Forest Pest Management
Asheville Field Office

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TREE INSECT AND DISEASE CONDITIONS - PUERTO RICO AND ST. CROIX, U.S. VIRGIN ISLANDS, 1983

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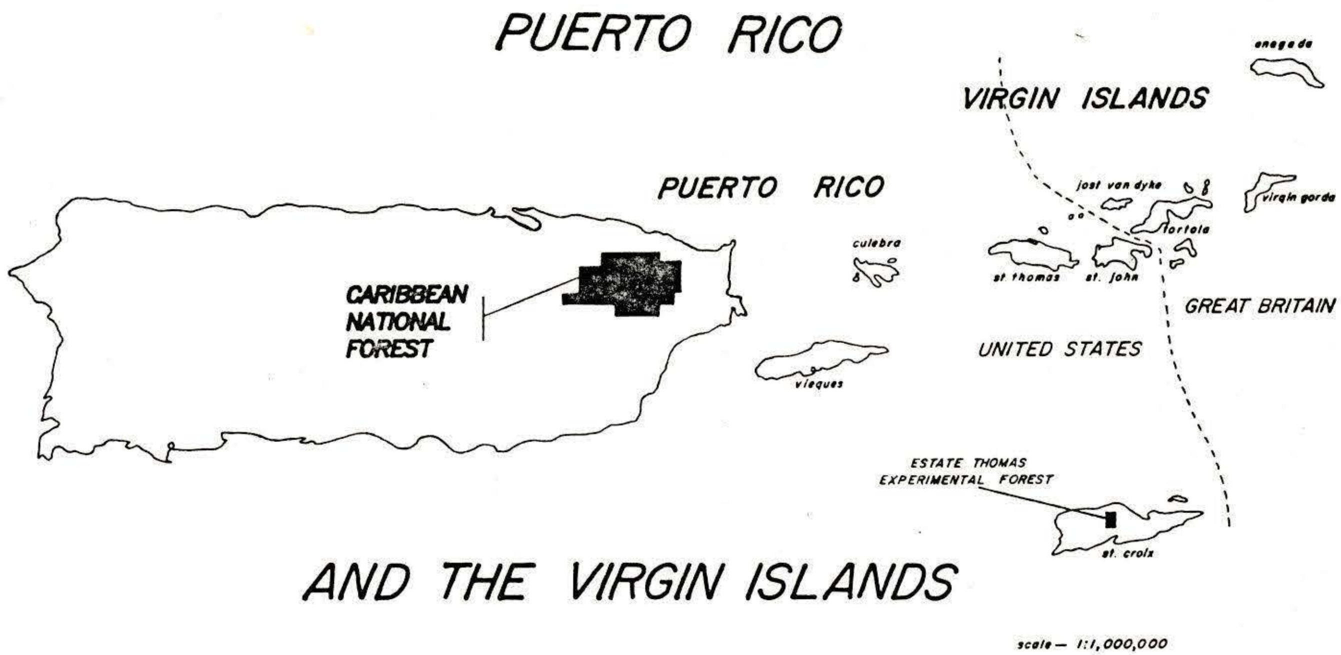
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ACKNOWLEDGEMENTS

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INTRODUCTION

The authors evaluated tree disease and insect pests of Puerto Rico and the Virgin Islands during September 19-28, 1983.

The purposes of this evaluation were:

1) To survey incidence of a canker disease described during an earlier evaluation (Oak and Barry, 1982).

2) To evaluate nursery pests and recent improvements in nursery cultural practices from a pest management perspective.

3) To evaluate shade tree pests as requested.

4) To evaluate incidence of forest product pests as requested.

These evaluations were carried out with the cooperation of:

The USDA Forest Service, Caribbean National Forest and the Institute of Tropical Forestry;

Forest Service, Puerto Rico Department of Natural Resources;

The U.S. Virgin Islands Extension Service, College of the Virgin Islands, St. Croix; and

The U.S. Virgin Islands Forestry Program, Virgin Islands Department of Agriculture, St. Croix.

This is the seventh disease and insect evaluation of the islands conducted during the past 11 years. Evaluations prior to 1972 are listed in the first Forest Pest Management Evaluation Report, No. 73-1-10, "Evaluation of Tree Diseases and Insect Pests in Puerto Rico and St. Croix, Virgin Islands, 1972" by W. R. Phelps and A. E. Landgraf. All evaluations conducted by Forest Pest Management since 1972 are listed in the Literature Cited section of this report.

This report is organized according to general management situations (nurseries, forest stands, non-forest trees and products). Each section contains descriptions of pest conditions occurring on various hosts, with illustrations. Management considerations are offered. Contact persons and a pest-host index for conditions observed during this evaluation are included in separate appendices. It is important to note that the role of some fungi associated with damaged plants are unknown. Without pathogenicity trials, causality cannot be assigned. This could not be accomplished with our limited time on the islands, and because of the lack of host material and constraints on experimentation with non-native pathogens on the mainland U.S. Nevertheless, consistent associations were observed. Until such trials can be accomplished by plant protection specialists on Puerto Rico and the Virgin Islands, these associations can help in evaluating the cause and determining the best methods for avoiding future losses.

NURSERIES

Most of the 1983 nursery crop grown in publicly-owned nurseries on Puerto Rico and St. Croix had been distributed before our visit, making evaluations of pest conditions of limited usefulness. Small numbers of trees of most species remained, but they probably represented undersized, pest-damaged, or otherwise low-quality stock. Because of these factors, the overall level of pest activity is unknown. However, diagnosis of the cause of any pest damage on these seedlings could be attempted. Methods of managing pests that are of known importance from earlier evaluations were discussed with nursery personnel, and recent improvements in nursery management were evaluated from a pest management perspective.

Two facilities operated by the Commonwealth of Puerto Rico and one each operated by the Virgin Islands government and the U.S. Forest Service (Caribbean National Forest) were visited. Pests found during the surveys are summarized in Table 1. Selected conditions are discussed in more detail.

Seed Pests

Two pests were found damaging mahogany seed. *Fusarium solani* was recovered from fruiting bodies on ungerminated mahogany seed coats (Fig. 1) and damped-off seedlings at two different nurseries. Isolations from whitish fruiting bodies on seed coats of ungerminated and damped-off seedlings, as well as dead seedling hypocotyls, yielded the fungus. Nursery managers indicated that losses are minimal and do not appreciably affect production.

Management of this condition is currently unnecessary. If losses increase, managers can consider changes in seed collection, extraction, and storage practices (to minimize contamination of entire seedlots); soil management methods (cover crops and crop rotation in bareroot nurseries; medium fumigation in containerized nurseries); seed separation (elimination of empty or fungus-damaged seed; or screening to detect seed pathogens).

A mahogany seed pod infested by a boring insect was collected by Jose Zambrana (USFS, Caribbean N.F.). Upon dissection, a single larva of the mahogany shoot borer, *Hypsipyla grandella* (Lepidoptera: Pyralidae), was found feeding on seeds and other tissues inside the pod (Fig. 2). While the entire pod may be killed after such attacks, this condition is not widespread, and seed supplies are not threatened.

