UNASYLVA No. 78 - FAO/IUFRO symposium on forest diseases and insects ...

www.fao.org/docrep/24847e/24847e02.htm Salinan

1. The importance of forest diseases and insects

The economic losses from forest diseases and insects were brought into focus for the first time on a worldwide basis at this Symposium. Reports from almost every major part of the world described losses from pests and pestilences either in killing forest trees and nursery seedlings, reducing growth, destroying wood in the living tree or in reducing the quality of wood or the quality of growing stock.

Intensive studies of diseases in the United States indicate that the losses caused in a sample year (1952) amounted to 35 percent of the gross annual growth. While diseases caused the greatest total impact of all injurious agents, including fire, in the United States, insects caused the heaviest mortality. Similar heavy impacts on forest production are estimated for Canada. To reduce these losses, the United States and Canada now employ several hundred forest entomologists and forest pathologists to develop and improve preventive and remedial measures and to detect and control epidemic outbreaks.

While the Symposium brought out that timber volume losses, in terms of decay and insect-caused mortality, are greatest in the old-growth natural stands of the world, the main concern of the future, as more and more natural stands are replaced by planted or otherwise artificially regenerated forests, are the new problems now appearing all over the world that are associated with man-made forests, the use of exotic species, monocultures, and large plantings of uniform age. Interference with the natural forest, which is so necessary for the efficient production of wood of desired species, has created many new disease and insect problems.

Thus, disease and insect losses associated with overmaturity in North America, Africa, India, Europe, and other parts of the world, are giving way to new types of problems resulting from our intensive nursery practices, the growing of planted forests, and the culture of second-growth forests.

FIGURE 1. - Windthrown white pine (Pinus strobus) following rotting of roots by Fomes annosus. This fungus has come from relative obscurity to become one of the major threats to North American coniferous plantations. (Photo: United States Forest Service)

FIGURE 2. - Typical brooms caused by dwarfmistletoe (Arceuthobium vaginatum f. cryptopodum) in ponderosa pine. A tree killed by heavy infection. Spread and intensification is accomplished primarily by explosive fruits. (Photo: United States Forest Service)

It is often very difficult to estimate realistically the losses from forest insects and diseases, but reliable examples of damage severe enough to have a major impact on the timber economy were cited from many parts of the world. Thus, bark beetles are currently ravaging the pine forests of Honduras, the mahogany shoot borer (*Hypsipyla*) is damaging to many related species throughout the tropics, bagworms recur severely and can completely defoliate wattle in parts of South Africa, caterpillars cause major defoliation in Pakistan, *Sirex noctilio* has been associated with the death of large numbers of pine in New Zealand, a scale insect has practically destroyed the cedars (*Juniperus*) of Bermuda, and both defoliators and bark beetles annually destroy millions of cubic feet of timber in North America The balsam woolly aphid (*Adelges piceae*) which is probably of European origin, is heavily damaging certain species of *Abies* in North America. These examples of major insect damage are only a few of those described at the Symposium.

In many countries, mainly in the tropics or subtropics, the actual and potential losses from insects and decay to wood in use is as great or greater than losses to the forest. Thus, the enormous cost of the preservative treatment of wood the world over must be charged to borers, termites, and rot; and the replacement of wood by other building materials must often be charged to the same causes. Between the time logs and lumber are cut and used, they are often subject to attack by stain, decay, and insects.

Quantitative examples have been cited of the loss from diseases in the United States which amounted to 35 percent of the gross annual increment, and Canadian disease losses amount to almost 36 million cubic meters per annum. In addition to these nationwide damage estimates, specific cases of major economic losses to forests from disease were given from all over the world.. Some examples are as follows: virtual extermination of the American chestnut by the blight fungus, major losses to sandalwood (*Santalum*) in India from the spike-disease virus, the "writing off" of 1,620 hectares of planted *Pinus radiata* in Kenya due to *Dothistroma* leaf disease, interference with the culture of poplar cultivars in Europe because of leaf diseases and a bacterial canker, the loss of millions of trees from the vascular *Fusarium* wilt of *Albizia* in Iran, southern Russia, and in the Western Hemisphere, the incalculable losses in Europe and North America from the Dutch elm disease, and millions of dollars in lost wood volume and in control costs resulting from conifer rusts, especially in North America. Mistletoes cause great losses in Europe, for example, reducing volume growth by 19 percent in Yugoslavia; and dwarf mistletoes are estimated to reduce growth by 10 percent in the west of the United States.

