

A Summary of Fungal Leaf Pathogens of *Eucalyptus* and the Diseases they Cause in South Africa*

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Eucalyptus leaf disease surveys conducted since 1984 in the Cape, Eastern Transvaal and Natal Forest Regions (Crous, Knox-Davies and Wingfield, 1988, 1989a, b, c) revealed a number of fungal leaf pathogens previously unreported in South Africa. This paper combines information gained during these surveys with records from previous sources (Doidge, 1950; Doidge *et al.*, 1953; Lundquist and Baxter, 1985). We also include a key to these *Eucalyptus* leaf pathogens. Opportunistic fungi such as *Botryosphaeria ribis* Grossenb. & Duggar, *Botrytis cinerea* Pers., *Cylindrocladium* spp. and *Hainesia lythri* (Desm.) Höhnel., which are commonly found on *Eucalyptus* leaves under stress conditions and which have a wide host range, have not been included.

Where possible, comment is made on the relative significance of the pathogens to *Eucalyptus* propagation. These evaluations are based on field observations, the relative importance of the *Eucalyptus* spp. affected, and reports from other countries.

Aulographina eucalypti (Cooke & Masee) von Arx & Muller

Anamorph: *Thyrinula eucalypti* (Cooke & Masee) Swart.

Occurrence. Most common in the Transvaal and Natal; not reported further south than the Eastern Cape.

Symptoms. Causes a severe leaf spotting of mature leaves (Figure 1). Lesions seldom penetrate through the leaf lamina and are distinct, brown, circular and corky. *A. eucalypti* often occurs in association with *Mycosphaerella nubilosa* (Cke.) Hansf.

Pathogen. Amphigenous hysterothecia and pycnidia occur on older lesions (Figure 2). Ascospores are hyaline, 2-celled, constricted at the septum, rounded at both ends and measure 9-(13)-16x3,5-(4)-5µm (Figure 3).

Hosts. *E. andrewsii* Maid., *E. coriaceae* A.Cunn., *E. dalrympleana* Maid., *E. elata* Dehnh., *E. fastigata* Deane & Maid., *E. gigantea* Hooke f., *E. globoidea* Blakely, *E. globulus* Labill., *E. hemiphloia* F. Muell., *E. macarthurii* Deane & Maid., *E. muelleriana* Howitt, *E. nitens* (Deane & Maid.) Maid., *E. obliqua* L. Heritier, *E. oreades* R.T. Bak., *E. pilularis* Sm., *E. quadrangulata* Deane & Maid., *E. regnans* F. Muell., *E. resinifera* Sm., *E. saligna* Sm.

Relative importance. Causes extensive defoliation, and can thus be of economic importance.

Pseudocercospora eucalyptorum Crous, Wingfield, Marasas & Sutton

Occurrence. Widely distributed throughout the Cape

Province and Natal. Infects a number of *Eucalyptus* spp., although it occurs most commonly on the older leaves of *E. nitens* (Crous, Wingfield, Marasas & Sutton, 1989).

Symptoms. Symptoms vary on the different hosts. Leaf spots range from subcircular and discrete to confluent, but on *E. nitens* they are always angular and confined by the leaf veins (Figure 4). Variable in colour from chlorotic to light brown and grey-brown, depending on age.

Pathogen. Grey to brown tufts of conidiophores are found on older lesions (Figure 5). Conidia are olivaceous, cylindrical, straight to slightly curved, indistinctly 1-6 septate (Figure 6), measure 23-(42)-65x2,5-(3,5)-4µm.

Hosts. *E. bridgesiana* R.T. Bak., *E. deanei* Maid., *E. nova-anglica* Deane & Maid., *E. nitens*, *E. pellita* F. Muell.

Relative importance. At present *P. eucalyptorum* does not seem to be of any economic importance.

Coniothyrium ovatum Swart

Occurrence. As yet, only found in the Western and Southern Cape.

Symptoms. Occurs on immature leaves on young growth and the lower branches of mature trees. Lesions are irregular, dark purple to black on the upper leaf surface, and light to dark brown on the lower surface (Figure 7).