Fertility-related Conditions

Many species in container nurseries showed symptoms of nutritional deficiency, soil pH irregularities, or other soil-related problems (Fig. 3). This was the most serious and widespread problem encountered in nurseries. In pines and hardwoods, foliage yellowing and undersized seedlings were common. Poor germination and post-emergence damping-off were more serious consequences in the pine crop (Figs. 4a and b). Some flats were devoid of seedlings. Pathogens were not recovered from affected seedlings, confirming diagnostic work by pest specialists at the University of Puerto Rico.

Table 1.--Summary of pest surveys of tree nurseries in Puerto Rico and the U.S. Virgin Islands, according to host species, September 1983. (P = condition present; a = condition absent; - = no host grown). See Appendix II for pest identification.

Host/Pest	Catalina	Monterrey	Cambalache	St. Croix
Mahogany - *Swietenia mahagoni*, *S. macrophylla*, hybrids				
vaquita	P	P	a	P
shoot borer	P	P	a	a
canker/ambrosia beetle complex	P	a	a	a
canker only	P	a	a	a
chlorosis	a	P	a	a
snails	a	P	P	P
damping-off	P	P	P	a
aphids	a	P	P	a
seed fungus	P	a	P	a
leaf miner	P	P	a	P
Pine - *Pinus caribaea* var. *hondurensis*	-		-	-
damping-off		P		
chlorosis		P		
Eucalyptus - *Eucalyptus robusta*, *E. deglupta*	-		-	-
leaf spot		P		
chlorosis		P		
Mahoe - *Hibiscus elatus*	-			-
leaf spot		P	P	
scarab beetle feeding		a	P	
transplant stress		P	P	
Citrus - *Citrus* spp.	-		-	-
sour orange scab		P		
unknown defoliator (lepidoptera)		P		
white fly		P		
vaquita		P		

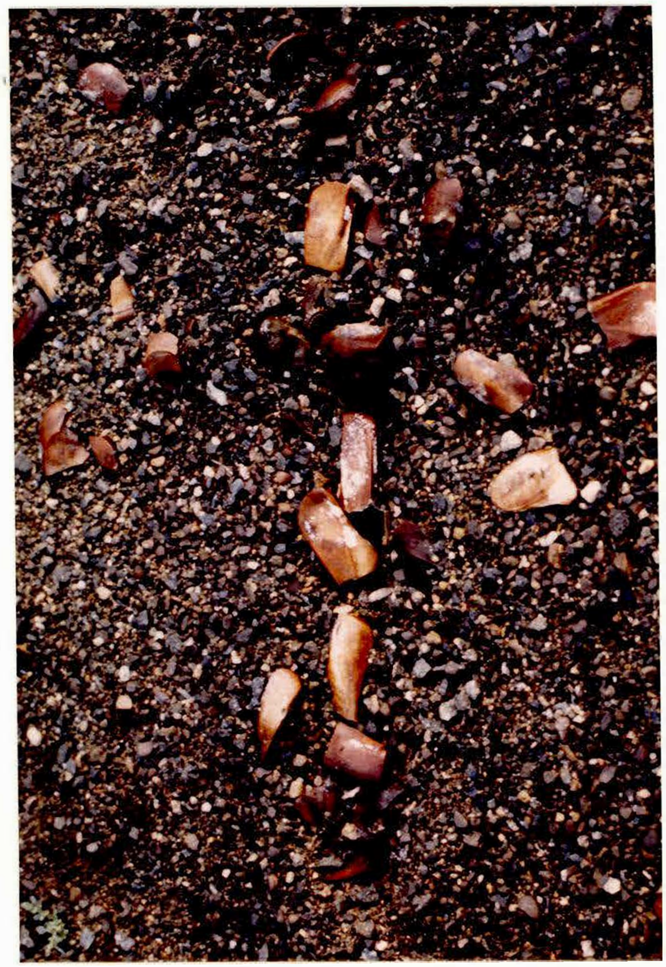

Figure 1.--*Fusarium solani* fruiting on the seed coat of ungerminated mahogany seed. This fungus was also associated with germinated but killed seedlings.

Figure 2.--Seed pod (top) with an entrance hole bored by the mahogany shoot borer. Inside, the seed and wings were being consumed by a single shoot borer larva (bottom)

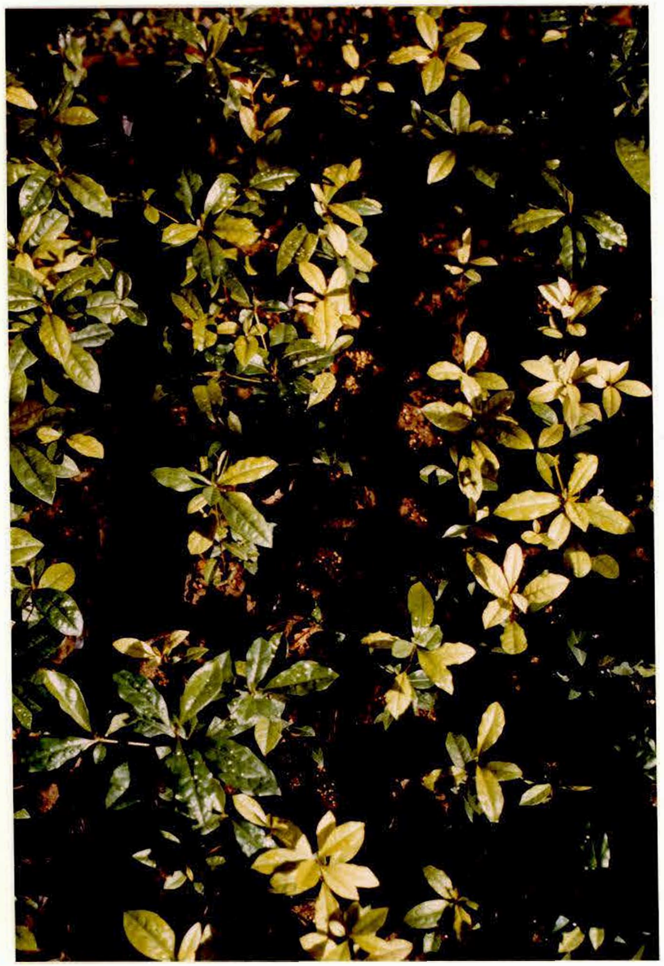

Figure 3.--Foliage chlorosis on hardwood seedlings, probably caused by high pH and/or nutrient deficiency in the soil.

Figures 4a and b.--Pathogens were absent from these pine seedlings with post-emergence damping-off. High pH and/or low soil fertility are the suspected causes.