Only a few countries have tried to quantify their losses from forest diseases and insects. Such quantification is best accomplished when the specialists in each type of impact, for example, disease, insects, fire, animals and weather, work in conjunction with the forest economists responsible for a country's forest resource statistics. In this way, the combined losses cannot amount to more than the total timber-production potential of a stand, an area, or a region, and some degree of standardization of methods of computing losses from destructive agents can be achieved. While some progress in this field of more and better quantification of losses in relation to growth increment, on a national scale, has been made, mainly in North America, the urgency to have more countries engage in this work was stressed at the Symposium. Appropriations for research and control often depend upon valid estimates of the losses caused by destructive agents. Such quantification also tends to channel research into the main sources of economic damage rather than into the personal interests of the research personnel.

The economics of disease and insect control expenditure involves far more than equating expenditure for successful control against value or timber destroyed. Where the timber destroyed is inaccessible, and would not have entered commerce anyway until replaced by another generation, dead timber may represent little or no loss. Park, recreational, and wildlife values are tangible yet difficult to assess.

In the United States, detection of insect outbreaks or disease is followed by appraisals of risk if no control is undertaken, together with evaluation of control methods available as to cost and probable effectiveness, and then a decision is made by a team of foresters and specialists as to the best course to be taken.

The roles of the three main means of disease and insect control, that is, silvicultural, biological and chemical, were presented to the Symposium. Silvicultural control measures have been used more in connection with diseases, and biological and chemical measures more in connection with insects, but all three have places in the control of certain diseases and insects.

Silvicultural control has greatly reduced the incidence of many diseases, at virtually no cost since the new systems of silviculture adopted were good ones aside from having pathologic benefits. Thus, lowering rotation ages has greatly reduced heart rot, keeping fire out of hardwood stands has greatly reduced butt rot, using fire as a silvicultural tool in reproducing longleaf pine (*Pinus palustris*) stands in the United States has been shown to control the brown-spot disease.

Pruning for quality lumber stops many kinds of branch cankers from becoming trunk cankers. Using an alternative resistant species in place of one sustaining disease or insect losses, is in practice in many parts of the world. Thus, silvicultural control is the most desirable of all measures, since it is preventive, and makes the most of host resistance and avoidance of attack, often at little or no cost, because the measures adopted are in harmony with other forest management objectives. The Symposium agreed that maximum use should be made of the silvicultural approach to control of diseases and insects.

Important new techniques are available today in the biological control of insects. Some have been highly successful in controlling forest insects. They include:

(a) introduction of entomophagous insects into new areas;
(b) microbial control;
(c) genetic manipulation;
(d) conservation of natural enemies;
(e) application of chemical or physical stimuli, and integrating several methods.

An excellent example of a self-perpetuating control of an insect through biological control was the sudden disappearance of the immensely damaging European spruce sawfly as a result of virus disease of the sawfly larvae acting in concert with some imported parasites. Another was the case of a damaging Eucalyptus beetle, which was introduced into Africa from Australia and was controlled by an egg parasite.

Biological control is essentially applied ecology. Biological control agents, by tending to be self-perpetuating, offer, like silvicultural measures, cheap, effective, and "natural" means of control.

Chemical control measures are in wide use in many countries throughout the world. They tend to be rapidly effective, easily applied (for example, by airplane), and available against many insects and fungi. However, the economics of their use over large areas of forest is highly complex. Since they are seldom selective and can have many harmful side effects to beneficial insects, fungi, man, fish, animals, and birds, these considerations enter into estimations of the value of using them. They have clear economic value in protection against soil-borne and airborne nursery insects and fungi through soil fumigation and sprays. They may have less clear ultimate economic value, in spite of rapid reduction in insect populations, against forest defoliators and bark beetles. The Symposium, in citing experience on every continent and in every climatic situation from tropical to subarctic, stressed not only the new disease and insect problems created by man-made against natural forest, but also stressed the fact that because of the expected higher returns, extra expense may be justified to protect a forest that has required large financial outlay to create, through nursery costs, site preparation and planting, than a forest inherited with the land, as in the case of the natural forest.

FIGURE 3. - P. radiata defoliated by Selidosema suavis. Forest on plains of Canterbury, N. Z. in dry climate, approx. 25 inches (635 mm) rainfall per year. All suppressed and subdominant trees killed, codominants defoliated up to three quarters of green crown, and dominants approximately one half. Epidemic contained by virus. (Photo: New Zealand Forest Service)

These out-of-pocket economic considerations are leading to such measures against the new problems associated with planted forests, as stump treatment against *Fomes annosus* rot in England, nursery stock treatment against *Hylobius* weevil attacks on the Planting sites in America and Europe, phosphate soil dressing to combat fused-needle disease of pine in Australia, and many other practices not a part of silviculture under conditions of natural regeneration.

