Studies to consider the possible origins of three canker pathogens of *Eucalyptus* in South Africa

Submitted by

Ronald Natale Heath

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MAGISTER SCIENTIAE

In the Faculty of Natural and Agricultural Sciences, Department of Plant Pathology and Microbiology, Forestry and Agricultural Biotechnology Institute, University of Pretoria, Pretoria, South Africa

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Study leaders:
Prof. Michael J. Wingfield
Dr. Jolanda Roux
Prof. Brenda D. Wingfield

This thesis is dedicated to my late grandfather

Livio Scribante

Wissen ist Macht wie schief gedacht

Wissen ist weinig

Können ist König

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Our Creator, God Almighty

PREFACE

A wide range of *Eucalyptus* spp. are grown commercially in plantations world-wide. Either as exotics or native, these trees are important hardwood resources used in a number of industries. Currently, approximately 19.3 million ha of commercial *Eucalyptus* plantations exist world-wide with a predicted growth of approximately 3 million ha per annum. However, it is widely recognised that *Eucalyptus* plantations are threatened by diseases. The pathogens that cause these diseases can include those native or exotic to areas where *Eucalyptus* spp. are propagated.

Chapter one of this thesis presents a review of the world-wide movement of plant pathogens, particularly in forestry. The means by which pathogens spread is discussed and the effects of the increased movement of humans and products on the spread of pathogens are considered. The impact of introduced plant diseases is illustrated using case studies of past social, economic and environmental impacts. The importance of determining the origin of pathogens and the means to accomplish this is also reviewed. The review reaches the conclusion that a holistic knowledge about pathogens is important for effective quarantine and control measures. This sets the stage for the rest of the thesis and highlights the important recent discovery of *Eucalyptus* pathogens on closely related hosts.

The experimental section of this thesis focuses on stem canker pathogens of *Eucalyptus* collected from alternative hosts belonging to the families Myrtaceae and Melastomataceae. These two families of trees reside in the Myrtales and based on molecular DNA sequence comparisons are known to be closely related. *Tibouchina* spp. reside in the Melastomataceae and are native to South America. Although they have no economic value, they are very popular as ornamentals and have been planted in a number of countries were *Eucalyptus* spp. are grown in plantations. South Africa has a number of native tree species in the Myrtaceae, including *Syzygium* spp. These species occur naturally in the same areas where *Eucalyptus* forestry is practiced commercially. Both *Tibouchina* and *Syzygium* spp. have been shown to be hosts of *Cryphonectria cubensis*, an important stem canker pathogen of *Eucalyptus* spp. A key aim of this thesis was to study canker pathogens of *Eucalyptus* spp., occurring on *Tibouchina* spp. and native *Syzygium* spp.

Cryphonectria cubensis causes a serious canker disease of many *Eucalyptus* spp. Species of *Eucalyptus, Syzygium* and *Tibouchina*, are hosts of this pathogen. Cryphonectria canker results in the formation of cankers and mortality of juvenile trees. It occurs in tropical and sub-tropical regions where high relative humidity and temperatures prevail. This disease has caused serious losses for many commercial forestry companies and has influenced the development of clonal *Eucalyptus* propagation in South Africa.

Recent studies based on morphology and DNA sequence data have indicated that *C. cubensis* represents three distinct taxonomic units and that it should possibly not reside in the genus *Cryphonectria*. The three groups encompassed in *C. cubensis* are represented by isolates from South America and central Africa, south east Asia and South Africa. Previously it was hypothesised that *C. cubensis* originated from Indonesia on *S. aromaticum*. In light of the new taxonomic data, this is, most likely not true for all three species. In the second chapter of this dissertation, I report the discovery of South African *C. cubensis* from native *Syzygium* spp. in South Africa. I discuss the importance of this finding related to the origin of South African *C. cubensis* and consider the pathogenicity of the isolates from *S. cordatum* on the native host as well as on *E. grandis*.

Chapter three of this dissertation considers the relatedness of three populations of *C. cubensis* on two exotic (*Tibouchina* and *Eucalyptus*) and one indigenous (*Syzygium*) South African hosts. The genetic structure of the three populations was determined using polymorphic DNA markers to provide some insight into the possible origin of the fungus and the kinship of the three populations. This chapter provides important information pertaining to the probable origin of South African *C. cubensis* on the exotic hosts.

Chapter four of this dissertation reports on the discovery of an undescribed *Endothiella* sp. on *Tibouchina* spp. from Australia. This fungus is characterised using DNA sequence data and morphological comparisons. The role of this fungus in causing disease was considered and the potential threat to commercial forestry and the native vegetation of Australia was discussed.

Botryosphaeria spp. are important pathogens of *Eucalyptus* spp. and various other plant genera including native plants and economically important agricultural crops. Chapter five of this dissertation reports on a survey of *Tibouchina* spp. growing in South Africa, New Zealand and Australia to determine which *Botryosphaeria* spp. occur on these trees. *Botryosphaeria* spp. infecting these trees are also compared with those infecting *Eucalyptus* spp. The comparisons are based on morphological observations and DNA sequence data. The pathogenicity of these isolates was, furthermore, tested under greenhouse conditions.

The impact and threat of exotic plant pathogens to economically important crops and to native ecosystems is increasing. Many factors are associated with this threat, not least the growing global trade, tourism and climate change. This dissertation includes studies that highlight the importance of monitoring not only commercial crops but also plants belonging to closely related genera that might act as reservoirs and alternate vectors for pathogens.