# FORESTRY & AGRICULTURAL BIOTECHNOLOGY INSTITUTE

# Biennial Report

## May 2009 - May 2011

FABI

The Forestry and Agricultural Biotechnology Institute (FABI) is located on the campus of the University of Pretoria. The primary objectives of the Institute are to:

- Promote the broad field of plant biotechnology through an interdisciplinary approach and with close linkage to a wide range of academic departments
- Undertake research of the highest possible calibre, while at the same time providing short and long term benefits to the forestry and agricultural sectors of South Africa
- Establish partnerships with industries linked to agriculture and forestry, both nationally and internationally, to produce new and improved products and thus to promote competitiveness in trading
- Promote the education, particularly of South Africans, in the fields of forestry and agriculture

The association of FABI with the University of Pretoria, one of the largest residential universities in South Africa, provides access to a wide range of human and technological resources. Currently, academic staff and postgraduate students from research programmes in the Departments of Biochemistry, Plant Science, Genetics, Microbiology and Plant Pathology, Zoology and Entomology and Plant Production are associated with FABI. This affords FABI the opportunity to build future resources in biotechnology which will be crucial to the future of forestry and agriculture in South Africa.

In every way, FABI represents an amalgamation of a tremendous base of expertise in forestry and agriculture from different universities and research organisations in South Africa and other countries through our collaborations. The Institute has been operational since 1998. This document represents the seventh FABI biennial report covering the period from May 2009 to May 2011.

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**Compilation, layout and design by TA Coutinho**

**Front page design: Retha Buitendach**
This hypothetical insect, called '*Pseudosirex eucalyptifolia'* has been assembled from diseased and/or insect-infested plant material that makes up various FABI research projects. *Head and thorax:* bark of a native African tree with bark beetle galleries. *Eyes: Eucalyptus* fruit. *Antennae:* pine twigs. *Wings: Eucalyptus* leaves with *Mycosphaerella* spp. infections. *Legs:* central veins of *Eucalyptus* leaves with *Leptocybe* galls. *Claws*: pine needles with red bands symptomatic of *Dothistroma* needle blight. *Abdomen:* bark of young *Eucalyptus* trees. *Ovipositor:* growth tip of a young pine.

**Forestry and Agricultural Biotechnology Institute**
***"FUTURE FORESTS and FOOD"***

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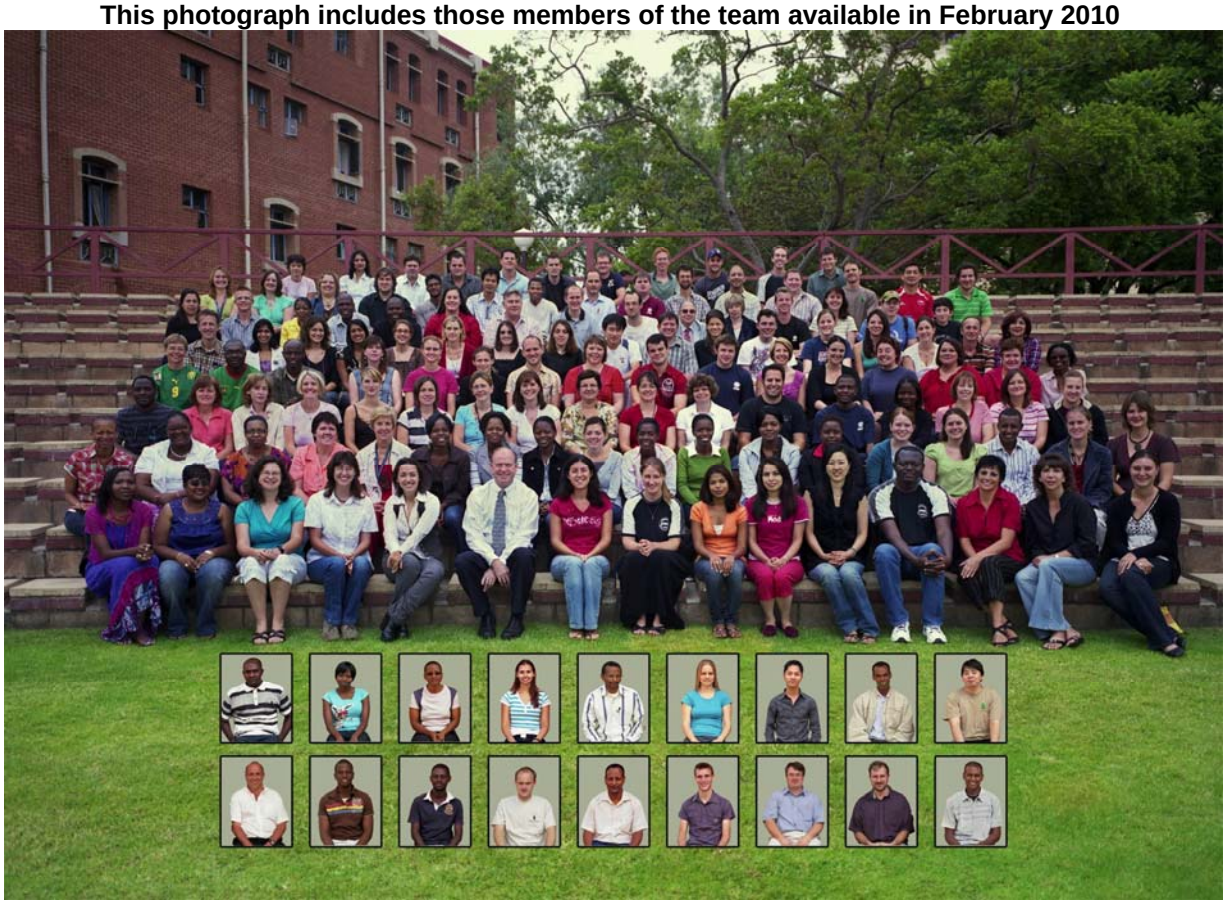
# FABI TEAM

**This photograph includes those members of the team available in February 2010**



**1st Row**
Grieta Mahlangu, Kershney Naidoo, Marieka Gryzenhout, Bernice Porter, Kai-Anne Clews, Mike Wingfield, Emilie Boissin, Irene Barnes, Kerry-Anne Pillay, Fahimeh Jami, Eunsung Oh, Gilbert Kamgan, Rose Visser, Helen Doman, Erika v/d Walt

**2nd Row**
Patience Ralikonyana, Valentina Nkosi, Lydia Twala, Vivienne Clarence, Jenny Hale, Lunghile Mthombeni, Christina Selowa, Linda Ndove, Amelia Keyser, Babalwa Mbebe, Mmatshepho Phasha, Tsholofelo Kibido, Tsholofelo Mojela, Chrizelle Beukes, Marija Kvas, Berhanu Fenta, Liesl v/d Linden, Ariska v/d Nest

**3rd Row**
Donald Chungu, Marlene Harney, Eva Muller, Maretha v/d Merwe, Alisa Postma, Gerda Fourie, Renate Zipfel, Noelani v/d Berg, Elna Cowley, Daleen van Dyk, Adri Veale, Eshchar Mizrachi, Divine Shyntum, Gugulethu Kubheka, Lisa-Danelle de Wet, Marcele Vermeulen, Juanita Engelbrecht

**4th Row**
Jolanda Roux, Didier Begoude, Jean Hakizimana, Anna Visser, Elsie Cruywagen, René Sutherland, Juan Vorster, Emma Steenkamp, Quentin Santana, Simon Martin, Marja O'Neill, Nicky Creux, Minique de Castro, Magda Fouche, Teresa Coutinho, Lucy Moleleki

**5th Row**
Duur Aanen, Sanushka Naidoo, Febé Wilken, Ronishree Naidoo, Katrin Fitza, Gudrun Dittrich-Schröder, Angelica Marsberg, Melissa Simpson, ShuaiFei Chen, Lorenzo Lombard, Heidi Fysh, Jonathan Botha, Bianca Farrow, Lindsay Kriel, Gabrielle Carstensen, Albé v/d Merwe, Bertha-Lucia Castro

**6th Row**
Tania Nobre, Michael Poulsen, Martha Mahlangu, Lenny Mashavha, Michael Mbenoun, Izette Greyling, Gert Marais, Ryan Nadel, Pieter De Maayer, Carl Roux, Brenda Wingfield, Stewart Mc Culloch, Bridgett Crampton, Martin Ranik, Juan Castro

**7th Row**
Jamie-Lee Sauer, Melissa Reynolds, Sonica Goddard, Jan Nagel, Waheed Mahomed, Deer Konkarn, Osmond Mlonyeni, Wilhelm de Beer, Eric Birkholz, Dave Berger, Bernard Slippers, Barend J/v Vuuren, Stephen Taerum, Alvaro Duran, Zander Human

**8th Row**
Magriet v/d Nest, Raj Deepika, Martin Coetzee, Markus Wilken, Francois Boshoff, Marc Bouwer, Hardus Hatting, Johan v/d Linde, Darryl Herron, James Mehl, Barry Christie

**Absent**
Friday Nweke, Lerato Maubane, Matsepo Taole, Jane Bredenkamp, Dawit Degefu, Jeanne Korsman, Tuan Duong, Wubetu Bihon, Xintao Mou, Fanus Venter, Godfrey Kgatle, Tondani Kone, Brett Hurley, Endale Gebre, Steven Hussey, Nicky Olivier, Jeff Garnas, Priyen Pillay.

# DIRECTOR'S REPORT

As I write this introduction to the seventh Biennial Report covering the years 2009 and 2010, I am reminded of the fact that FABI has now firmly entered its "teenage" years. In this regard, it is hard to believe how rapidly the Institute has become established, taking a firm position as a leading centre in Agricultural and Forest Biotechnology in South Africa, more widely on the African continent and also internationally. Even from the very early days of FABI's existence, there has been a steady stream of post graduate students (M.Sc., Ph.D. and post-doctoral fellows) graduating from programmes in the Institute and the tangible research outputs have increased substantially both in quality and quantity. FABI is clearly on an impressive trajectory into the future and this is squarely due to an incredibly committed leadership team via the FABI Management Committee (MANCOM) and a hugely impressive community of students and support staff. Importantly, we have also been guided by a superb Advisory Committee, including the Dean of the Faculty of Natural and Agricultural Sciences and heads of the seven departments that have links to FABI.

There have been countless exciting and important new developments since the publication of our previous Biennial Report in mid 2008. Importantly, the Institute was subjected to its second five year external review. This important and challenging process allowed the FABI Team to summarise and focus on achievements and challenges. Representatives of all levels of the team including key stakeholders were able to meet members of the review panel and to share their experiences and suggestions for the future growth and development of FABI. The outcome of this review was supportive and substantially positive, yet also included caveats and suggestions for refinement and improvement that have already been most useful to us.

An important question emerging from the second FABI review was how we would view the structure and focus of the Institute during its second decade. In this regard I think it is pertinent to consider the fact that FABI had relatively loose terms of reference at the time of its 'birth" and that it has gradually grown and changed to meet a rapidly changing agricultural and forestry environment. At the time of its establishment, DNA-based techniques were only beginning to impact on this field. The human genome had not been sequenced and we did not have access to the first complete plant genome. FABI took a leading role in introducing DNA-based technologies to many aspects of agriculture and forestry and it is surprising to look back on the astounding impact that this work has already had on South African agriculture, forestry and post graduate education. Thus, looking to the future, I believe that when we come to the end of the second decade of FABI's 'life" in 2017, only seven years hence, we will look back to find that the Institute has grown and changed as dramatically in its second decade, as it did during its first ten years.

Today, FABI includes approximately 180 academics, post graduate students and support staff. The group occupies various buildings, but the core of our activities is connected in FABI Main Building and FABI Square (www.fabinet.up.ac.za). As I write this introductory statement, we are only two weeks away from the inauguration of the new and eagerly awaited FABI Forestry Biocontrol centre. This modern facility, including quarantine greenhouses, incubation rooms and laboratories will allow rapid growth in our already well-established ability to support the South African forestry industry with biological control, particularly for invasive alien forest insect pests. Likewise, the new Plant Sciences Complex, including laboratories and offices that will allow for further growth of FABI activities is rising rapidly behind FABI Main Building and will reach completion within the next few months. This new mega-facility will synergise projects and programmes in all of the broad plant-related research and education and FABI will clearly form an integral part of this new growth and development.

During the past five years, FABI researchers have taken a strong lead in developing genome-based research in South Africa. There are many milestones in this process that bear mention here, but details are presented in various other parts of this report. Members of the FABI Team were, for example, the first in Africa to sequence the genome of a bacterial plant pathogen. Likewise, members of the group produced the first complete genome sequence of a eukaryote, the tree-infecting fungus *Fusarium circinatum*. Members of the Forest Molecular Genetics group in FABI have been integrally

involved in completing the first *Eucalyptus* genome sequence and these examples are merely a few of the many genomics (and related) projects that are already well-advanced in FABI. The Institute will clearly play a key role in the new University of Pretoria Institutional Research Theme (IRT) linked to genomics. In all, this field is set to have a huge impact on the future of FABI and equally on Agriculture and Forestry.

Returning to the point made at the start of this note and the fact that FABI has now entered the equivalent of its teenage years. While having grown rapidly and having achieved great success across a wide range of key performance indicators, the composition and core activities of the Institute are very different to those of 13 years ago. Like a teenager, FABI is vibrant and full of energy to grow and explore. It exists in the anticipation of the many exciting opportunities and challenges that lie ahead in post graduate education and plant research. The Institute is on a trajectory of growth but programmes and projects are also maturing beyond the uncertainty of the establishment phase. FABI looks very different today to its manifestation in its formative years and consistent with this fact, there is no absolute blueprint for the future of FABI. In my view, it is this freedom to grow and develop without undue constraints, which at least to some extent has defined the successes that FABI has already achieved. Following this view, FABI will likely be substantially different when it reaches its 20th birthday. But I have no doubt that it will still reflect superb levels of quality research and education in Agriculture and Forestry. This success will continue to rest on an incredible FABI TEAM that I have had the privilege to lead.

**Mike Wingfield Ph.D. (University of Minnesota), FRSSA, ASSAf**
**Mondi Professor of Forest Pathology, Director of FABI, the Tree Protection Co-operative Programme (TPCP) & the DST/NRF Centre of Excellence in Tree Health Biotechnology (CTHB)**

# RESEARCH REPORTS

## Centre for Applied Mycological Studies (CAMS)

**Research Leader:** Prof. Gert Marais

**Research Team:** Ms. Magda Fouché
Ms. Babalwa Mbebe
Ms. Annelie Lübben

**Objectives of the research programme:**

- Building collaboration between FABI and CSIR Biosciences
- Promoting mycological research in South Africa
- Exploiting the fungal culture collections of FABI and CSIR for value added products in the agricultural, food, medical and industrial fields
- Understanding the role of fungi and their mycotoxins in food and feed processing in South Africa
- Promoting mycology as a research discipline through education

**Highlights of our research:**

**CAMS team: Front from left to right – Aisha Mahomed-Ali, Magda Fouche, Gert Marais, Pranitha Dawlal. Back from left to right – Amelia Keyser, Ariska van der Nest, Francois van der Walt, Babalwa Mbebe, Qaqamba Mapatwana**

During the report period, CAMS has completed a number of projects that were part of its main objectives. For example, CAMS was involved in a Maize Trust project regarding the screening of 49 commercially produced maize cultivars in South Africa for their ability to withstand fungal attack during storage. Ten mycotoxigenic fungi, including both field and storage fungi, were evaluated for their ability to spread through stored maize. Cultivars that showed resistance towards field fungi included DKC 80-10, PAN 6146, AFG 4512 and DKC 78-15 Bt. Cultivars PAN 6844, PAN 6146 and PAN 6611 were more resistant to storage fungal attacks. An attempt was also made to evaluate the internal transcribed region (ITS) of the fungal rRNA gene in ten of the more important mycotoxigenic fungi in South African maize as a method to detect infestation. Fungi that were evaluated included *Alternaria alternata, Aspergillus flavus*, *Aspergillus ochraceus*, *Eurotium repens*, *Fusarium graminearum, Fusarium verticillioides*, *Penicillium islandicum*, *Phoma sorghina*, *Rhizopus oryzae* and *Stenocarpella maydis*. This was done by using the variation in the internal transcribed regions (ITS) of the fungal rRNA gene to detect and identify the fungi in infected samples. Results indicated that the ITS region can be useful in detecting the presence of mycotoxigenic fungi in maize. This was part of an MSc study of Ms Pranitha Dawlal who completed her degree in 2010.

A CTHB funded project on the screening of South African fungi for the ability to produce pyrazine flavours was also completed in 2010. The aim of this study was to evaluate South African fungi for their ability to produce pyrazine flavours, and more specifically methoxypyrazines. In total, 283 fungi from the CSIR and FABI fungal culture collections were screened for pyrazine aroma production through a sensory evaluation. Results indicated that 44% of the total fungi screened were positive pyrazine producers. Thereafter 11 selected fungi were screened for pyrazine production using Gas Chromatography-Mass Spectrometry Time of Flight (GC-MSTOF). Pyrazines were tentatively identified in 7 out of the 11 fungi by using mass spectral search routines. The production of 2-methoxy-3-isobutylpyrazine by *Penicillium purpurogenum* (MRC 181) and *Penicillium rubrum* (MRC

1723) as well as the production of 2-methoxy-3-isopropylpyrazine by *Penicillium rubrum* (MRC 1723) was confirmed by comparison of mass spectral data obtained from certified chemical standards and the Wiley library, retention time comparison and as well as by olfactory evaluation of the GC carrier gas stream exhaust. It can thus be concluded that fungi are good candidates for the production of methoxypyrazines and that other flavour products such as sesquiterpenes and isoamyl acetate may also be produced from these fungi. Ms Aisha Mahomed-Ali completed her MSc in 2010 based on the findings of this study.

In 2009, a CTHB project was completed where seven undescribed fungal species belonging to the Botryosphaeriaceae from *Acacia* trees in Southern Africa were found. As part of this study, surveys were done in Namibia, Pretoria area, and the Northern Cape Province on *Acacia mellifera*, *A. karoo, A. hebeclade, A. erioloba* and *A. tortilis*. Based on PCR-RFLP groupings, morphological characterization and multi locus DNA sequence data, a total of seven undescribed and three known species were identified. A single isolate of another apparently undescribed *Neofusicoccum* species was also found. This study contributes significantly to our understanding of the relation between indigenous plants such as *Acacia* species and fungal members of the Botryosphariaceae in southern Africa. This project was part of the MSc studies of Mr Francois van der Walt who completed is degree in 2009.

**Francois van der Walt recording data from his field site in the Northern Cape Province**

**Aisha Mahomed-Ali setting up a sniffing panel for pyrazine screening**

A Maize Trust funded project was completed in 2009 that investigated the migration and distribution of mycotoxigenic fungi in the dry milling system in South Africa. The study involved six of the bigger milling systems in South Africa where samples were taken from the grain silo right through to the various fractions and maize products produced. Results indicated that a wide variety of fungi are associated with South African maize products, although only a few seem to play a significant role in the contamination and presence of fungi and their mycotoxins. It was also found that maize products that are produced from the floury endosperm and hull of the kernel, including special maize meal, flour and chop, have a higher risk to contain high levels of fungi and their mycotoxins. Storage fungi also tend to increase dramatically during the milling process that can influence the shelf-life of products. It was found that at least 19 different *Penicillium* species are associated with maize products in South Africa.

# DST NRF Centre of Excellence in Tree Heath Biotechnology (CTHB)

**Director:** Prof. Mike Wingfield

**Programme manager:** Prof. Brenda Wingfield (2009)
Prof. Emma Steenkamp (2010)

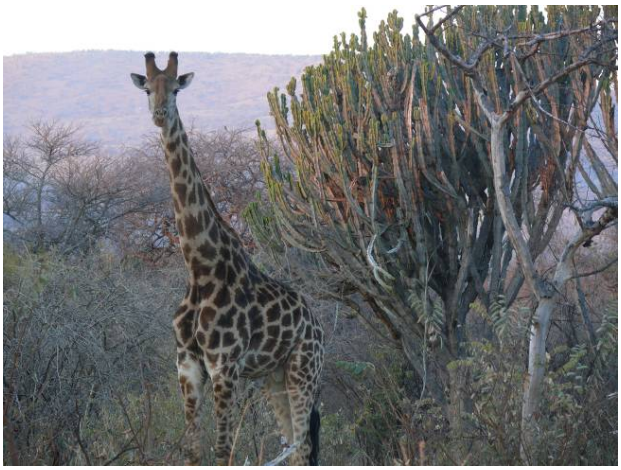
**Project leaders:** Prof. Teresa Coutinho
Prof. Pedro Crous
Prof. Jolanda Roux
Prof. Bernard Slippers
Prof. Wally Marasas
Dr. Gert Marais
Dr. Brett Hurley
Dr. Jeff Garnas
Dr. Martin Coetzee
Dr. Marieka Gryzenhout

**Objectives of the research programme:**
The CTHB has a focus on Tree Health and the application of Biotechnology to reduce the impact of pests and diseases that threaten indigenous trees in South Africa.

**Highlights of our research:**
Between 2004 and the end of 2009, the Centre of Excellence in Tree Health Biotechnology (CTHB) was one of two partially funded Department of Science and Technology (DST)/ National Research Foundation (NRF) Centres of Excellence. Although the focus of the original proposal was for a wide-ranging programme focussed mainly on commercially important trees, the CTHB moved their research focus to the health of native South African trees, as requested by the DST/NRF. Since its launch in 2005, the CTHB has gained considerable scientific recognition both nationally and abroad and has established a very clear niche in the Science system of South Africa. This was also evident from the results of the external review of the CTHB in 2009, where the panel of experts all agreed that the quality and unique nature of the research focus presents the CTHB with a distinct competitive edge and that the Centre receive full-funding for not only a further five-year period, but also beyond this period. Therefore, in September 2010, the CTHB achieved fully-funded status, thereby effectively doubling its grant funds for 2010 until the end of 2014. This has enabled the CTHB to expand its research scope by incorporating research conducted at other research institutions in areas that are aligned with the overall goals of the CTHB.

**Highlights of our research:**
The CTHB has a focus on Tree Health and the application of Biotechnology to reduce the impact of pests and diseases that threaten indigenous trees in South Africa. New research projects were identified for students starting their degree programmes in 2010 and 2011. In addition, significant progress has been made on the projects initiated in 2005-2009.

Consistent with the objectives of the CTHB, these projects focus on the health and diseases of a range of tree species that are indigenous to southern Africa. They include members of the Proteaceae and Rubiaceae, as well as the following:
*Acacia erioloba* (Camel Thorn)
*Acacia karroo* (Sweet Thorn)
*Acacia mellifera* (Black Thorn)
*Adansonia digitata* (Baobab)
*Pterocarpus angolensis* (Kiaat)



**Dying *Euphobia elegans* tree in Limpopo Province**

*Metrosideros angustifolia* (Lance-leaved Myrtle)
*Rapanea melanophloeos* (Cape Beech)
*Sclerocarya birrea* (Marula)
*Syzygium cordatum* (Waterberry)
*Syzygium guineense* (Water Pear)
*Terminalia* species

The pathogens that are under investigation include species in the Cryphonectriaceae and Uredinales (*Ravenelia*, *Puccinia* and *Uromyces),* as well as in the genera *Armillaria, Ganoderma, Botryosphaeria, Cylindrocladium, Dothistroma, Ceratocystis, Coniothyrium, Ophiostoma*, *Pantoea, Fusarium, Colletogloeopsis/Phaeophleospora/ Kirramyces), Mycosphaerella*, and *Phytophthora*. In almost all of these instances, our results illustrate that an extremely large diversity of microorganisms, many of which are new to Science and that might represent important pathogens, occupy these previously unexplored niches.

