EVALUATION OF TREE DISEASE AND INSECT PESTS IN PUERTO RICO AND THE U.S. VIRGIN ISLANDS, 1982

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Acknowledgement is made of the contribution of Amy Rossman and Lloyd Knutson, USDA Agricultural Research Service, Beltsville, Maryland, for their assistance in fungus culture and insect identification, respectively. Thanks also to Juan Munoz, Forest Supervisor, Caribbean National Forest, and J. A. Zambrana, USDA Forest Service, State and Private Forestry, Rio Piedras, Puerto Rico, for their excellent hospitality and invaluable assistance in the planning and execution of this evaluation. A list of other cooperators, without whom this evaluation could not have been done, appears in the appendix.

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INTRODUCTION

Evaluation of tree disease and insect pests of Puerto Rico (P.R.) and the U.S. Virgin Islands (U.S.V.I.) was conducted by the authors during the period of April 26 through May 5, 1982. Pest conditions in public and private tree nurseries, planted forest stands, and ornamental/urban environments in P.R. and St. Thomas, St. John, U.S.V.I., were assessed with emphasis on integrated pest management techniques to limit damage and subsequent losses. Personnel of federal, commonwealth, and private forest and resort installations accompanied and assisted the authors during their visits to various areas of interest. The objectives of this evaluation were to list tree pests observed on the Islands, make judgements as to their potential for damage, and provide nursery, forest, and urban tree managers with management guidelines.

Additionally, the authors were invited to present a seminar on tree disease and insect pests of P.R. and the U.S.V.I. to the faculty and students of the Crop Protection Department of the University of Puerto Rico, Mayaguez, P.R.

This is the sixth disease and insect evaluation of the Islands conducted during the past ten years. Evaluations conducted prior to 1972 are listed in the first Forest Pest Management Evaluation Report, entitled "Evaluation of Tree Diseases and Insect Pests in Puerto Rico and St. Croix, Virgin Islands, 1972" by W. R. Phelps and A. E. Landgraf (8). All evaluation and condition reports conducted by Forest Pest Management after 1972 are listed in the Literature Cited section of this report.

Insect and disease pests observed during this evaluation, along with management considerations, are described according to management areas and host species. It is important to point out that the roles of some of the fungi associated with damaged plants is unknown. Without pathogenicity trials, causality cannot be assigned. This could not be accomplished under the time constraints while on the Islands and the inavailability of host material upon return to the mainland. Nevertheless, consistant associations were observed. Until such trials can be accomplished by plant protection specialists on the Islands, consistant associations can help in determining the best methods for avoiding losses.

NURSERIES

Three public and two privately owned nurseries were evaluated for pest conditions. The Catalina Nursery is operated by Caribbean National Forest personnel in P.R., with the primary seedling crops being Swietenia macrophylla (Honduras mahogany) and a hybrid of S. macrophylla and S. mahagoni (West Indies mahogany). Seedlings are grown in raised beds for bareroot planting on the Caribbean National Forest. The Cambalache and Monterrey Nurseries, operated by the Commonwealth of P.R., Department of Natural Resources and Department of Agriculture, respectively, grow a wide variety of forest trees and ornamentals in plastic bag containers for planting on Commonwealth owned lands, private lands under reforestation incentive programs, and for sale to the public. The two private nurseries grow many containerized ornamentals for use on the islands of St. Thomas and St. John, U.S.V.I.

Pest conditions observed in nurseries are summarized in Tables 1 and 2 and are discussed individually below.

Canker-Ambrosia Beetle Complex

Boring holes caused by an ambrosia beetle, Xylosandrus compactus, appeared to provide good infection courts for a fungus or fungi, causing terminal dieback on mahogany (Fig. 1) at the Catalina Nursery and a nearby outplanting at Zarzal, Rio Grande, P.R. This is the first reported occurrence of X. compactus in P.R. (L. Knutson, USDA-ARS, Beltsville, Md.). Seedlings may develop forks as a result of attack. Associated fungi include Phomopsis spp., Lasiodiplodia theobromae, and Botryosphaeria dothidae; all of which are capable of inducing tree cankers, especially on stressed plants of many species (9). Ambrosia beetle attacks without associated cankers were not found. However, at the Monterrey Nursery, similar cankers without beetle attacks were observed. Overall incidence at Catalina was low (less than 5%), but pockets of 50 percent incidence were seen. Barry and Anderson (2) found similar beetle attacks in the mahogany-guaraguao understory of a 30 year old mahogany planting near Lake Guajataca, P.R., but the extent and appearance of cankers on mahogany seedlings is different. Some naturally regenerated seedlings from the Lake Guajataca area were transplanted near or on the Caribbean National Forest.

Management considerations - The possibility that this pest complex was introduced from transplanted wildlings from the Lake Guajataca area points out the need for care in the movement of plant materials on the Islands. Only pest-free stock should be moved after careful examination to avoid introducing pests to parts of the Islands where they are not yet present. For this reason, seedlings currently in nurseries should be closely examined and affected trees pruned well below the affected tissue and the prunings destroyed by burning. Chemical controls are unavailable and unnecessary if incidence remains low. It is not known if control of the insect would eliminate the disease. Maintaining seedling vigor can assist in minimizing damage caused by many tree pests.

Post Emergence Damping-off

The container nurseries evaluated had seedlings of various species exhibiting post emergence damping-off or transplant shock mortality. Damage was present in germination beds and in small container stock. Eucalyptus sp. at the Cambalache and Monterrey Nurseries were most severely affected, with large (greater than 25 seedlings) disease centers in germination beds and 5-10 percent of small container stock killed (Fig. 2). Caribbean pine germinants at Monterrey were also severely affected. Fusarium solani was associated with damping-off in the eucalypt germination beds. This fungus causes damping-off in many tree species. Additionally, Lasiodiplodia theobromae, a fungus capable of cankering stressed trees, was found in association with a dying hybrid mahogany. The role of L. theobromae in the tree's death is unknown, since it does not normally attack new germinated seedlings.

