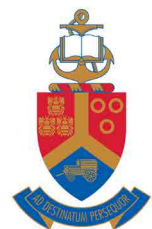


FABI

FORESTRY AND
AGRICULTURAL
BIOTECHNOLOGY
INSTITUTE

BIENNIAL REPORT

MAY 2017–MAY 2019



UNIVERSITEIT VAN PRETORIA
UNIVERSITY OF PRETORIA
YUNIBESITHI YA PRETORIA

The Forestry and Agricultural Biotechnology Institute (FABI) is based at 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 longer 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 business.
- Promote education, particularly of South Africans, in the fields of forestry and agriculture.

The association of FABI with the University of Pretoria, the largest residential University 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, Genetics, Microbiology, Chemistry, Plant and Soil Science, and Zoology and Entomology 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.

FABI, in every way, 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 eleven FABI Biennial Report covering the period from May 2017 to May 2019.

Director: Prof. Bernard Slippers
Forestry and Agricultural Biotechnology Institute (FABI)

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M Booij-Liewes






Forestry and Agricultural
Biotechnology Institute
BIENNIAL REPORT

May 2017–May 2019





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



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DIRECTOR'S FOREWORD

The period covered by this report has been one of transition and reflection. Professor Mike Wingfield stepped down as the founding Director of the Institute at the end of 2017. His contribution in the establishment and success of the Institute, and its impact nationally and internationally, cannot be overstated. It has thus been a time to appreciate, celebrate and thank this giant of South African science for his contribution to FABI and for what it means to students, staff, the University of Pretoria and various other stakeholders in South Africa and around the world.

FABI started its operations in 1998. 2018 thus marked the 20th year of its existence. Over this period (by the end of 2017) the institute produced 1250 research articles, eight books, 105 book chapters and thousands of contributions to national and international conferences. Importantly, we also completed 260 MSc and 160 PhD degrees. This number has continued to grow, as will be evident in this report. While the productivity alone is impressive, what is of critical importance is that the standard of these outputs and training competes with the best in the world. FABI has also established itself as a key partner to Government and Industry players in forestry and agriculture in South Africa and other parts of the world, making a substantive impact on their functioning and productivity.

We celebrated the 20th anniversary of the start of FABI with an international conference that included more than 300 FABI alumni, academics, Government and forestry Industry representatives, as well as many current FABI researchers, staff and students,

who attended the two-day celebration, themed “The Road to Research Excellence”. Over the two days we reflected on elements such as the deeply ingrained team-based approach and spirit; the power of interdisciplinarity, bringing together a broad range of skills around common problems; the importance of developing a critical mass of local capacity, as well as quality, global research networks; the world-class facilities and systems and the focus on excellence in everything we do; and the close collaboration with Industry and Government. Importantly, we celebrated the FABI experimental spirit that has characterized the past 20 years – that is the social experimental spirit – constantly exploring new ways to pursue research, training and solutions of an even higher quality.

Over the 20 years of its existence FABI contributed to various developments and new initiatives in the University, from postgraduate training and structures to physical developments. Most recently, it has also provided a base for the development of a





Over the 20 years of its existence FABI has contributed to many developments and new initiatives in the University. This included postgraduate training as well as physical developments. Most recently, FABI has also provided a base for the development of a major new transdisciplinary research institute at the University of Pretoria, namely Future Africa



major new transdisciplinary research institute at the University of Pretoria, namely Future Africa (www.futureafrica.science). The Future Africa Institute is located on the Hatfield Experimental Farm, where the TPCP and FABI also have important research facilities, including a nursery, greenhouses and tunnels, and the Biocontrol Research Centre. As the University looks to further develop the Hatfield Experimental Farm around Future Africa, FABI and its partners in the forestry and agricultural sectors will play an important role.

It is an immense privilege as Director to work with this very special FABI team. This team, which includes local Government, Industry and other research partners, as well as its global research networks, is the most valuable part of the institute. As a team we look forward to an exciting next phase in the development of FABI, building on the strong foundation of excellence, team work, and interdisciplinary research that have real impact in our society.

The University of Pretoria's new Future Africa campus will be the place where Africa's leading scientists and scholars from across the world and from a broad range of disciplines will come together to leverage the benefits of transdisciplinary research to address the grand challenges that face Africa and the world.

Issues of critical relevance to Africa will be tackled: from sustainable development and good governance, citizen participation and human rights, to advancing innovation for the bioresource economy.

In a world where ideas and technologies evolve rapidly and the challenges we face are multifaceted and transnational, Africa needs a new generation of original thinkers with international perspectives, yet with a scholarly vision and voice that is rooted in Africa.

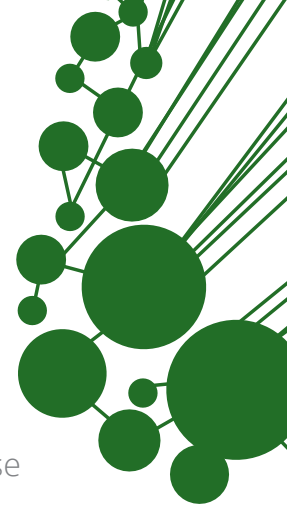
Prof. Bernard Slippers

Ph.D. (Pretoria), ASSAf, GYA, SAYAS
Director of FABI and the Tree Protection
Co-operative Programme (TPCP)



FABI IN A NUTSHELL

The Forestry and Agricultural Biotechnology Institute (FABI) at the University of Pretoria is a postgraduate research institute that was established in 1997, based on a recognition that the future of forestry and agriculture in South Africa will strongly depend on the incorporation of new and emerging technologies into these industries. Major opportunities for these industries have emerged in recent times, from the applications of biotechnology and bioinformatics, amongst many others.



RESEARCH OUTPUTS (May 2017–May 2019)

260 Papers published

127 International conferences

62 POSTERS

44 TALKS

126 National conferences

45 POSTERS

70 TALKS



WORLDWIDE COLLABORATION



Map depicting research collaboration based on joint journal publications. Yellow lines indicate papers where a FABIan is the first author. White lines indicate papers on which we have collaborated but where another institution has the lead author. Line thickness represents the number of papers





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RESEARCH GROUPS

FABI promotes research to support various industries linked to forestry and agriculture

- AVOCADO RESEARCH PROGRAMME (ARP)
- BACTERIAL GENOMICS AND TREE HEALTH
- CEREAL FOLIAR PATHOGEN RESEARCH
- CERC-FABI TREE PROTECTION PROGRAMME (CFTPP - CHINA)
- DST-NRF CENTRE OF EXCELLENCE IN TREE HEALTH BIOTECHNOLOGY (CTHB)
- DST-NRF SARCHI CHAIR IN FUNGAL GENOMICS
- EUCALYPTUS AND PINE PATHOGEN INTERACTIONS
- FOREST MOLECULAR GENETICS (FMG) PROGRAMME: GENOMICS AND BIOTECHNOLOGY FOR SUPERIOR WOOD AND FIBRE
- MACADAMIA PROTECTION PROGRAMME
- MOLECULAR PLANT-PATHOGEN INTERACTIONS (MPPI)
- MOLECULAR PLANT PHYSIOLOGY RESEARCH GROUP
- PHYTOBACTERIOLOGY PROGRAMME
- PLANT VIROLOGY
- POTATO SOFT ROT RESEARCH PROGRAMME
- PSHB RESEARCH NETWORK
- RGE-FABI TREE HEALTH PROGRAM (INDONESIA)
- SEED SCIENCE AND PATHOLOGY OF FLOWERS, TREES AND AGRONOMIC CROPS
- TREE PROTECTION CO-OPERATIVE PROGRAMME (TPCP)



STAFF AND RESEARCHERS 2017–2019

HONOURS STUDENTS SUPERVISED	MSc STUDENTS SUPERVISED	PhD STUDENTS SUPERVISED	FULL-TIME ACADEMIC STAFF	EXTRA-ORDINARY PROFESSORS	POST-DOCTORAL/ RESEARCH FELLOWS	ADMIN / TECHNICAL AND SUPPORT STAFF	PhD STUDENTS GRADUATED	MSc STUDENTS GRADUATED
89	87	64	24	14	46	48	25	24

FABI

FABI scientists undertake goal-directed research, in partnership with major players in the forestry and agricultural sectors in South Africa and in so doing promote both human capital and industrial development in the country.

Being based at the University of Pretoria provides FABI with the capacity to build future human resources in biotechnology, that are crucial to the future of forestry and agriculture in South Africa. It also enables collaboration and linkage with the majority of statutory bodies undertaking research in the plant and animal sciences.

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CLARIVATE ANALYTIC GLOBAL HIGHLY CITED RESEARCHERS



Prof. Mike Wingfield
Prof. Bernard Slippers
Prof. Pedro Crous

23

NRF-RATINGS

- 3 A-RATING
- 7 B-RATINGS
- 5 C-RATINGS
- 7 Y-RATINGS
- 2 P-RATING



FABI TEAM





RESEARCH REPORTS

MAY 2017–MAY 2019

RESEARCH REPORTS

Avocado Research Programme

Research Leader: Prof. Noëläni van den Berg

Team Members: Dr Ashok Prabhu
Dr Velushka Swart
Dr Zelda van Rooyen (Westfalia Technological Services)

Background

The Avocado Research Programme (ARP) was initiated at the University of Pretoria in 2008 under the auspices of the Hans Merensky Foundation and celebrated 10 years of research excellence in 2018. This industrial-academic research partnership has become an integral part of the R&D Strategy of Merensky Holdings and has benefitted both the University and the Industry. Through this partnership the university receives funds for world-class research and postgraduate student training while the industry has access to new research trends and novel experimental techniques that facilitate enhancements of the avocado selection programme.

Objectives of the Research Programme:

Avocado is an important agricultural crop that is continually gaining more popularity throughout South Africa and the world. However, production is hampered by both abiotic (salt and drought stress) and biotic stresses. Rootstock diseases caused by *Phytophthora cinnamomi* and *Rosellinia necatrix* are probably the most serious threat to production in countries where the pathogens are present. Both *Phytophthora* root rot and white root rot (caused by *R. necatrix*) are present in avocado growing regions in South Africa. Even though partially-resistant rootstocks are available for *P.cinnamomi* there are no commercially-available rootstocks with resistance to *R. necatrix*. In order to select suitable rootstocks, it is important to understand the mechanisms involved in host defence and pathogenicity strategies.

Our research objectives are:

- To investigate mechanisms of avocado defence against *P. cinnamomi*, the causal agent of *Phytophthora* root rot.
- To identify pathogenicity/virulence genes in the pathogen *P. cinnamomi*.
- To sequence the genome of Avocado, *P. cinnamomi* and *R. necatrix*.
- To use genome and transcriptome data of avocado and *P. cinnamomi*, respectively to gain further support for our current understanding of host defence and pathogen invasion strategies.
- To monitor *R. necatrix* and identify new and emerging diseases of avocado in South Africa such as the Polyphagous Shot Hole Borer and its fungal symbiont *Fusarium euwallaceae*.

Highlights of the Research:

Avocado Defence Responses

- An Agilent microarray was developed and used to profile the defence response of both a partially resistant and susceptible avocado rootstock to *P. cinnamomi*. Data obtained supported our hypothesis that a successful defence response was due to the early induction of key defence related genes in the salicylic acid (SA) and jasmonate (JA) pathways. Avocado responded through the expression of genes in the SA pathway during the first 12- 18 hours followed by a down regulation of these genes, but a significant upregulation of JA associated genes during later time points. Results from this study were published in PlosOne (van den Berg et al. 2018).
- Dr. Clara Pliego Pietro (Ifapa, Malaga, Spain), a collaborator of the programme, used the microarray to investigate the defence response of two rootstocks infected with *R. necatrix*. Results from this research indicated that the defence response was significantly different from the response to *P. cinnamomi*, supporting the phenotypic observation that *P. cinnamomi* -resistant rootstocks succumb to white root rot.



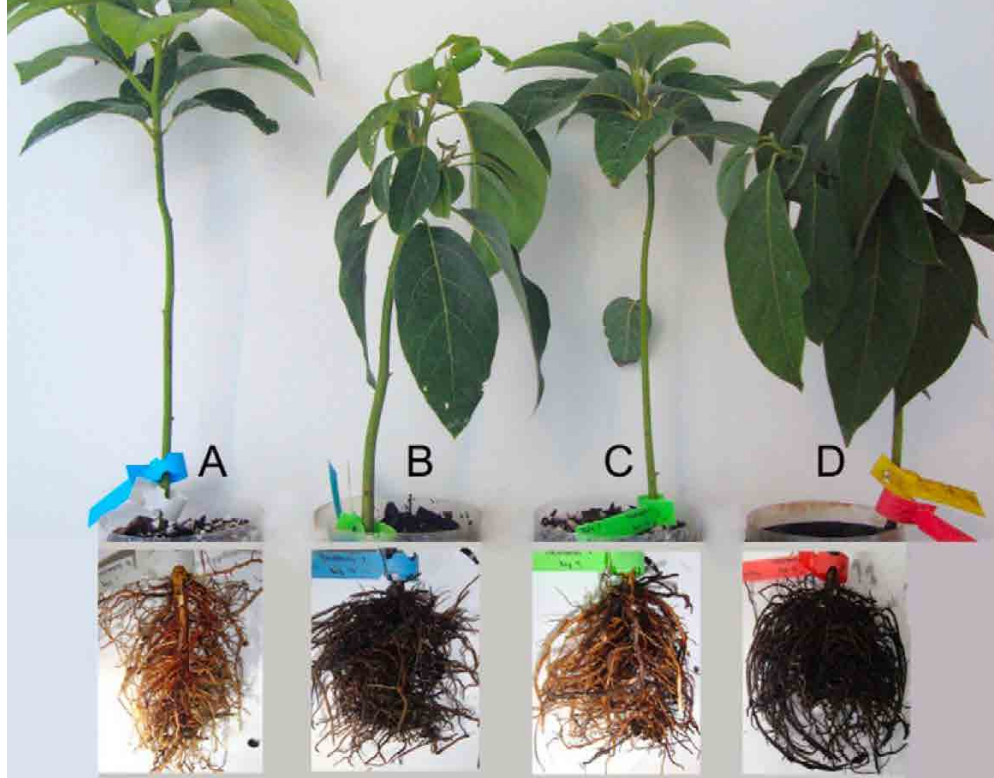
ARP planting Avocados for research trials

Avocado genome resources

- As a founding member of the Avocado Genome Consortium we have been involved in the sequencing of the avocado genome. The rootstock, VC75, was selected for sequencing as it has low levels of heterozygosity (low levels of heterozygosity simplifies the assembly of sequence reads obtained from DNA sequencing platforms into genome sequences). Sequencing and assembly of the genome have been completed and the annotation (identification of genes and assigning function to them) will be undertaken by a community of researchers and students globally.
- Genome re-sequencing of the *P. cinnamomi* resistant rootstock (R0.06) will be prioritised in 2019 and will generate important data that can be utilised by industry and future research.
- In addition to whole genomes sequence data, we have 92 avocado rootstocks that are genotyped based on single nucleotide polymorphisms (SNPs) profiles using the Fluidigm platform through our collaboration with Dr David Kuhn at the USDA.
- We have sequenced, assembled and annotated the transcriptomes of avocado infected with *P. cinnamomi* using a dual-RNA sequencing approach. This has allowed us to identify both host and pathogen genes involved in the interaction.

The production of avocado is hampered by both abiotic and biotic stresses. Diseases caused by *Phytophthora cinnamomi* and *Rosellinia necatrix* are probably the most serious in countries where the pathogens are present





White root rot symptoms (B and D) on Avocado plants, caused by *Rosellinia necatrix*

Phytophthora cinnamomi pathogenicity genes

- Several genes are associated with pathogenicity. To date we have identified a number of *RxLR* genes, Crinkler (CRN) effector genes and genes encoding for polygalacturonases (PGs), all that are involved in pathogenicity.
- RNA was obtained from avocado infected with *P. cinnamomi* and sequenced. Results from this experiment revealed the induction of a number of *RxLR* proteins, CRN effectors and PGs during the early infection of the host, further supporting their involvement in pathogenicity.



ARP collecting Avocado root samples

Rosellinia necatrix on avocado

- We play a vital role in monitoring and mapping of *R. necatrix* on avocado for the avocado industry. Through this service, the disease has now been detected in two major avocado production areas where it was previously not seen in South Africa.
- A number of avocado rootstocks have been screened for resistance against *R. necatrix* but none so far have shown significant resistance.
- To facilitate the timeous identification of the pathogen we are optimizing a high throughput PCR technique that can be used for screening plant material and soil and developing a semi-selective media to facilitate pathogen isolation and identification.

Euwallacea fornicatus and its symbiont *Fusarium euwallaceae* on avocado

- We identified the presence of the Polyphagous Shot Hole Borer and its pathogenic symbiont *F. euwallaceae* on an avocado tree in a garden in Sandton, South Africa.
- Subsequently we have been involved in monitoring commercial avocado orchards throughout the country. To date we have only identified a number of *Fusarium spp.* and other ambrosia beetles including *Xyloborus crassiusculus* and *X. ferrugineus*.



Bacterial Genomics and Tree Health

Research Leader: Prof. Fanus Venter

Research Team: Prof. Martin Coetzee
Prof. Teresa Coutinho
Prof. Emma Steenkamp

Background

Genome sequencing and comparisons are currently one of the leading drivers in biological research. The genome sequence of an organism not only serves as the blueprint of all the genes present but also provides the opportunity to expand our knowledge and understanding of the organism's biology. Genomics therefore forms an integral part of several projects in FABI.



Making sense of phylogenetic trees

Objectives of the Research Programme:

- To use phylogenomics to reconstruct the evolution of plant associated genera such as *Pantoea* and *Burkholderia sensu lato* in order to understand how members of these genera have evolved.
- To use the genomes of strains representing the different species of *Pantoea* and *Paraburkholderia* to validate genomic approaches for the delineation of bacterial species.
- To use comparative genomics to study the evolution of nitrogen fixation in *Paraburkholderia* species that are nodulating trees and other plant hosts endemic to the Cape Floristic Region.

Highlights of the Research:

- The large bacterial group, *Burkholderia sensu lato*, currently comprises more than a hundred species that employ a variety of lifestyles. Members of this group range from plant pathogens, plant-growth promoting bacteria as well as clinically-important species. The taxonomy of this group has been under intense scrutiny, due to the biotechnological potential of various beneficial strains and isolates. Our previous work supported the division of the group into three genera as was proposed by other groups. Recently, based on our use of phylogeneomics, we found good support for the recognition of two additional genera, namely *Mycetohabitans* (referring to the ability of species in this genus to inhabit the fungus *Rhizopus microsporus*) and *Trinickia* (named after M.J. Trinick, who first isolated beta-rhizobia from *Mimosa*).
- For the characterization and description of bacterial taxa, unique phenotypic or physiological traits in conjunction with phylogenetic support, are required to

differentiate closely-related bacteria. However, the use of biochemical tests has been increasingly shown to provide unreliable results that are often not reproducible. In addition, databases for biochemical characters are often incomplete as a limited number of tests are often performed. With the advances in genome sequencing, approaches for functional genomics have become increasingly popular. This allows for the prediction of metabolic pathways from genome sequences where all necessary genetic information for functioning systems are present. These approaches thus provide the opportunity to infer the metabolic capacity of organisms and provide the basis for many comparative genomics studies. Using this approach, we found that *Pantoea* could utilize a wider variety of energy sources in the form of carbohydrates, fatty acids and nucleotides and were able to recycle nutrients more efficiently than the sister genus *Tatumella*. This may contribute to increased fitness under nutrient limiting conditions and play a role in the opportunistic nature of members of *Pantoea*.

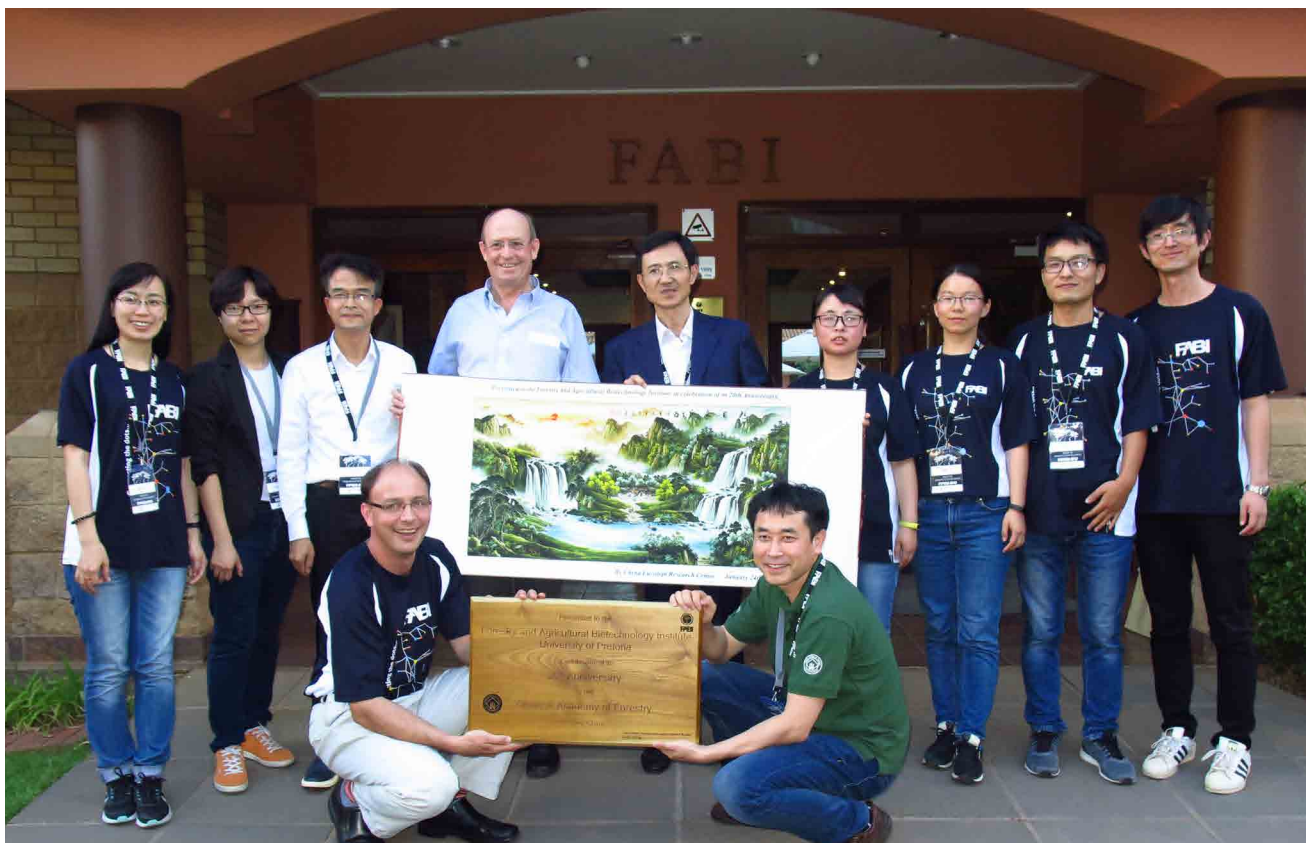


CERC-FABI Tree Protection Programme (CFTPP)

Research Leader: Dr ShuaiFei Chen (CERC, China & FABI)

Research Team: Prof. Wilhelm de Beer
Prof. Jolanda Roux
Prof. Bernard Slippers
Prof. Mike Wingfield
Prof. Yaojian Xie (CERC, China)

Dr Roger Arnold (CERC, China)
Dr Irene Barnes
Dr Tuan Duong
Mr GuoQing Li (CERC, China)
Ms QianLi Liu (CERC, China)



A senior delegation from the Chinese Academy of Forestry comprising Prof. Yaojian Xie, Director: China Eucalypt Research Centre, Mr YanQuan Li, Vice President, Chinese Academy of Forestry and Ms Yujie Chen, Deputy Director of International Co-operation and Exchange Division, presented FABI with a commemorative plaque and gift to celebrate the Institute's 20th anniversary and celebrate the close ties with the Academy

Background

The CERC-FABI Tree Protection Programme (CFTPP), is a co-operative venture programme established between the China Eucalypt Research Centre (CERC) of the Chinese Academy of Forestry in China, and the Forestry and Agricultural Biotechnology Institute (FABI), at the University of Pretoria in South Africa. This Programme arose from a long-term collaboration between the two institutions that was initiated in 2006 and formally established in 2014. The relationship initially arose from joint funding to the two groups respectively by the Governments of the People's Republic of China and the Republic of South Africa as part of bi-lateral funding managed by the Department of Science and Technology (South Africa) and Ministry of Science and Technology in China. This funding has been sustained at various levels and it has resulted in many important outputs in fundamental research, solutions to eucalypt disease problems and education of postgraduate students (Human Capacity Development).



Dr ShuaiFei Chen conducting student training while doing disease surveys in Chinese *Eucalyptus* plantations

Objectives of the Research Programme:

- To study the distribution, genetic diversity and biology of pathogens and pests threatening plantation forestry in southern China.
- To understand the interactions between pathogens/insects and their hosts.
- To provide support towards breeding and selection of pest-tolerant planting stock.
- To provide education for tree health specialists and facilitate research collaboration between researchers at CERC and FABI.

The CERC-FABI Tree Protection Programme is a co-operative venture programme established between the China Eucalypt Research Centre of the Chinese Academy of Forestry in China, and FABI. This Programme arose from a long-term collaboration between the two institutions, which was formally established in 2014

Highlights of the Research:

- The primary focus of CFTPP is to understand the distribution, genetic diversity, biology and pathogenicity of the important pathogens of eucalypt trees. Therefore, several studies are being conducted that consider important eucalypt plantation diseases, including leaf blight and seedling rot caused by species of *Calonectria*, stem canker disease caused by species in the families Botryosphaeriaceae and Cryphonectriaceae, and wilt caused by species of *Ceratocystis*.
- The CFTPP continues to screen eucalypt hybrids for tolerance to important diseases. The genotypes of *Eucalyptus urophylla* x *E. grandis* were used to determine their tolerances to pathogens in the Botryosphaeriaceae and Cryphonectriaceae at CERC. Tolerant genotypes were identified and will be tested in different regions for using in industries.
- The *Eucalyptus* plantations in China are increasingly threatened by insect pests. Important insect pests causing significant damage to the trees include the defoliator *Buzura suppressaria*, the wood borer *Endoclyta signifer* and the Eucalyptus gall wasp *Leptocybe invasa*. The CFTPP has conducted extensive surveys to assess the geographic distribution and levels of damage of these insect pests. This knowledge is now contributing to the development of management strategies for these insect pests.

DST-NRF Centre of Excellence in Tree Health Biotechnology (CTHB)

Director: Prof. Mike Wingfield (2004-2017), Prof. Emma Steenkamp (2018-)

Programme Manager: Prof. Martin Coetzee (since end 2017)

Project Leaders:

Prof. Nigel Barker (UP)

Prof. Teresa Coutinho (UP)

Prof. Pedro Crous (UP & Westerdijk Fungal Diversity Institute, the Netherlands)

Prof. Jo Dames (RU)

Prof. Wilhelm de Beer (UP)

Prof. Deanne Drake (Wits)

Prof. Leanne Dreyer (US)

Prof. Eastonce Gwata (UV)

Prof. Brett Hurley (UP)

Prof. Ednah Kunjeku (UV)

Prof. Gerhard Pietersen (UP & ARC)

Prof. Francois Roets (US)

Prof. Jolanda Roux (UP & Sappi)

Prof. Bernard Slippers (UP)

Prof. Alex Valentine (US)

Prof. Fanus Venter (UP)

Prof. Brenda Wingfield (UP)

Prof. Edward Witkowski (Wits)

Dr Irene Barnes (UP)

Dr Marieka Gryzenhout (UFS)

Dr Albé van der Merwe (UP)

Background

The primary goal of the CTHB is to promote the health of South Africa's woody resource through the application of biotechnology tools. To achieve this goal, the CTHB team typically studies the pathogens and pests that are associated with trees and other woody plants. Members of the Centre also explore the possible effects that factors such as climate change, fire, genetic diversity and human activity may have on the health of native woody resources and ecosystems. The CTHB is hosted by the Forestry and Agricultural Biotechnology Institute (FABI) at the University of Pretoria. It is structured as a virtual Centre of Excellence that conducts research via a collaborative network of scientists, with the central node of the network represented by researchers at UP. In addition to the UP group, the network includes researchers and their postgraduate students at many other institutions in South Africa. Since 2011, these included the Agricultural Research Council (ARC), Rhodes University (RU), and the Universities of Stellenbosch (US), the Witwatersrand (Wits), the Free State (UFS) and Venda (UV).



Prof. Ednah Kunjeku and students from the University of Venda on a field visit to the Mapungubwe National Park





Objectives of the Research Programme:

- Understanding the biology, ecology, genetics, population biology and systematics of insects and microbes associated with native woody plants.
- Broaden our knowledge regarding the biology and ecology of specific tree species, as well as the effect that human practices might have on these species, the ecosystems in which they occur and the conservation of natural habitats.
- Studying the possible impacts of soil properties and nutrients, microbial symbioses and climatic factors on the health of woody plants in diverse landscapes.
- Assessing the effects of drought, frost, fire and human activity on the sustainable use of indigenous woody resources.