Under the broadened scope of the CTHB, new research projects include further work on native trees such as *Acacia karoo* and *Acacia mellifera, Colophospermum mopane* (Mopane), *Adansonia digitata*, species of *Terminalia* and *Virgillia*, as well as members of the *Rutaceae* and *Proteacea*. Although some of the projects will focus on the microorganisms (e.g., Ophiostomatoid fungi and bacteria such as *Candidatus Liberibacter africanus*) associated with these hosts, the majority of the new projects will focus on issues not previously addressed by the CTHB. These include studies that consider aspects such as the effects of drought stress on native trees and the impact of forestry and climate change on woody natural resources.

**Dying camel thorn trees in the Northern Cape**

The CTHB has developed tangible collaboration with many research groups from around South Africa and internationally. The fact that the CTHB is now a fully-funded Centre of Excellence, is also facilitating more networking between researchers and those in other research groups and institutions in South Africa (e.g. at US, UFS, RU, UCT, WITS and the ARC and other African countries (e.g. Cameroon, Botswana, Mozambique and Zimbabwe.

The CTHB has established a firm research foundation, has passed successfully through the 5-year review and in May 2011 passed through Gate 4 to enter the Exiting Stage, running through to February 2013. The need to maintain the impetus of the Centres of Excellence and not to lose the strength that they have brought to Science in South Africa, is recognised by the NRF and DST. It is thus hoped that the CTHB and other Centres of Excellence will be offered support beyond the initial ten-year term. Failure to continue the supporting Centres of Excellence would clearly represent an unfortunate lost opportunity linked to the new synergies that will be developed in 2011 and beyond.

**Steven Taerum alongside a tree that has collapsed due to decay**

**Malformation of *Syzigium* flowers**

# CERC-FABI *Eucalyptus* Protection Programme (CFEPP)

**Research leader:** Dr. XuDong Zhou

**Research team:** Prof. Mike Wingfield
Prof. YaoJian Xie (CERC, China)
Prof. Jolanda Roux
Mr. Zhihua Wu (CERC, China)

**Objectives of the research programme:**

- To study *Eucalyptus* diseases and pests threatening plantation development in China
- To understand the biology and spread of these pests and pathogens
- To screen *Eucalyptus* hybrids tolerant to the most important diseases
- To train young researchers working on tree health
- To establish a model for the cooperation between South Africa and China
- To serve as the *Eucalyptus* health authority in China in the long run

**Highlights of our research:**

***Pathogen characterisation***

A large number of eucalypt disease surveys were conducted in South China where eucalypt trees are planted. Samples collected included diseased leaves, branches and stems both in nurseries and plantations. Isolations were done and these resulted in obtaining over 2000 fungal isolates representing at least eight morphological groups. Representative isolates of each group were further identified using the comparisons of morphology and DNA sequences. In total, twenty species of pathogens in the genera of *Chrysoporthe*, *Celoporthe*, *Lasiodiplodia*, *Fusicoccum*, *Neofusicoccum*, *Calonectria*, *Quambalaria* and *Teratosphaeria* were identified, including ten new to Science. Most of these findings have been published in internationally renowned journals.

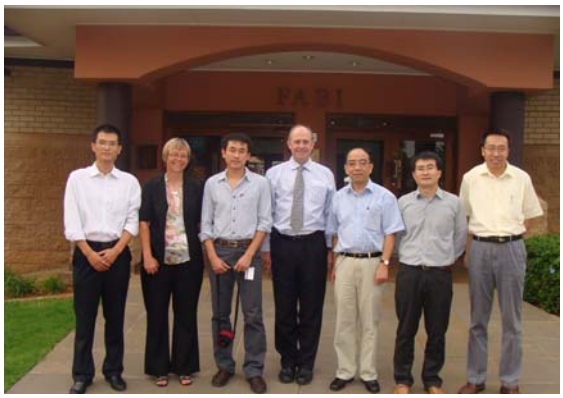
***Pathogenicity trials***

Isolates of pathogens were selected for pathogenicity trials both in glass house and field on different *Eucalyptus* genotypes. Results indicated that there existed variations in susceptibility of *Eucalyptus* genotypes to pathogens, emphasizing that great care should be taken when selecting isolates and when interpreting pathogenicity data. Potential disease-resistant clones have thus been identified.

**Prof. Li (the 2rd from the right), former vice president of Chinese Academy of Forestry visiting FABI**

***Capacity building***

CFEPP secured a very significant grant from Ministry of Finance, China in 2009, and a "*Eucalyptus* Health Biotechnology" lab was equipped with state-of-art facilities in 2010.



**Councillor An (3rd on the right) from Chinese embassy in South Africa attending Dr Chen's prestige seminar**

***Students training***

In the past two years, two full-time Ph.D students, Stephen Tareum and MingLiang Yin, and one full-time Msc student, Yan Wang, joined the team; one student, ShuaiFei Chen obtained his Ph.D degree.

# *Eucalyptus* Pine Pathogen Interactions (EPPI)

**Research leader:** Dr. Sanushka Naidoo

**Collaborators:** Prof. Dave Berger
Prof. Zander Myburg
Prof. Bernard Slippers
Dr. Noëlani van den Berg
Prof. Teresa Coutinho
Prof. Emma Steenkamp

**Objectives of the research programme:**
Research undertaken by the *Eucalyptus* Pine Pathogen Interactions (EPPI) programme aims to investigate the molecular basis of the defence response of forest trees to various pathogens. Long-lived forest tree species may be subjected to attack by various pests and pathogens during their life-time. Thus, the focus is on understanding broad-spectrum resistance to curb disease incidence.

Over the past two years, our research has focused on the gene discovery of defence response genes and defence pathways in model systems such as *Arabidopsis thaliana, in Pinus spp.* and in *Eucalyptus* species owing to the recent completion of the genome sequence of *Eucalyptus grandis*. In the next phase of the research, we aim to characterise the role of the identified genes in defence against various pathogens using functional studies. The ultimate objective of EPPI is to identify candidate genes and regulatory sequences that can be used to improve the resistance of forest trees to threatening pathogens in future either by conventional breeding or genetic manipulation.

**Highlights of our research:**
***Modelling tree defence responses in* Arabidopsis thaliana**
*Ralstonia solanacearum* is the causal agent of bacterial wilt disease and is able to infect a range of hosts including the tree species of the genus *Eucalyptus*. A *Eucalyptus* isolate of *R. solanacearum* has previously been shown to be pathogenic on *Arabidopsis* ecotype Col-5. We exploited this susceptible interaction to investigate the hosts response to bacterial wilt in the absence of genomic resources for *Eucalyptus* and recently published an article entitled "A *Eucalyptus* bacterial wilt isolate from South Africa is pathogenic on *Arabidopsis* and manipulates host defences" in Forest Pathology (Article first published online: 9 MAR 2010). We employed microarray technology to investigate the expression pattern of 5000 *Arabidopsis* genes in response to infection. A subset of 140 genes was shown to be differentially regulated by pathogen challenge. Bioinformatic comparison with publicly available *Arabidopsis* Affymetrix NASCArray data suggested that the response of *Arabidopsis* plants to both *Eucalyptus* (BCCF401) and tomato (GMI1000) isolates of *R. solanacearum* are highly correlated. Plants have an innate ability to defend themselves against pathogens (referred to as basal defence) as they are able to perceive non-self molecules that are pathogen derived (known as Pathogen Associated Molecular Patterns or PAMPs). An emerging theme in plant-pathogen interaction research is the ability of pathogens to actively suppress host defences. In our bioinformatics comparisons to PAMP-induced expression profiles, our research revealed that basal defences are countered by specific *R. solanacearum* effectors. It is hypothesized that such differentially regulated genes represent targets of *R. solanacearum* effectors.

**Ms Katrin Fitza applying "inducers" to *P. patula* seedlings**

***Gene discovery of defence orthologs in Eucalyptus***

The complete genome sequence of *Eucalyptus* grandis was released by the United States Department of Energy/Joint Genome Institute (DOE/JGI) in 2010 (www.pytozome.net). An expressed gene catalogue representing key tissue-specific transcriptomes for *Eucalyptus* was also generated by the Wood and Forest Molecular Genetics Programme directed by Prof. Zander Myburg (Mizrachi *et al*. 2010 *BMC Genomics*). Both these resources provide a unique opportunity to identify the orthologues of defence response genes in *Eucalyptus* through comparative genomics, by using sequences of known defence response genes from model organisms like *Arabidopsis*, *Populus* and rice. By using model organism sequence data, in conjunction with bioinformatics tools, defense-related gene sequences of high similarity were identified in the *E. grandis* genome sequence. Phylogenetics tools were used to map the relatedness of gene sequences based on similarity to a particular gene family member within each of the different gene families. Primers were designed for the most likely candidate orthologue for each of the investigated genes. Using this approach, we have been able to identify several putative marker genes diagnostic for the salicylic acid, methyl jasmonate and ethylene defence response pathways in *Eucalyptus.*


**Ms Therese de Castro presenting her MSc research based on the *Arabidopsis* - *R. solanacearum* pathosystem at the 2010 SAGS conference**

**Ms Ronishree Naidoo inspects *Eucalyptus* seedlings for bacterial wilt disease symptoms**

***Indced resistance against* Fusarium circinatum *in* Pinus patula**

*Pinus patula* is highly susceptible to the pitch canker fungus *F. circinatum*. Induced resistance has been recognised as a means to incite a type of broad-spectrum, long-lasting resistance against subsequent pest or pathogen attack. In collaboration with Mondi, we tested the efficacy of a panel of 10 inducers in reducing the disease severity of *F. circinatum* infection. Treatment with one biologically-derived inducer in particular resulted in reduced lesion lengths after artificial inoculations with the pathogen over a period of 6 weeks ($p<0.05$; Kruskal-Wallis test). Molecular analysis suggested that the inducer had enhanced the phenylpropanoid pathway to elicit defence in *P. patula*.

# Forest Molecular Genetics (FMG) Programme

**Research leader:** Prof. Zander Myburg

**Research Team:** Dr. Sanushka Naidoo
Dr. Noëlani van den Berg
Dr. Daleen van Dyk
Mr. Eshchar Mizrachi
Mr. Albe van der Merwe

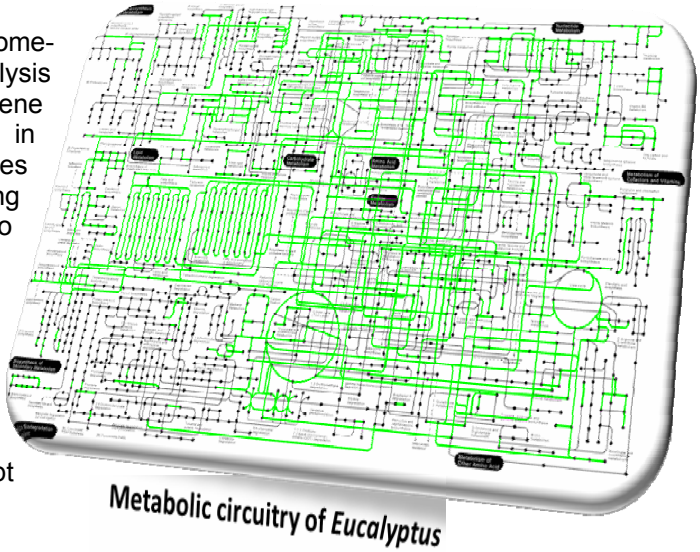
**Objectives of the research programme:**
The main focus of the FMG Programme is the genomics and molecular genetics of wood fibre development in fast-growing forest trees. This knowledge is used to develop biotechnology tools for the improvement of wood properties in plantation tree species grown in South Africa. High-throughput molecular (genomics) technologies are used to:

- Discover genes involved in wood fibre development in trees
- Dissect the regulatory networks and metabolic pathways underlying wood formation
- Test the function of candidate wood formation genes in trees
- Map tree genomes and associate markers and genes with trait variation in tree populations
- Develop practical molecular breeding tools (fingerprinting applications and trait-linked markers) for the genetic improvement of plantation (*Eucalyptus* and pine) tree species

**Highlights of our research:**
With the completion of the *Eucalyptus* genome sequence, and development of ultra-high-throughput DNA sequencing technology our research has over the past two years shifted towards whole-genome and whole-transcriptome analysis, and from individual trees to populations.

**Genes expressed in immature xylem cells (outer layer of exposed tissue) determine the structure and chemical composition of eucalypt wood**

***Transcriptome analysis.*** We are using high-throughput Illumina RNA sequencing technology to sequence the transcriptomes and profile gene expression of differentiating woody (e.g. immature xylem, cambium and phloem) and green (shoot tips, young and mature leaf) tisses to unravel the genetic regulation of tree growth and development. Over the past two years, we completed the sequencing and *de novo* assembly of six tissue transcriptomes of a fast-growing *Eucalyptus* $F_1$ hybrid (*E. grandis* x *E. urophylla*) clone (Sappi Forest Research) and characterised a gene catalogue of over 18,800 genes expressed in developing tissues of this clone. In addition, we sequenced and profiled the same six tissue transcriptomes from three *E. grandis* clones and the xylem and leaf transcriptomes of 30 *E. grandis* trees from a Mondi breeding trial. In 2010, the DST provided strategic funding to sequence the xylem transcriptomes of 200 F2 progeny of the Sappi F1 (*E. grandis* x *E. urophylla*) hybrid clone for which we produced the expressed gene catalogue. Transcriptome-wide analysis of gene expression in these trees is allowing us to characterise metabolic pathways, transcriptional networks and expressed genetic variation which underlie the variation in growth and wood quality traits observed in eucalypt breeding programmes.



Metabolic circuitry of *Eucalyptus*

***Genome mapping of wood property traits.*** We have produced high-density (<1 cM resolution, >2400 DArT and microsatellite marker) genetic linkage maps of the same $F_1$ hybrid clone (Sappi) used for transcriptome sequencing and of the *E. grandis* and *E. urophylla* parents used to develop two F2 backcross families (Sappi). The genetic maps are being used to map genomic regions (quantitative trait loci, QTLs) associated with volume growth (DBH), wood density, and a range of wood cell wall chemistry traits.

***The* Eucalyptus *Genome Project*.** The US Department of Energy (DOE) Joint Genome Institute (JGI) completed the 8X Sanger sequencing of the *E. grandis* genome in 2009 and in 2010 assembled the 11 chromosome (scaffold) sequences, based in large part on the high-density genetic maps produced in our research programme. In Jan 2011, the JGI and University of Ghent released draft annotations of the approximately 44,000 predicted protein-coding genes in the genome. In parallel to this effort, the DST has provided support to resequence the genomes of 32 eucalypt tree genomes for molecular marker (SNP) discovery and the establishment of a genome-assisted breeding platform for eucalypts at the University of Pretoria.

***In vitro* propagation of eucalypt clones**

***Genetic regulation of cellulose and hemi-cellulose biosynthesis.*** Cellulose and xylan are the two main carbohydrate components of fibre cell walls. The transcriptional networks regulating the production of these two biopolymers in wood are an important research focus. We previously isolated the promoters of the cellulose synthase (CesA) genes of *Eucalyptus* trees and identified cis-regulatory elements in these promoters that underlie the control of CesA gene expression. In the past two years, we have isolated a number of *Eucalyptus* transcription factors that are thought to bind to the promoters of cellulose and xylan biosynthesis genes and regulate the production of these biopolymers in wood. We also completed whole-transcriptome sequencing of differentiating tension wood (a specialized reaction wood formed on the upper side of bent stems) and normal wood, two tissues with large differences in crystalline cellulose, xylan and lignin content.

***Genetic transformation of* Eucalyptus *and* Populus *trees.*** The combination of genome mapping and transcriptome analysis of field-grown trees is creating hypotheses about individual canididate genes, which can be tested in transgenic trees. We have, with the assistance of a collaborator (Prof. Shawn Mansfield, University of British Columbia, UBC), established a poplar tree transformation system in FABI, and we are working towards a tissue culture and genetic ransformation protocol for commercially grown eucalypt clones.

***Wood chemistry analysis:*** We have over the past year established capacity to perform wood chemistry (Klason lignin and HPLC cell wall sugar) analyses in a shared Sappi-UP laboratory in the Department of Chemical Engineering at UP. This capacity allows us to measure wood chemistry traits in experimental populations and in transgenic trees.

***DNA fingerprinting and parentage analysis of trees.*** Microsatellite or simple sequence repeat (SSR) markers are powerful tools that can be used to fingerprint closely related trees and support routine tree breeding activities. We have developed microsatellite marker panels for *Eucalyptus* and *Pinus* tree species grown in South Africa and used these in a variety of applications including: clonal fingerprinting, detection of pollen contamination, and cross and selfing analysis in open and controlled crosses of *Eucalyptus* and pine trees. This capacity is available as a research service to forestry companies in South Africa.

**Tension wood development involves a massive reprogramming of transcription in xylem tissues, which can be used to identify genes involved in the regulation of cellulose, hemi-cellulose and lignin biosynthesis**

# Fruit Tree Biotechnology Programme

**Research leader:** Dr. Noëlani van den Berg

**Collaborators:** Dr. Sanushka Naidoo
Prof. Zander Myburg
Prof. Dave Berger
Prof. Teresa Coutinho

**Objectives of the research programme:**
The Fruit Tree Biotechnology Programme (FTBP) represents a cooperative venture between The Hans Merensky Foundation and the University of Pretoria, and deals with avocado disease problems, especially focusing on Phytophthora root rot (PRR) and understanding the mechanisms involved in rootstock tolerance. In addition, the FTBP is also involved in banana research focusing on the unconventional improvement of Cavendish bananas.

***Avocado Research at FABI***
Avocado root rot caused by *Phytophthora cinnamomi* is regarded as one of the most serious diseases of the fruit and has a large financial impact on the South African and world-wide avocado industry. Undoubtedly the most significant problem is the lack of total resistance against the disease. Despite the great importance of avocados in the agricultural sector, little is known about its genetics. Most of the superior avocado cultivars have been field selections within seedling populations but the genetic basis of resistance to PRR has yet to be studied.

**FTBP team members on a field trip**

The search for genes conferring resistance to diseases and pests has become an important objective towards understanding plant resistance and improving crop breeding. Little is known about the molecular processes underlying resistance responses, metabolic pathways and downstream signaling of the avocado-*P. cinnamomi* (*Pc*) interaction. The specific research has therefore focused on understanding the phenotypic and genotypic mechanisms underlying disease tolerance/resistance of avocado rootstocks against *P. cinnamomi*.
Research on the phenotypic characteristics of tolerant avocado rootstocks investigated the role of phenolics, peroxidases, glucanases and hydrogen peroxide in conferring tolerance to PRR. Light-, scanning and electron microscopy techniques were applied to unravel the *Phytophthora* infection process and the subsequent plant response.


**Barend Jansen van Vuuren examining an avocado tree for disease symptoms**

Avocado sequence data available on public data basis is restricted mainly to fruit and flowering expressed sequence tags (EST's) with hardly any data available for avocado rootstocks and more specific defense-related sequence data. In 2009, we generated the first set of transcriptomics data for avocado rootstocks. The cDNA libraries were generated from a tolerant avocado rootstock infected with *Phytophthora cinnamomi* over a time course ranging from 0h to 72 hpi. Sequence data has identified several EST's that have been linked with defense responses in other plants. Expression analysis, using quantitative real-time

PCR has been implemented to study gene expression in avocado rootstocks with varying levels of PRR-tolerance.

Additional research includes: elucidating the effect of flooding on PRR, isolating endophytes from avocado roots and investigating their use a biological control agents and of evaluating the cross-pathogenicity of *Phytophthora cinnamomi* isolates from *Eucalyptus* and avocado. We have also established a tissue-culture propagation technique for avocado and have embarked on attempting to transform avocado.

**Avocado planting day**

**Bianca Farrow and Waheed Mahomed making stem inoculations on avocado seedlings**

**Differences in disease symptom severity on three avocado rootstocks six weeks after inoculation with *P.cinnamomi* from left to right: R0.12 (susceptible) R0.10 (tolerant) and R0.06 (highly tolerant)**

***Banana Research at FABI***

Banana is the fourth most important food crop in the world and is grown mainly in the tropics and sub-tropics. Fusarium wilt threatens banana production world-wide and control strategies are unsuccessful. The most feasible control strategy is the use of resistant cultivars. Breeding for disease and pest resistance is difficult due to the parthenocarpic nature of banana. The improvement of bananas therefore, relies heavily on biotechnology.

The research is focused on:

- The unconventional improvement of banana using banana transformation
- Understanding the effect of cold-stress on Fusarium wilt disease development
- Elucidating the role of pathogenesis-related genes in conferring tolerance to Fusarium wilt.

We have generated transgenic banana harbouring two genes, *GT1* and *NH1*. Preliminary greenhouse trials have shown enhanced tolerance to Fusarium wilt. The molecular validation of the transgenic plants is continuing in our laboratory. The tissue-culture facility continuously produces high quality banana plantlets that are not commercially available for research purposes; these include resistant wild-type germplasm. Next generation 454 sequencing has generated EST data that will shed light on the gene regulation in bananas associated with cold stress and Fusarium wilt infection.

# Microbial Diversity & Evolution Research Programme

**Research leader:** Prof.Emma Steenkamp

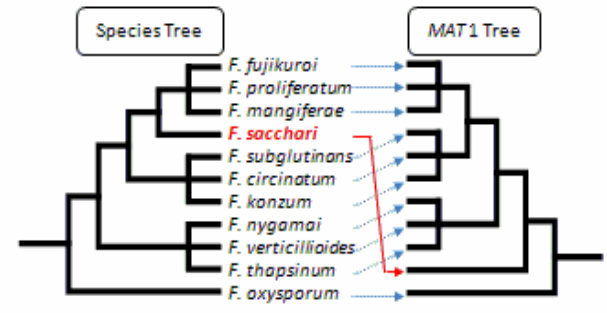
**Research Team:**
Prof. Wally Marasas
Prof. Brenda Wingfield
Prof. Mike Wingfield
Prof. Fanus Venter
Dr. Martin Coetzee
Dr. Albé van der Merwe

**Objectives of the research programme:**
This research programme focuses on evolution and the processes determining the evolution of microbial species. At the species/population interface we examine the phylogenetic, geographic and ecological distribution of extant bacterial and fungal species and/or species groups. As these studies are often severely affected by incomplete taxonomic sampling, we also explore the diversity of specific groups of bacteria and fungi in native South African environments with the aim of discovering new taxa.

Although a range of factors potentially influence the evolution of microbial species, we are specifically interested in the processes that that determine how individuals interact physically. For example, the outcomes of vegetative and sexual reproduction in fungi are distinctly different, with both processes impacting significantly on the evolutionary trajectory of a species. These processes are also likely to be involved in the maintenance of 'barriers' between species, thus limiting the effects horizontal gene transfer (HGT) between related and unrelated taxa (in the case of bacteria) or hybridization (in the case of bacteria). As a result, our experiments typically involve phylogenetics and population genetics, as well as conventional genetic methods such as controlled crosses, linkage mapping and the analyses of mutants. In some cases genomic data are also generated and analyzed.

**Some research highlights for 2009-2011:**

***Pyrosequencing allows for the large-scale production of microsatellite markers from enriched genomic libraries***
Microsatellites are perhaps the most informative group of markers for understanding the dynamics of natural populations. However, their identification and development are typically time consuming, labour intensive and expensive. In a recent study, we showed that the 454 Life Sciences/Roche GS-FLX genome sequencing system can facilitate, not only the efficient discovery of these markers from a range of eukaryotic organisms, but also at costs affordable to the average research group in South Africa (Santana et al. 2009, BioTechniques 46:217-223).