Management considerations - Soil used in germination beds is collected as needed from a nearby alluvial plain and reused for several tree crops. It is rototilled and treated with Diazinon between seedling crops. Repeated use of the same soil allows the buildup of pathogenic micro-organisms, which can cause the observed pest condition. Seedlings not killed can be infected at subsymptomatic or sublethal levels and may die later. Properly applied soil fumigants

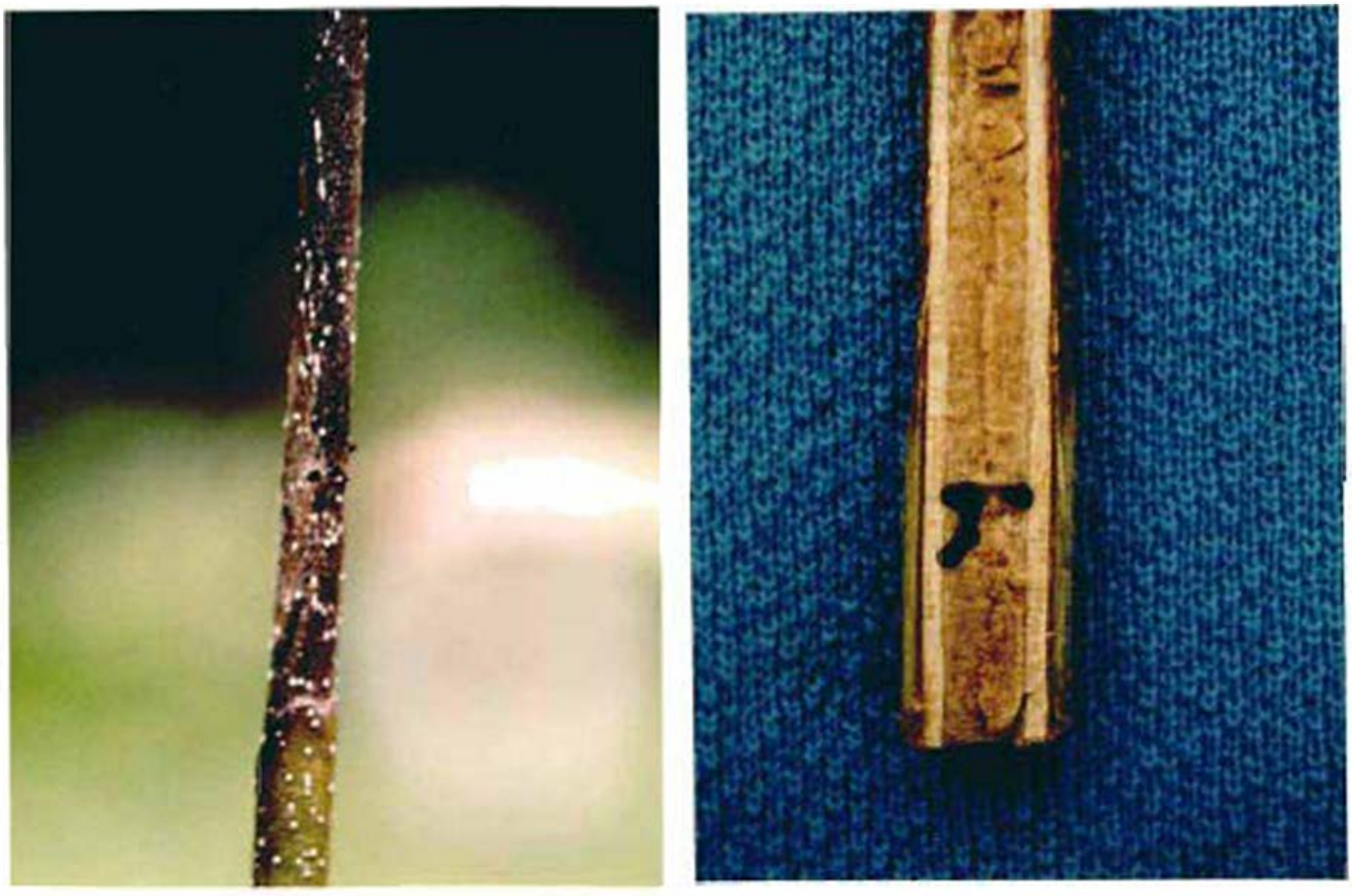


Figure 1 --Dead terminal shoot of mahogany attacked by an ambrosia beetle (Xylosandrus compactus) and colonized by several canker-causing fungi. At right is a close-up of a longitudinal section of a shoot showing pith-mining habit of the insect. Catalina Nursery, Caribbean National Forest.

Figure 2.--Damping-off losses in germination beds of Eucalyptus sp. Monterrey Nursery, Commonwealth of Puerto Rico.

(especially methyl bromide-chloropicrin formulations) provide highly effective, broad-spectrum control of soil-borne plant pests. However, a shortage of qualified applicators on hand and the hazardous nature of the gas may limit its use. The destruction of beneficial mycorrhizal fungi is a another drawback. Other management practices to be incorporated into an integrated control program to limit damping-off losses include:

1) Remove soil from germination beds after each crop, wash the bed thoroughly with 10 percent clorox, and rinse thoroughly with clean water. Multiple crops may be germinated in the beds before changing soil, if seedlings are closely monitored on a regular basis to detect damage.

2) When damage is detected, remove all diseased and dead seedlings, and a buffer of healthy appearing seedlings from the beds and destroy them by burning or burying. Culled trees should not be composted and used for organic soil ammendments or as mulch. Fungal spores and other resistant structures may not be killed by the composting process and may later infect susceptible crops

3) Do not replant containers where seedlings have died. If plant pathogens are responsible for mortality, inoculum present in soil may infect a transplanted healthy seedling, which may later die in the nursery, or worse, after distribution to the public. If environmental conditions (e.g., drought, mechanical damage) are the suspected cause, empty containers should be replanted only with the greatest caution and after removing all dead plant parts. Pathogens present in the soil may infect stressed or dying tissue. Therefore, soil from empty containers should not be re-used without fumigation.

Successful control of organisms causing damping-off reduces losses and helps to provide pest-free stock to the public.

Sour Orange Scab

Virtually all of the citrus stock (variety unknown) evaluated at the Monterrey Nursery was severely infected by the sour orange scab fungus (Elsinoe fawcetti). This fungus causes raised, corky lesions on the stem, leaves, and fruit of many varieties of citrus (Fig. 3). Variation in susceptibility among citrus families is great. Susceptible varieties include grapefruit (10), tangelo, common lemon, and sour orange (11). Intermediately susceptible varieties include tangerine and sweet lemon (11). Elsinoe fawcetti caused considerable economic loss when grapefruit was grown in P.R. as an export crop (10).

Young lesions first appear as watersoaked, translucent areas and develop into raised, corky protuberances. When found on leaves, the protuberance is usually on one side only. Succulent tissue is most easily colonized; when newly formed fruits are severely infected, they may not enlarge (11). Older, infected tissue is a source of inoculum for future infections.