Field visit to the Kruger National Park with Prof. Bernard Slippers, Prof. Ednah Kunjeku and PhD candidate Elelwani Ramabulana

Highlights of the Research:

- Most of the work focusing on insects and microbes associated with woody plants is conducted at the University of Pretoria. Most projects studying the effects of environmental and anthropogenic factors on the health of native woody hosts and natural habitats are conducted at the other institutions. The CTHB annually produces a large number of research papers of which more than 60, over the reporting period, dealt specifically with health issues of indigenous trees.
- As a successful Centre of Excellence, the CTHB is involved in various activities that either informs its research or that emanate from the previous research of the Centre. For example, the CTHB routinely conducts surveys and field experiments in various parts of South Africa and elsewhere on the continent. Together with its partner programme, the Tree Protection Co-operative Programme (TPCP), the CTHB also maintains a world-class disease and insect pest diagnostic clinic. To facilitate and enhance the research and extension activities of the CTHB, the Centre has developed and implemented a number of ancillary processes. These include various databases and collections to manage and store information, data and biological material used in projects.
- The CTHB is also actively involved in outreach initiatives aimed at promoting a robust and skilled South African human resource base. For this purpose, a formal mentorship programme is used to specifically target undergraduate students. The CTHB is also involved in a number of initiatives aimed at improving the public's understanding of science and providing high school learners with information about post-secondary education opportunities in the natural sciences.



DST-NRF SARChI Chair in Fungal Genomics

Research Chair: Prof. Brenda Wingfield

Collaborators: Prof. Martin Coetzee
Prof. Wilhelm de Beer
Prof. Bernard Slippers
Prof. Emma Steenkamp
Prof. Mike Wingfield
Dr Irene Barnes
Dr Tuan Duong
Dr Almuth Hammerbacher
Dr Kershney Naidoo (until 2018)
Dr Markus Wilken

Background

The DST-NRF SARChI Chair in Fungal Genomics was awarded in 2016. The focus of the Research Chair is on the application of genome technologies to understand, and exploit for national benefit, the genomic resources available in the genomes of economically important fungi. "Genomics" essentially represents a new approach to the study of biological systems. It incorporates a wide range of technologies, which together provide the key to innovation and to new routes to address old problems. The core of this field lies in the acquisition and manipulation of genomic sequence data. Equally important, "post-genomics" fields such as transcriptomics, proteomics, metabolomics and population genomics have the capacity to unlock the answers to questions underpinning the biological functions encoded in genomes. Together with genomics, these will form a strong basis for innovative research and biotechnological applications in agriculture and the health sciences. The Chair in Fungal Genomics aims to boost research in Genomics in general but with a specific focus on tree-infecting fungi. While bringing answers to important economic problems, a key output lies in human capacity development in a growing and crucially important component of the biological sciences.

Objectives of the Research Programme:

The field of molecular genetics of fungi is expanding rapidly now that we have access to hundreds of fungal genomes on which to base our research questions. This field is now firmly established in the genomics domain and many questions which would have been impossible to address are now largely within our grasp.

- In terms of phylogenetics we are no longer limited to single gene trees and we are able to follow the evolutionary histories of organisms. We now have sufficient whole genome sequences of fungal tree pathogens available to conduct phylogenomic studies. This will enable us to study the evolution of these organisms at the genome level.
- We have been able to identify Qualitative Trait Loci (QTLs) linked to growth in *Fusarium circinatum*, and plan to identify QTLs linked to pathogenicity in this pathogen. Very little characterisation of genes relating to pathogenicity has yet been achieved. Unravelling the basis of pathogenesis is likely to take us a long way towards understanding how fungi are able to move from one host to another, and in the process, evolve as separate species.
- We are also able to establish whether a newly discovered pathogen is closely related to other known species, what the population diversity of the fungus is and potentially to determine whether the pathogen has been introduced or has jumped from a native host. We are using the genomics approach to determine if how some pathogens seem to be able to infect new hosts, while others do not have this capacity.
- Single nuclear genes do not provide sufficient variation to allow us to resolve species boundaries. Now that we have whole genomes available to use, we will be able to use mitochondrial genes and genomes to help us better understand relationships between some of the most closely related species. Here, our hope is that the rate of change in these genes will be sufficiently rapid to allow better species resolution.

Genomics represents a new approach to the study of biological systems

Research Rationale and Questions:

- The SARChI Chair in Fungal Genomics and a grant from the Oppenheimer Memorial Trust financially supported several FABI researchers and students to attend the Fungal Genetics meeting in Asilomar (USA) in 2017 and early 2019. This meeting is the largest fungal genetics meeting and is attended by researchers from all over the world, including experts in the field.
- The first 'in-house' fungal genome has been sequenced using Oxford NanoPore sequencing technology. This technology provides a step towards fungal biologists being able to sequence the genomes of the fungi they work on for approximately US\$1,000 while in the comfort of their own laboratory. The genomes of several plant-pathogenic fungi in South Africa will now be sequenced in collaboration with other researchers at FABI.
- The first rust genome was sequenced in the programme. Sequencing and assembling the genomes of obligate plant pathogens and micro-organisms are challenging because of limited amounts of DNA, comparatively large genomes and high numbers of repeat regions. We were able to sequence the 1.2 gigabase genome of an obligate rust fungus, *Austropuccinia psidii*, the cause of rust on Myrtaceae, with a Chromium 10X library. Our results showed that this platform required less DNA than other methods, that the genome was sequenced and assembled at a lower cost and with better results. This sequencing platform has the potential to provide solutions with regards to sequencing and assembling genomes of other obligate plant pathogens (see McTaggart et al. 2018, Biotechniques).
- Mating is central to many fungal life cycles and is controlled by genes at the mating-type (MAT) locus. Genes typically flanking the MAT locus in sordariomycetes were found to be highly conserved in the Ceratocystidaceae and therefore not prone to recombination. However, we discovered unusually high recombination at the mating-type locus in Ceratocystidaceae (see Simpson et al. 2018, Fungal Biology). This discovery broadens our understanding of the genetics of mating type loci in fungi.
- Multiple independent origins for a 12,000bp subtelomeric locus associated with growth rate was discovered in *Fusarium circinatum* (see van Wyk et al. 2018, IMA Fungus). *Fusarium* is a diverse assemblage of fungi that includes a large number of species of considerable medical and agricultural importance. As has been shown for other fungi, our finding suggests that the emergence of the unique 12,000 bp region in *F. circinatum* is linked to the dynamic evolutionary processes associated with subtelomeres that, in turn, have been implicated in the ecological adaptation of fungal pathogens.

Eucalyptus and Pine Pathogen Interactions

Research Leader: Prof. Sanushka Naidoo

Research Team/Collaborators: Prof. Dave Berger
Prof. Martin Coetzee
Prof. Lucy Moleleki
Prof. Zander Myburg
Prof. Bernard Slippers
Prof. Emma Steenkamp
Dr Albé van der Merwe

Background

Eucalyptus and pine species planted as forest plantation species are subject to attack by various pests and pathogens. These trees use a sophisticated defence system to deal with such challenges. However, pests and pathogens have evolved mechanisms to overcome the host's defences. We are interested in this tree and pathogen or pest dialogue that constantly occurs to uncover tree resistance mechanisms. We are making use of model pathosystems to dissect tree defence responses. The first is the interaction between *Eucalyptus* and the blue gum chalcid, *Leptocybe invasa*, the second, between *Eucalyptus* and *Chrysoporthe austroafricana* and the third, Pines and *Fusarium circinatum*. Our approach involves various 'omics' tools and functional genetics.

Eucalyptus and pine trees planted in forests are attacked by various pests and pathogens

Objectives of the Research Programme:

- Defining the early responses of *Eucalyptus* to the insect pest, *Leptocybe invasa*, to reveal pest manipulation targets.
- Examining the interaction between *Eucalyptus* and the stem canker pathogen, *Chrysoporthe austroafricana*.
- To determine the host defence mechanism in pine and against the pitch canker pathogen *Fusarium circinatum*.
- Developing an integrated model of defence to uncover the basis of resistance and susceptibility in pines and *Eucalyptus*.
- Identifying key regulatory sequences and pathways that are important for improving defence against the insect pest.



The EPPI team





Sanushka Naidoo, Stefan Ferreira and Shannon Flemington inspecting *Eucalyptus grandis* clones for signs of heat stress

Highlights of the Research:

- We recently uncovered secondary metabolites associated with resistance and susceptibility to the blue gum chalcid, *Leptocybe invasa*. Various secondary metabolites such as plant terpenes are implicated in defence against insect pests. In a collaborative association study, we determined the terpenes produced by *E. grandis* leaves and susceptibility to *L. invasa*. Gamma terpinene and alpha pinene was found to be associated with susceptibility. Resistance was associated with iso-pinocarveol. Recent work by other researchers indicates that gamma-terpinene acts as an attractant to the insect pest.
- We developed genomic resources for two economically-important pine species. Genome sequencing in Pine species has been hampered by the very large genomes (up to 22Gb). We successfully sequenced the transcriptomes of *Pinus patula* (susceptible species) and *Pinus tecunumanii* (resistant species). We are currently engaged in transcriptome sequencing of other important pine species i.e. *Pinus greggii*, *Pinus oocarpa* and *Pinus maximinoi*.
- We identified a candidate defence gene in *Eucalyptus* that was implicated in defence against various biotic challenges. The function of the gene was determined in the model plant *Arabidopsis*. If the gene is knocked out in *Arabidopsis*, the plants become more susceptible to infection with a bacterial pathogen compared to the unchanged plants. The gene thus appears to be important for plant defence. In future studies, it is important to determine whether the *Eucalyptus* version of the gene confers resistance against pathogens.



Forest Molecular Genetics (FMG) Programme: Genomics and Biotechnology for Superior Wood and Fibre

Research Leader:

Prof. Alexander Myburg (FMG Director; Population Genetics and Molecular Breeding)
Prof. Eshchar Mizrachi (Systems and Evolutionary Biology)
Prof. Sanushka Naidoo (Pest and Disease Resistance)
Dr Nanette Christie (Bioinformatics and Computational Biology)
Dr Steven Hussey (Transcriptional Control and Synthetic Biology)
Dr Vicki Maloney (Genome Editing and Functional Genetics)

Background

The Forest Molecular Genetics (FMG) Programme focuses on the genetic control of wood development in fast-growing plantation trees, primarily *Eucalyptus* and tropical pines grown in South Africa. We utilise a number of research and technology platforms, namely: tree genomics; high-throughput DNA marker analysis; functional genetics; as well as wood phenotyping. We work in close collaboration with South African forestry companies, such as Sappi and Mondi, to develop capacity and resources for the application of tree biotechnology in operational tree improvement programmes. This research is supported by grants from the National Research Foundation (NRF), the Technology and Human Capacity for Industry Programme (THRIP) and the Department of Science and Technology (DST) of South Africa.

Objectives of the Research Programme:

- Understanding the genetic control of growth and development in fast-growing plantation trees with a view to enhance biomass production and improve wood properties for timber, pulp, paper, biomaterials and other bio-based products.
- Understanding molecular pest and disease resistance mechanisms in trees for biomass protection.
- Developing capacity and resources for the application of biotechnology solutions in tree improvement programmes and the development of woody biomass feedstock supporting the bioeconomy of South Africa.

Highlights of the Research:

- Following on the publication of the *Eucalyptus* genome (Myburg et al. 2014, Nature), the FMG Programme has made great strides towards developing and applying genomic resources to study the biology of forest trees and, in particular, growth and wood development, as well as pest and disease resistance. We have also rapidly expanded the genomic resources available for tropical and subtropical (Mexican and Central American) pine tree species grown in South Africa.
- The *Eucalyptus* genome sequence and pine transcriptome assemblies have allowed us to address topics such as genome diversity, systems genetics, comparative genomics, protein evolution, carbon allocation, organellar biology, resilience to pests and pathogens and woody biomass production in these two forestry genera. An applied outcome of this rich knowledge base is the development of genome-assisted breeding tools for South African tree improvement programmes.

We summarize research highlights for each of the major FMG focus areas below. Progress and research highlights towards pest and disease resistance mechanisms are reported in the section for the *Eucalyptus* and Pine Pest and Disease Interactions (EPPI) Programme of Prof. Sanushka Naidoo.

Modelling wood formation

- Our research programme was the first to propose applying a systems genetics approach to selecting pathways for intervention in tree biotechnology and published the first proof of concept study using tree material from a commercial forest (see Mizrachi et al., 2017 PNAS). This resource is now guiding the development of biotechnology strategies to improve wood properties for pulp and paper production in *Eucalyptus* trees.
- Our team was the first to propose and provide evidence for the existence of a “xyloplast” – a specialized version of plastids (organelles or self-contained metabolic factories within wood-forming cells) involved in wood formation (see Pinard and Mizrachi, 2018, Current Opinion in Plant Biology; Pinard et al., 2019, BMC Genomics; Pinard et al., 2019, New Phytologist). Research in this field will help understand how trees partition carbon between sugar and phenolic polymers during wood formation.
- Many land plants have evolved similar but distinct ways to grow upright. Ferns, cycads and palms are some examples of large plants that can grow tall despite not being able to make “true wood” as is seen in conifers and flowering trees such as *Eucalyptus* or *Populus*. Our team studies the evolution of wood formation by producing and analysing gene catalogs from “missing link” species (e.g. Vanneste et al., 2015, The Plant Cell; Roodt et al., 2017, Plos One; Roodt et al., 2019 Genome Biology and Evolution). This enables both piecing together the programme of wood formation in terms of essential or lost components in all these species, and also providing resources for comparative studies to better understand the impact of gene and genome duplications (van de Peer et al., 2017, *Nature Reviews Genetics*).

Synthetic biology resources for forest trees and transcriptional networks regulating wood formation

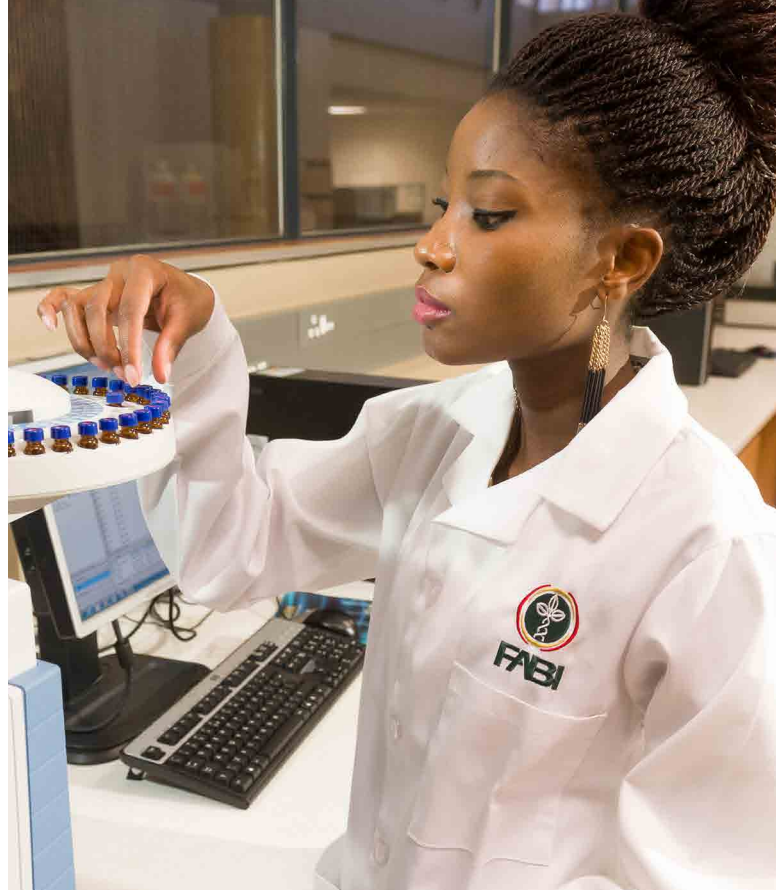
- Dr Steven Hussey has worked with the US Department of Energy Joint Genome Institute to produce synthetic DNA constructs for 286 secondary cell wall-related genes and promoters in *Eucalyptus* as standardised biological parts (Phytobricks) for Type IIS DNA assembly (see Hussey et al., 2019; ACS Synthetic Biology). It is currently the largest freely available synthetic biology resource for a forest tree, featuring 221 transcription factors and 65 promoter sequences.
- We have used this resource to help infer secondary cell wall-related transcriptional networks in *E. grandis*. For example, we have identified genome-wide binding sites of 23 NAC and MYB transcription factors involved in wood formation using DNA affinity purification sequencing (DAP-seq).
- The identification of functional protein-DNA interactions of importance to wood formation has been assisted by the identification of accessible chromatin in immature xylem (Brown et al., New Phytologist revision submitted). We have identified over 25,000 DNase I hypersensitive sites in immature xylem chromatin, and showed that considering transcription factor binding in accessible chromatin enhances the functional enrichment of predicted target genes.
- Complementing our work on physical protein-DNA interaction identification, we have also explored the dynamic activation of gene targets of secondary cell wall master regulators from *Eucalyptus* (see Laubscher et al. 2018, Scientific Reports).



Junior Tii-Kuzu
preparing samples for
PCR analysis



Shannon Flemmington investigating disease symptoms on *Eucalyptus* leaves




Maureen Tladi preparing samples for wood chemistry analysis at the SAPPI Technology Centre

Tersia Moabelo harvesting xylem tissue of *Eucalyptus*



Population genomics and DNA technologies for tree improvement

- In the past two years, our team has pursued new approaches to understand genome diversity and function towards the development of practical tree improvement tools based on high-throughput DNA marker technologies.
- Most commercially important traits are quantitative in nature and affected by hundreds of genes throughout the genome. Genome-wide DNA marker analysis has proven to be a powerful tool for tracking this genetic variation and developing predictive models of the breeding values of individual trees. Our team has used a single nucleotide polymorphism (SNP) marker chip with 60,000 DNA markers to genotype over 4,000 *Eucalyptus* trees from *E. grandis*, *E. dunnii*, *E. urophylla*, *E. nitens* and *E. grandis* x *E. urophylla* hybrids to achieve unprecedented resolution to understand genome diversity and rapidly dissect complex traits in these trees.
- Over the past two years, we collaborated with researchers in Sappi and Mondi tree improvement programmes to develop training populations and deploy genome-wide SNP genotyping to apply Genomic



The Forest Molecular Genetics Programme focuses on the genetic control of wood development in fast-growing plantation trees grown in South Africa

Selection technology for predicting tree breeding values for growth and wood property traits.

- Adding molecular traits such as gene expression variation to inform systems genetics modelling provides further biological insight into the molecular basis of complex trait variation (Mizrachi and Myburg, 2016, Current Opinion in Plant Biology). The FMG team has applied systems genetics approaches to dissect secondary cell wall (wood property) traits in *Eucalyptus*. This approach led to a successful interspecific backcross population of *E. grandis* x *E. urophylla* to map key genomic regions affecting gene expression variation (see Mizrachi et al. 2017, PNAS)
- The most comprehensive analysis of the genetic control of xylan biosynthesis to date in a forest tree was performed (Wierzbicki et al. New Phytologist, in revision) using a systems genetics approach
- The systems genetics data is a rich source for identifying genes and pathways influencing wood property traits (Wierzbicki et al. 2018, Frontiers in Plant Science). In the past two years we embarked on an effort to engineer cell wall traits such as xylan content and structure affecting pulp yield by employing new approaches such as CRISPR-Cas9 genome editing. In 2018, Dr Maloney produced the first genome edited forest tree on the African continent and functional analysis of this tree is under way.
- To make the complex systems genetics and transcriptional variation data accessible to FMG researchers and students, as well as international collaborators, we developed online resources to explore, analyse and visualize this data (qtIXplorer and *Eucalyptus* Genome Integrative Explorer, <https://eucgenie.org/>).
- With support from the Forestry Sector Innovation Fund (FSIF), we have embarked on the construction of a *Genome Diversity Atlas* for *Eucalyptus* and pine species grown in South Africa. One of the outcomes of the study is an international effort (collaboration with Camcore, North Carolina State University and University of Connecticut) to generate a multi-species SNP genotyping chip for tropical pines. This resource will be useful for genetic resource management and molecular breeding of pines.
- The FMG team has also embarked on *landscape genomics* an emerging field combining population genomics with analysis of interactions with environmental factors including biotic and abiotic stresses to predict tree genotypes that are best adapted to such environments. This team initiated the first phase of a landscape genomics study for *Eucalyptus grandis* and is making progress towards the aim of mapping the genomic variation available for this species in South Africa and in its natural range in Australia.
- Prof. Myburg, together with the FMG team, hosts the FMG DNA Marker Analysis Platform that provides routine DNA fingerprinting services to the SA Forestry Industry. In 2018, the platform reached the milestone of having produced DNA profiles for 50,000 trees representing a large proportion of tree breeding material in SA Tree Improvement Programmes.
- We collaborated with Creation Breeding Innovations (CBI, Dr Steve Verryrn) to develop an online forest molecular genetics resource (*Bioplasm*) that aims to make the extensive DNA fingerprinting and genome-wide diversity data created in FMG accessible to researchers and breeders of participating forestry industry partners.

Macadamia Protection Programme

Research Leader: Dr Gerda Fourie

Collaborators: Prof. Brett Hurley
Prof. Bernard Slippers
Prof. Noëlani van den Berg
Prof. Mike Wingfield

Background

The Macadamia Protection Programme (MPP) is a collaborative research partnership between Macadamia South Africa NPC (SAMAC), the University of Pretoria (UP) and the Forestry and Agricultural Biotechnology Institute (FABI). The programme was officially launched on 22 February 2017 and at that time only one BSc Honours student was working on the identification of the causal agent of macadamia husk rot, a fungal disease of the pericarp. Currently, there are three PhD and two MSc students in the programme working on different aspects of pest and disease problems, as well as one project that focuses on the genetic characterization of South African cultivars. In addition to growth with regards to student numbers, the MPP also established international collaborations with Dr Jeremy Allison from Natural Resources Canada and Prof. Andre Drenth from the University of Queensland, Australia. Both collaborators have formerly visited the programme and had the opportunity to spend time in South African macadamia orchards. Their contribution will add to the knowledge base and strength of the programme and we trust that this will ultimately help to reduce the impact of pests and diseases in order to keep the industry productive and profitable.



Macadamia dieback, caused by species within the *Botryosphaeriaceae*, a disease of growing concern

Objectives of the Research Programme:

- Providing biologically-relevant information to improve integrated pest management (IMP) systems. Effective implementation of IMP is built on information regarding pest identity, population dynamics, disease cycle, infection biology, epidemiology and spread. Such information on pests and diseases of economic importance, however, is either lacking or not well understood.
- Assisting in the generation of knowledge that will support the improvement or development of biological control and well as the use of pheromones for control of economically important pests.
- The generation of genetic tools to support macadamia cultivar breeding.

Highlights of the Research:

- A key component of the long-term success of the above-mentioned research objectives is continued monitoring of pests and diseases. The MPP therefore offers a disease diagnostic and extension service. Diseased material most frequently processed resulted from quick decline, branch dieback, Phytophthora root rot as well as raceme blight. Green mold and Dry mold, caused by *Cladosporium* and *Neopestalotiopsis*, were reported in South Africa for the first time. As a consequence, we have initiated a research project that will focus on gaining knowledge on these pathogens, both in terms of biology and epidemiology, in order to improve management of the pathogens.
- Another important fungal disease is Macadamia husk rot. Identification of the causal agent suggested that multiple species are capable of causing husk rot or inducing husk rot-like symptoms. Overall the results have serious implications for the management of this disease. Different fungi may have different environmental triggers that are conducive for disease, they may differ in the way in which they infect, how they survive and how they are spread. All of which will complicate control efforts.
- With regards to pests, we concluded that the identity of the dominant *Lepidoptera* species causing damage to macadamia nuts was *Thaumatotibia batrachopa* (Macadamia nut borer). Population analysis of the species from different growing regions suggested that there is little population differentiation in growing areas. Results from this study should therefore enable farmers to prioritise control efforts and possibly eliminate unnecessary practises.
- Of importance for future research is the availability of live insects to be used for research. During 2018 we successfully established lab reared populations of *T. batrachopa* (Macadamia nut borer) as well as *Bathycyba natalicola* (Two-spotted stink bug). This marks the start of research on the Two-spotted stink bug with the focus on quantifying potential resistance toward pesticides, characterizing the pheromones of these bugs and well as identification of egg parasitoids present in Macadamia orchards. These efforts will contribute towards the control of this economically-damaging pest.

Angel Maduke, a PhD candidate whose research project focuses on diseases of importance to Macadamia, isolating fungi from diseased material sampled during a field trip



Pupae of lab-reared *Thaumatotibia batrachopa* (Macadamia nut borer)



Mating of two lab-reared *Bathycyba natalicola* (two-spotted stink bug) adults



Third and fourth lab-reared *Bathycyba natalicola* (two-spotted stink bug) nymphal instars, a major pest of Macadamia





Molecular Plant-Pathogen Interactions (MPPI)

Research Leader: Prof. Dave Berger

Research Team: Prof. Terry Aveling
Prof. Burton Bluhm
Prof. Martin Coetzee
Prof. Kerstin Krüger
Prof. Zander Myburg
Prof. Gerhard Pietersen

Prof. Yves van de Peer
Dr Irene Barnes
Dr Bridget Crampton
Dr Tuan Duong
Dr Shane Murray

Background

Maize was introduced to Africa only a few hundred years ago, but it has become a staple crop and embedded in many cultures across the continent. Unfortunately, pests and pathogens reduce maize yields in sub-Saharan Africa by 30% on average according to a recent review in *Nature Ecology and Evolution*. Research by the MPPI group focuses on one of these pathogens, the fungus *Cercospora zeina*, that causes grey leaf spot (GLS) of maize in Africa. GLS is widespread globally but in all other maize-producing continents a second fungal species, *Cercospora zea-maydis* has also been associated with the disease. Researchers have long puzzled why *C. zeina* is unable to produce the toxin cercosporin but causes the same necrotic lesions on maize leaves as *C. zea-maydis*. The MPPI team worked with several local and international collaborators to produce the research outputs described below.

Objectives of the Research Programme:

- Understanding maize resistance to GLS at the molecular level.
- Characterizing the cercosporin biosynthetic pathway in *Cercospora zeina*.
- Cataloguing the population dynamics of *C. zeina* in Africa.
- Supporting nutritional food security research on the continent.

Pests and pathogens reduce maize yields in sub-Saharan Africa by 30%

Highlights of the Research:

- The whole genome sequence of an African isolate of *C. zeina* was determined (Wingfield et al. 2017, IMA Fungus).
- Our group was first to publish the transformation of *C. zeina* (Swart et al. 2017, Molecular Plant-Microbe Interactions).
- Gene expression and metabolite profiling of host and pathogen revealed that kauralexins are associated with maize resistance to GLS disease (Meyer et al. 2017, BMC Plant Biology), *C. zeina* lacks a functional copy of the *ctb7* cercosporin biosynthesis gene, and that *C. zeina* transformed with the functional *ctb7* gene from *C. zea-maydis* restores cercosporin production (Swart et al. 2017, Molecular Plant-Microbe Interactions)
- Production of Cassava in parts of southern, eastern and central Africa is seriously affected by Cassava brown streak disease (CBSD). At least two virus species cause CBSD: Cassava brown streak virus (CBSV) and Ugandan cassava brown streak virus (UCBSV). A time-course study revealed that a tolerant cassava line prevents Ugandan cassava brown streak virus (UCBSV) from hijacking the plants' protein-making machinery (Amuge et al. 2017, Scientific Reports). In contrast, UCBSV suppresses expression of defence genes in a susceptible cassava variety.
- We determined and published the chloroplast sequence of the nutritious leafy vegetable *Amaranthus tricolor* (Viljoen et al. 2018, Journal of Molecular Evolution). Phylogenomic analysis using sequences from this genome resolved phylogenetic relationships in the genus *Amaranthus* and identified unknown accessions in the local gene bank collection.
- Maize Yellow Mosaic Virus (MaYMV) was first described in 2016 (from maize in China). We made the first report of MaYMV in Tanzania, through assembly of the whole genome sequence of the virus from next-generation sequencing data (Read et al. 2018, Journal of Plant Pathology).



Team members presenting a maize diagnostics workshop in western Kenya



Molecular Plant Physiology Research Group

Research Leader: Prof. Juan Vorster

Team Members: Prof. Karl Kunert
Dr Eugene Makgopa

Background

The Molecular Plant Physiology Group does research focused around plant stress. We are particularly interested in improving drought resistance in legume crops such as soybean. Soybean is one of the most important grain crops in South Africa, particularly because of its high oil and protein content. As a legume, soybean has the ability to form symbiotic root nodules with Rhizobium bacteria. In exchange for carbohydrates from the plant, the bacteria fixes atmospheric Nitrogen and converts it to ammonia that the plant uses to build amino acids - the building blocks of proteins. Because of the specialized structure and function of root nodules, they are especially sensitive to drought conditions. This causes the premature senescence of the nodules and results in nitrogen deficiency and overall lower yield in soybean. One of the key enzyme families involved in senescence are cysteine proteases (also called death enzymes). In our research we focus on how these enzymes are involved in senescence, especially senescence initiated by age compared to premature senescence initiated by environmental stress such as drought. Identification of cysteine proteases induced during the early stages of drought-induced senescence will provide targets that, when silenced or inhibited, could delay senescence and improve nitrogen fixation. We are also interested in whether nodules formed by different Rhizobium species are equally sensitive to drought and how much of a role this can play in improving nitrogen fixation under drought conditions.

