Research Note

A Preliminary, Annotated List of Foliar Pathogens of *Eucalyptus* spp. in Chile

M.J. Wingfield[1], P.W. Crous[2] and H.L. Peredo[3]

[1] *Department of Microbiology and Biochemistry, University of the Orange Free State, P.O. Box 339, Bloemfontein 9300, South Africa.*
[2] *Department of Plant Pathology, University of Stellenbosch, Stellenbosch 7600, South Africa.*
[3] *Universidade Austral de Chile, Cassilla 567, Valdivia, Chile.*

SYNOPSIS

In an examination of symptomatic *Eucalyptus* leaves from Chile, several foliicolous fungi were found to be present. These include pathogens such as *Aulographina eucalypti, Ceuthospora innumera, Fairmaniella leprosa, Harknessia globosa* and *Thyriopsis sphaerospora*. In addition, two distinct species of *Mycosphaerella, M. swartii, M. cryptica* and their respective anamorphs *Sonderhenia eucalypticola* and *Colletogloeum nubilosum* were collected. Although several of these fungi are regarded as important foliar pathogens of *Eucalyptus* spp. elsewhere in the world, further surveys are required to determine their relative importance in Chile.

INTRODUCTION

In the past, forest plantations in Chile have been comprised mainly of exotic *Pinus* spp., especially *P. radiata* D. Don. More recently, however, there has been a tendency to establish plantations of *Eucalyptus* spp. of which *E. globulus* Labill. and *E. nitens* (Deane et Maid.) Maid. are particularly promising. Considerable research has been conducted on diseases of *P. radiata* in Chile, and especially on Dothistroma needle blight caused by *Dothistroma septospora* (Dorog.) M. Morelet and Sphaeropsis dieback caused by *Sphaeropsis sapinea* (Fr.) Dyko & B. Sutton (Butin and Peredo, 1986). In contrast, very little attention has been given to diseases of *Eucalyptus* spp.

The aim of this study was to determine and record the presence of leaf pathogens of *Eucalyptus* spp. in Chile. Material for examination was collected during routine examinations of *Eucalyptus* plantations by the third author. Material was also collected during a preliminary survey of plantations for leaf pathogens by the senior author during March 1990. Leaves were incubated in Petri dishes containing moistened filter paper at 25 °C under a mixture of cool white and near-ultraviolet light. After sporulation, fungi were examined microscopically and identified. Material representative of these fungi has been deposited in the National Collection of Fungi, Pretoria (PREM). Fungi documented in this report are listed alphabetically and are discussed in terms of their assumed importance.

Aulographina eucalypti (Cooke & Massee) Arx & E. Müll.

Aulographina eucalypti is a well-known pathogen of older *Eucalyptus* leaves, occurring on various *Eucalyptus* spp., and causing serious leaf spot in Australia (Wall and Keane, 1984), Brazil (Ferreira, 1989), New Zealand (Dick, 1982), United Kingdom (Spooner, 1981), South Africa (Crous *et al.*, 1989), and has now been found on *E. globulus* leaves in Chile.

Lesions occur mostly on mature foliage, are distinct, circular, brown, corky and do not extend through the leaf lamina. Amphigenous hysterothecia and pycnidia of *Thyrinula eucalypti* (Cooke and Massee) H.J. Swart (anamorph) occur on lesions. Ascospores are hyaline, 2-celled, constricted at the septum, rounded at both ends, 8,5-16 x 3-5 µm in size. The thin needle-like conidia of *T. eucalypti* do not germinate in culture, and are generally not regarded as infective propagules (Wall and Keane, 1984; Swart, 1988).

Ceuthospora innumera Massee

Two species of *Ceuthospora* are known to occur on *Eucalyptus* leaves, *C. lauri* (Grev.) Grev. (Crous, 1990b) and *C. innumera* (holomorph *Phacidium eucalypti* G.W. Beaton & Weste) (Ashton and Macauley, 1972; Swart, 1988; Crous, 1993). *Ceuthospora innumera* is distinguished from *C. lauri* by having larger conidia, smaller conidiogenous cells and by the absence of conidiophores (Swart, 1988).