Similar symptoms have been observed on sweet orange varieties on homeowner properties near San Juan, P.R. (J. A. Zambrana, personal communication). It is unknown if the cause is E. fawcetti or the sweet orange scab fungus, Elsinoe australis. Because of the greater commercial importance of sweet oranges, E. australis is considered a more troublesome problem in other citrus producing areas; e.g., Florida.

Figure 3.--Sour orange scab, caused by Elsinoe fawcetti, results in raised, corky lesions on leaves and, when severe, on stems and fruit of some citrus varieties. Monterrey Nursery, Commonwealth of Puerto Rico.

Management considerations - A preventive spray program can be initiated with copper sprays (e.g., Bordeaux mixture in early spring [6]), but this must be supported by a vigorous sanitation program (collecting and destroying affected plant parts on a timely basis). Additionally, disease-free root stock and scion materials should be used when grafting, and affected plants should not be shipped.

Plant pest regulatory personnel on the Islands should be contacted if the disease is found, so that timely sanitation and control can be initiated.

Leaf Spots and Foliage Blight

Leaf diseases were common in all nurseries and on a variety of trees, including mahogany, mahoe (Hibiscus elatus), and Eucalyptus sp. A warm, humid, tropical climate is conducive to the development of leaf diseases.

Colletotrichum orbiculare was commonly associated with leaf spots on mahogany species (Fig. 4), as well as herbaceous flowers and ornamentals. A Phoma sp. was recovered from damaged mahoe leaves, and a thread blight fungus (Corticium sp.) was found growing on leaves of plants in the shade at Monterrey. Damaged eucalyptus foliage had Phoma sp. and Chaetomella raphingena associated.

Management considerations - Leaf spots can cause damage by;

1) reducing or eliminating the photosynthetic area of the plant,

2) continuing to grow through the leaf tissue and petiole to the stem, causing a stem or branch canker, or

3) reducing tree vigor to the point where secondary pests can attack stressed root systems, stems, or leaves.

Since most foliage pathogens are favored by moist, cool conditions, control can be effected in some cases by moving affected nursery plants into the sun. Maintaining tree vigor through adequate irrigation and fertility can limit damage. Overhead irrigation systems keep foliage wet and may result in more disease. Trickle systems or watering from below will not result in foliage remaining wet for extended periods. Damaged leaves should be removed from the site, when practical, and destroyed to avoid inoculum proliferation on dead tissue. Fungicidal controls can be effective and should be considered as part of an integrated control strategy, but labels should be read thoroughly before use to ensure compliance.

Mahogany Shoot Borer

The mahogany shoot borer, Hypsipyla grandella, (Fig. 5) was present in all three public nurseries visited during this evaluation. At the Catalina Nursery, Caribbean National Forest, the shoot borer was affecting approximately 1 percent of the mahogany seedlings. This was the lightest incidence recorded during the last three evaluations. The application of topical sprays of an insecticide (2) has been particularly effective.

Figure 4.--Leaf spot on Honduras mahogany (Swietenia macrophylla) with fruiting of Colletotrichum orbiculare. Catalina Nursery, Caribbean National Forest.

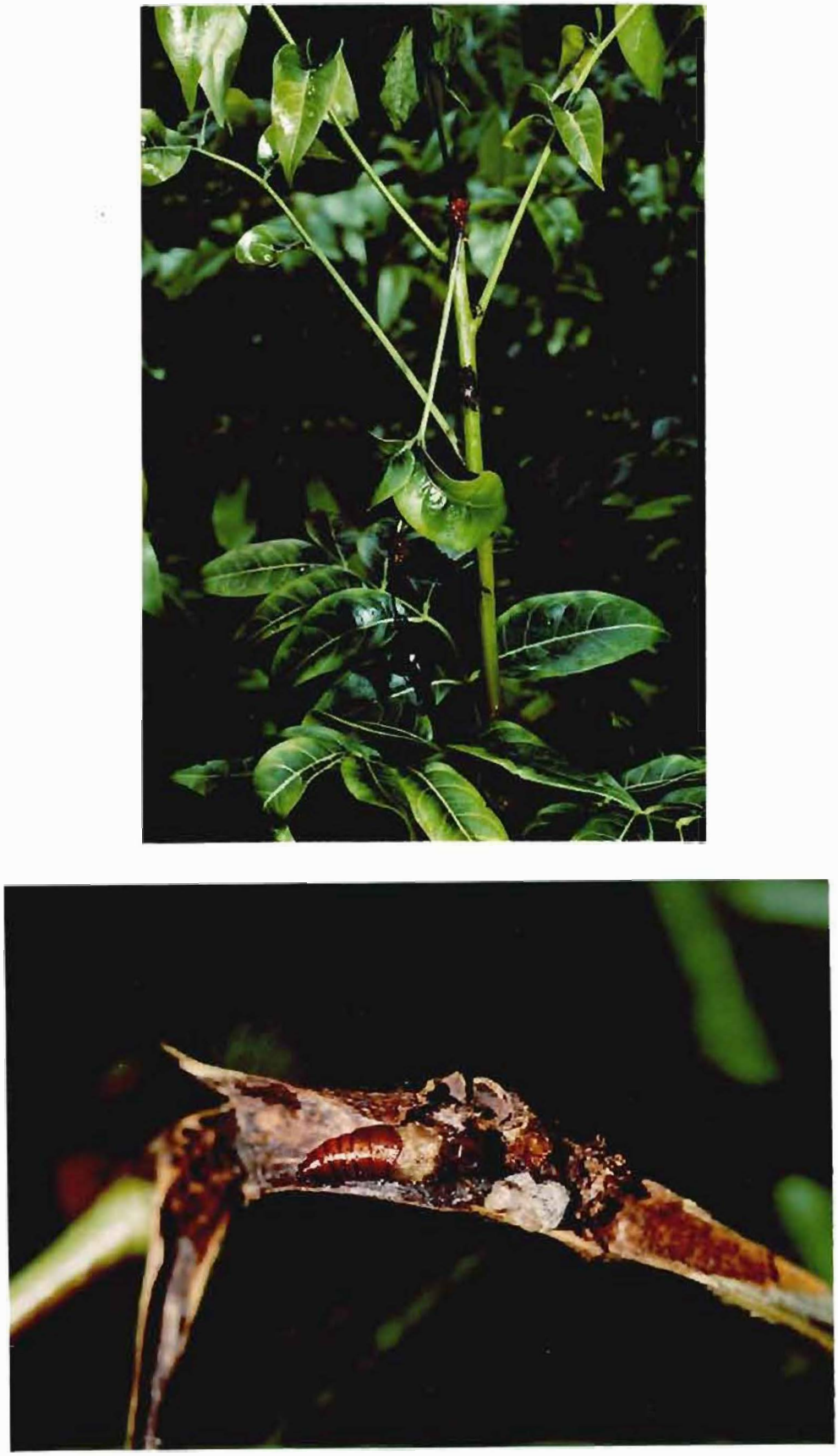


Figure 5.--Mahogany shoot borer damage (top) and pupa (bottom). Catalina Nursery, Caribbean National Forest.

