FABI

BIENNIAL REPORT

MAY 2021–MAY 2023

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 and information technology 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 services, 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 and Microbiology (BGM), Chemistry, Computer Science, Plant and Soil Science, Physics, and Zoology and Entomology are associated with FABI. This affords FABI the opportunity to build future resources in biotechnology and information technology 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 in the world, as well as partners in industry and government.

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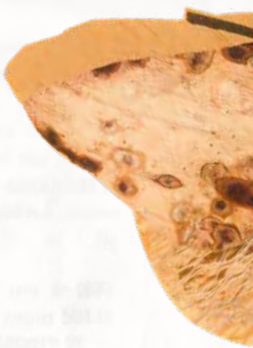

FABI

Forestry and Agricultural Biotechnology Institute

BIENNIAL REPORT

MAY 2021–MAY 2023

INNOVATION AFRICA
UNIVERSITY OF PRETORIA

UNIVERSITEIT VAN PRETORIA
UNIVERSITY OF PRETORIA
YUNIBESITHI YA PRETORIA

Cover artwork (Director's foreword)
Birth of a Symbiologist
Diana Six

From the artist: "*Birth of a Symbiologist* is autobiographical, as well as an exposition of the process of science. As a child, I was fascinated by nature. Early trips to second-hand stores and numerous camping trips provided me with a wealth of old books, magazines, and shoeboxes full of dried mushrooms, lichens, and rocks from which I pieced together an understanding of the natural world around me. These 'found objects' played a major role in who I would become as an adult. My development as a scientist was strikingly similar – taking knowledge developed by others in the past and adding bits and pieces I found along the way, I have emerged as a symbiologist. Unlike with insects metamorphosing from a cocoon with a predictable form, scientists emerge as a product of intention, imagination, and fortuitous encounters – each a very different animal."

Prof. Diana Six is a long-time collaborator of FABI, part of the board of the Centre of Excellence in Plant Health Biotechnology and Extraordinary Professor. She is one of the world's foremost experts on insect-fungal symbiosis that affect tree health and on climate change impacts on these interactions. Apart from her scientific expertise, Prof. Six is passionate about Sci-Art. She communicates the insights from her work powerfully through this medium. Apart from the appealing autobiographical message of the artwork, which also captures the journey of many FABIans, it was chosen because it communicates the beauty of the complex, intertwined symbiotic interactions from which life on earth emerges.

Inside cover artwork
Untitled mixed media
Retha Buitendach

From the artist: "The insatiable need to make things that honour nature's boundless beauty has been with me since childhood. As a child, I had great fun building things with flowers, twigs, and bits of throw-away cardboard and needlework scraps my mother collected in a box for us. I guess this was the start of my calling to be an artist."

Retha Buitendach's artworks deals with nature in both its macrocosmic and microcosmic detail. The hidden interconnectedness of all living things is an important underlying theme, as is the chance connections between seemingly unrelated things or even words. Unusual and microscopic life-forms as well as those seen every day are sometimes portrayed in unusual contexts, thereby inducing the onlooker to discover them anew. Man is shown to be unique in his ability to experience nature as a supremely beautiful artwork and to be unique in his ability to destroy it all. Her work is both naturalistic and surrealistic, combining the recognisable with what the imagination can add to it.

Content page artwork
Greta Grunow Guzek

The longer you look, the more you see. The image reflects the intricate connections amongst living organisms in ecosystems. These connections are critical to plant health and productivity, and is at the core of many FABI research programs.

CONTENT

DIRECTOR'S FOREWORD

Prof. Bernard Slippers
Director of FABI and Tree Protection Co-operative Programme

FABI is a dynamic and collaborative community dedicated to excellence in research and postgraduate training for Future Food and Forests. Over the past 25 years, we have evolved from humble beginnings to a substantial institute impacting forestry and agriculture in South Africa, Africa and beyond. For this purpose, we work in close partnership with local and international research organisations, industries and governments.

The past two years covered in this report have been remarkable in numerous ways. We've witnessed the world's recovery from the COVID-19 pandemic, driven by rapid advancements in molecular, digital and synthetic biology. Notably, the development of the first mRNA vaccines, created entirely through digital and synthetic processes, and that these were made available for testing before the first South African COVID-19 death, stands as a turning point in scientific innovation. Regrettably, this is not an area of speciality in South Africa, and we had to wait for access to the vaccines while losing many close colleagues from FABI and our community. This experience underscores the critical importance of staying at the forefront of technology to address the challenges of our interconnected and ever-changing world, whether in the realms of human health or forestry and agriculture. South Africa must invest in cutting-edge capacity and solidify connections with top-tier international research networks to ensure a resilient future for our businesses and society.

FABI is at the forefront of a new era of research and innovation in agriculture and forestry. The exciting new developments in biotechnology and digital technology are increasingly being employed side-by-side in our work, our seminars and in our service and interaction with partners. These developments include an in-house developed, cloud-based digital data platform, the Information Hub, which can integrate digital collection of data from various platforms, devices and sources. If you have not done so, download and join the Information Hub or Information Hub Go Apps on the Apple iStore or Google Playstore!

This platform underpins the digitization of our diagnostic clinic services, from the submission to feedback, to integration of this data with various other data sources. It also supports the roll-out of a National Forest Pest and Disease Surveillance system, digitization of plant nurseries and field sites, collection and sharing of climate data and much more.

At the same time, or globally-significant culture collection, which is also now registered with the World Federation of Culture Collections, is systematically being digitized. As we go to print, nearly 7,000 genomes have been sequenced for cultures from this collection, and the work continues apace. The powerful forces of Artificial Intelligence, Remote Sensing and Next Generation Sequencing, amongst others, are being combined in our facilities for a better future for our food and fibre production systems.

FABI stands on its strong foundations and history while continuously seeking innovative new ways to create opportunities for emerging talents, train students, and connect our research with society.

We are fortunate to have a world-class team, and we take pride in the excellence of our personnel, students, and the training we offer. The FABI team comprises around 350 individuals, including academic staff, research Fellows, students, as well as technical and administrative staff.

Our community encompasses 28 research programs, some of which are international programs or satellite labs in areas such as Tree Health, Chemical Ecology, Remote Sensing, and Artificial Intelligence. These linkages provide access to materials, world leading expertise and tools to help ensure the protection and productivity of our agricultural and forestry systems, as well as the discovery, description and protection of our biodiversity.

This community, alongside the outstanding work it produces, acts as a hub for a global network of experts in agriculture and forestry-related fields.

This hub facilitates the sharing of resources, the concentration of local and global talent, and the exchange of ideas and energy, making a significant contribution to the university and the nation.

The end of COVID-19 was a joyous moment for the FABI community, enabling us to reconnect in-person with one another and our stakeholders. We resumed our in-person meetings while continuing to engage online, from our Monday Morning Meetings (MMM) to Thursday Morning Seminars (TMS), monthly teas, SPOOF events, journal clubs, field trips, industry days, workshops, conferences, and more. These gatherings connect us locally and globally, fostering collaboration and knowledge exchange. If we have not engaged with you yet through one of these platforms, we hope to do so in future. And if not in person, then digitally via our various social media platforms, weekly newsletter, monthly online seminars – all accessible via our website: www.fabinet.up.ac.za. Connect with us!

FABI has for a long time emphasised the fusion of art and science, viewing the intersection of creative arts and science as valuable. Scientific art, or Sci-art, serves as a powerful tool for communication, bridging intellectual pursuits with emotions and reaching communities and individuals we might not otherwise connect with. It also provides inspiration and enjoyment for both viewers and artists. This report continues to explore this theme by delving deeper into the relationship between art within FABI and art produced by FABIans, enriching the text, sparking insights and discussions, and providing enjoyment.

We hope you'll experience this in the values presented in this biennial report, reflected in our scientific achievements, artistic expressions, and their intersections.

Join us as we reflect on another two years of excellence and impact on the lives and businesses of our stakeholders, personnel, postdoctoral Fellows and students. We extend our heartfelt gratitude for the dedication, passion, and partnerships that make FABI such a special place. Thank you for being part of our journey!

King Protea | Julia Kreiss

FABI IN A NUTSHELL

The Forestry and Agricultural Biotechnology Institute (FABI) at the University of Pretoria is a postgraduate training and 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 information sciences to many others.

NUMBER OF RESEARCH PAPERS SINCE 1998	NUMBER OF RESEARCH PAPERS 2022/23	TOTAL CITATIONS SINCE 1998	PhD STUDENTS GRADUATED SINCE 1998	MSc STUDENTS GRADUATED SINCE 1998
1 166	154	38 514	228	406

WORLDWIDE COLLABORATION

Map depicting FABI research collaborations based on joint journal publications.
Yellow lines indicate papers where a FABIan is the first author. Line thickness represents the number of papers.

Data based on the Web of Science Core Database. Only research papers and books were included.
Data as at the time of publication: November 2023.

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CLARIVATE ANALYTIC GLOBAL HIGHLY CITED RESEARCHERS

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

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RESEARCH GROUPS

- African Plant Systems Biology for the Bioeconomy (APSB)
- Applied Mycology
- Bacterial Genomics and Host Pathogen Interactions
- Biophysics
- Citrus Preharvest Disease Research Programme
- Crop Floral Biology and Environments (CFBE)
- DSI-NRF Centre of Excellence in Plant Health Biotechnology (CPHB)
- DSI-NRF SARChi Chair, Fungal Genomics
- Endophyte Ecology
- Eucalyptus and Pine Pathogen Interactions (EPPI)
- Forest Molecular Genetics (FMG) Programme
- Grain Research Programme (GRP)
- Hans Merensky Chair in Avocado Research
- Kiwifruit Protection Programme (KPP)
- Macadamia Protection Programme (MaPP)
- Molecular Plant-Pathogen Interactions (MPPI)
- Molecular Plant Physiology
- Phytobacteriology
- Plant Virology
- Potato Pathology Programme @UP
- Social Insects Research Group
- Systematics and Evolution of Symbiotic Nitrogen-Fixing Bacteria
- Tree Protection Co-operative Programme (TPCP)

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SATELLITE LABS AND INTERNATIONAL PROGRAMMES

- Satellite Lab in Applied Chemical Ecology
- Satellite Lab in Artificial Intelligence in Farming
- Satellite Lab in Remote Sensing of Plant Health
- RIFT-FABI Tree Protection Programme (RFTPP)
- RGE-FABI Tree Health Programme

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STAFF AND RESEARCHERS 2023

37 Full time academic staff
23 External research associates
19 Postdoctoral/research fellows
86 PhD students
102 MSc students
27 Hons students
10 Interns
45 Professional support staff

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 in the world, as well as partners in industry and government.