Objectives of the Research Programme:

- Characterizing soybean development under controlled and drought conditions.
 - Developing markers for drought tolerance.
 - Understanding the role of Rhizobium partners to improve nitrogen fixation under drought conditions.
-

We are particularly interested in improving drought resistance in legume crops such as soybean

Highlights of the Research:

- Using whole transcriptome RNA sequencing we developed comprehensive gene expression profiles for soybean roots and nodules under control and drought-stress conditions.
- Comparative analysis of the transcriptomes allowed us to identify genes induced under drought stress. These genes are currently being evaluated across different cultivars to determine their usefulness as drought stress senescence markers.
- We have identified physiological and phenotypical differences in nodulation characteristics under drought conditions using different inoculum partners. Currently we are evaluating these more carefully.



Soybean root nodules at different stages of development. Nodules actively fixing Nitrogen are pink in colour and turn brown as they start to age and die





Phytobacteriology Programme

Research Leader: Prof. Teresa Coutinho

Collaborators: Prof. Lucy Moleleki
Prof. Fanus Venter
Prof. Jacquie van der Waals (Dept. of Plant Sciences)
Prof. Mike Wingfield
Dr Almuth Hammerbacher
Dr Teresa Goszczynska (ARC-PPRI)
Dr Yolanda Petersen (ARC-Infruitec)

Background

The Phytobacteriology Programme was initiated in 2003. The primary focus of the programme was on pathogens that are regarded as opportunistic, e.g. *Pantoea ananatis* and research was conducted on how these pathogens initiate infection and eventually cause symptoms in their hosts. More recently the programme has expanded to include well-known, economically-important pathogenic bacteria such as *Ralstonia solanacearum*, *R. pseudosolanacearum*, *Pseudomonas syringae* and *Xanthomonas vasicola*.

Objectives of the Research Programme:

- Characterizing and typing isolates of pathogenic bacteria responsible for economically important diseases of agricultural crops and *Eucalyptus*.
- Studying the epidemiology, ecology and biology of selected emerging plant pathogenic bacteria.
- Identifying pathogenicity factors of selected plant pathogenic bacteria using a genomic approach.

Highlights of the Research:

***Pantoea ananatis* (pathogen of onions and Eucalyptus):**

- Swimming and twitching motility of the bacterial pathogen are essential for attachment to the host and virulence
- Two quorum sensing systems (EanI/R and RhII/R) are essential for pathogenicity and biofilm formation within the host
- A RNA binding protein Hfq is an important virulence regulator of *Pantoea ananatis* LMG 2665.
- A functional study of Hfq revealed that the absence of this protein resulted in the reduced biofilm production and attenuation of motility and pathogenicity of *Pantoea ananatis*.
- sRNA transcriptome analysis showed that up to 150 small RNAs (sRNA) were affected by hfq deletion mutation, uncovering vast number of sRNA that are regulated by Hfq.

***Ralstonia solanacearum* and *R. pseudosolanacearum* (pathogens of tomato and Eucalyptus):**

- Both *R. solanacearum* and *R. pseudosolanacearum* are capable of infecting tomato and *Eucalyptus*.
- The dominant species on tomato in South Africa is *R. pseudosolanacearum*.
- Based on observations in *Eucalyptus* plantations in many parts of the world, it is highly likely that both *Ralstonia* species are opportunists and only infect when the host is compromised by either biotic or abiotic factors.

***Pseudomonas syringae* pv. *syringae* and *P. viridiflava* (as pathogens of stone fruit trees)**

- Bacterial canker of cherry trees is caused by *P. syringae* pv. *syringae* phylogroup 2.
- The strains from cherry trees were capable of phenolic degradation which contributes to their virulence.
- *Pseudomonas syringae* sensu stricto and *Ps. viridiflava* were found to be associated with bacterial canker of plum trees in the Western Cape
- Both *Ps. syringae* and *Ps. viridiflava* were pathogenic on apricot and plum seedlings, indicative of non-specificity of *Ps. syringae* strains infecting *Prunus* spp.
- The analyzed data from the survey showed that drought stress of plum trees and area of the farm had the most significant influence on both disease outcome and ring nematode densities.

***Xanthomonas vasicola* (pathogen of banana, maize, sugarcane and Eucalyptus)**

- *Xanthomonas vasicola* has been confirmed as the causal agent of bacterial streak disease of maize.
- SNP-based molecular markers were developed for phylogeographic studies of the epidemiology of *Xv* pv. *musacearum* (*Xvm*) (causal agent of *Xanthomonas* wilt of banana).
- Multilocus variable number of tandem repeat analysis (MLVA) was used to genotype a population of *Xvm* from central and east Africa.



Bacterial leaf spot on *E. grandis*



Canker formed by *Pseudomonas syringae* pv. *syringae*



Potato Soft Rot Research Programme

Research Leader: Prof. Lucy Moleleki

Research Team: Prof. Teresa Coutinho
Prof. Sanushka Naidoo

Background

Potato is an economically important crop plant contributing significantly to the South African economy. Pests and pathogens contribute significantly to annual production losses. Currently, the research group focuses on the Soft Rot Enterobacteriaceae (SRE) and Root Knot Nematodes (*Meloidogyne spp.*) of potatoes. To increase productivity, accurate identification of these pathogens is essential. Part of our research is to develop molecular based methods to identify potato pathogens. Pathogens overcome host defences by interfering with various host surveillance system. We use genomics and transcriptomics to identify bacterial virulence factors as well as elucidate host defence mechanisms being targeted by these virulence factors.



A tolerant potato cultivar (*Solanum tuberosum* cv BP1) challenged with *Pectobacterium carotovorum* subs. *brasiliense*

Pests and pathogens contribute significantly to losses in the production of potato crops annually

Objectives of the Research Programme:

Amongst the different Soft Rot Enterobacteriaceae, *Pectobacterium carotovorum* subsp. *brasiliense* (*Pcb*) was identified as an important emerging pathogen of potatoes, not only in South Africa but globally. Much of our research therefore focuses on virulence mechanisms that *Pcb* utilises to infect potato stems and tubers. The broad aims of the research programme are

- To understand virulence mechanisms of *Pectobacterium* and *Dickeya* species.
- To study cognate defence responses in the host plant, potato.

Highlights of the Research:

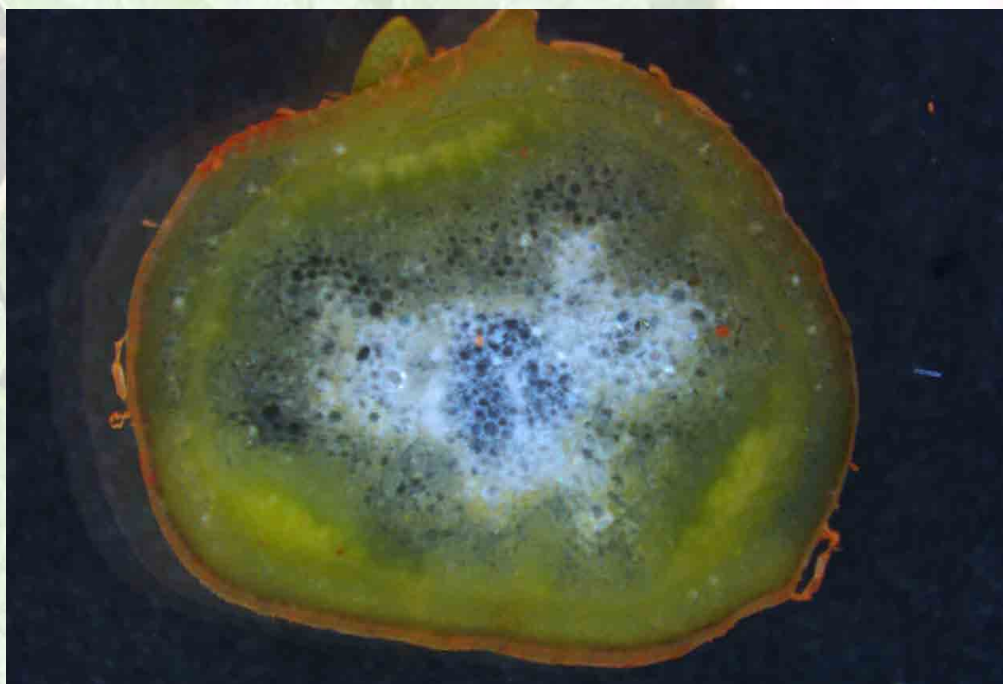
Identification of *Pcb* tolerant cultivars and associated defence mechanisms:

- We previously identified a potato cultivar that is tolerant to *Pcb* challenge.
- We compared potato leaf responses of a susceptible cultivar to those of a tolerant potato cultivar to *Pcb* challenge. Leaves of the susceptible cultivar typically showed excessive maceration and water-soaking. In addition, bacteria were able to proliferate, reaching high cell densities. In contrast, bacteria in the leaves of the tolerant cultivar were restricted to the point at which they were inoculated and were not able to proliferate.
- We investigated the defence response of the tolerant and the susceptible potato cultivars. Results from this study showed that the tolerant potato cultivar mounts a defence response relatively early compared to the susceptible cultivar. This includes increased levels of hydrogen peroxide, superoxide and oxidative burst.

Important SRE virulence factors

The leading causes of SRE (*Pectobacterium* and *Dickeya* spp.) have virulence factors that are common to both but also those that are unique. The growing number of publicly available genomes within the SRE is a valuable resource for identification of common and differentiating virulence determinants in this important group of phytopathogens. In a recent study we generated a full transcriptome profile of *Pcb* infecting potato tubers at two time points. We combined these transcriptome data with comparative genomics (using 100 publicly-available SRE genomes) to identify important virulence factors in both species.

- Our results showed that factors associated with antibacterial competition feature strongly in *Pcb* virulence and ability to outcompete other SRE. Some of these factors are unique for *Pcb*, and not present in related *Pectobacterium* and *Dickeya* species.
- The ability to navigate host environment through the use of methyl accepting chemotactic proteins (MCPs) is very important in virulence of *Pcb*, our next step will be to determine exact signals that are detected by these MCPs.
- Iron acquisition was found to play a role in virulence. In this regard, we discovered that mutating the global regulator responsible for iron homeostasis in *Pectobacterium* cells (Fur-protein) resulted in loss of virulence. We are now investigating the full set of genes under the regulation of the *Pcb* Fur transcriptional regulator.



A cross section of the tolerant potato cultivar (*Solanum carotovorum* cv BP1) showing enhanced structural defences

RGE-FABI Tree Health Programme

Research Leader: Prof. MJ Wingfield

Research Team: Prof. B. Slippers
Dr I Barnes
Dr A Duran (RGE)
Dr F Jami
Dr G Carstensen

Background

The RGE-FABI Tree Health Programme (RGE-FABI THP) was established in 2018 as a collaborative venture between the Indonesian-based Royal Golden Eagle (RGE) Group and the Forestry and Agricultural Biotechnology Institute (FABI) at the University of Pretoria. This partnership addresses challenges posed by pests and diseases to RGE's forestry operations in Indonesia and Brazil. The initiative involves FABI researchers working in partnership with RGE's divisions: Asia Pacific Resources International Holdings Limited (APRIL) and Brazil-based Bracell Limited.

Insect pests and diseases are emerging as one of the most important threats to plantation forestry globally. This situation presents significant challenges for all forestry companies. The RGE-FABI THP recognises FABI's capacity as the largest single group of scientists working on tree health globally. The research conducted by the FABI tree health team is broad including trees in natural ecosystems and planted forests. But its core focus is on reducing the impact of insect pests and pathogens in plantations of mainly non-native trees such as species of *Eucalyptus*, *Acacia* and *Pinus*. And it is in this domain that RGE and FABI will collaborate.

Professor Mike Wingfield, who has the responsibility of coordinating the RGE-FABI THP, is passionate regarding global collaboration. In this regard, his philosophy is that collaboration between forestry companies globally is essential

in order to resolve insect pest and pathogen problems affecting plantation forestry. Agents of plantation destruction are moving increasingly rapidly across continents. Consequently, knowledge of problems before they arise in new areas provides forestry companies with opportunities to plan ahead and to reduce losses. Likewise, collaboration in dealing with insect pests via biological control requires global partnerships and strategies that stretch beyond country borders. In this way the RGE-THP is valuable not only to the specific partners involved in the project but also to a broader international forestry community who must benefit from increased knowledge regarding pest problems in plantations globally.

The RGE-FABI THP is one of the most important and exciting global partnerships to have emerged recently. It will closely link the significant research programmes of RGE and FABI. And it will fund postgraduate students and postdoctoral Fellows from different parts of the world to study priority disease and pest problems across international boundaries. It will place the RGE forestry divisions at the forefront of pest and disease problems affecting particularly *Eucalyptus* and *Acacia*. And in doing so, it will also expand the research opportunities, education and experiences of young researchers with an interest in tree health and global collaborative ventures.

Objectives of the Research Programme:

- Conduct research on key pest and disease problems affecting plantations belong to the RGE Group in Indonesia and Brazil
 - Together with RGE R&D teams, transfer research results to pest and disease management options for RGE operations
 - Provide education opportunities in the field of forest pathology and entomology for RGE staff members
-

The RGE-FABI THP is one of the most important and exciting global partnerships focused on tree health to have emerged recently

Highlights of the Research:

Various new pests and pathogens affecting *Acacia* and *Eucalyptus* have been discovered and are currently being studied.



A Memorandum of Understanding was signed between RGE and the University of Pretoria launching the RGE-FABI Tree health Programme at FABI on 23 April 2018



Seed Science and Pathology of Flowers, Trees and Agronomic Crops

Research Leader: Prof. Terry Aveling

Collaborators: Prof. Paxie Chirwa
Prof. Bradley Flett
Dr Riana Jacobs
Dr Quenton Kritzinger
Dr Mariette Truter

Background

Seed science and technology involves several disciplines such as plant production, agronomy, plant physiology, plant science, entomology and plant pathology. The seed is the most important and essential starting point for a healthy plant. If a seed is not viable, a seedling will not emerge. If a seed has low vigour, a weak seedling will emerge which in turn may either succumb to environmental conditions or attack by pathogens or insects. It is therefore of the utmost importance to monitor seed to ensure that it is viable and will give rise to vigorous seedlings able to withstand unfavourable environmental conditions and pests.

Objectives of the Research Programme:

To investigate and solve seed problems for emerging and commercial farmers on a range of plants including seed pathology, seed vigour and seed treatments.

A seed is the most important and essential starting point for a healthy plant

Visiting drybean smallholder farmers in the Drakensberg, KwaZulu-Natal Province



Highlights of the Research:

- *Alternaria* leaf blight is currently one of the major potential disease threats of sunflower and is capable of causing yield losses in all production regions. *Alternaria helianthi* is the main cause of *Alternaria* leaf blight of sunflower in South Africa; however small-spored *Alternaria* species have been consistently isolated from leaf blight symptoms during recent surveys. In a recent study we found that *A. helianthi* could not be recovered from any of the sunflower lesions or seeds, with only *A. alternata* being retrieved from the symptomatic tissue. Pathogenicity tests showed that all the *A. alternata* isolates tested were capable of causing *Alternaria* leaf blight of sunflower as seen in the field. This is the first report of *A. alternata* causing leaf blight of sunflower in South Africa.
- *Alternaria* blight of sweet potato (*Ipomoea batatas* L.), caused by *Alternaria* spp., is a new disease recently reported in South Africa, but is common in southern and eastern Africa. Elsewhere in the world, the disease is controlled primarily using tolerant varieties. Twenty-five sweet potato varieties/breeding lines, from different origins were assessed for tolerance to *Alternaria* blight. The plants were planted in fields having a history of the disease and rated for tolerance based on a General Disease Index (GDI), with the lowest scores representing tolerance, and the higher scores representing susceptibility. Variety 199062-1 had the lowest GDI value, and was the most tolerant to *Alternaria* blight; while W 119 had the highest GDI value and was the most susceptible to the disease. Other varieties/breeding lines showed a variation in GDI values between most tolerant and most susceptible. Among the fungicides tested under field conditions, the mixture azoxystrobin-difenoconazole was the most effective in reducing the GDI. Fungicides pyraclostrobin-boscalid, unizeb, azoxystrobin-chlorothalonil and cymoxanil-mancozeb were also effective against the disease.
- The Aizoaceae, commonly known as mesembs or “ice plants” is a plant family endemic to Namaqualand, an area inside the Succulent Karoo biodiversity hotspot in South Africa. Here biome-specific factors drive germination success with more than 1,800 unique species contributing in making this the most diverse arid ecoregion in the world. We screened 10 species of Aizoaceae in this study and found that they are populated with fungal endophytes. Fifty-nine fungal species from 25 genera, including 14 rare species, were identified. Seasonal specificity was observed; with 32 and 21 fungal endophytes isolated only during the flowering and dry seasons, respectively. The genus *Fusarium* was the most



Collecting Mesemb (vygie) plant and seed samples in the Namaqua National Park



Students on a field trip to visit smallholder farmers in KwaZulu-Natal

abundant in samples from the flowering season, whilst *Alternaria* and *Cladosporium* were equally abundant in the dry season. Rarely isolated genera included *Neophaeosphaeria*, *Periconia*, *Preussia*, *Schizothecium* and *Truncatella*. *Fusarium oxysporum*, *Paecilomyces victoriae* and *Talaromyces pinophilus* were the largest contributors to the differences in community structure observed for fungal endophytes from the different seasons. Endophytic fungal richness was very high in comparison to other global arid regions. This was the first record of all these fungal species isolated from Aizoaceae plants in their endemic environment in the most biodiverse arid region in the world, the Succulent Karoo in South Africa.

Tree Protection Co-operative Programme (TPCP)

Director: Prof. Bernard Slippers

Team members: Prof. Martin Coetzee
Prof. Wilhelm de Beer
Prof. Brett Hurley
Prof. Sanushka Naidoo
Prof. Emma Steenkamp
Prof. Noëlani van den Berg
Prof. Fanus Venter

Prof. Brenda Wingfield
Prof. Mike Wingfield
Dr Irene Barnes
Dr Tuan Duong
Dr Gerda Fourie
Dr Almuth Hammerbacher
Dr Albé van der Merwe



The lerp psyllid
Spondylaspis cf.
plicatuloides on *Eucalyptus*

Background

The Tree Protection Co-operative Programme (TPCP) was established in 1990 and celebrated its 30th year of the operation in 2018. Over this period the TPCP has become an institution of the South African forestry industry and has been critical to its ability to deal with one of the greatest threats to its sustainability, namely pests and diseases. Today the programme serves all role players in the South Africa Forestry community, from large industries to small growers, to Government and civil society. The programme has demonstrated that it can deliver outstanding services to support pest management needs of the forestry sector, while at the same time ensuring that the highest quality of research and training of graduate students is maintained.

The TPCP provides a hub for international expertise and research on plantation pests and diseases. This linkage is increasingly relevant given the increasing rate at which pests and pathogens are moving around the world. This rate has increased at least 4 fold over the past two decades, and simply cannot be dealt with efficiently at a local scale any longer. The connections with researchers and industries globally provide key early warnings about new emerging pests and pathogens, but crucially also provides access to the best knowledge and experience for their management. It also provides access to management options.

The continued successes of the TPCP is the result of dedicated and high quality collaborative work of many contributors including students, technical and academic staff members of the University of Pretoria, industry members of the TPCP and their staff, including forestry researchers and managers, as well as collaborators and colleagues globally. The TPCP research team is grateful to this remarkable group of people who make important contributions to the common goal of the TPCP, namely, "keeping trees healthy".

The impact of the TPCP over the past 30 years has stretched well beyond its impact on dealing with forest pests and diseases. The programme provided the base for the establishment of the Forestry and Agricultural Biotechnology Institute (FABI) in 1998, which today houses a number of leading forest and agricultural biotechnology research programmes. Through this influence, the TPCP has made a major contribution to the development of research in this field in South Africa and globally.



Objectives of the Research Programme:

- Maintain a comprehensive programme that address the forestry pest and disease needs of the country and beyond; from knowledge generation, to training of specialists, and to the development and support for integrated management solutions.
 - Conduct high quality research that covers all key pathogen and pest groups in the country, including well-known and emerging pests and pathogens, a number of global studies on key groups, developing leading technologies to understand the biology, epidemiology and community ecology of these organisms, and developing and supporting biological control, monitoring, and management tools.
 - Provide a strong base for international linkage with leading researchers and programmes around the world.
 - Provides a platform to engage with various other research programmes in forestry and agricultural biotechnology to share knowledge, facilities and capacities.
 - Provide its members with integrated pest management solutions, while also ensuring that the industry can efficiently access the knowledge that is required to ensure long-term sustainability of plantation forestry in South Africa.
-



TPCP students inspecting wood decay during a field survey

Highlights of the Research:

- The TPCP supported the implementation of a highly efficient monitoring and management program that has brought the *Sirex noctilio* outbreaks to a management level. The work included support through world class basic research on the system, translation of the information for management and implementation of the management practices (in particular biological control). The program has assembled the most comprehensive global collections of the wasp, associated fungus and biological control organisms, and described the global invasion patterns, as well as variation in key traits that influence the evolution, symbiosis and management of the system. Deeper understanding of the mating system, visual and chemical ecology of the wasp is relevant to longer-term control efforts, including the potential for genetic manipulation.
- Several pests are affecting the health of *Eucalyptus* trees in South Africa and abroad. Members of the team discovered and described the global invasion of the cryptic lineages of the invasive Eucalyptus gall wasp, *Leptocybe invasa* lineage A and B. They also contributed basic knowledge on the host resistance, as well as biological control using *Selitrichodes neseri*, *Quadrastichus mendeli* and *Megastigmus zebrinus*. The team discovered, identified and monitor the emerging *Eucalyptus* pest, *Spondyliaspis* cf. *plicatuloides*, and its parasitoid, *Ophelimus maskelli*. Furthermore, the population level variation for *Gonipterus* sp. 2 and *Anaphes nitens* at phenotypic and genotypic level on *Eucalyptus* in South Africa and in the native range in Australia was determined.
- Identification and use of pheromones for mass trapping of pests has been one of the long term goals of the TPCP. This research led to the discovery of the major and two minor chemical components of pheromones produced by the *Coryphodema tristis* moth. Methods have now been developed for using the identified pheromone blend for mass trapping operations of this insect by the industry. The team is also making significant progress in the discovery of pheromone and kairomone chemical compounds for *Gonipterus* sp. 2, *Naudirillea* sp., *S. noctilio* and *Euproctis terminalis*.

- *Pissodes nemorensis* is a pest of various *Pinus* species. This species was previously misidentified in South Africa, and is now known to be an unidentified species of North American origin, referred to as *Pissodes* sp. SA. The interaction between this beetle and the Sirex wood wasp was described, as well as its interaction with different pine hosts, and with native and non-native parasitoids. Opportunities exist to improve biological control of *Pissodes* sp. SA by collecting parasitoids from its native range.
- The TPCP made a significant investment in identifying biological control agents and developing methods to use them against tree pests in South Africa. Apart from the nematode biological control program on the devastating Sirex wood wasp, the team also discovered and described known and previous unknown species of entomopathogenic nematode species of *Heterorhabditis* and *Steinernema*, and their bacterial symbionts, that show potential as biological control agents against white grubs (larvae of chafer beetles) that are important forestry and agricultural pests in the country. Furthermore, additional parasitoids of *Goniopteris*, *Anaphes inexpectatus* and *Centrodora damoni*, were collected and their basic biology studied.
- Over the past 20 years, there has been several bark and ambrosia beetle outbreaks and invasions in various parts of the world, causing massive mortality in planted and natural forests. The TPCP contributed extensive knowledge on the diversity, genetics, genomics and evolution of fungal symbionts of bark beetles, especially those associated with invasive species. A recent, and most concerning, discovery by the group was the first report in South Africa of the Polyphagous Shot Hole Borer, *Euwallacea whitfordiodendrus*. This beetle poses a major threat to a large number of tree species in urban, agricultural and native environments. Our work has tracked its movement across the country and added information about local biology and ecology.
- The TPCP conducts leading research on the understanding the pathology and population biology of the pitch canker fungus, *Fusarium circinatum*, including at the molecular biology level. The work included the assembly and annotation of a near-chromosome level genome of *F. circinatum*, associated comparative and genome-anchored genetic linkage map research that allowed for the identification of a large genomic region involved in growth of *F. circinatum*. Quantitative trait loci that are potentially linked to virulence/pathogenicity and traits crucial to the fitness of *F. circinatum* are currently being explored. Once identified, these loci can be targeted in the control of this fungus at the molecular level. Our research showed that the life-history traits of *F. circinatum* is ecologically flexible

The TPCP was established in 1990 and celebrated its 30th year of operation in 2018



Coniothyrium canker on *Eucalyptus*





Tree planting by members of the TPCP is a fun event

with a high evolutionary potential, thus allowing the pathogen to adapt to changing environments. Genomics and molecular biology aspects of the fungus are being pursued as additional tools for controlling this important pathogen. Ongoing work also focus on field biology aimed at understanding the dynamics of the pathogen in the nursery environment, climatic modelling, infection biology on seedlings, as well as the possible role of seedlings in attracting the pathogen to its roots.

- The rust pathogen *Austropuccinia psidii* poses a significant threat to Myrtaceae in South Africa and other regions of the world. The TPCP is deeply involved in detecting, description and monitoring of this fungus in South Africa, including comparative work with collections from around the world. This includes pathology work related to hosts in South Africa and other parts of the world, which is crucial for its management. The strain in South Africa is unique and differs from the “pandemic” strain. Our research demonstrated that there is evidence that recombination is occurring in the field, which is observed as teliospores in the field, and an increase in the genetic diversity of *A. psidii*. The genome of the South African strain has now been assembled and annotated for comparative genomics and molecular biology work.

- The rust infection on *Acacia mearnsii* in South Africa is caused by *Uromycladium acaciae* that appears to be of Australian origin. Critical research on the life-cycle and infection studies on the pathogen, including a rapid inoculation and screening protocol, have been completed. Screening for resistance against this fungus is ongoing.
- Soil-borne disease, and in particular those caused by *Phytophthora* diseases, are of serious concern locally and globally. TPCP research has shown that natural and plantation forests of South Africa harbour a large number of species, including a number of previously unreported species. The impact of different species on establishment of *Eucalyptus* trees is under investigation, and this contributes to disease screening. The role of the soil microbiome in the health of *Eucalyptus* species in South Africa is also considered.
- The Botryosphaerales fungi are some of the most important pathogens of native and planted trees around the world. They are particularly important in the context of climate change, as they are some of the most important stress associated pathogens of trees. Research from the TPCP contributed to broad understanding of the taxonomy, biology and evolution of this group, as well as its genetics and genomics, sexual reproduction and mating strategies and

infection biology. Our research also reveals global patterns of distribution and the spill-over of these fungi between native and non-native ecosystems.

- The Cryphonectriaceae are important primary pathogens of various trees around the world, including plantation forest trees such as *Eucalyptus*. Research in the group contributed to the understanding of global distributions, mating systems, origins and spill-over from native environments to commercial species and threats for future emergence of new disease outbreaks. In this regard the discovery of new species, as well as the understanding of these fungi as endophytic in native trees are important contributions from the group. The TPCP also contributed significantly to the understanding of genomes of key species infecting *Eucalyptus*.
- *Ceratocystis* species are emerging as global threats to forestry and agricultural industries, and have already resulted in severe losses of *Eucalyptus* spp. in South America and *Acacia mangium* in Asia. The TPCP contributed to monitoring and research of *Ceratocystis* on a global scale, including the description of new species linked to emerging disease outbreaks, understanding origins and global patterns of spread, as well as host range, ecology and management. The TPCP is also the leading producer of genomes and an understanding of evolution and speciation in this group.
- *Teratosphaeria* (Teratosphaeriaceae) is a large genus of fungi with several species that have become important tree pathogens, including many on *Eucalyptus*. The TPCP continues to study the two stem canker pathogens, *T. gauchensis* and *T. zuluensis*, and their potential for hybridization. The group had also produced leading research on the global diversity, spread and mating strategy of *T. destructans*, which is one of the most devastating pathogens in this genus. The genome sequence of a *T. destructans* isolate from South Africa has been determined and will serve as a data source for ongoing studies of this species.
- Dothistroma needle blight remains one of the most important diseases of *Pinus* spp. globally. Of the two species known to cause the disease, only *Dothistroma septosporum* has been detected in South Africa. Sentinel trials with South African pine material, have been planted in Colombia in order to determine the effects of this pathogen on our hybrid species. These collaborative efforts with CAMCORE will help to ensure that this pathogen does not cause problems on the growing *P. tecunumanii* resources in South Africa.
- Armillaria root rot is commonly encountered in forests and plantations around the world, including on *Pinus* spp. in South Africa. Research in the TPCP contributed to monitoring of disease outbreaks, definition of species concepts and a better understanding of the patterns of distribution of these pathogens globally.