Earlier evaluations have discussed seedling anomalies presumably caused by nutrient imbalances (Oak and Barry, 1982; Cordell and Barry, 1976). Field soil used in containerized nurseries should be assessed for soil-borne pests and treated (e.g., fumigated, steamed), thoroughly mixed, analyzed for fertility, and amended before use, if necessary. Losses in nurseries are compounded in the field when low-quality seedlings are outplanted. Mortality, slow early growth, and increased susceptibility to insect pests and diseases can result.

Major Mahogany Seedling Pests

Damage from shoot borers (Fig. 5), vaquita (Fig. 6), and an ambrosia beetle-canker complex (Fig. 7) was most prevalent at the Catalina Nursery (Caribbean National Forest). This is probably because the nursery site has been used for continuous bareroot mahogany production for several years, thus resulting in a buildup of insect populations and pathogen inoculum.

At the Monterrey Nursery, the vaquita caused the most serious damage, with mahogany and citrus also affected. Chemical controls were being used effectively there. As in 1982, stem cankers without associated ambrosia beetle attacks were found, but damage was infrequent.

Other Pests

The remaining pests are illustrated in figures 8 through 13. Most caused only minor damage or were restricted to a few locations. Defoliation and scarring of succulent terminal shoots were the result of heavy snail feeding at all container nurseries visited (Fig. 8). Though shoots are not frequently killed, multiple leaders often develop. Snails were being controlled with a molluscicide.

Nursery Improvements

Nursery management practices in container nurseries operated by Puerto Rico government agencies have undergone important changes since the 1982 evaluation. Additional shadehouses at the Cambalache Nursery have lessened dependence on natural shading by mahogany trees (Fig. 14). Raised bedding and an automatic overhead irrigation system have been installed at the Monterrey Nursery for growing pine seedlings (Fig. 15). Reusable styroblock containers are also in use.

All of these changes influence pest management. Seedling pests, such as mahogany shoot borers, that also attack overstory trees used for shading, are less likely to be problems when shadehouses are used. Harvesting these potential sources of pests further lessens the hazard. Uneven shading under these trees can result in uneven water demand, making effective irrigation difficult. Over- or under-supply of water results in low-vigor seedlings that are more susceptible to pest attack. Improvements at Cambalache should result in higher quality seedlings less likely to be damaged by pests.

Growing seedlings on raised beds with mesh tops (Figs. 4b and 15) helps eliminate inadequate drainage (Fig. 16), which often promotes root mortality from oxygen deficiency or root disease. However, containers will dry out more rapidly.

Figure 5.--Mahogany shoot borer caterpillar.

Figure 6.--Adult sugar cane root stock boring weevil (vaquita; Diaprepes abbreviatus) feeding on mahogany foliage. Larvae feed on roots.

Figure 7.--Shoot dieback of mahogany caused by canker-ambrosia beetle complex. The beetle (Xylosandrus compactus) enters the stem, allowing several canker fungi (Lasiodiplodia theobromae, Phomopsis sp., others) to infect and kill the top.

Figure 8.--In container nurseries, snails damage mahogany seedlings by stripping the foliage and scarring the succulent shoots. Multiple tops sometimes result.

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Figure 9.--Other pests - unidentified leaf miner (probably Diptera: Agromyzidae) of mahogany.

Figure 10.--Other pests - Skipper caterpillar (Lepidoptera: Hesperiidae) defoliating citrus.

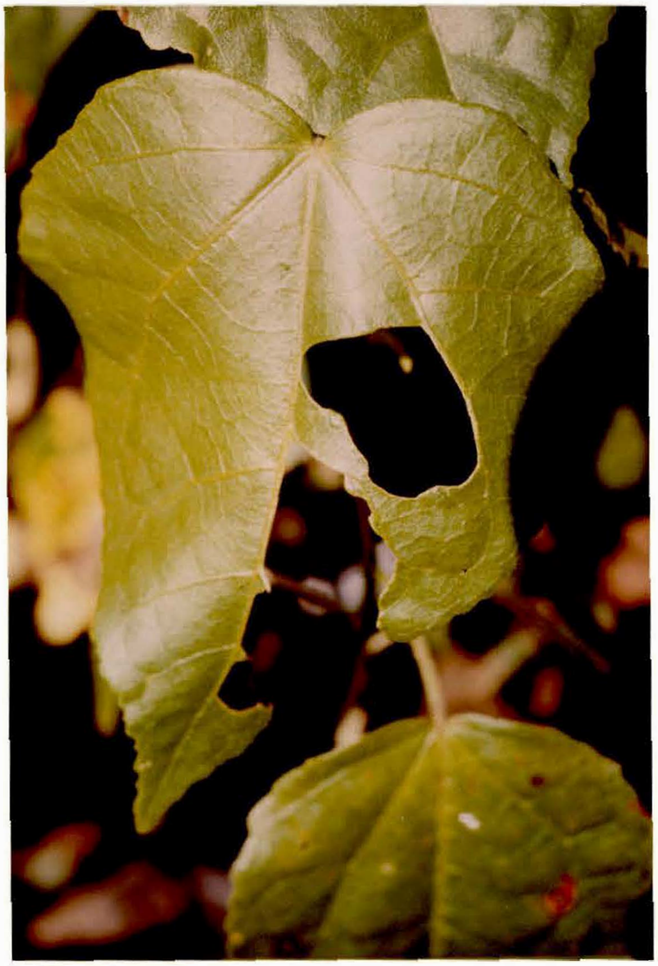

Figure 11.--Other pests - probable scarab beetle feeding injury on mahoe foliage (*Hibiscus elatus*).

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Figure 12.--Other pests - unidentified leaf spot on mahoe foliage.

Figure 13.--Other pests - whiteflies on citrus foliage.

Figure 14.--Mahogany overstory used for natural shading of container-grown hardwoods. Pests of the overstory may also damage seedlings of the same species. Utilization of additional shadehouses decreased this hazard.

Figure 15.--Newly-constructed raised beds with shade cloth and an overhead irrigation system.

Figure 16.--Poor aeration and root diseases can result when water periodically collects in seedling areas on the ground. Raised beds with mesh tops and controlled irrigation are partial solutions.

Automatic overhead irrigation provides efficient watering, if carefully monitored to ensure complete coverage without overlaps. Nozzles and pipelines must be checked regularly to ensure even coverage. However, more frequent misting with lower volumes promotes moisture retention by foliage, thereby encouraging some foliage diseases or stem cankers. This is partially offset by the increased air circulation in raised beds. Routine seedling inspection schedules should be maintained to detect and treat potential outbreaks.

Space utilization is more efficient, and cost of growing seedlings may be lower when reusable styroblock containers are used. However, pests can be harbored in media or seedling tissues remaining in the cavities after seedlings are planted. Styroblocks should be thoroughly cleaned before reuse. A 10 percent bleach-water solution provides some disinfection, but containers should be thoroughly rinsed with clean water to remove bleach residue. Fumigation more completely sterilizes containers, but qualified applicators are required. Fumigation is not required unless diseases with resistant structures (e.g., *Cylindrocladium* spp., *Phytophthora* spp.) become a problem.