In the collection from Chile conidiomata of a *Ceuthospora* sp. were found to occur on *Eucalyptus* leaves and leaf litter. Conidiomata were slightly different from those observed for *C. lauri* in South Africa. Multilocular conidiomata were predominantly epiphyllous to amphigenous, opening by an irregular rupture of dark brown to black cells, not light brown as observed around the furfuraceous margin of *C. lauri* on South African material. Conidia were hyaline, cylindrical with rounded ends and a mucilaginous, funnel-shaped, apical appendage, 17,5-22 x 3-3,5 µm, arising directly from conidiogenous cells lining the inner layer of the locule, that were flask-shaped, hyaline, 5,5-15 x 2-4 µm in size. The fact that conidia were larger than those reported for *C. lauri* (Sutton, 1980), that the conidiophores were reduced to conidiogenous cells, and the multilocular conidiomata differ from those of *C. lauri* observed on South African material, suggested the taxon *C. innumera* more suitable for this collection. Little is known of the pathogenicity and virulence of *Ceuthospora* spp., but inoculations done by Crous (1990b), and observations made by DiCosmo *et al.* (1984), suggest that most *Ceuthospora* spp. are saprophytic, and if pathogenic, have very low virulence.

Fairmaniella leprosa (Fairm.) Petr. & Syd.

Fairmaniella leprosa has been reported from various countries, including Australia, Chile, Hawaii, USA, New Zealand, South America, South Africa and Zambia (Viegas, 1961; Sutton, 1971; Swart, 1988; Crous *et al.*, 1989).

In a recent re-examination of the species, Swart (1988) stated that *F. leprosa* is a highly variable organism, and that its growth pattern could probably be influenced by its host. Great variation was also noted regarding symptom expression. This fungus has been reported to cause shoot and leaf necrosis with distinct corky, circular lesions (Crous *et al.*, 1989), and found to be of little significance in South Africa. In material collected from Chile, however, *F. leprosa* commonly occurred on leaves of *E. globulus*, causing round to irregular, dark brown, frequently amphigenous leaf spots, and appeared to be a common leaf inhabitant. Indications are that this pathogen is of much greater importance in Chile than in South Africa. This may be because of the high degree of susceptibility of *E. globulus*, a species not being propagated commercially in South Africa owing to its susceptibility to *Mycosphaerella molleriana* (Thüm.) Lindau (Purnell and Lundquist, 1986). Lesions and acervuli occurred mostly on the upper leaf surface. Conidia were thick-walled, light coloured, becoming medium to dark brown and slightly roughened, 4-7,5 x 3-4,5µm.

Harknessia globosa B. Sutton

This fungus has been reported from *Eucalyptus* leaves in Brazil, New Zealand and California, USA (Sutton, 1980; Nag Raj and Di Cosmo, 1981). Although it was reported from South Africa by Crous *et al.* (1989), a recent re-examination of the material, as well as of further collections and cultural studies have shown that South African collections could be better accommodated in *H. hawaiiensis* F. Stevens & E. Young (Crous *et al.*, 1993c). These two species are mainly distinguished by the fact that *H. hawaiiensis* has smaller conidia and shorter appendages than *H. globosa* (Nag Raj and DiCosmo, 1981). The dimensions of conidia and appendages of *H. hawaiiensis* also appear to be valuable taxonomic characteristics in culture (Crous *et al.*, 1993c).

Light-brown, irregular lesions extended through the lamina of *E. globulus* leaves. Conidiomata were abundant, amphigenous and exuded dark brown, smooth-walled, globose to subglobose conidia, 15,5-19 x 12,5-15,5 µm in size. Appendages were hyaline, cylindrical, but frequently with collapsed walls, 2-12,5µm. Although this species appears to be pathogenic, it is associated with less prominent lesions than the closely related *H. hawaiiensis*.

Mycosphaerella leaf spot

Mycosphaerella spp. are some of the most important leaf pathogens occurring on *Eucalyptus* (Dick, 1982; Crous and Wingfield, 1991). Prior to this study, two *Mycosphaerella* spp. have been known from South America, namely *M. molleriana* and *M. molleriana* var. *megalospora* Sousa da Câmara (Viegas, 1961). As there are no herbarium specimens available, these reports have not been confirmed. Recently, however, surveys of eucalypt plantations in Brazil have led to the description of two new *Mycosphaerella* species, namely *M. parkii* Crous, Wingfield, Ferreira & Alfenas and *M. suberosa* Crous, Ferreira, Alfenas & Wingfield (corky leaf spot) (Crous *et al.*, 1993a, 1993b). All indications are that these two fungi are potentially serious pathogens capable of causing serious leaf spot.