**Comparison between the phylogenetic tree inferred for the *Fusarium* species in *Gibberella fujikuroi* complex and the tree inferred from their sequences for mating type locus *MAT* 1. The divergent positions of *F. sacchari* in the two phylogenies are indicated in red.**

***HGT has shaped the evolution of the mating type locus in the* Gibberella fujikuroi *species complex***
Sexual reproduction and compatibility in Ascomycete fungi are determined by the genes encoded at the mating (*MAT*) type locus. Sequence analysis of this locus in *Gibberella fujikuroi* species complex revealed that *MAT* genes are generally divergent, which is apparently due to positive selection, as well as relaxed selective constraint (Martin et al. 2011, Fungal Genetics and Biology 48:731-740). Also, at least one of the species in this complex has acquired its MAT genes from an unrelated source, thus expanding the scope of eukaryotes and genomic loci in which HGT has been detected (See figure to the left) .

***Fungal mycelial growth rate is linked to the determinants of sexual and vegetative recognition***
Vegetative compatibility and sexual reproduction are determined by a set of genetic loci that harbour genes encoding proteins with diverse functions that range from DNA binding proteins to prions. By making use of genetic linkage mapping, we demonstrated that these two phenomena in *Amylostereum areolatum* are closely associated with the growth rate of the fungus (van der Nest et al. 2009, Fungal Genetics and Biology 46: 632-641). Although a similar link between a fitness property such as growth rate and sexual recognition has been shown for other fungi, this was the first time that fitness was linked to vegetative compatibility.

***The genetic determinants of nodulation and nitrogen-fixation in* Burkholderia *species associated with indigenous South African legumes have unique origins***
Exploration of the root-nodule bacteria of various papilionoid legumes indigenous to southern Africa has lead to the discovery of a large diversity of novel *Burkholderia* species (see figures below). These bacteria also appear to be unique in terms of their nodulation and nitrogen-fixation capabilities. In fact, the results of phylogenetic analysis with marker genes for both processes suggest an African origin for the genetic determinants of nodulation and nitrogen-fixation in indigenous *Burkholderia* species.

**Left: Nodules induced by a rhizobial bacterium on cowpea (*Vignia unguiculata*) roots**
**Right: *Hypocalyptus sophoroides* flowers.**

***Phylogenetic and population differentiation data confirm the existence of a distinct taxa within a well-established morphospecies***
Many microbial species are cryptic and not distinguishable based on cultural and morphological characteristics. Such species are thus only diagnosable using DNA-based methods coupled with population genetic procedures. Although the theoretical framework for this exists, the ideas and approaches introduced by scientists such as Dobzhanski and Mayr are not commonly employed for microbes. In our recent study, we used population genetic criteria for the separation of distinct but cryptic species of and an important fungal pathogen of eucalypts (Van der Merwe et al. 2010, Fungal Biology, 114: 966-979). We clearly showed that the *Chrysoporthe* canker is caused by three distinct pathogens with non-overlapping geographic ranges, with *C. deuterocubensis* in Southeast Asia, *C. cubensis* in South and Central America (see figure to right), and *C. austroafricana* in Africa.

**Sexual fruiting structures of *C. cubensis* from Colombia, with spore drops oozing from the necks of perithecia**

# Molecular Plant Pathogen Interactions

**Research leader:** Prof. Dave Berger

**Research team/collaborators:** Dr. Bridget Crampton
Dr. Boney Kuriakose
Dr. Sanushka Naidoo
Dr. Dean Oelofse (ARC)

**Objectives of the research programme:**

- Describe mechanisms whereby plants defend themselves against pathogens.
- Use phenotyping, GM plants, genomics and bioinformatics as tools in understanding plant function.

**Introduction**

The MPPI research group is involved in a range of research projects that address the general hypothesis that gene expression dictates phenotypes in plants, with particular emphasis on plant-pathogen interactions. The main projects are (i) "Genomics of quantitative disease resistance of African maize varieties" which focuses on grey leaf spot disease in maize; and (ii) study of an Arabidopsis-bacterial wilt pathosystem. We are also part of the EU SOL project on Health-based Consumer Quality Traits in Tomato and Potato (www.eu-sol.net), where we have developed a diversity array and explored the local Solanum biodiversity. In addition, there is good collaboration with the FMG and EPPI groups in FABI through mutual co-supervision of student projects. In this report, we have chosen to feature an example of our gene discovery work which was applied in collaboration with the Agricultural Research Council (ARC).

**Highlights of our research:**

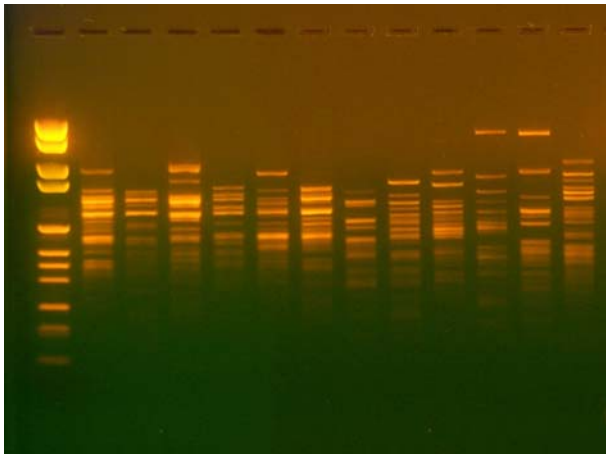
***Gene discovery pipeline developed and applied to a range of crops***

The SSHscreen and SSHdb software for gene discovery was developed through collaboration between the MPPI group, Department of Plant Science, Forestry and Agricultural Biotechnology Institute (FABI), the Bioinformatics and Computational Biology Unit in the Department of Biochemistry at UP, and the Department of Statistics, University of Oxford, UK. The SSHscreen software is particularly useful for studies of non-model organisms when the aim is to discover genes differentially expressed between two or more treatments using suppression subtractive hybridization (http://microarray.up.ac.za/SSHscreen/).


**Authors of the gene discovery study, Inge Gazendam and Nanette Coetzer, with an example of a drought stressed cowpea plant**

The SSHdb software was developed to manage and annotate the EST (expressed sequence tags) from SSH and other gene libraries. SSHdb provides a web-based interface for users to upload EST sequences to a personal database, where the sequences are automatically clipped of vector sequences, clustered, and annotated using BLASTX, BLASTN and Blast2GO (BMC Open access: Coetzer *et al.,* 2010, Plant Methods 6:10). The results are provided in a series of user-friendly tables, which can be accessed by collaborators from different sites, and edited and downloaded in different formats. SSHdb can be used for any set of DNA sequences, and users can register their own project at http://sshdb.bi.up.ac.za/. Currently there are pearl millet, tomato, Arabidopsis, cowpea and *Eucalyptus* datasets in SSHdb. SSHdb was developed by Nanette Coetzer as part of her MSc (Bioinformatics) degree at UP, awarded *cum laude* in 2010.

In a recent collaboration, between the MPPI group at UP and ARC-Roodeplaat Vegetable and Ornamental Plant Institute, the pipeline was applied to the discovery of drought response genes in cowpea plants (Coetzer *et al.,* 2010). Cowpea (*Vigna unguiculata*) is an important crop for food security in Africa, and thus a high priority in the ARC's research portfolio. The results indicated that cowpea plants protect themselves against drought by detoxification of unwanted compounds, stabilization of useful proteins, and down-regulation of photosynthesis. This work forms part of the PhD project of Inge Gazendam, and her current work entails functional studies of a candidate gene using transgenic plants.

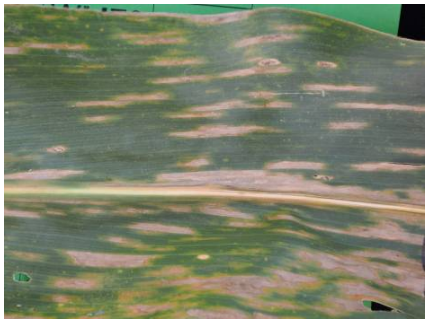


**Gel showing differentially expressed cowpea gene fragments after SSH**

Prof. Dave Berger was invited to present a talk on the gene discovery pipeline at the Plant Gene Discovery Congress, held in Vienna, Austria (February 2011). In work initiated by a former Postdoc at FABI, Dr Ana Slaughter, the SSH pipeline was used by researchers at the University of Neuchatel, Switzerland, for the discovery of grapevine genes involved in the response to the oomycete pathogen, *Plasmopora viticola* (Legay et al., 2011, European Journal of Plant Pathology 129: 281-301).

**Genomics of quantitative disease resistance in African maize varieties**

**Grey leaf spot disease**



**Grey leaf spot lesions**

**Prof. Burt Bluhm, University of Arkansas, USA**


**Project team members from FABI, PANNAR, CPGR and UKZN**

# Molecular Plant Physiology Programme

**Research leader:** Prof. Karl Kunert
Dr. Juan Vorster
Dr. Rachel Chikwamba

**Research team:** Dr. Urte Schlüter
Ms. Rosita Endah

**Objectives of the research programme:**
Major research focus was on investigating the interaction between cysteine proteases and cysteine protease inhibitors and the involvement of this protease-protease inhibitor system in soybean nodule development. Root nodules are important to fix nitrogen in legumes such as soybean. Since cysteine proteases have been previously identified to play an important role in plant senescence, a specific research target was the investigation of inhibitor function in preventing cysteine protease activity in particular during premature stress-induced nodule senescence. Elevated cysteine protease activity is causing severe protein degradation and ultimately nodule death. One research aspect focused on evaluating the consequence of changing amino acids by site-directed mutagenesis in the conserved motifs of two cysteine protease inhibitors derived from papaya and rice with the aim to improve the binding ability of native inhibitors to cysteine proteases. A modified inhibitor with a single change of an amino acid in the first inhibitor binding loop was identified which showed significantly improved activity against a variety of cysteine proteases including plant cysteine proteases. A soybean transformation system was further established to allow testing for the potential of the modified cysteine protease inhibitor to prevent premature nodule senescence. The knowledge gained from this research will ultimately contribute to a detailed understanding of the function and importance of the cysteine protease-cysteine protease inhibitor system in plants for stress-induced premature plant senescence.

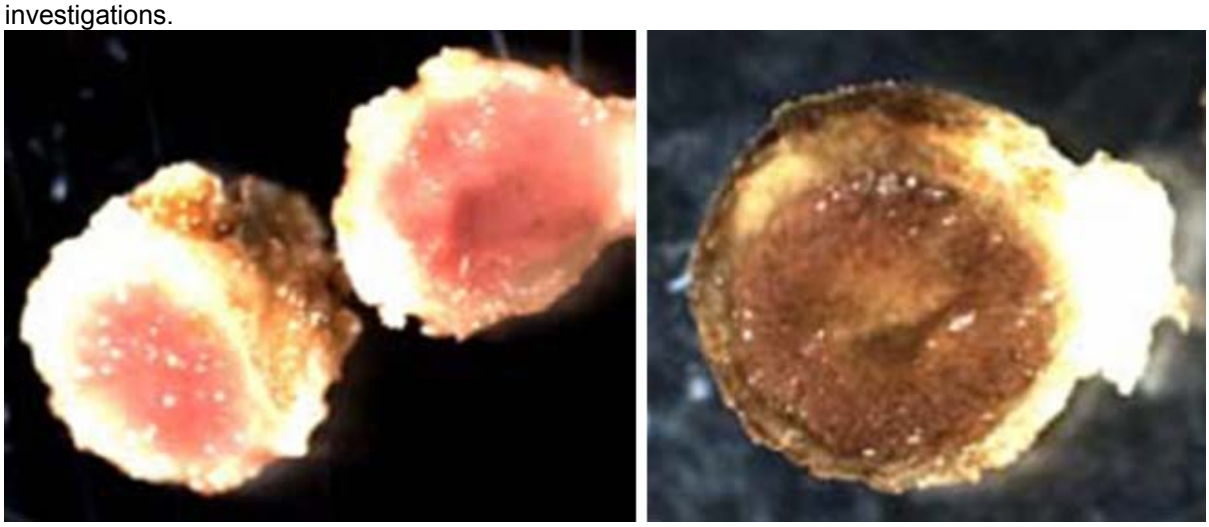
The overall objective of this research program is to understand stress biology and stress resistance. The first major research activity in 2009/10 has been the investigation of the cysteine protease /cysteine protease inhibitor system and its involvement in plant senescence and plant resistance against insects. A second research focus has been on understanding of gene function in broad-spectrum pathogen resistance. A further aspect of our research during this time focused on the plant genome and how genetic transfer between the nucleus and organelles could be affected by stress.

**Highlights of our research:**
Plants had to develop mechanisms to survive in harsh environments. Our work carried out with partners in the UK, USA, Canada and Africa contributes to understand these mechanisms in more detail, allowing plants to survive abiotic and biotic threats in environments relevant to Africa. Our ultimate goal is of applying the learnt principles to the design of crops that are better adapted to these environments.

**The molecular plant physiology research group**

***Nodule development***
Main research goal was the investigation of the role of cysteine proteases and their inhibitors (phytocystatins) in soybean nodule development with specific focus on the processes during nodule senescence. A detailed analysis of the nodule transcriptome of soybean nodules was performed by using microarray technology in close collaboration with Rothamsted Research, UK. For this experiment, nodules from two varieties grown in South Africa (Highveld Top and PAN 809) were harvested, total RNA extracted and sent to AROS Applied Biotechnology in Denmark for probing against a soybean chip. About 220 genes showed the same developmental pattern in both investigated soybean varieties, thereby 180 genes were up-regulated and only 40 genes were down-regulated in older nodules. About 17% of up-regulated gene sequences belonged to transcription factor families. Further, up-regulated genes identified are involved in cell wall modification, general metabolic regulation and stress response.

Seven gene sequences involved in protein degradation have been found to be up-regulated in eleven week old nodules. These gene sequences consisted of one cysteine protease, two peptidases and four mainly putative trypsin (serine protease) inhibitors. Parallel to the transcriptome analysis, activity of different proteases was tested in soybean crown nodules. These experiments clearly showed the appearance of a new protease band in zymograms appearing in older nodules. Contrary to our expectations, this protease does not seem to belong to the papain-like protease family. A more sensitive method using DCG-04 molecules, which are specific for the detection of papain-like proteins, indicated that cysteine proteases are present mainly in the young nodules. Investigation of the specific role of proteases from the papain family in nodule development will be the focus of further investigations.

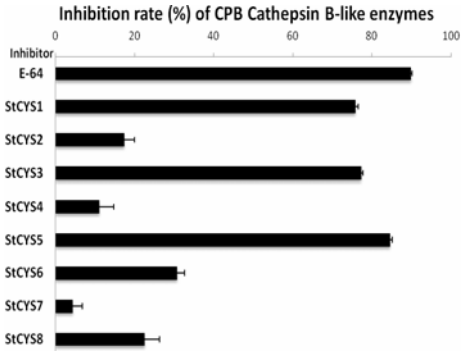


**Colour of crown nodules. Healthy nodules display a pink colour due to the heme cofactor of leghemoglobin indicating active nodule fixing nitrogen whereas brown/greenish shows a breakdown of leghemoglobin resulting in an organic molecule called biliverdin which has a green/brown colour (photo taken by Dr MC Mathabe)**

***The role of plant cystatins in insect resistance***

Protease inhibitors are a promising complement to Bt toxins for the development of insect-resistant transgenic crops intended for human use, given the absence of target cysteine proteases in the human gut and the widespread occurrence of these enzymes among herbivorous Coleoptera. At this stage their limited specificity against proteolytic enzymes and the ubiquity of protease-dependent processes in living organisms raise questions about their eventual non-target effects in agroecosystems. We are therefore studying the sequence/function relationship between different cystatins (cysteine protease inhibitors) and important cysteine proteases to better understand the elements important for inhibitor specificity and strength.

In a study conducted in collaboration with Prof. Dominique Michaud at Laval University in Quebec, Canada, we used the model of the potato multi cystatin consisting of eight cystatin units with some sequence variation in combination with the Colorado potato beetle (*Leptinotarsa decemlineata*) that has a cysteine protease compliment made up of over 20 identified variants. Using a combination of computer modelling to analyse and predict the various interactions as well as biochemical analysis of the individual cystatin units followed by biological feeding assays we studied the role and strength of the different units as well as the ability of the Colorado potato beetle to compensate for the presence of the individual inhibitors in its diet. In this study we demonstrated that the eight cysteine protease inhibitory domains of potato multicystatin exhibit strong functional variability against digestive cysteine proteases of the Colorado potato beetle and that the digestive system of the beetle is able to compensate differently depending on the relative strength and target of the inhibitor. This information brings us one step closer to the rational design of inhibitors with stronger inhibitory potential as well as targeted inhibition of selected proteases.




**Feeding assays and the differential inhibitory potential of the cystatin subunits against beetle gut extracts**

***Characterisation of the banana NPR1 gene***

The non-expressor of pathogenesis-related gene 1 *(NPR1*) is an essential positive regulator of salicylic acid (SA)-induced pathogenesis-related (PR) gene expression and systemic acquired resistance (SAR), which is important in broad spectrum pathogen resistance in plants. The group of Rachel Chikwamba has identified and isolated two novel full length *NPR1*-like genes; *MNPR1A* and *MNPR1B*, from banana by application of Southern blot analysis, polymerase chain reaction (PCR) and rapid amplification of cDNA ends (RACE) techniques. Expression of the *MNPR1* genes was directly related to *PR* gene expression known to be involved in fungal resistance after treatment of banana plants with various elicitors. Current activities to express the two genes in various Arabidopsis mutants, which are done in collaboration with the John Innes Institute, Norwich, UK and Leeds University, will in particular, unravel the NPR1 protein activation process.

**4 days after avirulent *P. syringae* infection**

**2 days after virulent *P. syringae* infection**

**Non-inoculated *Arabidopsis npr1-1* mutant leaf**

***Pseudomonas* infected Arabidopsis *npr 1-1* mutant leaf**

# Phytobacteriology Programme

**Research team:** Prof. Teresa Coutinho
Prof. Fanus Venter
Prof. Mike Wingfield
Prof. Jacques Theron
Dr. Lucy Moleleki

**Objectives of the research programme:**

- Develop rapid, reliable methods of accurately identifying phytopathogenic bacteria.
- Characterise and type isolates of pathogenic bacteria responsible for economically important diseases of *Eucalyptus* and selected agricultural crops.
- Study the epidemiology, ecology and biology of selected emerging plant pathogenic bacteria.
- Identify pathogenicity factors of selected plant pathogenic bacteria using a genomic approach.

**Highlights of our research:**

In 2009 we published a book entitled "Bacterial diseases of plants in South Africa". The purpose of the book was to give a brief history on this field of plant pathology in South Africa as well as providing information on how these microorganisms are now identified. A list of all bacteria recorded on agricultural, ornamental and forest tree species was provided. A selection of the diseases, particularly those responsible for large scale losses, is discussed in more detail. A number of first reports were included. These reports provide details on diseases not previously recorded in South Africa. Details pertaining to six quarantine bacterial pathogens were also provided in order to familiarize the community with these pathogens, and thus improve the chances of swift detection and identification should they appear in South Africa.

***Identification of bacterial plant pathogens***

The primary focus of our research activity in this area of phytobacteriology has been on the genus *Pantoea*. We have developed two methods to distinguish between existing *Pantoea* species and those new to Science, viz. f-AFLPs and multilocus sequence analysis using four housekeeping genes. The two methods have allowed us to describe fourteen new species of *Pantoea* and move existing species to other genera and from other genera to *Pantoea*.

Other projects on the identification of bacterial pathogens include the identification of the causal agent/s of crown gall, blight of pomegranate and blister bark disease of *Eucalyptus*. Crown gall of woody hosts in South Africa is caused by a number of "phylogenetic groups" within the *Agrobacterium tumefaciens* species complex (= *Rhizobium tumefaciens*). *Xanthomonas axonopodis* pv. *punicae* infecting pomegranates was identified in Gauteng thus confirming reports of this pathogen in the Western Cape. *Erwinia psidii* was found to cause blister bark symptoms on *Eucalyptus* in Uruguay. It appears that this pathogen has shifted hosts from guava to *Eucalyptus*.

***Genomics***

*Pantoea ananatis* is a ubiquitous organism found in almost every environment on earth. It has been implicated in diseases of a wide range of agronomic crops worldwide, including onion, maize, rice and pineapple, as well as a human disease. In South Africa, *P. ananatis* causes blight and dieback of *Eucalyptus*, resulting in severe losses of this important forestry resource. Nevertheless, little is known about the pathogenicity mechanisms utilised by this pathogen to cause disease in the host.

**Symptoms of bacterial blight on a *E. nitens* leaf**

The whole genome of a highly virulent *Eucalyptus*-pathogenic *P. ananatis strain*, LMG20103, was sequenced. This genome sequence was subsequently mined to identify a vast array of genes encoding putative pathogenicity determinants. Comparative genomics revealed that it has evolved to be

able to thrive in a wide range of environments and that this strain carries pathogenicity determinants that may allow it to infect hosts in both the animal and plant kingdoms. Interestingly, no Type II and III secretion systems, which form a major part of the pathogenicity arsenal of many plant pathogenic bacteria, are present in *P. ananatis*. However, three loci on the genome encode three distinct copies of the Type VI secretion system, which has recently been demonstrated to play an important role in diseases caused by many plant- and animal-pathogenic bacteria. *In silico* analysis of these secretion systems showed that they are likely to secrete several pathogenicity effectors which may have a role in *P. ananatis* infection of both plant and animal hosts. Another putative pathogenicity determinant identified from the genome, the exopolysaccharide ananatan, was experimentally demonstrated to play a role in disease expression on both onion seedlings and pineapple fruit. This was done through the production of a library of mutants which encompasses all the genes on the *P. ananatis* genome.

Genome sequencing enabled the identification of all the putative pathogenicity factors of *P. ananatis,* LMG20103, and the use of the mutant library and post-genomic techniques has and will allow the functional characterisation of many of these pathogenicity determinants. By this means, the mechanisms underlying the disease caused by *P. ananatis* on *Eucalyptus* and other hosts can be better understood. With this information, more directed and effective strategies for the control of this pathogen and its diseases can be developed.