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NRF RATINGS

3 A-ratings
7 B-ratings
21 C-ratings
3 P-ratings
5 Y-ratings

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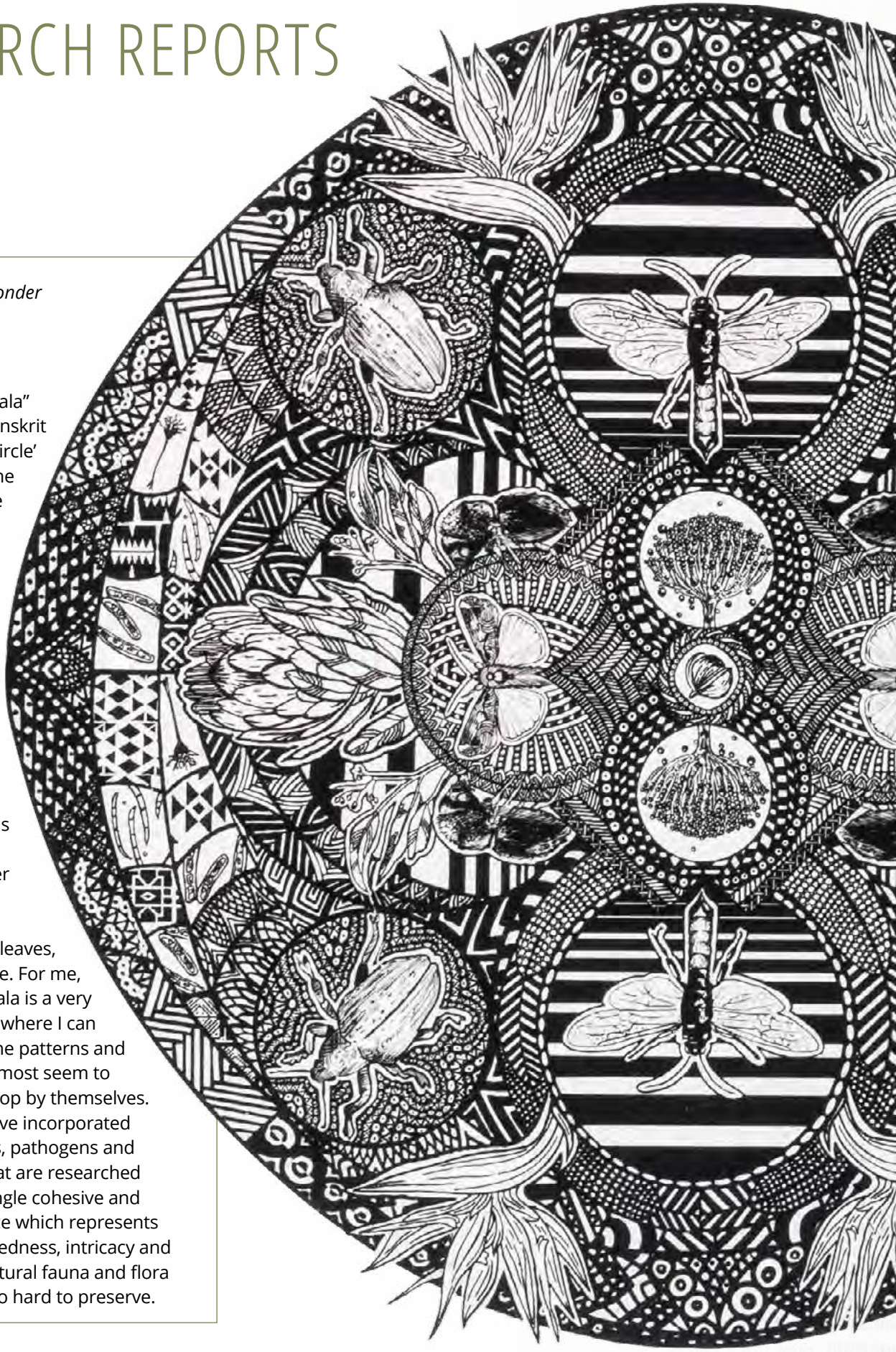
- To produce new and improved products and services, thus to promote competitiveness in business.
- Promote education, particularly of South Africans, in the fields of forestry and agriculture.

RESEARCH OUTPUT

RESEARCH REPORTS



Our world, our wonder
Matt Jackson

The word "mandala" comes from a Sanskrit term, meaning 'circle' in reference to the circular structure from which patterns and designs radiate symmetrically from a unifying centre. We can see these unifying patterns and fractals throughout nature, in the radiating patterns of flower petals, succulents, spider webs, tree rings, snowflakes, sea shells, trees and leaves, crystals and more. For me, creating a mandala is a very organic process, where I can become lost in the patterns and designs which almost seem to evolve and develop by themselves. In this piece, I have incorporated a variety of pests, pathogens and plant species, that are researched at FABI, into a single cohesive and harmonious piece which represents the interconnectedness, intricacy and beauty of our natural fauna and flora which we work so hard to preserve.

FRUIT, NUTS AND VEGETABLE CROPS

Ceratocystis is my mistress
Abstract *Ceratocystis, Endoconidiophora* and *Huntiella*

Abstract rust teliospores
Teliospores of *Sphaerophragmium, Puccinia* and *Uromycladium* inspired by species from South Africa

Oh oh oh Oomycete
Abstract *Phytophthora, Pythium* and *Plasmopara*

Alistair McTaggart

Captured in hues of blue and yellow, this series of abstract paintings delves into the intricate microscopic marvels concealed within our agricultural crops. Alistair McTaggart's brush captures teliospores of *Sphaerophragmium*, *Puccinia* and *Uromycladium* inspired by South African species alongside depictions of *Phytophthora*, *Pythium* and *Plasmopara*. These vibrant canvases bridge the gap between scientific exploration and artistic expression, portraying a colourful celebration of nature's complexities within the world of plant pathology. Each stroke tells a story of our research, where art and agriculture converges in a captivating dance of forms and colours.

BACTERIAL GENOMICS AND HOST PATHOGEN INTERACTIONS

Research leader: **Prof. Lucy Moleleki**

Research team:
Dr Jane Chepsergon

BACKGROUND

Potato is the fourth most important crop world-wide. South African potato production contributes about 0.3% to the global potato production and about 45% of gross vegetable production in South Africa. Some of the most important pests and pathogens affecting potato production include soft rot bacteria (*Pectobacterium and Dickeya* species), root knot nematodes (*Meloidogyne* species) and oomycetes (*Phytophthora* species). Our research seeks to understand the potato host pathogen interactions. To this end, our research group uses a variety of omics approaches to understand virulence mechanisms of potato pests and pathogens as well as defence mechanisms used by the host against this arsenal of virulence factors.

OBJECTIVES OF THE RESEARCH PROGRAMME

- Identify virulence factors in different potato pests and pathogens.
- Identify potato host defences elicited by important pathogens.

HIGHLIGHTS OF THE RESEARCH

In the past few years, we have focused our research on the identification of effectors present in the three groups of pathogens we study. Once identified, the next phase of research is functional characterisation to determine how pathogens utilise effectors to undermine host defences. This understanding will contribute to ongoing efforts combating pathogens and increasing food security. Towards this end, the highlights of this research are:

- Using *in silico* genomic approaches, we identified a 'core' set of effectors in *Phytophthora* and *Meloidogyne* species. These effectors can potentially be targeted in programmes that aim to breed durable resistance against these pathogens.
- Using a combination of *in silico* and proteomic analyses, we identified a set of type 6 secreted (T6SS) effectors in *Pectobacterium brasiliense*. Some of these effectors play a role in bacteria-bacteria competition.

CITRUS PREHARVEST DISEASE RESEARCH PROGRAMME

Research leader: **Prof. Jacquie van der Waals** (Citrus Research International)

Research team:
Prof. Teresa Coutinho
Prof. Chris Weldon
Dr Jan van Niekerk (Citrus Research International)

BACKGROUND

This research programme is fully funded by Citrus Research International, with emphasis on the sustainable management of important preharvest diseases, and pre- and postharvest insect pests of citrus in South Africa. The increased pressure on South African agriculture from the EU Green Deal, particularly on export crops such as citrus, necessitates the need to focus research on gaining a better understanding of the epidemiology of diseases and biology of insect pests in order to develop and advise on effective Integrated Pest Management strategies. The diseases currently under consideration in this programme are Phytophthora root rot, Botrytis grey mould and Alternaria brown spot. The complex of fruit flies (*Bactrocera* and *Ceratitis* species) and psyllids present or at risk of introduction to South Africa are the focus of our entomological research.

OBJECTIVES OF THE RESEARCH PROGRAMME

- **Project 1:** Determination of the efficacy of new oomycete fungicide-based approaches for managing *Phytophthora nicotianae* in citrus orchards.
- **Project 2:** Characterisation of the phosphonate sensitivity of *P. nicotianae* from South African citrus production regions.
- **Project 3:** Establish the interacting roles of protein bait location, application density and fruit fly physiological state on response by fruit flies (*Ceratitis capitata*, *Ceratitis cosyra* and *Bactrocera dorsalis*).

HIGHLIGHTS OF THE RESEARCH

- **Project 1:** A population of *Phytophthora nicotianae* isolates from citrus orchards in South Africa was screened *in vitro* for sensitivity to four new oomycete fungicide products. Results indicate that isolates were resistant to one of the products, while there was a range of sensitivity among isolates to the other three products. The results from this project will play a role in sustainable management of Phytophthora root rot of citrus in South Africa.
- **Project 2:** *In vitro* screening of potassium phosphite and ammonium phosphite against *Phytophthora nicotianae* isolates from citrus orchards in South Africa indicated the development of reduced sensitivity in the population. *In planta* trials showed that neither of the phosphonates tested could significantly reduce root rot severity or inoculum levels of any isolate, suggesting that even the sensitive isolates are resistant to current dosage rates of these products.