In surveying the eucalypt plantations of Chile, two additional *Mycosphaerella* spp. were found.

Mycosphaerella cryptica (Cooke) Hansf.

Pseudothecia of *Mycosphaerella cryptica* and acervuli of its anamorph *Colletogloeum nubilosum* Ganap. & Corbin were found to occur on juvenile and older leaves of *E. globulus, E. maidenii* F. Muell., *E. bicostata* Maid. *et al.* and *E. nitens* in Chile. This species causes lesions varying from regular, circular spots to larger blotches (Park and Keane, 1982). Lesions were usually a dark red-brown in colour. *Mycosphaerella cryptica* also causes stem cankers on *Eucalyptus* spp. in Australia (Park and Keane, 1982).

Amphigenous pseudothecia are mostly immersed on lesions. Ascospores show a distinct constriction at the septum, are rounded at both ends, and 9-12 x 3-4µm in size (*Figure1*). Ascospores germinated at right angles to the long axis of the spore, as described

by Park and Keane (1982) for *M. cryptica*. The fungus also occurred in close association with its anamorph, *Colletogloeum nubilosum*. Conidia were medium brown, verruculose, one-celled, 7-10 x 2,5-3,5 µm, arising via annellidic development from conidiogenous cells in acervuli or on superficial mycelium (*Figure 1*), closely fitting the description by Ganapathi and Corbin (1979).

Mycosphaerella walkeri R.F. Park & Keane

Mycosphaerella walkeri and its anamorph *Sonderhenia eucalypticola* (A.R. Davis) H. Swart & J. Walker were collected from leaves of *E. globulus, E. maidenii* and *E. nitens*, often also occurring in association with *M. cryptica*. *M. walkeri* occurs on a number of *Eucalyptus* spp. in Australia (Park and Keane, 1984; Swart and Walker, 1988). Park and Keane (1984) described *M. walkeri* from lesions on *E. globulus*, and also made connections with its anamorph *S. eucalypticola* in culture studies. Furthermore, they found a difference in infectivity between *S. eucalypticola* and *S. eucalyptorum* (Hansf.) H. Swart & J. Walker on different eucalypt hosts. These two species are further distinguished on the basis of cultural criteria, germination studies and conidial dimensions (Park and Keane, 1984).

Pseudothecia of *M. walkeri* were hypophyllous to amphigenous, erumpent, intermixed with pycnidia of *S. eucalypticola*. Asci were 40-70 x 14-17µm, whereas ascospores were 19-25 x 4-6 µm, showing a slight constriction at the septum of mature ascospores (*Figure 2*). Conidia were dark brown, finely roughened with up to three distosepta, 23-29 x 8-11 µm (*Figure 2*). Although *M. walkeri* causes prominent leaf spotting, its relative importance as a pathogen of *Eucalyptus* leaves is unknown at present.

Thyriopsis sphaerospora Marasas

This pathogen is known from an *E. urophylla* S.T. Blake x *E. grandis* hybrid in Brazil (Camara and Dianese, 1994), and *E. camaldulensis* Dehn, and various other *Eucalyptus* spp. in South Africa (Crous, 1990a).

Ascostromata are black, uni-or multilocular, single to aggregated in tight, round clusters, opening with an irregular dehiscence. Asci and pseudopara-