Pathogen. Of the five *Coniothyrium* spp. occurring on *Eucalyptus* (Sutton, 1971, 1975; Swart, 1986), only *C. ovatum* has been reported from South Africa (Crous, Knox-Davies and Wingfield, 1988). Substomatal pycnidia, which are prominent on the lower leaf surface, exude long black cirri of slightly roughened, dark brown conidia (Figure 8). Conidia are obovate with truncate bases and measure 7-(8,5)-10x5-(5,2)-6µm (Figure 9).

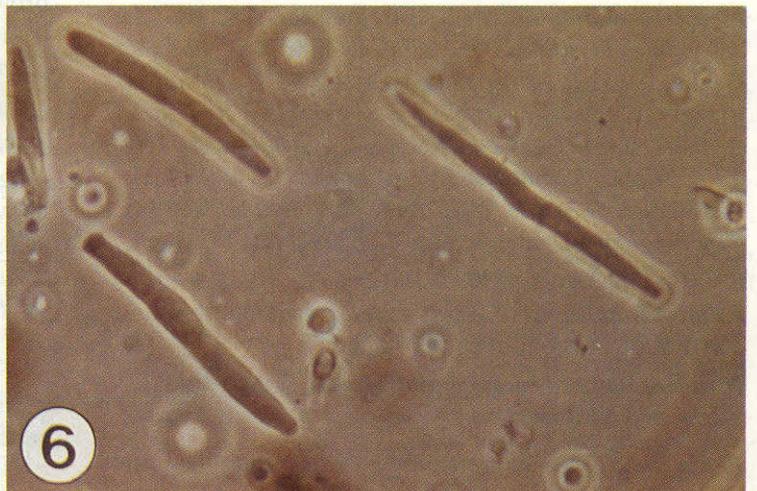
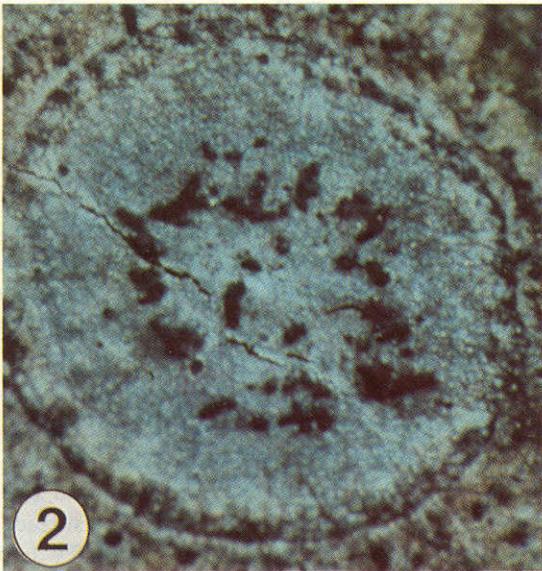
Hosts. *E. cladocalyx*, *E. lehmannii* Preiss: Schauer.