Chemical Pest Control Alternatives

All nurseries we visited use hand labor extensively in nursery operations. Pest management is no exception. However, the intensity of hand labor to the exclusion of other methods depends on several factors. Among these are: 1) seedling demand; 2) production capacity; 3) the portion of total production capacity being utilized; 4) the number of different species grown; 5) the method of seedling culture (bareroot vs. containerized); 6) the kinds of pests encountered; and 7) the availability of qualified pesticide applicators, equipment, and supplies. For example, the Catalina Nursery (USFS) grows a relatively small number of bareroot mahogany seedlings for use on the Caribbean National Forest. The major pests are the mahogany shoot borer, the vaquita (sugar cane root stock boring weevil), and a stem canker disease associated with ambrosia beetle attacks. None have yet caused catastrophic losses, and usually a seedling surplus is produced. Severely damaged seedlings can be discarded and those less severely damaged pruned and planted. Further, chemical pest control measures in small nurseries are often inadequate or inappropriate where watershed, wildlife, or other values are paramount. Lack of qualified pesticide applicators was an important factor limiting chemical pest control options in the past, but this has been remedied.

In contrast, the Monterrey Nursery (Puerto Rico Department of Agriculture) grows many different species of forest tree seedlings and ornamentals in larger numbers. A wide diversity of pests is present. Since pest control is not as easily or economically accomplished by hand, chemical control is a more important part of integrated pest control activities.

Appropriate use of chemical pesticides has increased in recent years, resulting in more and higher quality seedlings. If seedling demands increase in the future, and current production facilities are pushed closer to their limits, current practices may require modification. Chemical control strategies for important pests like the mahogany shoot borer and the vaquita will be needed as part of an integrated pest management system, utilizing natural controls to the extent possible. It is prudent to consider developing these alternatives in advance of potential pest epidemics.

FOREST STANDS

Forest plantings of several species were evaluated. An extensive survey of teak cankers was conducted, and a separate detailed report is available (Oak and Hoffard, 1984). The results are briefly summarized here.

In addition, several pine plantations (one newly-established, one recently thinned, and two unthinned) were visited, and conditions are summarized together. A few plantations of other species (mahogany, mahoe, and *Araucaria*) are also grouped.

Teak

Twelve teak plantations ranging between 12 and 43 years old were surveyed in Puerto Rico and St. Croix, U.S. Virgin Islands. Cankers were present in all stands, with 10 to 48 percent of the stems affected. Average incidence was 24 percent. Cankers were annual, lacked consistent causal association with any obvious condition (e.g., dead branch stubs, stem wounds, insect attack) (Fig. 1), but were often colonized by termites. Termite galleries and attendant brown staining were the major internal defects. Recovery of causal agents was inconsistent, but *Fusarium solani* was isolated from a few of the active cankers sampled.

Data from the survey are summarized in Table 1. This condition has seriously impacted the teak resource. Further research is needed to more completely understand the cause and produce management techniques to minimize losses.

Pine

A 4-month-old planting of *Pinus caribaea* var. *hondurensis* at Finca Longo, Caguas, P.R. was experiencing below normal survival. Seedlings were chlorotic, and many had brown-spotted foliage (Fig. 2). An isolate of *Pestallozia* sp. was recovered from the spots, but it is not considered an aggressive pathogen. It probably infects needles of seedlings weakened by other causes. Local foresters indicated that low-quality seedlings were planted. Low-vigor seedlings probably resulted from nutrient imbalances, low pH, and compaction of the growing medium due to incorrect mixing at the nursery. Despite these symptoms on older foliage, surviving trees were beginning to grow normally, with new foliage being symptom-free. If mortality does not continue, the plantation should be adequately stocked.

Two 18-year-old plantations were visited in the Carite State Forest, P.R. One had been recently thinned. The thinned stand had numerous basal wounds from logging machinery (Fig. 3), and some trees had been felled but not removed. Nevertheless, insect attacks were absent, and ambrosia beetle entrance holes were only occasionally found in branches of the felled trees. Saprophytic fungi were fruiting on cut stumps, and there was no evidence of root disease.

Basal wounding was the only serious concern in this stand. Internal defects and decay result, lowering the value of damaged stems when they are harvested later in the rotation. Trees along skid trails should be included in the thinning but removed last, as they can aid in maneuvering logs. They can then be removed without damage to residuals.

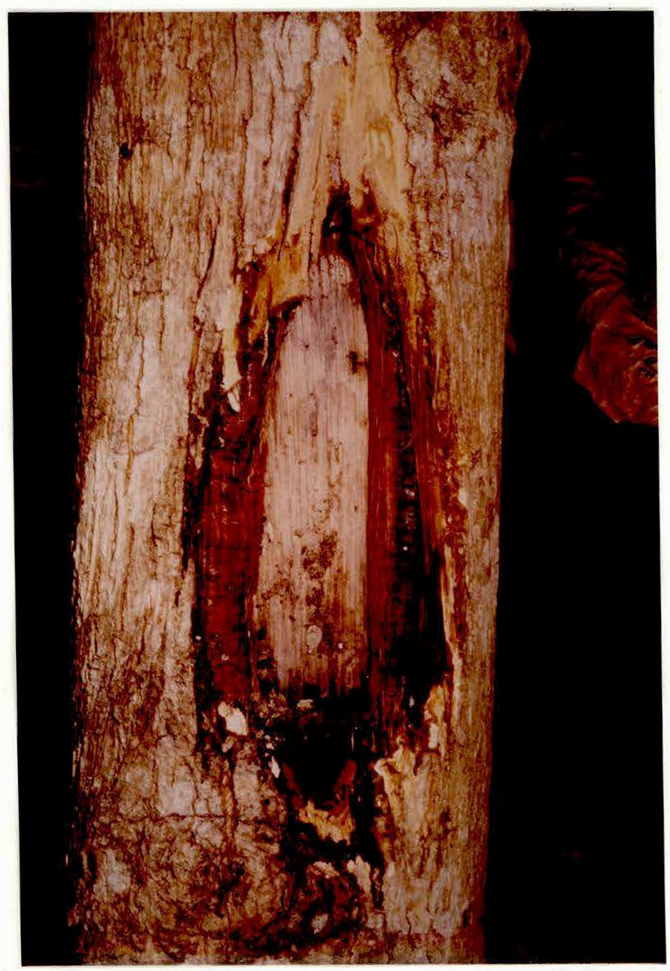


Figure 1.--Teak cankers.

Table 1.--Incidence and severity of cankers in 12 surveyed teak plantations, Puerto Rico and St. Croix, U.S. Virgin Islands, 1983.