Experiments to test the best location of protein baits to improve response by fruit flies

Reduced sensitivity did not result in a fitness penalty, which could present problems to the industry in terms of future use of these products.

- **Project 3:** In field cage tests we found a strong effect of bait location on response by *B. dorsalis*, *C. capitata* and *C. cosyra*, with more flies foraging on protein in the mid to upper canopy levels, and very few flies responding to bait placed on the ground. One-day-old flies with prior access to protein are less responsive to protein bait, while 10-day-old protein-deprived flies intensely forage for protein. Protein-deprived females are attracted to protein more than males. Response to protein bait increases with temperature before falling at temperatures higher than 30 °C. This is probably due to flies becoming more active as temperatures become warmer, and then seeking cool, sheltered microclimates to avoid heat stress when it is very hot. Our results clearly demonstrate that protein bait sprays should be applied to the tree canopy to target responsive flies, but that repeat applications are needed to kill flies as they age and become sexually mature.

HANS MERENSKY CHAIR IN AVOCADO RESEARCH

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

Research team:
Prof. Jacques Theron (Department of Biochemistry, Genetics and Microbiology, UP)
Prof. Aureliano Bombarely (Department of Biotechnology and Plant Breeding, Institute of Plant Molecular and Cellular Biology)
Dr Velushka Swart
Dr Robert Backer
Dr Juanita Engelbrecht
Dr Gerda Fourie

Applying commercial biocontrol products to avocado trees infected with *Rosellinia necatrix*

BACKGROUND

The Hans Merensky Chair in Avocado Research is an academic-industrial research partnership, and a flagship initiative for both the Hans Merensky Foundation and the University of Pretoria. Through a multidisciplinary approach, which includes plant pathology, molecular biology and generating both genomic and transcriptomic resources; our research has allowed significant progress in unravelling the avocado-*Phytophthora cinnamomi* interaction. In recent years we have broadened the scope of our programme to include other avocado pests and pathogens such as *Rosellinia necatrix*, ambrosia beetles and their fungal symbionts, as well as the Avocado sunblotch viroid (ASBVd). Our overarching aim is to conduct research that is of benefit to the avocado industry.

OBJECTIVES OF THE RESEARCH PROGRAMME

- Investigating the mechanisms of avocado defence against *Phytophthora cinnamomi*, the causal agent of Phytophthora root rot.
- Sequencing the genome of *Rosellinia necatrix,* the causal agent of White root rot, and developing microsatellite markers to assess the genetic diversity of the pathogen in South Africa.
- Identifying pathogenicity/virulence genes in *P. cinnamomi* and *R. necatrix*.
- Developing transformation protocols for *P. cinnamomic* and *R. necatrix.*
- Assessing the use of biocontrol agents as alternative control methods for White root rot in avocado.
- Investigating the molecular basis for avocado sunblotch disease.
- Identifying and monitoring ambrosia beetles and their fungal symbionts on avocado in South Africa.

HIGHLIGHTS OF THE RESEARCH

Avocado Omics Resources and Defence

- The availability of a high-quality avocado genome assembly (*Persea americana* West-Indian pure accession genome; Avocado Genome Consortium), has enabled the identification and characterisation of complete avocado defense gene families such as the *NLRs* (*Resistance*) and *CalS* (*callose synthase*) genes.
- A RNA-seq study of the global gene expression during infection of two avocado rootstocks of varying susceptibility to *P. cinnamomi,* has provided the most comprehensive overview of avocado defense response pathways to date.
- Expression profiles of the *NLR* genes demonstrated a prolonged immune response in the resistant rootstock which enables it to suppress *P. cinnamomi* growth and combat disease development.

Typical symptoms of avocado sunblotch disease on an avocado fruit

Phytophthora cinnamomi genetic diversity and pathogenicity genes

- Investigation of the genetic diversity among more than 300 South African *P. cinnamomi* isolates, provided novel insights into the spread of the pathogen and demonstrated the predominance of triploidy in the natural occurring population – which has important implications for disease management in avocado.
- Identification and characterisation of the polygalacturonases, which facilitate penetration and colonisation of the host plant; as well as RxLR, CRN and NLP effectors, provide a glimpse at the arsenal of pathogenicity factors utilised by *P. cinnamomi* to promote disease.
- We have established a stable transformation protocol for *P. cinnamomi* as well as a *Nicotiana benthamiana* pathosystem for rapid functional characterisation of candidate pathogenicity gene to enhance our understanding of the infection mechanism of the pathogen.

Rosellinia necatrix genomic resources and control

- The genome of an isolate of *R. necatrix* collected from an avocado orchard in South Africa has recently been sequenced, providing an important resource which has enabled the development of microsatellite markers for genetic diversity studies, as well as the identification of pathogenicity genes.
- Following on our previous *in vitro* and greenhouse trials, we are currently conducting field trials to assess the efficacy of Fluazinam and commercial biocontrol products against *R. necatrix* on avocado. Both could potentially form part of an integrated disease management strategy for White root rot.

Avocado sunblotch disease caused by Avocado sunblotch viroid (ASBVd)

- We used RNA sequencing to investigate host gene expression in avocado nursery trees asymptomatically infected with ASBVd. Plant defence responses, phytohormone networks, secondary metabolism, cellular transport as well as protein modification and degradation were all significantly affected by ASBVd infection.
- This work represents the first global gene expression study of ASBVd-infected avocado, and the transcriptional reprogramming observed during this asymptomatic infection improves our understanding of the molecular interactions underlying Avsunviroid-host interactions.

Ambrosia beetles and their symbionts on avocado

- We are continuously monitoring the presence of ambrosia beetles in avocado orchards throughout South Africa in a collaborative effort with the South African Avocado Growers' Association (SAAGA).
- To date, the Polyphagous Shot Hole Borer (PSHB) has only been detected in a single commercial avocado orchard, but the industry remains on high alert.
- The ambrosia beetle, *Xylosandrus crassiusculus* is prevalent in South Africa and can cause dieback, wilting and death of avocado trees.
- The fungal symbiont of *X. crassiusculus*, *Ambrosiella roeperi*, was shown to be pathogenic on commonly-planted avocado fruiting cultivars.

Avocado trees at Innovation Africa being prepared for a *Phytophthora cinnamomi* infection trial

Collection of root samples from avocado trees displaying symptoms of white root rot disease

Ambrosia beetles collected in a trap set up in an avocado orchard

KIWIFRUIT PROTECTION PROGRAMME (KPP)

Research leader: **Prof. Irene Barnes**

Research team:
Prof. Mike Wingfield | Prof. Bernard Slippers

BACKGROUND

The Kiwifruit Protection Programme (KPP) is the newest FABI initiative, formally launched in February 2023, in partnership with the South African Kiwi Growers Association. The KPP will conduct research into the characterisation, epidemiology, and control of some of the most important diseases affecting kiwifruit in South Africa. Diseases currently being investigated include Ceratocystis canker and wilt (*Ceratocystis* spp.), Verticillium wilt (*Verticillium* spp.), flower blight, and Pseudocercospora spot and rot (*Pseudocercospora* spp.). The KPP also supports local kiwifruit farmers by providing an extension and disease diagnostic service.

OBJECTIVES OF THE RESEARCH PROGRAMME

- Document diseases affecting kiwifruit grown across South Africa and isolate, preserve, study, and characterise the potential causal agents of the diseases.
- Provide a platform where kiwifruit varieties grown by farmers can be screened for resistance to infection by the most important pathogens.
- Develop an understanding of the epidemiology of the most important pathogens affecting kiwifruit and thus guide disease management in the orchards.
- Provide baseline knowledge of pest and disease threats to the South African kiwifruit industry.

HIGHLIGHTS OF THE RESEARCH

- Ph.D. candidate, Ms. Cheyenne Theron, is the first student to undertake work on kiwifruit diseases in FABI.
- A diagnostic clinic has been established, and by the end of the 2022-2023 season, several disease threats had already been identified. These will form the basis of future projects.

Official signing ceremony of the Kiwifruit Protection Programme (17 February 2023)

MOLECULAR PLANT PHYSIOLOGY

Research leader: **Prof. Juan Vorster**

Research team:
Prof. Karl Kunert

BACKGROUND

In order to ensure food security in a changing environment, farmers are faced with many challenges. Drought and the increasing threat of herbicide resistant weeds are just some of the challenges that need to be addressed. Our group has a long history on working to understand the physiological responses and adaptations relating to drought stress and drought resistance in plants. Together with international partners in Italy and France, we are working on developing climate-resilient dry bean varieties adapted to local growing conditions. These varieties should not only be able to resist drought conditions but should also produce more nutritious seeds, high in iron and zinc. Currently, we are evaluating different bean lines from different regions under both greenhouse and field conditions for drought resistance as well as the nutrient value of the seed.

Herbicide resistance is a growing threat in South Africa; working with industry as well as different Growers associations, we are monitoring the occurrence and spread of herbicide resistant weeds across South Africa. Not only do we identify cases of herbicide resistance, we also seek to understand the molecular mechanisms underlying these traits. Ultimately, we develop alternative management programs for farmers and track the success of these programs in controlling these weeds and preventing their spread.

OBJECTIVES OF THE RESEARCH PROGRAMME

- Evaluate dry bean lines under greenhouse and field conditions for drought resilience.
- Evaluate the effects of stress on the nutritional value of legume seeds.
- Monitor and evaluate cases of herbicide resistance in weeds.
- Determine the physiological mechanisms of confirmed cases of herbicide resistance in weeds.

HIGHLIGHTS OF THE RESEARCH

- We have identified mutant bean lines with elevated levels of free iron and are evaluating their growth under field conditions in Italy as well as in South Africa. These lines are also being compared against commercial lines used locally. We have shown differences in seed yield as well as nutrient content under drought conditions.
- Several cases of herbicide resistance in especially *Amaranthus* have been identified and evaluated. We are actively engaging with farmers as well as industry partners to continually monitor these populations, but also to develop alternative management plans in order to control these populations.