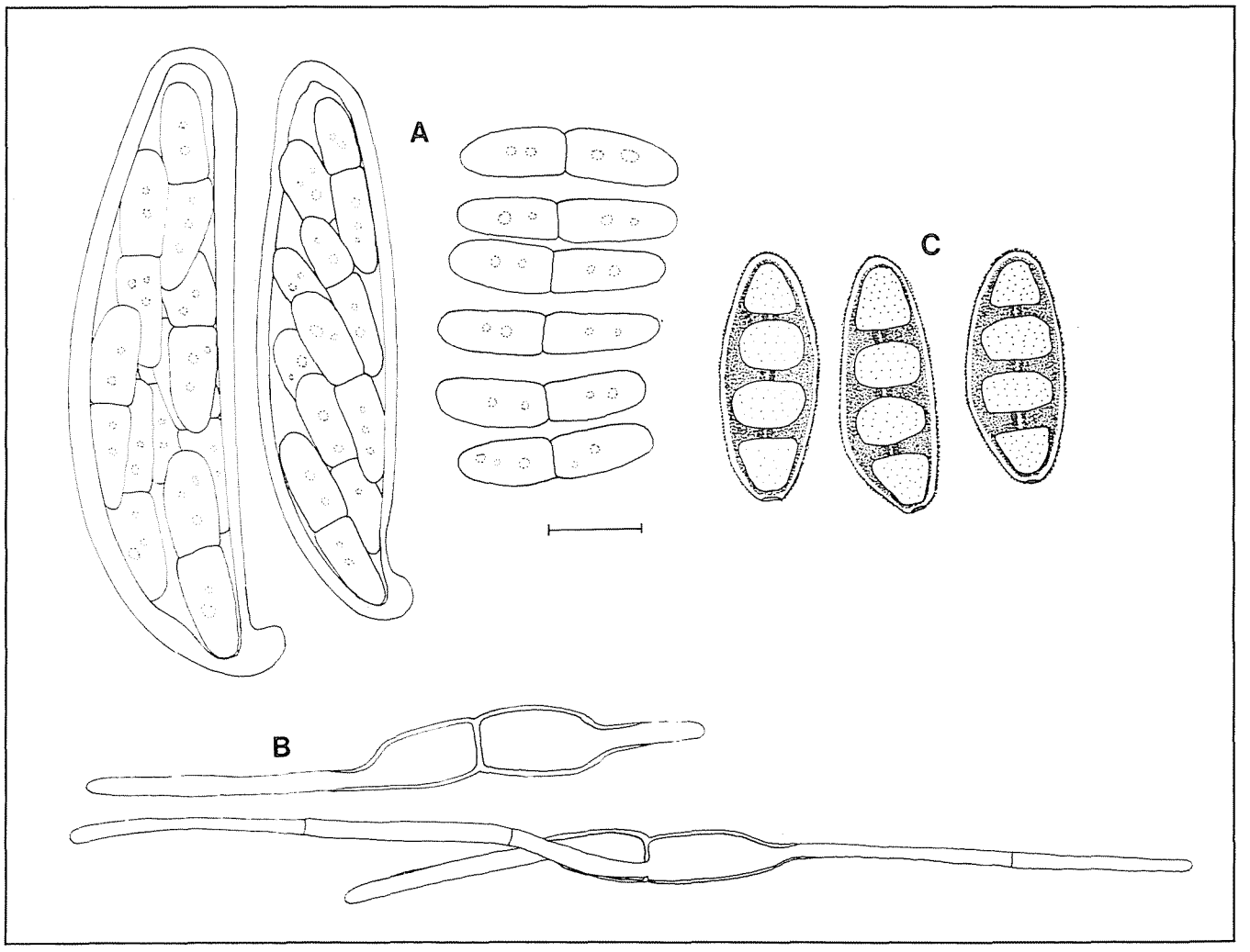

FIGURE 1. Mycosphaerella cryptica *and its anamorph* Colletogloeum nubilosum. *A. Ascospores constricted at their median septum. B. Germinating ascospores on MEA after 24* h. *C. Conidiophores and conidia* in vivo *(bar = 10* µm).

physes deliquesce before spore maturation (Marasas, 1966). Ascospores are hyaline, becoming dark brown, thick-walled, subglobose to globose, uni-septate, 11-14 x 10,5-13µm. In South Africa, severe infections have been observed to lead to premature defoliation.

CONCLUSIONS

Eucalyptus spp. have been established as exotics in plantations in many parts of the world. Indeed, this represents one of the most widely planted plantation trees propagated outside its native range (Zobel, 1993). These trees have largely been separated from their native pathogens, and in the long term, it must be expected that many of these will be introduced into exotic situations. This is likely to complicate and increase the cost of producing timber. Very little effort has been expended in recording pathogens occurring on exotic *Eucalyptus* spp. Records such as those presented in this report are an integral part of establishing a database on which to base strategies for reducing the impact of diseases in the future.

