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INSECT AND DISEASE CONDITIONS - PUERTO RICO AND THE UNITED STATES VIRGIN ISLANDS, 1976

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INSECT AND DISEASE CONDITIONS - PUERTO RICO AND THE UNITED STATES VIRGIN ISLANDS, 1976

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INTRODUCTION

During the period February 1-13, 1976, Charles E. Cordell and Patrick J. Barry of Forest Insect and Disease Management, Forest Resource Protection, Southeastern Area, State and Private Forestry, evaluated insect and disease problems on forest and ornamental tree species in Puerto Rico and the United States Virgin Islands. Personnel of State and Private Forestry, the Institute of Tropical Forestry, and the National Forests in Puerto Rico accompanied the authors during their scheduled visits to various Federal, Commonwealth, and private forest installations. A list of the installations visited and personnel contacted is in Appendix 1.

The primary objectives of the present evaluation were to examine insect and disease problems in experimental forest plantings, tree nurseries, and plantations. Additional effort was devoted to various ornamental and shade tree problems as time permitted.

This was the third insect and disease evaluation conducted during the past 4 years. Several insect and disease evaluations were conducted prior to 1972 and are listed in the first insect and disease evaluation report entitled "Evaluation of tree disease and insect pests in Puerto Rico and St. Croix, Virgin Islands, 1972" by William R. Phelps and Amel E. Landgraf.

Insect and disease problems observed during the present evaluation along with recommendations for the reduction of

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their impact to forest, nursery, shade, and ornamental trees are described according to forest tree crop and host species as follows:

Monterrey Commonwealth Nursery

The Monterrey Nursery located near Dorado Beach is a Commonwealth Department of Agriculture installation. Many different types, varieties, and species of fruit trees, shrubs, ornamentals, and improved vegetable seed are grown here for sale to the public. The nursery also produces several species of forest trees such as mahogany, teak, mahoe, Australian pine (*Casuarina*), and tropical pine (*Pinus caribaea*). Tree culture is primarily in cans, plastic packets, and plastic bags. Pine seedlings are germinated in seed beds and then transplanted into individual plastic packets for subsequent growth. No fertilizer, pesticides, or soil fumigants are applied to the soil prior to placing it in the containers.

The general appearance of the tree seedlings were chlorotic (yellowed) and stunted. A large seedling storage and growth development area showed some apparently healthy seedlings while others were stunted and yellowed. This was also observed in beds containing deciduous tree seedlings. This problem appears to be directly related to the soil types used in the containers and seedling beds. The unhealthy, yellow, and stunted seedlings apparently resulted from a mineral or nutrient deficiency in these soils (Fig. 1-A).

Recommendations have been offered by the U. S. Forest Service, State and Private Forestry and the Institute of Tropical Forestry relative to successful seedling culture at the nursery. An effective practical nursery program should be developed and presented to the nursery manager for both conifer and deciduous tree seedlings. The production of forest tree seedlings is apparently secondary to growing fruit and other ornamental shrubs and trees at the Monterrey Nursery. The Commonwealth and the U. S. Forest Service, however, have tentative plans to establish a forest tree nursery on the Toro Negro State Forest.

The following are the major insect and disease problems observed at the Monterrey Commonwealth Nursery:

The most important disease problem detected at the Monterrey Nursery was post-emergence damping-off of Caribbean pine, *Pinus caribea*, seedlings caused by the soil pathogenic fungus *Cylindrocladium floridanum* (*Calonectria kyotensis*). The fungus was isolated from over 50 percent (12/20) of tissue isolates made from symptomatic *P. caribea* roots and cultured by the authors on semiselective artificial media in the Plant Pathology Department, University of Puerto Rico, Rio Piedras, Puerto Rico. Typical post-emergence damping-off foliage, stem, and root symptoms and mortality were observed on scattered (less than 10 percent) 3- to 6-month old pine seedlings (Fig. 1-B). Symptoms observed on the "potted" P. caribea seedlings were very similar to those previously observed on seedlings of several southern pine species artificially inoculated with three species of Cylindrocladium in the greenhouse at Asheville, North Carolina (Cordell, 1976). This is apparently the first reported occurrence of C. floridanum (Cal. kyotensis) either in Puerto Rico or on P. caribea. Suggested supplemental evaluations and control action to reduce the impact of this serious root disease at the Monterrey Nursery will be outlined in a later section.

Root rot disease symptoms were also observed on mahogany, Swietenia mahogani, and teak, Tectona grandis, seedlings at this nursery. Tissue isolations from symptomatic roots consistently yielded a Fusarium fungus. Several species of Fusarium have been repeatedly associated with root rot and damping-off of several conifer and hardwood tree seedling species in widespread nursery locations throughout the United States (Smith, 1975) as well as in many other parts of the world.

A terminal canker and dieback was observed on mango, Mangifera, variety Edward, grafted seedlings. Isolations from symptomatic host material yielded the twig canker fungus Phomopsis. Approximately 5 to 10 percent of the mango seedlings displayed the terminal canker and dieback symptoms.

Finally, a number of foliage diseases were observed on several hardwood and ornamental seedling species at the Monterrey Nursery as well as at the Cruv Metropolitan Nursery - San Juan - and the small special project nursery on the Toro Negro State Forest. Foliage diseases observed included a leaf spot fungus, Phyllosticta solitaria, on black olive, Bucida buceras; a rust fungus, Uromyces jamaicensis, on poorman's orchid, Bauhimia morardra; and various leaf spot and blight fungi, Pestalotia, Phyllosticta, Phoma, and Dendrophoma, on several ornamental plant species.

An infestation of the "Sugar-Cane Root-Stalk Borer Weevil" or "Vaquita" (Diaprepes abbreviatus [L.]) (Beavers and Woodruff 1971) was detected in the 1-year-old mahogany transplants at the Monterrey Nursery. Larvae of this insect were causing approximately 25 percent mortality to the nursery transplanted stock (Fig. 1-C). Damage is caused by larval feeding on the lateral and tap roots of the young plants which gradually become chlorotic (turn yellow) and die (Fig. 1-D). This insect has been reported on seedlings of pepper, papaya, and mahogany by Wolcott (1948).

Adults of "Vaquita" were also found feeding throughout the nursery on mango and citrus stock. The adult insect (Fig. 1-E) was collected at the University of Puerto Rico Agricultural Experimental Station near Mayaguez, Puerto Rico, feeding on a pigeon pea plant.

At the Cruv Metropolitan Nursery near San Juan, Puerto Rico, a variety of scales (Homoptera:Coccidae) and aphids (Homoptera Aphiidae) were observed to be widespread on the flowering shrubs and ornamentals. Some plants were heavily infested and may suffer subsequent branch or terminal dieback. Other plants were covered with "sooty mold," caused by a fungus (Capnodium), which grows on the "honeydue" excreted by the scales and aphids. The sooty mold renders the plants unattractive and objectionable from an aesthetic point of view. Chemical control action, however, is seldom, if ever, warranted or desired for this obnoxious problem. On ornamental flowers, shrubs, vines, trees, and evergreens, Carbaryl®, Trithion®, and Malathion are registered for use against the scales and aphids. For scale control, the plants must be thoroughly wetted on both the upper and lower leaf surfaces. It is also important that the spray be properly timed to coincide with scale crawler emergence due to these very short-lived compounds. Elimination of the scales and/or aphids will subsequently eliminate the associated sooty mold development.