The Cambalache Nursery also experienced light damage by the shoot borer. At the time of this evaluation, most of the seedlings were small and in nursery beds inside shadehouses. The nursery manager pointed out numerous shoot borer attacks occurring in the larger mahogany overstory trees used as shade for potted seedlings kept outside. In this case, some chemical control may be necessary in the potted seedlings due to the high population of shoot borers in the area.

The Monterrey Nursery also had a very light infestation of shoot borers in potted seedlings, but no control is warranted.

Management considerations - Chemical control is possible in nurseries; however, only a few insecticides are currently registered for use against this pest. A better management consideration would be the use of a tree species other than the nursery crops for shade, border, or windbreak plantings. Shade can be obtained from mesh netting stretched from a rack over the seedlings. When using netting, the amount of shade can be controlled, and it eliminates the possibility of host trees attracting pests to the area.

Sugar Cane Root Stalk Borer Weevil (Vaquita)

The sugar cane root stalk borer (Diaprepres abbreviatus) was again present in all three forest nurseries visited on the island of P.R. A detailed description of the insect, its habits, and damage can be found in Beavers and Woodruff, 1971 (3).

The larvae and adults were feeding on roots and foliage at the Cambalache and Monterrey Nurseries (Fig. 6), but only larval root feeding was seen at the Catalina Nursery. Absence of adult foliage damage from feeding in the Catalina Nursery may have been due to successful control via topical insecticide applications.

Management considerations - Various insecticides are registered in P.R. for the control of this insect on other crops. Two of these insecticides appeared to provide some control at the Catalina Nursery. Further evaluations of some of the registered chemicals are being planned by Forest Pest Management, Forest Service Research, and the National Forest.

Leafhoppers

Leafhoppers were found on maria-santa maria (Calophyllum brasiliense) and almond (Terminalia catappa) in the Cambalache Nursery. Potted stock of these trees were produced at the Monterrey Nursery, but leafhopper damage was not found. In 1981, leafhopper damage was present on mahogany at the Catalina Nursery (2), but was not found during this evaluation.

Damage by leafhoppers is usually not a serious problem, unless the population of the pest is allowed to build up to high levels. The insect has piercing and sucking mouth parts and causes chlorosis, leaf flecking (Fig. 7), and curling of the leaves. In some cases, when feeding occurs on very young, small leaves, a shot hole appearance occurs as the leaves grow larger. If the damage is heavy, the trees are weakened and subjected to stress from other factors, such as climate, diseases, or other insects. Even though this damage is usually not fatal to the plant, it does make the seedlings unsightly and perhaps more difficult to market.

Figure 6.--Vaquita (sugar cane root stalk boring weevil = Diaprepres abbreviatus) larva (top) feeding on roots and adult (bottom) feeding on foliage of mahogany. Monterrey Nursery, Commonwealth of Puerto Rico.

Figure 7 --Leafhopper damage on foliage of mahogany. 1981.

Management considerations - The best control for this particular pest is a topical application of a registered insecticide. The material should be applied to both the upper and lower surface of the leaves. Timing of the application is important. The plants should be checked at least weekly for the pest. To check for leafhoppers, shake the foliage of the plant and look for small, light-colored, flying insects. If they are present, a spray should be applied before the population can build up to damaging levels.

Aphids and Scale Insects

Aphids and scale insects were found on aceitillo (Zanthoxylum flavum) and morolon (Coccoloba pubescens) in the Cambalache Nursery. These insects also have piercing and sucking mouth parts and cause damage similar to that caused by leafhoppers. The damage is usually chlorosis, leaf flecking, curling (Fig. 8a), and stunting of the leaves. Stem feeding (Fig. 8b) on thin-barked species may lower tree vigor, resulting in susceptibility to attack from other insects and diseases Terminal feeding can cause tip mortality when the insect populations are high.

The presence of aphids and scale insects can be determined by visual observation. Look for the insects on the underside of curled or off-color leaves. The presence of sooty mold (a thin, black coating on the lower leaves of a plant) is also a good indicator of either an aphid or scale insect infestation. Another good indicator is the presence of ants moving up and down on plants. Ants feed on the honeydew produced by aphids and are usually present when aphids are present.

Management considerations - Control for heavy populations of either aphids or scale insects can be obtained from the application of a registered insecticide. The material should be applied to the upper and lower sides of foliage. Timing of the application is important. Only spray when populations become a threat to the health of the plants. Premature insecticide applications can control any parasites or predators that may be holding the aphid or scale population to endemic levels. Maintenance of good tree vigor by timely irrigation and fertilization can help to minimize damage from aphids and scale insects.

Other Conditions

Very low density and poor quality stock was observed in mahogany and mahoe container beds at Monterrey. The problem was traced by nursery personnel to improper seed storage procedures. Seed is sold to private nurseries, which requires repeated entry into cold storage, and this results in fluctuating temperatures that are damaging to seed quality and viability. New procedures and added equipment are under consideration.

Areas of off-color and undersized trees were seen in pine stock at the Monterrey Nursery. No pests were consistently associated, and sub-optimal soil fertility or inappropriate pH is suspected. Field collected soil, used as growing medium, should be analyzed before use and ammended with appropriate nutrients to provide optimum growing conditions.

a.

b.

Figure 8a.--Aphids feeding on aceitillo (Zanthoxylum flavum) foliage. Cambalache Nursery, Commonwealth of Puerto Rico.

8b.--Scale insect infestation on stem of unidentified hardwood nursery stock.

Chlorotic and unthrifty seedlings of several species (esp. mahoe) were seen at the Cambalache Nursery. No pests were associated, and the suspected cause was drought and/or soil fertility. Labor shortages make frequent hand irrigation difficult to accomplish in this semi-arid area, and an automatic drip or overhead irrigation system would help keep trees adequately watered with a minimum of personnel. Water stressed seedlings may also be more attractive to insect and disease pests.

Pisolithus tinctorius, a mycorrhizal symbiont, is well established on windbreak pines at Monterrey. This provides a ready supply of natural inoculum for the pine germination beds and container stock. Mycorrhizal roots were found on container grown pines.