Dr Eston Mutitu from KEFRI is shown PSHB galleries in a felled tree by FABI postdoctoral Fellow Dr Mesfin Gossa

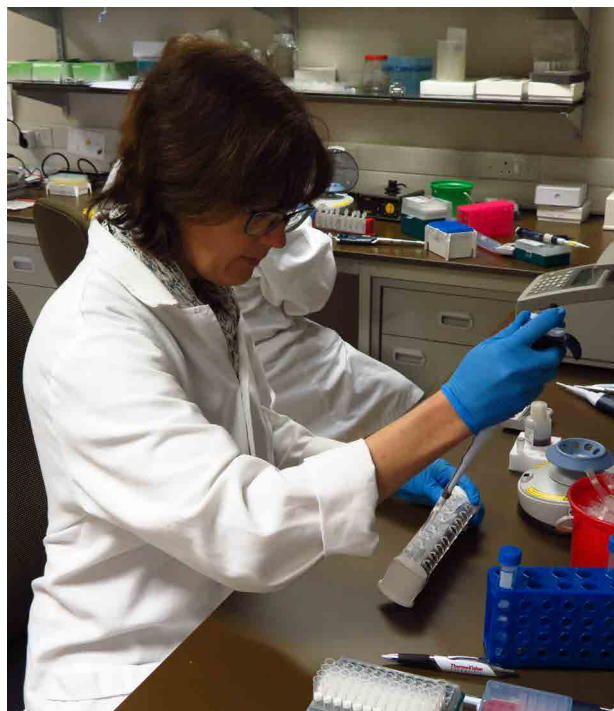
FABI FACILITIES

ION TORRENT SEQUENCING FACILITY

Facility director: Prof. Paulette Bloomer

Facility staff: Ms. Renate Zipfel
Mr. Nicky Olivier

The Ion Torrent Sequencing Facility at the University of Pretoria provides high-quality high-throughput sequencing solutions to researchers in southern Africa. Personal project planning meetings between Facility staff, researchers and students aim to optimize data and cost on a project-specific basis, while also involving students in project design decisions for career development. This close collaboration is crucial for interactive sample QC and project design optimization. Annual seminar sessions update attendees on new developments in sequencing technologies, while also showcasing staff and student research in next generation sequencing applications. To date the Facility has produced whole genome, targeted amplicon and metagenomic sequencing for virus, bacterial, fungal, human and veterinary samples in 200bp, 400bp and 600bp sequencing length chemistries.



Renate Zipfel assisting with the Ion Torrent library preparation

DNA SANGER SEQUENCING FACILITY

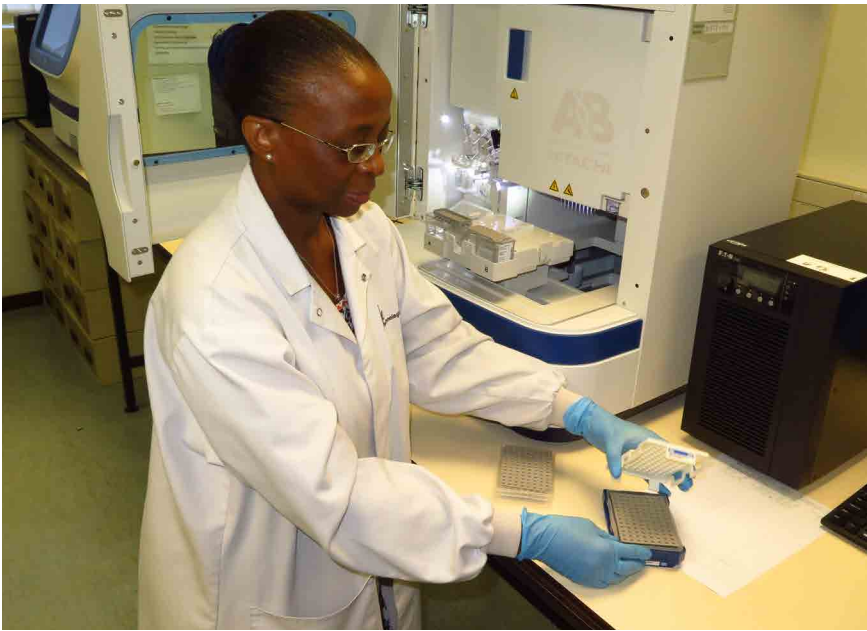
Custodians: Prof. P Bloomer and Prof. W-D Schubert

Staff: Ms. Renate Zipfel, Ms. Gladys Shabangu, Mr. Thuso Mapotsane

The DNA Sanger Sequencing Facility in the Faculty of Natural and Agricultural Sciences, has provided a DNA Sanger sequencing and fragment analysis service for researchers at the University of Pretoria for more than 20 years. The laboratory is situated on the third floor of the FABI Square and Bioinformatics building. The equipment housed in the facility is funded by the University of Pretoria and partly by a grant awarded by NRF National Equipment Platform (NEP 2011/2012; UID:78566). More than 40 research groups make use of the services of the facility, 12 of which are linked to FABI. During 2017 and 2018 the facility processed just short of 100,000 samples.

The resulting data are used for a wide range of applications including diagnostics related to diseases and pests; taxonomy of animals, plants, insects, fungi and bacteria; phylogenetics and population genetics analysis; DNA fingerprinting for parentage analysis and many other applications.

The DNA Sanger Sequencing Facility also provides technical support and training to clients making use of its services. The facility co-ordinates and hosts an annual Introductory Microsatellite Workshop in collaboration with Thermo Fisher Scientific in South Africa. The workshop is presented by members of



Sequence facility's Gladys Shabangu preparing ABI 454 for sequencing

staff and postdoctoral Fellows of the Department of Biochemistry, Genetics and Microbiology and Thermo Fisher Scientific including Dr Irene Barnes and Dr Tuan Duong from FABI. Of the 19 staff and students that attended the workshop in 2017, five were from FABI. In 2018, 22 staff and students participated, nine from FABI.

ACGT MICROARRAY FACILITY

Facility director: Prof. Dave Berger

Microarray scientific officer: Mr. Nicky Olivier

The ACGT (African Centre for Gene Technologies) Microarray Facility has a good track record in providing microarray services for researchers throughout Africa, including FABI. Current users of the ACGT Microarray Facility make use of the Agilent microarray platform, enabling the creation of custom array designs for organism of choice. Proprietary or publicly-available sequencing information is used to design slides containing 4 x 44,000 or 8 x 15,000 separate probes. The Facility boasts extensive expertise in experimental design, hybridization procedures and custom data analysis using open-source software (R and Bioconductor). In addition, the Facility is housed in a building with well-appointed laboratories for RNA isolation and all relevant molecular biology techniques. Researchers with limited access to such facilities at their home institutions are accommodated in these laboratories to perform the critical RNA isolations and hybridization procedures to ensure that the final data is representative of the biological effect under study. The Facility has not only been of great support to researchers in the Faculty of Natural and Agricultural Sciences, but also of the Faculties of Medicine and Veterinary Sciences, as well as various national and international research institutions.



DNA Sanger Sequencing sample preparation



TISSUE CULTURE PLATFORM AT FABI

Custodians: Prof. AA Myburg, Prof. Sanushka Naidoo, Ms. Adri Veale

Eucalyptus is cultivated as sources of woody biomass for various forest products. However, the long generation time of trees and the prolonged period required for evaluation of mature traits are strong limitations for classical breeding and selection. Functional genetics is an avenue that allows one to assess the function of candidate genes involved in wood formation as well as disease and pest resistance using genetic engineering tools such as transformation. Despite having established transformation protocols in several model species, these procedures in tree species such as *Eucalyptus* have been particularly challenging.

Thus Poplar has become a model tree species for genetic transformation, due to its high susceptibility to *Agrobacterium* and high regeneration rates. Production of transgenic poplar trees has been perceived as a possible approach for the control of diseases, and improvement of the plant quality. With the development of genome engineering technologies based on the CRISPR-associated RNA-guided endonuclease Cas9 systems that have broadened the agricultural research area, and brought in new opportunities to develop novel plant varieties, genetic engineering of poplar trees has become a powerful approach to test traits of high commercial value such as cellulose and hemi-cellulose



biosynthesis in trees. The tissue culture platform in FABI has established capacity for the development of transgenic *Arabidopsis* and Poplar plants and gene testing in the laboratory. From the laboratory we can transfer the plants to the growth facilities for comparative growth studies. We also have the capacity for routine tissue culture and *in vitro* propagation of a variety of different *Eucalyptus* genotypes.

DNA FINGERPRINTING PLATFORM

Custodians: Ms Melissa Reynolds
Prof. Zander Myburg

The DNA Fingerprinting Platform provides a high-throughput DNA fingerprinting research service to the South African forestry industry and academic collaborators towards tree improvement research. Our aim is to apply DNA markers in species of commercial importance to answer questions such as confirming clonal identity, reconstructing pedigrees and verifying species composition of pure species and hybrids. The Platform also provides support for molecular breeding applications by preparing DNA from tissues such as leaves, needles or cambium, to be used for SNP genotyping. Until now, our research services have been focused on Eucalypt and Pine species, however, a new SNP genotyping resource



Nasiphi Siguca preparing samples for DNA extraction



Cutting of leaf disks from samples for DNA extraction

is now available for Eucalyptus and Corymbia species, and a microsatellite genotyping resource in under development for Acacia. Furthermore, a SNP genotyping resource for the tropical Pines is in development and will be accessible to the South African forestry industry through the platform in 2020. To accommodate the increased demand resulting from these new resources, we are in the process of expanding the Platform to establish two parallel pipelines which will be fully operational early in 2020. This has been possible through dedicated funding from Forestry South Africa and the Forestry Sector Innovation Fund and with additional investment from the University of Pretoria and the FMG Consortium.

THE QUANTSTUDIO™ 12K FLEX REAL-TIME PCR FACILITY

Facility director: Prof. Sanushka Naidoo

Facility staff: Prof. Zander Myburg

Established in 2014 with a grant from the NRF National Equipment Platform (NEP), the QuantStudio™12K Flex Real-Time PCR facility has become an indispensable tool used by staff and students at the University of Pretoria and surrounding Universities across South Africa. The QuantStudio System allows for small to large-scale functional genomics studies, with two main functions: gene expression analysis or genotyping assays in either 384 well format or high throughput OpenArray® plates. In FABI, functional genomic characterization of wood development and disease resistance projects benefit from the facility. These projects include the expression analysis of hundreds of genes under varying conditions and treatments as well as SNP marker genotyping. In the past FMG as a group has used custom designed OpenArray® assays for SNP marker genotyping, and analysis of gene expression of pathogen defence related genes, and the activity of plastid genomes during the development of cambial layers in Eucalyptus trees. Since the establishment of the facility, the QuantStudio™ 12K Flex Platform has encouraged collaboration and mentorship across a wide range of research groups, Universities and Institutes. The facility has been used by researchers in many different fields, whether they are studying genetic markers of Alzheimer's disease or investigating genes related in the progression of Malaria through to researching drought tolerance in cassava. In short, the QuantStudio™12K Flex Real-Time PCR facility has answered the need for sensitive, high throughput qPCR analysis to researchers throughout Southern Africa.



MSc student Lungile Mabuza loading open array plates onto the QuantStudio 12K Flex Real-Time PCR instrument

FABI FUNGAL CULTURE COLLECTION

Academic member overseeing the collection:
Curator:
Technical staff:

Prof. Wilhelm de Beer
Dr Seonju Marincowitz
Ms. Lydia Twala and Ms. Valentina Nkosi

More than 200 academic articles were published in 2017 and 2018 based on studies using the cultures provided by the FABI Culture Collection

The FABI Culture Collection (also known as CMW in the scientific community) was established within the Tree Protection Co-operative Programme (TPCP) in 1989 as a small private collection of fungal pathogens of *Eucalyptus* diseases in South Africa. The collection has grown to accommodate more than 53,000 living cultures isolated from over 150 tree species worldwide. These cultures are generated from tree-health related projects by FABI researchers and their collaborators worldwide. The fungal cultures represent more than 150 fungal genera and over 1,000 fungal species. Between January 2017 and December 2018, more than 4,400 new cultures were deposited in the collection, while 2,700 cultures were requested for research and extracted from long-term storage. During the same period, more than 200 academic articles were published based on studies using the cultures provided by the CMW. It is the largest living fungal collection in Africa and the largest in the world containing tree-health related fungi.

The fungal cultures are stored in various ways. The main collection is housed in two walk-in cold-rooms in the FABI 1 and 2 buildings, while certain groups of fungi are freeze-dried and stored in dedicated -80°C freezers. In addition to maintaining cultures, the collection staff also oversee the microscope room with various state-of-the-art microscopes, a freeze microtome and freeze-dryer that is available for use to all FABI researchers. Five postgraduate students assist the collection staff for limited hours per week with some of the duties in the collection. All salaries in the collection are funded by the TPCP.



Fungal isolates in cold storage in the FABI fungal culture collection

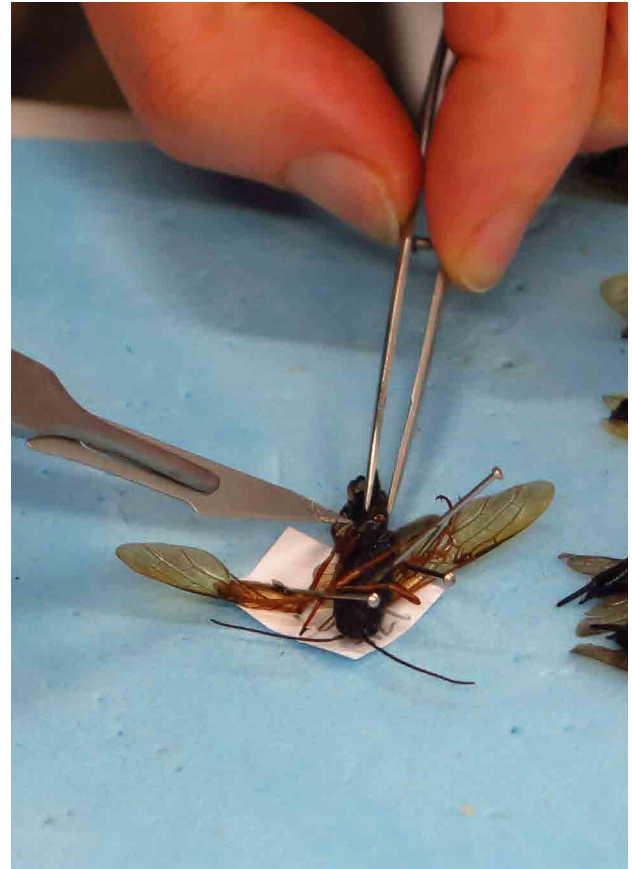


Prof. Wilhelm de Beer with the curator of the collection, Dr Seonju Marincowitz and Mrs Lydia Twala.

BIOCONTROL FACILITY AT FABI

Responsible persons: Prof. BP Hurley, Prof. B Slippers

The Biocontrol Facility, based on the Experimental Farm of the University of Pretoria provides state-of-the-art facilities for CTHB/TPCP research projects. These facilities include a Government-certified insect quarantine. This set of specially designed, access-controlled laboratories are where potential biocontrol agents, to use against insect pests on commercial plantations, are assessed before applying for Government permission for release. In addition, there are unrestricted laboratories that are equipped with walk-in fridges, autoclaves, incubators and microscopes. External facilities are available that include greenhouse tunnels where large-scale inoculation trials are conducted and seedlings are grown over winter and walk-in-cages that allow for trials under semi-natural conditions that can exclude or include insect pests, depending on what is needed. There is also a nursery that grows plants that are used for research either at the Biocontrol Facility or at the Hatfield campus. Research at the Biocontrol Facility is undertaken by postgraduates and highly qualified and experienced staff. This work includes research into, and rearing of the nematode *Deladenus*, the biocontrol agent for *Sirex noctilio*; research on biocontrol agents for *Eucalyptus* pests; and control of white grubs using entomopathogenic nematodes (EPNs). There are annual undergraduate practicals and frequent tours showcasing the facilities to both international and national guests.



Dissection of *Sirex noctilio*, a pest of *Pinus* species in South Africa

MONITORING TREE HEALTH AT SENTINEL SITES: BOTANICAL GARDENS AND ARBORETA

Research leaders: Dr Trudy Paap, Prof. Treena Burgess, Prof. Wilhelm de Beer, Prof. Bernard Slippers, JR Wilson (Stellenbosch University), Prof. Mike Wingfield

The majority of tree-damaging insect pests and pathogens arrive as accidental introductions, a by-product of increasing trade and globalisation. Most pests are not problematic in their natural range, consequently many damaging invasive pests were unknown to science prior to arriving and establishing in a new environment.

Therefore, they were not on watch lists and could not have been regulated against. The use of 'sentinel plantings', that is, plants established outside their natural range, is increasingly being used to identify

new host-pest associations, predict future tree health threats and gap-fill pest risk analyses. Botanical gardens and arboreta host a large range of exotic plant collections in diverse regions around the world, thus presenting a unique opportunity for sentinel research. In addition to their value for identification of novel host-pest interactions, when adjacent to high-risk sites such as ports, botanical gardens and arboreta can also provide an opportunity to detect damaging invasive forest pests during the initial stages of establishment. A sentinel research project monitoring tree health in botanical gardens and





Rugonectria sp. nov.



Ganoderma sp. on *Araucaria*

arboreta across South Africa was established in 2016. The project links South Africa's botanical gardens to the International Plant Sentinel Network (IPSN), a global platform established to coordinate sentinel research and facilitate information exchange and training of garden staff. A key focus of the project is the detection and diagnosis of threats to tree health. The project also provides garden staff with access to information and training to build capacity in the areas of biosecurity, pest detection, tree maintenance practices and management of existing tree health issues.

CHEMICAL ECOLOGY AT FABI

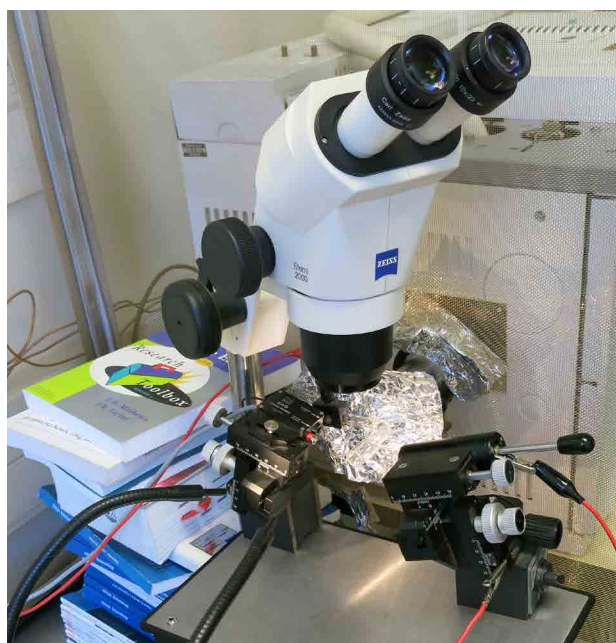
Responsible persons: Dr Almuth Hammerbacher, Dr Marc Bouwer

Chemical ecology is the study of how organisms interact with each other and their environment through chemical messages. These messages occur between different species and within a species. A good example of a chemical signal within a species is a sex pheromone which is produced to attract a mating partner.

Chemical signals between species are often more complex. Plants, for example, can produce volatile compounds in response to feeding by an insect herbivore. These volatiles can be a direct deterrent to the herbivore or can indirectly affect the herbivore by attracting natural enemies to the emitting plant.

Understanding the chemical ecology between pests and pathogens will aid in developing pest management strategies.

A variety of instruments are now available at FABI to strengthen chemical ecology at the Institute and to expand research relating to tree health.



Deciphering biologically-relevant chemical messages that function in ecological processes requires sophisticated equipment.



Dr Almuth Hammerbacher and the new GC-MS system installed in FABI in August 2018

These instruments included a gas-chromatography system coupled to an electro-antennogram detector to detect the response of insects to certain compounds.

A state-of-the-art Agilent gas chromatograph coupled to a mass spectrometer was recently purchased, as well as an Agilent liquid chromatograph coupled to a UV diode-array detector and a small Bruker ion trap mass spectrometer.

These instruments are now being used in a number of research projects in service to the forestry industry.

TREE HEALTH EXTENSION AND DIAGNOSTIC CLINIC

Responsible Researchers:

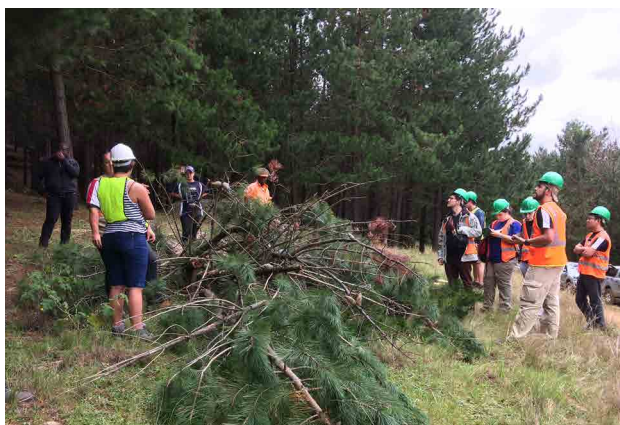
Prof. Jolanda Roux (Extension, monitoring and diagnostic clinic) (until 2018)
 Prof. Wilhelm de Beer (Diagnostic clinic, TreeHealthNet and FABI website) (2018-)
 Prof. Brett Hurley (Pest monitoring and extension)
 Prof. Bernard Slippers (Current FABI Director)
 Prof. Mike Wingfield (Past FABI Director)
 Ms. Izette Greyling (Extension and diagnostic clinic) (until 2018)
 Mr. Darryl Herron (Diagnostic Clinic)

The extension services of the Tree Protection Co-operative Programme (TPCP) and DST-NRF Centre of Excellence in Tree Health Biotechnology (CTHB) at FABI form an integral part of the research and services provided by these research programmes. Extension, which monitors pests and pathogens of native and plantation trees, provides a link between the research and the field - informing both. Field work is important, not only for postgraduate training but to create awareness of plant health amongst the general public, foresters, farmers and conservation staff.



Members of the TPCP/CTHB Diagnostic clinic with Rob Perry (Sappi) explaining cutting production





Members of the TPCP discuss the pitch canker pathogen, *Fusarium circinatum*, in a *Pinus greggii* compartment in the Eastern Cape



Students of the TPCP listen Dr Kitt Payn (Mondi) explaining the role of tree breeding in commercial forestry



Diagnostic clinic students being trained in the field

Extension services of the TPCP include a wide range of activities such as lectures presented at field days - mainly those organised by the Institute for Commercial Forestry Research (ICFR), reports in magazines and newspapers, radio and TV interviews, newsletters such as Tree Health News (using the email list server TreeHealthNet) and also via routine field visits. The TPCP extension services work closely with the TPCP/CTHB diagnostic clinic; the two are inseparable.

To ensure that the extension team, foresters and forestry managers receive the correct information, samples that are submitted through extension and via our stakeholders are processed in a world-class laboratory by well-trained diagnosticians. Correct

diagnoses are crucial to the monitoring function of the TPCP which is further extended by field visits linked to enquiries sent to the clinic.

A plant diagnostic clinic is a vital part of any plant producing industry. The more engaged a plant clinic is with the science, tools, techniques, pests and pathogens the more irreplaceable they become. The TPCP/CTHB diagnostic clinic is an extension of the TPCP and provides a powerful interface that connects TPCP research to the field. The clinic is well positioned within the TPCP and CTHB and that allows it to work in some of the best laboratories on the continent and to draw on the skills, expertise and research from some of the best tree pathologists in the world, making it world-class.



WORKSHOPS

Workshop in Kenya: “Maize foliar fungal pathogens – field scoring to molecular diagnostics”

As part of a South Africa-Kenya joint Science and Technology collaboration funded by the NRF of each country, the FABI team (Prof Dave Berger, Dr Irene Barnes and David Nsibo) presented a workshop entitled “Maize foliar fungal pathogens – field scoring to molecular diagnostics” at Maseno University near Kisumu, Western Kenya (August 2018). Guest speaker Dr. Suresh from CIMMYT-Kenya spoke on maize viral diseases, and Prof. Dida from Maseno covered resistance breeding. The workshop was attended by twenty academics and postgraduates from Maseno University, researchers from local seed companies and the Kenya Plant Health Inspectorate Service (KEPHIS).

Day one covered disease and pest diagnostics, and phenotyping for a maize breeding programme. Day two included field work, where maize plots at the Maseno University research farm were scored for the main foliar diseases. A microscopy practical followed. Day three was a series of hands-on tutorials on molecular diagnostics of fungi, including BLAST searches at the NCBI database, and construction of phylogenetic trees to ensure accurate species identification. David Nsibo illustrated population genetics for crop protection by presenting some of his PhD findings on the grey leaf spot pathogen of maize.

The First Polyphagous Shot Hole Borer Workshop in Africa

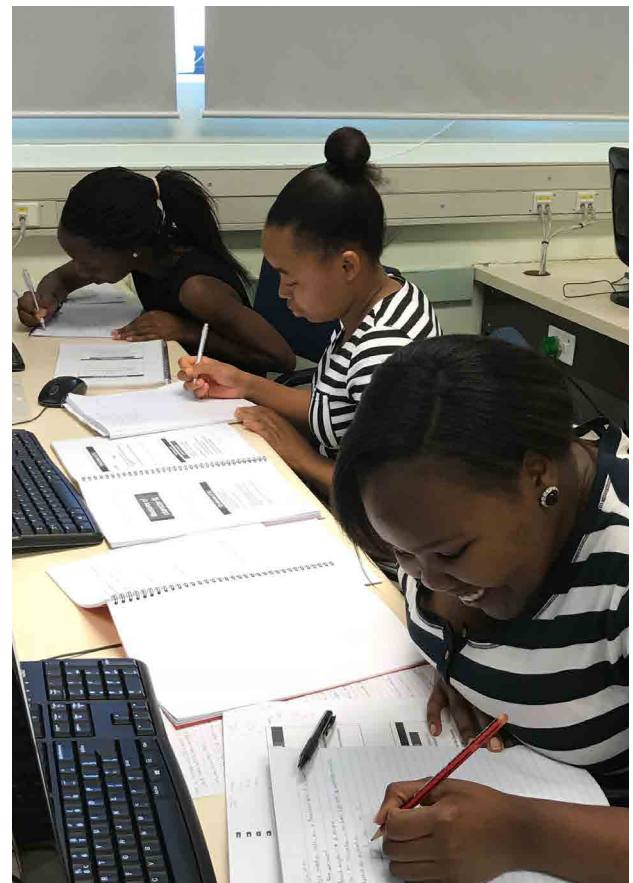
In November 2018 the first workshop in Africa specifically focused on the invasion of the Polyphagous Shot Hole Borer (PSHB) was hosted in FABI under the leadership of Prof. Wilhelm de Beer. CABI (Centre for Agriculture and Bioscience International) requested FABI to train scientists from across Africa to enable them to detect the presence of the PSHB elsewhere in Africa.

The workshop, fully funded by CABI, was attended by 25 people from 14 countries that included Botswana, Cameroon, Ethiopia, Ghana, Kenya, Malawi, Mozambique, Namibia, South Africa, Swaziland, Tanzania, Uganda, Zambia and Zimbabwe. Lectures were presented by various members of the FABI team, the ARC and the Early Warning Systems Division of DAFF, on aspects like the biology, life cycle,

symbiosis, impact, spread, control and management of the PSHB. The group visited streets with infested trees in Johannesburg where the beetle is killing hundreds of street trees. The attendees were also trained in basic lab techniques and the recognition of the PSHB and its fungal symbionts. A PSHB African Network under the guidance of Dr Arne Witt of CABI was formed, that will monitor and report possible PSHB infestations in Africa.

Metagenomics Workshop

In 2018, a metagenomic analysis workshop was presented from 22-26 October and organised by Dr Tuan Duong (academic staff member of FABI). The purpose of this workshop was to equip students and staff with the basic principles, experimental design, and data analysis in metagenomics and metatranscriptomics studies. The workshop was presented by Dr Richard Allen White III (Washington State University), Dr Martin Kemler (Ruhr-University Bochum), and Dr Maria Vivas (postdoctoral Fellow at FABI).



Phylogenetic training for workshop attendees



Making sense of Markov Chain Monte Carlo (MCM) simulations

Phylogenetics Workshops

Phylogenetic workshops presented at FABI under the auspices of the CTHB focus on the theoretical and applied aspects of contemporary methods used to infer phylogenetic relationships amongst organisms.

The importance of these workshops, within the plant pathology context, stems from the fact that understanding phylogenetic relationships is an essential aspect of pest and pathogen identification and management.

The workshops were initiated in 2004 following the realization that most researchers have limited experience in the practical application of evolutionary models and tree building algorithms as well as the execution of computer software used for the analyses. A major objective for the workshops has been to provide “hands-on” experience in the use of databases available on the world-wide-web and the range of software, both commercial and freeware, currently available for evolutionary biologists.

The workshops – designed and presented by Prof. Martin Coetzee – are offered on a yearly basis and cater for researchers ranging from novices to those having advanced background in the field.

Workshops form an important part of skills transfer and capacity development

Microsatellite workshops

Microsatellite workshops were developed for students with little to no experience in this technology and are presented yearly in collaboration with FABI staff. The workshop introduces the basic concepts relevant to the different methods used to develop microsatellite markers, PCR optimisation and how to analyse data. Short introductory lectures on population genetics and basic principles and the applications of genotyping by sequencing on the Ion Torrent (and Illumina platforms) are presented during the workshop. The workshops were co-ordinated by Ms Renate Zipfel (DNA Sanger Sequencing Facility at UP) and facilitated by research staff from the Department of Biochemistry, Genetics and Microbiology, including Dr Irene Barnes (academic staff member at FABI).

