

# Shoot and Needle Diseases of *Pinus* spp. in South Africa

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## SYNOPSIS

Fungi associated with needle and shoot diseases of *Pinus* spp. in South Africa were surveyed. *Sphaeropsis sapinea* caused shoot die-back of trees and seedlings of numerous pine species while *Colletotrichum acutatum* caused similar symptoms on seedlings of *P. radiata*. *Dothistroma septospora* was associated with needle blight of *P. radiata* only in the Eastern Cape Forest Region, while *Cercoseptoria pini-densiflorae* was associated with needle infections of a number of *Pinus* spp. in various parts of the country. *Cyclaneusma minus*, which has the potential to cause needle disease, occurred on senescent needles and needle litter of *Pinus* spp. throughout the country but was not associated with disease symptoms. Although the genus *Lophodermium* includes important pathogens of *Pinus* spp. only the saprophyte *L. australe* was found in the course of this study. A key is included to distinguish between the various fungi and possible control measures are considered.

## INTRODUCTION

Approximately half of the forest plantations in South Africa are planted to *Pinus* spp., which are exotic in this country. Foliage diseases, particularly those caused by exotic pathogens, have caused significant losses to pine plantings elsewhere in the world. However, pine shoot and needle diseases have received little attention in South Africa. To provide a basis for future studies, potentially important fungi found on pine needles and shoots during the course of routine surveys between 1984 and 1989 are discussed here. A key to facilitate their identification is included. Pertinent literature references pertaining to these fungi and comments on their control and on the possible impact that they might have on South African forestry are also provided.

## DISEASES AND CAUSATIVE FUNGI

### *Cercoseptoria* (Brown-needle disease)

*Cercoseptoria pini-densiflorae* (Hori & Nambu) Deighton

= *Cercospora pini-densiflorae* Hori & Nambu

Teleomorph: *Mycosphaerella gibsonii* Evans

**Introduction:** This disease was first observed in Asian countries, from where it seems to have spread to Africa and South America (Gibson, 1979). Brown-needle disease has only recently been recorded from South Africa (Ivory and Wingfield, 1986).

**Symptoms and morphology:** Trees are usually infected in the centre of the lower crown, with the disease spreading upwards and outwards to the branch tips (Ivory, 1987). The first symptoms of infection are light green bands appearing on the needles. The needles

then turn yellow, brown and finally a greyish colour. Conidia are produced during warm damp weather, when tufts of conidia are visible on erumpent stromata (Ivory and Wingfield, 1986) (Figure 1). Conidia are filiform, 3–7 septate, olivaceous, 20–60 × 2.5–4.5 μm in size. *C. pini-densiflorae* is probably a hemibiotroph surviving unfavourable conditions as mycelium in infected needle tissues (Gibson, 1979).

**Importance:** The disease is most severe in nurseries where seedlings can be entirely defoliated (Gibson, 1979). It can also be important in young plantations. Old foliage is usually infected first, but in severe cases all foliage can be affected. Conidia can remain viable for many months on dry, infected foliage, and occurrences of disease follow periods of persistent rainfall, or damp, humid conditions (Ivory, 1987).



FIGURE 1. Transverse section through a conidioma of *Cercoseptoria pini-densiflorae* on a needle (× 400).

*Hosts:* Brown-needle disease has been found on *P. radiata* D. Don, *P. canariensis* C. Smith, *P. griffithii* McClell, and *P. pinaster* Ait. in the Transvaal, Southern and Eastern Cape (M.H. Ivory, unpublished report; Ivory and Wingfield, 1986). The host range of this fungus is wide and it is possible that all commercially grown pine species in South Africa could be affected (Evans, 1984; Gibson, 1979; Mulder and Gibson, 1972).

### *Cyclaneusma*

*Cyclaneusma minus* (Butin) Di Cosmo, Peredo and Minter  
= *Naemycyclus minor* Butin

*Introduction:* Although this fungus causes a needle necrosis of older foliage in South Africa, it has been observed to induce premature defoliation of *Pinus* spp. in nurseries and plantations elsewhere (Millar and Minter, 1980). It has been reported to occur in Africa, South America, Europe and New Zealand (Gibson, 1979).

