

# Forest fungal diseases of Tanzania: background and current status

VINCENT R. NSOLOMO & KÅRE VENN

Department of Forest Biology, Sokoine University of Agriculture, Chuo Kikuu,  
Morogoro, Tanzania

Norwegian Forest Research Institute, Ås, Norway

Nsolomo, V.R. & K. Venn 1994. Forest fungal diseases of Tanzania: background and current status. *Norwegian Journal of Agricultural Sciences* 8: 189-201. ISSN 0801-5341.

A review of the background and current status of forest diseases in Tanzania is presented in this article. Outbreaks of the most destructive exotic and indigenous diseases are addressed and currently known diseases of both indigenous and exotic trees, including ornamental and agroforestry trees, are tabulated to form a preliminary checklist. It is concluded that more knowledge on forest diseases is still required and therefore further research is necessary to reveal the full extent of the diseases in both natural and plantation forests.

Key words: Check list, forest diseases, fungal pathogens, Tanzania.

*Vincent R. Nsolomo, Department of Forest Biology, Sokoine University of Agriculture, P.O. Box 3010 Chuo Kikuu, Morogoro, Tanzania.*

Tanzania has a vast forest area which covers 44 million ha (about half the country's total area) of which 80,000 ha comprise plantations. These forests have about 10,000 species of indigenous higher plants (Polhill 1968) of which more than 1,200 are tree species (Wilan 1965). If conservation and productivity are to be sustained, the natural and plantation forests will have to be protected against fire, indiscriminate cutting, encroachment and, equally importantly, against pests and diseases. Whilst the protection of the forests against hazards which are related to human activities can partly be achieved through law enforcement and use of extension services, protection against diseases requires, in addition, a much more integrated approach incorporating specialized knowledge on the types and nature of the diseases. Full utilization of such an approach has not yet been achieved, due to insufficient knowledge about diseases of many tree species growing in the country. This deficiency is also one of the major problems facing forest managers in the monitoring and reporting of diseases which prevail in their forests. This implies also that if such knowledge were available it would be incorporated in formulating management programmes involving protection of forests against potential diseases. Therefore, the role of research in providing such knowledge is of utmost importance.

Any information on tree diseases in Tanzania (for both indigenous and exotic trees, including ornamental and agroforestry trees) which is available today tends to be diffuse,

and the aim of this review is therefore to explain how the existing knowledge about forest diseases came about and to compile a list of the diseases that are currently scattered in various literature as a basis for reference and future work. This is achieved by presenting the background to forest disease research and knowledge in the country, discussing the most important disease outbreaks which have occurred, and then tabulating the currently known diseases of both indigenous and exotic trees, including ornamental and agroforestry trees.

## BACKGROUND TO FOREST DISEASE RESEARCH AND KNOWLEDGE

In East Africa, research in plant diseases including forest trees was conducted after the World War II by the then East African Agriculture and Forestry Research Organization (EAAFRO) which came under the auspices of the now defunct East African Community. EAAFRO catered for Tanzania, Kenya and Uganda. The section in EAAFRO dealing with forest diseases was formed as a result of an increase in disease outbreaks in exotic tree plantations (Gibson 1965a) which were established to supplement timber production from the natural forests. Research reports which are currently available indicate that the emphasis was on diseases of exotic trees such as pines, cypress, eucalyptus, teak, and others grown in E. Africa. Some diseases of indigenous trees of Tanzania are mentioned in some checklists (e.g. Riley 1960; Peregrine & Siddigi 1972; Ebbels & Allen 1979) which give the names of the host and pathogen and the kind of disease caused. Research reports by EAAFRO provide details on the infection biology, spread, economic impact of the diseases and the limitations to most pathogens in the case of exotic plantation trees while very few indigenous trees were covered in such detail. Sometimes pathological defects of indigenous trees of economic importance were mentioned in other fields of forestry, such as mensuration (e.g. Paterson 1965).

After the departure of most expatriate staff from EAAFRO and the break-up of the East African Community in February 1977, very little research was conducted in both the plantations and the natural forests due to the lack of/or very few local forest pathologists. The bulk of knowledge on forest diseases of indigenous and plantation forests and in related fields such as mycology is thus currently limited to reports by the EAAFRO and a few researchers who either visited the country or worked in the government departments of agriculture or forestry. Most of the work is chiefly acknowledged to the invaluable contribution by researchers from Britain, Nordic/Scandinavian and North American countries and the FAO who worked in, or visited E. Africa in the past. The researchers were plant pathologists or mycologists and some of the most important reports are those by Gibson (1956, 1957, 1960, 1962, 1965a, 1965b, 1966a, 1966b, 1967, 1968, 1975), Gibson & Corbett (1964), Procter (1965, 1967), Ivory (1967), Griffin (1967, 1968), Hocking & Jaffer (1967), Hocking (1968), Howland & Gibson (1969), Olembo (1969, 1972), Ryvarde (1972), Allen (1975a, 1975b), Ebbels & Allen (1979) and Ryvarde & Johansen (1980). Since then, only a very small amount of research has been accomplished by local and visiting researchers (e.g. Waring 1982; Diwani et al. 1984; Canon 1985; Tangwa et al. 1988; Renvall & Niemela 1993), and therefore, the gap in knowledge on diseases of indigenous trees and fungi in general is still enormous.