SABBATICAL VISITS

Prof. Z.W. de Beer: Short sabbatical at the University of Florida, Gainesville



Professor Wilhelm de Beer inspecting a Coral tree killed by PSHB together with Ben Faber at Huntington Botanical Garden

From May to July 2018, Prof. de Beer spent eight weeks in the laboratories of Prof. Jiri Hulcr, leader of the Ambrosia Symbiosis Research Group in the School of Forest Resources and Conservation at the University of Florida. The aim of Prof. de Beer's visit was to gain experience in laboratory and field techniques working with ambrosia beetles, because most of his experience to date was mainly with bark beetles, a related but ecologically different group of beetles. Prof. de Beer joined the Hulcr Group on several field collection trips in Florida, and he is involved in a number of projects related to the taxonomy of fungal associates of ambrosia beetles by members of the team.

During his sabbatical, Prof. de Beer also visited the laboratories of Prof. Randy Ploetz, a long-time collaborator of FABI in southern Florida. In addition, Prof. de Beer was able to spend a week in California visiting several research groups and field sites of Polyphagous Shot Hole Borer (PSHB) infestations. The PSHB invaded California about 10 years before it arrived in South Africa, and most of the research on the beetle and its fungus has been done in California.

The visit was particularly insightful to gain a better understanding of what the impact of PSHB might be in South Africa over the longer term.



Prof. Brett Hurley

Woodwasps, nematode-vectoring beetles and rearing leaf eating caterpillars were some of the topics that kept Prof. Brett Hurley busy from July 2018 to January 2019 during his sabbatical at the Great Lakes Forestry Centre (GLFC) in Sault Ste. Marie, Ontario, Canada. Prof. Hurley was hosted at the GLFC by Prof. Jeremy Allison, a collaborator at FABI and Extraordinary Professor of the University of Pretoria.

One of the objectives of the sabbatical period was to complete a number of projects on the Sirex woodwasp, *Sirex noctilio*, and write up the work for publication. *Sirex* has been introduced as a pest of pine trees in both South Africa and Canada, and has been the focus of many collaborative projects between GLFC and FABI. The projects include investigating the visual and chemical cues of *Sirex* and the potential use of these cues in traps, and the affect of attack density and co-occurring insects on *Sirex* survival. The sabbatical also provided an opportunity for Prof. Hurley to work on ten years of dissection data to investigate factors influencing the biological control of *Sirex* with a parasitic nematode. This work was in collaboration with colleagues at FABI and Prof. Allison and Drs. Chris MacQuarrie of GLFC.

Another objective of the sabbatical was to learn about the systems and protocols of the Insect Production and Quarantine Facility at GLFC. This facility produces laboratory-reared insects to facilitate research on various insect pests of forest trees, using well-established protocols and high levels of quality insurance. Many of the insects are reared on artificial media, methods that allow rearing insects that would otherwise be difficult to study. Rearing insects on artificial media has been identified as a key tool to further advance research at FABI on insect pests of agricultural and forestry importance.

Besides the objectives mentioned above, the sabbatical was an important period to engage with researchers in various areas of tree health research. This included participating in field trips to study the flight behaviour and other aspects of the Monochamus beetles, vectors of the nematode caused pine wilt disease, a serious problem in many countries and potential threat to South Africa. Prof. Hurley was also privileged to attend and participate in the joint meeting of the USA and Canada Entomological Societies that was held in Vancouver. Over 3,800 people attended the meeting, with 265 scientific sessions and 2,430 oral presentations.



Prof. Brett Hurley gaining experience in insect-rearing methods at the Great Lakes Forestry Centre

Besides strengthening the collaboration between GLFC and FABI, the sabbatical contributed two papers published in 2019, one that was submitted for review and two papers that will be submitted in the near future. Collaborations between the two institutes continue to grow with further exchange of researchers and development of new collaborative projects.

Prof. Hurley is an academic staff member at FABI, research leader in the Tree Protection Cooperative Programme (TCP) and the DST-NRF Centre of Excellence in Tree Health Biotechnology (CTHB) programme, and associate Professor in the Department of Zoology and Entomology. His research focus is on insect pests of forest trees, specifically examining the effect of these insect-plant interactions and how these effects can be managed in the context of an integrated management program. Much of his research focuses on the development and implementation of biological control as a management strategy.

AWARDS & HONOURS

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 organisations 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.

FABI Awards

A suite of awards made annually to exceptional FABIans and FABI stakeholders. FABI awards were presented for the first time in 2007 and these have come to be recognised as important and highly prized. The FABI awards 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.

- 2017** Valentine Nakato
- 2018** RunLei Chang
- 2018** Desré Pinard

Best Postdoctoral Fellow Publication

This award recognises the best publication produced by a postdoctoral Fellow in the award year. The recipient in the case of this award is chosen based on the ISI impact factor of the paper produced.

- 2017** Dr Alistair McTaggart
- 2018** Dr Markus Wilken

Best FABI MSc Thesis

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

- 2017** Drew Behrens (2017)
- 2018** Ginna Granados (2018)

FABI Award for Mentorship

MSc or PhD students who have demonstrated outstanding mentorship, in the broad sense, to other students.

- 2017** Benedicta Swalarsk-Parry
- 2017** Wilma Nel
- 2018** Jonathan Botha
- 2018** Erik Visser

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.

- 2017** Juanita Avontuur
- 2017** Benedicta Swalarsk-Parry
- 2017** Arista Fourie
- 2017** Angel Maduke

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.

- 2017** Prof. Susan Adendorff
- 2018** Xolani Hadebe
- 2018** Honest Maqwara

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.

- 2017** Sally Upfold (Institute for Commercial Forestry Research – ICFR)
- 2018** Prof. Andre Drenth (University of Queensland)

FABIan of the Year

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



- 2017** Andi Wilson
2018 Danielle Roodt Prinsloo

Best FABI Student Personal Website

Awarded to the student with the most creative, informative and up to date personal website.

- 2017** Quentin Guignard
2017 Darryl Herron
2018 Firehiwot Eshetu

Photographic Awards

Two awards are made annually for photographs judged to be the best in their category. These categories are:

Best Photograph Illustrating a FABian or FABians at Work

- 2017** Prof. Dave Burger
2018 Prof. Zander Myburg

Best Photograph Illustrating FABI Research

- 2017** Angelique du Preez (2017)
2018 Mathew Harris (2018)

AWARDS TO MANCOM:

Prof. Terry Aveling was nominated and appointed Vice-Chairperson of the Seed Health Committee 2016-2019 of the International Seed Testing Association. She is also chairperson of the International Society of Plant Pathology Seed Pathology Committee.

Dr Irene Barnes received the Ethel Mary Doidge Medal – Young Mycologist Award – from the International Mycological Association (IMA) in 2018. She was also the first runner-up in the Distinguished Young Women Researcher category of the South African Women in Science Awards.

Prof. Lucy Moleleki was awarded the Biotech Fundi Award for Capacity Development.

Prof. Brenda Wingfield was the recipient of the Harry Oppenheimer Memorial Fellowship. She was awarded a DST/NRF SARChI Research Chair in Fungal Genomics in 2016 and an Honorary Membership of Mycological Society of America 2017 (highest honour for an international mycologist). In 2018 she received the South African Society of Microbiology Gold Medal and was also the first female recipient of this award.

Dr ShuaiFei Chen was selected for the Youth Top-Notch Talent of National “Ten-thousand Talents Program” of China in 2018.

Prof. Mike Wingfield received the Distinguished Leadership Award for Internationals from his *alma mater*, the University of Minnesota in June 2017. He was described in the award citation, as being amongst the most productive scientists of his generation, and possibly ever, in the field of forest health. He was included in the Clarivate Analytics (Web of Science) list of the most Highly Cited Researchers in 2017 and 2018. This list contains the names of the people associated with the top one percent of citation in their specific field. Mike was also one of only 50 recipients of the prestigious Chinese Government Friendship Award for 2017. This is the highest award conferred on foreign experts who have made an outstanding contribution to the country's social and economic progress. The award was presented to Prof. Wingfield at a ceremony in the Great Hall of the People by Chinese Premier, His Excellency Li Keqiang. The award acknowledges his 20 years of collaboration with Chinese colleagues in the field of tree health as well as his work as President of the International Union of Forest Research Organisations (IUFRO). Prof Mike Wingfield received the Distinguished Forestry Award of the Southern African Institute of Forestry in 2018 for his contribution to forestry over the years. In 2019, he was presented with the Mondi CEO Award for Excellence. At the University of Pretoria's Academic Achievers' Awards night in May 2019, Prof Wingfield was bestowed the Vice-Chancellor's Award for Excellent Supervision acknowledging “excellence in mentoring and guidance” as well as the supervision and co-supervision of more than 100 PhD students and 68 MSc students.

Prof. Bernard Slippers was one of more than 6000 scientists in the world included in the Clarivate Analytics (Web of Science) list of the most Highly Cited Researchers in 2018. The Southern African Institute of Forestry honoured Prof. Slippers in 2018 with the Continuous Service Excellence Award to the Forestry Industry for his efforts to improve the industry.

In 2018, Extraordinary **Prof. Pedro Crous** received the Ainsworth Medal for extraordinary service for the International Mycological Association and world mycology.

As a representative of the South African Society of Microbiology, **Prof. Fanus Venter** was again selected to the board of the International Committee on Systematics of Prokaryotes in July 2017.

The Suid Afrikaanse Akademie vir Wetenskap en Kuns awarded **Prof. Jolanda Roux** the Havenga Prize for Natural Sciences in September 2017.

UNIVERSITY OF PRETORIA AWARDS:

Chancellor's Award for Research

Prof. Zander Myburg (2019)

Exception Young Researchers:

Prof. Eshchar Mizrachi (2018-2020)

Exceptional Achievers Awards:

Prof. Teresa Coutinho (2016-2019)

Prof. Zander Myburg, 2017-2019

Prof. Fanus Venter (2017-2019)

Prof Emma Steenkamp (2019)

Other University of Pretoria awards:

Dr Steven Hussey, Tuks Young Research Leadership Programme (2017)

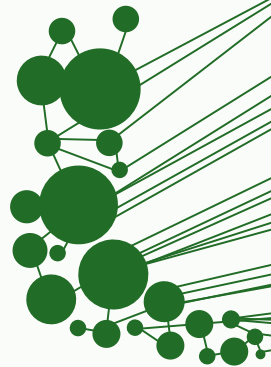
FELLOWSHIPS AWARDED:

Prof. Teresa Coutinho, Southern African Society of Plant Pathology (2017)

Prof. Sanuska Naidoo, Next Einstein Forum Fellowship (2018-2019)

Prof. Zander Myburg, SA Genetics Society Fellowship Award (2018).

Prof. Brenda Wingfield, American Phytopathological Society Fellow Award (2017)



PRESTIGIOUS BURSARIES/ SCHOLARSHIPS

Prestigious NRF bursary holders NRF scarce skills/innovation scholarships

Arista Fourie (2014-2017)
Ariska van der Nest (2014-2016)
Khumbuzile Bophela (2016-2019)
Gina Shin (2016-2019)
Katrien Brown (2017)
Martin Wierzbicki (2017)
Dineo Mailula (2017-2018)
Danielle Roodt (2017-2018)
Juanita Avontuur (2017-2019)
Sanele Moyana (2017-2019)
Marja O'Neill (2017-2019)
Benedicta Swalarsk-Parry (2017-2019)
Andrea Wilson (2017-2019)
Melissa Joubert (2018)
Mohamed Seedat (2018)
Barkat Ali (2018-2019)
Lomile Khoete (2018-2019)
Kira Lynn (2018-2019)
Wilma Nel (2018-2019)
Luki-Marie Scheepers (2018-2019)
Brenda Chitonga (2018-2020)
Siliindile Maphosa (2018-2020)
Leandri Bezuidenhout (2019)
Julia Candotti (2019)
Minette Havenga (2019)
Luke Kim (2019)
Nganea Nangambi (2019)

Claude Leon Postgraduate Fellowships

Dr Markus Wilken (2017)
Dr Mark Maistry (2016-2018)

Other prestigious scholarships

Danielle Roodt, South African Women in Science Award Winner (DST-Albertina Sisulu Doctoral Fellowship)
Phinda Magalula – Master Card Scholarship (2017-2018)



FABI 20: THE ROAD TO RESEARCH EXCELLENCE

FABI celebrated two decades of research excellence with a science symposium held on 24-25 January in the Aula Theatre on the Hatfield Campus of the University of Pretoria. More than 300 FABI alumni, academics, Government and forestry industry representatives, as well as many current FABI researchers, staff and students, attended the two-day celebration, themed "The Road to Research Excellence". After more than a year's planning the event was a resounding success, combining science with art, culture and celebration. The symposium featured 39 presentations including speed presentations by six FABI postgraduate students. Some 60 foreign guests travelled from 15 countries across the globe to attend the celebration. This number also included some of the researchers from seven South African and 22 international universities and research institutes. For the full programme visit <https://www.fabinet.up.ac.za/index.php/fabi/fabi-20th-anniversary-celebrations>





SOME SOCIAL HIGHLIGHTS IN FABI

ANNUAL SPOOF* MEETING 2018

**Society for the Presentation of Outrageous Findings*

Theme: The Magic Kingdom



ANNUAL SPOOF MEETING 2019

Theme: Medieval Theme



TEAM ACHIEVEMENTS: MAY 2017 TO END OF 2018

Danielle Roodt, a PhD student in FABI, has been selected to become a Plantae Fellow for the 2017-2018 period, the only African representative among a group of 35 scientists worldwide. Plantae is an online resource initiative started by the American Society of Plant Biologists (ASPB) to provide the plant science community with the most up-to-date information and advances in the field of plant biology. The Plantae platform focuses on science communication as well as disseminating the most recent publications to its community in the form of short summaries. For the next year, Danielle and the other Fellows will have the opportunity to enhance their writing skills, share their interests in plant science with others, and network and interact with international participants.

The University of Pretoria was ranked second in Mycology in the Centre for World University Rankings (CWUR) Rankings by Subject – one of only three South African Universities to make the 2017 Top 10 lists based on subject.

The analysis considers publications in scientific journals in specific subject areas. The articles in the journals of a specific subject, and their citations over the previous 10 years, are used to calculate the scores for the ranking. All data is obtained from the Web of Science. The University of Pretoria produced 346 'Mycology' articles from 2006 to 2015, the period on which the 2017 rankings is based. More than 330 of these papers were produced by FABIans.

COMMUNITY INITIATIVES



University of Pretoria “Community Engagement” photographic competition

The University of Pretoria had a University-wide (staff and students) photographic competition with the topic of “Community Engagement”. The aim was to promote and enhance awareness of social responsibility and community engagement activities by UP staff and students.

Photographs submitted by FABI staff featured in the winning categories with Prof. Dave Berger taking second prize (Fall armyworm awareness campaign), and a photo by Dr Irene Barnes featured in the top eight (maize disease field workshop in Kenya). The exercise was also a good lesson in protocol – all persons featured in the photos had to give their consent.

FABI Social Club Initiatives

FABI has several community outreach projects under the caring guidance of Prof. Noëlan van den Berg and, from 2019, Dr Gerda Fourie and the FABI Social Club. These projects encompass both the well-being of the community and encouraging learners to follow a career in science.

Blanket Drive

FABIans collected warm winter clothes, linen and 135 blankets during the 2017 Annual Blanket Drive. Sammy Prinsloo of Akanani, an organisation under the banner of the Tshwane Leadership Foundation, collected the winter warmers on 7 June. Based in Burgers Park, the organisation offers holistic support to homeless communities in the Tshwane city centre. Ms. Prinsloo said the donation had come at the

right time and would help to meet the demand for blankets at this time of the year.

Akanani provides not only food and toiletries to homeless children, women and men in Tshwane, but also referrals to health and legal services. To help homeless people get back on their feet and become independent, Akanani also assists with the processes of replacing lost identity documents and job applications, said Ms Prinsloo.

Flower Drive

The FABI Flower Drive 2018, was a year-long campaign to collect sanitary products for girls at school who cannot afford them. The high cost of sanitary products such as pads and tampons can be crippling, forcing girls to miss valuable time in the classroom every month. To mark the beginning of the school year, FABIans collected 189 packets of stationery items and 304 sanitary products.

Santa Shoebox

The festive season is about the joys of giving, so in this tradition, a group of FABIans from the Shaw Lab decided to ensure that eight underprivileged children received a Christmas gift in the form of a Santa Shoebox. This project succeeded in collecting and distributing more than 650,000 shoeboxes to children within South Africa and Namibia in 2016, with a goal of 760,000 shoeboxes aimed for this year, in the march to a million shoeboxes by 2019.

Anyone can pledge a shoebox by choosing a female/male child of a certain age. The shoebox is filled with eight items: toothbrush and toothpaste, face cloth



The CTHB outreach team inspiring future scientists during the Limpopo Career Week

and soap, sweet, toy and an item of stationary and clothing. This project aims to bring a smile to many a child's face, but also succeeded in making us smile.

FMG Undergraduate Bursary Programme

In 2016, FMG initiated an Undergraduate Bursary Programme in collaboration with Mondi and Sappi and welcomed three undergraduate students into the FMG team: Mr Tebogo Molemela (Mondi-FMG Undergraduate Bursary Recipient), Ms Lethabo Lefoka (Sappi-FMG Undergraduate Bursary Recipient) and Ms Medha Sood (FMG Undergraduate Bursary Recipient). These students were supported for three year (up till 2018).

CTHB Outreach Team

Apart from promoting postgraduate learning, the DST-NRF Centre of Excellence in Tree Health Biotechnology (CTHB), as part of FABI, has placed a strong emphasis on community engagement. Each year an outreach team consisting of postgraduate students from the Centre are engaging school learners, teachers and the general public. The team for 2018 included Juanita Avontuur (team leader; PhD), Angel Maduke (MSc), Arista Fourie (PhD), and Benedicta Swalarsk-Parry (PhD). In 2018 they were Juanita Avontuur (team leader, PhD), Benedicta Swalarsk-Parry (PhD), Angel Maduke (MSc), Modjadjji Makwela (MSc) and Fezile Mthunzi (MSc). The team is responsible for the outreach activities associated with science engagement initiatives such as the National Science Week, Scifest, visits to local schools, and visits by school learners to FABI and other SAASTA (South African Agency for Science and Technology Advancement) initiatives.



The CTHB outreach team are regular participants in the National Science Week



STAFF

Full time academic research staff

Prof. Bernard Slippers (Director)
Prof. Mike Wingfield (Founding Director)
Prof. Fanus Venter (Deputy Director)
Prof. Dave Berger
Prof. Teresa Coutinho
Prof. Zander Myburg
Prof. Emma Steenkamp
Prof. Brenda Wingfield
Assoc. Prof. Terry Aveling
Assoc. Prof. Martin Coetzee
Assoc. Prof. Wilhelm de Beer
Assoc. Prof. Brett Hurley
Assoc. Prof. Lucy Moleleki
Assoc. Prof. Sanushka Naidoo
Assoc. Prof. Noëlani van den Berg
Assoc. Prof. Juan Voster
Dr Irene Barnes
Dr Nicky Creux
Dr Tuan Duong
Dr Gerda Fourie
Dr Almuth Hammerbacher
Dr Steven Hussey
Dr Eshchar Mizrahi
Dr Albé van der Merwe

Honorary Professors and lecturers

Prof. Jeremy Allison
Prof. Treena Burgess
Prof. Karl Kunert (Emeritus Professor)
Prof. Stefan Naser
Prof. Gerhard Pietersen
Prof. Jolanda Roux
Assoc. Prof. Paul Birch
Assoc. Prof. Pedro Crous
Assoc. Prof. Ian Toth
Assoc. Prof. Steve Verryin
Dr Wubetu Bihon
Dr ShuaiFei Chen
Dr Bridget Crampton
Dr Carlos Rodas

Administrative staff

Mr. Morné Booij-Liewes
Ms. Helen Doman
Ms. Heidi Fysh
Ms. Martha Mahlangu (until July 2017)
Ms. Tumi Mogwera (until 2018)
Ms. Resego Moje (until June 2015)
Ms. Eva Müller
Ms. Thandeka Ngondo
Ms. Tshwarelo Sekhaulelo (from 2019)
Ms. Smeetha Singh
Ms. Namhla Tshisela
Ms. Madelein van Heerden
Ms. Estie van Rensburg

Programme Manager

Dr Ronishree Mangwanda

Technical and support staff

Ms. Samantha Bush
Ms. Juanita Engelbrecht
Mr. Feroze Ferris (2015-2018)

Ms. Onke Gayiya
Ms. Izette Greyling (until September 2018)
Ms. Ruth Guilande
Mr. Stephan Henning
Ms. Sandisiwe Jali
Ms. L'Zanne Jansen van Rensburg
Ms Mamadile Kgaphu
Mr. Joseph Khadile
Ms. Pritty Khumalo
Ms. Ncobile Kunene
Ms. Cebeni Langa
Ms. Grieta Mahlangu-Kobe
Ms. Christy Marais
Dr Seonju Marincowitz
Mr. Guelor Mayonde
Ms. Pfano Mbedzi
Ms. Zandile Mngadi (until May 2017)
Ms. Tersia Moabela
Ms. Lerato Moeng (Intern)
Ms. Patience Motaung
Dr Kershney Naidoo (until 2017)
Ms. Aysha Ndou
Mr. Celani Nkosi
Ms. Valentina Nkosi
Ms. Sophie Nyoni
Mr. Nicky Olivier
Ms. Marja O'Neill
Ms. Alisa Postma
Ms. Melissa Reynolds
Ms. Nicole Rudolph
Ms. Doleen Sehlabane (Intern)
Ms. Gladys Shabangu
Ms. Nasiphi Siguca
Mr. Bernard Smit
Ms. Maureen Tladi
Ms. Lydia Twala
Ms. Andisiwe Tyani
Ms. Karen van der Merwe
Ms. Adri Veale
Ms. Renate Zipfel

Information specialist

Ms. Rianie van der Linde

Postdoctoral Fellows and Senior Research Fellows

Dr Janneke Aylward

Senior Postdoctoral Research Fellow
Biology of *Teratosphaeria* pathogens of *Eucalyptus*.
Supervisors: MJ Wingfield, BD Wingfield

Dr Daniel Bellieny-Rabelo

Postdoctoral Fellow
Pectobacterium carotovorum brasiliense virulence factors.
Supervisor: L Moleleki

Dr Tanay Bose

Postdoctoral Fellow
Identifying the causal agent/s of root rot of *Eucalyptus nitens* and other *Eucalyptus* species, and developing mitigation strategies through silvicultural treatments to improve eucalypt root health.
Supervisors: B Slippers, MJ Wingfield, J Roux

Dr Marc Bouwer

Postdoctoral Fellow
Chemical ecology of pest insects in South African forestry industry.
Supervisors: B Slippers, ER Rohwer, M Wingfield

Dr Vuyiswa Bushula-Njah

Postdoctoral Fellow
Population genetics and genomics of *Fusarium xylarioides*.
Supervisor: ET Steenkamp, BD Wingfield

Dr Gabrielle Carstensen

Postdoctoral Fellow
Management of bacterial wilt in *Eucalyptus* plantations and nurseries in Brazil and Indonesia.
Supervisor: MJ Wingfield

Dr RunLei Chang

Postdoctoral Fellow
Comparative genomics of the human and animal pathogenic and saprophytic fungi in the genus *Sporothrix*.
Supervisors: BD Wingfield, TA Duong, MJ Wingfield

Dr Nanette Christie

Postdoctoral Fellow
Systems genetics of wood formation in *Eucalyptus* hybrids.
Supervisor: AA Myburg

Dr Lieschen de Vos

Senior Postdoctoral Research Fellow
Genomic comparison of species within the *Fusarium fujikuroi* species complex.
Supervisor: BD Wingfield

Dr Gudrun Dittrich-Schröder

Postdoctoral Fellow
Use of gene editing for pest control.
Supervisors: B Slippers, MJ Wingfield, BP Hurley

Dr Stuart Fraser (until 2017)

Postdoctoral Fellow
Identification and control of an emerging new rust disease of *Acacia mearnsii* in South Africa.
Supervisor: MJ Wingfield

Dr Felix Fru

Postdoctoral Fellow
Population genetics of *Fusarium circinatum* in South African nurseries.
Supervisors: ET Steenkamp, MJ Wingfield

Dr Mesfin Gossa

Postdoctoral Fellow
Diversity and distribution of *Eucalyptus* insect pests and their natural enemies in sub-Saharan Africa.
Supervisors: BP Hurley, B Slippers

Dr Fahimeh Jami

Senior Postdoctoral Research Fellow
Botryosphaerales species associated with *Eucalyptus* spp. and other trees in Indonesia and Brazil.
Supervisor: MJ Wingfield

Dr Aquillah Kanzi

Postdoctoral Fellow
Comparative genomics of fungal mitochondrial genomes.
Supervisor: BD Wingfield

Dr Godfrey Kgatle

Epidemiology and control of Phoma black stem and Alternaria leaf blight of sunflower in South Africa.
Supervisor: TA Aveling

Dr Riikka Linnakoski

Postdoctoral Fellow
Bark beetle-associated fungi: Diversity, pathogenicity and risks related to timber trade and climate change.
Supervisor: Prof. ZW de Beer

Dr FeiFei Liu

Postdoctoral Fellow
Comparative and population genomics of the *Eucalyptus* leaf blight pathogens in the genus *Calonectria* in China.
Supervisors: TA Duong, BD Wingfield, MJ Wingfield, SF Chen (CERC)

Dr Mark Maistry (until 2018)

Postdoctoral Fellow
Investigating proteins impacting organellar carbon metabolism during xylogenesis.
Supervisor: AA Myburg

Dr Vicki Maloney

Postdoctoral Fellow
CRISPR modification of xylan biosynthetic genes.
Supervisors: AA Myburg, E Mizrahi

Dr Alistair McTaggart (until 2017)

Senior Postdoctoral Research Fellow
Rust fungi of southern Africa.
Supervisor: MJ Wingfield

Dr Osmond Mlonyeni

Postdoctoral Fellow
The relevance of genetic diversity in the management of forest pests through biological control.
Supervisor: B Slippers

Dr Esther Muema

Postdoctoral Fellow
Diversity and abundance of total and nitrogen-fixing communities associated with legumes in the dryland soils of the Succulent Karoo biome in South Africa.
Supervisors: ET Steenkamp, FS Venter

Dr Awelani Mutshembele (until 2018)

Postdoctoral Fellow
Evolution of the MAT locus-bearing chromosomes in *Fusarium*.
Supervisor: BD Wingfield

Dr Sarah Mwangi

Postdoctoral Fellow
De novo assembly and annotation of susceptible and tolerant avocado root transcriptomes infected with *Phytophthora cinnamomi*.
Supervisor: N van den Berg

Dr Caryn Oates

Postdoctoral Fellow
The *Eucalyptus* immune co-expression network.
Supervisor: S Naidoo, K Denby

Dr Letrisha Padayachee

Postdoctoral Fellow
Development of low-cost point-of-care prototypes for HIV and Hepatitis B detection and viral load monitoring.
Supervisor: SG Hussey

Dr Trudy Paap

Senior Postdoctoral Research Fellow
Monitoring tree health at sentinel sites: botanic gardens and arboreta.
Supervisor: MJ Wingfield



Dr Marike Palmer

Postdoctoral Fellow
Genome-based bacterial systematics.
Supervisors: SN Venter, ET Steenkamp

Dr Raphael Ployet

Postdoctoral Fellow
Systems genetics and transcriptional control of dissolving pulp and biorefinery traits in *Eucalyptus*.
Supervisors: AA Myburg, SG Hussey

Dr Laure-Anne Poissonnier

Postdoctoral Fellow
Role of diet in long-lived termite reproductive system.
Supervisor: ZW de Beer

Dr Ashok Prabhu

Postdoctoral Fellow
Establishment of an *Agrobacterium rhizogenes*-mediated transformation system in avocado (2017).
Label-free quantitative proteomics approach to understand the avocado *Phytophthora cinnamomi* interaction (2018).
Supervisor: N van den Berg

Dr Danielle Roodt

Postdoctoral Fellow
The molecular mechanisms and biosynthesis of plant secondary metabolites in non-coniferous gymnosperms with a specific focus on lignin.
Supervisor: E Mizrachi

Dr Quentin Santana

Postdoctoral Fellow
Genetic determinants of vegetative incompatibility and female fertility in *Fusarium circinatum*.
Supervisors: ET Steenkamp, BD Wingfield, MPA Coetzee

Dr Michelle Schröder

Postdoctoral Fellow
Biological control of the Eucalyptus Snout Beetle.
Supervisors: BP Hurley, B Slippers, MJ Wingfield

Dr Louise Shuey (until 2017)

Postdoctoral Fellow
Defence responses in *Eucalyptus* to fungal pathogens.
Supervisor: AA Myburg

Dr Divine Shyntum

Postdoctoral Fellow
Antibacterial competition mechanisms of *Pectobacterium carotovorum brasiliense*.
Supervisor: L Moleleki

Dr Siphathele Sibanda (until 2019)

Postdoctoral Fellow
Functional analysis of quorum sensing in *Pantoea ananatis*.
Supervisor: TA Coutinho

Dr Melissa Simpson

Postdoctoral Fellow
Mating in *Ceratocystis fimbriata*.
Supervisor: BD Wingfield

Dr Hiroyuki Suzuki

Postdoctoral Fellow
Taxonomical and biological studies on tree pathogens residing in the Cryphonectoriaceae.
Supervisor: MJ Wingfield

Dr Velushka Swart

Postdoctoral Fellow
Callose depositions in *Persea americana* as a defence mechanism against *Phytophthora cinnamomi*.
Supervisor: N van den Berg

Dr Magriet van der Nest (until 2019)

Senior Postdoctoral Fellow
Evolution and pathogenicity of Ceratocystidaceae.
Supervisor: BD Wingfield

Dr Erik Visser

Postdoctoral Fellow
Feasibility of RNAi-based *Fusarium circinatum* control in commercially important pine species through application of dsRNA targeting pathogen ergosterol biosynthesis.
Supervisors: S Naidoo, AA Myburg

Dr Maria Vivas

Postdoctoral Fellow
New generation planted forests: Environmental maternal effects on the resistance of *Eucalyptus grandis* to pathogens and the structuring of fungal endophytic communities.
Supervisor: B Slippers

Dr Markus Wilken

Postdoctoral Fellow
The mating-type locus of species in the family Ceratocystidaceae.
Supervisors: BD Wingfield, ET Steenkamp, MJ Wingfield

Dr Neriman Yilmaz

Senior Postdoctoral Fellowship
Systematic studies on *Fusarium species*.
Supervisors: PW Crous, B Slippers, MJ Wingfield

PhD students**Omotayo Adegeye**

The role of peptide pheromones and receptors in the biology of *Fusarium* species in the *Fusarium* species complex.
Supervisors: ET Steenkamp, BD Wingfield, NA van der Merwe, MJ Wingfield

Barkat Ali

Taxonomy, genome sequencing and population genetics of *Uromycladium acaciae*.
Supervisors: NA van der Merwe, A McTaggart

Teddy Amuge

Genome-wide transcriptome analysis of cassava challenged with Ugandan Cassava Brown Streak Virus (UCBSV).
Supervisors: DK Berger, M Ferguson (IITA), AA Myburg

Juanita Avontuur

The genus *Bradyrhizobium*: current and future perspectives.
Supervisors: ET Steenkamp, SN Venter, MPA Coetzee

Robert Backer

Molecular cloning and functional characterisation of *NPR1-like* genes from *Persea americana* (Mill.).
Supervisors: N van den Berg, S Naidoo

Felipe Balocchi

Araucaria canker disease in Chile.
Supervisors: I Barnes, MJ Wingfield, R Ahumada

Khumbuzile Bophela

Abiotic and biotic factors associated with slow plum decline in the Western Cape.
Supervisors: TA Coutinho, Y Petersen, C Bull

Annie Chan

The evolution on the South African CFR plant-associated rhizobia symbionts.
Supervisors: SN Venter, ET Steenkamp

Jane Chepsergon

Identification and characterisation of *Phytophthora* effectors.
Supervisors: L Moleleki, P Birch

Brenda Chitonga

Development of methods for functional characterisations of effectors.