Mahogany (Swietenia mahogani)

The most destructive insect pest on mahogany is the mahogany shoot borer, Hypsipyla grandella (Zeller). Terminal damage to the plant is almost severe enough to preclude the planting of this valuable timber species (Fig. 2-A).

The development of new information on this insect is continuing both in South America and in Puerto Rico. These efforts should eventually lead to procedures for effective control of this pest. Currently, emphasis is being placed on finding a "time release" pesticide capsule for a systemic compound that will kill the insect. Work is also being conducted concerning the isolation of the moth's sex attractant. Another promising development concerns the fact that the adult moth is attracted to the plant by a specific odor of the host tree (Grijpma and

Figure 1. Insect and disease problems observed in nurseries in Puerto Rico.

A - Seedlings displaying nutrient deficiency symptoms at the Monterrey Nursery.

B - Post-emergence damping-off symptoms caused by the soil pathogenic fungus, Cylindrocladium floridanum, on Pinus caribea potted seedlings at the Monterrey Commonwealth Nursery. Comparison of damped-off and apparently healthy P. caribea seedlings.

C & D - Symptoms and damage caused by the sugar-cane root-stalk borer weevil on 1-year-old mahogany transplants.

E - Adult sugar-cane root-stalk borer weevil on pigeon pea leaf at University of Puerto Rico Agricultural Experiment Station near Mayaguez, P.R.

A

B

C

D

E

Ramalho, 1969). These workers showed that the adult moth has preference to particular species of the plant family, Meliaceae. Additional development of this olifactory response could lead to the future development of attractants to be used against Hypsipyla (Grijpma and Ramalno, 1969). In addition, control derived through the selection and propagation of genetically resistant trees is also possible. Finally, silvicultural control techniques also show promise against the shoot borer. It has been demonstrated that where mahogany is grown on open sites and in conjunction with extensive site preparation, attack by the borer is severe.

During our visit to the Caribbean National Forest, a variety of mahogany plantings were observed. On open sites without an overstory, mahogany was severely attacked by the borer. On sites where some overstory or forest is maintained between rows of mahogany, attacks by the shoot borer were less severe. One such planting in particular showed a significant reduction in attack by the borer. This planting was established in rows spaced 30 feet apart with tree spacing 6 feet apart within the rows. Brush and the overstory were cleared away approximately 5 to 6 feet on both sides of the planted tree rows, thus leaving a strip of native forest 18 to 20 feet wide between rows (Fig. 2-B). An unidentified scale insect was also observed on open grown mahogany. However, it was not causing any mortality or dieback (Fig. 2-C).

In addition to the mahogany seedling root rot diseases previously described at the Monterrey Nursery, three additional and distinctively different mahogany disease problems were observed in experimental and reforestation plantings. The first problem was pointed out by Axel Frederikson, State and Private Forester, St. Croix, Virgin Islands, in a young mahogany experimental planting on the Estate Thomas Experimental Forest - St. Croix. Terminal dieback, foliage chlorosis (yellowing), and twig hypertrophism (nodal gouting) were pronounced on 8-10 trees in one corner of the planting (Fig. 3-A). Symptoms were either limited to, or considerably accentuated, in the tree terminals (Fig. 3-B) and were not observed in any other section of the planting. The symptom patterns were highly suggestive of a localized soil toxicity problem and apparently limited to one isolated corner of the planting. Trees derived from several parents and seed sources all displayed similar symptoms and damage in the one localized area. There was no evidence of either fungus-caused disease or insect damage on any foliage, branches, stems, or roots of symptomatic trees. Soil samples were collected from the root rhizosphere, of both symptomatic and nonsymptomatic trees and forwarded to the soils testing laboratory, University of Georgia, Athens, Georgia, for chemical analysis. Similar soil samples were also tested at the University of Puerto Rico. Results of pH analysis along with available macro- and micro-nutrient levels in the two soils supporting the

Figure 2. Insect problems observed in mahogany (*Swietenia mahogani*) experimental plantings and reforestation in Puerto Rico.

A - Terminal damage on mahogany caused by mahogany shoot borer.

B - Example of mahogany planting techniques on Caribbean National Forest to reduce impact of shoot borer.

C - Unidentified scale insect on open grown mahogany.

A

B

C

symptomatic and non-symptomatic trees are summarized in Table 1.

Examination of Table 1 shows very little differences in either pH or macro- and micro-nutrient availability between the two soil samples. Consequently, these factors are apparently not associated with the observed symptoms. The only abnormalities observed were the high levels of calcium and low levels of total nitrogen. However, levels of both these nutrients were approximately the same for both soil samples. Unfortunately, soil toxicity analysis was not available from the Georgia laboratory at this time. Such an analysis should be considered in future evaluations of the mahogany planting.

A second mahogany disease problem was pointed out and observed in experimental plantings on the Carite State Forest in southeastern Puerto Rico. As previously stated, however, disease symptoms and damage observed in these plantings were distinctively different from those observed in the Estate Thomas plantings on St. Croix. Foliage and root symptoms along with mortality patterns observed in these plantings suggested a root- and/or butt-rot fungus causal agent. Extensive foliage wilt and crown dieback were apparent in two of the three adjacent plantings observed (Fig. 3-C). In addition, 25 to 50 percent mortality was already apparent in the two adjacent plantings. Examination of the roots and basal stems of several symptomatic trees also revealed extensive root- and butt-rot damage (Fig. 3-D). Very little symptom expression or mortality were observed in a third adjacent planting located less than 50 meters from the second planting. Consequently, site conditions were similar in all three plantings and there were no apparent correlations between disease symptom and damage patterns and site factors. Symptomatic root samples were collected for laboratory examination and culturing at the Forest Insect and Disease Management laboratory, Asheville, North Carolina. Fungi consistently isolated from the root samples have been forwarded to the United States Forest Service Forest Mycology Laboratory, Madison, Wisconsin, for identification and results will be forwarded when available.