## FOREST DISEASE OUTBREAKS

The introduction of exotic tree species provided an opportunity for the emergence of new diseases which were previously only found in the native countries (Gibson 1967; Griffin 1968). Root pathogens such as *Poria* sp., *Helicobasidium compactum* and *Ustulina deusta* were introduced in E. Africa with the exotics (Griffin 1968). Today, there is a considerable risk of loss from diseases in many tree species due to the increase in the number of pathogens.

Among the most serious diseases which were "imported" are the *Dothistroma* blight of pines caused by the ascomycete fungus *Mycosphaerella pini* (syn. *Scirrhia pini*, imperfect stage: *Dothistroma pini*), the cypress canker caused by *Rhynchosphaeria cupressi* (syn. *Leptentypa cupressi*; imperfect stage: *Monochaetia unicornis*) and, recently, a severe leaf spot disease of *Eucalyptus maidenii* caused by *Mycosphaerella molleriana* (imperfect stage: *Sphaeropsis molleriana*).

The *Dothistroma* blight, first observed in northern Tanzania in 1958 at Shume forest plantations (Ivory & Paterson 1970), spread vigorously and virtually wiped out the young plantations of *Pinus radiata* in E. Africa and Malawi within 20 years. The disease led the governments of E. Africa to abandon further planting of *P. radiata* in 1964 (Diwani et al. 1984) and the government of Malawi to clearfell its last compartment of *P. radiata* in 1978 (Zulu 1991). *P. radiata* was a superior conifer tree in terms of wood quality and was comparable to the most durable indigenous timber trees growing in the region. Similarly, the planting of *Cupressus macrocarpa* (which was very susceptible to the *Monochaetia* canker) had been stopped earlier in E. Africa in the early 1950s and replaced with *C. lusitanica*, which is less susceptible to the pathogen (Olembo 1969).

The leaf spotting fungus *M. molleriana* (first observed in Tanzania in 1991) has attacked *Eucalyptus maidenii* throughout the country causing severe necrotic spots leading to foliage drying and defoliation in nursery seedlings, coppice sprouts and in young plantation trees which have not acquired their mature foliage form. Mature foliage is also attacked in some trees but the damage is mild when compared to the juvenile foliage and no defoliation occurs. There is a possibility that the pathogen has spread throughout E. Africa due to similarity in the climate throughout the region. The fungus was previously reported in Brazil as "unusually severe" (Gibson 1975) and as "serious" in Malawi (Zulu 1991). In South Africa, a mycosphaerella leaf disease was first reported on an unspecified *Eucalyptus* sp. as early as 1923, but a few years later it was reported as "very serious" on *E. maidenii* and *E. globulus* to the extent that the two eucalyptus species were abandoned as commercial forest species of South Africa (Lundquist 1987). Three species of this fungal genus, namely *M. molleriana*, *M. heimii* and *M. nubilosa*, have been reported to attack foliage of eucalyptus trees in Africa (Gibson 1975). In South Africa the *Mycosphaerella* leaf disease has been found on 10 eucalyptus species and pathogens were identified as being *M. molleriana* and *M. nubilosa* (Lundquist 1987). This therefore implies that Tanzania is facing yet another serious disease outbreak which is capable of causing great damage to the many eucalyptus species growing in the country.

Serious indigenous diseases also exist which have caused an unquantified amount of loss to economically important timber trees. Among these diseases is the heart rot of stem of *Ocotea usambarensis* (East African camphor tree) which has been attributed to a number

of basidiomycete fungi with the most widely reported pathogen being *Phellinus senex* (syn. *Fomes senex*; *Polyporus senex*). There are many fungi that attack the tree species and the ones that are most likely to cause decay are mentioned by Ebbels & Allen (1979) and Renvall & Niemelä (1993). Damage to the tree by the pathogens is enormous and in most localities where this species grows, for example the Uluguru mountains, its regeneration capacity has been affected because many stumps which could have had coppice or root sucker regeneration are simply rotting away (Mwamba 1986). In its favourite habitats in the Usambara and Kilimanjaro mountains the species is also in decline, which is manifest in some trees of all age classes as dieback of leading branches and stem-decay symptoms. Hamilton et al. (1989) described the virtual total lack of regeneration of *O. usambarensis* in the East Usambara mountains as a "remarkable feature", suggesting the severity of the problem. The species used to be a potential commercial tree which provided round and sawn timber for local and export markets, but now its supply has been greatly affected by the decay diseases.

Another native disease is the root rot of numerous tree species caused by *Armillaria mellea* (s.l.). It has been reported that *A. mellea* destroyed 66% of a large compartment of pines and *Grevillea robusta* trees (specific size unspecified) at Usa River in the Mount Meru Forest Project, northern Tanzania (Diwani et al. 1984).

The presence of indigenous and exotic trees in the same ecosystem creates possibilities for the exotic pathogens to attack indigenous hosts and the indigenous pathogens to attack the exotic hosts. This interaction brings about a complex combination of disease problems which could probably be easily controlled in the native ecosystems. For example, the tropical trees are said to be only slightly susceptible to infection by *A. mellea* root disease, but when a conifer plantation is established on a site with contaminated stumps or other plant debris from a cleared natural forest, heavy damage to the conifers is normally expected (Gibson 1960; Olembo 1972). This also means that new strains of disease agents (which could be more virulent) could have evolved to attack new hosts as a result of changes in climate and food characteristics. Gibson & Corbett (1964) found that *A. mellea* in Malawi existed in various forms while the same situation has been found also in Europe (e.g., Raabe 1980). Today, *Armillaria* is the most widely reported disease found on 15% of all the tree species reported to have one or more diseases (see Tables 1 and 2). The extent to which the exotic pathogens have spread and infected the indigenous hosts in Tanzania has yet to be determined because no comprehensive surveys have been conducted in the natural forests.