Supervisor: L Moleleki

Juanita Engelbrecht

Genomic studies of *Phytophthora cinnamomi*.

Supervisor: N van den Berg

Firehiwot Eshetu

The molecular ecology of *Sirex-Amylostereum* invasion in Australia and New Zealand and its biocontrol agent, *Deladenus siricidicola*.

Supervisors: B Slippers, I Barnes, H Nahrung (University of the Sunshine Coast)

Katrin Fitza

Diversity, specificity and admixture in the *Sirex* - *Amylostereum* - *Deladenus* symbiosis.

Supervisors: B Slippers, J Garnas

Arista Fourie

A genomic approach towards understanding host specificity and pathogenicity in two *Ceratocystis* species.

Supervisors: I Barnes, BD Wingfield, MJ Wingfield, MA van der Nest

Ginna Granados

Genetics and genomics of pine needle pathogens with special reference to *Dothistroma septosporum*.

Supervisors: I Barnes, MJ Wingfield, CA Rodas

Quentin Guignard

Visual and chemical ecology of an invasive pest, *Sirex noctilio*.

Supervisors: B Slippers, J Allison

Yosef Hamba Tola

Characterization of honey bee gut microbiome and evaluation of its potential effects on bee health in Kenya.

Supervisors: J Paredes (ICIPE), B Slippers, J Herren (ICIPE), M Lattorff (ICIPE)

Minette Havenga

Biology and pathology of *Teratosphaeria destructans* on *Eucalyptus*.

Supervisors: J Aylward, BD Wingfield, MJ Wingfield, LL Dreyer (Stellenbosch University), F Roets (Stellenbosch University)

Darryl Herron

The characterization of *Fusarium circinatum* and other fusaria from grasses in South Africa.

Supervisors: ET Steenkamp, BD Wingfield, MJ Wingfield

Joey Hulbert

Phytophthora diversity in the Cape Floristic Region.

Supervisors: MJ Wingfield, F Roets, T Burgess

Miekie Human

Identification and characterisation of *Exserohilum turcicum* effectors.

Supervisors: BG Crampton, DK Berger

Agil Katumanyane

Evaluation of entomopathogenic nematodes as bio-control agents in the management of white grubs in forestry and sugarcane plantations of South Africa.

Supervisors: BP Hurley, B Slippers, M Wondafrash, AP Malan

Tsholofelo Kibido

Effect of soybean rhizobium partner on nodulation under drought conditions.

Supervisors: BJ Vorster, E Makgopa

Brigitte Langenhoven

Insight into the sorghum defense response against *Exserohilum turcicum* infection.

Supervisors: BG Crampton, S Murray (University of Cape Town)

GuoQing Li

Diversity and Biology of Botryosphaeriaceae species associate with *Eucalyptus* in South China.

Supervisors: SF Chen, B Slippers, MJ Wingfield

JieQiong Li

Investigation of taxonomy, mating types and population biology of *Calonectria* species.

Supervisors: SF Chen, I Barnes, MJ Wingfield

QianLi Liu

Phylogenetic revision, genomics and population diversity of *Calonectria* species.

Supervisors: SF Chen, T Duong, BD Wingfield, MJ Wingfield

Johan Liversage

Blue light perception in the maize foliar pathogen *Exserohilum turcicum*.

Supervisors: BG Crampton, S Stoychev

Angel Maduke

Flower, twig and nut diseases of Macadamia.

Supervisors: G Fourie, B Slippers, E van der Linde, MJ Wingfield

Privilege Makunde

Biology and ecology of eucalypt lerp psyllids in South Africa: *Spondylaspis* cf. *plicatuloides* and *Glycaspis brimblecombei* (Hemiptera: Psyllidae).

Supervisors: BP Hurley, B Slippers

Edgar Mangwende

Seed-borne and seed-transmitted diseases of *Eucalyptus* spp.

Supervisors: TAS Aveling, P Chirwa

Mkhululi Maphosa

Detection and analysis of genomic structural variants within *Fusarium circinatum*.

Supervisors: BD Wingfield, ET Steenkamp

Silindile Maphosa

T6SS Anti-eukaryotic effectors of phytopathogenic bacteria.

Supervisor: L Moleleki

Angelica Marsberg de Villiers

Characterisation of the endophyte-host interaction using *Botryosphaeria dothidea* and *Eucalyptus grandis*.

Supervisors: B Slippers, MJ Wingfield

Mandy Messal

Towards a mechanistic understanding of fungal community interactions in *Eucalyptus* using ecological genomics.

Supervisors: B Slippers, S Naidoo, M Kemler

Lorraine Mhoswa

Genome wide association study for *leptocybe* resistance and associated chemotypes in *E. grandis*

Supervisors: S Naidoo, AA Myburg

Rachel Mkandawire

Fusarium and mite species associated with malformed inflorescences in *Syzygium cordatum*.

Supervisors: ET Steenkamp, G Fourie, MJ Wingfield, N Yilmaz

Mmoledi Mphahlele

Genome-wide selection for growth and wood property traits in *Eucalyptus grandis*.

Supervisors: AA Myburg, F Isik, G Hodge



Jan Nagel

Insights into the biology and evolution of Botryosphaeriaceae from genomes.

Supervisors: B Slippers, MJ Wingfield

Wilma Nel

Investigating the diversity of ambrosia beetles and their fungal symbionts in South African native forests.

Supervisors: TA Duong, MJ Wingfield, ZW de Beer

Ntombi Nkomo

Functional characterization of *Pectobacterium carotovorum brasiliense* transcriptional regulators.

Supervisors: L Moleleki, D Shyntum, D Bellieny-Rabelo

David Nsibo

Population genetics of *Cercospora zeina* in East and southern Africa.

Supervisors: DK Berger, I Barnes

Inosters Nzuki

QTL mapping for pest and disease resistance in cassava cultivars Kiroba and AR37-80 and coincidence of QTL with introgression regions from *Manihot glaziovii*.

Supervisors: AA Myburg, NA van der Merwe, M Ferguson (IITA)

Marja O'Neill

Fine-scale population structure of native *Eucalyptus grandis*, and genomic architecture of artificial selection in South African breeding populations.

Supervisors: AA Myburg, J Acosta, J Borevitz

Elisa Pal

Biology and management of *Bathycoelia natalicola* associated with macadamia.

Supervisors: G Fourie, B Slippers, BP Hurley

Nam Pham

Studies on the biotic factors associated with Eucalyptus Little Leaf Syndrome (ELLS) in North Sumatra.

Supervisors: MJ Wingfield, I Barnes, B Slippers

Mmatshapho Phasha

Functional characterization of virulence genes in *Fusarium circinatum*.

Supervisors: ET Steenkamp, MPA Coetzee, BD Wingfield

Desre Pinard

The roles of plastids and mitochondria during *Eucalyptus xylogenesis*.

Supervisors: E Mizrachi, AA Myburg

Alisa Postma

Genomics resources for studying the evolutionary ecology of the invasive woodwasp, *Sirex noctilio*.

Supervisors: B Slippers, F Joubert

Joséphine Queffelec

Sirex noctilio: Influence of reproductive biology on the dynamics of an invasive species.

Supervisors: B Slippers, JD Allison, JM Greeff

Jane Ramaswe

Investigation of growth and pathogenicity of *Fusarium circinatum*.

Supervisors: BD Wingfield, ET Steenkamp, L de Vos

Ipeleng Randome

Functional relevance of woody plant specific transcription factors.

Supervisors: SG Hussey, AA Myburg, J Grima-Petenatti

Mary Ranketse

Genetic characterisation and resources for macadamia nut cultivars for advanced genetic breeding.

Supervisors: C Hefer, AA Myburg

Mohammad Sayari

Secondary metabolite pathways in Ceratocystidaceae.

Supervisors: BD Wingfield, ET Steenkamp

Gina Shin

Small RNAs in *Pantoea ananatis*.

Supervisors: TA Coutinho, L Moleleki, D Shyntum

Benedicta Swalarsk-Parry

Understanding growth and virulence in the South African population of *Fusarium circinatum*.

Supervisors: ET Steenkamp, L de Vos, BD Wingfield

Lazarus Takawira

Inferring secondary cell wall-associated transcriptional regulatory networks in *Eucalyptus grandis* through high-throughput DNA affinity purification sequencing.

Supervisors: SG Hussey, AA Myburg, E Mizrachi

Michel Tchotet Tchoumi

Diversity and taxonomy of wood-rotting Basidiomycetous fungi in South Africa.

Supervisors: J Roux, MPA Coetzee, M Rajchenberg (CIEFAP)

Demissew Teshome

Eucalyptus defence response to fungal pathogens under elevated temperature.

Supervisors: S Naidoo, AA Myburg

Renaan Thompson

Prevalence, isolation and characterisation of *Sydowia polyspora* from *Pinus* spp. in South Africa.

Supervisors: TAS Aveling, G Brodal

Ariska van der Nest

Diversity and population structure of three important needle blight pathogens of *Pinus* species.

Supervisors: I Barnes, MJ Wingfield

Stephanie van Wyk

Repeat-Induced Point mutations in the *Fusarium fujikuroi* species complex.

Supervisors: ET Steenkamp, NA van der Merwe, BD Wingfield, L de Vos

Tanya Welgemoed

Population genomics of *Cercospora zeina*.

Supervisors: DK Berger, I Barnes, TA Duong

Andi Wilson

Unisexual reproduction in filamentous ascomycete fungi, with particular reference to *Huntia moniliformis*.

Supervisors: BD Wingfield, MA van der Nest, PM Wilken, MJ Wingfield

MSc students**Michael Austin**

The circadian clock and diurnal rhythms of *Eucalyptus* carbon source and sink tissues.

Supervisors: E Mizrachi, AA Myburg, D Pinard

Leandri Bezuidenhout

Functional characterisation of *Sirex noctilio* chemosensory genes.

Supervisors: B Slippers, TA Duong, J Allison

Johnathan Bredenkamp

Functional analysis of the sex pheromone receptors in *Fusarium circinatum*.

Supervisors: ET Steenkamp, BD Wingfield, G Fourie

Katrien Brown

The accessible chromatin landscape of *Eucalyptus grandis*.

Supervisors: SG Hussey, E Mizrachi, AA Myburg

Michael Bufe

The early physiological responses of three avocado (*Persea americana* Mill.) rootstocks to infection with *Phytophthora cinnamomi* Rands.

Supervisors: N Taylor, N van den Berg, J Vorster, M Beukes

Julia Candotti

Genomic dissection of cellulose pulp processing traits in fast-growing *Eucalyptus* hybrids.

Supervisors: AA Myburg, E Mizrachi

Derick Claassens

Identifying potential plant-growth promoting endophytes of forestry trees.

Supervisors: ET Steenkamp, SN Venter

Claudio de Nuzzo

Endogenous peptide defence in maize against the fall armyworm *Spodoptera frugiperda* (J.E. Smith).

Supervisors: DK Berger, K Kruger

Claudette Dewing

Comparative genomics reveal molecular factors implicated in host-specificity in agricultural important *Fusarium* species.

Supervisors: L de Vos, MA van der Nest, ET Steenkamp, BD Wingfield

Michael du Toit

The beetle-fungus interaction, causing Fusarium Dieback on *Persea americana*.

Supervisors: N van den Berg, G Fourie, ZW de Beer

Stephan Engelbrecht

Genome-wide allele-specific expression analysis of *Eucalyptus* hybrids.

Supervisors: AA Myburg, N Christie

Shawn Fell

The impact of the Polyphagous Shot Hole Borer on pecan trees in South Africa

Supervisors: ZW de Beer, BP Hurley, G Marais (University of the Free State)

Stefan Ferreira

The role of Transketolase and Transaldolase in carbon partitioning to lignin.

Supervisors: E Mizrachi, V Maloney

Shannon Flemington

Systemic Induced resistance in *Eucalyptus grandis*.

Supervisors: S Naidoo, L Shuey

Caitlin Gevers

Novel interactions of gall forming wasps of *Eucalyptus*.

Supervisors: BP Hurley

Allan Gonzalez

Polyphagous Shot Hole Borer (PSHB) impact on native forests in Kwazulu-Natal ecosystems.

Supervisor: ZW de Beer

Alessandro Gricia

The T6SS of *Pectobacterium carotovorum* *Brasiliense*.

Supervisor: L Moleleki

Lichelle Grobler

Agrobacterium-mediated CRISPR-Cas9 genome editing in *Nicotiana benthamiana*.

Supervisors: BG Crampton, P Pillay (CSIR) MM O'Kennedy (CSIR)

Juanita Hanneman

The *in vitro* morphological and transcriptomic effects induced by phosphite on *Phytophthora cinnamomi*.

Supervisors N van den Berg

Mathew Harris

Exploring fungal biogeography in an age of metabarcoding and metagenomics.

Supervisors: M Greve, B Slippers, M Kemler

Jesse Hartley

Isolation and detection of the white root rot pathogen, *Rosellinia necatrix*, on avocado.

Supervisor: N van den Berg

Daniel Harty

Functional characterisation of novel *Arabidopsis* genes of unknown function involved in wood formation.

Supervisors: E Mizrachi, D Pinard, D Roodt, SG Hussey

Stephan Henning

Genome diversity atlas of commercially relevant eucalypts in South Africa.

Supervisors: AA Myburg, M Reynolds, M O'Neill

Granny Hlongwane

Investigating the *Ceratocystis* disease outbreak in *Eucalyptus* clones in KwaZulu-Natal.

Supervisors: I Barnes, MJ Wingfield, J Roux

Matthew Jackson

Understanding the population genetics and emergence of Bt-resistance of *Busseola fusca* and *Spodoptera frugiperda* in South Africa.

Supervisors: B Slippers, B Hurley, K Krüger

Robert Jansen van Vuuren

Maize responses to fall armyworm.

Supervisors: DK Berger, K Kruger

Johannes Christoff Joubert

Host preference of *Gonipterus* sp. 2 and chemical analysis of susceptible and resistant *Eucalyptus* species.

Supervisors: A Hammerbacher, M Schroder, B Hurley

Melissa Joubert

Nep1-like protein effectors of *Phytophthora cinnamomi*.

Supervisor: N van den Berg

Eugene Kabwe

Cercospora zeina genome annotation for effectors.

Supervisors: DK Berger, T Duong

Tamanique Kampman

The transcriptomes of *Pinus gregii* and *Pinus maximinoii*.

Supervisors: S Naidoo, J Wegrzyn

Lomile Khoete

Investigating the population diversity of *Gonipterus* in South Africa.

Supervisors: MPA Coetzee, I Barnes, B Hurley, B Slippers, M Schröder

Sung Hyu Luke Kim

Exploring glucuronoxylan biosynthesis genes and their potential for biorefinery applications of woody biomass.

Supervisors: V Maloney, AA Myburg, E Mizrachi

Rosa Knoppersen

The role of the gut microbiota of *Gonipterus* sp. 2 in tolerating the chemical defences of *Eucalyptus*.

Supervisors: A Hammerbacher, TA Coutinho

Frances Lane

Transformation systems in Ceratocystidaceae.

Supervisors: BD Wingfield, PM Wilken



Anneri Lotter

Sequencing, assembly and phasing of an F1 *Eucalyptus uraphylla* x *E. grandis* hybrid genome.
Supervisors: AA Myburg, E Mizrachi, TA Duong

Lizette Loubser

eQTL dissection of the systems genetics of wood biorefinery traits in *Eucalyptus*.
Supervisors: AA Myburg, N Christie, E Mizrachi

Kira Lynn

Emerging ambrosia beetle pests and their fungal associates in Indonesia.
Supervisors: I Barnes, MJ Wingfield, W de Beer, A Duran

Thapelo Maboko

A genetic transformation system for *Chrysosporthe austroafricana*.
Supervisors: NA van der Merwe, BG Crampton, EC Kunjoku (University of Venda)

Lungile Mabuza

Functional characterization of basic leucine zipper transcription factors.
Supervisors: SG Hussey, AA Myburg

Phinda Magagula

Physiological response of South African avocado rootstocks to *Rosellinia necatrix* and evaluation of potential control strategies.
Supervisors: N van den Berg, N Taylor

Annah Mahlangu

Seed quality of farm-saved bean seed of smallholder farmers in the Drakensberg.
Supervisors: TAS Aveling, Q. Kritzinger, D Marais

Dineo Mailula

Production of fusel alcohols by fungi in the family Ceratocystidaceae.
Supervisors: A Hammerbacher, BD Wingfield, MA Van der nest

Pozisa Majaja

Morphological and molecular identification of *Fusarium* species in *Zea mays* and *Eragrostis tef*.
Supervisors: NA van der Merwe, N Yilmaz

Sophie Makua

Gene expression analysis of the woodwasp, *Sirex noctilio*: Responses to nematode infection, fungal infection and wounding.
Supervisors: B Slippers, A Postma, MPA Coetzee

Modjadji Makwela

Mycorrhizae associated with South African endemic and endangered orchids.
Supervisors: A Hammerbacher, TK Bose, MPA Coetzee, BD Wingfield

Charmaine Malebe

Microbiome of *Trillium africanum* nodules.
Supervisor: TA Coutinho

Tintswalo Maluleke

Transcriptomic characterization of the banana weevil, *Cosmopolites sordidus* proteases.
Supervisor: BJ Vorster

Ingrid Marais

RNAi against *Cercospora zeina*.
Supervisors: DK Berger, J Theron

Aaron Maringa

Elucidating the early response of *Phytophthora cinnamomi* during avocado infection using a modified sampling method.
Supervisors: N van den Berg, V Swart

Nomaswazi Maseko

Description and functional analysis of core promoters from members of the Sordariomycetes.
Supervisors: PM Wilken, BD Wingfield, ET Steenkamp

Keamogetswe Maswanganyi

The effects of endophytes on host selection by a tree-killing ambrosia beetle: Polyphagous Shot Hole Borer.
Supervisors: A Hammerbacher, ZW de Beer

Lazarus Mavima

Taxonomic characterization of *Paraburkholderia tuberum-like* rhizobia from diverse legumes.
Supervisors: ET Steenkamp, SN Venter

Pfano Mbedzi

Evaluation of simple sequence repeats (SSR) markers associated with resistance to *Sclerotinia sclerotiorum* (Lib.) de Barry in commercial South African soybean cultivars.
Supervisors: BJ Vorster, JE van der Waals

Nikki Miguel

The T6SS effectors of *Pectobacterium carotovorum* Brasiliense.
Supervisor: L Moleleki

Tsakani Miyambo

Identification and characterization of polygalacturonases in *Phytophthora cinnamomi*.
Supervisors: N van den Berg, AS Prabhu

Sthembiso Mngadi

Accessory chromosomes in *Fusarium circinatum*.
Supervisors: L de Vos, BD Wingfield, ET Steenkamp

Patience Modiba

Role of Oomycetes in slow plum decline in the Western Cape.
Supervisors: TA Coutinho, T Bose

Seamus Morgan

Taxonomy and biology of *Quambalaria* spp. infecting eucalypts in South Africa.
Supervisors: ZW de Beer, MJ Wingfield

Sanele Moyana

Diversity of *Methylobacterium* isolates nodulating indigenous legumes in South Africa.
Supervisors: SN Venter, ET Steenkamp

Fezile Mthunzi

Characterizing terpene synthase genes in *Armillaria* species, with special reference to *Armillaria mellea*.
Supervisors: MPA Coetzee, A Hammerbacher, BD Wingfield

Zanelle Mufamadi

Identification of the causal agents and management of husk rot on macadamia in South Africa.
Supervisors: G Fourie, N van den Berg

Nganea Nangammbi

CRISPR-Cas9 editing and testing of xylan-associated genes.
Supervisors: V Maloney, AA Myburg

Kayla Noeth

Seasonal development and trapping of *Coryphodema tristis* in *Eucalyptus nitens* plantations.
Supervisors: BP Hurley, B Slippers

Miranda Procter

Title of thesis: Redefining generic boundaries in the Ophiostomatales (Ascomycota).
Supervisors: ZW de Beer, MJ Wingfield, TA Duong

Lizzy Ramela

Taxonomy and diversity of rhizobial species associated with non-native legumes in southern Africa.
Supervisors: ET Steenkamp, SN Venter

Emeldah Rikhotso

Leaf pathogens of *Eucalyptus* in South Africa with particular reference to *Teratosphaeria destructans*.

Supervisors: J Roux, A Hammerbacher, S Fraser, I Greyling

Luki-Marie Scheepers

Chemical Ecology of two forestry pests in South Africa.

Supervisors: MC Bouwer, B Slippers, E Rohwer

Lebone Sebapu

The delineation of species in Ceratocystidaceae using microsatellite markers.

Supervisors: TA Duong, BD Wingfield

Mohamed Seedat

Identification of CRN effector genes in *Phytophthora cinnamomi* during avocado root infection.

Supervisors: N van den Berg, S Naidoo

Carol-Ann Segal

Functional analysis of a *Cercospora zeina* effector.

Supervisors: DK Berger

Sydney Sithole

Non-ribosomal peptide synthetases from the genomes of selected *Chrysosporthe* species.

Supervisors: NA van der Merwe, ET Steenkamp, S Naidoo

Ashleigh Smith

Characterization of Lepidoptera species associated with Macadamia in South Africa.

Supervisors: G Fourie, B Slippers, BP Hurley

Robyn Smith

The terpene synthase gene family in *Pinus* species and their expression patterns under *Fusarium circinatum* challenge.

Supervisors: S Naidoo, MPA Coetzee

Nicole Soal

Characterisation of catechol oxidase in Ceratocystidaceae.

Supervisors: BD Wingfield, A Hammerbacher, MPA Coetzee, MA van der Nest

Byron Sonnekus

The diversity of Pentatomidea species and their natural enemies in Macadamia orchards in South Africa.

Supervisors: G Fourie, B Slippers, BP Hurley

Julanie Stapelberg

Recombinant protein production potential of South African microalgae.

Supervisors: BG Crampton, R Roth (CSIR), M Crampton (CSIR)

Hannes Strydom

Modelling the population dynamics of CRISPR-Cas9 in *Sirex noctilio*.

Supervisors: B Slippers, M Chapwanya, R Ouifki

Zorada Swart

Deladenus siricidicola evasion of the host immune response during parasitism of *Sirex noctilio*.

Supervisors: B Slippers, TA Duong, A Postma, BD Wingfield

Taponeswa Tasiya

Understanding the diversity, origin and nodulation capabilities of rhizobia isolated from *Acacia mearnsii* and *Dichrostachys cinerea*.

Supervisors: MPA Coetzee, ET Steenkamp, SN Venter

Catherine Tatham

Characterization of the *Teratosphaeria destructans* genome.

Supervisors: BD Wingfield, PM Wilken, MJ Wingfield

Junior Tii-kuzu

Towards a genome diversity atlas for tropical pine tree species grown in southern Africa and South America.

Supervisors: AA Myburg, A Kanzler, K Payn

Garyn Townsend

Impact of the polyphagous shot hole borer in natural forests of the southern Cape

Supervisors: ZW de Beer, M Hill (Rhodes University), F Roets (Stellenbosch University)

QuanChao Wang

Diversity and biology of *Calonectria* species in Leizhou Peninsula in southern China.

Supervisor: SF Chen

Wen Wang

Phylogeny, host diversity and pathogenicity of Cryphonectriaceae on Myrtales in southern China.

Supervisor: SF Chen

Raven Wienk

Genetic diversity and population structure analysis of the South African Avocado rootstock germplasm using SNP markers.

Supervisors: N van den Berg, N Abeysekara

WenXia Wu

Pathogenicity of *Calonectria* species on *Eucalyptus urophylla* x *E. grandis* genotypes in China.

Supervisor: SF Chen

Nomakula Zim

Comparative genomics of *Xanthomonas vasicola* strains from different hosts.