MACADAMIA PROTECTION PROGRAMME (MaPP)

Research leader: **Dr Gerda Fourie**

Research team:
Prof. Olufemi Akinsanmi (University of Queensland, Australia)
Prof. Jeremy Allison
Prof. Brett Hurley
Prof. Bernard Slippers
Prof. Emma Steenkamp
Prof. Noëlani van den Berg
Prof. Fanus Venter
Prof. Mike Wingfield
Prof. Brenda Wingfield
Dr Nicky Cruex
Dr Neriman Yilmaz

BACKGROUND

The Macadamia Protection Programme (MaPP) is a collaborative research partnership between Macadamia South Africa NPC (SAMAC), the University of Pretoria (UP) and the Forestry and Agricultural Biotechnology Institute (FABI). Through a multidisciplinary approach, our goal is to conduct solution-orientated research that will translate to practical pest and disease management options for macadamia growers.

The programme also provides extension as well as pest and disease diagnostic services to the macadamia industry.

OBJECTIVES OF THE RESEARCH PROGRAMME

- Identify causal agent(s) of macadamia diseases and identify pests of economic concern.
- Study pest and pathogen biology, epidemiology and spread.
- Study environmental conditions conducive to disease development.
- Investigate alternative control options, including pheromone-based products for pest and disease management.

HIGHLIGHTS OF THE RESEARCH

Disease research

- Three novel *Calonectria* species were confirmed as husk pathogens causing Calonectria husk rot. In addition, four *Colletotrichum* species were associated with Anthracnose husk rot, while a large diversity of *Diaporthe* species were identified as Phomopsis husk rot pathogens.
- The prevalence of the different husk rot species also revealed intriguing clues to the epidemiology of these diseases. *Calonectria* spp. were mostly obtained from the Limpopo province. In Mpumalanga, *Diaporthe* showed a tendency for higher isolation frequency in early nut developmental stages, with higher numbers of *Colletotrichum* obtained from more mature nut developmental stages.
- Dry flower is the dominant flower blight disease present in South Africa. The causal agents of both dry flower and green mould can, however, be isolated from the same raceme with green mould that was rarely found.
- A high diversity of species within the *Botryosphaeriaceae* were detected from healthy and diseased tissue in the macadamia canopy, which confirms the endophytic nature of these latent pathogens.

Elisa Pal setting up a pheromone trial to test the efficacy of these lures to capture stink bugs in macadamia orchards

Pest research

- Population genetic analysis of *Bathycoelia distincta* suggested active movement of this important stink bug species between growing regions.
- Insecticide exposure of *B. distincta* revealed that organophosphates are more toxic to *B. distincta* than pyrethroids and that sub-lethal exposure of insecticide may accelerate the development of the F1 generation.
- Analyses from gland extracts and volatiles from stressed *B. distincta* revealed that six major compounds are released, while behavioural experiments confirmed that a blend of *(E)*-2-hexenal, *(E)*-2-decenal and *(E)*-4-oxohex-2-enal can induce an alarm response in *B. distincta*.
- The genome and transcriptome of *Thaumatothibia batrachopa* is currently being analysed in order to characterise genes involved in sex pheromones and chemosentation.
- The presence of ambrosia beetles in macadamia orchards is of growing concern.
- A day-degree model for *Acanthococcus ironsidei* is being developed, and a survey to identify native predators and parasitoids, that can be used in conservation biological control, is underway.

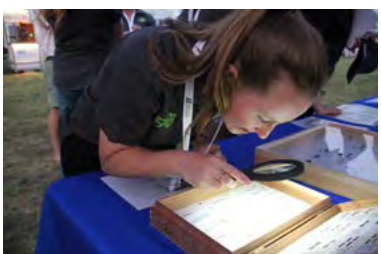
Macadamia Protection Programme exhibition to teach growers about macadamia pest and diseases

The macadamia team at grower days educating growers about the Polyphagous Shot Hole Borer

Survey to determine the dominant flower blight disease in South Africa

Macadamia felted coccid sampling

Flower blight pathogenicity assays



Beetle collection on display at the Macadamia Protection exhibition stand

PHYTOBACTERIOLOGY

Research leader: **Prof. Teresa Coutinho**

Research team:
Dr Khumbuzile Bophela
Dr Pedre Lebre (CMEG, UP)

BACKGROUND

Diseases caused by plant pathogenic bacteria are of significant importance in agriculture and horticulture due to their potential to cause economic losses and reduce crop productivity. Some bacterial species typically do not cause disease in healthy plants but take advantage of weakened or stressed plants to establish infection. These bacteria are considered opportunistic pathogens because they exploit the opportunity presented by compromised plant health to invade and cause disease. The primary focus of this programme is on trying to understand how these bacteria cause disease in stressed hosts.

OBJECTIVES OF THE RESEARCH PROGRAMME

- Determine the etiology of plant-associated and plant-pathogenic bacteria of agricultural crops.
- Investigate pathogenicity factors in *Pantoea ananatis*, *Rahnella* spp. and *Enterobacter* spp. responsible for bacterial rot of onion bulbs.
- Characterise the bacterial community associated with bacterial rot of onion bulbs.
- Determine how *Xanthomonas vasicola* pv. *vasculorum* jumped hosts from sugarcane to *Eucalyptus.*

HIGHLIGHTS OF THE RESEARCH

- A novel *Ewingella* sp. was isolated from onions in the USA and shown to be one of the causes of bulb decay and will be described as *E. allii*.
- As part of a collaboration with ZHAW, Switzerland, two novel species in the genus *Kosokonia* and *Phytobacter*, also isolated from onions in the USA, will be described as *K. beeriae* and *P. cepae.*
- As part of a collaboration with the University of Georgia, USA, pathogenicity factors in *Pantoea ananatis* and in other *Pantoea* species, important in causing diseases in onion, were described.
- Endophytic bacteria and viruses, potentially beneficial and/or pathogenic, are present in asymptomatic and symptomatic onion bulbs.
- A genomic island unique to the *Eucalyptus grandis* strains of *X. vasicola* pv. *vasculorum* but with insertion sequences predicted to come from the sugarcane strain, possible by horizontal gene transfer, were identified thus confirming the likely host jump from sugarcane.

Bacterial bulb rot symptoms caused by *Rahnella perminowiae*

POTATO PATHOLOGY PROGRAMME @UP

Research leader: **Prof. Jacquie van der Waals**

Research team:
Prof. Teresa Coutinho
Prof. Martin Steyn (Department of Plant and Soil Sciences, UP)

BACKGROUND

The primary research focus of the Potato Pathology Programme is the epidemiology, diagnosis and control of soil- and seed-borne diseases of potatoes. Diseases currently being investigated in this research programme include powdery scab (*Spongospora subterranea* f. sp. *subterranea*), and blackleg and soft rot (*Pectobacterium* and *Dickeya* spp.). Soil and seed-borne pathogens are among the most limiting factors in the production of potatoes and thus the main focus of the Potato Pathology Programme @UP is understanding these pathogens and epidemiology of the diseases in order to improve management in the field. In order to do this, various techniques are combined to better understand disease spread and development in the field, interaction of host and pathogen, and ultimately use this information to provide growers with a risk assessment for the disease under consideration.

OBJECTIVES OF THE RESEARCH PROGRAMME

- **Project 1:** The purpose of this study is to establish the host status of *Spongospora subterranea* f. sp. *subterranea* (Sss) of various cover and rotation crop species that are often planted in potato production fields in South Africa.
- **Project 2:** Identification, characterisation and symptomatology of the primary Soft Rotting Pectobacteriaceae (SRP) on potatoes in South Africa.
- **Project 3:** Development of region-specific crop rotation programmes for the Eastern Free State.
- **Project 4:** Evaluation of different agricultural practices to improve soil and potato health in a climate change context.
- **Project 5:** Investigation of changes in the soil microbiome of potatoes after infection with *Rhizoctonia solani.*

HIGHLIGHTS OF THE RESEARCH

- **Project 1:** Results from the Sss host status project have expanded our knowledge of the diversity of Sss hosts, not only in South Africa but also abroad. Of the species recorded to be Sss hosts, 23 are newly-recorded hosts in South Africa and 14 globally.
- **Project 2:** *Pectobacterium brasiliense* remains most prevalent in the South African potato industry. Other species were identified, but were less aggressive than *P. brasiliense* in pot trials. Lack of detection of *Dickeya solani* in any of the samples tested suggests that this destructive pathogen is not yet present in the South African potato industry. This work was published in Potato Research (2022).
- **Project 3:** Clear differences between rotation schedules were noted in terms of soil and plant health after one full crop rotation cycle.
- **Project 4:** Initial results from field and pot trials indicate that an integrated pest and pathogen management strategy improves soil microbiome diversity and functionality, as well as crop health, compared to a conventional chemical programme and a biological management programme.
- **Project 5:** Shifts in the soil microbial community resulting from the addition of *Rhizoctonia solani* AG 3-PT inoculum to the rhizosphere and bulk soil revealed potential fungal and bacterial key indicators of Rhizoctonia disease suppression.

Rhizosphere sampling of potato plants to investigate changes in the soil microbiome after infestation with *Rhizoctonia solani*

GRAIN CROPS

In this captivating illustrative tapestry, embodying the spirit of 'grain crops', an arboreal-like plant, bathed in warm, earthy terracotta undertones, serves as a canvas for a harmonious blend of organic forms. Simplistic yet charming, the natural motifs are interwoven among the leaves, celebrating the coexistence of fauna and flora within the world of grain agriculture. This piece not only evokes the abundance of harvest but also captures the essence of agricultural harmony, where the rhythmic sway of grain meets the presence of livestock in a symbiotic dance. Beyond the mere visual representation, the artwork becomes an ode to the interconnectedness of grain crops and the creatures they sustain, celebrating the rich tapestry that roots our agricultural landscapes in a single, harmonious composition.