Two private nurseries on the U.S.V.I. were visited where ornamental and fruit trees were the major crops. Insect and disease conditions were evaluated on several species and findings appear in Table 2. Effective control procedures are being instituted by nursery managers and impact is generally low.

Lack of labeling information for tropical trees and experimental use of compounds on crops and pests was discussed with personnel from the College of the Virgin Islands, Cooperative Extension Service. The recent addition of a plant protection specialist on St. Croix will help in accurate diagnosis, which is the first essential step in effective pest control.

Table 1 --Nursery pests evaluated in public nurseries in Puerto Rico, 1982.

Host	Damage	Nursery		
		Catalina (USFS)	Cambalache (PR-DNR)	Monterrey (PR-DA)
Mahogany - *Swietenia mahagoni*, *S. macrophylla*, and hybrids	ambrosia beetle/canker	P 1/	a	P 2/
	shoot borer	P 1/	P	P
	leaf spots	P	a	P
	post-emergence damping-off	a	P	a
	Vaquita	P (roots)	P (roots & foliage)	P (roots & foliage)
	low density	a	a	P
Mahoe - *Hibiscus elatus*	leaf spots	-	P	P
	thread blight	-	a	P
	nutrient deficiency/drought	-	P	a
	low density	-	a	P
Caribbean pine - *Pinus caribaea*	nutrient deficiency	-	-	P
	post-emergence damping-off	-	-	P
	low density	-	-	P
	Pisolithus tinctorius mycorrhizae	-	-	P
Eucalyptus - *Eucalyptus deglupta*	leaf spots	-	P	P
	transplant loss	-	P	P
	post-emergence damping-off	-	a	P

Table 1.--(con't)

Host	Damage	Nursery		
		Catalina (USFS)	Cambalache (PR-DNR)	Monterrey (PR-DA)
Citrus - unknown	sour orange scab	-	-	P
Almond - Terminalia catappa	leafhopper	-	P	a
Morolon - Coccoloba pubescens	scale insect	-	P	-
Aceitillo - Zanthoxylum flavum	aphids	-	P	-
Maria-Santa Maria - Calophyllum brasiliense	leafhopper	-	P	a

1/ Also present at Zarzal outplanting near nursery.

2/ No ambrosia beetle injury present

P = present
a = absent
- = no host grown

Table 2.--Pests of ornamentals in U.S.V.I. private nurseries.

Host	Damage	Pest Associated
Carrisia speciosa	stem canker with dieback	Botryodiplodia dothidae
Erythrina spp.	leaf spot shoot borer	Phoma spp. unidentified lepidoptera
Murraya pamiculata	leaf miner	unidentified
Oleander spp. and Aleurites fordii	twig infestation	unidentified scale
Jasminium salincia	leaf infestation	unidentified scale

FORESTS

During this evaluation, the authors evaluated managed plantations of mainly non-native forest species of Caribbean pine and teak in P.R.

Pine Damage

Spider mites In 1981, a spider mite problem was observed on oocarpa pine (Pinus oocarpa) and Caribbean pine (Pinus caribaea) in one of the Oxford International Pine Provenance Trials in the Anasco area (2). Anasco is located in the western part of the Island. Revisitation to this area showed that the spider mite was still present (Fig. 9a), but at a much lower level than in 1981. Feeding was again heavier on oocarpa pine, and the edge effect described in 1981 (trees on the outer edge of the plantation were affected more than trees in the interior) was again obvious. The spider mite population was high on young, natural regeneration of Caribbean pine in open areas where there was minimal overstory or shade from surrounding trees.

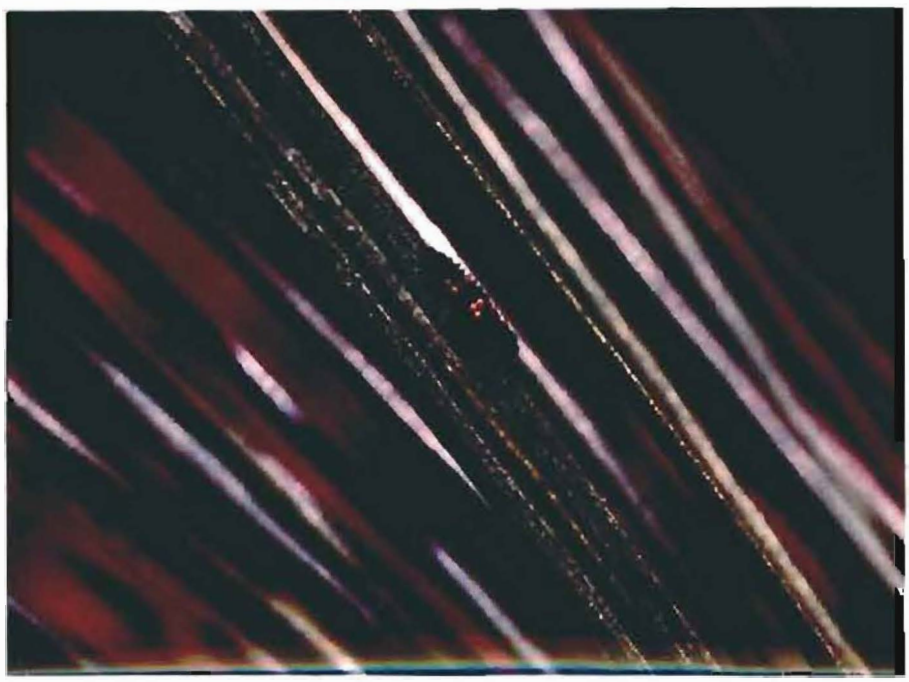
During this evaluation, ladybird beetles (adults and larvae) were observed on a 2-3 meter tall natural regeneration adjacent to the plantations (Fig. 9b). This natural predator could be a major reason why the mite population was lower than in previous years. Management of spider mites through silvicultural methods or chemicals is not necessary at this time.

Basal resinosis. External resinosis was observed on the stems of 16 to 17 year old P. caribaea, beginning near the ground line or up to 1 meter above the ground and extending distally for 1 to 2 meters (Fig. 10a,b). Resin-soaking occurred from the bark into the xylem several centimeters. Affected trees were found in abundance at two plantings in P.R. (the Lake Caonillas spacing study and the Cerro Gordo planting). The understory of both stands had burned, but the symptoms described are not typical of basal fire scars. Attempts to isolate pathogens from affected tissue and soil near basal damage were not successful.

The cause of this damage could be fire in the dense and high understory vegetation. Plantings should be monitored to establish associations with fire or other management practices. More complete assessment of biotic causes was not possible and should be considered in future evaluations. Management practices to control the condition cannot be recommended without a clear understanding of cause. Additionally, the intended product may not be compromised by the damage, thereby making control unnecessary.