The seven fungi found to cause leaf spots on *Eucalyptus* spp. in this study are all relatively well-known on the host. As far as we are aware, however, *M. cryptica* has only been recorded from Australia and New Zealand, whereas *M. walkeri* is known from Australia (Park and Keane, 1982, 1984; Dick, 1982), and its anamorph state has been recorded from New Zealand (Dick, 1990). Although *M. walkeri* is not known to be particularly virulent, *M. cryptica* is one of the most destructive species causing serious disease problems in Australia (Park and Keane, 1982, 1984). It must be expected that *M. cryptica* could ultimately rank amongst the most important leaf pathogens of *Eucalyptus* spp. in Chile. In contrast to a species such as *M. molleriana* which is well established world-wide (Crous *et al.*, 1991), it is of particular interest that *M. cryptica* has apparently only recently been introduced into Chile, and has not been observed in either Columbia or Brazil. These preliminary records suggest, therefore, that more extensive surveys are required in South America to help characterise the leaf pathogens of *Eucalyptus* spp. on this continent.

ACKNOWLEDGEMENTS

We are grateful to the South African Forestry Industry and to Corporación National Florestal Chile, for financial support that made these collections possible. We also thank Dr Kevin Darrow, formerly of Shell Chile, for his enthusiastic assistance.

REFERENCES

ASHTON, D.H., and MACAULEY, B.J., 1972. Winter leaf spot disease of seedlings of *Eucalyptus regnans* and its relation to forest litter. *Transactions of the British Mycological Society* 58: 377-386.

CAMARA, M.P.S., and DIANESE, J.C., 1994. *Thyriopsis sphaerospora* on leaves of Eucalyptus sp. in Brasilia Distrito Federal, a New Record for Brazil. *Fitopatologia Brasileira* 19: 106-108.

CROUS, P.W., 1990a. South African leaf pathogens: *Eucalyptus* part 2. *Forestry News* 90:15.

CROUS, P.W., 1990b. Two newly reported leaf pathogens of *Eucalyptus* in South Africa. *South African Forestry Journal* 157: 12-15.

CROUS, P.W., 1993. New and interesting fungi. 13. Foliicolous microfungi. *South African Journal of Botany* 59: 602-610.

CROUS, P.W., FERREIRA, F.A., ALFENAS, A., and WINGFIELD, M.J., 1993a. *Mycosphaerella suberosa* associated with corky leaf spots on *Eucalyptus* in Brazil. *Mycologia* 85: 705-710.

CROUS, P.W., KNOX-DAVIES, P.S., and WINGFIELD, M.J., 1989. A summary of fungal leaf pathogens of *Eucalyptus* and the diseases they cause in South Africa. *South African Forestry Journal* 149: 9-16.

CROUS, P.W., and WINGFIELD, M.J., 1991. *Eucalyptus* leaf pathogens in South Africa: A national perspective. In: Proceedings of the IUFRO symposium for intensive forestry. The role of eucalypts. Southern African Institue of Forestry, Pretoria, South Africa. pp. 749-759.