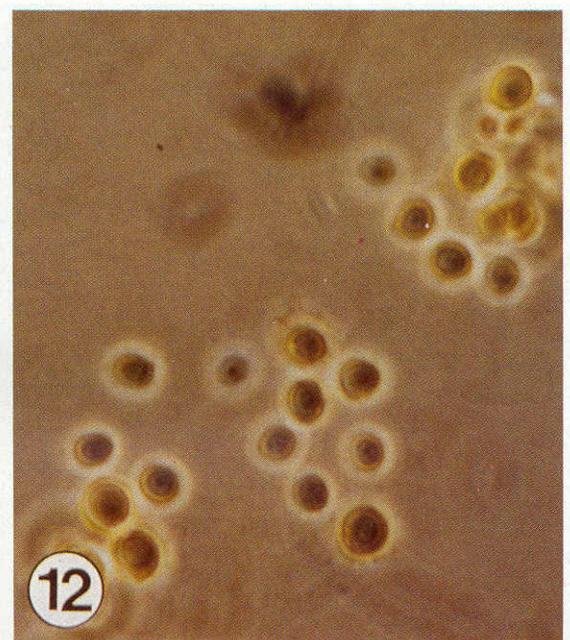
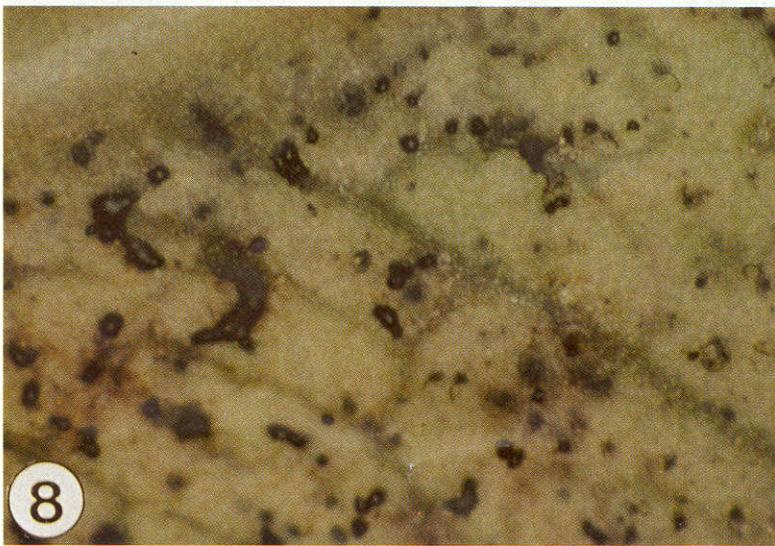
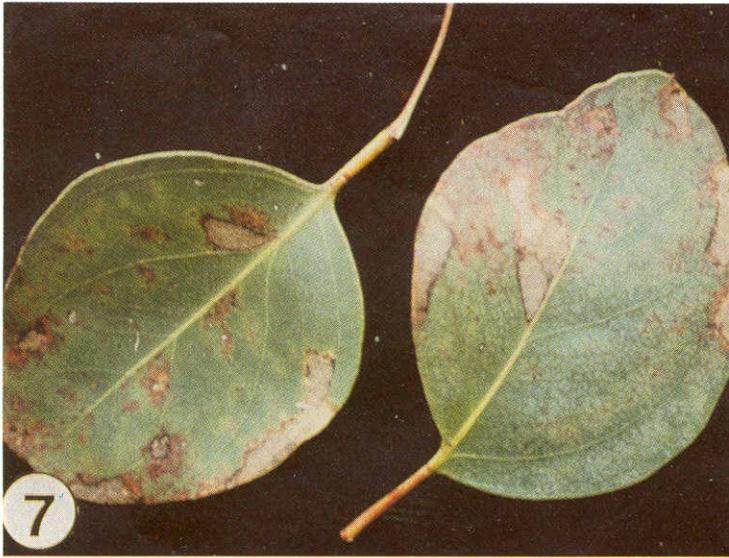
Relative importance. It seems likely that trees will outgrow this pathogen owing to its inability to infect actively-growing mature foliage. The relative unim-

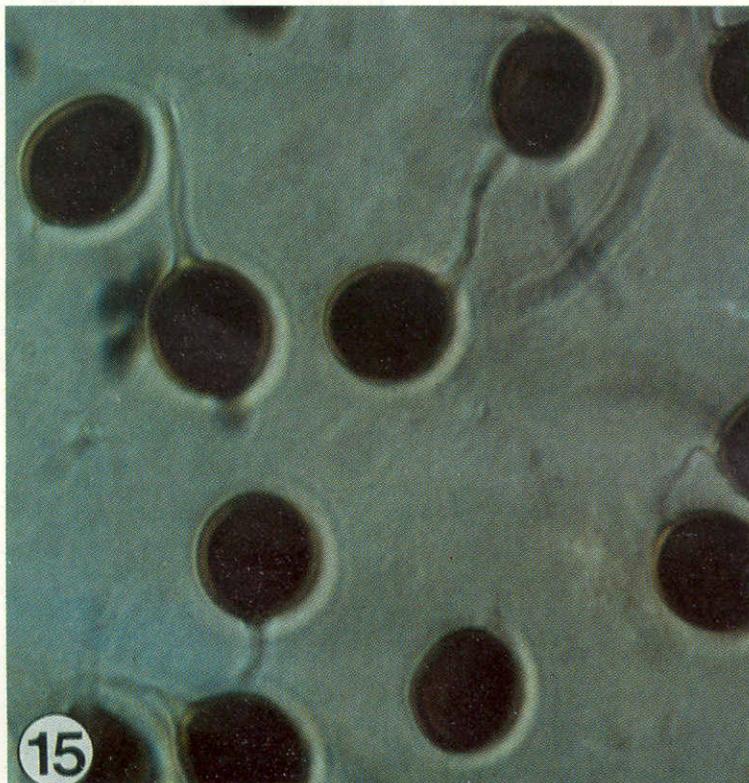
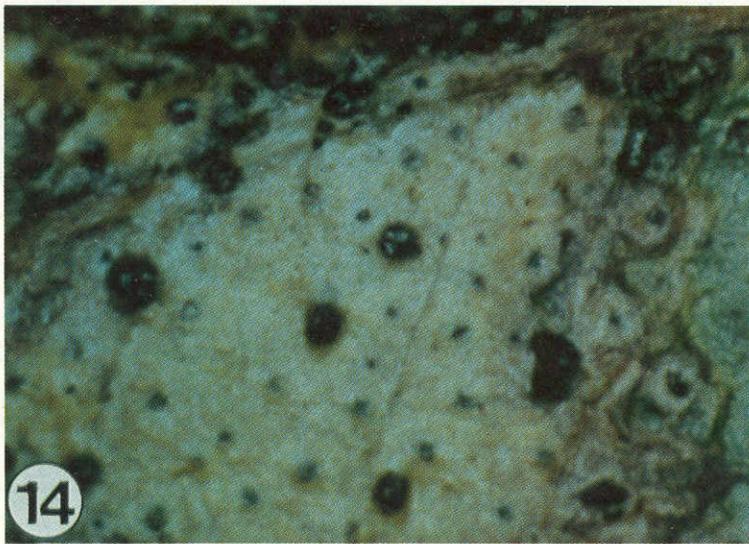
* Part of an M.Sc. Agric. thesis submitted by the first author to the University of Stellenbosch.