Forest	Location	Age	DBH	Basal Area (feet)	Percent Incidence	Percent of Cankered Trees With Multiple Cankers	Average Height to Cankers (feet)
Rio Abajo	Nieves 1	43	14	95	40	40	8
Cambalache	Los Ortices	42	12	110	14	43	18
St. Croix	Est. Thomas 1	28	8	70	48	50	12
St. Croix	Est. Thomas 2	28	9	80	26	23	10
St. Croix	Est. William	26	7	105	20	40	10
St. Croix	Plessen	26	7	50	16	25	8
Rio Abajo	Santa Rosa 1	23	7	80	22	27	12
Rio Abajo	Nieves 2	20	9	100	10	60	8
Rio Abajo	Santa Rosa 2	16	8	80	32	44	10
Rio Abajo	Las Vegas	13	5	85	26	23	6
Cambalache	Burnt	12	6	90	16	13	6
Cambalache	Camping Area	unk	4	90	22	9	9
	Average	25	8	86	24	33	10

Figure 2.--Foliage chlorosis and spotting on a newly-planted pine seedling. Though a fungus was recovered from the spots, it is only weakly pathogenic, and the condition is probably due to improper nursery practice (high pH of growing medium).

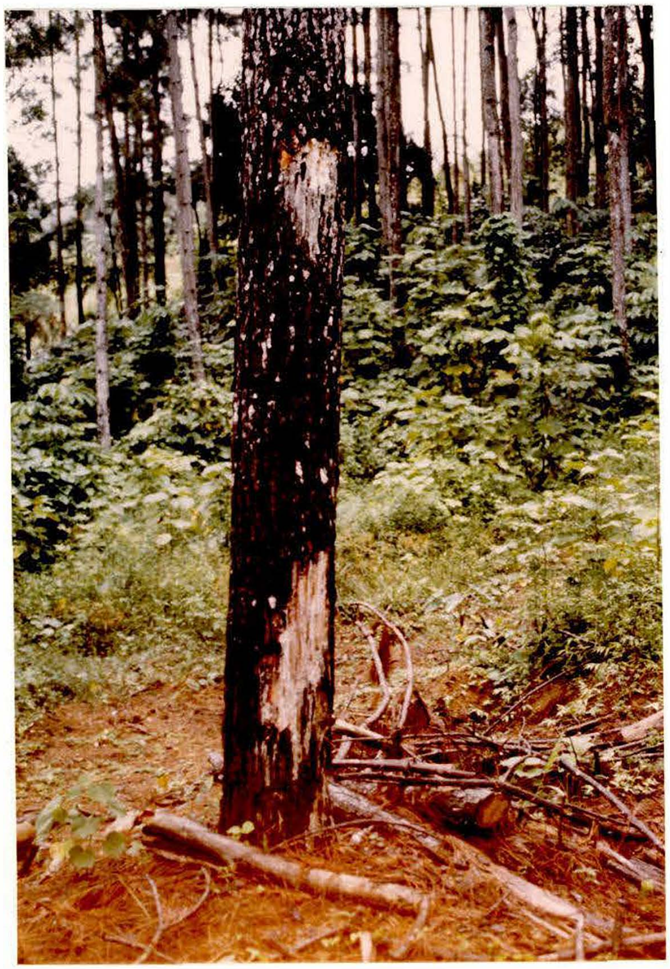


Figure 3.--Basal wounds on a pine tree following thinning. Such wounds are entry points for decay and stain, and for insect pests. Trees with this extent of damage should have been removed in the thinning.

A nearby unthinned plantation was in overall good health, but two widely separated, windthrown trees were found. Their root collar areas were decayed in a honeycombed pattern, except for localized areas of resin soaking. The decay pattern was unlike that caused by known root pathogens causing important losses in pine forests elsewhere (e.g., Fomes annosus), and the symptomatic wood did not yield an identifiable pathogen. The condition is not considered a threat to the planting, because surrounding trees displayed no symptoms of root disease. The mortality pattern suggests these trees were isolated victims, possibly occupying lower crown positions. This plantation could benefit from thinning. Subsequent growth should be monitored for indications of currently unseen root disease (reduced annual increment, foliage yellowing, foliage dwarfing, windthrow, basal resin soaking, or tree mortality).

Mahogany

Plantations on the Caribbean National Forest (CNF) and the vicinity of Caguas were visited. Both were established within the last year. The CNF planting was established in a swath cut in a secondary forest. Because mahogany shoot borers seem to prefer open-grown mahogany, this practice minimizes their effects. Shoot borer attacks were infrequent, and overall, the plantation condition was excellent. No dead seedlings were found.

The Caguas planting was done in an open pasture, without the benefit of overstory shading thought necessary to avoid damage from the shoot borer. Nevertheless, shoot borer attacks were absent. However, vaquita larvae root feeding killed a few stems (Fig. 4), and cattle damaged others (branch breakage; stem wounds by rubbing) (Fig. 5). Vaquita damage was also present and could have resulted from larval infestations established when trees were in the nursery. Damage may have occurred entirely in the nursery, or it could have continued in the field if insects were present in the containers. Seedlings planted on the CNF are grown bareroot at the Catalina Nursery, where vaquita-damaged trees are culled or root pruned. Since no soil infested with vaquita larvae is planted with the seedlings, damage to field plantings is unlikely. To eliminate this hazard when using container stock, control of vaquita larvae in the nursery through chemicals or other means is imperative.

Livestock should be excluded from plantings until seedlings are large enough to tolerate injury. Overstocking of trees or livestock on the same land could result in lowered value of both.

Other Species

One plantation each of Araucaria heterophylla (Carite State Forest, P.R.) and mahoe, Hibiscus elatus, (Rio Abajo State Forest, P.R.) were visited. A dieback of the lower branches of Araucaria was associated with a heavy scale insect infestation. An isolate of Pestallozia sp. was also cultured from dead tissue, but this fungus is considered only weakly pathogenic. Scales were most likely the cause of shoot dieback, but this condition was not sufficient to warrant treatment.

The mahoe planting was one of the oldest on Puerto Rico, having been established in 1945. About 1955, a heavy infestation of white peach scale was responsible for top-kill of some trees. Stem cankers have since been reported. We observed cankers on two trees but were unable to sample them due to their

Figure 4.--Root injury caused by vaquita weevil larvae in a newly-established mahogany planting.

Figure 5.--Cattle caused this stem wound on a young mahogany tree. Wood production and other uses of the land must be balanced to obtain maximum values.

position on the stem (over 30 feet aboveground) (Fig. 6). They were relatively narrow, having killed about a quarter or less of the circumference, but were quite long (10 feet or more). This condition is infrequently encountered and may have resulted from an earlier white peach scale infestation.

Another mahoe had a black exudate emanating from a stem wound of unknown origin. This exudate ran down the stem several feet, but formed a hard ball near its origin (Fig. 7). This resembled a similar exudate associated with teak cankers found in an earlier evaluation (Oak and Barry, 1982). This occurrence on two such diverse hosts suggests that it is the result of the same organism. Similar symptoms (slime flux) in hardwood trees in temperate climate zones are caused by several species of bacteria. Because it has been found in association with healed teak branch stubs, uncankered stem wounds on teak and mahoe, and a few teak cankers, it is probably not the cause of cankers on either species.