Control efforts against insects using direct chemical means had an early special appeal because of the dramatic rapid reduction of insect populations accomplished. However, the side effects already noted have put many of these measures under a cloud of adverse public opinion and of close official scrutiny. Chemical fungicides are seldom used against diseases in the forest. The forest pathologist can rarely hope to achieve disease reduction by reduction in amount of inoculum except in the case of the dwarf mistletoes (Loranthaceae). Therefore, the success of his measures, which include:

(a) stand composition (tree species) manipulation;
(b) achieving a diversity of age classes;
(c) avoiding injury from fire and logging, and
(d) lowering rotation ages,

although often effective, have been less obvious, even to foresters, than the killing of large numbers of insects by insecticides. Thus, forest pathology aims at becoming more and more "preventive medicine" rather than attempting to deal with curative measures on serious diseases attacking trees on hundreds of thousands of acres of wild land. The best control of a disease or insect is to have a tree that cannot be seriously attacked or a stand that can sustain the attack.

While this Symposium opened the subject of the magnitude of investment justified to prevent or control disease and insect at-back, it soon became apparent that hardly two outbreaks were alike, and this subject could not be generalized. Many specific cases were dealt with ranging from the question of trying to control the balsam woolly aphid in the southeastern United

States where only recreational values were involved, to the question of controlling dwarf mistletoes to protect the water conservation value of certain forests, to the question of controlling many insects affecting strictly wood production.

The appraisal of the impact of every important insect attack or new disease situation must include every aspect of the silviculture and economics of the forest affected if these appraisals are to have value in determining control efforts and the direction that research should take.

Intercontinental spread of forest pathogens and insects and the appraisal and prediction of hazards

The sessions of the Symposium at Oxford emphasized that natural and planted forests throughout the world are threatened by numerous damaging forest pathogens and insects. The hazards of intercontinental spread of these pests and the inherent problems of appraisal and prediction were the subjects of three major papers[1] with many other contributions providing pertinent data.

[1] HEPTING, G. H. Appraisal and prediction of international forest disease hazards.

NORDIN, V. J. The intercontinental spread of forest pathogens.

SIMMONDS, F. J. The spread of forest insects in the world, with particular reference to biological control.

This chapter reviews the information with particular reference to the risks and methods of intercontinental spread and to procedures for appraising and predicting pathogens and insects as internationally dangerous.

Risks of intercontinental spread

Previous records of intercontinental spread of forest pathogens and insects discussed at this Symposium verified the extreme damage and devastation that can result from an introduction of a pathogen or insect to another continent. Chestnut blight (*Endothia parasitica*) was cited as an example of an introduced disease that eliminated a commercially important tree species in the United States and the Symposium was reminded frequently that white pine blister rust (*Cronartium ribicola*) and Dutch elm disease (*Ceratocystis ulmi*) continue to cause severe annual losses in plantations, natural forests, woodlots, and urban areas in many parts of the world. Examples of the many destructive introduced insects included the larch sawfly

(*Pristiphora ericsonii*), balsam woolly aphid (*Adelges piceae*), European pine shoot moth (*Rhyacionia buoliana*), and the fall webworm (*Hyphantria cunea*).

FIGURE 4. - Blight-killed chestnut snag near Bennett Gap on the Blue Ridge Parkway. Note the young chestnut sprouts at left. These are about as large as sprouts get before the blight hits them. The causal fungus is *Endothia parasitica*. (Photo: United States Forest Service)

FIGURE 5. - The European pine shoot moth has been a serious introduced pest of pine plantations in eastern North America for years and more recently is posing a similar threat in northwestern United States. Plant quarantine officers regularly report this pest in shipments being examined at North American ports. (Photo: Canada Department of Forestry)

It was concluded that there are many recognized pests at present of restricted geographic distribution that constitute a great potential danger to the forests of other continents. Further, pathogens and insects of minor significance in their native habitats may become serious pests in a new environment, for example, European *Adelges piceae* and Asiatic *Endothia parasitica* in North America. In addition, "new" pests may be revealed in certain countries following adequate scientific exploration.

Intercontinental dispersal

Both natural and artificial means of intercontinental dispersal of pests were discussed. Natural dispersal methods, although obviously largely beyond human control, were assessed because of their possible influence in weakening or nullifying exclusionary efforts by man. The natural spread of pathogens and insects can occur in many ways: through the air, water, soil, birds, and mammals. These may play vital roles in continental or more local disease and insect epidemiology, but it was concluded that they have little significance in intercontinental pest dispersal except in contiguous areas of Europe and Asia where the host tree may be uninterrupted by natural barriers such as deserts, oceans or mountains.

Human activities provide the greatest hazard to the spread of pathogens and insects through the intercontinental exchange of living plants and products, utilizing rapid methods of transportation. The most dangerous carriers for diseases and insects include living plants, soil, seeds, cuttings, and wood products such as logs, lumber, and manufactured products.

In the commerce of living plants, exotics present special hazards. A pest of an exotic may be destructive to a native tree or a pest of minor significance in its native environment may become extremely damaging to its host in a new habitat. Because of these dangers it was strongly recommended that a tree should be introduced to a new habitat only if it is superior to native species and cannot be reproduced by seed.