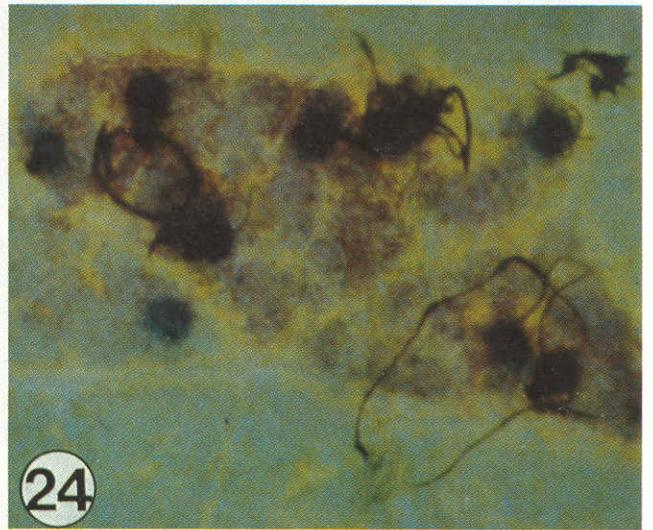
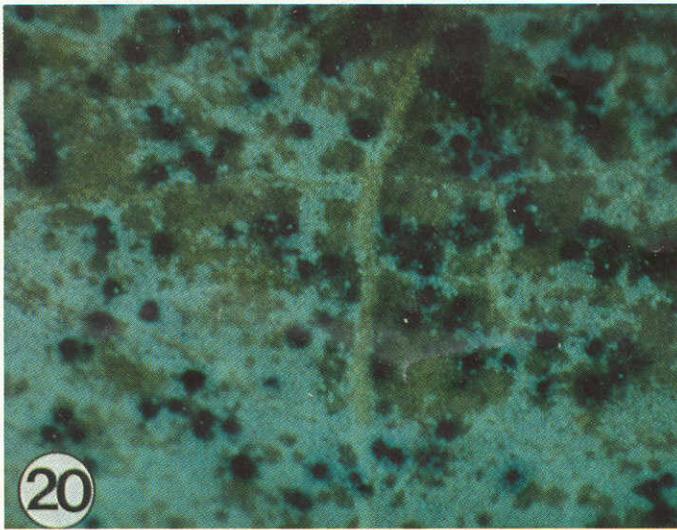
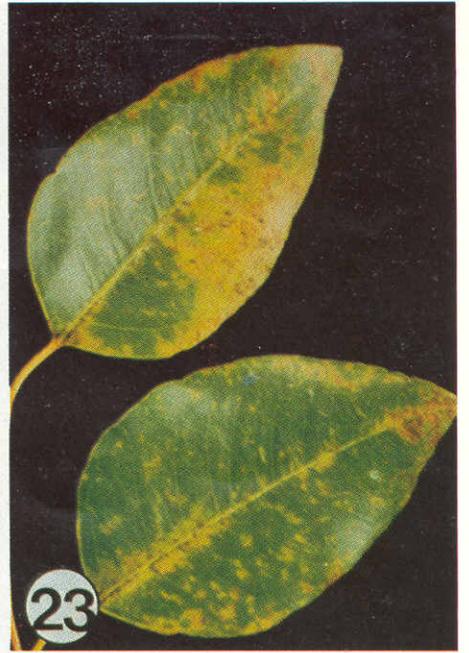
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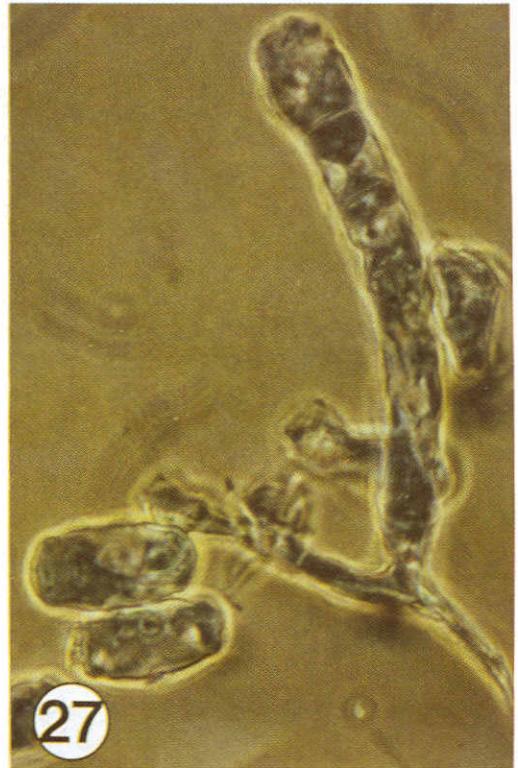