Figure 6.--An elongated canker of unknown origin on mahoe (*Hibiscus elatus*).

Figure 7.--A bacterial flux associated with a stem wound on a mahoe stem probably produced this hard ball. A similar condition was observed on teak in an earlier evaluation.

NON-FOREST TREE PESTS

Damaging tree pests have been frequently found in ornamental and recreational settings during past evaluations, and their importance to the tropical landscape has been discussed (Oak and Barry, 1982; Barry and Anderson, 1981; Cordell and Barry, 1976; Flavell and Phelps, 1973; Phelps and Landgraf, 1972). During this evaluation, most non-forest tree pests were observed along roadsides or at the St. George Botanical Garden, St. Croix. Additionally, we were asked to visit a private farm on St. Croix where damage was occurring on avocado and other fruit trees.

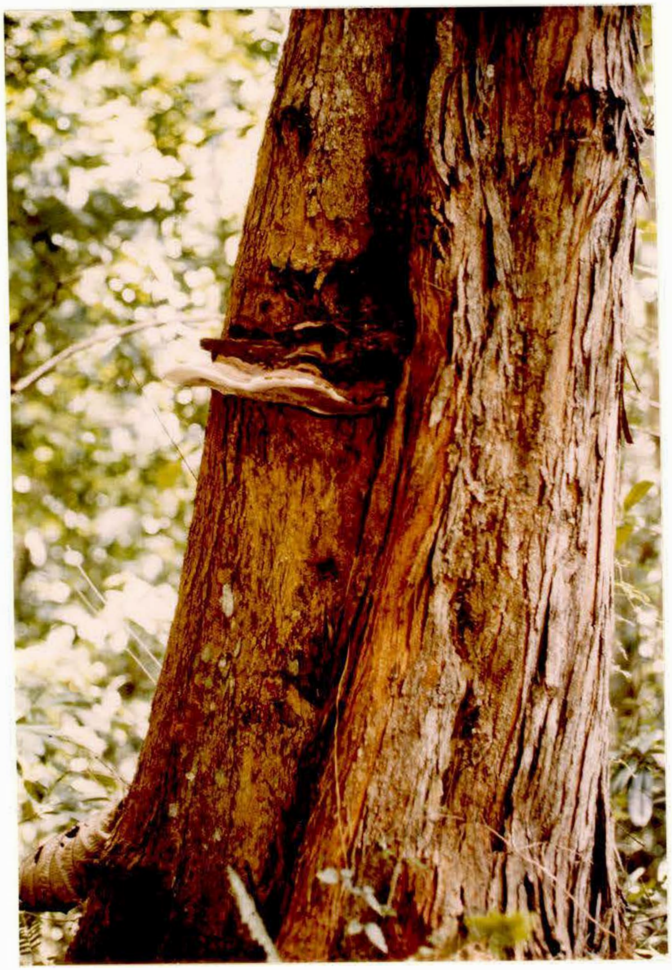
Roadside trees are subject to many stresses that predispose them to insect and disease pests. Among these are soil compaction, trunk and stem wounds, lack of or incorrect branch pruning, induced drought due to road surfaces which inhibit water percolation into the soil, and, in urban settings, air pollution. These stresses are exacerbated when tree species and site are incorrectly matched. When tree vigor is low, what should be an attractive asset to the landscape poses a threat to safety.

Evidence of decay was common on damaged roadside trees. Fungal fruiting bodies on damaged trees (Fig. 1) and poorly healed branch stubs (Fig. 2) indicate substantial internal defect. Correct pruning promotes rapid healing and minimizes chances of later decay. Dead trees may decay rapidly in the tropical environment and when found in high traffic areas, they should be promptly removed. Elsewhere, the decision to remove the tree is influenced by the degree of defect, the location of the tree (potential for severe injury or high economic damage in the event of tree failure), and the ability to provide therapeutic measures (e.g., corrective pruning, fertilization, and irrigation). While there is little hope for improving the health of severely damaged trees, therapeutic measures for trees with less damage can be beneficial in some situations.

Diseases are expected to cause mortality of at least two large ornamental trees at the St. George Botanical Garden on St. Croix, U.S. Virgin Islands. The garden is a popular tourist attraction, and trees are an important component of the landscape.

A canker was killing the bark and cambium of a large kapok (Ceiba pentandra) at the entrance to the Visitor's Center. The buttress roots showed a blackening of the normally greenish-grey bark, with fissures forming down to the wood where the bark had died (Fig. 3a). Beneath these blackened areas, the thick, corky bark was dead down to the wood. A jelly-like gum was also produced (Fig. 3b). The gum may have been produced by the host or the invading organism. The wood was stained in these dead areas. There was no evidence of insect activity or fungal fruiting. The fungus Lasiodiplodia theobromae was recovered very readily after culturing symptomatic bark and wood chips. This organism is a common pathogen, especially on trees under stress of various origins. No clues as to a possible predisposing stress was evident, however. Callus was not being formed, indicative of canker healing, and branch dieback in the upper crown was beginning (Fig. 3c).

Nearby was a multi-stemmed red manjack tree (Cordia nitida) showing top dieback (Fig. 4a). On closer examination, we discovered that top kill was a reflection of the death of one of the four stems. A fungus was found fruiting on the base of the tree (Fig. 4b), and the remaining stems were themselves



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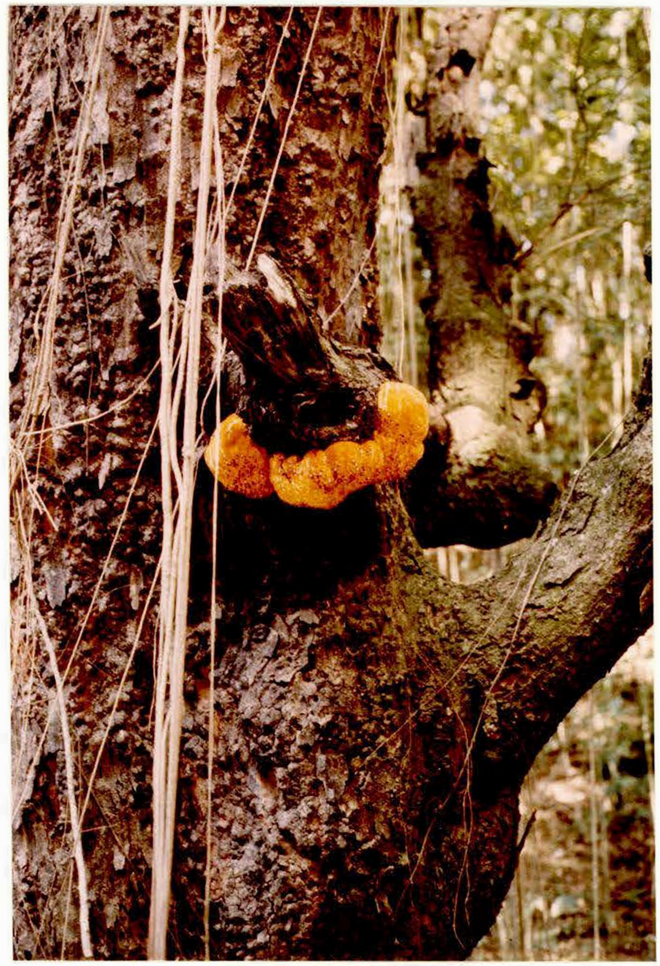

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Figure 1.--Fruiting of Ganoderma applanatum on a roadside Australian pine (Casuarina equistifolia). Butt and stem injury resulting from road construction or traffic probably provided an infection opportunity.