**Pectobacterium *spp*.**

*Pectobacterium* species collectively account for major losses in potato and crop productions. Members of this genus which are of significant economic importance in potato production include *P. atrosepticum* (*Pa*), *P. carotovorum* (*Pc*) and more recently *P. brasiliensis* (*Pb*). Together these species are responsible for potato black leg and tuber soft rot disease complex. They are often isolated together from diseased potato plants albeit at different ratios. Environmental factors as well as strain specific genes may play a role in fitness and competitive advantage of each of these species at a cost to the other two species. To this end, we investigated the effect of temperature and inoculum on *in vitro* growth rate and virulence of the different South African *Pb* isolates in comparison to *Pa* (sequenced genome strain), *Pc* (type strain) and *Pb* (sequenced genome and type strain). Higher temperatures, from 25 – 40 °C, appeared to favour growth rate and virulence of all *Pb* and *Pc* isolates tested. This was evident from increases observed in *in vitro* growth rate as well as *in planta* growth rate as indicated by the average macerated tissue of *Pb* and *Pc* isolates with increasing temperatures. On the other hand, lower temperatures (20 – 25 °C) appeared to favour growth and virulence of *Pa*. This would seem to suggest that *Pb* and *Pc* are better competitors compared to *Pa* at these elevated temperatures perhaps explaining why the two are found in higher ratios than *Pa* in South African fields. *Pb* compared to *Pc* was found to be significantly more virulent on stems and tubers even when low levels of inoculum (1 x $10^2$ cfu/ml$^{-1}$) were used. Interestingly, *Pb* isolates like *Pa* can elicit blackleg whereas most *Pc* isolates do not cause blackleg. It has previously been shown that presence of the phytotoxin biosynthesis genes (*cfa* and *cfl* locus) is linked with blackleg symptom developement. In our study, isolates of *Pb* that are able to elicit blackleg were shown to have *cfa*6, *cfa*7 and *cfl* (coronafacic ligase) genes. The phytotoxin coronatine acts as a jasmonic acid mimic in plants. Injection of coronatine into the plant by *Pseudomonas syringae* mimics and increases jasmonic acid levels in the plant and which in turn leads to suppression of salicylic acid mediated defences. None of the *Pectobacterium sp* have so far been shown to produce the phytotoxin coronatine. However, *Pa* has been shown to synthesise coronafacoyl conjugates such as *cfa*-valine and *cfa*-isoleucine, both of which are structurally analogous to jasmonyl amide, possibly acting as jasmonic acid mimics *in planta*. It would be interesting to study the role of the *Pb cfa* locus in blackleg symptom development and suppression of host defences.

**Potato plant exhibiting blackleg symptoms**

# Seed Pathology Research Programme

**Research leader:** Prof. Terry Aveling

**Research team:** Dr. Quenton Kritzinger
Prof. Nico Labuschagne

**Objectives of the research programme:**
To evaluate fungicides, biological agents and botanical extracts to control seed- and soilborne diseases of maize, cowpea and beans

**Highlights of our research:**
***Efficacy and crop tolerance of Stamina (BAS 500 12 F FS) formulations***

**Bean plants showing typical symptoms of anthracnose**

The best treatment under extreme pathogen pressure in a Petri dish with *Fusarium* sp., *Pythium* sp. or *Rhizoctonia* sp. appeared to be the Stamina + Flite treatment. Germination percentage of the Monsanto DKC78-15B seed in the standard germination test was very high (90 to 99%). The slightly lower percentage germination (86 to 90%) in the cold test than in the standard germination test indicates that the seeds did succumb to some stress. Percentage germination in all treatments except the Celest XL treatment remained very high (98 - 100%) after 2-day accelerated ageing. After 4-day accelerated ageing the seeds succumbed to stress and the germination decreased. Stamina + Flite had a germination percentage of 100 after both 2-day and 4-day accelerated ageing. These tests and the values for Mean Just Germination Time (MJGT) and Mean Germination Time (MGT) which already reached between 0.99 and 1 and 0.97 and 0.99, respectively only four days after planting indicated that the Monsanto DKC78-15B maize cultivar had a very high seed vigour. None of the treatments caused any phytotoxicity in any of the greenhouse trials.

**Postgraduate students harvesting a maize seed treatment trial (left), Control of maize seedlings diseases in a greenhouse using fungicide seed treatments (right)**

In the *Fusarium* sp. inoculated soil planted with PANNAR 6Q308B seed, Stamina (0.15ml/1000 seed) and Stamina + Flite had higher percentage emergences than the inoculated control successfully reducing pre-emergence damping-off. Stamina + Flite successfully prevented pre-emergence damping-off in the PANNAR 6Q308B seed in soil inoculated with *Rhizoctonia* sp. and all the treatments maintained the same level of emergence as the uninoculated control. All treatments also successfully reduced percentage diseased plants when compared with the inoculated control.

***Efficacy of biological agents as soil amendments on maize to promote growth and control soilborne pathogens***

A pilot trial was done to determine the shelf-life of the Plant Growth Promotor Rhizobacteria (PGPR) S1 and S2 isolates on the compost pellets. This involved incubating pellets inoculated with two PGPR isolates as five different formulations at 25 and 37˚C for three months. The five formulations were carboxy methyl cellulose (CMC) (1%), CMC (2%), sugar (5%), powder and a liquid suspension. Following quantification of PGPR isolates it was clear that both S1 and S2 survived better at 25 than at 37˚C. Samples inoculated with the powder formulation delivered the highest counts (1.27 x 106 CFU/ml) of S1 and S2 followed by CMC (2%) (8.42 x 105 CFU/ml), CMC (1%) (4.53 x 105 CFU/ml) and the liquid suspension (2.39 x 105 CFU/ml). The sugar formulation had the lowest S1 and S2 counts (1.07 x 105 CFU/ml).

***Efficacy of botanical extracts to control* Colletotrichum *spp. on cowpea and bean***

Acetone, ethyl acetate and water extracts of *Ipomoea batatas, Carica papaya, Allium sativum, Syzigium cordatum, Chlorophytum comosum* and *Agapanthus caulescens* were screened *in vitro* for their antifungal activities against *Colletotrichum lindemuthianum* and *C. dematium* of cowpea and common bean using the agar disc infusion and microtitre double dilution techniques. The same extracts were then tested for antifungal in vivo as a seed treatment against anthracnose disease. The water extracts of *C. papaya* and *Syzygium* were active against *C. lindemuthianum. Syzygium, Allium* and *Chlorophytum* water extracts were active against *C. dematium*. Agapanthus water extracts and all the acetone extracts tested *in vivo* effectively reduced the incidence and severity of bean anthracnose disease. *Agapanthus* acetone, garlic water, both acetone and water extracts of pawpaw and *Syzygium* performed well *in vivo* in reducing cowpea anthracnose disease and compared well with Celest® XL and non-inoculated control.

**Maize seedlings with Pythium root rot (left), healthy plant (right)**

# Tree Protection Cooperative Programme (TPCP)

**Research leader:** Prof. Mike Wingfield

**Research team:**
Prof. Jolanda Roux
Prof. Bernard Slippers
Prof. Fanus Venter
Prof. Emma Steenkamp
Prof. Brenda Wingfield
Dr. Martin Coetzee
Dr. Brett Hurley
Dr. XuDong Zhou
Dr. Jeff Garnas
Dr. Irene Barnes
Mr. Albé van der Merwe
Mr. Wilhelm de Beer

**Objectives of the research programme:**

- Development of field monitoring techniques to recognize the appearance of new pests and diseases, as well as to monitor the spread and impact of those already established in South Africa.
- Identify new and important tree pests and pathogens and evaluate their genetic structure so that they can be more effectively controlled.
- Develop methods to screen trees for tolerance to the most important diseases present in the country.
- Establish and evaluate contemporary breeding strategies in order to produce disease and pest tolerant species, clones and hybrids.
- Establish an understanding of the biology of tree pests and pathogens to promote their better management.
- Study and evaluate novel strategies for disease and pest control, particularly biological control.

**Highlights of our research:**

**The TPCP team at a team building session held in January 2011**

The first formal year of activity of the Tree Protection Co-operative Programme (TPCP) was in 1990 and 2010 thus marked the 21st year of existence of the Programme. Like many other unique initiatives that come to reach unplanned and unexpected levels of excellence, the TPCP had a very small beginning, with a signing ceremony held in 1990 including three founder companies (H.L.H. Timber company that is no longer in existence, Mondi and Sappi). At the time of the establishment of the TPCP, there was only one disease of particular concern to South African forestry. This was the canker disease of *Eucalyptus* caused by what was believed to be *Cryphonectria cubensis*. It is noteworthy that the serious Coniothyrium canker disease had not yet appeared, the pitch canker pathogen was not known in South Africa and there was no knowledge of Botryosphaeria diseases on *Eucalyptus*. Insect pests were known but not of great concern and the ravages of the Sirex

**Larvae of the cossid moth infesting a *E. nitens* tree**

woodwasp, the Eucalyptus gall wasp, *Leptocybe invasa,* and the bronze bug, *Thaumastocoris peregrinus,* that were to appear in later years, were not considered. Yet, there was an understanding that South African Forestry would likely be seriously affected by pests and diseases in the future and this was clearly the basis of the vision of the founder directors of the TPCP.

At this point, and after 21 years of TPCP research, extension and education in the interests of South African Forestry, it is relevant to consider the fact that there are many pest and pathogen problems not present in South Africa and that threaten the future of the industry. Some of those problems already present are likely to continue to complicate the future sustainability of plantations and unexpected host shifts of pests and pathogens from native to non-native trees appear likely to challenge the productivity of forestry in the future. While 20:20 vision in hindsight is a common human characteristic, a pro-active approach to forest protection is desirable. We believe that the TPCP now has a sufficiently firm foundation to ensure that new problems will be recognized rapidly and that appropriate actions will thus emerge considerably more easily than was the case two decades ago. It is, however, crucial to maintain a solid momentum in forest protection support and to ensure that human capacity in this field is not lost.

**Dr Chongxing Zhang, Eston Mutitu and Dawit Degefu examining a *E. nitens* tree infested with the cossid moth**

The notion that pests and pathogens will continue to appear in areas where they are not known is well established amongst forest protection specialists. It is also (perhaps in some cases reluctantly) recognized by the more visionary amongst forestry professionals. The driving force underpinning this trend has traditionally been linked to the gradual arrival of pests and pathogens that were separated from potential hosts either by vicariance or in more recent times, anthropogenic forces. What has been particularly important and a biological phenomenon that was not recognized until relatively recently is the adaptation of host-specific pests and pathogens to infect/infest plants that are even distantly related to their original hosts. These are sometimes referred to as new encounter pests and pathogens, but we believe that this term tends to underestimate the importance of dramatic and unpredictable levels of adaptation. New encounters, novel associations and unexpected levels of adaptation will in our view come to represent some of the most important threats to world forestry in the future. These 'new" pests and pathogens will find increasingly greater opportunities to move globally with increasing levels of movement of people and products. Chris Bright's "return to Pangea" might not be as far-fetched as some people have chosen to believe.

**TPCP students inoculating a *Sirex*-infested tree with the parasitic nematode, *Deladenus siricidicola***

Dealing with the growing threat of pests and pathogens to forests (both plantations and native woody ecosystems) will be increasingly difficult and increasingly important in the future. From an industry point of view, successful forestry will depend entirely on the ability to reduce the impact of diseases and insect damage sufficiently successfully to ensure profitability. The TPCP provides a superb foundation to ensure that this will be possible. Yet a long term strategy that entrenches Government support is essential. Thus, the Department of Agriculture, Forestry and Fisheries (DAFF) led initiative to develop a Forest Protection Strategy for South Africa has been timely. The TPCP team has participated actively in developing the pest and pathogen component of this strategy for which the

final document was completed at the end of 2010. It is now a sincere hope that the most important elements of the Strategy will be supported and implemented.

Some pest and pathogen problems absorb a proportionally larger element of TPCP time than others. These include projects dealing with the Sirex woodwasp, *Sirex noctilio*, the pitch canker pathogen, *Fusarium circinatum*, the Eucalyptus gall wasp, *Leptocybe invasa,* and the Eucalyptus Bronze Bug, *Thaumastocoris peregrinus*. All of these include elements of extension, education, research and field level management. However, a substantial effort is made to maintain capacity to deal with other pest and disease problems as they arise and also to remain at the forefront of global developments in forest protection such that new problems are encountered and understood as early as possible.

*Leptocybe invasa* and *T. peregrinus* present huge threats to *Eucalyptus* forestry in South Africa. Both pests are now much better understood than they were just a few years ago. Much effort has gone into monitoring the spread of these insect pests and in the case of *L. invasa*, into establishing screening programmes to assist TPCP members in understanding which clones will be most threatened by the pest. However, the most important and key issue for the future is to establish effective biological control programmes for both pests. A very substantial effort is being made to develop and test the most promising agents and at least one agent for each pest should be available for release by the end of 2011. The more complex challenge will be to obtain Government permission to make these releases and this process has already begun.

***Gonipterus scuttelatus* adult and larva on a eucalypt leaf**

The growing importance of forest pests in South Africa has necessitated the establishment of specialized facilities to develop biological control agents. This has required some years of planning such facilities and complex negotiations to gain funding for their establishment. Towards the end of 2009, the University of Pretoria agreed to make the funding (approximately R5 million) available to build the facilities. Due to the fact that these facilities are highly specialized, the building programme has taken much of 2010 to complete. This would also not have been possible without tremendous time commitments by Wilhelm de Beer, Bernard Slippers and Brett Hurley. Establishment of the facility was completed late in 2010 and the first *Sirex* nematodes will be produced in them for the 2011 inoculation year. Most importantly, these word-class facilities will make it possible to substantially accelerate biological control projects crucial to South African forestry. It is also fortunate that funding through THRIP and other leverage initiatives has made it possible to add moveable equipment to the facility that went beyond the capacity of the UP budget.

**Exudation of pitch, typical of trees infected with the pitch canker fungus**

As pressure on the TPCP has grown to provide extended support for forestry in South Africa, there has been a growing need for additional space for the Programme in FABI. In order to address this space requirement, we have been able to successfully negotiate for space in the new Plant Sciences Complex that is currently being built alongside FABI. This will make available additional offices and three laboratories that will significantly benefit the TPCP. In addition, the FABI space in the new building will accommodate staff linked to the new post graduate programme in Forestry at the University of Pretoria. This will clearly bring new connections to forestry-related disciplines not currently part of the TPCP focus and thus also new levels of synergy.

Although this might seem somewhat "foreign" and distant to many foresters, having available genomes and genomics will unquestionably become a driving force in many aspects of forestry in the future. A few years ago, the idea that we might have available the entire genome of, for example, a eukaryote fungus was hard to imagine. Yet the confluence of biological sciences with engineering and the physical sciences has very rapidly led to the development of new tools for DNA sequencing that are making whole genome sequencing rapid and relatively inexpensive. It has thus been possible for members of the TPCP team to sequence the first eukaryotic genome in Africa and the genome of choice for sequencing was that of the pitch canker pathogen, *F. circinatum*. Having this genome available for study might aptly be compared with having access to an 'encyclopaedia' for the pathogen. In a very short period of time a huge amount of information has emerged for the pitch canker fungus and exciting discoveries that will promote more effective management lie ahead. The fact that FABI has led this and other genome projects including being deeply involved in the *Eucalyptus grandis* genome project has put the Institute at the forefront of a new wave of scientific growth. It has also strongly influenced the University of Pretoria's decision to provide robust support for an "Institutional Research Theme" in genomics. Forestry in South Africa and tree health in general will benefit substantially from these developments in the future.

Research provides the foundation for all of the activities of the TPCP. This is a logical approach to a discipline that requires a very substantial scientific base. It is also consistent with a programme that gains the majority of its funding through leveraging funding from a University and from programmes linked to education. It is, however, important to recognize that disease and pest monitoring and extension are fundamentally important to the TPCP. These elements of the Programme are perhaps more visible to many TPCP members than the research outputs. They provide an essential basis to ensure that new disease and insect problems are identified and that existing problems are fully understood and treated. As has been true in the past, the TPCP team members spend a substantial amount of time in the field, assisting foresters and member companies with disease and pest problems. The extension wing of the TPCP is also fundamentally linked to the disease and insect pest diagnostic services of that collectively ensures the most effective pest and disease support and monitoring programme that we are able to achieve.

**Gudrun Dittrich-Schroder at a *Leptocybe* Awareness Day in Zululand**

In terms of research, the TPCP strives to focus on all the major pest and disease problems of relevance to Forestry in South Africa. Emphasis is placed on those problems that are most important. Thus, greater attention is paid to *Sirex*, *Thaumastocoris*, *Leptocybe* and the pitch canker fungus than to some of the less important problems. At the same time, it is necessary to retain a balance between short-term objectives and longer term goals. This balance allows the Programme the ability to serve both requirements of a University environment and the forestry industry. In addition to maintain this sometimes complex balance, it is necessary to retain the skills and techniques that are crucial to achieving the goals of the Programme. This can be complicated in a University environment where most students leave after completing degrees. In this regard, the TPCP is in the fortunate position of having eleven PhD level staff members in the Programme and thus a relatively large buffering capacity in terms of continuity. Yet it remains a challenge to secure students covering the breadth of interests and skills to serve the various focal issues relevant to human capacity development, skills development, problem solving in terms of tree health problems and academic excellence.

# SABBATICAL VISITS

**Professors BD and MJ Wingfield**

**Visit to the University of California, Berkeley, USA (June - December 2009)**

The term sabbatical is derived from the word Sabbath which refers to the day of rest. The term these days refers to the leave granted [usually every 7th year] to University academics to travel and to make a change from their usual duties. Given the origin of the word, one might be forgiven for thinking that a sabbatical is a glorified vacation. In this day and age, there are no such luxuries and while sabbatical leave is still granted to staff at many universities around the world, the expectation is that while they are relieved from many of their normal duties, they use this time to undertake research and learning, which will be beneficial to their careers and to their future responsibilities to students. A sabbatical should thus be rejuvenating but also hard work and the member of staff should bring back to his or her research programme, new technologies as well as research ideas and products.

**Mike and Brenda with Tom Gordon and members of his research team**

Professors Brenda and Mike Wingfield undertook a sabbatical in the latter part of 2009 that was aimed at expanding the research horizons of their respective research programmes. Prof. Brenda Wingfield had spent the two years prior to the sabbatical securing the funds to sequence the genome of the pine pathogen *Fusarium circinatum*. She felt that an essential part of her research future would be intricately linked to genome sequences and their analyses and that the best way to learn and embrace a new technology would be to "do it hands on". Prof. Wingfield's plan for her sabbatical was thus to learn how to deal with a relatively large genome, its assembly, annotation and other means of characterisation. While the genome was planned to be sequenced a few months before the start of the sabbatical, the final sequence data and assembly were only completed in the week before she left for UC Davis in California. She thus left South Africa with the sequence data quite literally "hot off the press", all 43 000 000 bases stored on a single computer disc and carefully archived on her computer.

Prof. Brenda Wingfield was hosted during her sabbatical by Professor Tom Gordon the Head of Department of Plant Pathology and Professor Ian Korf, a member of faculty at UC Davis in the Genome Centre. She spent her sabbatical moving between these two very different environments. During the sabbatical she learned first hand the power of having the sequence of a genome; in her first week she was able to help Stephanie Slinski a PhD student determine the entire sequence of gene she had spent the last six months studying. She [Brenda] stretched her mind by attending a week long workshop learning how to write the computer programming

**Mike looking for fungi**

language PERL [just the basics]. With the assistance of Ian Korf, the annotation pipeline MAKER was used to annotate the *F. circinatum* genome. She and a PhD student Quentin Santana who came over to join her, learned how to use the programme Apollo so that they could assess the first round of annotation and guide subsequent rounds of annotation. During her sabbatical she spent many hours first learning how to annotate and then manually annotating hundreds of genes. The learning curve was extremely steep and sometimes frustrating, which is probably "par for the course" when learning anything new and different. Prof. Wingfield spent her entire sabbatical "in silico" and did not once venture into a traditional molecular laboratory other than to talk with people and occasionally to help Prof. Mike Wingfield making isolations from bark beetles!

On her return to South Africa, Prof. Brenda Wingfield has been the driving force behind the manual annotation of the *F. circinatum* genome and has subsequently established capacity at the University of Pretoria to annotate eukaryotic genomes. The analysis of the *F. circinatum* genome is still a work in progress. The product of her sabbatical is obvious when observing the increasing number of student projects, which involve the use of this genome sequence, as well as the other genome projects that have recently been initiated.

**Mike and Brenda in San Francisco**

Prof. Mike Wingfield's sabbatical was spent equally fruitfully but in a manner very different to that of Prof. Brenda Wingfield. While she did not do a single experiment in the laboratory, Prof. Mike Wingfield spent many days on field trips sampling diseased trees and collecting bark beetles, particularly *Dendroctonusvalens* (Red Turpentine Beetle) that infest declining trees. This collecting work was followed by many hundreds of hours isolating fungi from these very precious samples. Through having a base in the USA, Prof. Wingfield was able to easily undertake field trips in California and also to other parts of the country where RTB is found. He was hosted by Prof. Tom Gordon and thus used Prof. Gordon's facilities for his laboratory. His work was also conducted in collaboration with colleagues in the US Forest Service such as Nancy Gillette and Kevin Dodds, Don Owen of Calfire and forms part of a long-term collaboration with Jianhua Sun of the Chinese Academy of Science in Beijing. The analyses of the cultures collected by Prof. Wingfield began in California but are continuing as part of various student projects in South Africa and China. The emerging results are fascinating, relate to some of the factors underlying invasions of pests and pathogens in forest ecosystems and they highlight the importance of novel associations between pests and pathogens.

**Beverly Wingfield**

During his sabbatical, he accepted invitations to visit colleagues in various parts of the USA, to forge new collaborations and to present lectures. Prof. Wingfield cannot visit any part of the world without inspecting the local forest pest and pathogens. On short trips with Tom Gordon and with various colleagues he had an opportunity to inspect disease and pest problems such as sudden oak death, pitch canker, thousand cankers disease, the impact of the mountain pine beetle and others. He also needed to leave the USA on a few occasions to attend meetings in South Africa, Australia, Vietnam and Argentina, but these side-trips were managed to allow maximum time for research in the USA.

Professors Brenda and Mike Wingfield thus had very busy but very different sabbaticals. They rented a very simple house in Davis CA as their base and learnt what it is like to live in California using only public transport. The bus system around the University in Davis is relatively good. Their daughter joined them for four months and enjoyed herself

cycling around the little town of Davis in the Californian Central Valley. Various FABI colleagues (Bernard Slippers, Irene Barnes) and students joined them to share in their experiences and to attend local congresses such as the annual meeting of the Mycological Society of America and the annual meeting of the American Phytopathological Society. They are planning their next sabbatical in five year's time but are also very happy to be back at home in South Africa.

**Professor A Myburg**

**Visit to the University of British Columbia, Vancouver, BC, Canada (January to December 2010)**

**Zander Myburg with Shawn Mansfield**

Prof Zander Myburg spent 12 months as a visiting professor at the University of British Columbia (UBC) in Vancouver. The visit was hosted by Prof. Shawn Mansfield, a collaborator at the UBC Department of Wood Science. While on sabbatical, Prof. Myburg worked with Prof. Mansfield and Prof. Carl Douglas (UBC Dept of Botany) on whole-transcriptome sequencing and gene expression profiling of developing leaf and xylem tissues of *Eucalyptus grandis* and *Populus trichocarpa* trees. These two woody angiosperms, the first forest trees for which genome sequences have been produced, have evolved separately and are adapted to different environments, but are both efficient at producing cellulose-rich wood fibre. Analysis of the xylem and leaf transcriptomes of eucalypt and poplar trees (in comparison to that of the woody model plant, *Arabidopsis thaliana*) will reveal genes and regulatory mechanisms that are shared by woody plants and that may underlie differences in growth, wood development and chemistry between eucalypts and poplars. This ongoing work is supported by the Department of Science and Technology (DST) and by a new grant from Genome Canada/Genome BC, which will fund the genome and transcriptome sequencing of more than 1000 poplar trees with a focus on bioenergy feedstock traits. Matching funding from the DST is supporting transcriptome sequencing and profiling of 200 *Eucalyptus* trees and genome resequencing of 32 *Eucalyptus* trees in South Africa with a focus pulp, paper and bioenergy related traits. Another objective of the sabbatical visit was to collaborate on the analysis of wood physical and chemical properties in transgenic trees and tree breeding populations. Prof. Mansfield is an international leader in the field of tree biotechnology and wood analysis, and is internationally recognized for his work on carbon allocation and cellulose biosynthesis in trees. During 2010, Professors Myburg and Mansfield collaborated on the transfer of capacity to University of Pretoria for cell wall chemistry (Klason lignin and HPLC cell wall sugar) analysis. A technician was trained in the UP Department of Chemical Engineering and is now providing routine analytical support to the Forest Molecular Genetics programme. Availability of the *E. grandis* genome sequence, and technology for whole-transcriptome profiling of individual trees and experimental populations have accelerated the identification of candidate genes for a range of wood developmental processes. Functional genetic analysis of these genes requires gene testing in transgenic trees. Genetic transformation of poplars is routine in many international laboratories, including that of Prof. Mansfield at UBC. One of his sabbatical aims was that Prof. Myburg transferred plant materials and a transformation protocol for poplar trees to University of Pretoria. The first transgenic poplar plants expressing cell wall regulating genes have already been produced at FABI and will be tested in 2011. Finally, the sabbatical year in Vancouver offered many opportunities to enjoy the spectacular natural beauty of British Columbia, an experience that is highly recommended.