The exchange of seeds between countries was regarded as the safest way to provide propagative material if seeds are kept clean of foreign debris and effectively treated by fumigants and fungicides to eliminate injurious seed inhabiting insects and pathogens.

This examination of intercontinental dispersal methods led to considerations of procedures to exclude, delay, or limit the seriousness of exotic pests. While these procedures were considered in several presentations and receive more detailed attention in other chapters, the following general approaches were recommended as the most important activities requiring co-ordination at both national and international levels. An effective and continuing forest insect and disease survey should be developed by countries for detection, appraisal, and as a basis for research; programs of research need to be intensified, and in many cases, initiated, to identify the forest pests of economic consequence as a prerequisite for effective quarantines, control, or eradication; more effective quarantines are required, developed and maintained on the most recent available knowledge; and further, countries should maintain facilities for prompt control action so that introductions can be eliminated or contained. To assist in the promotion and development of these activities the Symposium recommended that FAO appoint to its forestry staff, specialists in forest entomology and pathology.

FIGURE 6. - The introduction of the Dutch elm disease and its bark beetle vector into North America has had very serious results. The disease is now well established throughout most of the natural range of white elm and threatens the existence of this valuable species. (Photo: Canada Department of Forestry)

Appraisal and prediction

There is no comprehensive method of developing hazard ratings for potential forest pests although helpful data are provided by literature contributions from various countries that list and rate both native and introduced pests and report regularly on research activities. However, these are only starting points in the accumulation of data necessary for effective appraisal and prediction.

One approach to appraising international pest hazards is the strategic establishment of test plantations of the most important trees to expose them to the world's pests. This approach has considerable value and much can be learned by thorough inspections of existing exotic plantations. Such plantings are also useful for determining how and where a tree species grows best, and for providing sources of breeding stock for genetic studies.

However, while much useful information on the appraisal of pest hazards can be derived from plantations, there are too many weaknesses to make it the sole method of hazard appraisal. For example, disease and insect incidence fluctuates widely from place to place, and the replication required to incorporate the spectrum of variability for so many pests and host trees to obtain comprehensive and valid appraisals is so formidable as to be impractical and prohibitive.

FIGURE 7. - In the absence of their normal complement of natural control agents, introduced insects and diseases can often become serious pests in their new surroundings. The balsam woolly aphid is a minor pest in Europe but its depredations on the east and west coasts of North America have prompted a worldwide search and study of potential predators. In the illustration, the effect of predators on test trees is being carefully measured. (Photo: Canada Department of Forestry)

Therefore, the need for improved means of evaluating pest hazards on an international basis was recognized.

In the field of forest diseases an interesting proposal for appraising and predicting disease hazards (abbreviated APPRE) was presented to assist any country to define which of the world's tree pathogens are of potential danger. The two main objectives of this method are to permit pathologists of any country to determine:

1. Which native tree diseases pose a threat to other countries with reference to import decisions, quarantines, control measures, and needed research.

2. Which diseases in other lands pose a threat to their own forests.

Since this system would depend upon ready access to the world's accumulated knowledge on a pathogen, an information retrieval procedure was described as a basic requirement and entitled, International Tree Disease Information Register (INTREDIS). This register would accumulate published information on tree diseases on punched cards suited to electronic sorting and would rapidly provide a printed record of available literature on a pest according to host tree and other particulars.

The APPRE procedure, therefore, has its foundation in a centralized system of information retrieval, a system not yet established. An important soilborne pathogen, *Phytophthora cinnamomi*, was used as an example in predicting the hazard to forests in various parts of the world from a specific pathogen. A very useful detailed description was provided comparing the present distribution of this pathogen with its expected distribution as determined by the published knowledge of the organism and based on climate, soil, hosts, and other factors known to limit the pathogen or make aggressive attacks unlikely.

Another illustration showed how the threat of disease to a given species in one part of the world could be estimated. *Pinus radiata* in New Zealand was used as the example, along with the knowledge available of its diseases elsewhere and of differences and similarities in climate, hosts and alternate hosts, soil, and other factors between New Zealand and the areas where these diseases are active. The system would provide, in simple tabular form, the pertinent hazard data, including a list of pathogens and information for each on its presence or absence in the country, where to expect damage, and the reason why damage is to be anticipated.

One of the major weaknesses in the appraisal and prediction of internationally dangerous pests and the effective implementation of a procedure such as APPRE is the need for the essential information resulting from increased surveys and research in some countries, and even the beginnings of such programs in others.

The Symposium recognized the importance of an information retrieval system and requested the proposer of the system and a small committee to undertake further enquiry into the implementation of such a scheme and report the results to IUFRO and FAO by 1 June 1965.