#### KNOWN DISEASES OF INDIGENOUS AND EXOTIC TREES

Research during the past 50 years has shown an increase in the number of forest disease outbreaks in Tanzania. This fact is partly explained by Tables 1 and 2 which present the currently known diseases of indigenous and exotic trees, respectively. The tables form a preliminary checklist into which new diseases (formerly unidentified or unreported) can be added. The information has been gathered from various reports written since the introduction of forest disease research in East Africa.

Table 1. Known fungal diseases of indigenous tree species in Tanzania

Tree species	Pathogen	Disease/part infected	
<i>ADANSONIA DIGITATA</i>	<i>Leveillula taurica</i> (mildew)	Leaves	(6) <sup>1)</sup>
<i>AFZELIA QUANZENSIS</i>	<i>Microstoma</i> sp.	White leaf spot	(2)
<i>ALBIZIA VERSICOLOR</i>	<i>Phomopsis mendax</i>	Dieback	(6)
<i>ALBIZIA PETERSIANA</i>	<i>Phomopsis mendax</i>	Dieback	(6)
<i>ANTHOCLEISTA ORIENTALIS</i>	<i>Pucciniosira mitragynes</i> (Rust)	Leaves	(6)
<i>ARUNDINARIA ALPINA</i>	<i>Engleromyces goetzii</i>	Stem canker	(6)
<i>BRACHYSTEGLIA SPICIFORMIS</i>	<i>Oidium</i> sp. (mildew)	Leaves	(2)
	<i>Phyllachora brachystegiae</i>	Leaf spot	(2)
<i>BRACHYSTEGLIA SP.</i>	<i>Perisporiopsis brachystegiae</i>	Black spots on leaves	(6)
<i>GALODENDRUM CAPENSE</i>	<i>Phloeospora</i> sp.	Leaf spot	(6)
<i>CASSIA SINGUEANA</i>	<i>Ravenelia baumiana</i> (Rust)	Leaves	(2)
<i>CEPHALOSPHERA USAMBARENSIS</i>	<i>Armillaria mellea</i> s.l.	Root rot	(30)
<i>COMBRETUM MOLLE</i>	<i>Uredo combreticola</i> (Rust)	Leaves	(1)
<i>COMBRETUM PURPUREIFLORUM</i>	<i>Aecidium</i> sp. (Rust)	Leaves	(2)
<i>DALBERGIA NITIDULA</i>	<i>Mycosphaerella dalbergiae</i>	Leaf spot	(6)
	<i>Phomopsis dalbergiae</i>	Leaf spot	(6)
	<i>Phyllachora dalbergiae</i>	Leaf spot	(2)
	<i>Uredo</i> sp. (rust)	Covers foliage	(2)
<i>ELAEIS GUINEENSIS</i> (oil palm)	<i>Cercospora elaeidis</i>	Leaf freckle	(6)
	<i>Pestalotiopsis palmarum</i>	Leaf spot	(6)
<i>EUPHORBIA TIRUCALLI</i>	<i>Sphaeropsis euphorbiae</i>	Stem canker	(6)
<i>HARUNGANA MADAGASCARIENSIS</i>	<i>Pestalotia harongae</i>	Leaf spot	(6)
<i>JUNIPERUS EXCELSA</i> (PROCERA)	<i>Antrodia juniperina</i>		
	(syn. <i>Agaricus juniperina</i> )	Cubical stem rot	(43)
	<i>Calisopsis nigra</i>	Galls	(6)
	<i>Daedalea juniperina</i>	Stem rot	(6)
	<i>Daedalea quercina</i>	Cubical stem rot	(6)
	<i>Omphalotus olearius</i>	Stump decay	(6)
	<i>Pyrofomes demidoffii</i>		
	(syn. <i>Polyporus demidoffii</i> )	Branch/stem rot (Pers. Comm.) <sup>2)</sup>	
	<i>Ganoderma lucidum</i>	Stem rot (Pers. Comm.)	
<i>KHAYA ANTHOTHECA</i> (NYASICA)	<i>Mellora khayae</i> (Sooty mildew)	Premature defoliation	(6)
<i>MACARANGA KILIMANDSCHARICA</i>	<i>Englerula macarangae</i>	Leaves	(2)
<i>MAESOPSIS EMINII</i>	<i>Fusarium solani</i>	Stem canker	(6)
<i>MARKHAMIA OBTUSIFOLIA</i>	<i>Cladosporium oxysporum</i>	Leaf blight	(2)
	<i>Mycosphaerella</i> sp.	Leaf blight	(2)
<i>MILICIA (CHLOROPHORA) EXCELSA</i>	<i>Armillaria mellea</i> s.l.	Root rot	(20)
	<i>Helicobasidium brebissonii</i>		
	(syn. <i>H. purpureum</i> , <i>Rhizoctonia crocarum</i> )	Purple butt/root rot	(20)
<i>NUXIA CONGESTA</i>	<i>Phellinus punctatus</i>	Stem rot (Pers. Comm.)	
	<i>Oxyporus populinus</i>	Stem rot (Pers. Comm.)	
<i>OCOTEA USAMBARENSIS</i>	<i>Armillaria mellea</i> s.l.	Root rot (Pers. Comm.)	
	<i>Loweporus inflexibilis</i>	Root and butt rot	(40)
	<i>Pestalotiopsis</i> sp.	Leaf blotch (Pers. Comm.)	
	<i>Phellinus (Fomes) allardii</i>	Stem decay	(40)
	<i>Phellinus apiahynus</i>	Root and stem decay	(40)
	<i>Phellinus senex</i>	Heart rot	(10)
	<i>Stereum hirsutum</i>	Streaked white rot	(6)
<i>OLEA CAPENSIS</i> (WELWITSCHII)	<i>Alternaria porri</i>	Seedling leaf spot	(6)
	<i>Alternaria tenuissima</i>	Seedling collar rot	(6)
	<i>Cladosporium oxysporum</i>	Seedling leaf spot	(2)
	<i>Macrophomina phaseolina</i>	Seedling collar rot	(6)
	<i>Meliora petiolaris</i> (Sooty mildew)	Leaf spot/defoliation	(2)
	<i>Myrothecium verrucaria</i>	Seedling collar rot	(6)