**Forest Science Centre at UBC**

**Zander Myburg and family on Whistler Mountain, BC**

# SERVICES

## Tree Health Extension

**Responsible researchers:** Prof. Jolanda Roux (Extension, Monitoring, Diagnostic Clinic)
Ms. Izette Greyling (Diagnostic Clinic and Extension)
Dr. Brett Hurley (Pest monitoring, Diagnostics and Extension)
Prof. Bernard Slippers
Prof. Mike Wingfield
Dr. Jeff Garnas
Mr. Wilhelm de Beer (Treehealthnet)

**Objectives:**
Extension activities form an important component of the Tree Protection Co-operative Programme (TPCP) and DST/NRF Centre of Excellence in Tree Health Biotechnology (CTHB). These activities are divided into a number of components. They include all activities linked to the monitoring of pests and diseases of native and plantation trees. Furthermore, they form an important component in the training of our post-graduate students and the creation of awareness amongst the general public, foresters, farmers and conservation staff. Monitoring includes efforts to detect new pathogens and pests in a timely fashion and the evaluation of the change in status of pathogens and pests, which have been present for many years. One of the key components of the monitoring programme is the Diagnostic Clinic that provides the means for rapid detection of new diseases and pests. Data from the clinic and field extension/monitoring activities also form part of a longer term historical record of pests and diseases in South Africa and many other countries where the teams work.

**Extension activities 2009/2010**
The extension services of the TPCP are managed via a broad range of mechanisms. These include: lectures presented at field days, mainly those organised by the ICFR, reports in magazines and newspapers, radio and TV interviews, newsletters such as Tree Health News and also via routine field visits. The extension services of the TPCP are also closely linked to the pest and disease diagnostic clinic. Thus, where samples are sent to the clinic for diagnoses, follow-up visits to the field to inspect problems first hand are common. This then forms part of an intensive network used to monitor the health of plantations.

Visits to plantations and nurseries by TPCP staff and students remain one of the most important components of the programme. Field trips include those specifically to provide extension lectures, those that are associated with the diagnoses of pests and diseases, as well as those that are linked to field research work of TPCP students. During 2010, 665 person days were spent in the forestry areas of South Africa. This remains a very high output but it is sufficiently important to undertake field work that this is encouraged rather than discouraged.

The e-mail list server TreeHealthNet has continued to grow and this has become a major base for communication between the TPCP team and their forestry stakeholders. The list server is used to announce field trips such that foresters are able to make easy contact with team members traveling to the field and feedback on new discoveries can be rapidly disseminated using this mode of communication. The server currently connects more than 200 foresters and it is anticipated that it will grow in importance in the future. We, therefore, encourage all foresters in South Africa to join. This is simply achieved by writing a note to Wilhelm de Beer (Wilhelm.deBeer@fabi.up.ac.za) and being listed on TreeHealthNet@kendy.up.ac.za. Once listed, it is possible for any member to write a message and this will rapidly reach all other members.

Like TreeHealthNet, the TPCP web pages form an extremely important part of the portal of communication between the Programme and its members. All newsletters of the TPCP are posted on the website and all disease diagnostic aids can also be found there. This is a major source of information for members and it is being very actively used. The TPCP site can be accessed via the FABI site at www.fabinet.up.ac.za. Recently, information and images of the main forestry pests and diseases were added to the website under a new “Forest Threats” section.

The newsletter of the TPCP "Tree Protection News" represents an important means of distributing information to members. Issues of the newsletter were distributed during 2009 and again in 2010. These were dispatched by the ICFR together with ICFR News. In addition to Tree Protection News, articles have regularly been produced for magazines or newspapers to inform foresters and the public of our activities. Various news items are also regularly posted on the TPCP web site.

**Diagnostic Clinic**

The insect pest and disease diagnostic clinic provides an important service to the members of the TPCP. This service is actively used and, as mentioned previously, it also provides one of the mechanisms by which new pest and disease problems emerging in plantations can be identified rapidly.

The TPCP pest and disease diagnostic clinic overlaps with a similar programme managed for the Centre of Excellence in Tree Health Biotechnology. The clinic thus deals with samples not only from plantations but those representing native or amenity trees. Many pests and pathogens are found in gardens before they appear in plantations and combining the TPCP and CTHB diagnosis responsibilities provides substantial synergy for both programmes.

The clinic received a total number of 2472 samples from January until the end of December 2010. Pine samples comprised 85 % of the total number of samples received, with the majority of these samples received for *Fusarium* screening. *Eucalyptus* samples made up 2.8 % and *Acacia mearnsii* (Wattle) samples only comprised about 0.7 % of the total number of samples. Soil samples received comprised 1.5 % of all samples received. Seed samples, received for *Fusarium* screening comprised 9 % while samples from non-forestry and indigenous trees as well as water samples, categorized as “other”, comprised 1 % of the samples.

**Left to right, top to bottom: Michael Mbenoun and Wubetu Bihon setting up insect traps; Gilbert Kamgam Nkuekan and Linda Ndlove busy with an inoculation trial to screen eucalypts for disease tolerance; Jolanda Roux and Shuaifei Chen studying the roots of an *Acacia erioloba* tree for the cause of the disease**

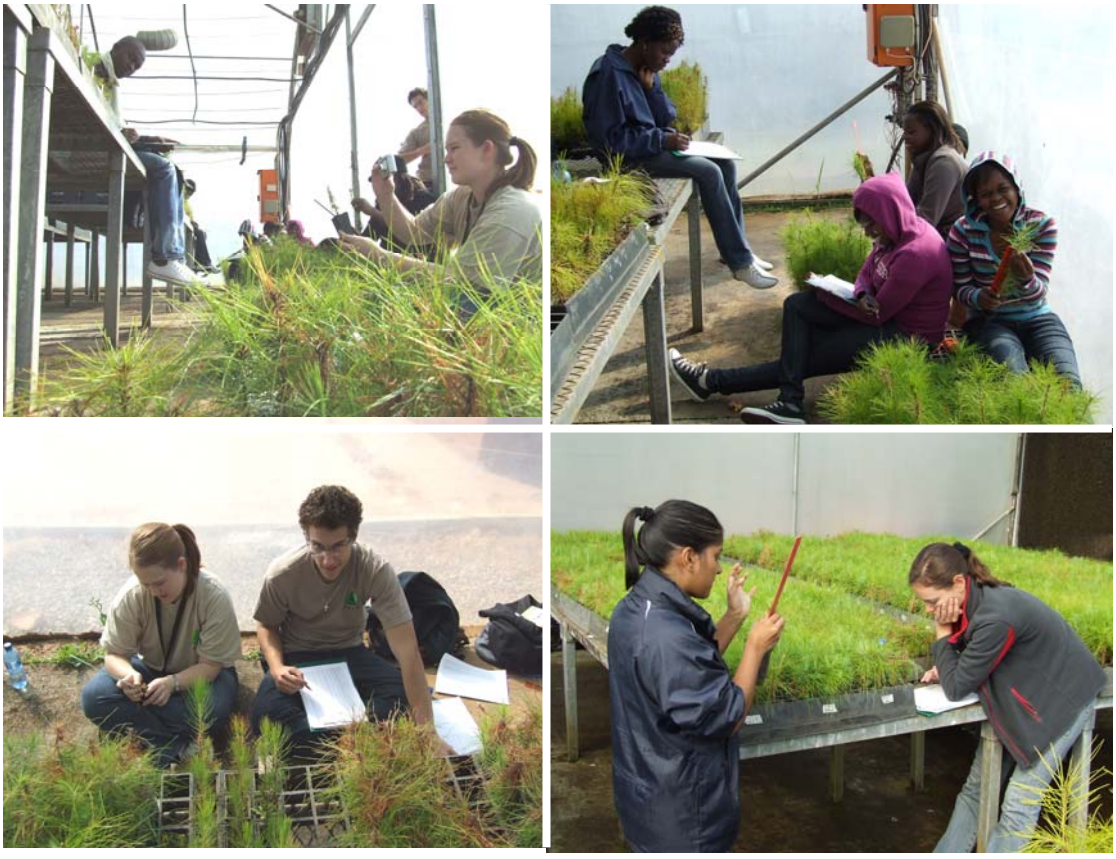
# Pine Pitch Canker Screening Facility

**Facility management team:**
Prof. Teresa Coutinho
Prof. Jolanda Roux
Prof. Emma Steenkamp
Prof. Mike Wingfield

**Technical manager:**
Ms. Bernice Porter

**Technical committee:**
Mr. A Nel (Sappi Forests)
Dr. K Payne (Mondi)
Mr. P Hongwane (KLF)
Mr. G Mitchell (York Timbers)
Dr. J Chan (BG Bison)
Mr. B Maree (Hans Merensky)

In 2005 a collaborative project was launched by Sappi Forests, Mondi Business Paper and Komatiland Forestry to have their pine breeding stock screened for tolerance to the pitch canker fungus, *Fusarium circinatum*. Twice a year, between 15 000 and 20 000 seedlings and/or cuttings are inoculated with the fungus and lesion development measured after six weeks. Research was undertaken previously to determine the best inoculation technique to use as well as which isolates to select for optimal screening. It was recently decided, as opposed to the combination of three isolates usually used as the inoculum, only one virulent isolate would be used in future inoculations. In 2010 the facility was expanded to include trees to be inoculated from Hans Merensky, BG Bison and York Timbers.



**Students measuring lesions six weeks after inoculation with the pitch canker fungus**

# Microarray service

**Facility manager:** Prof. Dave Berger

**Microarray scientific officer:** Mr. Nicky Olivier

The ACGT (African Centre for Gene Technologies) Microarray Facility provides a service of printing DNA samples on glass slides at a density up to 9200 unique genes per slide. A maximum of 36 replicate slides are produced in a single spotting run. Printing is performed using a Generation III Array Spotter (Molecular Dynamics Inc, Sunnyvale, California, USA) housed in a controlled-environment laboratory. Arrayed slides are made available to users who either carry out the required experimental procedures in their own laboratories, or use the laboratory facilities at the University of Pretoria. Processed slides are brought to the Facility for the scanning service, during which the fluorescence signals across the glass slides are measured and quantified using a GenePix 4000B Scanner (Molecular Devices Corporation, Foster City, California, USA). The captured microarray images and computed raw data are then provided to the user electronically. The Facility has a resident statistician who can assist users in the data analysis procedure using custom scripts in R and limma.

**Experion automated electrophoresis system**

Recent developments at the ACGT Microarray Facility include the acquisition of a Bio-Rad Experion automated electrophoresis system. A kind loan from BioRad, the Experion automated electrophoresis system allows for the rapid and reproducible separation and analysis of nucleic acid samples. Upon completion of an analysis the Experion software provides a RNA quality indicator (RQI), a numerical quality rating for eukaryotic total RNA samples. The RQI enables researchers to quickly judge the integrity of a total RNA sample and complements the visual display of the electropherogram and the ribosomal peak area ratio, and the RQI can serve as a benchmark for future related studies. The system is ideal for RNA quality control for applications such as microarrays and RT-qPCR. RNA analyses on the Experion are offered as a cost-only service to researchers from the University or those using the microarray facility. DNA analyses are performed on request, but the analysis kits must be provided by the user.

Due to the increased availability of genome sequence information, it has become feasible for many researchers to perform microarrays using the flexible Agilent platform. Several researchers have designed their own arrays and successfully used these in their research programs, while catalog arrays are also available from Agilent. The expertise in the Facility to provide technical advice has also increased, and we can offer quality technical support for all phases of the Agilent microarray process. Species studied in the last two years include *Rhipicephalus Boophilus microplus* (ticks), *Arabidopsis thaliana*, *Zea mays* (maize), *Tritichum aestivum* (wheat), *Homo sapiens* (cancer), *Plasmodium falciparum* (malaria) and *Sorghum bicolor*.

For more information, please consult http://microarray.up.ac.za/

Two FABI research groups have recently used the ACGT Microarray Facility in their research projects. The Molecular Plant-Pathogen Interactions group has an ongoing project on expression profiling the response of maize plants to grey leaf spot disease using whole genome maize arrays. The Forest Molecular Genetics group studied the gene expression profiles of *Arabidopsis thaliana* mutants over-expressing selected genes involved in wood formation.

Departments/Institutions that made use of the Facility include: the University of Pretoria Departments of Biochemistry, Genetics, Plant Science, Medical Physiology, University of Johannesburg Department of Biochemistry, University of the Witwatersrand Schools of Molecular and Cell Biology and Anatomical Sciences, CSIR Biosciences, and the University of the Free State Departments of Genetics and Biotechnology.

**Microarray data analysis training**

For the past few years, members of the Molecular Plant Pathogen Interactions (MPPI) research group have presented the Microarray data analysis module of the National Bioinformatics Training course supported by the Department of Science and Technology. Each year's class is made up of postgraduate students from throughout South Africa, as well as several other African countries.

**Microarray data analysis course participants hard at work (2010)**

**Participants demonstrating a "Beach Microarray": genes can be either up- or down-regulated!**

# Lightcycler 480 Facility

**Facility manager:** Prof. Dave Berger
Prof. Zander Myburg

**Technician:** Ms. Ronishree Naidoo

The Roche Lightcycler 480 at the University of Pretoria was purchased in 2006 with funding provided by the University of Pretoria and the NRF. The instrument is managed jointly by Prof. Dave Berger and Prof. Zander Myburg, while students and technical assistants from Prof. Myburg's research group administer all aspects of the instrument. Technicians responsible for the instrument to date are Nicky Creux, Martin Ranik, Marja O'Neill and Ronishree Naidoo. To increase the level of service, preferential pricing on consumables are negotiated and users can then purchase their consumables directly from the Facility.

Two training workshops are presented annually in concert with Roche, and students and researchers gain valuable experience in most aspects of a qPCR experiment, including data analysis and experimental design. These training workshops were attended by 3 principal researchers and 64 postgraduate students in 2009 to 2011, greatly increasing the level of expertise and the awareness in the local scientific community. Software for results analysis is also available from the facility, and this assists researchers to conform to MIQE standards for GLP and publication purposes. To date, numerous students have benefited from the availability of the instrument, and the quality of research has improved immensely. For the period of 2009-2011 a total of nine publications have been published in peer-reviewed journals, while 15 post-graduate students have graduated.

Departments/Institutions that made use of the Facility include the University of Pretoria Departments of Biochemistry, Genetics, Microbiology and Plant Pathology, Plant Science, FABI and CSIR Biosciences.

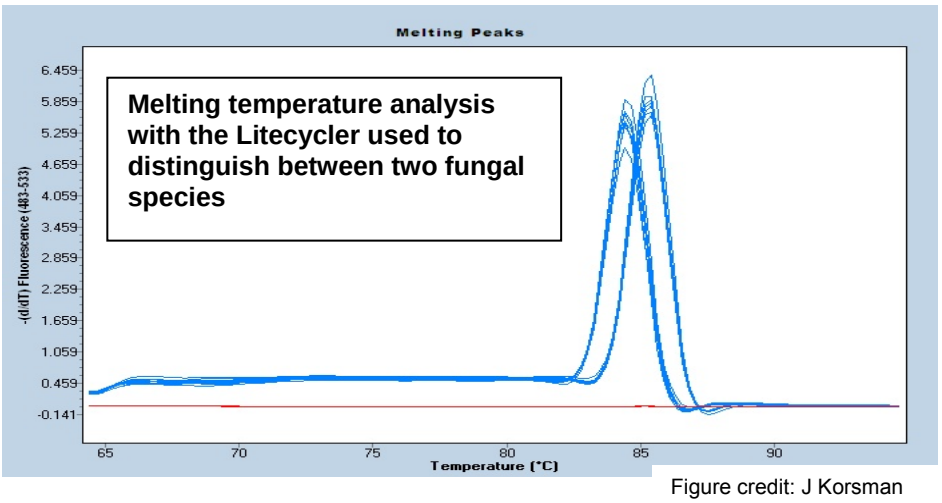



Figure credit: J Korsman

# AWARDS

**Awards for Excellence in FABI**

Ever since its establishment in 1998, FABI has pursued excellence across its many key performance indicators. This approach has resulted in many accolades for FABI students, academic staff members and for the Institute itself. Large numbers of students have thus received prestigious bursaries from various organisations, awards for research excellence and for travel to mention but a few. Likewise academic staff members have received special awards from organistions such as the Department of Water Affairs and Forestry, the Department of Science and Technology, the National Research Foundation, the South African Association for Art and Science, the Royal Society of South Africa, the Academy of Sciences of South Africa and various others. Against this background of excellence, the FABI Management makes a suite of awards to be made annually to exceptional FABIANS and FABI stakeholders.

FABI awards were made for the first time in 2007 and these have already come to be recognised as important and highly prized. The FABI awards for 2009-2010 are as follows:

**Best FABI student publication**

Given the importance of research quality in FABI, one award recognises the best publication produced by a FABI student in the award year. The recipient in the case of this award is easily chosen based on the ISI impact factor of the paper produced.

**2009 Gerda Fourie**
**2010 Guillermo Perez**

**Best FABI MSc thesis**

This award is given to an MSc student who achieved the highest mark through external examination of a thesis.

**2009 Joha Grobbelaar**
**2010 Marija Kvas**

**FABI award for mentorship**

This award is given to an MSc or PhD student who has demonstrated outstanding mentorship, in the broad sense, to other students.

**2009 Markus Wilken**
**Tuan Dong**
**2010 Eshchar Mizrachi**

**Best FABI student personal website**

The aim of this award is to encourage FABI students to produce personal web sites of high quality. Selection of the winner in this case is made through confidential ballot by students.

**2009 Alvaro Duran**
**2010 Fahimeh Jami**

**Best FABI student feature article on the website**

The FABI web site includes short popular exposes of research papers and the best of these is selected by students to receive this award.

**2009 Ryan Nadel**
**2010 Pieter de Maayer**

**FABI award for "getting the message to the public"**

This award goes to a student who has excelled in transferring the FABI Science message to the public. Tangible evidence of transferring the accomplishments of FABI, or the Science conducted by FABI or its members to the public must be demonstrated.

**2009 Kershney Naidoo**
**2010 Markus Wilkin**

**FABI award for recognising contributions by a member of staff of the University**

This award is made to a member of staff of the University of Pretoria that has provided exceptional support to FABI.

**2009 Dr. Simon Kotze**
**Prof. Henk Huismans**
**2010 Dr. Alan Hall**
**Prof. Chris van der Merwe**

**FABI award for recognising contributions by a person external to the University**

This award acknowledges the exceptional contributions to FABI by a stakeholder external to the University of Pretoria. Selection of the recipient is made by the FABI community.

**2009 Prof. Wally Marasas**
**2010 Dr. Hugh Glen**

**FABIAN of the year**

This is FABI's premium award for students and it recognises excellence across a broad range of areas including research, mentorship, support to the maintenance of the structures of the Institute and others. The recipient is chosen by FABI students.

**2009 Ryan Nadel**
**2010 Nicky Creux**

## African Union Award to Prof. Brenda Wingfield

The African Union honoured Prof. Brenda Wingfield with an AU Women Scientist Regional Award which recognises her great scientific achievements and contribution, through Science, to the socio-economic development of Africa. The official awards ceremony was held on African Union Day, 9 September 2009, at the African Union Commission Headquarters Conference Centre in Addis Ababa, Ethiopia. The honourable South African Ambassador to Ethiopia received the award on her behalf. The AU's Women Scientists' Award Programme stems from the Commission of African Union's attempts to promote Science in Africa and is being implemented by Regional Economic Communities within the five regions in Africa.

## GDARD Award to Prof. Mike Wingfield

Prof. Mike Wingfield was the recipient of the "BIotec Fundi Capacity Builder Award 2009" at a function held at the Innovation Hub, Pretoria, on Monday 31 August 2009. This was one of six Biotech Fundi Awards presented at the Gala event as part of a comprehensive incentive scheme set up by the Gauteng Department of Agriculture and Rural Development (GDARD) to support, promote and develop those individuals and companies who make a significant impact on the Biotech sector in Gauteng.

The specific award presented to Prof. Mike Wingfield is reserved for a person who has gone the extra mile with regards to empowering students and colleagues by imparting his insight and skills in order to add to trainees' market readiness in the biotech sector.

**Figures from left to right, top to bottom**
**Mike Wingfield handing the awards to Ryan Nadel (2009); Joha Grobbelaar (2009); Professor Wally Marasas (2009); Professor Henk Huismans (2009); Nicky Creux (2010); Esh Mizrachi (2010); Pieter de Maayer (2010) and Dr Simon Kotze (2010)**

# WORKSHOPS & CONFERENCES

## Jamboree for the manual Annotation of the *Fusarum circinatum* genome

A “Genome Jamboree“to annotate the genome of the causal agent of Pine Pitch Canker, *Fusarium circinatum* was held in May 2010. This was not a “jamboree” in the traditional sense but a workshop to complete the manual annotation of this important fungal genome. The DNA sequence for this genome was generated in 2009 and the first assembly done in the same year. The computer annotation was performed using the MAKER annotation pipeline. The output from this pipeline is a format of the genome that is compatible with the programme APOLLO. The latter is a programme that was used for the manual curation (that is manually checking the computer generated annotation) of the genome.

The *F. circinatum* genome jamboree had one very novel element; that most of the people involved in the process were post graduate students. While annotation represents one of the biggest log jams in any genome programme, most people with a basic degree in Biology can easily learn how to curate a genome. While the computer annotation programmes are becoming increasingly sophisticated, they are still not as effective as a skilled human at correctly predicting all gene coding regions. The students involved in the annotation process were exposed to a two-day training course reinforcing the theoretical background in gene and genome structure, as well as treating the basic concepts and requirements of the annotation process. This included learning how to use the programme APOLLO.

At the beginning of 2010, all the annotators were individually supplied with approximately 700 genes to annotate. These were produced using the MAKER pipeline and the gene predicting programmes Augustus and GeneMark, sequence data from three other *Fusarium* genomes and mRNA sequences. This ensured that most of the potential Open Reading frames would be predicted and indicated in Apollo. The main challenge for the curators was thus to determine that the correct start and stop codons had been predicted and to check the positions of the introns. As most genes in *Fusarium circinatum* have at least 2-3 introns, some intense concentration and time was required to complete the annoatation. Prior to the jamboree, more than half of the predicted genes had been manually scrutinised. During the week long jamboree, the remainder of the genes were checked for accuracy of annoatation.

The genome of *Fusarium circinatum* was shown to be 45 Mb in size and it has approximately 15 000 protein coding genes [Open reading frames]. The genome was sequenced using the Roche FLX 454 pyrosequencing technology and the sequence currently available represents an 11 times coverage of the genome.