*Symptoms and morphology:* *Cyclaneusma minus* causes a chlorotic speckling, which turns necrotic, and eventually kills the whole needle (Millar and Minter, 1980). In South Africa, however, it occurs mainly as a saprophyte on dead needles. The fungus forms pycnidia in the dying leaf tissue, and apothecia within the dead foliage. Apothecia are amphigenous, concolorous with needles, subepidermal, breaking open with a longitudinal split, turning the upper epidermis back in two flaps (Figure 2). Asci are subcylindrical and paraphysate. Ascospores filiform, hyaline, smooth, 2-septate, with mucous caps at both ends, 65–100 × 2,5–3 μm in size. Conidia are bacilliform, 6–9,5 × 1 μm in size (Di Cosmo, Peredo and Minter, 1983; Millar and Minter, 1980).

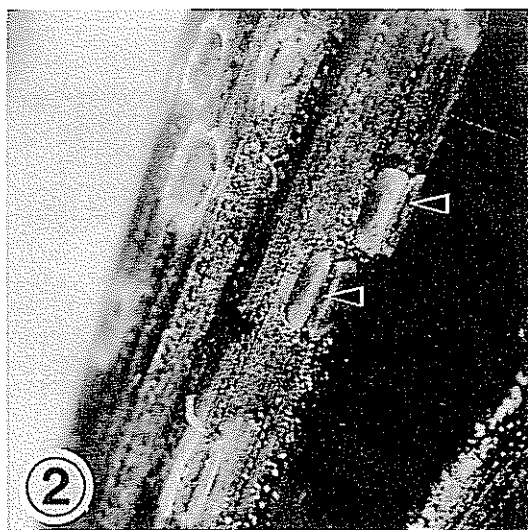


FIGURE 2. Apothecia of *Cyclaneusma minus*, with visible flaps (arrowed) on a needle (× 10).

*Importance:* This fungus causes considerable damage to pines grown for Christmas trees in Eastern U.S.A. and also to some degree in Australia and New Zealand (Millar and Minter, 1980). In contrast, many authors are of the opinion that *C. minus* is a weak parasite or saprophyte (Gibson, 1979). Although it is widespread in South Africa, there is no evidence to suggest that it is a serious pathogen.

*Hosts:* *Cyclaneusma minus* has previously been reported to occur on *P. radiata*, *P. thunbergii* Parl. and *Pinus* sp. in the Eastern Transvaal (Lundquist, 1986), as well as on *P. pinaster* in the Cape Province (Lundquist, 1987). In our surveys we found it on dead foliage of all *Pinus* spp. examined.

### *Lophodermium*

*Lophodermium australe* Dearness  
Anamorph: *Leptostroma durissimum* Cooke

*Introduction:* More than 20 species of *Lophodermium* colonise needles of coniferous trees. Only one of these, *L. seditiosum* Minter, Staley & Millar can be considered as a primary pathogen (Sinclair, Lyon and Johnson, 1987; Minter, 1981). Roux and Lundquist (1984) reported the presence of *L. seditiosum* *L. indianum* Singh & Minter and *L. australe* from South Africa. During the course of our surveys, only the saprophyte *L. australe* was found. The initial report cannot be verified because no herbarium specimens were retained. *Lophodermium australe* is common in the tropics, and can easily be confused with other species (Minter and Millar, 1978). This fact, the absence of disease, and the results of our studies suggest that only *L. australe* occurs in South Africa.

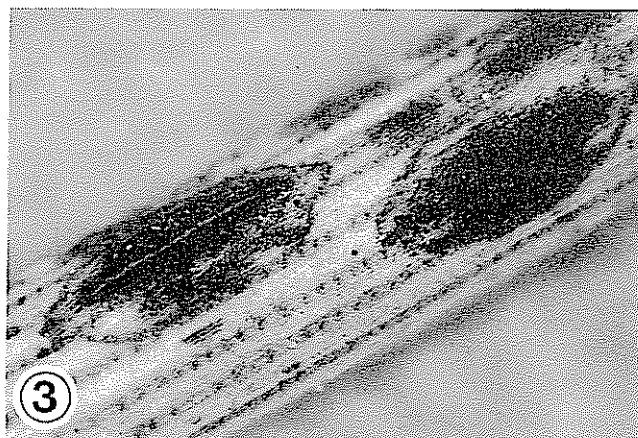


FIGURE 3. An elongated ascocarp of *Lophodermium australe* on a needle (× 40).

*Symptoms and morphology:* *Lophodermium* spp. are easily recognised on dead needles by the elongate, black fruiting structures which open by a central longitudinal split (Figure 3). The depth of the ascocarp is characteristic for each *Lophodermium* sp., and is determined by examining the mid-point vertical sections.