Figure 2.--Fruiting of an unknown fungus at the base of a poorly healed branch stub of a roadside tree on St. Croix. Internal decay has probably occurred.

3a

3b

3c

Figure 3.--Canker of kapok (Cieba pentandra); a. blackening and fissuring of affected area; b. surface of wood beneath a canker with a gelatinous exudate; c. crown dieback is a sign of incipient decline.

Figure 4.--Dieback in the crown of a multi-stemmed red manjack (<u>Cordia nitida</u>) (top). Closeup of the butt section showing fruiting of a <u>Corticium</u>-like fungus that probably caused the death of one stem (bottom). Other stems were also colonized.

heavily infected. The fruiting was crustlike, appressed to the bark, whitish when fresh, and turning grey with age. White mats of fungus material (mycelial mats) were found between the wood and dead cambium. The wood was discolored brown. A fungus was readily recovered from dead wood. Tan-colored spores formed in abundance on the upper surface of the fungus in culture, but they did not germinate, and the fungus died before it could be identified. Neither clamp connections nor basidia were seen in early microscopic examinations of the hyphae, but this fungus resembles a pathogenic basidiomycete of the genus Corticium. The survival of the red manjack is very unlikely, while the future of the cankered kapok is uncertain, at best. Plans for replacing these trees should be made. Planting before the trees die or are removed will ensure more rapid occupancy of the vacant space and lessen the impact of such removals. Suggestions for replacement species can be obtained from the Virgin Islands Forestry Program and others familiar with local species and their growth characteristics and pest sensitivities.

A few other trees showed signs of pest damage, but they were not likely to suffer mortality. A kapok tree was nearly defoliated. The petioles of completely consumed leaves, as well as a few partially consumed leaves, remained in the crown (Fig. 5). The damage was presumably caused by leaf feeding insects, but none were found. A single defoliation is not likely to result in significant damage, but repeated attacks will result in reduced vigor and enhanced susceptibility to other pests, such as the canker disease described earlier.

The conditions we observed accentuated a need for training in recognition of tree insects and diseases, procedures for their management, and the importance of frequent surveys for damage. By detecting and recognizing damage early, serious losses and expensive replacement can be avoided. Additional training in proper maintenance procedures, like fertilization, irrigation, and pruning (Fig. 6), is important in a comprehensive tree care program. Such training has been provided by the Virgin Islands Forestry Program and USDA Forest Service, Forest Pest Management personnel in conjunction with the USDI National Park Service. Future training opportunities are scheduled as requested.

Other tree pests were observed damaging various fruit trees and ornamentals on the farm of a private grower on St. Croix. Earlier, Cooperative Extension Service plant protection specialists from the College of the Virgin Islands diagnosed thrips injury on avocado (Persea americana) foliage and recommended a spray schedule to manage the damage (Fig. 7). The grower indicated avocado introductions from Puerto Rico seemed less severely damaged than those from Florida. This suggests the value of using local sources of plant material and local pest and horticultural expertise, when available, before turning to non-native sources. The Virgin Islands Cooperative Extension Service already provides much needed pest management assistance to those islands' agricultural concerns and has shown interest in developing more assistance programs for pests of trees.

Figure 5.--Defoliated crown of kapok (Ceiba pentandra), presumably caused by insects feeding on the leaves.

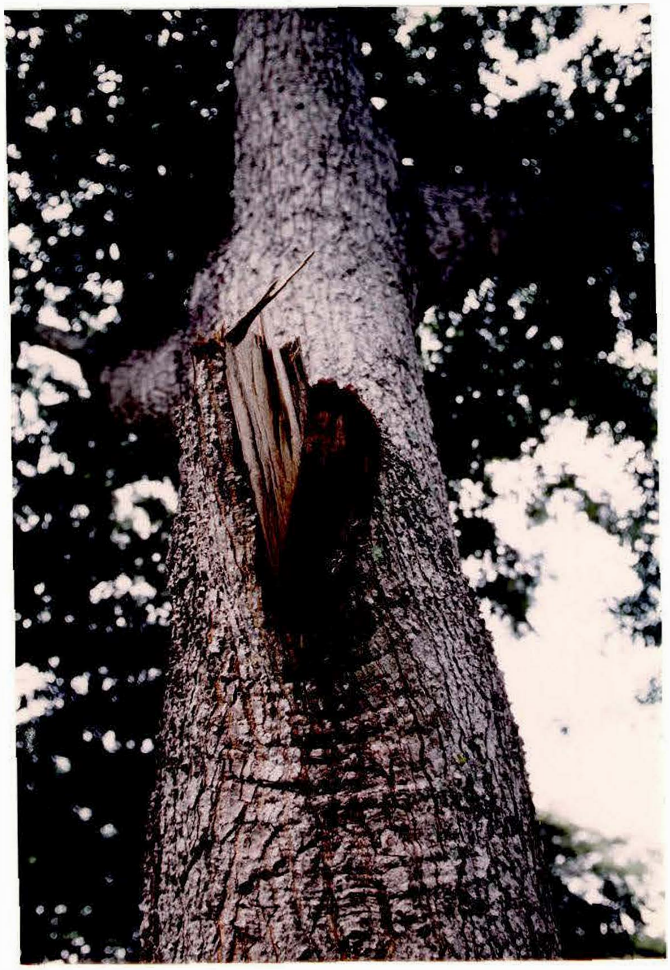

Figure 6.--Improperly pruned branch stubs should be pruned smoothly without damaging the callus collar where the branch joins the stem.

Figure 7.--Foliar damage caused by thrips on avocado (Persea americana).

FOREST PRODUCTS PESTS

Several pests of wood products were noted at the Rio Abajo sawmill. While widespread, few of the pests seemed of much economic significance.

Ambrosia beetles were common in boards of several hardwood tree species. In most cases, associated stain was confined to galleries (Fig. 1), but occasionally it spread from the tunnels to surrounding wood (Fig. 2). This latter damage resembles that caused by the Columbian timber beetle in the continental United States. These "steamboats" or "grease spots" have virtually no effect on structural integrity of wood, but they do discount the value of veneer by as much as 25 percent on the U.S. mainland. This type of damage was most prevalent in mahogany. Many species of ambrosia beetles attack trees on the stump, and susceptibility is not always vigor related. Consequently, control in forests is difficult.