In addition to the manual analysis of the predicted genes, Mark Yandell from the University of Utah did some further analyses on the genome. He also tutored a group of the students regarding some of the additional analyses that could be done to characterise the genome. This jamboree thus served to complete the annotation of the *F. cricinatum* genome and to teach a number of students about annotation and other ways of characterising a genome. As is the case with all genomes, the work is actually never finished. However the *F. circinatum* genome is now available for further studies that will contribute to the management of this important pine pathogen.

**The annotation team starting at bottom left**

**Brenda Wingfield, Mmatshepho Phasha, Chrizell Beukes and Kershney Naidoo**
**Irene Barnes, Rene Sutherland, Simon Martin and Stefan Bam**
**Emma Steenkamp, Gerda Fourie and Oleg Reva**
**Lieschen de Vos, Melissa Simpson and Annie Chan,**
**Fanus Venter, Magriet van der Nest, Alisa Postma, Martin Coetzee and Albe van der Merwe**
**Markus Wilken, Quentin Santana and Renate Zipfel**
**Stephanie Slinski, Mark Yandell and Darryl Herron.**

# PUBLICATIONS 2009-2011

**These lists include only publications that had appeared by the end of May 2011. Manuscripts in press and submitted for publication are not included.**

**Books**

**BRUCE T, FOYER C, HALFORD N, KEYS A, KUNERT K, LAWLOR D, PARRY M, RUSSELL G eds.** (2010) Africa's Engine for Growth-Plant Science and Biotechnology hold the key". Aspects of Applied Biology, Vol 96.

**COUTINHO TA, GOSZCZYNSKA T, LENNOX C, VENTER SN** (2009) Bacterial diseases of plants in South Africa. Briza publications, Pretoria, South Africa.

**GRYZENHOUT M, WINGFIELD BD, WINGFIELD MJ** (2009) The Cryphonectriaceae: Tree killing and bark inhabiting fungi. American Phytopathological Society Press, St. Paul, Minnesota.

## Chapters in books and symposium proceedings

**AVELING TAS, GOSZCZYNSKA T** (2009) Bacterial seedborne diseases in South Africa. In: Bacterial Diseases of Plants in South Africa. Edited by T.A. Coutinho, CL Lennox, T Goszczynska, SN Venter. Briza Publications, South Africa, pp. 12-17.

**ENDAH R, COUTINHO T, CHIKWAMBA R** (2010) *Xanthmonas campestris* pv. *musacearum* induces sequential expression of two NRP-1 like genes in banana*. Aspects of Applied Biology* **96**, *Agriculture: Africa's "engine for growth" – Plant science and biotechnology hold the key*, Rothamsted, UK.

**TALENGERA D, BEEMSTER GTS, FIORANI F, INZE D, KUNERT K, TUSHEMEREIRWE WK** (2009). Transformation of banana (*Musa* spp.) with a D-type cyclin gene from *Arabidopsis thaliana* (ArathCYCD2:1) *In:. Aspects of Applied Biology* **96**, *Agriculture: Africa's "engine for growth" – Plant science and biotechnology hold the key*, Rothamsted, UK.

**WINGFIELD MJ, SLIPPERS B, ROUX J, WINGFIELD BD (**2010) Fifty Years of Tree Pest and Pathogen Invasions, Increasingly Threatening World Forests: Fifty Years of Invasion Ecology: The Legacy of Charles Elton Pages: 89–99, 2010. Ed David M. Richardson.

## In refereed journals

**AANEN DK, SLIPPERS B, WINGFIELD MJ** (2009) Biological pest control in beetle agriculture. *Trends in Microbiology* **17:** 179-182.

**BEGOUDE BAD, GRYZENHOUT M, WINGFIELD MJ, ROUX J** (2010) *Aurifilum*, a new fungal genus in the Cryphonectriaceae from *Terminalia* species in Cameroon. *Antonie van Leeuwenhoek* **3**: 263-278.

**BEGOUDE BAD, SLIPPERS B, WINGFIELD MJ, ROUX J** (2009) Botryosphaeriaceae associated with *Terminalia catappa* in Cameroon, South Africa and Madagascar. *Mycological Progress* **9:** 101-123.

**BENCHABANE M, SCHLÜTER U, VORSTER J, GOULET MC, MICHAUD D** (2010) Plant cystatins*. Biochemie* **92:** 1657-66.

**BIHON W, SLIPPERS B, BURGESS T, WINGFIELD MJ, WINGFIELD BD** (2011). Sources of *Diplodia pinea* endophytic infections in *Pinus patula* and *P. radiata* seedlings in South Africa. *Forest Pathology* **41:** 175–181.

**BOGALE M, STEENKAMP ET, WINGFIELD MJ, WINGFIELD BD** (2009) Diverse *Fusarium solani* isolates colonise agricultural environments in Ethiopia. *European Journal of Plant Pathology* **124:** 369–378.

**BRADY CL, CLEENWERCK I, VENTER SN, ENGELBEEN K, DE VOS P, COUTINHO TA** (2010) Emended description of the genus *Pantoea* and description of four novel species from human clinical samples, *Pantoea septica* sp. nov., *Pantoea eucrina* sp. nov., *Pantoea brenneri* sp. nov. and *Pantoea conspicua* sp. nov., and transfer of *Pectobacterium cypripedii* (Hori 1911) Brenner et al. 1973 emend. Hauben *et al*. 1998 to the genus *Pantoea* emend. as *Pantoea cypripedii* comb. nov. *International Journal of Systematic and Evolutionary Microbiology* **60:** 2430-2440.

**BRADY CL, DENMAN S, PALENZUELA PR, VENTER SN, COUTINHO TA** (2010*)* Description of *Gibbsiella quercinecans* gen. nov., sp. nov., associated with Acute Oak Decline*. Systematic and Applied Microbiology* **33,** 444-450.

**BRADY CL, GOSZCZYNSKA T, VENTER SN, CLEENWERCK I, GITAITIS R, DE VOS P, COUTINHO TA** (2011) *Pantoea allii* sp. nov., a novel species isolated from onion and onion seed. *International Journal of Systematic and Evolutionary Microbiology* **61:** 932-937.

**BRADY CL, VENTER SN, CLEENWERCK I, ENGELBEEN K, DE VOS P, WINGFIELD MJ, TELECHEA N, COUTINHO TA** (2009) Isolation of *Enterobacter cowanii* from *Eucalyptus* showing symptoms of bacterial blight and dieback in Uruguay. *Letters in Microbiology* **49:** 461-465.

**BRADY CL, VENTER SN, CLEENWERCK I, ENGELBEEN K, VANCANNEYT M, SWINGS J, COUTINHO TA** (2009) *Pantoea vagans* sp. nov., *Pantoea eucalypti* sp. nov., *Pantoea deleyi* sp. nov. and *Pantoea anthophila* sp. nov. *International Journal of Systematic and Evolutionary Microbiology* **59:** 2339 – 2345.

**BRADY CL, VENTER SN, CLEENWERCK I, VANDEMEULEBROECKE K, DE VOS P, COUTINHO TA** (2010) Transfer of *Pantoea citrea, Pantoea punctata* and *Pantoea terrea* to the genus *Tatumella* emend. as *Tatumella citrea* comb. nov., *Tatumella punctata* comb. nov. and *Tatumella terrea* comb. nov. and description of *Tatumella morbirosei* sp. nov. International *Journal of Systematic and Evolutionary Microbiology* **60:** 484-494.

**CHEN SF, GRYZENHOUT M, ROUX J, XIE YJ, WINGFIELD MJ, ZHOU XD** (2010) Identification and Pathogenicity of *Chrysoporthe cubensis* on *Eucalyptus* and *Syzygium* spp. in South China. *Plant Disease* **94:** 1143-1150.

**CHEN SF, LOMBARD L, ROUX J, XIE YJ, WINGFIELD MJ, ZHOU XD** (2011) Novel species of *Calonectria* associated with Eucalyptus leaf blight in Southeast China. *Persoonia* **26:** 1-12.

**CHUNGU D, GRYZENHOUT M, KANKOLONGO MA, WINGFIELD MJ, ROUX J** (2009) Taxonomy and pathogenicity of two *Chrysoporthe* species from *Eucalyptus grandis* and *Syzygium guineense* in Zambia. *Mycological Progress* **3:** 379-393.

**CHUNGU D, MUIMBA-KANKOLONGO A, WINGFIELD MJ, ROUX J** (2010) Identification of fungal pathogens occurring in eucalypt and pine plantations in Zambia by comparing DNA-sequences. *Forestry* **83:** 507-515.

**COETZEE MPA, MAPHOSA L, MWENJE E, WINGFIELD MJ, WINGFIELD BD** (2009) Characterisation of *Armillaria* species based on pectic isozyme analyses. *Fungal Diversity* **36:** 9-16.

**COETZER N, GAZENDAM I, OELOFSE D, BERGER DK** (2010) SSHscreen and SSHdb, generic software for microarray based gene discovery: application to the stress response in cowpea. *Plant Methods* **6:** 10.

**COUTINHO TA, BRADY CL, VAN DER VAART M, VENTER SN, TELECHEA N, PEREZ C, WINGFIELD MJ** (2011) A new shoot and stem disease of *Eucalyptus* species caused by *Erwinia psidii. Australasian Plant Pathology* **40:** 55-60.

**COUTINHO TA, VENTER SN** (2009) *Pantoea ananatis*: an unconventional plant pathologen. *Molecular Plant Pathology* **10:** 235-335.

**CRAMPTON BG, HEIN I, BERGER DK** (2009) Salicylic acid confers resistance to a biotrophic rust pathogen, *Puccinia substriata* in pearl millet, *Pennisetum glaucum*. *Molecular Plant Pathology* **10:** 291-304.

**CROUS PW, BRAUN U, WINGFIELD MJ, WOOD AR, SHIN HD, SUMMERELL BA, ALFENAS AC, CUMAGUN CJR, GROENEWALD JZ** (2009) Phylogeny and taxonomy of obscure genera of microfungi. *Persoonia* **22:** 139–161.

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**CROUS PW, SUMMERELL BA, CARNEGIE AJ, WINGFIELD MJ, HUNTER GC, BURGESS TI, ANDJIC V, BARBER PA, GROENEWALD JZ** (2009) Unravelling *Mycosphaerella*: do you believe in genera? *Persoonia* **23:** 99–118.

**CROUS PW, SUMMERELL BA, CARNEGIE AJ, WINGFIELD MJ, GROENEWALD JZ** (2009) Novel species of *Mycosphaerellaceae* and *Teratosphaeriaceae*. *Persoonia* **23:** 119–146.

**CROUS PW, WINGFIELD MJ, GROENEWALD JZ** (2009) Niche sharing reflects a poorly understood biodiversity phenomenon. *Persoonia* **22:** 83–94.

**CRUYWAGEN E, DE BEER ZW, ROUX J, WINGFIELD MJ** (2010) Three new *Graphium* species from baobab trees in South Africa and Madagascar. *Persoonia* **25:** 61-71.

**CULLIS CA, VORSTER BJ, VAN DER VYVER C, KUNERT KJ** (2009). Transfer of genetic material between the chloroplast and nucleus: how is it related to stress in plants? *Annales of Botany* (London) **103:** 625-33.

**DE MAAYER P, CHAN WY, VENTER SN, TOTH IK, BIRCH PRJ, JOUBERT F, COUTINHO TA** (2010) The genome sequence of *Pantoea ananatis* LMG20103, the causative agent of *Eucalyptus* blight and dieback. *Journal of Bacteriology* **192:** 2936-3937.

**DE WET J, SLIPPERS B, PREISIG O, WINGFIELD BD, TSOPELAS P, ALKMANOS Y, WINGFIELD MJ** (2009) Molecular and morphological characterisation of *Dothiorella casuarini* sp. nov. and other Botryosphaeriaceae with *Diplodia*-like conidia. *Mycologia* **101**: 503–511.

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**VAN DER LINDEN L, NAIDOO S, BERGER DK** (2009) Single gene resistance to *Ralstonia solanacearum*, the bacterial wilt pathogen of many tropical crops. The Tropical Crops Biotechnology conference at Hazyview 21-25 July 2009.

**VAN DER LINDEN LE, DE CASTRO T, NAIDOO S, FOUCHE-WEICH J MYBURG A DENBY K, MARCO Y, BERGER DK** (2010) Plant defense against the *Eucalyptus* bacterial wilt pathogen *Ralstonia solanacearum* in *Arabidopsis thaliana* ecotype Kil-0, 21st biennial congress of the SA Genetics Society, Free State, RSA.

**VAN DER LINDEN LE, NAIDOO S, BERGER DK** (2009) Genetic analysis of an *Arabidopsis thaliana* ecotype showing resistance to a bacterial wilt isolate from *Eucalyptus*. 35th Annual Conference of the South African Association of Botanists (SAAB), Stellenbosch, South Africa.

**VAN DER MERWE JJ, COUTINHO TA, VAN DER WAALS JE** (2009) Effect of Si soil amendments on defense responses of potato tubers to *Pectobacterium* spp. Proceedings of the 46th Annual Congress of the Southern African Society for Plant Pathology, Gordon's Bay.

**VAN DER MERWE NA, STEENKAMP ET, COETZEE MPA, GRYZENHOUT M, WINGFIELD MJ WINGFIELD BD** (2010) Allopatric speciation in *Chrysoporthe* is not linked to continental drift. 21st South African Genetics Society Congress Bloemfontein.

**VAN DER NEST A, STEENKAMP ET, MARAIS GJ** (2009) Phylogenetic definition of *Phoma sorghina* based on the ITS, EF-1α and β-tubulin gene regions. Abstracts of the 46th Congress of the Southern African Society for Plant Pathology / 6th Congress of the African Mycological Association, 25-28 January 2009, Villa Via Hotel, Gordon's Bay.

**VAN DYK MM, REYNOLDS SM, GODDARD S, COWLEY E, MYBURG AA** (2010) Microsatellite markers for fingerprinting and parentage analysis in eucalypt and pine tree breeding programmes. South African Plant Breeders Association Symposium, Stellenbosch, 6-7 April 2010

**VAN DYK MM, REYNOLDS SM, O'NEILL MM, RALIKONYANA P, MYBURG AA, FMG RESEARCH TEAM** (2010) DNA fingerprinting: A platform for clonal identification and parentage analysis in breeding programmes. Fourth Forest Science Symposium, Pietermaritzburg, 3-4 August 2010

**VAN JAARSVELD I, JOUBERT F, MYBURG AA** (2009) Computational identification of putative miRNA genes and targets in the newly sequenced *Eucalyptus grandis* genome. Second Southern African Bioinformatics Workshop, Riverside Hotel and Conference, 11-12 October 2009

**VAN SCHALKWYK A, WENZL P, KILLIAN A, BERGER DK** (2010) Bin-mapping diversity array (DArT) markers to genomic regions of *Solanum lycopersicum* x *Solanum pennellii* introgression lines. 8th Southern African Plant Breeding Symposium, Stellenbosch, South Africa.

**VAN WYK SJP, ROSE LJ, COUTINHO TA, WINGFIELD MJ, VILJOEN A** (2009) Optimizing species-specific primers to distinguish between *Fusarium circinatum* and *Fusarium proliferatum*. Proceedings of the 46th Annual Congress of the Southern African Society for Plant Pathology, Gordon's Bay.

**VAN WYK SJP, ROSE LJ, COUTINHO TA, WINGFIELD MJ, VILJOEN A** (2009) Screening *Pinus* spp. and families for resistance to the pitch canker fungus, *Fusarium circinatum*. Proceedings of the 46th Annual Congress of the Southern African Society for Plant Pathology, Gordon's Bay.

**VAN ZYL K, VAN DER NEST MA, SLIPPERS B, STENLID J, WINGFIELD MJ, WINGFIELD BD** (2009) Identification and characterisation of selectively induced genes expressed during vegetative incompatibility in *Amylostereum areolatum*. Proceedings of the 46th Annual Congress of the Southern African Society for Plant Pathology, Gordon's Bay.

**VERMEULEN M, BEGOUDE BAD, GRYZENHOUT M, WINGFIELD MJ, ROUX J** (2009) A new genus in the Cryphonectriaceae associated with Combretaceae and Lythraceae in Africa. Proceedings of the 35th Congress of the South African Association of Botanists and International Workshop on Phosphate as a limiting resource, University of Stellenbosch, Stellenbosch, South Africa.

**VERMEULEN M, GRYZENHOUT M, WINGFIELD MJ, ROUX J** (2009) New host and geographic records for the Cryphonectriaceae in Africa. Proceedings of the 46th Annual Congress of the Southern African Society for Plant Pathology, Gordon's Bay.

**VERMEULEN M, GRYZENHOUT M, WINGFIELD MJ, ROUX J** (2011) Cryphonectriaceae: An unexplored group of tree pathogens in Africa. Proceedings of the 47th Annual Congress of the Southern African Society for Plant Pathology, Kruger Park.

**VILJOEN E, VAN SCHALKWYK A, VAN WYK B, BERGER DK** (2010) Diversity analysis of cultivated *Solanum nigrum* complex accessions in South Africa. Regional Plant Biotechnology Forum, FABI, University of Pretoria.

**WILKEN F, NAIDOO R, VAN DEN BERG N, BERGER DK, MYBURG A, NAIDOO S** (2011) Gene expression profiling of putative defence gene orthologs in *Eucalyptus nitens* upon challenge with *Phytophthora cinnamomi*. South African Society of Plant Pathologists meeting, Kruger National Park, January 2011.

**WILKEN FE, ROS B, BERGER DK** (2009) Expression analysis of the defence gene *SGT1* (suppressor of the G2 allele of *skp1*) in pearl millet (*Pennisetum glaucum*) during salicylic acid treatment. 35th Congress of the SA Association of Botanists (SAAB), Stellenbosch, RSA.

**WILKEN PM, DE BEER ZW, STEENKAMP ET, WINGFIELD MJ, WINGFIELD BD** (2011) Full genome sequencing contributes to an understanding of mating in *Ceratocystis fimbriata.* Proceedings of the 47th Annual Congress of the Southern African Society for Plant Pathology, Kruger Park.

**WILKEN PM, DE BEER ZW, WINGFIELD MJ, WINGFIELD BD** (2010) Presence of both *MAT1-1* and *MAT1-2* mating idiomorph sequences in single spore isolates of the heterothallic fungus, *Ophiostoma quercus.* 21st South African Genetics Society Congress Bloemfontein.

**WILKEN PM, WINGFIELD MJ, DE BEER ZW, WINGFIELD BD** (2009) Mating (MAT) genes in the fungal genus *Ophiostoma*. Proceedings of the 46th Annual Congress of the Southern African Society for Plant Pathology, Gordon's Bay.

**WINGFIELD BD** (2009) The future of DNA based identification of fungi. Proceedings of the 46th Annual Congress of the Southern African Society for Plant Pathology, Gordon's Bay.

# SEMINAR PRESENTATIONS

All postgraduate students linked to FABI present two seminars each year on a Thursday morning. Special seminars, presented by invited speakers, are also regularly held. The following is a list of invited seminars held during the reporting period:

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**Prof. Steven Lindow**
University of California, Berkeley, USA
January 2009
Pathogen confusion and control of *Xylella fastidiosa*

**Dr. Jeff Garnas**
Dartmouth College, USA
February 2009
Elucidating the role of non-native insects and disease in structuring forests: a case study of beech bark disease in North America

**Dr. Jennifer Juzwik**
USDA Forest Services, St. Paul, USA
March 2009
*Ceratocystis* spp. and their insect vectors in the USA

**Prof. Don Lee**
Department of Forestry, Seoul National University, Korea/President of IUFRO
March 2009
Introduction to IUFRO

**Dr. Ian Toth**
Scottish Crops Research Institute, Scotland, UK
April 2009
An update on *Pectobacterium* genomics

**Dr. Zvi Mendel**
Volcani Centre, Israel
May 2009
Conservation biological control of the pine processionary moth (*Thaumetopoea wilkinsoni*)

**Prof. Volker Brözel**
South Dakota State University, USA
May 2009
Escape from the laboratory: Characterising growth of *Bacillus subtilis* in its native environment

**Dr. Andre Drenth**
University of Queensland, Australia
September 2009
Management of diseases in tree crops

**Prof. Arnold Caplan**
Case Western Reserve University, USA
September 2009
Adult mesenchymal stem cells and their use in cell-based therapies

**Dr. Herve Vandershuren**
Plant Biotechnology Lab, ETH, Zürich, Switzerland
December 2009
Engineering virus resistance in plants" from "keep it encapsidated" to "keep it silent"

**Dr. Michael Poulsen**
University of Wisconsin, USA
January 2010
Microbial interactions shaping insect-fungus symbioses

**Dr. Alvaro Gaitan**
Cenicafe, Colombia
February 2010
Current challenges in biotic and abiotic stresses to Colombian coffee plantations

**Dr. Lizette Koekemoer**
National Institute for Communicable Diseases, NHLS
March 2010
The distribution and control of malaria: a Southern African perspective

**Dr. Lizel Mostert**
Dept of Plant Pathology, University of Stellenbosch
July 2010
Fungal taxonomic novelties associated with trunk diseases of deciduous fruit trees

**Prof. Douglas Maxwell**
University of Wisconsin Madison, USA
September 2010
Breeding tomatoes for resistance to begomoviruses and *Ralstonia solanacearum* in Guatemala, Central America

**Dr. Brion Duffy**
Agroscope, Switzerland
October 2010
*Pantoea* as a biocontrol agent against fire blight: biosafety, genomics and environmental impact issues

**Prof. John Leslie**
Kansas State University, USA
October 2010
*Fusarium* species in shades of gray

**Dr. Ignazio Carbone**
North Carolina State University, USA
November 2010
The evolution of mycotoxin diversity in natural and experimental populations of *Aspergillus flavus* and *Aspergillus parasiticus*

**Dr. Eva Thuenemann**
John Innes Centre Norwich, UK
November 2010
The many roles of cowpea mosaic virus: biotechnological applications

**Dr. Rosie Bradshaw**
Massey University, New Zealand
November 2010
The story of dothistromin toxin and the *new Dothistroma septosporum* genome

**Dr. Jane Olwoch**
Dept of Geography and Geoinformatics, University of Pretoria
November 2010
Climate change, vectors and vector-borne diseases: global and regional perspectives

**Prof. Burt Bluhm**
University of Arkansas, USA
January 2011
Functional genomics and genome sequencing of *Cercospora* and *Fusarium* pathogens of maize

**Dr. Michael Poulson**
University of Copenhagen, Denmark
February 2011
From ants to termites: exploring the fungus-growing termite microbiome

**Prof. Melissa MacHale**
North Carolina State University, USA
February 2011
From concrete jungles to savannas: new long-term socio-ecological programs in the United States and South Africa

**Prof. Toshiya Muranaka**
Osaka University, Japan
March 2011
Metabolic diversity of terpenoids in plants and its application to combinatorial biosynthesis

**Prof. Lindsey du Toit**
Washington State University, USA
March 2011
Starting a Career in Applied Plant Pathology

**Dr. Miroslav Kolarik**
Institute of Microbiology, Czech Republic
April 2011
*Geosmithia* as regular and widespread symbionts of bark beetles

**Prof. Tom Coudron**
Division of Plant Sciences, United States Department of Agriculture, USA
May 2011
Global Forces Influencing the Future of Biological Control

# FABI TEAM
# 2009-2011

## Full time academic & research staff

Prof. Dave Berger
Prof. Teresa Coutinho
Prof. Karl Kunert
Prof. Gerhard Pietersen
Prof. Jolanda Roux
Prof. Brenda Wingfield
Prof. Michael Wingfield
Assoc Prof. Terry Aveling
Assoc Prof. Zander Myburg
Assoc Prof. Bernard Slippers
Assoc Prof. Emma Steenkamp
Assoc Prof. Fanus Venter
Dr.Rachel Chikwamba
Dr. Martin Coetzee
Dr. Jeff Garnas
Dr. Marieka Gryzenhout (until May 2010)
Dr. Brett Hurley
Dr. Gert Marais (until December 2010)
Dr. Lucy Moleleki
Dr. Sanuska Naidoo
Dr. Noëlani van den Berg
Dr. Juan Vorster
Dr. XuDong Zhou
Mr. Wilhelm de Beer
Mr. Albe van der Merwe