FIGURE 1. Symptoms caused by *Aulographina eucalypti* on young and older leaves of *E. nitens*.

FIGURE 2. *Hysterothecia* and pycnidia of *A. eucalypti* (x360).

FIGURE 3. Asci and ascospores of *A. eucalypti* (x2250).

FIGURE 4. Angular lesions caused by *Pseudocercospora eucalyptorum* on older leaves of *E. nitens*.

FIGURE 5. Grey-brown tufts of conidiophores of *P. eucalyptorum* (x720).

FIGURE 6. Conidia of *P. eucalyptorum* (x2 250).

FIGURE 7. Symptoms caused by *Coniothyrium ovatum* on *E. cladocalyx*.

FIGURE 8. Exuding conidia of *C. ovatum* (x560).

FIGURE 9. Conidia of *C. ovatum* (x2 250).

FIGURE 10. Symptoms caused by *Fairmaniella leprosa* on leaves of *E. globulus*.

FIGURE 11. Acervuli of *F. leprosa* (x175).

FIGURE 12. Conidia of *F. leprosa* (x2 250).

FIGURE 13: Symptoms caused by *Harknessia eucalypti* on leaves of *E. maidenii* (left) and *E. nitens* (right).

FIGURE 14. Fructifications of *H. eucalypti* (x500).

FIGURE 15. Conidia of *H. eucalypti* (x2 250).

FIGURE 16. Symptoms caused by *Harknessia globosa* on leaves of *E. nitens* clone.

FIGURE 17. Fructifications of *H. globosa* (x300).

FIGURE 18. Conidia of *H. globosa* (x2 250).

FIGURE 19. Symptoms caused by *Mycosphaerella nubilosa* on *E. nitens*.

FIGURE 20. Pseudothecia of *M. nubilosa* (x560).

FIGURE 21. Asci and ascospores of *M. nubilosa* (x2 250).

FIGURE 22. Symptoms caused by *Phaeoseptoria eucalypti* on the lower surface of *E. grandis* leaves.

FIGURE 23. Symptoms caused by *P. eucalypti* on the upper surface of *E. grandis* leaves.

FIGURE 24. Exuding conidia of *P. eucalypti* (x720).

FIGURE 25. Conidia of *P. eucalypti* (x1 750).