APPLIED MYCOLOGY

Research leader: **Prof. Cobus Visagie**

Research team:
Prof. Pedro Crous
Prof. Bernard Slippers
Prof. Emma Steenkamp
Prof. Brenda Wingfield
Prof. Mike Wingfield
Dr Neriman Yilmaz

BACKGROUND

Fungi play an important role in many aspects of human life, e.g. as decomposers in the carbon cycle, in the production of food and drinks, and many species produce useful medicines or enzymes. Despite all these benefits, fungi can also cause serious problems for humans, animals and plants. One of the most important is the production of various mycotoxins in food and feed, which cause serious health problems in both humans and animals if consumed above the limit. Mycotoxins affect producers, suppliers, retailers and consumers and pose a significant risk to food safety and the United Nations Sustainable Development Goal 2 (SDG2) to end hunger by 2030.

Our research aims to better understand fungal communities that produce mycotoxins in agricultural crops, food and feed and why they produce these toxic compounds. The focus is on the diversity and taxonomy of genera such as *Alternaria*, *Aspergillus*, *Fusarium*, *Penicillium* and *Talaromyces*, but many others are also studied. In doing so, we isolate and identify fungi using modern taxonomic approaches, publish and release newly- generated DNA reference sequences, and at the same time build national biodiversity resources by contributing species to national and international fungal culture collections. Our research group is also developing uniform rapid monitoring methods to identify important mycotoxin-producing species along the value chain. Ultimately, our goal is to safeguard food and feed from farm to fork for future generations.

OBJECTIVES OF THE RESEARCH PROGRAMME

- Expand biodiversity resources such as culture and DNA collections.
- Complete taxonomic revisions of important fungal genera, like *Aspergillus*, *Fusarium* and *Penicillium*.
- Develop novel culture-independent detection methods to better detect species and microbiomes.
- Study genomes and transcriptomes to better understand why, when and how specific species produce mycotoxins.
- Study specific grain diseases like Northern corn leaf blight caused by *Exserohilum turcicum*.

HIGHLIGHTS OF THE RESEARCH

- A major update of the taxonomy of *Eurotiales*, which includes important genera such as *Aspergillus*, *Byssochlamys*, *Penicillium* and *Talaromyces*, was published in 2020. Building on this study, we have published several manuscripts that re-evaluated the taxonomy of *Aspergillus* species classified in section *Candidi*, series *Nigri* and series *Versicolores*. These studies will greatly improve species identification and serve the community working on these important fungi well.
- The Future Leaders-African Independent Research (FLAIR, FLR\R1\201831) project has been completed. The project documented fungal diversity and their mycotoxins from pre-stored maize, soybean, sunflower and animal feed collected across South Africa. Isolations resulted in 4538 fungal strains deposited in culture collections that represent 118 genera and more than 500 species. From these, the project generated 6500 new DNA reference sequences, while hundreds of strains has been selected for whole genome sequencing.
- The *Fusarium fujikuroi* species complex (FFSC) includes more than 60 phylogenetic species that are of both phytopathological and clinical importance. A stable taxonomy and nomenclature are thus crucial. As a result, we reviewed the FFSC using morphology and phylogenetics, introducing three new species, epitypifying six species, neotypifying one species and validating two species.

- A new partnership was launched on 8 May 2023 between the Forestry and Agricultural Biotechnology Institute (FABI) at the University of Pretoria and Milk South Africa (Milk SA) to study Sporidesmin-induced liver disease (SILD) in dairy cattle in the Eastern Cape province of South Africa. The disease is commonly referred to as facial eczema, but is actually not a skin disease, but a liver disease caused by the mycotoxin Sporidesmin, which is produced by the fungus *Pseudopithomyces chartarum.*
- Professor Cobus Visagie and Dr Neriman Yilmaz are part of an international project, Mycobiomics, funded by the Marie Skłodowska-Curie Actions Research and Innovation Staff Exchanges (MSCA-RISE). The aim of the project is for research teams from Asia, Africa and Europe to join forces and study fungal microbiomes for potentially useful metabolites and biological control agents using 'omics techniques. It involves eight partners from seven countries. We received guest visitors from the Netherlands, the Czech Republic and Austria. Researchers and students from FABI have visited partners in Austria, Germany and the Netherlands.
- We described and named a newly-discovered yeast species after the famous Italian painter, draughtsman, engineer, scientist, theorist, sculptor, and architect Leonardo da Vinci. This xerophilic species was isolated from a log house situated outside Ottawa, Canada, as part of a worldwide survey of culturable fungi occurring in house dust. It was, however, not the first time that this species had been detected. Several previous culture-dependent and -independent surveys in many parts of the world have recorded its presence on a wide variety of substrates including indoor air, cave wall paintings, bats, mummies, and most notably in this case, the iconic self-portrait of Leonardo da Vinci that was sketched with red chalk on paper ca. 1512. Those previous studies were never able to correctly identify or name the species. The paper describing *Blastobotrys davincii* was published in the journal Yeast in a special issue named 'Fantastic Yeasts'.

CROP FLORAL BIOLOGY AND ENVIRONMENTS (CFBE)

Research leader: **Dr Nicky Creux**

Research team:
Prof. Emma Archer (Department of Geography, UP)
Dr Gert Ceronio (Department of Soil, Crop and Climate Sciences, UFS)
Dr Dirk Swanevelder (Biotechnology platform, ARC)
Dr Markus Wilken
Deon du Toit (Grain Crops, ARC)
Andrew Mokhele (Grain Crops, ARC)

Collecting tissues to unravel the genetic and environmental control of flowering in sunflower

BACKGROUND

The Crop Floral Biology and Environments (CFBE) programme was established in 2019 with a major focus on understanding how changing environments will affect crop floral biology, pollination and ultimately yield. The programme has grown rapidly over this period and has expanded the focus to understanding the broader effects of climate on crop plant development, pathogen load and yield. This multi-disciplinary programme has brought together meteorologists, agronomists, biotechnologists, engineers and plant biologists to provide a holistic view of plant-environment interactions. The growing connections with local and international university and industry partners has provided a strong basis from which to explore the important questions facing agriculture in light of climate change.

OBJECTIVES OF THE RESEARCH PROGRAMME

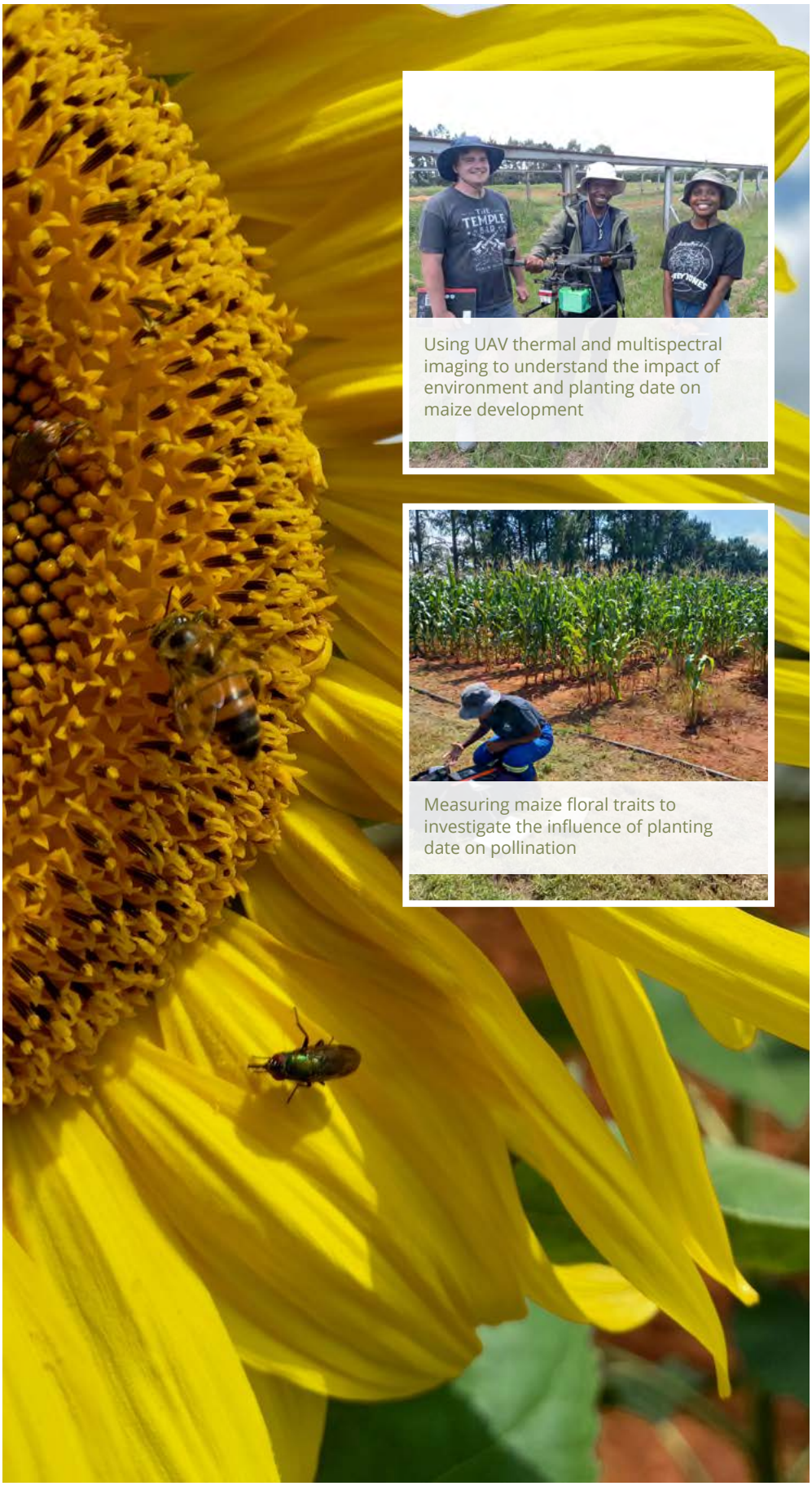
Pollination is a fundamental process in plant biology describing the transfer of pollen from the male to female parts of the plant. In out-crossing plant species, this pollen transfer is difficult, often requiring the movement of pollen between plants and sometimes across great distances. Plants have evolved a large array of different strategies to overcome these physical barriers using either abiotic (wind or rain) or biotic (insects) methods to mobilise pollen. Many of these pollination strategies are affected by external environmental conditions such as seasonal changes and fluctuations in ambient temperature. There is currently little information on how plants regulate the timing of floral organ maturation or what implications climate change may have on these precisely timed mechanisms or pollination strategies. These events are particularly understudied in crop species. Little is known about the combined effects of agricultural practices and a changing environment on plant development or pollination, which directly impact yield and food security.