Supervisors: TA Coutinho, S McFarlane, E Wicker

4th year and Honours students

Rebecca Ackermann (2017)

Leandri Bezuidenhout (2017)

Marlise Buys (2017)

Derick Claassens (2017)

Claudette Dewing (2017)

Michael du Toit (2017)

Aurona Gerber (2017)

Jesse Hartley (2017)

Angelique Jacobsohn (2017)

Johannes Joubert (2017)

Lomile Khoete (2017)

Eugene Kabwe (2017)

Paige Klepper (2017)

Hye Jin Lim (2017)

Deanah Lloyd (2017)

Lizette Loubser (2017)

Kira Lynn (2017)

Lungile Mabuza (2017)

Mancha Mabaso (2017)

Kayleigh Maier (2017)

Phinda Magalula (2017)

Modjadji Makwela (2017)

Fezile Mthunzi (2017)

Ashleigh Smith (2017)

Nicole Soal (2017)

Hannes Strydom (2017)

Dorris Tswane (2017)

Francois Viljoen (2017)

Nomakula Zim (2017)

Mike Austin (2018)

Jenna Craddock (2018)

Shawn Fell (2018)

Stefan Ferreira (2018)

Samantha Goldswain (2018)

Petrus Gostmann (2018)

Phillip Greeff (2018)



Sarah Hogenbirk-Wynberger (2018)
 Elsabé Hordijk (2018)
 Robert Jansen van Vuuren (2018)
 Bianca-Lee Jones (2018)
 Rosa Knoppersen (2018)
 Precious Kothibe (2018)
 Zané Kroner (2018)
 Kaelan Lang (2018)
 Anneri Lötter (2018)
 Ophelia Maila (2018)
 Aaron Maringa (2018)
 Nomaswazi Maseko (2018)
 Keamogetswe Maswanganyi (2018)
 Sthembiso Mngadi (2018)
 Ngokoana Mokakabye (2018)
 Jamie Mollentze (2018)
 Lizzy Ramela (2018)
 So Ri La (2018)
 Lebone Sebatu (2018)
 Byron Sonnekus (2018)
 Tapeswa Tasiya (2018)
 Palesa Thys (2018)
 Sharlene van der Walt (2018)
 Divan van Ruler (2018)
 Raven Wienk (2018)
 Surprise Baloyi (2019)
 Ruby May Ebbeling (2019)
 Eleanor Froneman (2019)
 Casey Gill (2019)
 Constant Hoogkamer (2019)
 Verushka Ibanez (2019)
 Daniella Krämer (2019)
 Kyle Leeuwendaal (2019)
 Christopher Liakos (2019)
 Tiego Mohlaba (2019)
 Trystan Nadasen (2019)
 Kgopotso Phakwago (2019)
 Jenna-Lee Price (2019)
 Boitshoko Rammuki (2019)
 Claire Randolph (2019)
 Ingrid Roeloff (2019)
 Lenteli van Zyl (2019)
 Kevin Scheepers (2019)
 Cassandra Schoeman (2019)
 Medha Sood (2019)
 Shae Swanepoel (2019)
 Louisa Terblanche (2019)
 Cheyenne Theron (2019)
 Dee Twiddy (2019)
 Nicole van Vuuren (2019)
 Anien Viljoen (2019)
 Keenan Williams (2019)
 Mondli Xaba (2019)

Student assistants

Prof. Dave Berger:
 Trystan Nadasen (2018)
 Kevin Scheepers (2018)

Prof. Noelani van den Berg:
 Lize Eliot (2017)

CTHB mentorship students

(Mentors are indicated next to the student names)

Anne Ankermann (2017) – Dr Gudrun Dittrich-Schröder (Postdoc) and Dr Michelle Schröder (Postdoc)

Vusimuzi Chiloane (2017) - Mkhululi Maphosa (PhD)
 Nokukhanya Dube (2017) - Angel Maduke (MSc)
 Robert Jansen van Vuuren (2017) - Tanay Bose (PhD)
 Daniel Joubert (2017) - Dr Stuart Fraser (Postdoc) and Izette Greyling (PhD)
 Letabo Lefoka (2017) - Esna du Plessis (MSc) and Angelique du Preez (PhD)
 Sade Magabotha (2017-2018) - Benedicta Swalarsk-Parry (MSc)
 Christopher Marais (2017) - Aquillah Kanzi (PhD)
 Jamie Mollentze (2017) - Ariska van der Nest (PhD)
 Khanyisile Nkosi (2017) - Dr Magriet van der Nest (Research Fellow)
 Marin Peroski (2017) - Dr Albe van der Merwe (Senior Lecturer)
 Rochelle Rademan (2017) - Darryl Herron (PhD)
 Elke Roos (2017) - Andi Wilson (PhD)
 Kadima Tshiyoyo (2017) - Emeldah Rikhotso (MSc)
 Amber Tulloch (2017) - Kay Bophela (PhD)
 Mandelie van der Walt (2017) - Stephanie van Wyk (PhD)
 Palesa Zulu (2017) - Dr Markus Wilken (Postdoc)
 Carla Buitendag (2018) - Andi Wilson (PhD)
 Michelle Durow (2018) - Aquillah Kanzi (Postdoc)
 Deanne du Plessis (2019) - Dr Markus Wilken (Postdoc), Frances Lane (MSc) and Nomaswazi Maseko (MSc)
 Jireh Janse van Rensburg (2018-2019) - Dr Albe van der Merwe and Mohammad Sayari (PhD)
 Ropafadzai Jawa (2019) - Benedicta Swalarsk-Parry (PhD)
 Marizanne Jones (2019) - Michelle Schroder (PhD)
 Christopher Liakos (2018) - Mohammad Sayari (PhD)
 Sade Magabotha (2018) - Benedicta Swalarsk-Parry (PhD)
 Precious Makua (2018) - Angel Maduke (PhD) and Sydney Sithole (MSc)
 Lesego Malekana (2019) - Mesfin Bogale (Postdoc)
 Murunwa Netshidongololwe (2018) - Miranda Erasmus (MSc)
 Jenna-Lee Price (2018) - Darryl Heron (PhD)
 Boitshoko Rammuki (2018) - Dr Vuyiswa Bushula-Njah (Postdoc)
 Micaela Schagen (2019) - Firehiwot Eshetu (PhD)
 Alinaswe Selebi (2018) - Tayo Adenigba (PhD) and Mmatshapo Phasha (PhD)
 Nhlanhla Simelane (2019) - Darryl Herron (PhD)
 Cheyenne Theron (2018) - Ginna Grandos (PhD) and Ariska van der Nest (PhD)
 Sizwe Tshabalala (2019) - Carol-Ann Segal (MSc)
 Samuel Tshiyoyo (2018) - Emeldah Rikhotso (MSc)
 Jade Tulloch (2019) - Hannes Strydom (MSc)
 Dee Twiddy (2018) - Wilma Nel (PhD)
 Megan van den Berg (2018) - Nam Pham (PhD)
 Melandre van Lill (2019) - Ginna Grandos (PhD)
 Nicole van Vuuren (2018) - Mkhululi Maphosa (PhD)
 Luka van Wyk (2019) - Dr Vuyiswa Bushula-Njah (Postdoc)
 Damian vaz de Sousa (2019) - Dr Esther Muema (Postdoc)
 Sheldon Viviers (2019) - Angel Maduke (PhD)

FMG mentorship students

Ruby Ebbeling (2017-2018)
 Lethabo Lefoka (2017-2018)
 Tebogo Molemela (2017-2018)
 Bernard Smit (2017-2018)
 Medha Sood (2017-2018)
 Kelly Pinker (2018)
 Vasili Balios (2018-2019)
 Dominique le Roy (2019)
 Mudzunga Mandavha (2018-2019)
 Thabang Makofane (2019)
 Michal Slupski (2019)

RECENT GRADUATES

PhD

Dr Chrizelle Beukes

Title of thesis: Genomic diversity and phylogeography of South African rhizobia.
Supervisor: ET Steenkamp
Co-supervisors: SN Venter, MM le Roux, T Stepkowski

Dr Tanay Bose

Title of thesis: *Phytophthora* species diversity associated with native and non-native forests in South Africa.
Supervisor: MJ Wingfield
Co-supervisors: J Roux, TI Burgess (Murdoch University, Australia)

Dr Gabrielle Carstensen

Title of thesis: Bacterial wilt of *Eucalyptus*: Understanding pathogenicity and the virulence of the causal agents.
Supervisor: TA Coutinho
Co-supervisors: SN Venter, MJ Wingfield

Dr Runlei Chang

Title of thesis: Ophiostomatoid fungi associated with conifer-infesting bark beetles in China.
Supervisor: ZW de Beer
Co-supervisors: MJ Wingfield, XD Zhou, TA Duong

Dr Madgeleen Cilliers

Title of thesis: Drought stress-induced changes in the soybean nodule transcriptome.
Supervisor: BJ Vorster
Co-supervisor: PDR van Heerden

Dr Natrisha Devnarain

Title of thesis: Elucidation of drought tolerance mechanisms in South African *Sorghum bicolor* (L.) Moench landraces.
Supervisor: BG Crampton
Co-supervisor: J Becker
External co-supervisor: M O'Kennedy (Council for Scientific and Industrial Research)

Dr Felix Fru

Title of thesis: Population genetics and ecology of *Fusarium circinatum* on *Pinus* species in eastern South Africa.
Supervisor: J Roux
Co-supervisors: ET Steenkamp; MJ Wingfield

Dr Zander Human

Title of thesis: The microbial ecology of *Protea repens* (Proteaceae) infructescences and the surrounding environment.
Supervisor: ZW de Beer
Co-supervisors: SN Venter, MJ Wingfield

Dr Delphin Kandolo

Title of thesis: Alternaria blight of sweet potato in South Africa and development of an integrated disease management strategy.
Supervisor: TA Aveling
Co-supervisor: JE van der Waals
External co-supervisor: M Truter (Agricultural Research Council)

Dr Godfrey Kgatle

Title of thesis: Alternaria blight of sunflower caused by *Alternaria alternata* and its control in South Africa.
Supervisor: TA Aveling
External co-supervisors: B Flett (Agricultural Research Council); M Truter (Agricultural Research Council)

Dr Feifei Liu

Title of thesis: Species diversity and host associations of plant pathogenic *Ceratocystis* species in China.
Supervisor: SF Chen
Co-supervisors: MJ Wingfield, I Barnes

Dr Esther Masumba

Title of thesis: Mapping of QTL associated with resistance to Cassava Brown Streak and Mosaic Diseases in outcrossing cassava farmer varieties from Tanzania.
Supervisor: NA van der Merwe
Co-supervisor: AA Myburg
External co-supervisor: M Ferguson (International Institute of Tropical Agriculture, Kenya)

Dr Osmond Mlonyeni

Title of thesis: Characterization of genetic variability in the *Sirex-Amylostereum-Deladenus* symbioses.
Supervisor: B Slippers
Co-supervisors: J Greeff, MJ Wingfield, BD Wingfield

Dr Gloria Valentine Nakato

Title of thesis: *Xanthomonas campestris* pv. *musacearum*: population diversity and the identification of potential sources of resistance from banana accessions representing the *Musa* diversity worldwide.
Supervisor: TA Coutinho
Co-supervisors: G Mahuku (International Institute of Tropical Agriculture (IITA), Tanzania), EPP Wicker (CIRAD Agricultural Research for Development, France)

Dr Caryn Oates

Title of thesis: A systems biology understanding of the *Eucalyptus-Leptocybe invasa* interaction.
Supervisors: S Naidoo
Co-supervisors: B Slippers, AA Myburg

Dr Margot Otto

Title of thesis: Bacterial canker of cherry trees: biology and epidemiology of the causal agent.
Supervisor: TA Coutinho
Co-supervisor: J Roux
External co-supervisor: Y Petersen (Agricultural Research Council)

Dr Marike Palmer

Title of thesis: Genome-based systematics of taxa in the *Erwiniaceae*.
Supervisor: SN Venter
Co-supervisors: ET Steenkamp; MPA Coetzee

Dr Zelda Pieterse

Title of thesis: Fungal biodiversity associated with selected Aizoaceae in the Namaqua National Park in the Succulent Karoo biome.
Supervisor: TA Aveling
External co-supervisor: A Venter (Agricultural Research Council)

Dr Vou Moses Shutt

Title of thesis: Bacterial pathogens of tomato in South Africa: identification, population diversity and cultivar susceptibility.
Supervisor: TA Coutinho
Co-supervisors: JE van der Waals, T Goszczynska (Agricultural Research Council)

Dr Melissa Simpson

Title of thesis: Mating in *Ceratocystis fimbriate*.
Supervisor: BD Wingfield
Co-supervisors: MJ Wingfield, MPA Coetzee, MA van der Nest

Dr Elrea Strydom

Soybean blotchy mosaic virus: Molecular characterization and seasonal persistence.
Supervisor: G Pietersen

Dr Collins Tanui

Title of thesis: Transcriptome profiling of *Pectobacterium carotovorum* subsp. *brasiliense* reveals genes involved in ecological fitness and virulence mechanisms during infection
Supervisor: LN Moleleki

Dr Johan van der Linde

Title of thesis: Fungi, insects and abiotic factors associated with the death of *Euphorbia ingens* in South Africa.
Supervisor: J Roux
Co-supervisors: MJ Wingfield, DL Six (University of Montana, USA)

Dr Erika Viljoen

Title of thesis: Genetic diversity analysis of the *Amaranthus* genus using genomic tools.
Supervisor: DK Berger

Dr Erik Visser

Title of thesis: Assembly of the *Pinus patula* transcriptome responding to *Fusarium circinatum* challenge.
Supervisors: S Naidoo
Co-supervisors: AA Myburg, J Wegrzyn

MSC**Daniel Ali (posthumously)**

Title of thesis: Cryphonectriaceae from native Myrtales in Indonesia, La Reunion and South Africa.
Supervisor: MJ Wingfield
Co-supervisors: J Roux, AR McTaggart

Samantha Bush

Title of thesis: Host preference of the invasive *Glycaspis brimblecombei* and host specificity of its parasitoid, *Psyllaephagus bliteus*.
Supervisor: BP Hurley
Co-supervisor: Prof B Slippers

Caitlin Botha

Title of thesis: The genetics of sexual reproduction in *Amylostereum areolatum*.
Supervisor: B Slippers
Co-supervisors: MPA Coetzee; MA van der Nest

Edohan Clasen

Title of thesis: Horizontal gene transfer in eukaryotes with a special focus on the nematode *Deladenus siricidicola*.
Supervisor: B Slippers
Co-supervisors: O Reva, Dr RE Pierneef, A Postma Smidt

Donovin Coles

Title of thesis: Functional characterisation of *Arabidopsis thaliana* nitrate transporter NRT2.5 in plant defence.
Supervisor: S Naidoo
External co-supervisor: R Mewalal (Oak Ridge National Laboratory, USA)

Esna du Plessis

Title of thesis: Dissertation: Population biology and impact of *Austropuccinia psidii* in South Africa.
Supervisor: J Roux
Co-supervisors: I Barnes, AR McTaggart

Yves du Toit

Title of thesis: The development and use of a comparative transcriptomics analysis tool for *Eucalyptus* defence interactions.
Supervisor: S Naidoo
Co-supervisor: N Christie

Ludwig Eksteen

Title of thesis: Dissertation: Patterns and drivers of host use by the European woodwasp, *Sirex noctilio*, in South African pine plantations.
Supervisor: JR Garnas
Co-supervisor: BP Hurley

Ginna Granados

Title of thesis: Studies on *Puccinia psidii* and Cryphonectriaceae on Myrtales in Colombia.
Supervisor: MJ Wingfield
Co-supervisors: J Roux, AR McTaggart

Megan Harris

Title of thesis: Characterization of viruses associated with Grapevine Leafroll disease in *Vitis* rootstocks in South Africa.
Supervisor: G Pietersen

Angel Maduke

Title of thesis: Botryosphaeriaceae native and exotic Myrtaceae trees in southern and eastern Africa.
Supervisor: J Roux
Co-supervisors: MJ Wingfield, D Pavlic

Zimbili Mlunjwa

Title of thesis: Expression analysis of selected maize primary metabolism genes in response to *Cercospora zeina* inoculation in the glasshouse.
Supervisor: DK Berger

Dorah Mwangola

Title of thesis: Population genetics of *Chrysosporthe austroafricana* in southern Africa.
Supervisor: NA van der Merwe
Co-supervisor: J Roux

Wilma Nel

Title of thesis: Taxonomy and biology of the plant pathogenic fungus *Thielaviopsis basicola*.
Supervisor: ZW de Beer
Co-supervisors: BD Wingfield, MJ Wingfield, TA Duong, A Hammerbacher

Alandie Nieuwoudt

Title of thesis: Development of a CRISPR-Cas9 gene knockout system for *Exserohilum turcicum*.
Supervisor: BG Crampton

Mashudu Nxumalo

Characterization of *Burkholderia* isolates associated with root nodules of *Vachellia karoo* in South Africa.
Supervisor: SN Venter
Co-supervisor: ET Steenkamp

Nam Pham

Title of thesis: New *Calonectria* and *Cylindrocladiella* species from Vietnam, Malaysia and Indonesia.
Supervisor: MJ Wingfield
Co-supervisors: I Barnes, SF Chen

Stefan Priem

Title of thesis: Characterisation of the cellulose biosynthesis cluster and its role in *Pectobacterium* adherence to biotic and abiotic surfaces.
Supervisor: LN Moleleki
Co-supervisor: TA Coutinho

Redzuan Rauf

Title of thesis: Dissertation: Ceratocystis wilt on *Acacia mangium* and *Chrysosporthe* canker on *Eucalyptus* in Sabah, Malaysia.
Supervisor: MJ Wingfield
Co-supervisor: I Barnes

Bianca Rodrigues-Jardim

Title of thesis: Dissertation: Characterisation of *Sirex noctilio* and *Culicoides imicola* sex determination pathways.
Supervisor: WC Fick
Co-supervisors: B Slippers, A Postma-Smidt

Kavani Sanasi

Title of thesis: Ophiostomatoid fungi associated with pine-infesting bark beetles in Guatemala.
Supervisor: ZW de Beer
Co-supervisors: MJ Wingfield, TA Duong

Riaan Swanepoel

Title of thesis: Optimizing Illumina *de novo* transcriptome assembly for non-model plants.
Supervisor: E Mizrahi
Co-supervisor: F Joubert

Tanya Welgemoed

Title of thesis: *De novo* assembly of transcriptomes from near-isogenic maize lines for novel defence gene discovery.
Supervisor: DK Berger
External co-supervisor: RE Pierneef (Agricultural Research Council)

Martin Wierzbicki

Title of thesis: Systems genetics of xylan modification in *Eucalyptus grandis* x *E. urophylla* hybrids.
Supervisor: AA Myburg
Co-supervisor: E Mizrahi

PRESENTATIONS AT CONFERENCES

INTERNATIONAL CONFERENCES: 2017–2019

- Adenigba OO, Wingfield BD, Duong TA, van der Merwe NA, Wingfield MJ, Steenkamp ET. 2017. Evidence of birth and death evolution in the α -pheromone precursor gene of *Fusarium circinatum*. 29th Fungal Genetics Conference 2017, Asilomar Hotel and Conference Grounds, Pacific Grove, USA, 14–19 March.
- Aylward J, Dreyer LL, Roets F, Wingfield BD, Wingfield MJ. 2019. Phylogenomics of Teratosphaeria leaf and stem pathogens. 30th Fungal Genetics Conference, Asilomar Hotel and Conference Grounds, Pacific Grove, California, USA, 12–17 March.
- Aylward J, Steenkamp ET, Dreyer LL, Roets F, Wingfield MJ, Wingfield BD. 2019. Idiosyncrasies of the mating type (MAT) locus in Capnodiales genomes. 30th Fungal Genetics Conference, Asilomar Hotel and Conference Grounds, Pacific Grove, California, USA, 12–17 March.
- Barnes I, Wingfield MJ, Bradshaw RE. 2018. Intercontinental collaborative research significantly enhances our understanding of an invasive pine needle pathogen. 11th International Mycological Congress, Puerto Rico Convention Centre, San Juan, Puerto Rico, 16–21 July. (Ethyl Doidge Keynote Lecture).
- Barnes I, Wingfield MJ, Harrington TC, Keith LM. 2018. Two new Ceratocystis species cause the serious and devastating rapid 'ōhi' a death (ROD) on native *Metrosideros polymorpha* in Hawaii. International Congress of Plant Pathology (ICPP), Hynes Convention Center, Boston, USA, 29 July–3 August.
- Barnes I, Wingfield MJ, Mongwaketsi K, Jami F, Garnas J. 2018. Tolerance of *Pinus patula* hybrids to novel *Fusarium circinatum* haplotypes from Guatemala and Nicaragua. International Congress of Plant Pathology (ICPP), Hynes Convention Center, Boston, USA, 29 July–3 August.
- Barnes I. 2018. Threat of *Dothistroma septosporum* to plantation forestry - with a South African perspective. HealGenCAR Conference. Clonal forestry and breeding for resistance to pests and pathogens. Höör, Sweden, 12–14 June. (Invited Keynote)
- Berger DK, Swart V, Crampton BG, Ridenour JB, Olivier NA, Meyer JJM, Bluhm BH. 2017. Molecular basis for lack of cercosporin production in *Cercospora zeina*, gray leaf spot pathogen of maize. 29th Fungal Genetics Conference, Asilomar Hotel and Conference Grounds, USA, 14–19 March.
- Berger DK. 2018. Genetically modified crops and food safety. Second International Scientific Conference on Food Security and Safety, Pretoria, South Africa, 15 October.
- Bouwer MC, Slippers B, Aguirre Gil OJ, Allison JD. 2017. Plume structure of intercept traps for trapping *Monoctonus* spp. (Coleoptera: Cerambycidae). International Society of Chemical Ecology, Kyoto, Japan, 23–27 August.
- Bouwer MC, Slippers B, Wingfield MJ, Rohwer ER. 2018. Mass trapping of the Eucalyptus cossid moth (*Coryphodema tristis*) in South Africa. International Society of Chemical Ecology, Budapest, Hungary, 12–17 Aug 2018
- Chang RL, Duong TA, Taerum SJ, Wingfield MJ, Zhou XD, De Beer ZW. 2017. Fungal symbionts of the conifer-infesting bark beetle *Ips typographus* in China. XIX International Botanical Congress, Shenzhen, China, 23–29 July.
- Christie N, Mannapperuma C, van der Merwe K, Mähler N, Delhomme N., Mizrahi E, Street NR, Myburg AA. 2017. A systems genetics browser for genome-wide expression association data in forest trees. Plant & Animal Genome XXV Conference. San Diego, USA. January.
- Christie N, Tobias P, Naidoo S and Külheim C. 2017. Classification and clustering of the *Eucalyptus grandis* NBS-LRR gene family. Plant and Animal Genome Conference, San Diego, USA, 16–18 January.
- Christie N, Tobias PA, Naidoo S, Külheim C. 2017. Classification and clustering of the *Eucalyptus grandis* NBS-LRR gene family. Plant and Animal Genome XXV Conference. San Diego, USA. 16–18 January.
- Christie N, Wierzbicki MP, Hussey SG, Mizrahi E, Myburg AA. 2018. Genetic architecture of transcriptome variation shaping wood biology in *Eucalyptus*. 42nd New Phytologist Symposium - The biology of wood: from cell to trees. Lake Tahoe, California. 10–12 July.
- Coles, DW, Du Toit, Y, Hussey, SG, Mewalal, R, Christie, N, Myburg, AA, Naidoo S. 2017. Identification and characterisation of Nitrate Transporter 2.5 as a target defence response gene in *Eucalyptus grandis*. IUFRO Tree Biotechnology Congress, Chile, 4–9 June.
- de Beer ZW, Conlon BH, de Fine Licht HH, Aanen DK, Poulsen M. 2017. Searching for the *Podaxis* fungus on the trails of early explorers in southern Africa with the help of rural communities. XIX International Botanical Congress (IBC 2017), Shenzhen, China, 23–29 July.
- de Beer ZW, Duong TA, Erasmus M, Wingfield MJ. 2017. The Evolution of Fungal Taxonomy over two centuries: a case study in the Ophiostomatales. XIX International Botanical Congress (IBC 2017), Shenzhen, China, 23–29 July.
- de Beer ZW, Duong TA, Marincowitz S, Wingfield MJ. 2018. *Hawksworthiomyces sequentia* ENAS: a case study in DNA-based taxonomy. 11th International Mycological Congress (IMC), San Juan, Puerto Rico, 16–21 July.
- de Beer ZW, Duong TA, Procter (Erasmus) M, Wingfield BD, Wingfield MJ. 2017. The Evolution of Fungal Taxonomy over two centuries: a case study in the Ophiostomatales. XIX International Botanical Congress 2017, Shenzhen Convention and Exhibition Centre, Shenzhen, China, 23–29 July.
- de Beer ZW, Duong TA, Wingfield MJ. 2017. Subspecies taxonomy in the Ophiostomatales. Cryptic Speciation in Classifications, CBS Symposium, CBS-KNAW, Utrecht, 1 September.
- de Beer ZW. 2017. Designating DNA types: an update. Cryptic Speciation in Classifications, CBS Symposium, CBS-KNAW, Utrecht, 1 September.



- de Vos L, Dewing C, Van der Nest MA, Wingfield MJ, Wingfield BD, Steenkamp ET. 2018. Genome comparisons reveal factors responsible for host specificity in the *Fusarium fujikuroi* species complex. International Congress of Plant Pathology (ICPP), Hynes Convention Center, Boston, USA, 29 July–3 August.
- Denancé N, Henry C, Aveling T, Grimault V. 2018. Is seed a pathway? Updating the list of seed-borne diseases. 8th ISTA-SHC Seed Health Symposium and 6th International Seed Health Conference, Poznań, Poland, 4–7 September.
- Dewing C, van der Nest MA, Santana QC, Steenkamp ET, Wingfield BD, de Vos L. 2019. Genome comparisons reveal processes implicated in host specificity in the *Fusarium fujikuroi* species complex. 30th Fungal Genetics Conference, Asilomar Hotel and Conference Grounds, Pacific Grove, USA, 12–17 March.
- Dittrich-Schröder G, Clasen E, Hurley BP, Wingfield MJ, Slippers B. 2018. An online mitochondrial DNA sequence database to support pest management research in *Eucalyptus* and *Pinus* plantations. *Eucalyptus* 2018, Managing *Eucalyptus* plantations under global change, Le Corum, Montpellier, France, 17–21 September.
- Dittrich-Schröder G, Gevers C, Hurley BP, Wingfield MJ, Slippers B. 2018. The use of molecular techniques to understand pest introductions and pest complexes. *Eucalyptus* 2018, Managing *Eucalyptus* plantations under global change, Le Corum, Montpellier, France, 17–21 September.
- Dittrich-Schröder G, Hurley BP, Wingfield MJ, Slippers B. 2017. Gall-forming wasps threaten non-native plantation grown *Eucalyptus*. IUFRO 125th Anniversary Congress, Freiburg, Germany, 18–22 September.
- Dittrich-Schröder G, Postma-Smidt A, Hurley BP, Wingfield MJ, Slippers B. 2017. Integrating next generation population genetics and gene editing tools to control invasive insect pests – a case study with the invasive *Eucalyptus* pest *Leptocybe invasa*. International Workshop on “Assessing the Security Implications of Genome Editing Technology”, Hannover, Germany, 11–13 October.
- Duong TA, Hammerbacher A, Wingfield MJ, Chen SF, Chang R, Liu FF, Wingfield BD. 2018. Applying population genomics to understand the genomic basis of speciation, pathogenicity and host specialization in *Ceratocystis fimbriata sensu lato*. International Congress of Plant Pathology (ICPP), Boston, USA, 29 September–3 August.
- Duong TA, Wingfield MJ, de Beer ZW, Wingfield BD. 2017. Mating type loci suggest ancestral heterothallism and convergent evolution towards homothallism in Ophiostomatales lineages. 29th Fungal Genetics Conference, Asilomar Hotel and Conference Grounds, Pacific Grove, USA, 14–19 March.
- Duong TA, Wingfield MJ, Le V, de Beer ZW, Wingfield BD. 2018. Comparative genomics reveals the role of transposable elements in the evolution of pathogenicity in fungal pathogens of conifers. International Congress of Plant Pathology (ICPP), Boston, USA, 29 July–3 August.
- Engelbrecht J, Duong TA, Van den Berg N. 2017. Identification and characterization of polymorphic microsatellite markers to study *Phytophthora cinnamomi* populations. 8th Meeting of IUFRO Working Party: *Phytophthora* in Forests and Natural Ecosystem, Sapa, Vietnam, 19–25 March.
- Engelbrecht S, Mizrahi E, Christie N, Myburg AA. 2017. Genome-wide analysis of allele-specific expression during xylogenesis in *Eucalyptus* hybrids. IUFRO Tree Biotechnology 2017 Conference. Concepción, Chile. June.
- Eshetu FB, Nahrung H, Barnes I, Fitz KNE, Elms S, Slippers B. 2018. Genetic diversity of the biocontrol nematode *Deladenus siricidicola* in Australia and New Zealand. International Congress on Invertebrate Pathology and Microbial Control and the 51st Annual Meeting of the Society for Invertebrate Pathology, Qt Gold Coast Hotel, Australia, Gold Coast, 12–16 August.
- Fitz KNE, Eshetu F, Garnas JR, Ahumada R, Ayres MP, Krivak-Tetley FE, Lombardero MJ, Barnes I, Nahrung H, Wingfield MJ, Slippers B. 2018. Genetic diversity in global collection of *Deladenus siricidicola*. International Congress on Invertebrate Pathology and Microbial Control and the 51st Annual Meeting of the Society for Invertebrate Pathology, Qt Gold Coast Hotel, Australia, Gold Coast, 12–16 August.
- Fourie A, de Jonge R, van der Nest MA, Wingfield MJ, Wingfield BD, Barnes I. 2018. Whole genome comparisons of the host specific species *Ceratocystis fimbriata sensu stricto* and *C. manginecans*. International Conference for Plant Pathology, Boston, USA, 29 July–3 August.
- Fourie A, Wingfield MJ, Wingfield BD, van der Nest MA, de Vos L, Barnes I. 2018. Identification of genomic regions associated with host specificity and aggressiveness in *Ceratocystis* species. International Conference for Plant Pathology, Boston, USA, 29 July–3 August.
- Granados GM, McTaggart AR, Rodas CA, Roux J, Wingfield MJ. 2017. Can Melastomataceae endophytes be a threat to *Eucalyptus* plantations in Colombia?. IUFRO 125th Anniversary Congress, The Konzerthaus, Freiburg, Germany, 18–22 September.
- Granados GM, McTaggart AR, Rodas CA, Roux J, Wingfield MJ. 2018. Cryphonectriaceae endophytes in Melastomataceae: latent pathogens in hiding. International Congress of Plant Pathology (ICPP), Hynes Convention Center, Boston, USA, 29 July–3 August.
- Granados GM, McTaggart AR, Rodas CA, Roux J, Wingfield MJ. 2018. Endophytic Cryphonectriaceae in the Melastomataceae threaten *Eucalyptus* plantation forestry in Colombia and globally. 11th International Mycological Congress, Puerto Rico Convention Centre, San Juan, Puerto Rico, 16–21 July.
- Hammerbacher A, Wingfield B. 2018. Chemical defence responses of Australian *Acacia* trees to infection by *Ceratocystis* species. 34th ISCE Meeting, International Society of Chemical Ecology, Budapest, Hungary, 12–18 August 2018.
- Hammerbacher A. 2018. The sweet smell of decay: bark beetles are attracted to volatile by-products produced during detoxification of host defenses by their associated fungi. 34th ISCE Meeting, International Society of Chemical Ecology, Budapest, HU, 12–18 August 2018.
- Herron DA, de Beer ZW, Slippers B, Wingfield MJ. 2018. More “Ideal Plant Clinics” (IPC) required in the Anthropocene. 11th International Congress of Plant Pathology, Boston, USA, 29 July–3 August.
- Herron DA, Steenkamp ET, Wingfield BD, Wingfield MJ. 2018. The pitch canker fungus (PCR), *Fusarium circinatum*: endophytic on grasses in South Africa. 11th International Congress of Plant Pathology, Boston, USA, 29 July–3 August.
- Hulbert JM, Burgess T, Roets F, Wingfield MJ. 2017. Public engagement to survey *Phytophthora* in South Africa. IUFRO Working Party *Phytophthora* in Forests and Natural Ecosystems (7.02.09), Sapa, Vietnam, 19–24 March.
- Hulbert JM, Burgess TI, Roets F, Wingfield MJ. 2018. Pathogen hunters: non-scientist engagement in plant disease research. International Congress of Plant Pathology (ICPP), Hynes Convention Center, Boston, USA, 29 July–3 August.
- Hulbert JM, Burgess TI, Roets F, Wingfield MJ. 2018. The Cape Town Hypothesis Test: *Phytophthora* in urban vs natural environments. International Congress of Plant Pathology (ICPP), Hynes Convention Center, Boston, USA, 29 July–3 August.
- Hulbert JM, Roux J, Burgess T, Roets F, Wingfield MJ. 2017. Cape Citizen Science: public engagement to detect and discover *Phytophthora* species in South Africa. IUFRO 125th Anniversary Congress, Konzerthaus Freiburg, Freiburg, Germany, 18–22 September.
- Hulbert JM, Roux J, Burgess T, Roets F, Wingfield MJ. 2017. Citizen science initiatives: opportunities to manage global forest pest challenges. IUFRO 125th Anniversary Congress, Konzerthaus Freiburg, Freiburg, Germany, 18–22 September.