FIGURE 26. Leaves covered with white mycelium of *Sphaerotheca pannosa*.

FIGURE 27. Conidia of *S. pannosa* (x1 750).

portance of recorded hosts also reduces its potential significance.

***Fairmaniella leprosa* (Fairm.) Petrak & Syd.**

Occurrence. At present only known from Franschoek and Stellenbosch in the Cape Province (Crous, Knox-Davies and Wingfield, 1989c). Here it occurs on mature, older leaves 4 m above the ground, below the actively-growing crown.

Symptoms. Hard, round, corky, brown lesions on the leaf lamina and petioles (Figure 10). Lesions are distinct and usually do not extend through the lamina.

Pathogen. Amphigenous acervuli occur on lesions (Figure 11), with brown, thick-walled conidia varying in shape from elongate to broadly elliptical. Conidia measure 4-(5)-6,5x3-(4)-4,5 μm (Figure 12).

Relative importance. Judging from the limited host range and distribution, this fungus appears to be a highly specific pathogen. It is, therefore, doubtful if it will be of great economic importance in South Africa.

***Harknessia eucalypti* Cke. apud Cke. & Hark.**

Occurrence. On mature and juvenile leaves of *Eucalyptus* spp. at Stellenbosch (Crous, Knox-Davies and Wingfield, 1989c).

Symptoms. Prominent leaf and stem necrosis; lesions distinct, light brown, round to irregular in shape, penetrating through the lamina (Figure 13).

Pathogen. Fructifications extrude black conidial masses (Figure 14). Conidia dark brown, smooth-walled, broadly ventricose with bluntly apiculate apices, measuring 16-(19)-22x8-(12)-14 μm . Hyaline appendages 2-(8,5)-18 μm long (Figure 15). Unlike many other *Eucalyptus* leaf pathogens, *H. eucalypti* can grow in culture.

Hosts. *E. globulus*, *E. maidenii* F. Muell., *E. nitens*.

Relative importance. Unknown.

***Harknessia globosa* Sutton**

Occurrence. Only found in nurseries in the Eastern Transvaal (Crous, Knox-Davies and Wingfield, 1989c).

Symptoms. Prominent leaf spots on young *E. grandis* Hill: Maid.; Lesions round, amphigenous, brown and 5-15 mm in diameter (Figure 16).

Pathogen. Fructifications occur on older lesions, extruding black conidial masses (Figure 17). Conidia dark brown, smooth-walled, globose to subglobose, measuring 10-(13,5)-15x9-(11)-13 μm . Hyaline appendages are 1-(4)-9 μm long (Figure 18).

Hosts. *E. grandis*

Relative importance. Only found in nurseries, which suggests that it is of minor importance.

***Mycosphaerella nubilosa* (Cke.) Hansf.**

Occurrence. Appears to be the only *Mycosphaerella*

sp. occurring on *Eucalyptus* spp. in South Africa (Crous, Knox-Davies and Wingfield, 1989b) and is found throughout the country.

Symptoms. Occurs mainly on immature foliage, where it causes large yellow to brown lesions and a twisting of the leaf lamina (Park and Keane, 1982). In South Africa, lesions vary from pin-head spots to round or irregular spots, which coalesce to form large blotches (Figure 19).

Pathogen. Pseudothecia occur on both the upper and lower surfaces of the lesions (Figure 20). Asci measure 35-(54)-63x8-(10)-15 μm . Ascospores not constricted at the septum, tapering towards the base and measuring 9-(13,5)-18x3-(3,5)-4 μm (Figure 21).

Hosts. *E. bicostata* Maid. et al., *E. camaldulensis* Dehnh., *E. dalrympleana*, *E. globulus*, *E. grandis*, *E. grandis x nitens* hybrids, *E. macarthurii*, *E. maidenii*, *E. nitens*, *E. nova-anglica*, *E. saligna*, *E. smithii* R.T. Bak., *E. stuartiana* F. Muell., *E. tereticornis* Sm., *E. viminalis* Labill.

Relative importance. Young *E. nitens* (Deane & Maid.) Maid. trees of the Victoria Provenances are highly susceptible to infection which usually leads to total loss of juvenile leaves (Lundquist and Purnell, 1987). Mature leaves can also be infected. *M. nubilosa* has severely affected the propagation of *E. nitens* and *E. globulus* in South Africa. Its common occurrence on *E. grandis* and hybrids of *E. grandis* and *E. nitens* is of concern.