A third, and yet distinctively different, problem was pointed out and observed in a West Indies (small-leaf) mahogany reforestation planting on the Guanica State Forest in southwestern Puerto Rico. Symptoms observed in this planting included dwarfed and reduced foliage production on apparently stunted trees. This condition was observed to be widespread in the vast majority of the mahogany growing in this area. As pointed out by Jose Zambrana and the State Forest manager, however, this condition appears to be physiological in origin and most likely caused by adverse site and environmental conditions that prevail in the area. Relatively low-quality site and soil conditions were

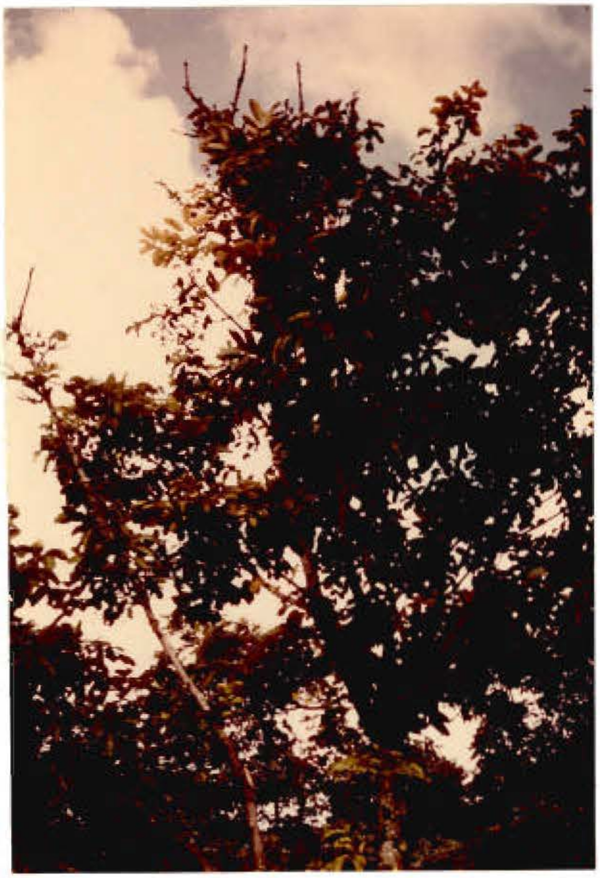
Figure 3. Disease problems observed in mahogany (*Swietenia mahogani*) experimental plantings and reforestation in Puerto Rico and the Virgin Islands.

A - Symptoms observed on affected mahogany trees at Estate Thomas Experimental Forest - St. Croix, V.I.

B - Close-up view of terminal symptoms on affected mahogany trees at Estate Thomas Experimental Forest.

C - Foliage wilt and crown dieback symptoms and mortality observed in the mahogany experimental plantings on the Carite State Forest - Puerto Rico.

D - Root discoloration and decay symptoms observed on damaged mahogany trees in the experimental planting on the Carite State Forest.



A

B

C

D

Table 1. Analysis of soil samples collected from the root rhizospheres of symptomatic and non-symptomatic mahogany at the Estate Thomas Experimental Plantings, St. Croix, Virgin Islands - February, 1976[a]

A.

Sample No.	Tree Conditions	pH	K	Ca	Available Nutrients[b] Mg	Al	Mn	Cu	N-%
1	Symptomatic	7.7	173	21,800	130	8	1	0.3	0.3
2	Apparently Healthy	7.7	158	21,100	279	9	4	0.3	0.32

B.

Sample No.	Tree Condition	pH	Available Nutrients[c] P	K
1	Symptomatic	7.5	7.0	326
2	Apparently Healthy	7.6	7.3	350

[a] Analysis results in A. obtained from soils laboratory, University of Georgia, Athens, Georgia, and in B. from University of Puerto Rico, Rio Piedras, Puerto Rico.

[b] With the exception of N (total nitrogen) expressed as lbs./acre.

[c] Expressed as mg of nutrients per kg of soil.

predominant along with the prevailing dry seasons with minimal rainfall. The coarse light soil in this area also possesses a correspondingly reduced water-holding capacity that is also apparently unfavorable for the faster-growing mahogany. The effects of these inter-related site and environmental factors were also exemplified on an associated hardwood species, lignum vitae (*Guaiacum sanctum*), which was growing much better than the mahogany under these adverse site conditions. In fact, this indigenous species will probably overtop and replace the stunted mahogany in the distant future. Lignum vitae is a very slow-growing tree with excellent survival and reproductive characteristics under adverse site and environmental conditions such as those observed on the Guanica State Forest.

Finally, observations of several additional mahogany plantings on the Sabana Ranger District, Caribbean National Forest, did not reveal any disease problems. These observations included a variety of seed sources, age groups, planting sites, and planting site preparations.

Eucalyptus (*Eucalyptus* spp.)

Eucalyptus plantings were observed on the Rio Abajo and Toro Negro State Forests in Puerto Rico. A black gumosis condition was observed on several eucalyptus trees on the Toro Negro State Forest. Examination of cross sections of a felled tree revealed black resinous pockets concentrated in irregular patterns along the annual growth rings (Fig. 4-A). Samples were collected from the resinosus pockets for laboratory culturing and diagnosis. No pathogenic fungi, however, were isolated from any samples. Subsequent discussions with Dr. Charles S. Hodges[3/], Principal Plant Pathologist, Southeastern Forest Experiment Station, Research Triangle Park, North Carolina, revealed that the gumosis condition is apparently a genetic characteristic of many *Eucalyptus* spp. Hodges related that a similar gumosis condition was frequently observed on *Eucalyptus* spp. plantings in Brazil. Consequently, with the possible exception of genetic selection and propagation of *Eucalyptus* spp. with inherently low incidences of gumosis, control action in regards to this condition is neither available nor warranted.

A basal stem canker disease was observed on one isolated windthrown tree in the *Eucalyptus deglypta* experimental planting on the Rio Abajo State Forest along with several *Eucalyptus* spp. trees on the Toro Negro State Forest. The fungus, *Diaporthe*

3/ Personal communication with C. E. Cordell in April, 1976.

cubensis, was isolated from basal stem canker sample material. This fungus has been recently associated with locally severe stem cankers (Fig. 4-B) and scattered mortality on several Eucalyptus spp. in Brazil and south Florida by Hodges.4/ Apparently this is the first reported occurrence of D. cubensis on Eucalyptus in Puerto Rico. The disease could represent a potential hazard to future Eucalyptus spp. plantings in Puerto Rico. Consequently, field forestry personnel should be alerted to this disease problem and instructed to report any suspected disease occurrence to the State and Private Forestry personnel for further diagnosis, evaluation, and recommendation of warranted control action.

An unidentified weevil (Curculionidae, subfamily Cryptorhynchinae) is presently causing considerable mortality to Eucalyptus deglypta Blume and Eucalyptus decaisneana Blume nom. illegit, in a provenance trial experimental planting by the Institute of Tropical Forestry on the Rio Abajo State Forest. Typical damage by this insect is larval mining in a girdling fashion on the main bole of the tree (Fig. 4-C). Larval girdling and mining in the tree often results in wind throw at the point of initial attack (Fig. 4-D). In many cases, larvae of this weevil were observed feeding and girdling in the root collar at ground level on young trees 3 to 4 inches in diameter at breast height. Both larvae and adult specimens of the insect have been forwarded to the Systematic Entomology Laboratory, Washington, D. C., for identification.

Lindane is registered for control of stem borers in trees and could be used on this insect problem if necessary.