The objectives of the research programme are to:

- Investigate the regulatory mechanisms underlying a flower's response to temperature and how these can be harnessed to protect flowering and pollination from extreme weather events such as heatwaves.
- Identify the factors associated with agricultural practices, such as planting date, which alter the climate under which a crop is grown and assess how these changes might affect crop development, pollination and yield.
- Predict the local effects of climate change on crop development and yield in South Africa and the impact on plant health and pathogen load.

HIGHLIGHTS OF THE RESEARCH

- Detailed physiological measurements of sunflower floral organs were taken. The data indicated that temperature regulates the timing of pollen emergence and pollinator visits, we identified several adaptive mechanisms sunflower employs to withstand high-temperature stress and maintain yields even under adverse conditions.
- There have been several conflicting reports on how climate change might affect crop production in South Africa. Our recent findings suggest that the planting date could be altered to adjust to the longer summers predicted under climate change but that this will require sufficient moisture or supplemental irrigation.
- We are using the ARC high-throughput phenotyping platform and UAV remote sensing technologies to assess phenotypic changes in plant development at different planting dates. Data obtained from this platform will provide detailed measurements of plant growth and development under different planting dates for these critical South African crops.



Using UAV thermal and multispectral imaging to understand the impact of environment and planting date on maize development

Measuring maize floral traits to investigate the influence of planting date on pollination

GRAIN RESEARCH PROGRAMME (GRP)

Research leader: **Prof. Cobus Visagie**

Research team:
Prof. Dave Berger
Prof. Martin Coetzee
Prof. Brett Hurley
Prof Kerstin Krüger
Prof. Bernard Slippers
Prof. Emma Steenkamp
Prof. Albé van der Merwe
Prof. Cobus Visagie
Prof. Brenda Wingfield
Dr Chrizelle Beukes (James Hutton Institute, Scotland)
Dr Nicky Creux
Dr Lieschen de Vos
Dr Gudrun Dittrich-Schröder
Dr Miekie Human (Grain SA)
Dr Mahlane Godfrey Kgatle
Dr Robert Mangani
Dr Thabiso Motaung
Dr Esther Muema
Dr David Nsibo
Dr David Read
Dr Quentin Santana (ARC)
Dr Michelle Schröder
Dr Marinda Visser (Grain SA)
Dr Markus Wilken
Dr Neriman Yilmaz
Mr Stefan Links (Grain SA)

BACKGROUND

The National Grain Research Programme (NGRP) was established and developed by a team of multidisciplinary grain researchers from various institutes and programmes at FABI and elsewhere in South Africa. The vision of the NGRP is to contribute to South Africa's food security and bioeconomy by conducting basic and solution-oriented research, which in turn forms the basis for further innovation in South Africa's agricultural sector. To this end, we collaborate with stakeholders in the grain sector and initiate research that supports the sector by identifying future challenges for the industry and exploring solutions to these challenges. The Grain Research Programme @ FABI-UP (GRP) provides disease extension diagnostic services and a disease clinic to agricultural stakeholders and has thus far been supported by Grain SA via the Department of Science and Innovation funding. Thanks to a long-term and stable investment by the South African forestry sector (including government and industry), FABI has provided such a service to the forestry sector for the past 34 years. This has led to the development of knowledge on which pests and diseases should be prioritised and based on this information, several research programmes have been launched to address these problems and prevent potential future problems. An important aspect that has made the clinic so successful is that the research projects and our disease clinic work together and support each other, rather than working in isolation. An important foundation for this work is the culture and insect collections, which provide important biological reference material for research and diagnostics.

The GRP clinic builds on these foundations and follows a similar model. The clinic was established during the 2020/21 growing season and has since made ±4,500 fungal and viral disease and ±35,000 insect collections across 210 farms. This collection data is captured in the Information Hub hosted by the Innovation Africa @UP which offers a cloud-based digital tool to safely and effectively collect and collate information, add value to connected data (interdisciplinary), and produce useable outputs from it (broad user community). In the process, we collect valuable information regarding the distribution and severity of diseases and infestations across the country. As a collective, this information is invaluable to direct research efforts and resources to address current problems and pre-emptively future problems.

Fungal isolations have resulted in close to 10,000 strains accessioned in our culture collections, which now amongst others include important plant pathogens classified in *Alternaria*, *Cercospora*, *Exserohilum*, *Fusarium*, *Sclerotinia*, *Stenorcarpella,* etc. These strains are available to the research community and are extensively used by various research projects.

HIGHLIGHTS OF THE RESEARCH

- The NGRP constitution was finalised and a board appointed in November 2021. Board members include representatives from three academic research institutions (FABI at the University of Pretoria, Stellenbosch University and University of the Free State), three industry partners (Grain SA, SANSOR, Maize Trust) and two government departments (Department of Science and Innovation (DSI), Department of Land Reform and Rural Development (DALRRD)). Mr Jannie de Villiers was appointed Chairperson, while Prof. Cobus Visagie (representing academia) and Dr Miekie Human (representing industry) were appointed as Co-Directors of the programme.
- Annual research days for the programme were held at the University of Pretoria (9 May 2022) and Stellenbosch University (3-4 April 2023), respectively. These meetings provide an opportunity to showcase grain research from partner research institutes and to have open discussions with industry and government on the research directions and priorities needed to address the major challenges related to grain production in the country.
- The research projects in the GRP @FABI-UP span a wide range of themes and disciplines. There are 35 active research projects divided into seven main themes (agronomy, biosecurity, plant physiology, soil microbial ecology, diagnostics, pests and diseases and surveys). Several GRP students have graduated and are continuing their careers in grain research and academia.

MOLECULAR PLANT-PATHOGEN INTERACTIONS (MPPI)

Research leader: **Prof. Dave Berger**

Research team:
Prof. Irene Barnes
Prof. Mathews Dida (Maseno University, Kenya)
Prof. Tuan Duong
Prof. Ingo Hein (James Hutton Institute, University of Dundee, Scotland)
Prof. Fourie Joubert (Department of Biochemistry, Genetics and Microbiology, UP)
Prof. Nelishia Pillay (Department of Computer Science, UP)
Prof. Eva Stukenbrock (Max Planck Institute for Evolutionary Biology and University of Kiel, Germany)
Prof. Jacques Theron (Department of Biochemistry, Genetics and Microbiology, UP)
Prof. Yves Van de Peer (VIB and Ghent University, Belgium)
Prof. Cobus Visagie
Prof. Steve Whitham (Iowa State University, USA)
Dr Simo Maduna (NIBIO, Norway)
Dr David Nsibo

BACKGROUND

The MPPI research group conducts collaborative research on crop diseases of economic importance in Africa and globally. The main research focus is Grey leaf spot (GLS) disease in maize. This pathosystem is used as a research model to understand molecular mechanisms of plant host resistance and fungal pathogenicity. The goal is to develop sustainable management strategies for long-term food security. MPPI also started a genomics project on the biodiversity conservation of the medicinally-important *Greyia* tree genus, endemic to South Africa.

OBJECTIVES OF THE RESEARCH PROGRAMME

- Understanding maize resistance to GLS disease.
- Determining molecular mechanisms of pathogenicity in the GLS pathogen *Cercospora zeina*.
- Tracing the origins and population diversity of *Cercospora zeina* in Africa.
- Developing diagnostics and RNA-based control methods for maize foliar diseases.
- Collecting foundational biodiversity and genetic data on the *Greyia* tree genus.

New powdery mildew fungus *Phyllactinia greyiae* on *Greyia* leaf

HIGHLIGHTS OF THE RESEARCH

- QTL mapping of a CIMMYT tropical maize population for foliar disease resistance in Western Kenya was completed.
- The genome sequence of the fungus *Cercospora zeina* that causes GLS of maize was determined using PacBio long read sequencing.
- The pathogenicity effector gene catalogue of *C. zeina* was identified.
- A protocol was set up in the model plant tobacco for testing the impact of *C. zeina* effectors on plant immunity.
- Three *C. zeina* effectors were shown to induce plant immunity responses in tobacco.
- Towards development of an RNA-based fungicide, cultures of *C. zeina* were shown to take up dsRNA which silenced fungal genes and specifically suppressed fungal growth.
- Artificial Intelligence (AI) using neural networks was used to develop a method to identify GLS disease symptoms in maize leaves from field collections with mixed disease symptoms.
- Computational progress was made in using AI to quantify maize rust symptoms from glasshouse inoculation experiments.
- A powdery mildew fungus *Phyllactinia greyiae* Visagie, D. Kidanemariam, D.K. Berger & M. Bradshaw, *sp. nov* was identified and named from leaves of *Greyia sutherlandii.*

MPPI team with Syngenta at Cedara field site

Window into maize in growth room

Dawit Kidanemariam isolating RNA in the lab

Nkosinathi Ndaba sampling disease in maize field

Dennis Omondi isolating *Cercospora* single spores

Dennis Omondi with Dr David Nsibo scoring maize diseases in Kenya

Using the Biosecurity App to capture maize disease images

Dawit Kidanemariam scoring maize disease in the glasshouse

PLANT VIROLOGY

Research leader: **Dr David Read**

Research team:
Prof. Gerhard Pietersen (Patho Solutions, Wellington, Western Cape)
Prof. Bernard Slippers
Prof. Emma Steenkamp

BACKGROUND

Plant viruses are responsible for significantly reducing the yields and profitability of crops. Knowledge of the diversity and distribution of viruses associated with many crops is limited, preventing effective management of their associated disease. This is complicated by cryptic infections, which in most cases do not elicit visible symptoms but may still result in reduced yields. The advent of non-targeting high-throughput sequencing has represented a paradigm shift in the way in which novel and emerging viruses are identified and characterised. The Plant Virology Group makes use of these technologies to characterise viral populations associated with a diverse range of crops, with a focus on olives, hops, sunflower and canola. In addition to plant viruses, the scope of research has grown to include the study of mycoviruses associated particularly with members of the Ceratocystidaceae family.