Competition. Caribbean pine planted near Las Marias, P.R., showed evidence of early growth suppression. The stand was 17 years old and part had been planted under Brazilian coffee trees and part under the smaller Arabian coffee. The Brazilian coffee canopy was closed at the time of our observations, while the Arabian coffee trees still had ample growing space. The differing size and growth habits of the two varieties seemed to influence early pine growth, since the pines in the Arabian coffee area were already small sawtimber size (Fig. 11), while those in the Brazilian coffee area were small to medium pole-size. Increment cores are difficult to interpret, since pine growth in the tropics does not follow the patterns of definite early- and

a.



b.

Figure 9a.--Spider mite infestations of Caribbean pine (Pinus caribaea). Anasco, Puerto Rico.

9b.--Larva of ladybird beetle, predator of spider mite adults, immatures and eggs.

a b

Figure 10a,b.--External and internal basal resinosis of Caribbean pine (Pinus caribaea) at Lake Caonillas, Puerto Rico

Figure 11.--Seventeen-year-old Caribbean pine (Pinus caribaea) growing among Arabian coffee trees at Las Marias, Puerto Rico.

late-wood formation of trees growing in temperate climates. However it did appear from the cores that early growth of the pines was slower under the Brazilian coffee. The site quality of the two areas did not appear to differ.

Management considerations. The trees have already grown well above the coffee canopy in both areas, so shading is no longer a problem. Competition for soil moisture and nutrients may occur at times during the year, but growth impacts on pines or coffee are not known. Avoidance of planting under dense vegetation of any sort would eliminate early shading and competition. However, spider mites may then become a problem. Removal of the overstory once pine is established may be desirable if pine is the crop of primary interest. The potential for other pest problems occurring on trees under competitive stress is higher than for those without such stress.

Teak Damage

Canker rot. Teak (Tectona grandis) was affected by a canker and rot in pole-size stands at the Mayaguez Institute of Tropical Agriculture (MITA) and in pole- and sawtimber-size stands on the Rio Abajo State Forest in P.R. Increment cores taken from affected stems near cankers showed dark brown staining and smelled of anaerobic micro-organism activity (sour, vinegar smell; putrid liquid and gas escape when tapped). Cankers were associated with dead branch stubs or main stem forks two to several meters above the ground and were often several meters in length, encompassing one-fourth to one-half the tree's circumference (Fig. 12a). Resupinate (flat, appressed), grey-black, sterile material was found associated with old branch stubs and canker faces on several widely separated trees (Fig. 12b,c).

Attempted isolation of potential fungus causes from canker margins, rotted wood, and the grey-black material was unsuccessful.

Cordell and Barry (4) and Phelps and Landgraf (8) described a similar condition on teak in the Rio Abajo State Forest and on St. Croix, respectively. Cordell and Barry isolated a basidiomycete from decayed wood, but it was not identified. Phelps and Landgraf described the condition as a Hypoxylon spp. canker, but did not indicate whether isolation of the organism was attempted. Their description of the grey-black material is consistent with the non-fruiting Hypoxylon-like material collected during this survey. The 1976 and 1972 observations are at variance (no evidence of Hypoxylon fruiting in 1976), but we feel there is enough agreement in the accounts of 1982, 1976, and 1972 that the conditions are the same in all locations and at different observation dates. These observations indicate a widespread and severe condition in P.R. and the U.S.V.I.

Management considerations. If the growing of teak is to become a commercial enterprise in P.R. or the U.S.V.I., the cause, extent, distribution, and severity of this disease needs to be assessed. Evaluation of associations with site, age, and management practices could assist in lessening or eliminating the disease and associated product value loss. After such a survey, management practices to mitigate the problem could be investigated.

a.

Figure 12a.--Large canker on stem of teak (Tecona grandis) with dead branch stub associated. Rio Abajo State Forest, Puerto Rico.

12b.--Sterile material (perhaps fungus-produced) in healing branch stub of teak. Rio Abajo State Forest, Puerto Rico.

12c.--Sterile material produced on stem of pole-size teak. Rio Abajo State Forest, Puerto Rico

b.

c.

Activities suggested to minimize canker rot problems on other hardwood hosts in temperate climates include: proper site selection; favoring other, unaffected species; maintaining tree vigor; hand pruning of declining branches or promoting conditions for natural pruning; and sanitation salvage of affected stems. Some of the practices may apply to tropical climates, but may require alteration to accommodate the different wood characteristics and growth habits of tropical tree species.

Mahogany Damage

Mahogany shoot borer (Hypsipyla grandella). Hybrid mahogany (Swietenia mahagoni x S. macrophylla) was damaged by the shoot borer at a newly established outplanting near Zarzal, Rio Grande, P.R. (also, see ambrosia beetle-canker complex). Incidence was very light and could have been residual from nursery infestations. The biology of this terminal boring insect is detailed in previous evaluations (2,4,5,8) and elsewhere (7).

Management considerations. Direct controls of the shoot borer with insecticides in forest stands are not currently available. Some success has been achieved with experimental applications in nurseries. The best control available in forest stands is strip planting of seedlings with shade from native forest vegetation from the sides, but control is not complete. Severe or repeated damage may result in forking or stem crooks, but many trees can recover to produce marketable stems.

URBAN AND OTHER SITES

People Pressure Conditions - U.S. Virgin Islands National Park, St. John, U.S. Virgin Islands

The U.S. Virgin Islands National Park is a small, intensively used park with historic sites, camping, and permanent cabin facilities available. Most campsites are within short walking distance of beaches behind low (1-2 meters), vegetated dunes. Numerous trails and dirt roads are available for backpacking or day hiking. Because of the intensive use of facilities, numerous instances of tree decline occur.

Abiotic and biotic factors are associated with damage and often occur in combinations. A list of conditions appears below.

Abiotic factors

Soil compaction.
Basal wounding by vehicles or construction equipment (Fig. 13a).
Lantern burns.
Machete and/or axe wounds (Fig. 13a).
Root exposure and damage due to foot traffic and road construction (Fig. 13b).
Soil nutrient deficiencies (palm).

a. b.

Figure 13.--Abiotic factors contributing to tree decline in areas of heavy use include: basal wounds by vehicles; wounds caused by axe machete, and knife-wielding park users (a); and heavy foot traffic over tree roots (b). U.S. Virgin Islands National Park, St. John, U.S. Virgin Islands.