***Phaeoseptoria eucalypti* Hansf. emend. Walker**

Occurrence. Found on *Eucalyptus* spp. throughout South Africa (Crous, Knox-Davies and Wingfield, 1988). Usually occurs only on the lower leaves, below the actively growing crown.

Symptoms. Lesions irregular, brown, and surrounded by a prominent purple discolouration (Figure 22, 23).

Pathogen. Substomatal pycnidia, which are prominent on the lower leaf lamina, exude long black cirri of slightly roughened conidia (Figure 24). Conidia elongate with a rounded to attenuate apex and subtruncate base, 40-(47)-55x4-(5)-6 μm , with 3-(4)-7 transverse septa (Figure 25).

Hosts. *E. bicostata*, *E. camaldulensis*, *E. cladocalyx*, *E. dunnii* Maid., *E. globulus*, *E. grandis*, *E. grandis x camaldulensis*, *E. grandis x cladocalyx*, *E. grandis x nitens*, *E. grandis x tereticornis*, *E. grandis x urophylla*, *E. macarthurii*, *E. macarthurii x grandis*, *E. macarthurii x tereticornis*, *E. maidenii*, *E. nitens*, *E. nova-anglica*, *E. quadrangulata*, *E. resinifera*, *E. saligna*, *E. tereticornis*.

Relative importance. Causes a severe infection of younger leaves of some *E. grandis* clones. It can also cause severe damage to seedlings in nurseries (Sharma, Mohanan and Florence, 1984) and hedges used in clonal propagation (Crous, Knox-Davies and Wingfield, 1988). It remains doubtful whether *P. eucalypti* can completely defoliate healthy mature trees, but there is

evidence to suggest that it becomes more important when trees are under stress. Because of the significance of *E. grandis* to the South African forestry industry, this fungus should be considered one of the more important *Eucalyptus* leaf pathogens.

***Sphaerotheca pannosa* (Wallr.:Fr.) Lev.**

Occurrence. Although powdery mildew is well known on *Eucalyptus* spp. (Boesewinkel, 1981), it has only recently been reported from South Africa, (Crous, Knox-Davies and Wingfield, 1989a).

Symptoms. Leaves are covered with a densely interwoven white mycelium. The fungus favours young leaves and shoots (Figure 26); however, Boesewinkel (1981) and Gibson (1975) report that it can cause spotting and malformation of older growth.

Pathogen. Conidia produced in chains (4-8 per chain), and ellipsoidal, hyaline, measuring 21-(29)-35x12-(15)-19 µm (Figure 27).

Hosts. *E. nitens*, *E. nitens x camaldulensis*, *Eucalyptus* sp.

Relative importance. *S. pannosa* (rose mildew) occurs naturally on roses, but has adapted to infect eucalypts. This fungus has been recorded only once, and its importance is unknown. G.J.M.A. Gorter (Plant Protection Research Institute, Pretoria, personal communication) is of the opinion that it is the same "form" which usually infects peaches.

KEY TO EUCALYPTUS LEAF PATHOGENS IN SOUTH AFRICA

1. Leaves covered with densely interwoven white mycelium, which turns brown with age; conidia in chains, ellipsoidal, hyaline (Fig. 27) *Sphaerotheca pannosa*
Not as above, fungus causing leaf and stem necrosis 2
2. Spores predominantly conidia 3
Spores predominantly ascospores 7
3. Conidia single-celled 4
Conidia septate 6
4. Conidia with appendages 8
5. Conidia without appendages 9
6. Conidia, cylindrical, straight to slightly curved, indistinctly 1-6 septate; borne on amphigenous tufts of conidiophores on older lesions, mostly greyish (Fig. 6) *Pseudocercospora eucalyptorum*
Conidia dark, slightly roughened, elongate, distinctly 3-7 septate; extruded in long black cirri from hypophyllous substomatal pycnidia (Fig. 25) *Phaeoseptoria eucalypti*
7. Ascospores in amphigenous, black, often branched hysterothecia which open by a longitudinal slit; ascospores hyaline, 2-celled, constricted at the septum, rounded at both ends (Fig. 3) *Aulographina eucalypti*
Ascospores in amphigenous pseudothecia, 2-celled, not constricted at the septum