Table 1. Cont.

Tree species	Pathogen	Disease/part infected
<i>PACHYSTELA MSOLO</i>	<i>Helminthosporium pachystelae</i>	Leaf spot (6)
<i>PODOCARPUS USAMBARENSIS</i>	<i>Ganoderma australe</i>	Stem rot (Pers. Comm.)
<i>RAPANEA SP.</i>	<i>Stereum hirsutum</i>	Timber decay (6)
<i>STERCULIA AFRICANA</i>	<i>Macrophylllosticta sterculiae</i>	Leaf net-spot (6)
<i>STOEBE KILIMANDSCHARICA</i>	<i>Aecidium elytropappi</i> (Rust)	Leaves (6)
<i>STRYCHNOS POTATORUM</i>	<i>Cercospora strychni</i>	Leaf blight (6)
	<i>Mycosphaerella sp.</i>	Leaf spot (6)
	<i>Strosporium sp.</i>	Leaf blight (6)
<i>STRYCHNOS STUHLMANII</i>	<i>Phyllosticta strychni</i>	Leaf spot (6)
<i>SYNADENIUM GRANTII</i>	<i>Phyllosticta sp.</i>	Leaf spot (2)
<i>TAMARINDUS INDICA</i>	<i>Gloesporium tamarindi</i>	Leaf spot (6)
	<i>Mycosphaerella tamarindi</i>	Leaf spot (6)
<i>TECLEA NOBILIS</i>	<i>Puccinia tecleae</i> (rust)	Leaves (6)
<i>TECLEA SIMPLICIFOLIA</i>	<i>Puccinia tecleae</i>	Leaves (6)
<i>TRICHILIA EMETICA (ROKA)</i>	<i>Cercospora sp.</i>	Leaf spot (6)

<sup>1)</sup> Numbers in parentheses correspond to the numbers given in the list of references to indicate the source of the information. For convenience, only one reference per disease is provided

<sup>2)</sup> Pers. Comm. = Personal Communication

Table 2. Known fungal diseases of exotic tree species in Tanzania

Tree species	Pathogen	Disease/part infected
<i>ACACIA MEARNSII (MOLLISMA)</i>	<i>Poria vincta</i> var. <i>cinerea</i>	Root rot (6) <sup>1)</sup>
	<i>Stereum hirsutum</i>	Timber decay (6)
<i>ACACIA MELANOXYLON</i>	<i>Poria vincta</i> var. <i>cinerea</i>	Root rot (6)
<i>ACACIA SPP.</i>	<i>Ravenelia volkensii</i>	Witches broom (6)
	<i>Armillaria mellea</i> s.l.	Root rot (6)
<i>ALBIZIA LEBBECK</i>	<i>Phomopsis mendax</i>	Dieback (2)
	<i>Uredo ngamboensis</i> (rust)	Defoliation (6)
<i>ANACARDIUM OCCIDENTALE</i> (cashew)	<i>Gliocladium roseum</i>	Dieback (6)
	<i>Oldium anacardii</i> (mildew)	Kills inflorescence (Pers. Comm.) <sup>2)</sup>
<i>BAUHINIA SP.</i>	<i>Oldium sp.</i>	Pods (6)
<i>CAMELLIA SINENSIS</i>	<i>Phomopsis theae</i>	Collar and branch canker (6)
<i>CASSIA ABSUS</i>	<i>Ravenelia berkleyi</i> (Rust)	Leaves (2)
<i>CASSIA ALATA</i>	<i>Phomopsis cassiae</i>	Wilt and Dieback (6)
<i>CASSIA FLORIBUNDA</i>	<i>Macrophomina phaseolina</i>	Black root rot (18)
<i>CASSIA LAEVIGATA</i>	<i>Macrophomina phaseolina</i>	Black root rot (18)
<i>CASSIA OBTUSIFOLIA</i>	<i>Aecidium cassiae</i> (Rust)	Leaves (6)
	<i>Fusarium sp.</i> (? <i>F. avenaceum</i> )	Stem canker (6)
	<i>Oidium sp.</i>	Leaves (6)
<i>CASSIA OCCIDENTALIS</i>	<i>Oldium sp.</i>	Leaves (6)
	<i>Pseudoperonospora sp.</i>	Disc-spot of leaves (6)
<i>CASSIA SENNA</i>	<i>Corticium rolfsii</i>	Wilt (18)
	<i>Fusarium oxysporum</i>	Seedling death (6)
<i>CASSIA SIAMEA</i>	<i>Cercosporidium cassiae</i>	Defoliation (18)
	<i>Oldium sp.</i>	Defoliation (1)
	<i>Polyporus baudoni</i>	Root rot (35)

Table 2. Cont.