Biotic factors

Ganoderma applanatum root and butt rot on wounded trees (Fig. 14a).
Aspidiotus destructor - palm frond scale (Fig. 14b).
Stem decay by unknown fungus
Slime flux caused by anaerobic bacteria in wood of wounded and stressed trees.

Combinations of the above factors lead to decline-type symptoms in most tree species. Symptoms include twig or branch dieback, poor healing response of branch stubs or wounds, and root, butt, and stem decay. Such trees can be highly hazardous to park employees and users when they are positioned near high traffic areas (roads or paths) or campsites, picnic areas, and cabins due to loss of windfirmness and ability to withstand environmental stresses. Continued abuse of shoreline vegetation could result in loss of shade and wind protection, and increased beach erosion during storms.

Management considerations. The following practices can help to alleviate tree stresses caused by activities associated with recreation use.

1. Providing lantern posts at campsites and picnic areas to prevent lantern burns and subsequent stem decay.

2. Cover heavily used trails with a layer of large wood or bark chips to lessen soil compaction, root damage, and subsequent root and butt decay.

3. Provide educational materials to park users on the effects of tree abuse by carving, hacking, or other wounding.

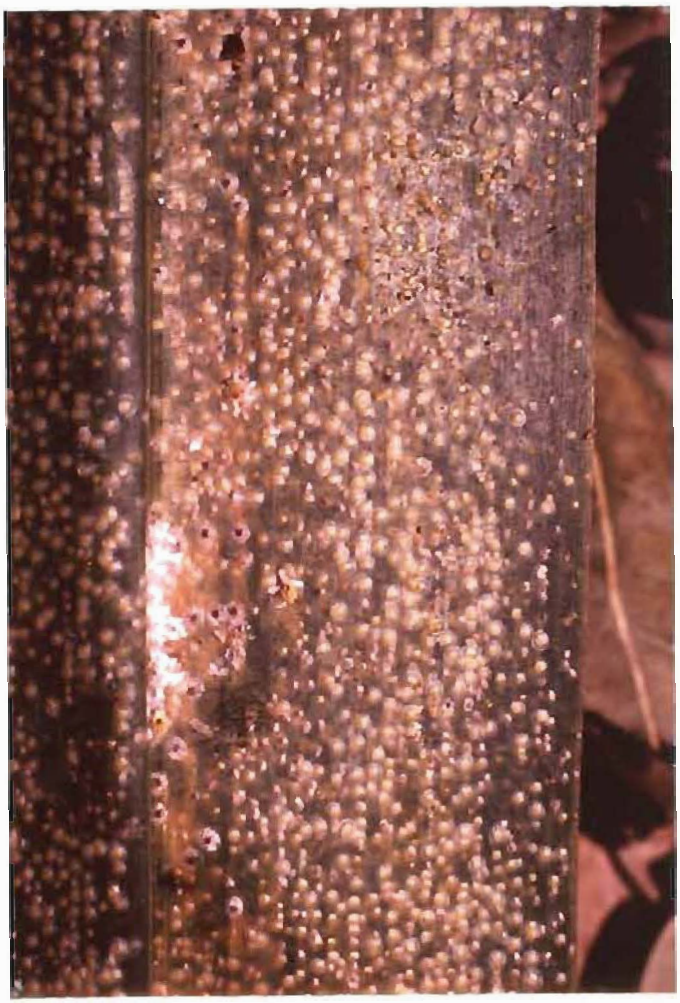
4. Directing traffic to beaches through a few routes, thereby minimizing damage to most shoreline vegetation.

5. Initiating a vegetation management program, including hazard tree identification and removal, correct pruning techniques, fertilization where needed, tree replacement, and public education.

Forest Pest Management can provide training and literature for park personnel on this subject, if requested.

Park officials were initially concerned about the possible presence of lethal yellows on coconut palms in various locations throughout the park. Observations indicated no lethal yellows present. The chlorotic appearance of older palm fronds and the progressive tip burn are the result of palm frond scale infestations (Aspidiotus destructor) and magnesium deficiency. Treatment consists of old frond pruning and fertilization, if desired. Though palm lethal yellows are not yet present on the U.S.V.I., the park area could be a prime entry point, given the number of visitors and the likelihood of their carrying affected plant materials and introducing the problem from elsewhere in the Caribbean. Park personnel should remain vigilant, as rapid action may prevent disease spread.

a



b.

Figure 14.--Trees stressed by conditions in recreation areas are often attacked by fungi (a. Ganoderma applanatum) and insect pests (b. Aspidiotus destructor; palm frond scale).

FRUIT CROPS

Mango (Mangifera indica). Commercial mango groves were visited on St. Thomas, U.S.V.I., with Cooperative Agricultural Extension Service personnel from the College of the Virgin Islands. A recurrent anthracnose-like disease of mango (Fig. 15, probably caused by Colletotrichum gloeosporioides) has resulted in reduced yield and fruit quality. Extension personnel have been working with commercial growers to develop spray schedules to control this disease. The lack of registered fungicides for tropical plant diseases has hampered efforts. Difficulty in procuring adequate amounts of registered compounds on the Island has added to the problems.

An integrated approach to managing the disease is taken by pest specialists, and efforts to combine non-chemical control procedures (sanitation of diseased material in groves and tree vigor maintenance) is incorporated into control strategies.

Papaya (Carica papaya). Papaya plants on St. Thomas continue to be affected by an as yet misunderstood disease problem, which results in reduced fruit size and yield, and mortality of plants. Reduced size and number of leaves, premature leaf abscission, wilting, and watersoaked stem lesions are also symptoms (Fig. 16). The disease was described in a previous evaluation (4). The cause had not been determined at the time of that report, but since then, advances have been made by researchers at the College of the Virgin Islands. A complex of organisms acting together appears to be the cause, and efforts to determine the role of each continue. When disease etiology is known, controls can be instituted. Resistance breeding is still a part of the control strategy.

Cacao (Theobroma cacao). Experimental and yard tree plantings of cacao were observed at MITA, Mayaguez, P.R., and private residences on St. Thomas, U.S.V.I., respectively. Anthracnose was common, and a fungus (Colletotrichum orbiculare) was consistently associated. Symptoms included leaf spot and marginal leaf necrosis on older leaves and marginal and veinal necrosis on young, succulent leaves (Fig. 17).

Management considerations. Control is not warranted at this time, since impact appears slight and trees occur mostly as single individuals. Homeowners may limit damage by removing affected leaves from the tree and destroying them by burning or burying. Preventive fungicide sprays may prove successful in the future if the amount of growing stock increases.