- (Fig. 21) *Mycosphaerella nubilosa*
8. Conidia dark brown, smooth-walled, broadly ventricose with bluntly apiculate apices and hyaline appendages 2-(8,5)-18 µm (Fig. 15) *Harknessia eucalypti*
Conidia dark brown, smooth-walled, globose to subglobose with hyaline appendages 1-(4)-9µm (Fig. 18) *Harknessia globosa*
9. Pycnidia hypophyllous, substomatal, exuding long black cirri of slightly roughened obovate conidia with truncate bases (Fig. 9) *Coniothyrium ovatum*
Acervuli amphigenous; conidia brown, thick-walled, elongate to broadly ellipsoidal (Fig. 12) *Fairmaniella leprosa*

REFERENCES

BOESEWINKEL, H.J. 1981. A first recording of rose mildew, *Sphaerotheca pannosa* on three species of *Eucalyptus*. *Nova Hedwigia* 34: 721-730.

CROUS, P.W., KNOX-DAVIES, P.S. and WINGFIELD, M.J., 1988. *Phaeoseptoria eucalypti* and *Coniothyrium ovatum* on *Eucalyptus* spp. in South Africa. *Phytophylactica* 20: 337-340.

CROUS, P.W., KNOX-DAVIES, P.S., and WINGFIELD, M.J., 1989a. A list of *Eucalyptus* leaf fungi and their potential importance to South African Forestry. *South African Forestry Journal* 149: 17-29.

CROUS, P.W., KNOX-DAVIES, P.S., and WINGFIELD, M.J. 1989b. *Mycosphaerella nubilosa* on *Eucalyptus* spp. in South Africa. (Abst.) *Phytophylactica* 21: 109.

CROUS, P.W., KNOX-DAVIES, P.S., and WINGFIELD, M.J., 1989c. Newly-recorded foliage pathogens of *Eucalyptus* spp. in South Africa. *Phytophylactica* 21: 85-88.

CROUS, P.W., WINGFIELD, M.J., MARASAS, W.F.O., and SUTTON, B.C., 1989. *Pseudocercospora eucalyptorum* sp. nov. on *Eucalyptus* leaves. *Mycological Research* (in press).

DICK, M., 1982. Leaf-inhabiting fungi of eucalypts in New Zealand. *New Zealand Forest Service Report* 1594: 525-537.

DOIDGE, E.M., 1950. The South African fungi and lichens to the end of 1945. *Bothalia* 5: 1-1094.

DOIDGE, E.M., BOTTOMLEY, A.M., VAN DER PLANK, J.E., and PAUER, G.D., 1953. A revised list of plant diseases in South Africa. South African Department of Agriculture. *Science Bulletin* 346.

GIBSON, I.A.S., 1975. Diseases of forest trees widely planted as exotics in the tropics and southern hemisphere. Part 1. Commonwealth Mycological Institute, Kew.

LUNDQUIST, J.E., and BAXTER, A.P., 1985. Fungi associated with *Eucalyptus* in South Africa. *South African Forestry Journal* 138: 9-19.

LUNDQUIST, J.E., and PURNELL, P.C., 1987. Effects of *Mycosphaerella* leaf spot on growth of *Eucalyptus nitens*. *Plant Disease* 71: 1025-1029.

PARK, R.F., and KEANE, P.J., 1982. Three *Mycosphaerella* species from leaf diseases of *Eucalyptus*. *Transactions of the British Mycological Society* 79: 95-100.

SHARMA, J.K. MOHANAN, C., and MARIA FLORENCE, E.J., 1984. Nursery diseases of *Eucalyptus* in Kerala. *European Journal of Forest Pathology* 14: 7-89.

SUTTON, B.C., 1971. The genus *Harknessia* and similar fungi on *Eucalyptus*. Commonwealth Mycological Institute. *Mycological Papers* 123: 1-46.

SUTTON, B.C., 1975. *Eucalyptus* microfungi: *Satchmopsis* gen. nov., and new species of *Coniella*, *Coniothyrium* and *Harknessia*. *Nova Hedwigia* 26: 1-16.

SWART, H.J., 1986. Australian leaf-inhabiting fungi. 21. *Coniothyrium* on *Eucalyptus*. *Transactions of the British Mycological Society* 86: 494-496.