OBJECTIVES OF THE RESEARCH PROGRAMME

- Characterise viral populations associated with crops of emerging importance, making use of high-throughput RNA-seq and metaviromics approaches.
- Implementation of diagnostic assays, based on PCR or immunogenic-based tests, for the detection of the viruses detected using metaviromics.
- Screening of local germplasm of selected crops for potential resistance to certain viruses.

HIGHLIGHTS OF THE RESEARCH

- Between 2021 and 2023, 1,600 individual samples were collected predominantly from olives, hops, sunflower and canola and some ornamental and native plant species. Metaviromic datasets, based on RNAseq, were generated for 550 of these samples.
- The generation of this data has led to the first reports of at least six previously described and eight novel viruses associated with the focus crops.
- The group has also published 13 peer-reviewed articles during the reporting period, reporting on many potentially important agricultural pathogens for the first time.

Symptoms on sunflower, associated with the infection of a novel member of the *Umbravirus* genus

Untitled
Helen Timm

FORESTRY

Ganoderma
Rosa Emelia

In this compelling painting, *Ganoderma* mushrooms ascend a tree trunk into a vibrant spectacle of salmon and jade shades against a darkened backdrop. This lively composition reflects the intricate interconnectedness of the forest ecosystem, portraying a symbiotic interplay where fungi contribute to the forest's vitality, and the forest, in return, provides a nurturing home to diverse fungal forms. Each detail narrates a tale of collaboration, underscoring the dynamic relationships that thrive within the forest. The artwork stands as an eloquent tribute to the hidden complexities and harmonious balance inherent in forestry, and the intertwined beauty that defines the lifeblood of our woodlands.

Rosa Emelia is an Indonesian artist from northern Sumatra. She has lived and worked in Kerinci Pangkalan, Riau province since 1994. Those were the very early days of the town's development. Her first job was canteen cooking for contractor workers building the new paper factory. She is still cooking and housekeeping and enjoys to paint scenes from nature around her. Presented to FABI by Rob Pallet in September 2018.

DSI-NRF CENTRE OF EXCELLENCE IN PLANT HEALTH BIOTECHNOLOGY (CPHB)

Director: **Prof. Emma Steenkamp**
Programme Manager: **Prof. Martin Coetzee**

Project leaders:

Prof. Irene Barnes
Prof. Dave Berger
Prof. Pedro Crous
Prof. Wilhelm De Beer (retired 2022)
Prof. Tuan Duong
Prof. Leanne Dreyer (University of Stellenbosch)
Prof. Eastonce Gwata (University of Venda)
Prof. Almuth Hammerbacher
Prof. Brett Hurley
Prof. Godwin Mchau (University of Venda)
Prof. Sanushka Naidoo
Prof. Francois Roets (University of Stellenbosch)
Prof. Jolanda Roux (Sappi)
Prof. Bernard Slippers
Prof. Alex Valentine (University of Stellenbosch)
Prof. Noëlani van den Berg
Prof. Albé van der Merwe
Prof. Fanus Venter
Prof. Cobus Visagie
Prof. Brenda Wingfield
Prof. Mike Wingfield
Dr Nicky Creux
Dr Gerda Fourie
Dr Thabiso Motaung
Dr David Nsibo
Dr Marinda Visser (Grain SA)
Dr Markus Wilken
Dr Neriman Yilmaz

BACKGROUND

The primary goal of the CPHB (previously the Centre of Excellence in Tree Health Biotechnology (CTHB)) is to promote the health of South Africa's woody and agricultural resources through the application of biotechnology tools. To achieve this goal, the CPHB team studies the pathogens and pests associated with trees and agricultural crops. 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 plant resources and ecosystems. Although most of the CPHB's activities happen at FABI, it also conducts research via a collaborative network of scientists, both locally and abroad.

OBJECTIVES OF THE RESEARCH PROGRAMME

- Understand the biology, ecology, genetics, population biology and systematics of insects and microbes associated with woody plants and agricultural crops.
- 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.
- Study the possible impacts of soil properties and nutrients, microbial symbioses and climatic factors on the health of woody plants and in diverse landscapes and on various agricultural crop species.
- Assessing the effects of drought, frost, fire and human activity on the sustainable use of indigenous woody and agricultural resources.
- Develop human capacity in phytosanitation and biosecurity through an internship programme.

HIGHLIGHTS OF THE RESEARCH

- As a successful Centre of Excellence, the CPHB is involved in various activities that either inform its research or that emanate from the previous research of the Centre. For example, the CPHB routinely conducts surveys and field experiments in various parts of South Africa and elsewhere on the continent. Together with its partner programmes (i.e., the Grain Research Programme (GRP) and the Tree Protection Co-operative Programme (TPCP) at FABI), the CPHB also maintains a world-class disease and insect pest diagnostic clinic. To facilitate and enhance the research and extension activities of the CPHB, the Centre has developed and implemented several ancillary processes. These include various databases and collections to manage and store information, data and biological material used in projects.
- Web-based and smartphone apps were developed to capture information such as host species, disease symptoms, the severity of disease symptoms and geographic location. These data are being integrated with the diagnostic results of each sample from the Pest and Pathogen Diagnostic Clinic at FABI. This integration will allow for future data science analysis to determine the possible pest and disease trends in South Africa. In addition, these electronic platforms will represent important means by which the CPHB communicate with and disseminates information among its stakeholders.
- In addition to contributing to South Africa's critical networking function of linking African researchers, the CPHB maintained collaborations with numerous researchers at other institutions in South Africa and the rest of the world. At the international level, the CPHB has active collaborations with more than 100 researchers from more than 30 countries worldwide. These research networks are kept vibrant, not only by the staff of the CPHB through, for example mutual research visits, but also by the students of the CPHB who are encouraged to attend at least one national scientific meeting each year and one international scientific meeting during their degrees.
- The CPHB Internship Programme was initiated in 2019. The success of the initial program led to the establishment of the FABI Internship Programme in Biosecurity and Phytosanitation in 2021. The programme was successful in training a total of 21 interns between 2021 and 2022. Two of the interns from the 2021-2022 cohort continued with their postgraduate studies in FABI. In the reporting period for 2023, 10 interns were accepted into the program.
- The CPHB members were highly productive in their research outputs and training of students. During the reporting period, the CPHB, together with its sister program, the TPCP, published more than 232 scientific papers and seven book chapters that dealt with the health issues of trees and agricultural crops. In total, 29 students graduated during this period with research projects linked to the programme.

Untitled
Erich Meyer

DSI-NRF SARCHI CHAIR, FUNGAL GENOMICS

Research leader: **Prof. Brenda Wingfield**

Research team:	**Prof. Bernard Slippers**
Prof. Irene Barnes	**Prof. Emma Steenkamp**
Prof. Martin Coetzee	**Prof. Albé van der Merwe**
Prof. Tuan Duong	**Prof. Cobus Visagie**
Prof. Almuth Hammerbacher	**Prof. Mike Wingfield**
	Dr Markus Wilken

BACKGROUND

With the availability of numerous fungal genomes, the field of molecular genetics of fungi has experienced rapid growth, establishing itself firmly within the realm of genomics. Previously unanswerable questions can now be tackled, thanks to this wealth of genomic data. As biological systems are dynamic, new plant pathogens are continuously being described. Leveraging tools developed through previous research, we can now detect and manage these emerging pathogens using an ever-expanding array of technologies. We have devised and implemented novel techniques to assess the threat posed by pathogens to forests and forestry. Furthermore, we can determine the relationship of newly-discovered pathogens to known species, evaluate their population diversity, and potentially discern whether they were introduced or have transitioned from native hosts. By addressing such inquiries, we gain insights into the global pathways through which pathogens spread and how some are capable of infecting new hosts.