HERBICIDE DAMAGE

A herbicide problem that was encountered during the 1981 evaluation at the Navy House, San Juan, P.R., has improved considerably. A variety of trees, shrub and herbaceous plant species, including palm (Cocos nurcifera), flamboyan (Delonix regia), and oleander (Oleander sp.), had been killed or were in various stages of decline.

The termination of the use of herbicides to control grass has improved the problem on the U.S. Navy Compound many-fold. There was no additional tree or shrub mortality observed during this evaluation. Indicators of improvement

Figure 15.--Foliage symptoms of an anthracnose-like disease on mango (Mangifera indica). St. Thomas, U.S. Virgin Islands. Flowers and young fruits are also affected

Figure 16 --Stem lesions, dead foliage, and undersized fruit of papaya (*Carica papaya*) affected by a complex of disease-causing agents. St. Thomas, U.S. Virgin Islands.

Figure 17 --Anthracnose of cacao (Theobroma cacao) on succulent (left) and older (right) foliage. Colletotrichum orbiculare was consistently associated.

were healthy sprouting of flamboyan (Fig. 18) from stumps of previously killed back and cut trees and grass beginning to restablish itself on areas where the herbicide had been applied. These factors indicate that the damaged trees and shrubs still living have a chance to overcome the herbicide damage. The Base Commander has begun practices to reverse the damage caused by the herbicides and is initiating the recommendations of fertilization for the hardwoods and palms. He is also planning a replanting program to replace the dead trees.

Management considerations. Further improvement to the problem can be obtained by the following:

1. Pruning and fertilizing the living hardwoods.

2. Fertilizing the palms.

3. Starting the replanting program to replace other dead hardwoods.

4. Corrective pruning of some of the stump sprouts of the flamboyan could result in a replacement without replanting.

J. A. Zambrana offered the assistance of State and Private Forestry in contacting individuals with the P.R.-D.N.R. for assistance in this tree replacement program. It was also recommended that the Commander consult a professional tree service for the pruning job needed on the very large hardwood trees.

MISCELLANEOUS URBAN AND SHADE TREE

Site selection. Site selection is often not carefully done in urban and shade tree settings. Several instances were observed at Camp Santiago Army National Guard Training Center, located in the south-central semi-arid region of P.R. While biotic agents were present on some declining trees (scales, aphids, decay fungi, leaf disease), the direct causes of poor tree appearance were site inadequacies.

Shade plantings of rosewood (Pterocarpus indicus) and mahogany (Swietenia mahagoni, S. macrophylla, and hybrids) along the paved entrance road to the base showed twig and branch dieback, premature leaf abscission, and poor growth (Fig. 19). None of these tree species are especially well suited to the dry soil conditions prevailing in this area. The damage was inadvertantly avoided on one side of the road because of a leaky underground water line and exacerbated on the opposite side by trafficing of heavy military equipment, such as tanks and other tracked vehicles. In an effort to minimize damage to the roadway, the trees were damaged. Dry soil conditions combined with soil compaction resulted in tree decline.

A nearby, closely spaced planting of sapling-sized maria-santa maria, Honduras and hybrid mahogany, and rosewood were showing poor vigor and form (Fig. 20). These trees were to be used as replacements when trees died elsewhere on the base or where vegetation was needed. This planting provided an opportunity to observe the relative fitness of different trees for the semi-arid sites common in this part of the Island. Only hybrid mahogany, which tended toward the small-leaf mahogany, appeared suited to the area. J. A.

Figure 19.--Roadside planting of rosewood (Pterocarpus indicus) at Camp Santiago National Guard Training Base, Puerto Rico. Trees at left are suffering from drought and soil compaction from vehicular traffic off the road. Trees at right are irrigated by leaky water lines.

Figure 18.--Root collar sprouting of flamboyan (Delonix regia) previously killed back with herbicide used to control grass. Judicious pruning of this sapling can help to produce an attractive yard tree, eliminating the need for replanting. Navy House, San Juan, Puerto Rico.

Figure 20.--Maria-santa maria (Calophyllum brasiliense) showing poor adaptation to dry sites common on Camp Santiago. Hybrid mahogany in left background showing better appearance

Zambrana suggested black olive (Ucar = Bucida buceras) as another appropriate selection. One or two specimen black olive trees on the base showed good growth, form, and overall appearance.

Close examination of bigleaf mahogany, rosewood, and maria-santa maria planted on the base and in the replacement planting revealed infestations of leaf and twig aphids and scale insects. The trees' poor adaptation to the prevailing growing conditions resulted in poor vigor and susceptibility to attacks by these insects. Chemical controls are not recommended.

Other site problems observed were in urban and city situations. Trees were planted too close to roads, in small spaces between sidewalks and streets, over water lines, next to stone and concrete walls, against houses, and under power lines (Fig. 21). In some instances, trees that were not salt tolerant were planted too close to sea walls where salt spray could be blown onto them.

Management considerations. Site and species should always be matched. Pay close attention to all potential limiting factors when picking a species for a particular site. Examples are moisture availability, fertility, space (for both roots and tree crown), and salt tolerance. Assistance can be obtained from USDA Forest Service, State and Private Forestry, and the Commonwealth of Puerto Rico, Department of Natural Resources, in choosing the appropriate tree for the desired site.

The authors noted the excellent job done of urban tree maintenance and planning accomplished by the builders of the new zoo at Mayaguez. Trees were well suited to the site, plenty of growing space was provided, and trees were well protected from visitors and animals alike.

Mechanical damage. Damage from machete and grounds keeping equipment remains at a high level. Tree vigor can be severely compromised by the opening of such wounds. Root and stem insects and diseases can gain access and further depress the ability of the tree to grow vigorously (Fig. 22).

Such attacks can lead to root and stem decay, tree mortality, or failure in wind, causing personal or property damage.

Management considerations. Public education through radio, newspapers, schools, and publications on tree care is the best method to prevent mechanical damage. Ground maintenance personnel should be trained in the proper tree care techniques, such as pruning and tree fertilizing methods and rates. Tree replacement should also be a consideration in certain cases where injury is going to result in death of the tree or its failure in violent weather.

Figure 21.--Urban trees need ample space to provide the amenities city dwellers desire. Inadequate growing space for crowns and roots results in premature tree decline and may result in expensive property damage and replanting costs.

Figure 22.--Examples of common mechanical injury in urban tree environments. Stem wounds resulting from use of trees for utility poles (left) and lawn mowing machines (right) allow decay fungi to enter and weaken the tree.

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APPENDIX

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Report #82-1-32
August 1982

EVALUATION OF TREE DISEASE AND INSECT PESTS IN PUERTO RICO AND THE U.S. VIRGIN ISLANDS, 1982

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