Tree species	Pathogen	Disease/part infected	
<i>CASSUARINA MONTANA</i>	<i>Armillaria mellea</i> s.l.	Root rot	(6)
<i>CEDRELLA</i> SPP.	<i>Armillaria mellea</i> s.l.	Root rot	(18)
	<i>Ceratocystis montiformis</i>	Dieback	(18)
<i>CINNAMOMUM CAMPHORA</i>	<i>Armillaria mellea</i> s.l.	Root rot	(6)
<i>CINNAMOMUM ZEYLANICUM</i>	<i>Colletotricum cingulata</i>	Leaf spot	(6)
	<i>Phyllosticta</i> sp.	Leaf spot	(6)
<i>CITRUS AURANTIFOLIA</i> (lime)	<i>Gloeosporium limeticola</i>	Withertip	(6)
<i>CITRUS LIMON</i> (lemon)	<i>Alternaria citri</i>	Leaf spot	(6)
	<i>Fusarium</i> sp.	Rough lemon of nursery seedlings	(6)
<i>CITRUS PARADISI</i> (grape fruit)	<i>Fusarium solani</i>	Root gummosis	(6)
<i>CITRUS SINENSIS</i> (orange)	<i>Phytophthora nicotianae</i> var. <i>parasitica</i>	Gummosis	(6)
<i>COCOS NUCIFERA</i> (coconut)	<i>Asteridium ferrugineum</i>	Sooty mould	(6)
	<i>Ganoderma</i> sp.	Stem rot	(6)
	<i>Gloeosporium</i> sp.	Nut fall and calyx end rot	(6)
	<i>Lasmeniella cocoes</i>	Leaf spot	(6)
	<i>Marasmiellus coccophilus</i>	Lethal bole rot	(6)
	<i>Phytophthora palmivora</i>	Nut fall and Calyx end rot	(6)
	<i>Pseudoepicoccum cocos</i>	Zonate leaf spot	(6)
	<i>Zukalia stuhlmanniana</i> (Sooty mould)	Leaves	(6)
<i>CUPRESSUS ARIZONA</i>	<i>Rhynchosphaeria cupressi</i>	Stem canker	(32)
<i>CUPRESSUS LINDLEY</i>	<i>Rhynchosphaeria cupressi</i>	Stem canker	(5)
<i>CUPRESSUS LUSITANICA</i>	<i>Armillaria</i> s.l.	Butt rot	(33)
	<i>Corioliolus versicolor</i>	White sap rot of timber	(6)
	<i>Fusicoccum tingens</i>	Associated with death of young trees	(6)
	<i>Peniophora ceberella</i>	Butt rot	(6)
	<i>Poria vincta</i> var. <i>cinerea</i>	Root rot	(6)
	<i>Poria vaillantii</i>	Brown cubical rot of timber	(6)
	<i>Rhynchosphaeria cupressi</i> (syn. <i>Leptentypa cupressi</i> )		
	(Imperfect stage: <i>Monochaetia unicornis</i> )	Stem canker	(6)
<i>DELONIX (PONCIANA) REGIA</i>	<i>Inonotus ochroporus</i>	Wood rot	(6)
<i>EUCALYPTUS MAIDENII</i>	<i>Mycosphaerella molleriana</i>		
	(Imperfect stage: <i>Sphaeropsis molleriana</i> )	Leaf spot & defoliation (Pers. Comm.)	
<i>EUCALYPTUS</i> SPP.	<i>Armillaria mellea</i> s.l.	Root rot	(18)
<i>EUGENIA AROMATICA</i> (clove)	<i>Armillaria mellea</i> s.l.	Root rot	(18)
	<i>Botryodiplodia</i> sp.	Seedling death	(6)
	<i>Endothia eugeniae</i>	Dieback	(6)
	<i>Valsa eugeniae</i>	Sudden death of trees	(6)
<i>EUGENIA JAMBOS</i>	<i>Endothia eugeniae</i>	Dieback	(6)
<i>FICUS ELASTICA</i>	<i>Colletotricum cingulata</i>		(6)
	(Perfect state: <i>Glomerella cingulata</i> )	Leaves	(6)
	<i>Phoma atrocincta</i>	Petiole	(1)
<i>GMELINA ARBOREA</i>	<i>Irpex flavus</i>	White sap rot of logs	(35)
	<i>Polyporus baudoni</i>	Root rot	(35)
	<i>Xylosphaera (Xylaria) multiplex</i>	Butt rot and death	(6)
<i>GREVILLEA ROBUSTA</i>	<i>Armillaria mellea</i> s.l.	Root rot	(5)
<i>MANGIFERA INDICA</i>	<i>Capnodium mangiferae</i>	Leaf spot	(6)
	<i>Dimerosporium mangiferae</i>	Sooty mould	(6)
	<i>Phyllosticta mangiferae</i>	Leaf spot	(6)
<i>PARKINSONIA ACULEATA</i>	<i>Ganoderma vanmeelli</i>	Wood rot	(6)
<i>PERSEA AMERICANA</i>	<i>Curvularia intermedius</i>	Leaves	(6)

## 196 Forest fungal diseases of Tanzania

Table 2. Cont.