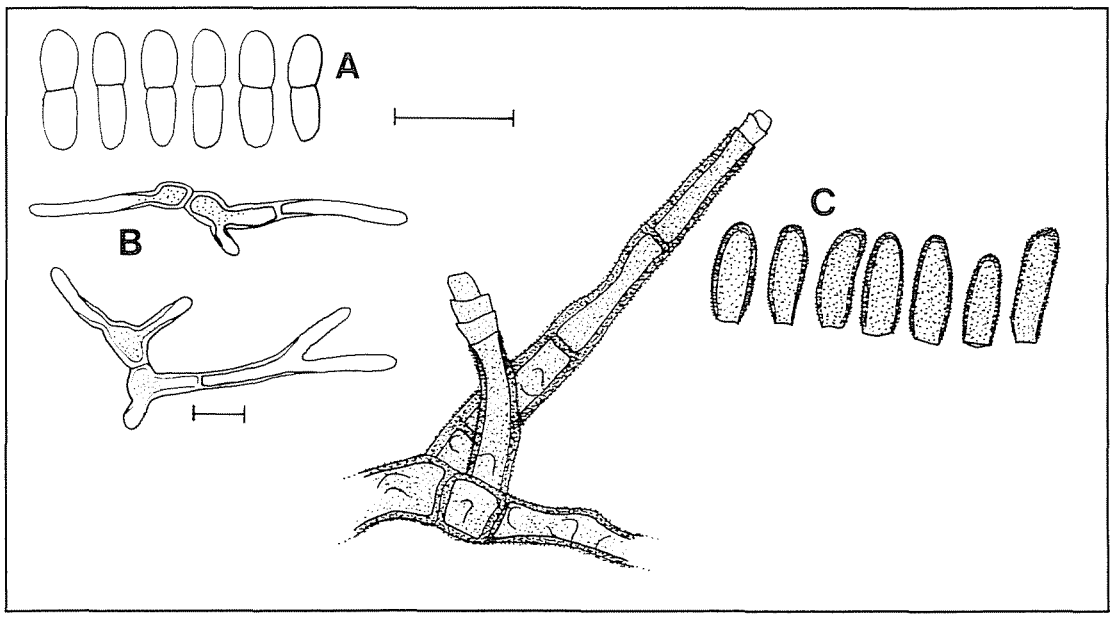

FIGURE 2. Mycosphaerella walkeri *and its anamorph* Sonderhenia eucalypticola. *A. Asci and ascospores. B. Ascospores germinating on MEA after 24* h. *C. Conidia (bar = 10* µm).

CROUS, P.W., WINGFIELD, M.J., FERREIRA, F.A., and ALFENAS, A., 1993b. *Mycosphaerella parkii* and *Phyllosticta eucalyptorum,* two species from *Eucalyptus* leaves in Brazil.*Mycological Research* 97: 582-584.

CROUS, P.W., WINGFIELD, M.J., and NAG RAJ., T.R., 1993c. *Harknessia* spp. occurring in South Africa. *Mycologia* 85: 108-118.

CROUS, P.W., WINGFIELD, M.J., and PARK, R.F., (1991). *Mycosphaerella nubilosa* a synonym of *M. molleriana*. *Mycological Research* 95: 628-632.

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

DICK, M., 1990. Leaf-inhabiting fungi of eucalypts in New Zealand II. *New Zealand Journal of Forestry Science* 20: 65-74.

DICOSMO, F., NAG RAJ, T.R., and KENDRICK, W.B., 1984. A revision of the Phacidiaceae and related anamorphs. *Mycotaxon* 21: 1-234.

FERREIRA, F.A., 1989. Patologia Florestal. *Principais Doenças Florestais No Brasil.* Sociedade de Investigaçoes Florestais, Viçosa.

GANAPATHI, A., and CORBIN, J.B., 1979. *Colletogloeum nubilosum* sp. nov., the imperfect state of *Mycosphaerella nubilosa* on *Eucalyptus* in New Zealand. *Transactions of the British Mycological Society* 72: 237-244.

MARASAS, W.F.O., 1966. New species of Ascomycetes and a new genus of Sphaeropsidaceae from Transvaal. *Bothalia* 9: 203-215.

NAG RAJ, T.R., and F. DI COSMO., 1981. A monograph of *Harknessia* and *Mastigosporella* with notes on associated teleomorphs. *Bibliotheca Mycologica* 80: 1-62.

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.

PARK, R.F., and KEANE, P.J., 1984. Further *Mycosphaerella* species causing leaf diseases of *Eucalyptus*. *Transactions of the British Mycological Society* 83: 93-105.

PURNELL, R.C., and LUNDQUIST, J.E., 1986. Provenance variation of *Eucalyptus nitens* on the Eastern Transvaal Highveld of South Africa. *South African Forestry Journal* 138: 23-31.

SPOONER, B.M., 1981. New records and species of British microfungi. *Transactions of the British Mycological Society* 76: 265-301.

SUTTON, B.C., 1971. Coelomycetes 4. The genus *Harknessia,* and similar fungi on *Eucalyptus*. *Mycological Papers* 123: 1-46.

SUTTON, B.C., 1980. *The Coelomycetes.* International Mycological Institute, Surrey, UK.

SWART, H.J., 1988. Australian leaf-inhabiting fungi 26. Some noteworthy coelomycetes on *Eucalyptus*. *Transactions of the British Mycological Society* 90: 279-291.

SWART, H.J., and WALKER, J., 1988. Australian leaf-inhabiting fungi 28. *Hendersonia* on *Eucalyptus*. *Transactions of the British Mycological Society* 90: 633-641.

VIEGAS, A.P., 1961. *Indice de Fungos Da América Do Sul.* Instituto Agronomico, Campinas, Brazil.

WALL, E., and KEANE, P.J., 1984. Leaf spot of *Eucalyptus* caused by *Aulographina eucalypti*. *Transactions of the British Mycological Society* 82: 257-273.

ZOBEL, B.J., 1993. Clonal forestry in the eucalypts. In *Clonal Forestry II. Conservation and Application*. Eds. M.R. Ahuja and W.J. Libby. Springer Verlag, Berlin.