Caribbean Pine (Pinus caribea)

With the exception of the Cylindrocladium damping-off problem detected on the P. caribea seedlings at the Monterrey Nursery, no additional disease or insect problems were observed in any of the several P. caribea plantings examined in Puerto Rico.

At least two root rot pathogens, however, may pose future serious threats to plantations of introduced P. caribea in Puerto Rico. Two species of Cylindrocladium (C. scoparium and C. clavatum) have recently been associated with localized severe pine plantation mortality in Brazil (Hodges and May, 1972). Trees up to 15 years old were killed in groups and pine hosts

4/ Personal communication with C. E. Cordell in April, 1976.

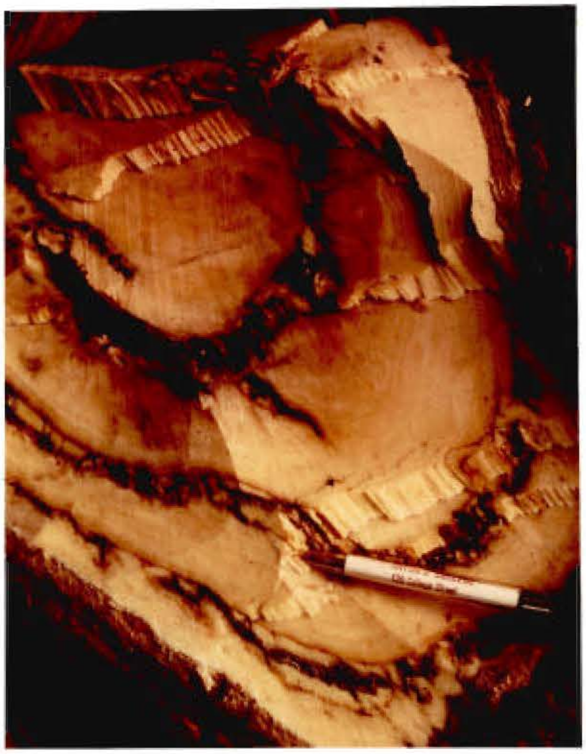
Figure 4. Insect and disease problems observed in *Eucalyptus* spp. experimental plantings in Puerto Rico.

A - Cross-section of *Eucalyptus* sp. basal stem showing typical black gumosis pockets occurring primarily in the annual growth rings.

B - Basal stem canker symptoms associated with *Diaporthe cubensis* infection on *Eucalyptus* spp. in south Florida.

C - Typical damage to *Eucalyptus deglypla* by the larvae of a weevil (*Curculionidae*, subfamily *Cryptorhynchinae*).

D - Example of stem breakage at point of insect attack.



A

B

C

D

included *P. caribea*. In addition, *C. scoparium* has been associated with mortality in a pole-sized yellow-poplar (*Liriodendron tulipifera*) plantation (Ross, 1967) and a pole-sized sweetgum (*Liquidambar styraciflua*) natural stand (Cordell and Rowan, 1975) near Athens, Georgia. The pathogenicity of three closely-related species of *Cylindrocladium* have also recently been demonstrated as causal agents of seedling damping-off and root rot of six southern United States pine species along with six *Eucalyptus* spp. presently grown in southern Florida (Cordell, 1976; Cordell, unpublished data). Therefore, the recent initial detection of *C. floridanum* on *P. caribea* seedlings in the Monterrey Nursery along with the above reports emphasizes the potential threat of this pathogenic soil fungus to *P. caribea* reforestation as well as nursery production.

Annosus root rot, caused by the fungus *Fomes annosus*, is perhaps the most serious root rot disease of pines and is generally distributed worldwide. Although *F. annosus* has not been detected in Puerto Rico, this fungus has a very widespread pine host range. Probably one of the major factors relating to the apparent absence of the fungus in the relatively young *P. caribea* plantations in Puerto Rico along with the isolated island locality, is the characteristic association of the disease with commercial-aged plantations and most frequently with thinnings. The fungus characteristically makes its entrance into healthy stands through freshly exposed stump tops and root grafts between the cut stumps and adjacent living trees. Mortality can be severe on some sites and can occur in less than 2 years following thinning. Mortality has been most severe in plantations established on former agricultural sites and on deep sandy soils with low water tables.

Recommendations for reducing the potential impact of these two serious root rot fungi to future *P. caribea* plantations will be discussed in a later section, Meanwhile, field foresters and land managers should be alerted to these diseases and any suspected disease occurrence should be promptly reported to appropriate State and Private foresters and plant pathologists.

Black Olive (Ucar) (*Bucida buceras*)

A mite, *Eriophyes buceras*, has been observed in many locations throughout Puerto Rico on the black olive, *Bucida buceras*. Feeding by the mites causes the tree to produce a purple-like substance on the leaves, limbs, and fruit of the tree. This substance then falls from the trees, staining pavement, cars, and anyone or anything under the trees. Black Olive is considered as one of the better ornamental and shade trees for the island and this pest is now making it somewhat less popular. Control of this pest can best be obtained through the application of a registered miticide.

Several foliage diseases were observed on black olive nursery seedlings and shade trees. Examination of foliage samples in the laboratory revealed the leaf fungi *Phyllosticta*, *Phoma*, and *Pestalotia*. Suggested control procedures for the nurseries and high-value shade trees will be included in a later section on foliage disease control.

The most damaging problem observed on black olive was associated with a variety of atmospheric contaminants in several localized areas. This abiotic disease problem will be discussed in a later section.

Kadam (*Anthocephalus cadamba*)

The thrips, *Selenothrips rubrocinctus* (Giard) on kadam, *Anthocephalus cadamba* continues to be a problem on the Liquillo National Forest, Puerto Rico. This damage was reported in three previous reports by Geary, T. F., 1970 (unpublished report), Phelps, W. R. and Landgraf, A. E., 1972 and Flavell, T. H. and Phelps, W. R., 1973. Concern for the tree has been voiced because of possible impact on tree growth rate and/or survival of this valuable timber species. As previously related, the insect attacks physiological old leaves and damage does not become visible until the leaves are nearly ready to drop. Flavell and Phelps (1973) recommended a routine growth study to check height and diameter changes with time. They also suggested that if the thrips damage is causing significant reduction in growth that possible solutions may include growing kadam in mixed stands or the selection of resistant clones. This practice has been successfull in Trinidad with cocoa to reduce damage by the same species of thrips (Flavell and Phelps, 1973). Chemical control at this time would be economically impractical.

Teak (*Tectona grandis*)

Another introduced hardwood tree species in the Puerto Rican and Virgin Island forests is teak. This is a valuable hardwood timber species with good quality sawtimber selling at $3,000 per MBF. Teak wood is highly recognized for such diverse uses as furniture, building materials, ties, poles, and fence posts.