Ascocarps of *L. australe* occur on older needles, are black or a faint grey in colour, with "lips", and partly subepidermal in vertical section. They appear as a thin black line when dry, becoming more elliptical when wet, opening by a single longitudinal split. Ascospores are filiform, in a gelatinous sheath,  $55-120 \times 2 \mu\text{m}$  in size (Minter, 1981).

**Importance:** *L. australe* occurs only on *Pinus* spp., is saprophytic, and found mainly on older needles or leaf litter (M.H. Ivory, unpublished report; Minter, 1981). This fungus is, therefore, unlikely to be of any economic importance in South Africa.

**Hosts:** Found on dead foliage of various *Pinus* spp. throughout South Africa.

#### *Dothistroma* (Red band needle blight)

*Dothistroma septospora* (Dorog.) Morelet var. *keniense* (Ivory) Sutton

= *Dothistroma pini* Hulbary

Teleomorph: *Mycosphaerella pini* E. Rostrup apud Munk

= *Scirrhia pini* Funk & Parker

**Introduction:** This is one of the most important foliage diseases of exotic tropical pines (Ivory, 1987). *Dothistroma septospora* is reported to be native to Central America, but has been reported from numerous *Pinus* spp. at various locations in America, Africa, Asia, Europe, New Zealand and Australia (Evans, 1984; Gibson, 1979). The fungus is a primary pathogen that invades and kills pine foliage (Gibson, 1972).



FIGURE 4. Chlorotic bands and acervuli (arrowed), of *Dothistroma septospora* on needles of *P. radiata* ( $\times 10$ ).

**Symptoms and morphology:** Red band or Dothistroma needle blight can be identified by chlorotic or red bands on the needles. These bands spread to cover the entire needle which ultimately turns brown and is shed (Figure 4). Although initially found on the older needles at the base of branches in the lower half of the tree, it may spread to the younger foliage at the branch tips. In cases of acute infection, the tree may be left with only tufts of the current year's needles. Foliage of all ages, including young primary needles, is susceptible on many *Pinus* spp. (Ivory, 1987). Conidiomata occur in the red bands, are acervular, subepidermal, innate becoming erumpent. Conidia are holoblastic, hyaline, smooth, 1-3 septate, short-clavate, with a truncate base,  $25,7-35,1 \times 1,2-3,5 \mu\text{m}$  (Roux, 1984).

Three varieties of *Dothistroma septospora* are recognised. These are separated on the basis of conidium length (Ivory, 1967). According to Ivory (unpublished report) *D. septospora* var. *keniense* occurs in South Africa, having conidia of intermediate length, between those of var. *septospora* (Dorog.) Morelet and var. *lineare* (Thyr and Shaw) Sutton. Roux (1984) found conidia from cultures to be of variable length. The fact that these three taxa are chiefly distinguished on this characteristic, places their validity in question.

**Importance:** Infectious needle diseases such as red band needle blight and brown-needle disease can defoliate young pines every year and eventually kill the trees (Evans, 1984; Gibson, 1972, 1979; Ivory, 1967). Red band needle blight has made growing of *P. radiata* in areas north of South Africa impossible (Gibson, 1979). The disease is known to occur sporadically, causing infection levels of over 25 % with reduced growth some years (M.H. Ivory, unpublished report) and being almost totally absent the next. In New Zealand and certain parts of Africa, however, *D. septospora* has caused severe losses of *P. radiata*, and aerial spraying with copper fungicides has to be implemented (Gibson, 1979). The survival of conidia of *D. septospora* in infected pine foliage is dependent on environmental conditions, and studies have shown conidia to remain viable at 18 °C for up to 11 months in dry needles (Gibson, Christensen and Munga, 1964). In contrast Gadgil (1970) has found the pathogen to disappear from litter in under two months in damp conditions. Gibson (1972) ascribes this to probable microbial competition and the obligate parasitic nature of the fungus. In South Africa the disease has remained restricted to the Eastern Cape Forest Region. Here it defoliates trees in some years and can hardly be found at other times.

**Hosts:** In South Africa red band needle blight occurs primarily in the Eastern Cape, on species such as *P. canariensis* and *P. radiata* (M.H. Ivory, unpublished report). Although it has been reported on *P. patula* Schlecht. et Cham. (Lundquist and Roux, 1984), this species is usually regarded as only moderately suscep-

tible (Gibson, 1979; Ivory, 1987; Marks, Fisher and Walters, 1982).