Tree species	Pathogen	Disease/part infected	
<i>PHOENIX DACTYLIFERA</i>	<i>Zukalia stuhlmanniana</i>	Leaves	(6)
<i>PINUS</i> SPP.	<i>Alternaria</i> sp.	Tip dieback, <i>P. patula</i>	(6)
	<i>Armillaria mellea</i> s.l.	Root rot	(9)
	<i>Botryodiplodia theobromae</i> (syn. <i>Diplodia natalensis</i> )	Needle blotch	(24)
	<i>Cercospora pini-densiflorae</i>	Needle blight	(6)
	<i>Cladosporium</i> sp.	Seedling browning and dieback in <i>P. patula</i>	(6)
	<i>Fusarium oxysporum</i>	Tip blight of <i>P. patula</i>	(6)
	<i>Fusarium</i> sp.	Damping off	(7)
	<i>Fusicoccum tingens</i>		
	(Perfect stage: <i>Botryosphaeria ribis</i> )	Dead top of <i>P. patula</i> & <i>P. radiata</i> ; Dieback of <i>P. caribaea</i>	(25)
	(Imperfect stage: <i>Mycosphaerella pini</i> (syn. <i>Scirrhia pini</i> )	Needle blight in <i>P. radiata</i> , <i>P. caribaea</i> & <i>P. montezumae</i>	(6)
	<i>Mycosphaerella pinicola</i>	Needle blight	(6)
	<i>Naemacyclus niveus</i>	Needle cast, <i>P. radiata</i>	(6)
	<i>Pestalotiopsis cruenta</i>	Needle blotch and cast	(6)
	<i>Phytophthora</i> spp.	Damping off	(8)
	<i>Pythium</i> spp.	Damping off	(7)
	<i>Sphaeropsis sapinea</i> (syn. <i>Diplodia pinea</i> )	Shoot dieback	(24)
	<i>Stereum sanguinolentum</i> (Syn. <i>Haematostereum sanguinolentum</i> )	Stem and log decay	(19)
	<i>Thanatephorus cucumeris</i> (Imperfect stage: <i>Rhizoctonia solani</i> )	Damping off	(7)
	<i>Armillaria mellea</i> s.l.	Root rot	(20)
	<i>Cephaleuros</i> sp. (algae fungus)	Leaf spot	(6)
<i>Fusarium semitectum</i>	Root	(22)	
<i>Fusarium solani</i>	Canker, wood pink stain	(23)	
<i>Helicobasidium compactum</i>	Violet root rot	(22)	
<i>Nectria haematococca</i>	Stem canker in nurseries	(6)	
<i>Poria</i> sp.	Root rot	(22)	
<i>Rhizoctonia</i> sp.	Root	(6)	
<i>Ustilina deusta</i>	Stem	(22)	
<i>TERMINALIA CATAPPA</i>	<i>Cercospora catappae</i>	Leaf spot	(6)
<i>TERMINALIA IVORENSIS</i>	<i>Mycosphaerella</i> sp.	Leaf blotch	(6)
<i>THEOBROMA CACAO</i>	<i>Calonectria rigidiuscula</i>		(6)
	(Imperfect state: <i>Fusarium decemcellulare</i> )	Dieback	(6)
	<i>Cercospora</i> sp.	Leaf spot	(6)
	<i>Fusarium solani</i>	Roots	(6)
	<i>Phomopsis folliculicola</i>	Dieback	(6)
<i>TOONA CILIATA</i>	<i>Pestalotiopsis disseminata</i>	Stem canker	(6)
	<i>Thyronectria pseudotrichia</i>	Stem necrosis and twig dieback	(6)

<sup>1</sup>) Numbers in parentheses correspond to the numbers given in the list of references to indicate the source of the information. For convenience, only one reference per disease is provided

<sup>2</sup>) Pers. Comm. = Personal Communication



## CONCLUSION

The list of diseases presented in Tables 1 and 2 shows the existence of indigenous and exotic pathogens which can cause severe damage to trees. Some pathogens are capable of attacking more than one host species and may therefore be difficult to control. The list also shows that only 36 indigenous and 45 exotic tree species have been covered so far. However, owing to the fact that Tanzania has a vast forest area and an enormous species diversity, it is justifiable to speculate that there must be many more diseases attacking more tree species than are presented in this report. Moreover, the tables report more diseases of exotic trees than those of indigenous trees although indigenous species in the country are far more numerous than exotic species. The reason for this is that in the past the emphasis was on exotic trees as timber supplements of the indigenous forest trees and also because many of the exotics are grown as plantation and ornamental trees in areas that are easily accessible to foresters and researchers.

Outbreaks have also been significant and severe. Consequently, future prevention of such epidemics should be given priority in forest management programmes. Some initiatives to address the problems through promoting resistance in susceptible species can be taken. For example, some pioneer research was carried out to select resistant genotypes of *P. radiata* against the *Dothistroma* blight (Ivory & Paterson 1970). Although this work was not continued, due to the paucity of experts and other resources which faced forest disease research, it was a good starting-point towards the revival of the conifer in East Africa.

Successful results in research on breeding for disease resistance in some susceptible species in other parts of the world have added impetus to tree breeding. For example, in New Zealand clones of *Pinus radiata* resistant to the *Dothistroma* needle blight are already under development through gradual selection for healthy trees (Ivory & Speight 1993). In the USA it was possible to establish resistant varieties of chestnut trees (*Castanea dentata*) through hybridization of the native survivors of the chestnut blight fungus, *Endothia parasitica* syn. *Cryphonectria parasitica* with the more resistant members of the genus from Europe and Asia (Beattie & Driller 1954). This means that tree breeding in Tanzania can also make use of the common hybridization principles used in tree improvement in order to establish disease resistant forests.