## Technical staff

Ms. Elme Breytenbach
Ms. Daphne Chokoe
Ms. Elna Cowley
Mr. Jurgens de Bruin
Ms. Samantha Bush
Ms. Monique de Castro
Mr. Neil de Jager
Ms. Gerda Fourie
Ms. Sonica Godard
Ms. Izette Greyling
Ms. Marlene Harney
Mr. Hardus Hatting
Ms. Tracey Hatherell
Ms. Alex Jansen van Rensburg
Ms. L'Zanne Jansen van Rensburg
Ms. Pritty Khumalo
Ms. Jeanne Korsman
Ms. Annelie Lübben
Ms. Grieta Mahlangu
Ms. Babalwa Mbebe
Dr. Seonju Marinkowitz
Mr. Eshchar Mizrachi
Ms. Eva Müller
Ms. Karin Muller
Mr. Duncan Newman
Ms. Valentina Nkosi
Mr. Nicky Olivier
Ms. Marja O'Neill
Ms. Bernice Porter
Ms. Patience Ralikonyana
Ms. Melissa Reynolds
Ms. Heidi Roos
Ms. Belinda Schepers
Ms. Anita Steyn
Ms. Melissa Turton
Ms. Lydia Twala
Ms. Liesl van der Linden
Ms. Erika van der Walt
Dr. Daleen van Dyk
Ms. Irene van Nugteren
Ms. Adri Veale

## Administrative staff

Ms. Mmampe Aphane
Ms. Vivienne Clarence
Ms. Helen Doman
Ms. Magda Fouche (until end of December 2010)
Ms. Jenny Hale
Ms. Adrene Laubsher
Ms. Martha Mahlangu
Ms. Annette Schnetler
Ms. Rose Visser

## Information specialist

Ms. Leonie Muller (until end of April 2009)
Ms. Elna Randall (until end of December 2010)
Ms. Janice de Wee

## Honorary professors/lecturers

Prof. P Birch
Prof. PW Crous
Prof. WFO Marasas
Prof. JP van der Walt
Prof. J Webster
Prof. S Neser
Dr. T Burgess
Dr. B Eisenberg
Dr. O Preisig
Dr. I Toth

## UP research fellows

**Dr Irene Barnes**
Mating strategies in the native fungal pathogen, *Ceratocystis albifundus*
**Dr Martin Coetzee** (until Dec 2009)
Evolution of mitochondria genomes of *Armillaria*

## Postdoctoral fellows

**Dr Wubetu Bihon**
Understanding the global population genetics of *Diplodia pinea* and its life cycle in plantation pines
**Dr Emilie Boissin**
Molecular ecology and evolution of tree pests and pathogens, with a particular focus on the *Sirex-Amylostereum* symbiosis
**Dr Carrie Brady**
Taxonomy of plant associated members of the Enterobacteriaceae
**Dr Shuaifei Chen**
Cryphonectriaceae associated with native trees in the Western Cape Province
**Dr Bridget Crampton**
Genomics of quantitative disease resistance in African maize varieties
**Dr Pieter de Maayer**
Comparative and functional genomics of *Pantoea* spp.
**Dr Raj Deepika Kaul**
Development and optimisation of an *in vitro* regeneration and genetic transformation protocol for genetic modification of cellulose biosynthesis in *Eucalyptus* clones grown in South Africa
**Dr Martin Kemler**
The influence of climate on latent pathogens of native South African trees, with a particular focus on the Botryosphaeriaceae
**Dr Boney Kuriakose**
High quality Solanaceous crops for consumer, processors and producers by exploration of natural biodiversity through Diversity Array Technology
**Dr Lu Min**
Ophiostomatoid fungi associated with bark beetles
**Dr Eunsong Oh**
*Phytophthora* species in the indigenous forests of South Africa
**Dr Donovan Porter**
Survival of *Pantoea ananatis* in the environment
**Dr Pedro Ramon**
Conifer bark beetles and associated phytopathogenic fungi: diagnostics, epidemiology and integrated control

**Dr Francois Roets**
Phylogeny of the Ophiostomatales on *Protea* species in South Africa
**Dr Urte Schlüter**
Nodule senescence under drought stress
**Dr Daleen van Dyk**
Genetic dissection of gene expression regulation, metabolite profiles and wood fibre traits in *Eucalyptus* hybrid tree populations
**Dr Juan Vorster**
Protein modeling and design
**Dr Chongxing Zhang**
The diversity and genetics of nematodes for biological control of forest insects

## Postgraduate students

## PhD students

**Elbie Beukes** (registered at University of Stellenbosch)
Enhancement of the probiotic potential of Southern African produced kefir
**Advisors:** TJ Britz, ET Steenkamp & PJ Jooste
**Marc Bouwer**
Identifying pheromone components for forest insect pests in South Africa
**Advisors:** B Slippers, MJ Wingfield & E Rohwer
**Nicky Creux**
Transcriptional regulation of cellulose biosynthesis in *Eucalyptus* trees
**Advisor:** AA Myburg
**Elsie Cruywagen**
A survey of diseases of *Adansonia digitata* (baobab) and related species
**Advisors:** MJ Wingfield, J Roux & B Slippers
**Wilhelm de Beer**
The occurrence of Ophiostomatoid fungi in wood and wood products in South Africa
**Advisor:** MJ Wingfield
**Dawit Degefu**
Biology and biological control of *Coryphodema tristis*
**Advisors:** B Slippers, B Hurley & MJ Wingfield
**Lieschenn de Vos**
Characterisation of the *Fusarium circinatum* genome
**Advisors:** BD Wingfield, MJ Wingfield & AA Myburg
**Gudren Dittrich-Schroder**
Diversity and control of *Leptocybe invasa*
**Advisors:** B Slippers, MJ Wingfield & B Hurley
**Kosi Dongo**
Mycotoxins associated with maize beer in Mpumalanga
**Advisor:** TAS Aveling
**Nicoleen Douglas-Smit**
Transmission of Aster yellows to grapevine by insect vectors.
**Advisors**: K Kruger & G Pietersen
**Tuan Duong**
Molecular characterisation of *Leptographium serpens* and related species
**Advisors:** MJ Wingfield & BD Wingfield
**Rosita Endah**
Functional characterisation of two NPRI genes
**Advisors:** KJ Kunert & R Chikwamba
**Berhanu Fenta**
The role of the protease/protease inhibitor system in nodule senescence under water deficit in legumes
**Advisor:** KJ Kunert
**Marna Ferreira**
Spread of grapevine leafroll-associated virus 3 (GLRaV-3) by scale insects.
**Advisors:** K Kruger & G Pietersen
**Gerda Fourie**
A study of virulence of *Fusarium circinatum* from a genomics perspective

**Advisors:** ET Steenkamp, BD Wingfield & MJ Wingfield

**Inge Gazemdam**
Identification of genes in cowpea responding to drought stress
**Advisors:** DK Berger & D Oelofse

**Endale Gebre**
Induction of dwarfism for lodging resistance in Tef (*Eragrostis tef*)
**Advisor:** KJ Kunert

**Andile Grootboom**
Increasing the lysine content in maize by engineering proteinase inhibitor
**Advisors:** R Chikwamba & KJ Kunert

**James Harrison**
Complementary morphological and molecular approaches to plantation white grubs (Scarabaeidae) identification
**Advisors:** MJ Wingfield

**Fahimeh Jami**
Phylogeography of Botryosphaeriaceae on *Acacia*
**Advisors:** MJ Wingfield, B Slippers & M Gryzenhout

**Luke Jimu**
Diseases of eucalypts in Zimbabwe, with particular reference to Kirramyces stem canker
**Advisors:** J Roux, E Mwenje & MJ Wingfield

**Gilbert Kamgam Nkuekam**
Ophiostomatoid fungi on broad-leaf trees, with particular reference to southern Africa
**Advisors:** J Roux & MJ Wingfield

**Presidor Kendabie**
Mapping of determinants of drought in *Musa*
**Advisors:** A-M Oberholster & AA Myburg

**Maythasith Konkarn**
Ophiostomatoid fungi associated with bark beetles in Thailand
**Advisors:** XD Zhou, ZW de Beer, K Hyde & MJ Wingfield

**Jeanne Korsman**
Functional studies of maize defence genes against grey leaf spot
**Advisors:** DK Berger & B Crampton

**Anand Kullan**
Genetic mapping of wood property and growth traits in interspecific hybrid progeny of *Eucalyptus* tree species
**Advisor**: AA Myburg

**Michael Luttig**
Characterisation of a citrus tristeza closterovirus population which interferes with Huanglongbing infection
**Advisors:** BD Wingfield & B Manicom

**Eugene Makgopa**
Cystatin expression in transgenic soybean
**Advisor:** K Kunert

**Jacoline Mans**
Factors associated with the decline of *Acacia erioloba* in South Africa
**Advisors:** J Roux & A van Rooyen

**Celia Martins**
Drought stress in cowpea
**Advisor:** KJ Kunert

**Michael Mbenoun**
*Ceratocystis* spp. and their insect vectors on trees in Africa
**Advisors:** J Roux, MJ Wingfield, BD Wingfield & BAD Begoude

**James Mehl**
Phylogeography and ecology of selected species of Botryosphaeriaceae
**Advisors:** MJ Wingfield, B Slippers & J Roux

**Ritesh Mewalal**
Functional characterisation of secondary cell wall-related proteins of unknown functions (SCW-PUFs) implicated in development of *Eucalyptus* wood
**Advisor:** AA Myburg

**Alaine Misse**
Diversity of bio-ecology of *Ceratocystis* spp. and their arthropod vectors on Afromantane trees in Cameroon and South Africa
**Advisors**: J Roux, F Roets & MJ Wingfield

**Glen Mitchell**
Tolerance and susceptibility of *Pinus* species to *Fusarium circinatum*
**Advisors:** TA Coutinho, ET Steenkamp & MJ Wingfield
**Eshchar Mizrachi**
Transcriptome analysis of wood formation in a fast growing *Eucalyptus* grandis x *E. urophylla* hybrid plantation forest tree as a method of refining candidate genes for forest biotechnology
**Advisor:** AA Myburg
**Osmond Mlonyeni**
Genetics and evolution of virulence in the nematode *Deladenus siricidicola*
**Advisors:** B Slippers, BD Wingfield, J Greeff & MJ Wingfield
**Lorraine Moses**
Fumonisin regulating genes in *Fusarium verticillioides* and other fumonisin producing fungi
**Advisors:** BD Wingfield, MJ Wingfield & WFO Marasas
**XinTao Mou**
*Cylindrocladium* spp. on eucalypts in China
**Advisors:** XD Zhou, J Roux & MJ Wingfield
**Josephine Muchwezi**
Identification of resistance proteins against banana weevils
**Advisors:** K Kunert, A Viljoen & Chikwamba R
**Eston Mutitu**
*Thaumastocoris peregrinus* and its biological control agent *Cleruchoides noackae*
**Advisors:** B Slippers, J Garnas, B Hurley & MJ Wingfield
**Kershney Naidoo**
Molecular fungal diagnostics of *Ceratocystis albifundus*
**Advisors:** BD Wingfield & MJ Wingfield
**Elizabeth Ngadze**
Studies on *Ralstonia solanacearum* of potatoes in Zimbabwe
**Advisors:** J van der Waals & TA Coutinho
**Marie Onanema**
Impact of cartegena protocol on Cameroon
**Advisors:** KJ Kunert & R Chikwamba
**Alexander Osorio**
Diseases of mangroves and their associates in South Africa
**Advisors:** J Roux, MJ Wingfield & ZW de Beer
**Martin Ranik**
Molecular genetics of cellulose and hemi-cellulose biosynthesis in *Eucalyptus*
**Advisor:** AA Myburg
**Quentin Santana**
Molecular characterisation of vegetative compatibility in the pitch canker fungus, *Fusarium circinatum*
**Advisors:** MPA Coetzee, BD Wingfield, ET Steenkamp & MJ Wingfield
**Catherine Scott**
Characterisation and strain dynamics of Citrus tristeza virus within the grapefruit mild strain cross-protecting GFMS 12 population
**Advisor:** G Pietersen
**Divine Shyntum**
Pathogenecity and host specificity exhibited by *Pantoea ananatis*
**Advisors:** TA Coutinho, SN Venter & I Toth
**Rene Sutherland**
The effect of cold stress on resistance in Cavendish bananas to Fusarium wilt
**Advisors:** N van den Berg, A Viljoen, R Chikwamba, AA Myburg
**Steven Taerum**
*Ophiostoma* spp. associated with bark beetles in China
**Advisors:** Z XuDong, ZW de Beer & MJ Wingfield
**David Talengera**
Identification and regulation of cyclin genes in banana
**Advisor:** KJ Kunert
**Matsepo Taole**
Population biology and phylogenetic reassessment of the *Eucalyptus* pathogen, *Kirramyces epicoccoides*
**Advisors:** BD Wingfield, MJ Wingfield & T Burgess
**Albé van der Merwe**
Phylogeography and population biology of *Chrysoporthe austroafricana* and allied species
**Advisors:** BD Wingfield, ET Steenkamp & MJ Wingfield

**Marelize van Wyk**
The genus *Ceratocystis*
**Advisors:** MJ Wingfield & BD Wingfield
**Tania Weller**
Role of Type IV pili in *Pantoea ananatis*
**Advisors:** J Theron & TA Coutinho
**Markus Wilkin**
Characterisation of the *Ceratocystis fimbriata* genome
**Advisors:** BD Wingfield, MJ Wingfield & ET Steenkamp

## Current MSc/MSc (Agric) students

**Chrizelle Beukes**
Isolation, identification and characterisation of the root nodule bacteria associated with *Pterocarpus* and *Hypocalyptus* species
**Advisors:** ET Steenkamp, SN Venter & I Law
**Eric Birkholtz**
Microbial community associated with *Sirex noctilio* larvae
**Advisors:** SN Venter & B Slippers
**Francois Boshoff**
Phylogeography of *Bradyrhizobium* species associated with native and non-native *Acacia* species
**Advisors:** ET Steenkamp & SN Venter
**Jonathan Botha**
The characterisation of a promoter-protein interaction in the wood fibre cells of *Eucalyptus grandis*
**Advisor:** AA Myburg
**Jane Bredenkamp**
Root-specific defence responses in *Arabidopsis*
**Advisors:** DK Berger & S Naidoo
**Gabrielle Carstensen**
Identification of bacteria causing leaf nodules in *Pavetta* spp.
**Advisors:** TA Coutinho & SN Venter
**Annie Chan**
Assembly of the *Pantoea ananatis* genome and confirmation of metabolic pathways
**Advisors:** SN Venter & TA Coutinho
**Barry Christie**
Understanding root rot resistance in avocados
**Advisors:** N van den Berg, TAS Aveling & K Pegg
**Lise-Danielle de Wet**
Population dynamics of *Fusarium circinatum* in the pine nursery environment
**Advisors:** ET Steenkamp, BD Wingfield, MJ Wingfield & N Jones
**Herman de Bruin**
Characterizing the diversity of *Beauveria* species in South African forest insects
**Advisors:** B Slippers & ZW de Beer
**Siphathele Dube**
The role of quorum sensing in *Pantoea ananatis*
**Advisors:** TA Coutinho & J Theron
**Juanita Engelbrecht**
Isolation of defense genes from the superior 0.09 rootstock in response to *Phytophthora cinnamomi*
**Advisors:** N van den Berg & AA Myburg
**Bianco Farrow**
Elucidating the early response of *Persea americana* to hypoxia in association with *Phytophthora cinnamomi*
**Advisors:** N van den Berg, C Maritz-Oliver & N Taylor
**Katrin Fitza**
Molecular basis of induced resistance in *Pinus patula*
**Advisor:** S Naidoo
**Dina Gomez**
Ophiostomatoid fungi from bark beetles in China with special reference to species with *Leptographium* and *Pesotum* anamorphs
**Advisors:** XD Zhou, K Jacobs & MJ Wingfield
**Jean Hakizimana**
Understanding the role of oxygen stress and endophytes in avocado root

**Advisors:** N van den Berg, M Gryzenhout & TA Coutinho

**Tracy Hall**

Characterisation of the *Ceratocystis moniliformis* genome

**Advisors:** BD Wingfield, MJ Wingfield & M Wilkin

**Darryl Herron**

*Gibberella fujikuroi* complex associated pines

**Advisors:** ET Steenkamp, BD Wingfield, MJ Wingfield & WFO Marasas

**Monique Heystek**

Promoter studies in maize

**Advisors:** DK Berger & B Crampton

**Steven Hussey**

Analysis of cellulose biosynthesis-related transcription factor binding sites in *Arabidopsis* and *Eucalyptus*

**Advisors:** AA Myburg & DK Berger

**Zander Human**

Actinomycetes associated with bark beetles

**Advisors:** SN Venter, B Slippers, MJ Wingfield & ZW de Beer

**Carlo Jackson**

Viral induced gene silencing of selected genes in wheat using Barley SMV

**Advisor:** A-M Botha-Oberholster

**Barend Jansen van Vuuren**

Population dynamics of *Phytophthora cinnamomi* in South African avocado orchards

**Advisors:** N van den Berg & I Barnes

**Amelia Keyser**

Botryosphaeriaceae associated with Acacias in Africa with special reference to *Acacia millefera*

**Advisors:** GJ Marais, ET Steenkamp & C Erasmus

**Tsholofelo Kibido**

Protection of exogenous glutathione reductase against protease-mediated degradation

**Advisor:** KJ Kunert

**Lindsay Kriel**

Development of tissue culture, in vitro micropropagation and transformation techniques and the characterisation of thaumatin, a potential defence-related gene in *Persea americana* Mill.

**Advisor:** N van den Berg

**Tondani Kone**

Characterisation of the pheromone receptors of *Fusarium* spp.

**Advisors:** ET Steenkamp, BD Wingfield, NA van der Merwe & G Fourie

**Gugu Kubheka**

Colonization patterns of mCherry and GFP tagged *Pectobacterium carotovorum* subsp. *brasiliensis* strains

**Advisors:** L Moleleki & TA Coutinho

**Alinke Labuschagne**

Fungicide seed treatment of maize: crop tolerance and efficacy against soilborne diseases

**Advisor:** TAS Aveling

**Rynier Lourens**

The cloning and characterisation of the non-expressor of pathogenesis related 1 (NPR1) gene in two economically important crops, *Eucalyptus grandis* and *Persea americana*

**Advisors:** N van den Berg, S Naidoo & AA Myburg

**Godfrey Kgatle**

A new pathogen of sunflower?

**Advisor:** TAS Aveling

**Cornell Kortenhoven**

Molecular evolution of *Armillaria fuscipes*

**Advisors:** MPA Coetzee, J Roux & BD Wingfield

**Waheed Mahomed**

High throughput EST sequencing of defense related genes from avocado in response to *Phytophthora cinnamomi*

**Advisors:** N van den Berg & AA Myburg

**Eugene Makgopa**

Expression of NPR1 in plants

**Advisors:** KJ Kunert & R Chikwamba

**Olga Makhari**

Vegetative compatibility in the pitch canker fungus, *Fusarium circinatum*

**Advisors:** ET Steenkamp, TA Coutinho & MJ Wingfield

**Qaqamba Mapatwana**
A population study on the occurrence of *Fusarium verticillioides* and fumonisins in the maize milling process
**Advisors:** GJ Marais, ET Steenkamp & C Erasmus
**Angelica Marsberg**
Characterising the distribution and diversity of the endophytic fungi associated with *Syzygium cordatum*, a tree native to South Africa, using DNA barcoding and pyrosequencing
**Advisors:** M Gryzenhout, B Slippers & MJ Wingfield
**Johnny Masangwa**
The effect of plant extracts on anthracnose of *Phaseolus vulgaris* and *Vigna unguicilata*
Advisors: TAS Aveling & Q Kritzinger
**Abigail Mashamba**
Nodule-specific expression of cysteine proteinase inhibitors in soybean
**Advisors:** K Kunert & U Schlüter
**Lenny Mashavha**
Characterisation of the T6SS and its secretome in *Pectobacterium carotovorum* subsp. *brasiliensis*
**Advisors:** L Moleleki & TA Coutinho
**Thuto Matsioloko**
Using cDNA-AFLP and microarray analysis for rapid identification of *Diuraphis noxia* induced expressed genes
**Advisors**: A-M Oberholster & AA Myburg
**Lerato Maubane**
Identification of fungal endophytes of *Pinus radiata*, from non-native range South Africa, Western Cape
**Advisors:** M Gryzenhout, B Slippers & MJ Wingfield
**Silvia Mausse-Sitoe**
Diseases of eucalypts in Mozambique with special reference to the Cryphonectriaceae
**Advisors:** J Roux, S Chen & MJ Wingfield
**Phasha Mmatshepho**
Characterisation of introns in *Fusarium circinatum*
**Advisors:** ET Steenkamp, BD Wingfield & MPA Coetzee
**Valery Moloto**
Characterisation of *Agrobacterium* spp. in South Africa
**Advisors:** TA Coutinho & T Goszczynska
**Aobakwe Mongae**
The interaction between *Meloidogyne* spp. with pathogenic bacteria and their host plant, *Solanum tuberosum*
**Advisors:** L Moleleki & P Hammes
**Lunghile Mtombeni**
Description of the *Burkholderia* species that nodulate *Hypocalyptus* and related genera
**Advisors:** ET Steenkamp & SN Venter
**Karin Muller**
Mapping *Dn1* in a "Tugela DNA'" and "Tugela Fast Grow" mapping population
**Advisor:** A-M Oberholster
**Jan Nagel**
*Phytophthora* species in South Africa
**Advisors:** B Slippers, M Gryzenhout & MJ Wingfield
**Ronishree Naidoo**
Gene expression profiling of a *Eucalyptus* hybrid challenged with *Ralstonia solanacearum*
**Advisors:** S Naidoo, AA Myburg, DK Berger & TA Coutinho
**Linda Ndlove**
Botryosphaeriaceae occurring on Southern Hemisphere gymnosperms, with specific reference to *Podocarpus* spp. in South Africa
**Advisors:** B Slippers, MJ Wingfield & E Cruywagen
**Nokukhanya Nxumalo**
Epidemiology of *Fusarium* spp. causing wilt on potatoes in South Africa
**Advisors:** J van der Waals & TA Coutinho
**Caryn Oates**
Host responses to the gall wasp *Leptocybe invasa*
**Advisors:** S Naidoo, B Slippers & AA Myburg
**Edward Onkendi**
Molecular characterisation of *Meloidogyne* spp. infecting potato in South Africa
**Advisor:** L Moleleki