- Hurley BP, Gevers C, Dittrich-Schröder G, Slippers B. 2017. Investigating the complex gall community of *Leptocybe invasa*. 5th International Symposium on Biological Control of Arthropods, Langkawi, Malaysia, 11–15 September.
- Hurley BP, Greyling I, Wingfield MJ, Slippers B. 2018. Pests and pathogens increasingly threaten plantation forestry in South Africa. IUFRO Working Party 7.02.13, Punta del Este, Uruguay 21–23 March (invited speaker).
- Hurley BP, Slippers B, Wingfield MJ. 2017. Biological control of insects in plantation forests: Optimizing an old approach for diverse and changing environments. IUFRO 125th Anniversary Congress, Freiburg, Germany, 18–22 September.
- Hurley BP. 2018. Insect pests of plantation trees: Challenges and responses. IUFRO Working Party 7.02.13, Punta del Este, Uruguay, 21–23 March.
- Hussey S, Brown K, Mizrahi E, Myburg AA. 2017. Accessible chromatin mapping in *Eucalyptus grandis* vascular tissue. Plant and Animal Genome XXVI Conference. San Diego, USA. 13–17 January.
- Hussey S, Mizrahi E, Deutsch S, Yoshikuni Y, O'Malley R, Brady SM, Grima-Pettenati J, Myburg AA. 2017. Transcriptional regulation and synthetic biology resources for woody biomass improvement in *Eucalyptus*. IUFRO Tree Biotechnology 2017 Conference. Concepción, Chile. 4–9 June.
- Jami F, Marincowitz S, Crous PW, Slippers B, Le Roux JJ, Richardson DM, Wingfield MJ. 2017. Comparison of the Botryosphaeriaceae on *Acacia koa* and *A. heterophylla*: Evidence of a long-standing separation of two genetically close, but geographically isolated, tree populations. IUFRO 125th Anniversary Congress, Freiburg, Germany, 18–22 September.
- Jami F, Marincowitz S, Crous PW, Slippers B, le Roux JJ, Richardson DM, Wingfield MJ. 2018. Botryosphaeriaceae diversity on *Acacia koa* and *A. heterophylla* in La Réunion and Hawaiian Islands. International Congress of Plant Pathology (ICPP), Boston, USA, 29 July–3 August.
- Jami F, Migliorini D, Burgess TI, Crous PW, Slippers B, Wingfield MJ. 2018. Diversity of Botryosphaeriaceae on Proteaceae in South Africa, Australia and Portugal. International Congress of Plant Pathology (ICPP), Boston, USA, 29 July–3 August.
- Kanzi AM, Wingfield BD, Steenkamp ET, Van der Merwe NA. 2017. Genome sequencing reveals a heterothallic mating system in the *Eucalyptus* pathogen *Chrysosporthe austroafricana*. 29th Fungal Genetics Conference, Pacific Grove, California, USA, 14–19 March.
- Kritzinger Q, Aveling TAS. 2018. Seed health challenges in the smallholder informal seed system. Global impact of international seed movement: Regulatory implications of seed health testing. 11th International Congress of Plant Pathology, Boston, Massachusetts, USA, 29 July–3 August (talk – invited speaker).
- Kunert KJ, Vorster BJ, Cullis CA. 2018. Breeding orphan legumes to survive stressful environments: A South African perspective. AAUN workshop: New plant breeding methods for sustainable use of genetic resources and security of food production, University of Mauritius, Mauritius, 29–31 January.
- Lasarov I, Linnakoski R, Tikkanen O-P, Duong TA, de Beer ZW, Wingfield MJ. 2018. Fungal and yeast associates of phoretic mites on *Ips typographus* in Finland. 11th International Mycological Congress (IMC), San Juan, Puerto Rico, 16–21 July.
- Laubscher M, Brown K, Tonfack B, Mizrahi E, Myburg AA, Hussey SG. 2017. Spatial expression and transcriptional targets of EgrNAC26 and EgrNAC61, master regulators of fibre and vessel biosynthesis in *Eucalyptus grandis*. International Union of Forest Research Organizations (IUFRO) Tree Biotechnology Conference. Concepción, Chile. 4–9 June.
- Li JQ, Wingfield B, Wingfield MJ, Barnes I, Fourie A, Chen SF. 2018. Characterization of the mating type (*MAT*) loci in *Calonectria* species pathogenic to *Eucalyptus*. IUFRO *Eucalyptus* Conference, Montpellier, France, 17–21 September.
- Mahlangu AZ, Kritzinger Q, Aveling TAS. 2018. Seed-borne mycoflora and mycotoxins associated with farm-saved dry bean seeds stored by subsistence farmers in the uThukela District, KwaZulu-Natal. Second International Conference for Food Safety and Security, Pretoria, South Africa, 15–17 October.
- Maloney VJ, Wierzbicki M, Mansfield SD, Mizrahi E, Myburg AA. 2017. Engineering xylan acetylation in wood cell walls using CRISPR repression. Plant Cell Wall Research Conference. Asilomar, USA. June.
- Maphosa M, Steenkamp ET, Wingfield BD. 2017. Characterization of the core and accessory genomes of *Fusarium circinatum*. Applied Bioinformatics and Public Health Microbiology, Wellcome Genome Campus Conference Centre, Hinxton, Cambridge, UK, 17–19 May.
- Mhoswa L, O'Neill MM, Mphahlele MM, Oates CN, Payn KG, Slippers B, Myburg AA, Naidoo SA. 2018. Genome-Wide Association Study in *Eucalyptus grandis* reveals genomic regions and positional candidate genes for the insect pest, *Leptocybe invasa*. International Union of Forestry Research Organizations (IUFRO) Working Group 2.08.03 Meeting: "Improvement and Culture of Eucalypts", Montpellier, France 17–21 September.
- Miller AN, Réblová M, Nguyen N-p, Warnow T, Schoch CL, de Beer ZW, Crous PW, Duong TA, Ferrer A, Hashimoto A, Hernández-Restrepo M, Hubka V, Huhndorf SM, Jaklitsch W, Krusys A, Kuhnert E, Lombard L, Luangsa-ard JJD, Luo J, Marin-Felix Y, Matsumura M, Raja HA, Rossman AY, Sakayaroj J, Seifert KA, Shearer CA, Stadler M, Stchigel AM, Štěpánek V, Sueterong S, Tanaka K, Voglmayr H, Wendt L, Wingfield BD, Wingfield MJ, Zhang N. 2017. Overview of Sordariomycetes. IX Latin American Congress of Mycology, Lima, Peru. 22–25 August.
- Mizrahi E, Pinard D, Behrens, Ekoka E, van de Peer Y, Marchal, Myburg AA. 2017. Carbon metabolism: What are organelles doing during wood formation. IUFRO Tree Biotechnology 2017 Conference. Concepcion, Chile. 4–9 June.
- Mizrahi E, Pinard D, Roodt D, Swanepoel RL, Behrens A, Maistry M, Maloney VJ, van de Peer Y, Marchal K, Myburg AA. 2017. Reverse engineering networks of secondary growth and their evolution in plants. 42nd New Phytologist Symposium - The biology of wood: from cell to trees. Lake Tahoe, USA. July.
- Mlunjwa ZE, Berger DK. 2017. Expression of candidate maize defense genes in response to *Cercospora zeina*. The 3rd International Conference on Global Food Security, Cape Town, South Africa, 3–6 December.
- Morgan SW, Schroder M, Paap T, Marincowitz S, Wingfield MJ, de Beer ZW. 2017. New species of *Quambalaria* from *Eucalyptus* seed capsules and eucalypt-feeding insects in South Africa. XIX International Botanical Congress (IBC 2017), Shenzhen, China, 23–29 July.
- Myburg AA, Christie N, Engelbrecht S, Wierzbicki M, Mizrahi E. 2017. System genetics dissection of wood formation in *Eucalyptus*. IUFRO Tree Biotechnology 2017 Conference. Concepcion, Chile. 4–9 June (invited plenary speaker).
- Myburg AA, Christie N, Engelbrecht S, Wierzbicki M, Pinard D, Mansfield S, Mizrahi E. 2017. Systems genetics dissection of secondary cell wall formation in *Eucalyptus* interspecific hybrids. The International Botanical Congress (IBC 2017). Shenzhen, China. 23–29 July (invited plenary speaker).
- Myburg AA. 2017. Genome diversity of commercially grown *Eucalyptus* species and hybrids: Towards landscape genomics for genetic resource management and molecular breeding. International Union of Forestry Research Organizations (IUFRO) Working Group 2.08.03 Meeting: "Improvement and Culture of Eucalypts". Montpellier, France. 17–21 September.



- Myburg AA. 2018. Systems genetics of xylan biosynthesis. International Symposium on Forest Tree Molecular Biology and Biotechnology. Harbin, China. 24–26 July.
- Naidoo S, Mhoswa L, Oates CN, Mphahlele M, Külheim C, Slippers B and Myburg AA. 2017. A multiomics approach to understanding host defence response against the insect pest *Leptocybe invasa* in *Eucalyptus grandis*. IUFRO 125th Anniversary Conference, Freiburg, Germany, 18–22 September.
- Naidoo S, Mhoswa L, Oates CN, Mphahlele M, Külheim C, Slippers B and Myburg AA. 2017. A multiomics approach to understanding host defence response against the insect pest *Leptocybe invasa* in *Eucalyptus grandis*. IUFRO Tree Biotechnology Congress, Chile, 4–9 June.
- Naidoo S, Oates CN, Mhoswa L, O'Neil M, Acosta JJ, Christie N, Mphahlele MM, Payn KG, Myburg AA, Slippers, Külheim C. 2018. Factors underpinning resistance against the galling pest, *Leptocybe invasa* in *Eucalyptus grandis*. International Tree Resistance Workshop, Mount Sterling, Ohio, USA, 5–10 August.
- Nel WJ, Duong TA, Wingfield BD, Wingfield MJ, de Beer ZW. 2017. A new genus and sister species described for the globally important, multi-host root pathogen, *Thielaviopsis basicola*. XIX International Botanical Congress 2017, Shenzhen Convention and Exhibition Centre, Shenzhen, China, 23–29 July.
- Nel WJ, Duong TA, Wingfield BD, Wingfield MJ, de Beer ZW. 2018. Taxonomy and mating strategy of *Thielaviopsis basicola* – a globally important pathogen of agricultural crops. 2018 International Mycological Congress, Puerto Rico Conference Centre, San Juan, Puerto Rico, USA, 16–21 July.
- Nel WJ, Duong TA, Wingfield BD, Wingfield MJ, Hammerbacher A, de Beer ZW. 2017. The important root rot pathogen *Thielaviopsis basicola* shown to be heterothallic. 29th Fungal Genetics Conference 2017, Asilomar Hotel and Conference Grounds, Asilomar, USA, 14–19 March.
- Nsibo, DL, Kunene, NT, Barnes I, Berger DK. 2017. Influence of farming practices on the genetic diversity of *Cercospora zeina*, an important maize pathogen in South Africa. The 3rd International Conference on Global Food Security, Cape Town, South Africa, 3–6 December.
- Osorio JA, Linnakoski R, Wingfield MJ, de Beer ZW, Roux J. 2018. A new species in the Mycosphaerellaceae from *Cecidomyiidae* leaf galls on *Avicennia marina* in South Africa. 11th International Mycological Congress (IMC), San Juan, Puerto Rico, 16–21 July.
- Paap T, de Beer ZW, Burgess TI, Wingfield MJ. 2018. Sentinel tree research in botanical gardens of South Africa. COST Action FP1401 Final Meeting: Sentinel plantings for detecting alien, potentially damaging tree pests, Campus Sursee, Sursee, Switzerland, 8–12 October.
- Paap T, Hulbert J, Wilson JR, Burgess TI, Wingfield MJ. 2017. Botanical gardens: Sentinel plantings to detect new and emerging *Phytophthora* risks. IUFRO Working Party *Phytophthora* in forests and natural ecosystems (7.02.09), Sapa, Vietnam, 19–24 March.
- Pham NQ, Barnes I, Chen SF, Roux J, Pham TQ, Wingfield MJ. 2017. Novel *Calonectria* species from plantation and nursery soils in South-East Asia. IUFRO 125th Anniversary Congress, Konzerthaus Freiburg, Freiburg, Germany, 18–22 September.
- Potgieter L, Wingfield BD, van der Nest MA, Coetzee MPA. 2017. *In silico* characterisation of Endo-polygalacturonase in members of the Agaricales. 29th Fungal Genetics Conference. Asilomar, Pacific Grove, California, USA, 14–19 March.
- Procter M, Duong TA, Wingfield MJ, de Beer ZW. 2018. Redefining genera in the Ophiostomatales. 2018 International Mycological Congress, Puerto Rico Conference Centre, San Juan, Puerto Rico, 16–21 July.
- Roodt D, Swanepoel RL, van de Peer Y, Mizrahi E. 2018. Mechanisms underlying angiosperm-like traits in the gymnospermous Gnetales lineage. American Society of Plant Biologists Conference. Montreal, Canada. 14–18 July.
- Sayari M, van der Nest MA, Steenkamp E, Wingfield BD. 2018. Agrobacterium-mediated transformation of *Ceratocystis*. International Congress of Plant Pathology (ICPP), Hynes Convention Center, Boston, USA, 29 July–3 August.
- Schröder ML, Nahrung HF, Lawson SA, Slippers B, Wingfield MJ and Hurley BP. 2017. Biological control of the *Gonipterus scutellatus* species complex: Testing the species, climatic or phenological mismatch hypotheses. 5th International Symposium on Biological Control of Arthropods, Meritus Pelangi Beach Resort, Langkawi, Malaysia, 11–15 September.
- Shin G, Moleleki LN, Shyntum D, Coutinho TA. 2018. Hfq is important in biofilm formation, motility and pathogenicity of the plant pathogen *Pantoea ananatis*. International Congress of Plant Pathology, Boston, USA, 29 July–3 August.
- Shutt V, Goszczynska T, van der Waals J, Coutinho TA. 2018. Characterization of *Xanthomonas* spp. causing black spot of tomato in South Africa. International Congress of Plant Pathology, Boston, USA, 29 July–3 August 2018.
- Sibanda, Moleleki LN, Shyntum D, Coutinho TA. 2018. Transcriptome profiling reveals EanI/R quorum regulon in *Pantoea ananatis* LMG 2665^T. International Congress of Plant Pathology, Boston, USA, 29 July–3 August 2018.
- Slippers B, Barnes I, Steenkamp ET, Wingfield MJ. 2018. The worldwide web of forest fungi. International Congress of Plant Pathology, Boston, USA, 29 July–3 August (invited speaker).
- Slippers B, Kemler M, McTaggart M, Vivas M, Naidoo S, Wingfield MJ. 2017. 'Omics' approaches to the pathobiome offer pre-emptive solutions to plant biosecurity. IUMS international Congress, Singapore, 17–21 July (invited keynote).
- Slippers B, Kemler M, Vivas M, Messal M, McTaggart A, Naidoo S, Wingfield MJ. 2018. The plant endophytic microbiome and biosecurity: *Eucalyptus* as an example. IUFRO *Eucalyptus*, Montpellier, France, 17–21 September.
- Slippers B. 2017. The role of molecular ecology in the management of invasive pests and pathogens in plantation forestry 125th IUFRO Anniversary Congress, Freiburg, Germany, 18–22 September.
- Smith A, Hurley BP, Slippers B, Fourie G. 2018. Characterisation of Lepidoptera species associated with Macadamia nut damage in South Africa. 8th International Macadamia Symposium, Lincang China, 16–18 October.
- Swalarsk-Parry BS, Steenkamp ET, Hammerbacher A, Wingfield BD, de Vos L. 2018. Association of a quantitative trait locus with growth of *Fusarium circinatum*. 11th International Congress of Plant Pathology, Hynes Convention Center, Boston, USA, 29 July–3 August.
- Tchotet Tchoumi JM, Coetzee MPA, Rajchenberg M, Roux R. 2018. Diversity and taxonomy of *Ganoderma* species in South Africa, inferred from morphology and a multi-locus phylogeny. 11th International Mycological Congress, Puerto Rico Convention Centre, San Juan, Puerto Rico, 16–21 July.
- Ullah C, Unsicker S, Fellenberg C, Constabel P, Tsai C-J, Reichelt M, Schmidt A, Gershenzon J, Hammerbacher A. 2018. Poplar activates defenses against the rust fungus *Melampsora larici-populina* by upregulating the salicylic acid pathway leading to the accumulation of catechin and proanthocyanidins. Plant Biology 2018, American Society of Plant Biologists and Canadian Society of Plant Biologists, Montreal, Canada, 14–18 July.
- van Wyk S, de Vos L, Wingfield BD, van der Merwe NA, Steenkamp ET. 2017. Repeat-Induced Point mutations: Driving genome divergence of the *Fusarium fujikuroi* species complex. 29th Fungal Genetics Conference, Asilomar Hotel and Conference Grounds, Asilomar, USA, 14–19 March.
- Venter SN, Palmer M, Steenkamp ET. 2018. What exactly are bacterial subspecies? 4th Meeting of the Bergey's

- International Society for Microbial Systematics (BISMis), Muldersdrift, South Africa, 8–11 April.
- Venter SN. 2017. Phenotypic checklists: What are the alternatives? ICSP session on Role of genome sequence analysis in polyphasic taxonomy and prokaryotic systematics at the 7th Congress of European Microbiologists, Valencia, Spain, 9–13 July (invited speaker).
- Visser EA, Wegrzyn JL, Myburg AA, Naidoo S. 2018. Host responses to *Fusarium circinatum* challenge in a resistant and susceptible pine species. Plant and Animal Genome Conference, San Diego, USA, 16–20 January.
- Vivas M, Kemler M, Rolo V, Wingfield MJ, Slippers B. 2017. Environmental maternal effects on the morphology, physiology and interactions of *Eucalyptus grandis*. 40th New Phytologist Symposium Plant epigenetics: from mechanisms to ecological relevance, University of Vienna, Vienna, Austria, 12–15 September.
- Vivas M, Kemler M, Rolo V, Wingfield MJ, Slippers B. 2017. Environmental maternal effects on the phenotype and interactions of *Eucalyptus* seedlings. IUFRO 125th Anniversary Congress, The Konzerthaus, Freiburg, Germany, 18–22 September.
- Vorster BJ, Kibido T. 2018. Influence of drought on Soybean nodulation and nitrogen fixation. 13th European Nitrogen Fixation Conference, Stockholm, Sweden, 18–21 August.
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- Avontuur J, Steenkamp ET, van Zyl E, Beukes CW, Chan WY, Palmer M, Venter SN. 2017. Delineation of novel *Bradyrhizobium* species using a genealogical concordance perspective. 13th South African Society for Systematic Biology (SASSB), Hosted by University of Pretoria at SANBI Education Centre, Pretoria, South Africa, 2–4 July.
- Aylward J, Roets F, Dreyer LL, Wingfield BD, Wingfield MJ. 2019. Recombination or multiple introductions? Evaluating sexual reproduction in two *Eucalyptus* stem canker pathogens. South African Society for Plant Pathology, Club Mykonos, Langebaan, South Africa, 21–24 January.
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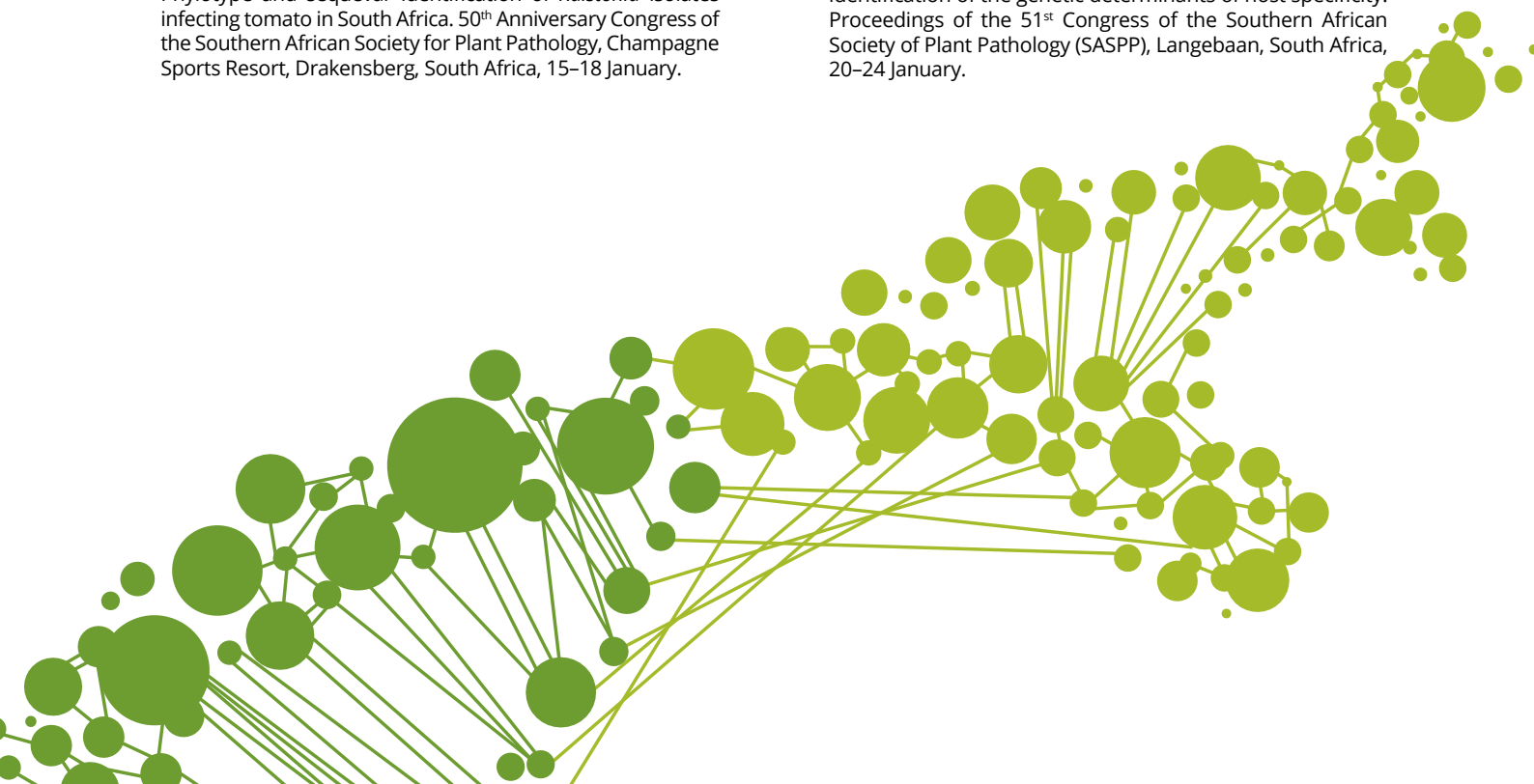


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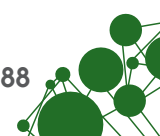
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GUEST SEMINAR PRESENTATIONS

Dr Wayne Hancock

Southern Cross University, Australia
Genetics and development - the link between genetics/
science and the field.
April 2019

Prof. Steven Chown

Monash University, Australia
Choosing our future: Antarctic science in a global setting.
February 2019

Dr Richard Allan White III

Washington State University, USA
The soil microbiome: A vital ecosystem in transition
revealed by multiomics.
October 2018

Prof. Robert Park

University of Sydney, Australia
Approaching 100 years of cereal rust research at the
University of Sydney: Lessons learnt and the way ahead.
October 2018

Prof. Randy Ploetz

University of Florida, USA
Fate of the most important fruit.
October 2018

Dr Michelle Ploetz

Miami Dade College, USA
An accelerated content-based English (ACE) programme.
October 2018

Prof. Virginia Morales Olmos

University of the Republic, Uruguay
An estimate of the economic impact of *Teratosphaeria
nebulosi* on *Eucalyptus globulus* plantations in Uruguay.
October 2018

Dr Elizabeth Dann

University of Queensland, Australia
Avocado pathology research in Australia.
October 2018

Dr Emmanuel Wicker

French Agricultural Research Centre for International
Development (CIRAD), France
What makes a plant pathogen cause emerging disease?
August 2018

Dr Chris Malumphy

Food and Environment Research Agency (FERA) Science,
United Kingdom.
New and emerging pest threats to trees in the UK.
June 2018

Prof. Gilles Boeuf

Universite Pierre et Marie Curie, France
Biodiversity facing climate change.
April 2018

Dr Ramon Roselló-Móra

Mediterranean Institute for Advanced Studies (IMEDEA),
Spain
Diversity in hypersaline environments.
April 2018

Prof. Duur Aanen

Wageningen University, the Netherlands
The "too-much-talent" effect in fungi
FABI 20th Anniversary Symposium
January 2018

Dr Christine Beemelmans

Hans Knöll Institute, Germany
The chemistry of defensive symbioses – The tale of two
natural product discoveries!
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Alexander Buck

International Union of Forest Research Organizations
(IUFRO), Austria
Connecting the dots – The importance of global
collaboration.
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Prof. Treena Burgess

Murdoch University, Australia
The making of a career; a chance meeting that has led to 20
years of research collaboration.
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Prof. ShuaiFei Chen

China Eucalypt Research Centre, Chinese Academy of
Forestry, China
FABI-China: Good friendships, great achievements and a
bright future.
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Prof. Jim Correll

University of Arkansas, USA
Applied plant pathology in the Genomics Era.
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Westerdijk Fungal Biodiversity Institute, the Netherlands
No space, no money = foliar diseases.
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Australian National University, Australia
Mycorrhizal Fungi of Australian orchids.
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Science policy, budgets and PhD studies: Why they matter.
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Fabius defensoris: A taxonomy history.
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Laurel wilt: An evolving pathosystem.
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National Research Foundation, South Africa
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University of Montana, USA
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Manukau Institute of Technology, New Zealand
Change – adjustment – resilience – endurance – convergence – future – innovation.
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University of Copenhagen, Denmark
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Dr Johan van Zyl

African Rainbow Capital, South Africa
Establishing FABI.
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Dr Len van Zyl

ArrayXpress Inc., USA
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Dutch elm disease in Italy, studies on its possible management
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Utrecht University, the Netherlands
Elucidating molecular mechanisms of plant-microbe interactions.
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Instituto Nacional de Tecnologia Agropecuaria (INTA), Argentina
Forestry sector in Argentina: Pests and diseases of *Eucalyptus*.
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Dr Jonathan Plett

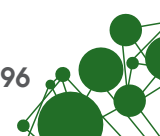
Western Sydney University
Tuning in to rhizosphere radio: Decoding the conversations between plants and microbes to breed more sustainable crops.
August 2017

Dr Sofie de Meyer

Centre for Rhizobium Studies, Murdoch University, Australia
Productive resilient legume symbioses well matched for farming systems.
June 2017

Dr Euan James

James Hatton Institute, Scotland
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June 2017



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- Camcore Breeding And Conservation Cooperative
- Cape Pine (Pty) Ltd
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- Department Of Agriculture, Forestry And Fisheries (DAFF) [now Department Of Environmental Affairs, Forestry And Fisheries (DEAFF)]
- Department of Agriculture and Land Management?
- Department of Science and Technology (DST) [Now Department of Science and Innovation (DSI)]
- DST-NRF Centre Of Excellence Programme
- DST/TIA Funding
- EU FP7 Testa Project
- Forest Molecular Genetics Consortium (Sappi And Mondi)
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