An effort has also been taken to investigate how silvicultural and cultural methods in forest management could limit disease incidence. For example, trials of *O. usambarensis* were established in natural forests of the Usambara and Kilimanjaro mountains in the late 1950s to determine the best treatments in regenerating the species in order to reduce the incidence of transmitting the heart rot of stem and butt to the next regeneration (Kimario 1972; Mugasha 1978). Again, owing to lack of forest disease experts and other research resources, this research has had to be abandoned. As a result of insufficient research projects, there has been a stagnation in knowledge on forest diseases and the subsequent efforts to control them. Given that resources were available, possible areas of emphasis would be to carry out more surveys covering all forest types; to study how breeding techniques can be used to develop resistance in susceptible species; to study the effect of diseases on the regeneration capacity of forests; to study the ecological factors and management techniques that might limit the establishment and spread of disease; and to study the effect of diseases on wood quality. Such studies will provide information which

will help forest managers to include certain measures in the protection of forests against potential diseases when formulating management programmes.

#### REFERENCES

1. Allen, D.J. 1975a. Additions to the fungi and plant diseases of Malawi. *Society of Malawi Journal* 28: 35-44.
2. Allen, D.J. 1975b. A further supplementary checklist of Tanzania plant diseases. Ministry of Agriculture, Dar-es-Salaam. Unpublished.
3. Beattie, R.K. & J.D. Driller 1954. Fifty years of chestnut blight in America. *American Journal of Forestry* 52: 323-329.
4. Canon, P. 1985. Studies in fire protection, stumpage and dieback. Technical Cooperation Programme - United Republic of Tanzania, FAO, Rome. Document No. 2. Pp 3-24.
5. Diwani, S.A., O. Kumburu, E.N. Mshiu & E.Z. Kisaka 1984. Preliminary report on the survey of forest tree diseases and pests in Sao Hill Forest Plantation. Ministry of Lands, Natural Resources and Tourism, Division of Forestry, Dar-es-Salaam. Unpublished.
6. Ebbels, D.L. & D.J. Allen 1979. A supplementary and annotated list of plant diseases, pathogens and associated fungi in Tanzania. *Phytopathological Paper* No. 22. Commonwealth Agricultural Bureau, Kew, Surrey, England. Pp 89.
7. Gibson, I.A.S. 1956. Sowing density and damping off in pine seedlings. *East African Agricultural and Forestry Journal* 21: 183-188.
8. Gibson, I.A.S. 1957. Saprophytic fungi and destroyers of germinating pine seeds. *East African Agricultural and Forestry Journal* 22: 203-206.
9. Gibson, I.A.S. 1960. *Armillaria* root rot in Kenya pine plantations. *Commonwealth Forestry Review* 39: 94-99.
10. Gibson, I.A.S. 1962. Report on a tour of plantation and forest areas in Tanganyika, Nyasaland and Southern Rhodesia, 3rd February-3rd March, 1962. Kenya Forest Division. Unpublished.
11. Gibson, I.A.S. & D.C. Corbett 1964. Variation in isolates from *Armillaria* root disease in Nyasaland. *Phytopathology* 54(1): 122-123.

12. Gibson, I.A.S. 1965a. Forest pathology in East Africa. *East African Agricultural and Forestry Journal* 31(2): 194-198.
13. Gibson, I.A.S. 1965b. A note on *Stereum sanguinolentum* (Alb. et. Schw.) Fr., a new record for Kenya forests. *East African Agricultural and Forestry Journal* 32(1): 38-40.
14. Gibson, I.A.S. 1966a. Cercospora blight of pines. EAAFRO Mycological Paper No. 30. Muguga, Kenya. Unpublished.
15. Gibson, I.A.S. 1966b. A note on fungicides for use on forest stations. East African Agriculture and Forestry Research Organization. Mycological note No. 47.
16. Gibson, I.A.S. 1967. The present world situation in regard to the spread of internationally dangerous forest diseases. *East African Agricultural and Forestry Journal* 32(4): 478-483.
17. Gibson, I.A.S. 1968. The changing role and needs of forest pathology in the Commonwealth. Proceedings of the 9<sup>th</sup> British Commonwealth Forestry Conference. Commonwealth Forestry Institute, Oxford. Pp. 1-3.
18. Gibson, I.A.S. 1975. Diseases of Forest Trees Widely Planted as Exotics in the Tropics and Southern Hemisphere. Part One. Important Members of the Myritaceae, Leguminosae, Verbenaceae and Meliaceae. Commonwealth Forestry Institute, Oxford. Pp. 51.
19. Griffin, H.D. 1967. Further studies on *Stereum sanguinolentum* Alb. & Schw. ex Fries in Kenya forest plantations. EAAFRO Mycological Note No. 49. Muguga, Kenya. Unpublished.
20. Griffin, H.D. 1968. Forest tree diseases. Report to the Government of Tanzania. Report No. TA 2533. UNDP/FAO, Rome.
21. Hamilton, A.C., C.K. Ruffo, I.V. Mwashia, C. Mmari, P. Binggeli & A. Macfadyen 1989. Profile diagrams of the East Usambara forests. In: A.C. Hamilton & R. Bensted-Smith, (eds.); *Forest Conservation in the East Usambara Mountains, Tanzania*. The IUCN Forest Programme. Man Graphics Ltd., Nairobi, Kenya. Pp. 241-254.
22. Hocking, D. & A.A. Jaffer 1967. Field observations on root rot of teak in Tanzania. *FAO Plant Protection Bulletin* 15(1): 10-14.
23. Hocking, D. 1968. Stem canker and pink stain on teak in Tanzania associated with *Fusarium solani*. *Plant Disease Reporter* 52(8): 628-629.