**Kerry-Anne Pillay**
Diversity of endophytic fungi of *Eucalyptus*
**Advisors:** B Slippers, M Gryzenhout & MJ Wingfield
**Priyen Pillay**
The influence of cystatins on the expression of FMD VP1 protein expression in different cellular compartments of tobacco
**Advisors:** K Kunert, R Chikwamba & U Schlüter
**Francina Philane**
Diversity of rhizobia associated with the root nodules of *Lebeckia* species
**Advisors:** ET Steenkamp & SN Venter
**Desre Pinnard**
Characterisation of cellulose binding module-containing proteins in the *Eucalyptus grandis* genome
**Advisor:** AA Myburg
**Rudi Pretorius**
Unravelling the *Pectobacterium carotovorum* subsp. *brasiliensis* quorum sensing regulon
**Advisors:** L Moleleki & J Theron
**Sitha Ramsuchit**
Pathogenicity of mating types of *Phytophthora cinnamomi* in *Eucalyptus* and Avocado
**Advisors:** N van den Berg & S Naidoo
**David Read**
Citrus tristeza virus populations in Grapefruit trees, pre-immunized with two different cross-protecting sources
**Advisor:** G Pietersen
**Anandi Reitmann**
Identification of pathogenicity-related genes in *Phytophthora cinnamomi*
**Advisors:** N van den Berg & DK Berger
**Nicole Rudolph**
Plant growth promoting rhizobacteria amended to manure and their effect on maize cultivation
**Advisors:** TAS Aveling & N Labuschagne
**Jamie-Lee Sauer Moss**
The subcellular localization of *Eucalyptus grandis* sucrose synthase (*SUSY*) proteins expressed in *Arabidopsis thaliana*
**Advisors:** AA Myburg & S Naidoo
**Irene Schoeman**
Virus-induced gene silencing in pearl millet
**Advisors:** DK Berger & I Hein
**Thia Schultz**
Transcript profiling of *Diuraphis noxia* elicited responses in Betta NILs
**Advisor:** A-M Botha-Oberholster
**Christina Selowa**
Elucidation of the role of pathogenesis related proteins in *Musa accuminata*
**Advisor:** N van den Berg
**Gina Shin**
Population genetics of *Pantoea ananatis*
**Advisors:** SN Venter & TA Coutinho
**Janine Silberbauer**
Whole transcrptome analysis of genes induced during tension wood formation in *Eucalyptus* trees
**Advisors:** AA Myburg, DK Berger & F Joubert
**Melissa Simpson**
Characterisation of microsatellites in *Ceratocystis fimbriata*
**Advisors:** BD Wingfield, MJ Wingfield & M Wilkin
**Ancel Stewart**
Enterobacteriaceae endophytes in healthy *Eucalyptus* leaves
**Advisors:** SN Venter & TA Coutinho
**Annie Thomas**
Impact of genetically modified plants on the South African flora
**Advisors:** K Kunert & AJ Buys
**Renaan Thompson**
Detection of *Fusarium* species on maize seed
**Advisor:** TAS Aveling
**Johan van der Linde**
Factors associated with decline of *Euphorbia ingens* in the Limpopo Province, South Africa
**Advisors:** J Roux, D Six & MJ Wingfield

**Ariska van der Nest**
Comparative study on *Phoma sorghina* associated with indigenous trees and commercially produced food crops
**Advisors:** GJ Marais & ET Steenkamp
**Ida van Jaarsveld**
De novo discovery of cis-regulatory motifs and modules which are implication in the transcriptional regulation of genes associated with secondary cell wall formation and cellulose biosynthesis in *Eucalyptus grandis*
**Advisor:** AA Myburg
**Sophia van Coller**
Study of mutation rates in *Fusarium circinatum*
**Advisors:** ET Steenkamp & BD Wingfield
**Stefan van Wyk**
Cystatin mutation for improved activity
**Advisor:** K Kunert
**Marcele Vermeulen**
Ecology and distribution of Cryphonectriaceae in southern Africa
**Advisors:** J Roux, M Gryzenhout & MJ Wingfield
**Erika Viljoen**
Morphology, genetic relationships and metabolite content in members of the *Solanum nigrum* L. complex used for jam production in the Highveld regions of South Africa
**Advisors:** DK Berger, A van Schalkwyk & AA van Wyk
**Ronel Viljoen**
Characterisation of "*Candidatus* Liberibacter africanus subsp. capense"
**Advisor:** G Pietersen
**Helen Walsh**
Establishment of LAMP and ICAN protocols for the detection of Grapevine Leafroll-associated virus 3.
**Advisor:** G Pietersen
**Febé Wilken**
Transcript profiling of the compatible interaction between *Eucalyptus* and *Phytophthora cinnamomi*
**Advisor:** S Naidoo, AA Myburg, DK Berger & N van den Berg
**Amy Wooding**
Reproduction and transmission in the *Sirex-Amylostereum* Symbiosis
**Advisors:** B Slippers, MJ Wingfield, J Garnas & J Greef
**Oliver Zablocki**
Development and application of Illumina sequencing protocols for Citrus Tristeza virus population studies
**Advisor:** G Pietersen

## 4th year and honours students

Jonathan Botha (2009)
Gabriella Carstensen (2009)
David de Veredicis (2009)
Bianco Farrow (2009)
Zander Human (2009)
Gugu Kubheka (2009)
Stewart McCulloch (2009)
David de Veredicis (2009)
Mmatshepo Phasha (2009)
Fati Thobejane (2009)
Tondane Kone (2009)
Ida van Jaarsveld (2009)
Magdeleen du Plessis (2010)
Tracey Hall (2010)
Barend Jansen van Vuuren (2010)
Desre Pinnard (2010)
Melissa Simpson (2010)
Gina Shin (2010)
Rynhard Smit (2010)
Phia van Coller (2011)
Stefan Bam (2011)
Pooja Singh (2011)
Brigitte Lombard (2011)
Andrew dos Santos (2011)
Cornell Kortenhoven (2011)
Rofhiwa Nesamari (2011)
Vanessa Cronje (2011)
Elrea Appelgryn (2011)
Jacolene Lubbe (2011)
Rachida Said (2011)
Janneke Grové (2011)
Odirile Tabane (2011)

## Student assistants

Hanno Barnard (2009)
Jenny Ceronio (2009)
Candice-Lee Eatwell (2009)
Monique Heystek (2009)
Mase Moleleki (2009)
Marinda Moller (2009)
Bongani Qekwana (2009-2011)
Theresa Scott (2009)
Michelle Silberbauer (2009)
Rynhard Smit (2009)
Thomas Schmidt (2009)
Phia van Coller (2009)
Lionel Moolman (2010)
Timmy Baloyi (2010)
Nelisiwe Khumalo (2009-2010)
Linda Ferreira (2010)
Beatrice Mangoanatala (2010)
Calvin Mophuting (2010)
Mischa Muller (2010)
Gerhard van Biljon (2010)
Anna-Mari Kok (2011)
Izaan van der Merwe (2011)
PG Erasmus (2011)
Tintswalo Maluleke (2011)

## CTHB Mentorship students

Riaan Theron (2009)
Barend Jansen van Vuuren (2009)
Aobakwe Mongae (2009)
Thembi Moloantoa (2009)
Vusi Letsoale (2009)
Letta Mbula (2009)
Nadja Roelofse (2009)
Gina Shin (2009)
Sphiwe Sibanyoni (2009)
Arista Fourie (2009)
Nigel Peacock (2009)
Elre Pretorius (2009)
Danielle Snyman (2009)
Jake van der Merwe (2009)
Norwesi Refilwe Babedi (2010)
Vanessa Cronje (2010)
Marike du Plessis (2010)
Elodie Ekoka-Etouman (2010)
Arista Fourie (2010)
Janneke Grové (2010)
Nelien Hartzer (2010)
Ioanna Milenova (2010)
Keamogetse Mohlala (2010)
Phenyo Kgaugelo Molamu (2010)
Tshilidzi Reginah Mudau (2010)
Tanzelle Oberholster (2010)
Elre Pretorius (2010)
Megan Calvert (2010)
Mia Kruger (2010)
Bafokeng Mpeta (2010)
Angelique du Preez (2011)
Mariette Ferreira (2011)
Tanweer Goolam Mahomed (2011)
Thalo Mohajane (2011)
Danielle Roodt (2011)
Wilke Wtrasheim (2011)
Annika Theron (2011)
Esline Theron (2011)
Shaun van der Walt (2011)
Brigitte van Dyke (2011)
Maria Kruger (2011)
Colan Balkwill (2011)
Ethan Besaars (2011)
Robwynne Clark (2011)
Thokozile Mhlambi (2011)
Samila Ramcharither (2011)
Michael Reich (2011)
Mohamed Seedat (2011)
Omphile Sehoole (2011)
Andrea Wilson (2011)

## Faculty Mentorship students

Deon de Jager (2011)
Faith Kavishe (2011)
Saranya Naidoo (2011)
Naadhira Omar Ismail (2011)
Amy Visser (2011)

## FTBP Mentorship students

Mohamed Siedat (2011)

## Graduates (January 2009 to April 2011)

## PhD

**Carrie Brady (2009)**
Taxonomic evaluation of the genus *Pantoea* based on a multigene approach
**Advisors:** SN Venter & TA Coutinho
**Irene Barnes (2009)**
Taxonomy, Phylogeny and population biology of the red band needle blight pathogen and related species
**Advisors:** BD Wingfield & MJ Wingfield
**Juanita de Wet (2009)**
Molecular studies on the taxonomy, host-association and viruses of the *Diploidia*-like anamorphs of the Botyosphaeriaceae
**Advisors:** MJ Wingfield, O Preisig & BD Wingfield
**Ronald Heath (2009)**
*Ceratocystis* species in the southern and eastern Africa with particular reference to *Ceratocystis albifundus*
**Advisors:** J Roux & MJ Wingfield
**Draginja Pavlic (2009)**
Taxonomy and population diversity of Botryosphaeriaceae associated with woody hosts in South Africa and Western Australia
**Advisors:** B Slippers, TA Coutinho & MJ Wingfield
**Seyed Ziaratnia**
Identification and characterization of a novel trizne and cinnamate 4-hydroxylase in *Helichysum aureonitens* Sch. Bip.
**Advisors:** M Meyer & K Kunert
**Didier Begoude (2010)**
Characterization of Botryosphaeriaceae and Cryphonectriaceae associated with *Terminalia* spp. in Africa.
**Advisors:** J Roux, MJ Wingfield & B Slippers
**Alvaro Duran (2010)**
Determination and Characterization of the causal agent of *Pinus radiata* needle blight in Chile
**Advisors:** MJ Wingfield, B Slippers & BD Wingfield
**Brett Hurley (2010)**
Factors influencing the control of the Sirex woodwasp in South Africa
**Advisors:** B Slippers & MJ Wingfield
**Lorenzo Lombard (2010)**
Phylogeny and taxonomy of *Calonectria* and its *Cylindrocladium* anamorphs
**Advisors:** MJ Wingfield & PW Crous
**Bongani Maseko (2010)**
Die-back of cold tolerant *Eucalyptus* associated with *Phytophthora* spp.
**Advisors:** TA Coutinho, MJ Wingfield, BD Wingfield & T Burgess
**Ryan Nadel (2010)**
Molecular and chemical ecology of the *Eucalyptus* pest, *Thaumastocoris peregrinus*
**Advisors:** B Slippers, M Scholtz & MJ Wingfield
**Wubetu Bihon (2011)**
Understanding the global population genetics of *Diplodia pinea* and its life cycle in plantation pines
**Advisors:** BD Wingfield, B Slippers, MJ Wingfield & T Burgess
**Shuaifei Chen (2011)**
Fungal diseases of eucalypts in China
**Advisors:** XD Zhou, MJ Wingfield, J Roux & Y Xie
**Maria-Noel Cortinas (2011)**
Taxonomy and population genetics of *Kirramyces* spp. causing stem cankers on *Eucalyptus* trees
**Advisors:** BD Wingfield & MJ Wingfield
**Pieter de Maayer (2011)**
Genome comparison to identify selected pathogenicity factors of a plant-associated *Pantoea ananatis* strain
**Advisors:** TA Coutinho, SN Venter & P Birch

**Adriaana Jacobs (2011)**
Taxonomy of species within the *Gibberella fujikuroi* complex
**Advisors:** TA Coutinho, BD Wingfield, MJ Wingfield & WFO Marasas
**Alejandro-Guillermo Perez-Suarez (2011)**
Global genetic diversity of the *Eucalyptus* leaf pathogen *Teratosphaeria nubilosa* species complex in native forests and commercial plantations
**Advisors:** MJ Wingfield, B Slippers & BD Wingfield
**Dirk Swanevelder (2011)**
Aphid-plant interactions and the possible role of an endosymbiont in aphid biotype development
**Advisors:** A-M Oberholster & E Venter
**Magriet van der Nest (2011)**
Mycelial compatibility in *Amylostereum areolatum*
**Advisors:** BD Wingfield, B Slippers, J Stenlid & MJ Wingfield

## MSc

**Philip Law *cum laude* (2009)**
Development and application of analysis modules in MADIBA, a web-based toolkit for the interpretation of microarray data
**Advisors:** DK Berger & F Joubert
**Joha Grobbelaar (2009)**
Taxonomy, phylogeny and species diversity in the *Ophiostoma quercus* complex
**Advisors:** BD Wingfield, P Bloomer & MJ Wingfield
**Mamodisa Maleme (2009)**
A characterization of latent Botryosphaeriaceae on diverse *Eucalyptus* species
**Advisors:** B Slippers, D Pavlic, BD Wingfield & MJ Wingfield
**Vuledzani Muthelo (2009)**
Molecular characterisation of *Ganoderma* species
**Advisors:** M Coetzee, BD Wingfield & MJ Wingfield
**Hanlie van der Merwe (2009)**
Black leg and soft rot of potato caused by *Pectobacterium carotovorum* subsp. *brasiliensis*
**Advisors:** J van der Waals, TA Coutinho & L Korsten
**Francois van der Walt (2009)**
Botryosphaeriaceae associated with *Acacia* species in southern Africa with special reference to *A. mellifera*
**Advisors:** G Marais, J Roux, B Slippers & MJ Wingfield
**Natalie van Zuydam (2009)**
Molecular characterisation of *Leptographium* species using a high density, oligonucleotide microarray chip
**Advisors:** BD Wingfield, K Jacobs & MJ Wingfield
**Markus Wilken (2009)**
Development and application of mating-type based markers in the genus *Ophiostoma*
**Advisors:** BD Wingfield, MJ Wingfield & ZW de Beer
**Donald Chungu (2010)**
Diseases of plantation forestry trees in Zambia
**Advisors:** J Roux, MJ Wingfield, Muimba A Konkolongo
**Nanette Coetzer *cum laude* (2010)**
SSH screen and SSHdb: software for microarray-based screening and sequence management of cDNA libraries
**Advisor:** DK Berger
**Marija Kvas *cum laude* (2010)**
Fusarium species associated with *Syzigium cordatum* malformation
**Advisors:** ET Steenkamp, BD Wingfield, MJ Wingfield & WFO Marasas
**Tinyiko Mokoena (2010)**
Reduction of proteinase inhibitors in soybean
**Advisors:** R Chikwamba & K Kunert
**Mmoledi Mphahlele (2010)**
Site-directed mutagenesis and functional analysis of *Eucalyptus* sucrose synthase 1 (EgSuSy1) in *Arabidopsis thaliana*
**Advisor:** AA Myburg
**Grant McNair (2010)**
Functional genetic analysis of micro RNA genes and targets in *Eucalyptus* trees
**Advisors:** AA Myburg & J Theron

**James Mehl (2010)**
Fungi associated with the die-back of *Pterocarpus angolensis* (kiaat) in South Africa
**Advisors:** MJ Wingfield, J Roux & C Geldenhuys
**Marja O'Neill (2010)**
Functional genetic testing of the *EgCesA1* gene in *Arabidopsis thaliana*
**Advisors:** AA Myburg & S Naidoo
**Therese de Castro (2011)**
Investigating the role of the candidate defense response gene peroxidase 34 in defense against *Ralstonia solanacearum*
**Advisors:** S Naidoo, AA Myburg & DK Berger
**Simon Martin *cum laude* (2011)**
Mating type and pheromone genes in the *Gibberella fujikuroi* species complex: an evolutionary perspective
**Advisors:** BD Wingfield, MJ Wingfield & ET Steenkamp
**Bernice Porter (2011)**
Pathogenicity and competition studies on *Fusarium circinatum*, a pathogen of pine trees
**Advisors:** TA Coutinho & MJ Wingfield
**Liesl van der Linden *cum laude* (2011)**
Genetic studies of bacterial wilt disease resistance in *Arabidopsis thaliana*
**Advisors:** DK Berger & S Naidoo
**Tania Weller (2011)**
Identification and characterisation of pili (fimbriae) mediating attachment of *Pantoea ananatis* to *Eucalyptus* leaf surfaces
**Advisors:** J Theron, TA Coutinho & I Toth

## Prestigious NRF bursary holders

Nicky Creux
Steven Hussey
Mmoledi Mphahlele
Kershney Naidoo
Rene Sutherland
Marelize van Wyk

## NRF scarce skills/innovation scholarships

Gerda Fourie (2009-2011)
Tsholofelo Kibido (2009-2010)
Abigail Mashamba (2009-2010)
Ronishree Naidoo (2009-2010)
Liesl van der Linden (2007-2009)
Febé Wilken (2009-2010)

## Mandela-Rhodes scholarships

Steven Hussey
Osmond Mlonyeni
Mmatshepho Phasha

## Other scholarships

Charline Kamburona (DAAD, TUCSAN Scholarship)
Eugenia Itumeleng Kgang (ARC and NRF Equity Scholarship)
Endale Gebre, Ethiopian Institute of Agricultural Research (EIAR)
Berhanu Fenta, International Center for Tropical Agriculture (CIAT)
Barry Christie, Hans Merensky Foundation
Juanita Engelbrecht, Hans Merensky Foundation
Christina Selowa, TIA PlantBio Trust

# MANAGEMENT

**Management committee**

Prof. MJ Wingfield (Chairman)
Prof. DK Berger
Prof. TA Coutinho
Prof. J Roux
Prof. K Kunert
Prof. G Pietersen
Assoc. Prof. TAS Aveling
Assoc. Prof. AA Myburg
Assoc. Prof. B Slippers
Assoc. Prof. ET Steenkamp
Dr. R Chikwamba
Dr. M Coetzee
Dr. J Garnas
Dr. B Hurley
Dr. L Moleleki
Dr. S Naidoo
Dr. N van den Berg
Kershney Naidoo (Postgraduate student representative 2009)
Markus Wilkin (Postgraduate student representative 2010)

**Advisory committee**

**Prof. A Ströh** (Chairman), Dean of the Faculty of Natural and Agricultural Sciences
**Prof. P Bloomer**, Head of the Department of Genetics
**Prof. SN Venter**, Head of the Department of Microbiology & Plant Pathology
**Prof. J Verschoor**, Head of the Department of Biochemistry
**Prof. M Meyer**, Head of the Department of Plant Science
**Prof. C Allandale**, Head of the Department of Plant Production
**Prof. S Nicolson**, Head of the Department of Zoology & Entomology
**Prof. M Wingfield**, Director of FABI

# Some social highlights in FABI

## Annual SPOOF* meeting

***Society for the Presentation of Outrageous Findings**

**Theme: Survivor (2009)**

**From top to bottom, left to right:**
**Ryan Nadel and Kerry-Anne Pillay; Lisa Upshur, Johan van der Linde and Darryl Heron; Mike and Brenda Wingfield; Guillermo Perez; Bernard Slippers and Draginja Pavlic**

**Theme: TV characters (2010)**


**Left to right, top to bottom**
**Katrin Fitza, Ronishree Naidoo and Nigel Mangwanda; Irene Barnes and Eunsung Oh; Sophia van Coller, Tracey Hall and Rynier de Bruin; Mike Wingfield and Ryan Nadel; Kai-Anne Clews, Terry Aveling and Alinke Labuschagne; and Rebeka Gluhbegovic and Marija Kvas**

# Year end function 2009

**From left to right, top to bottom**

**Wally and Rika Marasas; Osmond Mlonyeni, Siphokazi Mabandla, Qaqamba Mapatwana, Babalwa Mbebe Phasha Mmatshepho; Nicky Creux, Leo Langenhoven, Jeanne Korsman and Jonathan Botha; Herman du Bruin, Juanita Engelbrecht, Kerry-Anne Naidoo and Marcel Vermeulen; Lenny Mashavha, Ntando Buthelezi and Tondani Kone; Fahimeh Jami, Eusong Oh, Gudrun Drittrich-Schroder, Blanca Ahumada and Guillermo Perez**

# Year end function 2010

**From left to right, top to bottom**

**XuDong Zhou, Fahimeh Jami and Deer Konkarn; Deon Fourie, Alisa Postma, Eusong Oh, Irene Barnes, Kevin Barnes, Gudrun Dittrich-Shroder, Karl Dittrich-Shroder and Guillermo Perez, Linda Ndlove, Lerato Maubane and Christina Selowa; Jana Slippers, Mike Wingfield and Bernard Slippers; Gina Shin, Izette Greyling and Gabrielle Carstensen; Cornel van Kortenhoeven, Barend Jansen van Vuuren and Marc Bouwer**

# COMMUNITY SERVICE ACTIVITIES

## 2009/2010 MYRE (Mpepu Rural Youth Encouragement Outrearch Programme)

The Centre of Excellence in Tree Health Biotechnology (CTHB) has engaged with a variety of student and science outreach groups. In particular, they have supported the MRYE Outreach Programme since 2005. In 2009, MRYE undertook three outreach visits. The first (17-26 January) was to schools in the Free State and KwaZulu-Natal. For their second outreach activity, MRYE and representatives of Denver College were invited to visit Bethanie Youth Club in North-West Province on 2 May for a Careers Expo organised by Malebo Ditlopo. The third visit for 2009 was organised to Limpopo and Mpumalanga (27 June to 6 July). In 2010, MRYE undertook two long trips – the first to Mpumalanga between 4 and 11 April. Eleven schools were visited over the 5 days by 9 members of the MRYE team. Their second long trip took place to North-West Province between 13 and 18 July, where 14 schools were visited by 7 members of the MRYE team. Their third visit was a short one to Kwazulu Natal where they combined the trip with the celebration of Samukelo Vilakazi's (the founder of MRYE) graduation as an electronics engineer from UP. On this trip, the group visited 3 schools.

**MYRE group with pupils from the Ekuthuthukeni High School, KZN**

**Member of the MYRE group assisting learners**

## 2009 The Ark Nursery School

On the 1st December 2009 the FTBP initiated a community project, with the help from sponsors outside the University. A Christmas party was organised for children from The Ark nursery school, which supports children from less privileged, emotionally neglected and financially poor South Africans. The School was established for children who are in need and are looked after in many ways, by teaching and educating them, and fulfilling crucial needs in their lives.

**Left to right, top to bottom**
**FABI community project at The Ark nursery school, 2009:**
**Children anticipating a jump on the castle that was being set up; A little girl receiving a present from Father Christmas; Ariska van der Nest and Barry Christie during an unplanned swim with the children; and group photo of everyone who participated in the event.**

## Blanket Drive 2010 for the Salvation Army

FTBP initiated a blanket project in order to donate blankets to people who do not have homes or something cosy to keep them warm in winter. This event was supervised by Dr Noëlani van den Berg. New Blankets from FABI were donated to this project. We ended up donating over 130 blankets to the Salvation Army.


**Dr Noelani van den Berg (back left) with some of the students who were involved in the project (from left to right Osmond Mlonyeni, Juanita Engelbrecht, Jan Nagel and Tracy Hall; The handing over of blankets to The Salvation Army.**

## Community Project 2010 Mamelodi nursery school

FABI tends to do things better and bigger each year, and the community project in December 2010 was no exception. FABIans from a variety of research groups participated in giving 150 children from a nursery school in Mamelodi a marvellous Christmas party. There were jumping castles, lots to eat, presents, and most importantly - lots of love.

**FABIans interacting with children at a nursery school in Mamelodi, December 2010**

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**Many of these commercial companies or organisations fund more than one programme in FABI**

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