A severe and widespread stem canker and rot disease problem was pointed out and observed on teak sawtimber-size trees on the Rio Abajo State Forest. Basal as well as mid-stem cankers (10 feet or more above ground) were observed on several trees (Fig. 5). Examination of the cankers also revealed a pronounced advanced rot pattern, extending above and below the cankers and into the sapwood beneath them. These symptoms suggested the presence of a canker-rot fungus and samples were collected from canker margins and stem cross sections for laboratory culturing and diagnosis. Fungi isolated from symptomatic tissues were forwarded to the United States Forest Service mycological laboratory at Madison, Wisconsin, for identification. Fungus culture examinations at the Asheville, North Carolina, laboratory suggested the isolated fungi to belong to the fungus order Basidiomycetes, which contains the vast majority of the hardwood stem rot and canker fungi. Results of the fungi identifications will be forwarded when available from the Madison mycological laboratory.

Phelps and Landgraf (1972), observed an apparently somewhat similar canker disease problem on teak in an experimental planting on St. Croix where the fungus, _Hypoxylon_, was associated with the canker. No evidence of _Hypoxylon_ was observed either on the cankers or in laboratory cultures relative to the present teak canker-rot problem on the Rio Abajo State Forest.

Silvicultural control measures designed to reduce the future disease impact in the high-value teak sawtimber stands will be outlined in a later section and were discussed with the State forest manager and State and private forester, Jose Zambrana.

Kapok (_Ceiba pentandra_)

The kapok, _Ceiba pentandra_, defoliation previously observed in 1973 by Flavell and Phelps was again present at the time of this evaluation. The insect was not present on the trees, however, but the trees had sustained about 50 percent or more defoliation. The defoliation was confined to the large trees in the Caneel Bay Plantation and the Virgin Islands National Park, St. John, Virgin Islands. Additional efforts should be made to collect specimens of this defoliator for identification purposes. Feeding by the insect probably occurs sometime between late April and September.

Figure 5. Diseases observed on teak, <u>Tectona grandis</u>, on the Rio Abajo State Forest. Large stem canker on bole of a sawtimber size tree.

Mahoe (*Hibiscus elatus*)

A unique bark pattern condition was pointed out and observed in mahoe plantings on the Toro Negro State Forest. Trees with smooth- and rough-bark characteristics were interspersed throughout the plantings (Fig. 5-A-B). Forestry personnel were concerned about a fungus causal agent for this problem. Examination of several bark surfaces along with tree cross sections cut through the roughened bark, however, failed to reveal any evidence of a disease or insect causal agent. The bark patterns and distribution within the mahoe plantings suggested a high probability that this phenomenon is genetic in origin. Smooth-bark and rough-bark trees frequently occurred in close proximity in the stands with a high proportion of both types observed (Fig. 6-A-B). Similar bark patterns have been observed by the authors in several *Eucalyptus* spp. plantings in south Florida and are also considered to be genetically inherent in this hardwood tree genus. Consequently, direct control measures are neither practical nor warranted for this bark condition. A possible practical solution, if desired, would involve the selection and vegetative propagation of mahoe with the smooth-bark condition. Since smooth-bark mahoe is highly desired and much more practical for peeled fence posts, the genetic selection approach may warrant considerations in the future.

A few isolated windthrown and stem-damaged mahoe were also observed in a young planting on the Toro Negro State Forest similar to the 15-year-old planting observed by Flavell and Phelps (1973). Examination of exposed root systems and damaged stems, however, failed to reveal any discernible disease or insect causal agents. Laboratory cultures of symptomatic stem samples also failed to reveal any pathogenic fungus organisms.

Mistletoe (*Phoradendron* spp.)

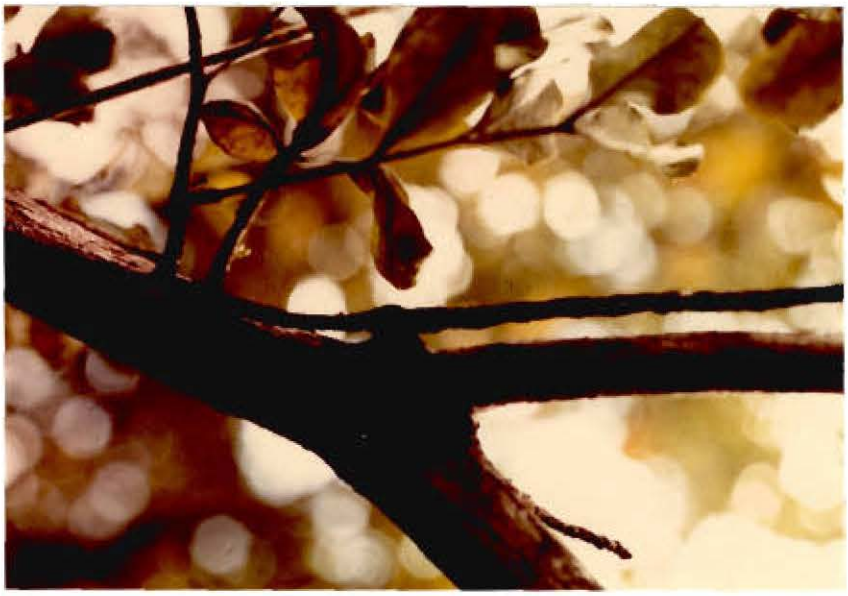
Two species of parasitic mistletoes were observed - the first on a fig (*Ficus* sp.) on the Rio Abajo State Forest and the second on a dwarf almond (*Terminalia* sp.) at the Fountain Valley Nursery, St. Croix, Virgin Islands. The typical mistletoe parasite-host tree condition was observed in both cases (Fig. 7). A number of *Phoradendron* spp. have been observed and described as parasites on a variety of tree hosts throughout Puerto Rico and the Virgin Islands. Since the mistletoes are true parasites, they extract variable quantities of nutrients and water from the host tree. Although mortality is rare, notable host tree growth reduction

Figure 6. A natural stand of mahoe, _Hibiscus elatus_, on the Toro Negro State Forest with trees displaying the rough-bark (A) and smooth-bark (B) characteristics.

A

B

Figure 7. Mistletoe (*Phoradendron* sp.) parasite observed on dwarf almond (*Terminalia* sp.) at the Fountain Valley Nursery, St. Croix, V.I.



may result from heavy mistletoe infection. Another significant growth reduction factor may result from reduced photosynthesis by the host tree foliage as a result of competition and shading-out by abundant mistletoe growth.

Any control desired on high-value trees, viz., shade and ornamental trees and experimental plantings, can be achieved by pruning out host tree branches with mistletoe infection. When possible, infected branches should be pruned at least 6 to 12 inches proximally (towards the main stem) from the closest mistletoe infection. Periodic followup examinations of pruned trees are warranted to assure eradication of all mistletoe infection.

Papaya (Carica papaya)

The Federal Agricultural Experiment Station in St. Croix, United States Virgin Islands, has been testing several varieties of papaya (Carica papaya) from all parts of the tropical world for over 20 years. There are 45 species of papaya that are indigenous to the West Indies and Central America. Papaya is one of the fastest growing plants, bears fruit when one year old, and produces the most popular tropical fruit in the world (Hargreaves and Hargreaves, 1965).