Another type of damage was more common on hardwood logs. Larval galleries of metallic wood borers (family Buprestidae) were evident beneath bark of many logs (Fig. 3). Most tree-infesting metallic wood borers attack severely weakened or recently killed trees. When bark on fresh-cut logs is left intact, they can cause damage by tunneling into the wood. This can also occur on green lumber if wane is not removed. In these cases, they can be controlled by removing bark before storage, cutting all wane before boards are stacked, or subjecting logs to a constant water spray or underwater storage.

Some staining in teak lumber is attributable to the teak canker disease discussed earlier in this report. Dissection of cankered trees showed that staining is apparently aggravated by termite infestation of the cankered area. Typically, staining extends far beyond the externally visible limits of the canker face (Fig. 4), if termites are present. This disguises the extent of damage until logs are sawn. Since termites prefer relatively moist wood, the canker disease and associated high wood moisture content probably serves to intensify infestation severity. Despite significant losses in individual trees, impact of canker disease in teak is less significant than in other tree species. Nevertheless, if teak products become an important market, the canker disease and accompanying degrade may limit opportunities for exploiting it.

Tree wounds of all origins result in staining of wood. Wood products from affected trees may still be marketable at a lower price, but structural integrity is rarely affected. However, wounds also open the tree to invasion by wood decay organisms. When such infection occurs and is not effectively compartmentalized by the trees' inherent mechanisms (e.g., plugging of the vascular system above and below the wound, callusing, wood micro-structure), extensive cull results (Fig. 5). Management practices which minimize damage to the residual stand after thinning or other activities will lessen the chances of wounding and subsequent staining. Avoiding damage will also discourage insect borers, which are typically attracted to wounds of living trees as egg deposition sites.

Another form of stain noted at Rio Abajo was bluestain (Fig. 6). Often vectored by insects, bluestain does not affect wood quality in sawlogs, but may be less desirable to some consumers because of appearance.

Local foresters also reported molds and stain of wood chip products at Rio Abajo. Such defects make these products unmarketable, limiting the potential economic gain. Proper drying can help control these conditions.

Figure 1.--Staining confined to gallery of an ambrosia beetle (family Scolytidae).

Figure 2.--Staining in wood adjacent to ambrosia beetle (Scolytidae or Platypodidae) gallery (lower right of stained area).

Figure 3.--Frass in larval tunnels of metallic wood-borer beetles (Buprestidae).

Figure 4.--Dissected teak log showing extent of staining associated with canker. Staining extends far beyond canker face.

Figure 5.--Wound in buttlog of tree--an infection court for wood staining and decay fungi.

Figure 6.--Bluestain in roughcut lumber.

APPENDIX I

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APPENDIX II

1983 Puerto Rico and St. Croix, U.S.V.I. Summary of Conditions and Associated Pests

1. Mahogany (*Swietenia mahagoni*, *S. macrophylla*, and hybrids) post-emergence damping-off with seedcoat fungus.
   Fusarium solani, *Lasiodiplodia theobromae*.

2. *Pinus caribaea* var. *hondurensis* windthrow - decayed roots.
   Unknown; non-sporulating fungus.

3. Red manjack (*Cordia nitida*) tree mortality with resupinate fruiting.
   Unknown; possibly *Corticium* sp. or *Corticium-like* fungus.

4. Mahogany (*Swietenia mahagoni*, *S. macrophylla*, and hybrids) shoot dieback with and without *Xylosandrus compactus* ambrosia beetle (Coleoptera: Scolytidae) attack.
   Fusarium latericium, *Botryospharea* (*Dothiorella*) *dothidae*, *F. solani*.

5. Kapok (*Ceiba pentandra*) stem canker.
   Lasiodiplodia theobromae; bacterial growth was also lush.

6. Foliage spotting of *Pinus caribaea* var. *hondurensis* seedling.
   Pestallozia sp. (secondary to nutrient deficiency).

7. Twig dieback of *Araucaria* seedling.
   Unidentified scale infestation with *Pestallozia* sp. associated.

8. Teak (*Tectona grandis*) stem canker.

   Fusarium solani; 3 isolates identified as *F. solani* had variable macroconidia, varying from quite blunt, rounded ends to more distinctly pointed ends, somewhat resembling *F. oxysporum*. All isolates had abundant microconidia, varying from blunt and ovoid to more slender ones, resembling *F. oxysporum*. All isolates had sparse chlamydospores, very long and slender phialides, and were brown to tan colored. Medium beneath colonies was not colored. In spite of conidial variability, all isolates were named *F. solani*. They came from 3 separate cankers, 2 of which were developing on stump sprouts or basal sprouts. These had the best chance of yielding the pathogen, because the cankers were freshly developing. The third canker was older [developed several years ago], had termites, and was seemingly inactive. The more *oxysporum-like* isolates came from the two young, developing cankers.

   Single isolates of *Fusarium roseum* and *Lasiodiplodia theobromae* were also recovered but not considered causal.

9. Twig dieback of mahogany (*Swietenia mahagoni*, *S. macrophylla*, and hybrids) seedlings and seed pod damage.
   LEPIDOPTERA: Pyralidae; mahogany shoot borer, *Hypsipyla grandella*.

10. Root damage to mahogany (*Swietenia mahagoni*, *S. macrophylla*, and hybrids).
    COLEOPTERA: Curculionidae; vaquita weevil, *Diaprepres abbreviatus*.

11. Foliage damage to citrus (Citrus sp.) at Cambalache Nursery.
LEPIDOPTERA: Hesperiidae, genus and species unrecognized.

12. Foliar damage to citrus (Citrus sp.) at Cambalache and Monterrey Nurseries.
COLEOPTERA: Scarabadidae (Scarab beetles), genus and species unknown.

13. Damage to logs at Rio Abajo sawmill.
COLEOPTERA: Scolytidae, Platypodidae (ambrosia beetles); Buprestidae (metallic wood borers or flatheaded wood borers). Stain; cause unknown.

14. Termites feeding in association with teak (Tectona grandis) canker.
ISOPTERA: Kalotermitidae drywood termites; Kalotermes snyderi.

15. Fertility and/or pH-related conditions on conifer and hardwood nursery stock.

16. Leaf spots on mahoe (Hibiscus elatus) and eucalyptus (Eucalyptus deglupta) nursery stock.
Cause unknown.

17. Leaf miner on mahogany (Swietenia macrophylla) foliage (nursery stock).
Identity unknown; possibly DIPTERA: Agromyzidae.

18. Snail on mahogany (Swietenia mahagoni, S. macrophylla, and hybrids) foliage (nursery stock).
Identity unknown.

19. Whitefly on citrus (Citrus sp.) foliage (nursery stock).
HOMOPTERA: Aleyrodidae. Species unknown.

20. Avocado (Persea americana) foliage flecking caused by thrips.
THYSANOPTERA: family unknown.

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