Ironwood thickets are a component of Guam's forest surveys, where it is considered a secondary forest species. It grows nearly everywhere with the exception of undisturbed limestone forests.

IMPORTANCE

Casuarina equisetifolia is one of the most common trees occurring on frost-free beaches anywhere in the world and constitutes some 3% of all trees planted in tropical areas. Ironwood's ability to thrive under Guam's harsh conditions of salt spray, typhoon force winds, and drought has been largely responsible for it being one of the dominant trees in the Marianas.

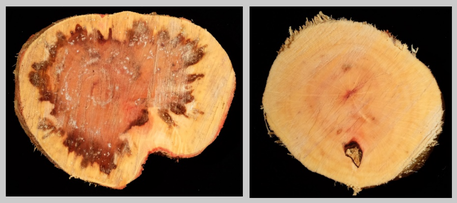
ONSET IRONWOOD TREE DECLINE (IWTD)

Though normally considered a healthy and a highly environmental tolerant tree, a reduction in the health of some tree stands was noticed in 2002. In 2008, the condition was designated as ironwood tree decline (IWTD).

SYMPTOMATOLOGY

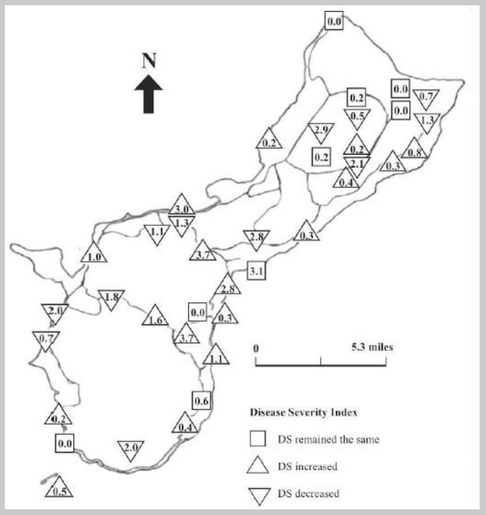
Left tree Right tree

Symptom progression of IWTD begins with mild thinning of foliage with little or no internal discoloration progressing (right tree) to severe die-back of branches and extensive internal discoloration (left tree).



Left tree Right tree

IWTD SURVEYS



Thirty-eight sites (1,427 trees) were surveyed for IWTD: survey 1 October 2008 to June 2009 and survey 2 July 2009 to December. A response variable was determined for each tree using a five-levels of decline severity ranking each tree was evaluated for IWTD: (DS), 0=healthy, 1=slight damage, 2=distinctly damaged, 3=heavily damaged, and 4=nearly dead. For each tree and site, explanatory variables of decline were measured including tree circumference, fire damage, typhoon damage, presence or absence of termites, presence or absence of "conks", and various geographical or cultural conditions. Modeling identified levels of landscape management practices and the presence of conks and termites as significant predictive factors.

IDENTIFICATION OF CONK

Subsequent research in 2012 determined the conks were primarily those of the pathogenic heart-rot fungus *Ganoderma australe* species complex.

SAMPLING FOR RALSTONIA SOLANACEARUM

Based on seedling inoculations studies in 2013 and tree survey results for *Ralstonia solanacearum* using Agdia Inc. specific ImmunoStrip® ISK 33900 in 2015 (left), it was concluded that the bacterial wilt pathogen *R. solanacearum* was also associated with IWTD. The ImmunoStrip® was successful in detecting *Rs* in 80 µl water extracts or ooze from infected trees (middle) and from 0.15 g samples of drill shaving (right).

IRONWOOD DECLINE CONTRIBUTORS

Biotic factors	Emerging factors	Relevance Low * to High ****
Branch dieback	*Pestalotiopsis*	*
Root rot	*Fusarium*	*
Wood rot	*Ganoderma australe*	***
Xylem residing bacteria	*Ralstonia solanacearum*	****
	Wetwood bacteria	**
Nematodes	*Helicotylenchus*	*
Insects	Termites	**
	Selitrichodes casuarinae	*
Abiotic factors	**Emerging factors**	**Relevance**
Weather	Typhoon damage	*
Management	Poor tree care practices	**

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SELECTED REFERENCES

Ayin, C.M., Schlub, R. L., Yasuhara-Bell, J., Alvarez, A.M. 2015 Identification and characterization of bacteria associated with decline of ironwood (*Casuarina equisetifolia*) in Guam. Australasian Plant Pathology (2015) 44:225-334.
Schlub, K. A. 2010. Investigating the Ironwood Tree (*Casuarina equisetifolia*) Decline on Guam Using Applied Multinomial Modeling. M. Åp. Stat. thesis, Louisiana State University.
Schlub, R. L., Mendia, R. C., Aiseam, C. C., Mendi, R. C. Davis, J. K. and Aime, M. C. 2012. Survey of wood decay fungi on *Casuarina equisetifolia* (ironwood) on the islands of Guam and Saipan. Phytopathology 102:P416.