In 1955, a very damaging disease problem was initially observed on several varieties of papaya, particularly the desirable "solo" variety, in St. Croix, Virgin Islands, Bird, et. al. (1966) reported their field evaluation and experimental test results of the papaya disease problem which included detailed symptom descriptions, fungus isolations from symptomatic hosts, host inoculation procedures, and suggested control measures.

Dr. Darshan Padda, Research Horticulturist, College of the Virgin Islands Experiment Station, St. Croix, Virgin Islands, requested the authors examine the papaya disease problem in a varietal progeny experimental planting at the Federal Agricultural Experiment Station. Disease symptoms observed on the affected papaya test plants were apparently very similar to those previously described by Bird, et. al. (1966) and consisted of chlorotic (yellowed) and wilted foliage along with dwarfed fruit (Fig. 8-A). In addition, there were conspicuous discolored, slightly-sunken, water-soaked spots on the stems (Fig. 8-B). Samples were collected from symptomatic stem tissues for laboratory culturing and diagnosis. Excavation and examination of roots on several symptomatic papayas revealed no evidence of root disease or insect presence. Symptomatic papaya samples were also forwarded to Dr. Carter Seymour, Plant Pathologist,

Figure 8. Papaya (*Carica papaya*) disease problem observed on St. Croix, U.S. Virgin Islands.

A - Chlorotic (yellowed) and wilted foliage symptoms along with dwarfed unmerchantable fruit.

B - Close-up of discolored, slightly-sunken, and water-soaked ("greasy" appearance) stem symptoms.

A

B

Florida Division of Plant Industry, Gainesville, Florida, for diagnosis and evaluation of a possible virus or mycoplasma causal agent. Seymour (1975) describes a virus disease on avocado (Persea americana) that is fairly widely distributed in southern Florida. Disease symptoms described for the avocado virus disease were also somewhat similar to those presently observed on the St. Croix papaya.

Bird, et.al. (1966) consistently isolated two fungus pathogens, Corynespora cassiicola and a Botryodiplodia sp., from various tissues of symptomatic papaya. These consistent fungus isolations, successful fungus reinoculations and similar symptom development on papaya hosts, along with the absence of any virus, mycoplasma, or root disease evidence led them to the conclusion that the two related foliage and stem isolated fungi were primarily responsible for the disease. Results of the present laboratory analyses will be forwarded to the appropriate concerned agencies when available.

Dr. Padda demonstrated the results of a preliminary genetic selection and propagation experimental study where progeny obtained from one apparently disease-resistant papaya parent showed considerable disease resistance as compared with previously known susceptible progeny. This is probably one of the most effective long-range control approaches to the disease problem. However, as Dr. Padda repeatedly emphasized, present effective and practical control measures are urgently needed in the interim period. This is a very serious and rapidly spreading disease on St. Croix that is apparently already a serious hazard to papaya production.

There is no experimentally-proven effective chemical control either presently available or registered for the papaya disease. Several possible fungicide protective sprays and soil drenche were discussed with Dr. Padda that should warrant future consideration for disease control efficacy and host toxicity field testing. A number of new promising fungicides are presently available that have provided effective control of similar diseases on other plants. Published data and results concerning these fungicides and control efficacy on several host species have been forwarded to Dr. Padda.

One of the major problems encountered in obtaining approval and registration of any suitable experimentally-proven fungicide for the present disease will involve the expansion of the particular fungicide to include papaya in the Virgin Islands. Such pesticide use expansion frequently requires considerable effort and financial expenditures by the basic producer. Consequently, a substantial anticipated increased pesticide market may be required to offset these expenditures.

Ornamentals and Shade Trees

The cottony cushion scale, Icerya purchasii Maskell was found on two species of flowering shrubs in the Caneel Bay Plantation's Nursery, St. Johns, United States, Virgin Islands. Cafeillo, Ixora ferra (Jacq.) (Fig. 9-A), frangipani Plumeria alba L. and P. rubra L. were heavily infested with this scale. Another unidentified flowering shrub was also heavily infested with the scale (Fig. 9-B).

The Cafeillo was also covered with "sooty mold," caused by the fungus (Capnodium sp.), which grows on the "honeydew" excreted by the scales (Fig. 9-C). This mold makes the plant quite unattractive. Three registered pesticides Carbaryl, Trithion®, or Malathion can be used to control this scale. For maximum control effectiveness, the insecticidal spray should be timed to coincide with scale crawler emergence and the plants must be thoroughly wetted on both the upper and lower leaf surfaces. Sooty mold was also observed on red manjack, Cordia callococca L. Near the main dining area at the plantation. Finally, a leaf beetle, Altica sp. was observed feeding on various species of Jussiaea and coffee on the Toro Negro State Forest, Puerto Rico (Fig. 9-D). This insect is a leaf feeder and can do considerable damage to young plants. Carbaryl and Malathion are also registered for control of leaf beetles.

Sea Grape (Coccolobis unifera)

Several insects were observed on sea grape, Coccolobis unifera, a valuable plant for beach erosion control and windbreaks in Puerto Rico and the Virgin Islands. The leaf-rolling weevil, Euscelus coccolobae Wolcott, was observed in widespread locations in both Puerto Rico and the Virgin Islands, but was not causing serious damage. In 1973, Flavell and Phelps observed a Lepidopterous tip moth infesting the terminals of sea grapes on the Virgin Islands National Park, St. Johns, Virgin Islands. The same insect was observed during the present evaluation, however, it was very scarce and difficult to find. The leaf miner, Eunebristis zingrella, was also observed on the Virgin Islands National Park, St. Johns, Virgin Islands (Fig. 10-A). This insect probably will never reach sufficiently-high population levels, however, to cause significant damage to the host. The most serious insect pest of sea grape, a stem

Figure 9. Insects and diseases affecting ornamentals, shrubs, shade trees and plants in Puerto Rico and the U.S. Virgin Islands.

Cottony cushion scale damage on (A) the plant shrub Cafeillo (Ixora ferra) and (B) an unidentified flowering shrub in the Caneel Bay Plantation Nursery, St. Johns Virgin Islands.

C - Sooty mold (capnodium sp.) fungus symptoms observed in association with the scale infestations on the plant shrubs at the Caneel Bay Plantation Nursery.

D - Adult leaf beetle Altica sp. observed feeding on Jussiaea spp. and coffee plants in the Toro Negro State Park.

A & C

B

D

borer, Psychonoctua personalis (Lepidoptera cossidae), was observed by Flavell and Phelps in 1973 and again during this evaluation. This stem borer affects the main trunks of large sea grapes and was observed at the Caneel Bay Plantation, St. Johns, Virgin Islands. Stem damage to some plants was sufficiently extensive to cause appreciable breakage by light to moderate winds. As previously indicated, lindane is registered for control of stem borers in trees and could also be used on this insect problem if necessary.