24. Howland, A.K. & I.A.S. Gibson 1969. A note on *Diplodia* spp. on pines in East Africa. *East African Agricultural and Forestry Journal* 35(1): 45-48.
25. Ivory, M.H. 1967. *Fusicoccum tingens* Goid: A wound pathogen of pines in East Africa. *East African Agricultural and Forestry Journal* 32(3): 341-343.
26. Ivory, M.H. & D.N. Paterson 1970. Progress in breeding *Pinus radiata* resistant to *Dothistroma* needle blight in East Africa. *Silvae Genetica* 19: 38-42.
27. Ivory, M.H. & M.R. Speight 1993. Pest Management. In: L. Pancel (ed.), *Tropical Forestry Handbook, Volume 2*. Springer-Verlag. Berlin, London, New York. Pp. 1142-1219.
28. Kimaryo, P.E. 1972. Initial intensive and medium thinnings increase Dbh growth in second growth camphor regeneration. *Tanzania Silviculture Research Note*, No. 26. Division of Forestry, Dar es Salaam.
29. Lundquist, J.E. 1987. A history of five forestry diseases in South Africa. *South African Forestry Journal* 140: 51-59.
30. Mugasha, A.G. 1978. Tanzania natural forests' silvicultural research review report. *Tanzania Silvicultural Technical Note (New Series) No. 39*. Division of Forestry, Dar es Salaam. Unpublished.
31. Mwamba, B.K. 1986. The ecology and distribution of *Ocotea usambarensis* in the Uluguru mountains. A special project report. Faculty of Forestry, Sokoine University of Agriculture. Morogoro, Tanzania. Unpublished.
32. Olembo, T.W. 1969. The incidence of cypress canker disease in E. Africa. *East African Agricultural and Forestry Journal* 35(2): 166-173.
33. Olembo, T.W. 1972. Studies on *Armillaria mellea* in East Africa. Effect of soil chelates on penetration and colonization of *Pinus patula* and *Cupressus lusitanica* wood cylinders by *Armillaria mellea* (Vahl. ex Fr.) Kummer. *European Journal of Forest Pathology* 2(3): 134-140.
34. Paterson, D.N. 1965. The determination of log volume errors due to methods of measurements and other defects for four important indigenous Kenya tree species. *East African Agricultural and Forestry Journal* 31: 125-131.
35. Peregrine, W.T.H. & M.A. Siddigi 1972. A revised and annotated list of plant diseases in Malawi. *Phytopathological Paper No. 16*. Commonwealth Mycological Institute Kew, England.

36. Polhill, R.M. 1968. Tanzania vegetation. In: Hedberg & Hedberg (eds.), Conservation of Vegetation of Africa South of Sahara. Proceedings of a symposium on AETFAT. Uppsala, Sweden. Pp. 166-170.
37. Procter, J.E.A. 1965. Diseases of pines in the Southern Highlands Province Tanganyika. East African Agricultural and Forestry Journal 31: 203-209.
38. Procter, J.E.A. 1967. A nutritional disorder of pines. Commonwealth Forestry Review 46: 145-152.
39. Raabe, R.D. 1980. Variation in pathogenicity and virulence in *Fomes annosus* (Fr.) Karst and *Armillaria mellea* (Vahl. ex. Fr.) Kummer. In: Resistance to Diseases and Pests in Forest Trees. Proceedings of the 3<sup>rd</sup> international workshop on genetics of host-parasite interactions in forestry. Wageningen. Pp. 251-259.
40. Renvall, P. & T. Niemelä 1993. *Ocotea usambarensis* and its fungal decayers in natural stands. Bulletin Jardin Botanique National de Belgique 62: 403-414.
41. Riley, E.A. 1960. A revised list of plant diseases in Tanganyika Territory. Mycological Papers No. 75. Commonwealth Mycological Institute. Kew, England. Pp. 28.
42. Ryvarde, L. 1972. A critical checklist of the *Polyporaceae* in tropical East Africa. Norwegian Journal of Botany 19: 229-238.
43. Ryvarde, L. & I. Johansen 1980. A Preliminary Polypore Flora of East Africa. Fungiflora, Oslo. Pp. 636.
44. Tangwa, J.L., S.A.O. Chamshama & V.R. Nsolomo 1988. Dieback disorder in *Pinus patula*, *P. elliottii* and *P. caribaea* at Sao Hill, southern Tanzania. Commonwealth Forestry Review 67(3): 263-268.
45. Waring, H.D. 1982. Dieback in Pines and Eucalyptus. Sao Hill Forest Protection. Technical Cooperation Programme, United Republic of Tanzania. FAO, Rome. Document No. 2.
46. Wilan, R.L. 1965. A master plan for silvicultural research in Tanzania. Forest Division, Ministry of Agriculture, Forests and Wildlife, Dar-es-Salaam. Pp. 26.
47. Zulu, T.S. 1991. Introduction to the major forest diseases in Malawi. In: C.Z. Chilima (ed.), Proceedings of the 1991 Forest Pest and Disease Monitoring course. Forestry Research Institute of Malawi. Pp. 15-19.