### *Sphaeropsis* (Shoot blight)

*Sphaeropsis sapinea* (Fr.) Dyko & Sutton  
= *Diplodia pinea* (Desm.) Kickx

**Introduction:** *Sphaeropsis sapinea* has been reported from many locations in North and South America, Europe, Africa, Asia and New Zealand (Gibson, 1979). It was first reported in South Africa in 1910 from diseased shoots of *P. radiata* and *P. mugo* Turra (= *P. montana* 1911). (Bancroft, 1911). This fungus owes much of its international notoriety as a pathogen to the extensive damage it has caused in South Africa in plantations of *P. radiata* and *P. patula* following the wounding of trees by hail (Laughton, 1937; Lückhoff, 1964; Gibson, 1979; Zwolinski, Swart and Wingfield, 1989a, 1989b). Although most reports associate *S. sapinea* with predisposing factors such as drought, nutrient deficiencies and wounding, it has been shown to infect pine tissue in the absence of wounds and other predisposing factors (Swart, Wingfield and Knox-Davies, 1985; 1987b).



FIGURE 5. A shoot infected with *Sphaeropsis sapinea*.

**Symptoms and morphology:** Shoots of *Pinus* spp. are most susceptible during spring when shoot tissue is succulent. The first indication that infection has taken place is a small, grey-green spot on a needle or bract. This spot enlarges until eventually, after a couple of weeks, the entire shoot dies, becoming pale brown (Figure 5), with the terminal portion assuming a

crooked appearance (Waterman, 1943). Black pycnidia (less than 0,5 mm in width) later form on dead needles (Figure 6). These contain many conidia, which are yellowish to brown, oblong to clavata, rounded at apex with blunt basal end, 0–1 septate, 30–45 × 10–16 μm in size.



FIGURE 6. Black pycnidia of *S. sapinea* forming on needles (× 25).

**Importance:** Surveys conducted over a number of years in South Africa have revealed that die-back resulting from shoot blight caused by *S. sapinea*, is the most common disease of *Pinus* spp. More than 76 % of cases involving shoot-blight in forests were associated with either the occurrence of hail damage, or drought, or both factors simultaneously (Swart, Wingfield and Knox-Davies, 1987b).

**Hosts:** *Sphaeropsis* shoot blight can occur on all commercially grown pine species in all pine growing areas of the country (Swart, Wingfield and Knox-Davies, 1987a, 1987b). There are, however, significant differences in the relative susceptibilities of the five main commercial *Pinus* spp. grown in this country. *P. radiata* is most susceptible to *S. sapinea* infection followed by *P. pinaster* and *P. patula*. *P. elliottii* is slightly more resistant than the latter, but the most resistant species is *P. taeda* (Swart, Wingfield and Knox-Davies, 1988).

### *Colletotrichum* (Terminal Crook Disease)

*Colletotrichum acutatum* Simmonds, f. sp. *pineae* Dingley and Gilmour

**Introduction:** This disease was first reported from nurseries in New Zealand (Gilmour, 1966). It has subsequently been found in Australia, Kenya, Malaysia, Canada, Chile, India and South Africa (Gibson, 1979; Ivory, 1987; Lundquist, 1984).

**Symptoms and morphology:** Translucent lesions form at the base of primary needles below the apex of the leading shoot of seedlings. Lesions then extend into young stems, causing a typical terminal crook (Ivory, 1987). *C. acutatum* causes death of the terminal bud and a thickening of the stem. Tissue death is confined to the immature stem and needle tissue in the terminal bud (Vanner and Gilmour, 1973) (Figure 7). Infections pass to other buds, causing the growing point to appear bushy and stunted (Gibson, 1979). Brown acervuli are formed on the growing point and the base of infected needles. Conidia are smooth, fusiform, non-septate, 8–14 × 2,5–4 μm in size (Gibson, 1979).

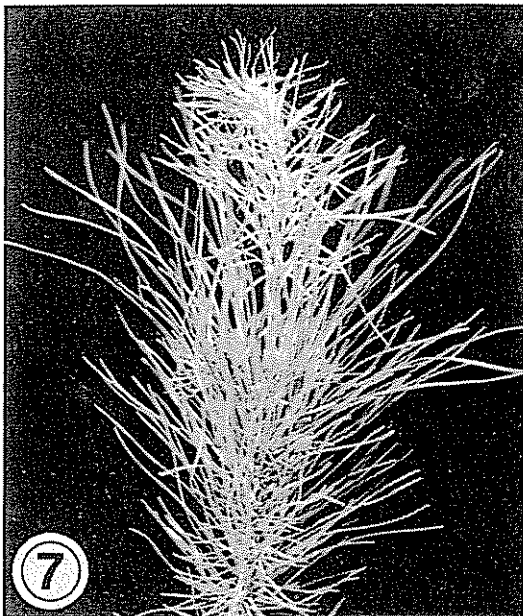


FIGURE 7. Terminal shoot infected with *Colletotrichum acutatum*.