Several additional diseases were also observed on shade and ornamental trees and plants in both Puerto Rico and the Virgin Islands. A listing of plant hosts and diseases observed is as follows:

Sea grape (Coccolobis unifera)	- Phyllosticta, Phoma, and Pestalotia - leaf spots and blights (Fig. 10-B).
Queen of Flowers (Bauhinia sp.)	- Phyllosticta and Uromyces jamaicensis - leaf spots and rust (Fig. 10-C).
Black Olive (Ucar) (Bucida buceras)	- Phyllosticta - leaf spot.
Acacia (Albizzia sp.	- Mechanical (machete) damage on lower stem and Polyporus lucidus root- and butt-rot (Fig. 10-D).
Saman, Raintree (Samanea saman)	- Slime flux caused by bacteria. Drain pipes are installed to drain off slime flux and reduce internal tree pressures produced by the infectious bacteria in host tree heart wood and phloem tissues (Fig. 11-A).

Salt spray damage was evident on exposed foliage of several shade and ornamental trees and plants in the Condado, Puerto Rico, beach front area (Fig. 11-B and C) and at Fort St. Cristobel in old San Juan. Coconut palms (Cocos nucifera) displayed symptoms of probable salt spray damage at the St. Cristobel Fort area.

Finally, examination of numerous palms in both Puerto Rico and the Virgin Islands did not reveal any evidence of the dreaded lethal yellows virus disease that has been so destructive on coconut palms in southern Florida during recent years. Continued surveillance should be maintained for this disease, however, and any suspected occurrence should be promptly reported to appropriate plant pathologists for subsequent disease diagnosis and evaluation.

Figure 10. Insects and diseases affecting ornamentals, shrubs, shade trees, and plants in Puerto Rico and the U.S. Virgin Islands.

A - Leaf miner damage caused by *Eunebristis zingrella* on a sea grape leaf on the Virgin Islands, N.P., St. Johns, V.I.

B - Leaf spot and blight symptoms caused by the fungi *Phyllosticta*, *Phoma*, and *Pestalotia* observed on sea grape foliage in Puerto Rico and the Virgin Islands.

C - Leaf spot and rust symptoms caused by the fungi *Phyllosticta* and *Uromyces jamaicensis* observed on Queen of Flowers (*Bauhinia* sp.) in Puerto Rico.

D - *Polyporus lucidus* fruiting body growing at the base of an Acacia (*Albizzia* sp.) tree at the Annaberg Sugar Mill ruins on the Virgin Islands N.P., St. Johns, V.I.

A

B

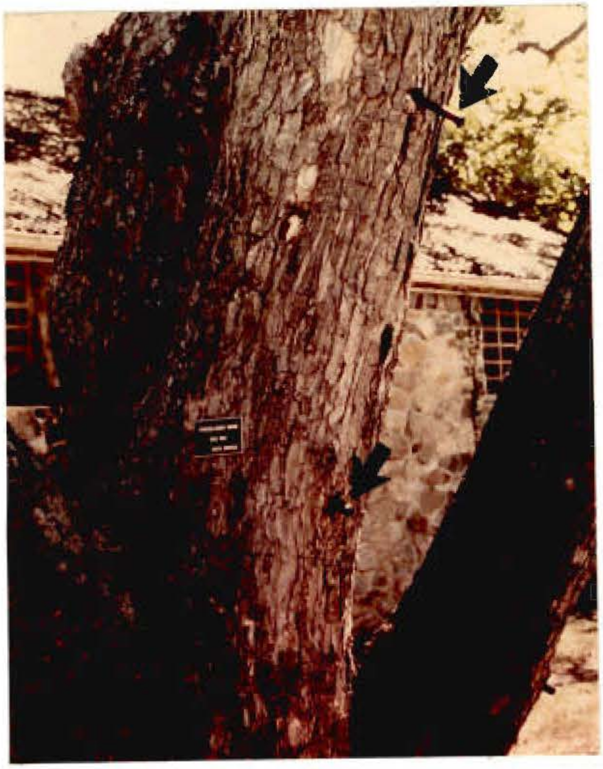
C

D

Figure 11. Diseases affecting ornatmental, shrubs, and shade trees and plants in Puerto Rico and the U.S. Virgin Islands.

A - Slime flux caused by bacteria on Saman or raintree (Samanea saman) at the Caneel Bay Plantation resort area, St. Johns, V.I. Drain pipes (arrows) have been installed in tree bole to drain off the slime flux and reduce internal tree pressures produced by the bacterial infection.

B - Salt spray symptoms and damage observed on foliage of a rubber plant (B) and Queen of Flowers tree (C) in the Condado beach front area, Puerto Rico.



A

C

B

Environmental Pollution

Environmental pollution sources and apparent host plant damage continued to be quite evident and seemed to be increasing around industrial complexes and municipalities in Puerto Rico and the Virgin Islands. Several industries were emitting variable quantities of visible smoke, particulates, and various gasses into the atmosphere (Fig. 12-A). Automobile and other associated urban emissions were quite apparent in highly populated towns such as San Juan, Puerto Rico. Symptoms of environmental pollution damage were evident on a variety of trees and ornamental plants in these areas. Damaged tree species included West Indies mahogany, mango (Fig. 12-B), almond, moca, and black olive. A very high incidence of black olive mortality was observed in naturally-forested areas adjacent to the Guayahilla industrial complex near Ponce, Puerto Rico (Fig. 12-C). However, foliar symptoms and overall damage on figs (*Ficus* spp.) growing within the industrial boundary were slight when compared with the foliage symptoms, terminal dieback, and mortality observed on adjacent mango, mahogany, almond, and black olive (Fig. 12-D).

Increased urbanization and industrialization in Puerto Rico and the Virgin Islands will undoubtedly result in a corresponding increase in environmental pollution and damage to host plants. Two of the most practical means of slowing this increase are:

1. Identification and toxic emission reduction of pollutant sources.

2. Propagation of the more resistant tree species such as the figs in high-hazard areas.

Discussion and Recommendations

A variety of both conifer and hardwood insect and disease problems were observed during this evaluation along with several additional problems on shade and ornamental trees and plants. These included root, stem, branch, and foliage problems in nurseries, experimental plantings, reforestation, and ornamental and shade trees. Consequently, this tropical caribbean area apparently affords a good habitat for a variety of tree and plant insects and diseases in association with the large variety of host tree species encountered.

Figure 12: Environmental pollution symptoms and damage observed on tree species in Puerto Rico.

A - Typical industrial source (sugar refinery) of atmospheric smoke and gas emissions.

B - Crown dieback symptoms observed on mango (Mangifera) at the Guayahilla Industrial Complex near Ponce, P.R.

C - Black olive (Bucera bucerus) mortality (gray-stem trees) observed in a naturally-forested area near the Guayahilla Industrial Complex.

D - Absence of foliage symptoms and damage observed on fig (Ficus sp.) (arrow) as compared with extensive symptoms and damage observed on several adjacent tree species growing within the Guayahilla Industrial Complex boundary.