**Importance:** This is primarily a nursery disease causing death of young seedlings (Gibson and Munga, 1969), and severe stunting of older transplanted trees (Gibson, 1979). Diseased seedlings planted out in the field recover within 9 to 12 months (Gibson, 1979; Ray, 1975). However, the fungus can persist in infected tissues for at least two years, and as conidia in soil for one month (Ivory, 1987). Maximum infection occurs at 23 °C and 90 % RH (Newhook and Nair, 1974). The disease is rarely fatal, but if unchecked can cause stunted growth, making seedlings unsuitable for planting at the required time.

**Hosts:** In South Africa *C. acutatum* has been observed only on *P. radiata* seedlings in the Southern Cape.

## KEY TO PINE SHOOT AND NEEDLE DISEASES IN SOUTH AFRICA

1. Symptoms: Severe stunting of seedling or shoots, dead needle clusters and die-back 4  
Symptoms: restricted to needle fascicles 2

2. Causing blight of healthy young and older needles 3  
Asymptomatic on older, senescent or dead needles 5

3. Chlorotic or red bands occur on older needles, spreading over the whole needle which turns brown; conidiomata acervular, black, subepidermal to erumpent *Dothistroma septospora*

Light green bands occur on young needles, spreading over the whole needle, turning yellow, and eventually grey-brown; conidiomata grey to black, a stroma with fasciculate conidiophores

*Cercoseptoria pini-densiflorae*

Small grey-green spots occur on needles or bracts, spreading until the entire shoot is dead or light brown *Sphaeropsis sapinea*

4. Fungus penetrating immature stem tissue, causing tips of young seedlings to develop a terminal crook, stem thickened below the infected tip; conidiomata acervular, black, mainly on stem *Colletotrichum acutatum*

Fungus primarily penetrating mature tissue through wounds, causing die-back, cankers, bud-wilt and defoliation; conidiomata pycnidial, black, mainly on older needles *Sphaeropsis sapinea*

5. Ascocarps apothecia, black, partly subepidermal, elliptical, opening by a median longitudinal slit; ascospores non-septate, filiform, smooth, in gelatinous sheath, 55–120 × 2 μm *Lophodermium australe*

Ascocarps apothecia, concolorous with needles, subepidermal, breaking open the epidermis with a median longitudinal split, turning back to form two flaps; ascospores 2-septate, filiform, smooth, with mucous caps at each end, 65–100 × 2,5–3 μm *Cyclaneusma minus*

## CONTROL

Damage due to pine shoot and needle diseases can be reduced through the application of a number of management strategies, selection of resistant varieties and species as well as through chemical control. If losses due to these diseases are experienced, the following management or control strategies could be applied.

1. Hygiene – a nursery programme should include soil fumigation, removal of infected seedlings and good ventilation of nursery beds.

2. Resistance selection – the most practical control measure for *Sphaeropsis sapinea* infection is to plant resistant species or cultivars (Lückhoff, 1964; Gibson, 1979). Much work, however, remains to be done regarding the selection of resistant cultivars among species such as *P. radiata* and *P. pinaster*.
3. Cultural practices – infection of pruning wounds and staining of cut timber will also be reduced if trees are pruned or felled during cooler months of the year (Swart, Wingfield and Knox-Davies, 1987b). Physiological stress due to nutrient deficiencies can also be alleviated by fertilization (Brown, Bevege and Stevens, 1981).
4. Chemical control – can be achieved for *Colletotrichum acutatum* (Gibson, 1979; Gilmour and Vanner, 1972; Ivory, 1987; Ray, 1975). *Cercoseptoria pini-densiflorae* (Ivory, 1987), and *Sphaeropsis sapinea* (Van der Westhuizen, 1968). *Dothistroma septospora* can be effectively controlled with copper fungicides, applied at the prescribed rates (Gibson, 1972). This can also reduce sporulation of the pathogen in established lesions (Gibson, Howland and Munga, 1970).

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