A

B

C

D

The root diseases (Cylindrocladium and Fusarium) at the Monterrey Nursery represent an immediate area of concern and where additional disease diagnosis and control evaluations should be considered. Nursery seedbed control evaluations should be established to determine the effectiveness of previously experimentally proven soil fumigants and fungicides for control of these pathogenic soil fungi at the Monterrey Nursery. The development of a seedbed fertilization program for the nursery through cooperation by research scientists at the ITF, pathologists of SEA, S&PF, and University of Puerto Rico scientists should also be a high priority consideration of future nursery management plans. In addition, the nursery seedlings should be evaluated for mycorrhizal feeder root development. Any significant feeder root mycorrhizal deficiencies detected may be alleviated by seedling growth media inoculations with selected mycorrhizal fungi along with manipulation of growth media fertility, pH, etc. The Southeastern Area, State and Private Forestry nursery disease specialist will be available to assist with any aspects of this work as needed and desired.

Two other root disease problem areas of immediate concern are the potential root rots (Cylindrocladium and Fomes annosus) in experimental plantings and reforestation of Caribbean pine along with several hardwood species. As previously pointed out, these two potentially-serious disease problems should be brought to the immediate attention of all concerned research, university, and field forestry personnel. Field forestry personnel should be trained to recognize the diagnostic host symptoms and fungus signs associated with these diseases and any suspected occurrence should be promptly reported to appropriate personnel for further action. Considering the unique island isolation factor involved, the probability of F. annosus invasion in Puerto Rico is relatively low as compared with the United States mainland. Consequently, with the fungus Cylindrocladium already established in the P. caribea seedlings, it represents a considerably higher potential hazard to field plantings. The earliest possible detection of either disease occurrence, however, will facilitate the most expedient followup evaluation and control action as required. Special precautions should also be taken to prevent the transport of any infected P. caribea seedlings or infested soil from the Monterrey Nursery. The root systems of all seedlings to be outplanted should be carefully examined for root rot symptoms at planting date and all seedlings with root rot should be properly disposed of by burning or burial in a "safe" quarantined area. Mechanical transport is a primary means of spread of Cylindrocladium and the fungus can survive for extended periods of time on buried plant tissues and even in free soil. Consequently, the most effective action presently needed in reducing the potential impact of these diseases is prevention and early detection.

Additional evaluations are needed concerning the mahogany root disease problem in the Carite State Forest experimental plantings along with the eucalyptus plantings on the Rio Abajo and Toto Negro State Forests. Meanwhile, all concerned agencies and personnel should be familiarized with these problems and instructed to report similar disease occurrences when encountered. These supplementary evaluations should be included in future examinations of disease and insect conditions in Puerto Rico and the Virgin Islands by SEA, S&PF pathologists.

A *disease evaluation survey* to determine the incidence and impact of the teak stem canker disease problem should be conducted by the S&PF forester. Field forestry personnel should also be trained in regards to the disease symptoms, damage characteristics, and possible methods of reducing the disease impact to future teak stands. In addition, the establishment of disease evaluation plots designed to determine the various relationships of stem canker characteristics, site, and silvicultural techniques with subsequent disease mortality and impact would be very beneficial in obtaining needed information in making future timber management decisions regarding this disease problem. Meanwhile, field foresters are presently removing all merchantable teak with obvious stem canker damage in an effort to salvage affected trees prior to mortality and thereby reduce the overall disease impact. This practice should be continued until alternative actions are dictated by subsequent field evaluations and disease plot impact data.

A disease evaluation and research plan should be incorporated into the papaya research studies at the Virgin Islands Research Station on St. Croix. As previously indicated, this is a very severe and economically-significant disease problem where considerable disease evaluation and research are apparently warranted. Data concerning the disease impact, infection process and methods of spread, and effective registered chemical control procedures are urgently needed. Dr. Padda has been forwarded requested literature and suggestions concerning possible methods of reducing the future disease impact. Dr. Carter Seymour, Florida Department of Agriculture plant pathologist, has also agreed to assist with future diagnosis and evaluation of the disease.

As needed and desired, the variety of tree and ornamental plant foliage disease problems can be controlled by properly timed sprays using such fungicides as Benlate (benomyl), Manzate (maneb), and Daconil (bravo). Considering the difficulty of disease occurrence predictions in this subtropical environment, the most effective treatment alternative probably consists of biweekly systematic sprays following the initial occurrence of disease symptoms. All Federal and Commonwealth pesticide regulations along with the instructions concerning dosage rates, application procedures, safety precautions, etc., included on respective fungicide, labels should be closely adhered to.

is unlawful to use a pesticide product inconsistent with labeling as stated in the Federal Insecticide, Fungicide, Rodenticide Act, as amended, Section 12 (a)(2)(G).

ally, the occurrence and significance of observed disease insect problems should be discussed with all concerned estry-related agencies in Puerto Rico and the Virgin Islands. s will facilitate the opportunity for increased cooperative jects with such agencies as the University of Puerto Rico, lege of the Virgin Islands, Caneel Bay Plantation, and the ional Park Service in future coordinated forest pest action grams.

est Insect and Disease Management has the responsibility the detection, evaluation and control of any insect or ease related problems. Therefore, either the Asheville, th Carolina, Field Office or the Atlanta, Georgia, Area ice should be notified of any such problems.

est Resource Protection also has a pesticide coordinator in Environmental Quality Evaluation Group who could be helpful obtaining information on pesticides registered for a particu- insect or disease problem. Any usage of pesticides on eral lands should be cleared through the Forest Insect and ease Management Group at either Asheville, North Carolina, Atlanta, Georgia. We are also available for technical istance to the Commonwealth of Puerto Rico and the United tes Virgin Islands Government.

is our recommendation that the next insect and disease luation be scheduled for the spring (April or May) of 1977. s is considered as the season of maximum insect and disease ivity in Puerto Rico and the United States Virgin Islands.

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APPENDIX

Areas visited and personnel contacted by the authors during the 1976 insect and disease evaluation of Puerto Rico and the United States Virgin Islands.

Institute of Tropical Forestry, Rio Piedras, Puerto Rico

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Leon Liegel, Research Forester
Robert Venator, Research Forester

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Silrerio Medina, Entomologist
J. C. Garcia, Entomologist
Dr. Roman, Entomologist

Cruv Metropolitan Nursery, San Juan, Puerto Rico

Nursery Superintendent

Monterrey Commonwealth Nursery, near Dorado Beach, Puerto Rico

Nursery Superintendent

Caribbean National Forest (Liquillo), Sabina Ranger District

Jose Lefebre, District Ranger
Jorge Negron, Forestry Technician

Rio Abajo State Forest, Puerto Rico

Forest Manager

St. Croix, United States Virgin Islands

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Larry Bough, Forester, United States Virgin Islands

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Dr. Darshan S. Padda, Research Horticulturist

Fountain Valley Nursery, St. Croix, United States Virgin Islands

Ralph Cochrane, Nursery Manager

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