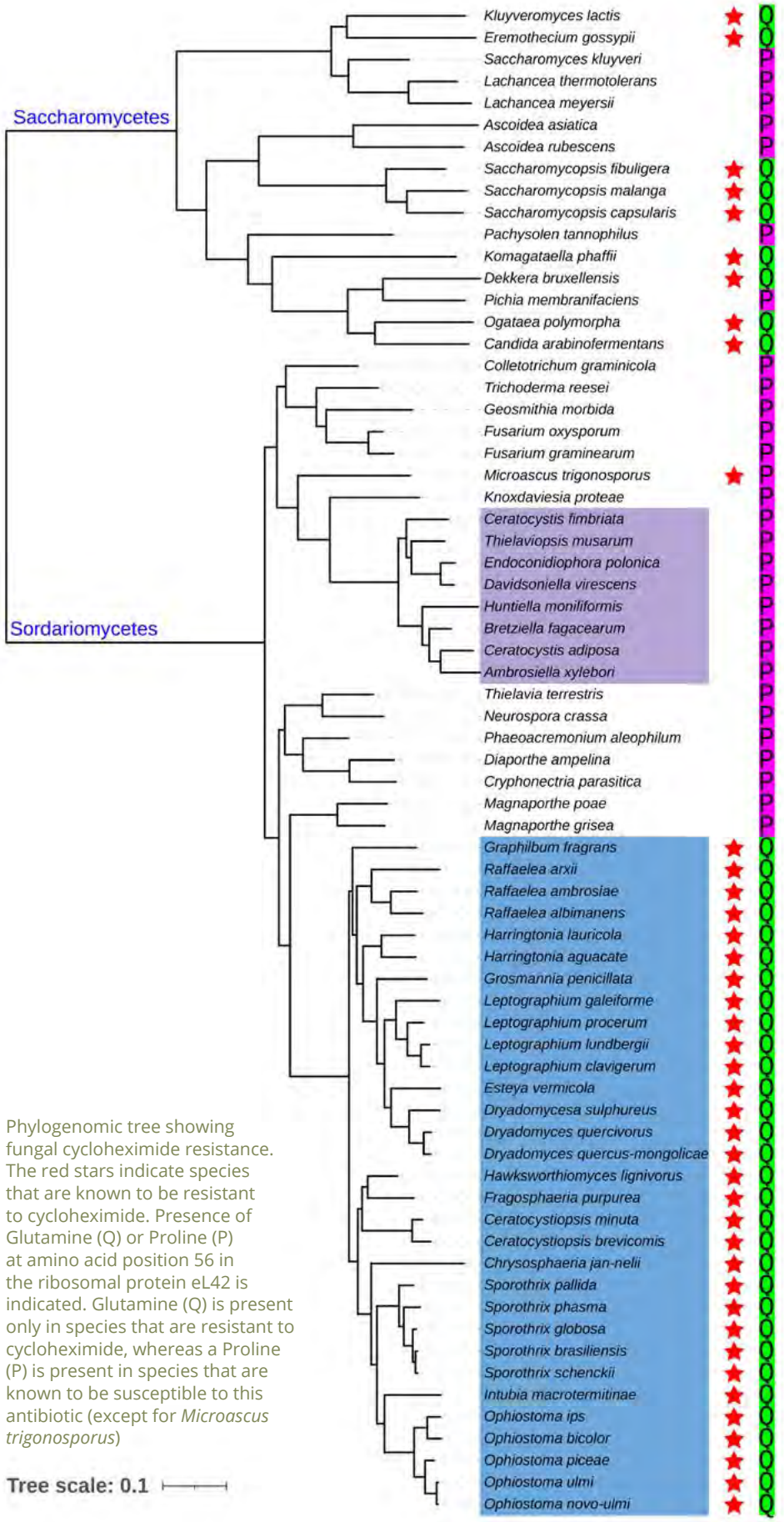
OBJECTIVES OF THE RESEARCH PROGRAMME

The research undertaken in this program centres around the worldwide dispersal and evolution of fungal pathogens affecting trees. These fungi serve as excellent models for investigating various research inquiries pertaining to the characteristics of mating-type genes, chromosome structure and count, pathogenicity, resistance to fungicides, and population genetics of fungal pathogens affecting plants. To address these research questions, we employ a range of tools, including phylogenetic analysis, population genetics analysis, genomics tools, and molecular techniques like gene knockouts, including the utilisation of CRISPR-Cas technology.

HIGHLIGHTS OF THE RESEARCH

- A gene identified as being linked to pathogenicity using GWAS (Genome Wide Association Studies) was knocked out in an isolate of *Fusarium circinatum* using CRISPR-Cas9 technology. Further studies are ongoing to show the functional characteristics of this gene knockout.
- A gene identified as being linked to pathogenicity using phylogenomic studies was knocked out in an isolate of *Leptographium wagneri* using CRISPR-Cas9 technology. Further studies are ongoing to functionally characterise this knock out.
- We have used the RNA sequence (RNAseq) data generated from a number of species to identify mycoviruses in some fungal pathogens. This means we have for the first time identified a variety of different viruses in these pathogens
- We continue to expand our whole genome sequence data for important tree pathogens.
- We have identified the mechanism of action of cycloheximide resistance in the Ophiostomatales. This work will be followed up by a similar study in yeast that might have significance in yeasts that cause disease in humans.

- Our research has shown that pine root exudate results in a chemotrophic response in *Fusarium circinatum*. The pheromone receptor STE2 is involved in this response, and this information provides an important candidate protein to target in the management of this pathogen in commercial pine seedling nurseries.
- We discovered a range of fungicide resistance in *Fusarium circinatum* isolates in South Africa, and this information will be used to guide the industry in developing disease management strategies.
- We developed a pipeline to extract a fungal genome assembly resolved from a sample accidentally contaminated by multiple taxa. Many environmental samples have other micro-organisms living with them. Distinguishing which genes belong to which genomes have only now become possible with a number of reference genomes being available.
- We reported on Cypress canker that was discovered causing disease on a native South African tree, the iconic *Widdringtonia nodiflora*.



Phylogenomic tree showing fungal cycloheximide resistance. The red stars indicate species that are known to be resistant to cycloheximide. Presence of Glutamine (Q) or Proline (P) at amino acid position 56 in the ribosomal protein eL42 is indicated. Glutamine (Q) is present only in species that are resistant to cycloheximide, whereas a Proline (P) is present in species that are known to be susceptible to this antibiotic (except for *Microascus trigonosporus*)

EUCALYPTUS AND PINE PATHOGEN INTERACTIONS (EPPI)

Research leader: **Prof. Sanushka Naidoo**

Research team:
Prof. Zeno Apostolides (BGM, UP)
Prof. Almuth Hammerbacher
Prof. Steven Hussey
Prof. Eshchar Mizrachi
Prof. Zander Myburg
Prof. Bernard Slippers
Prof. Emma Steenkamp
Prof. Albé van der Merwe
Prof. Brenda Wingfield
Prof. Mike Wingfield

BACKGROUND

One of the greatest threats to the sustainability of global forestry is the ever-increasing number and spread of pests and diseases that can severely reduce the productivity of the plantations. Changing climate is also expected to negatively impact forestry, introducing a stressful environment for forest trees and increasing susceptibility to pests and pathogens. Coupled with biological control, improved silvicultural processes and knowledge of the pests and pathogens, is the need to identify and develop resilient tree genotypes with increased resistance against these abiotic and biotic stresses.

OBJECTIVES OF THE RESEARCH PROGRAMME

It is critical that we have an in-depth understanding of the *Eucalyptus* immune system, Pine defence mechanisms and various plant-pest and plant-pathogen interactions that can be exploited to confer resistance against the swath of pests and pathogens that currently threaten productivity in these species. Our research, therefore, focuses on:

- 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*.
- Uncovering 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.

HIGHLIGHTS OF THE RESEARCH

- We conducted an extensive Genome Wide Association Study (GWAS) and identified DNA markers associated with resistance against the insect pest, *Leptocybe invasa*. These markers, under a SA patent, are the subject of our current research which aims to uncover the candidate genes within these associated loci. Such candidate genes are to be converted into specific markers to select *Eucalyptus* genotypes resistant to the insect pest.
- Our work with the canker pathogen, *Chrysoporthe austroafricana* has expanded to population level. Here, a *Eucalyptus grandis* x *Eucalyptus urophylla* backcross to *E. grandis* population was established by Sappi and Mondi. In 2022, we completed our third consecutive annual *C. austroafricana* inoculation trial on over 3,000 ramets of one-year-old *Eucalyptus grandis* x *Eucalyptus urophylla* backcross to *E. grandis* clones. Then in an epic field-trip, the team alongside Sappi, performed in-field inoculations on 6,000 trees. The research is part of a systems genetics study to uncover genes and pathways associated with resistance against *C. austroafricana*.
- Recently, our investigation of the interaction between *Eucalyptus* and the Myrtle rust pathogen, *Austropuccinia psidii* revealed that brassinosteroid signalling was a key factor in defence. We are testing this hypothesis together with our Australian collaborators.

- In a collaboration with the TPCP, we developed a controlled inoculation system for *Teratosphaeria destructans* which allows us to discriminate resistant and susceptible genotypes. We have been investigating the molecular mechanisms underlying the resistance against the pathogen. We are thus now well-positioned to determine DNA markers associated with resistance against the destructive pathogen in structured populations.
- EPPI has made great strides in the study of the intersection between abiotic stress such as drought and pathogen infection. The observed impact of drought on the *C. austroafricana-E. grandis* interaction has highlighted the importance of this type of research in light of climate change, as there appears to be a critical link between the two that places plantations at risk. We identified some of the gene regulatory shifts that drought imposes in trees that predisposes the host to increased pathogen susceptibility.
- A valuable tool for molecular breeding in pines was generated in collaboration with the FMG programme and the Pine SNP consortium. The transcriptomes for various pine species that we generated previously, along with new DNA information, was successfully mined to identify SNP markers for the development of the tropical pine SNP Chip. We are working with industry partners, Sappi and York, who have generated *Pinus patula* x *Pinus tecunumanii* LE hybrid populations to identify the DNA markers linked to *Fusarium circinatum* resistance.

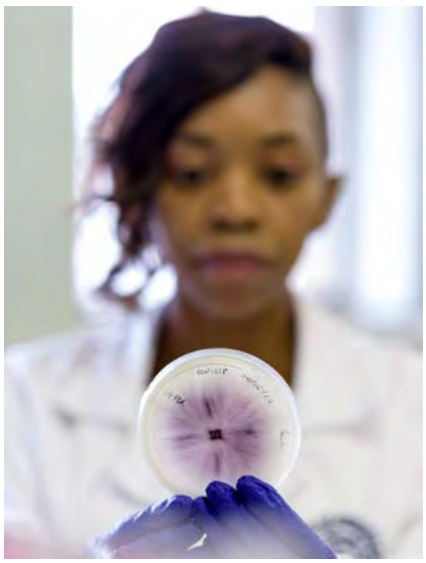
As part of this effort, we are developing a precision phenotyping assay based on fungal load to determine if individuals are resistant or susceptible to the pathogen.

- We have also adopted the Eucalyptus hairy root transformation to test candidate defence genes. We have had success in transforming *Eucalyptus nitens* roots with the marker gene, DsRed and we are now working towards increasing the transformation efficiency optimising the expression of the candidate defence gene.
- Overall together with our many collaborators, EPPI is making strong progress towards identifying the underlying defence mechanisms contributing to resistance against various pests and pathogens. We are closer to identifying markers which can be used as part of the toolbox for yield protection in forestry.

FOREST MOLECULAR GENETICS (FMG) PROGRAMME

Research leader: **Prof. Zander Myburg**

Research team:
Prof. Steven Hussey (Transcriptional Regulation and Bioengineering of Wood Development)
Dr Nanette Christie (Bioinformatics, Data Science and Pine Genomics)
Dr Marja O'Neill-Mostert (*Eucalyptus* Genomics)



BACKGROUND AND OBJECTIVES

The Forest Molecular Genetics (FMG) Programme (www.fmg.science) is an industry- and government-supported initiative focused on the genetic control of tree growth and development. We aim to enhance woody biomass production and improve wood properties for timber, pulp, paper, and biomaterials production. We have also embarked, along with international partners, on large-scale tree genome sequencing for a landscape genomics view of genotype by environment interactions and resilience to climate change. Concomitant with this, we collaborate with the Eucalyptus Pine Pathogen Interaction (EPPI) Programme and Tree Protection Co-operative Programme (TPCP) to enhance pest and disease resistance in trees for yield protection and resilience. We work in close collaboration with South African forestry companies to develop capacity and resources for the application of genomic technologies in tree improvement programmes. Over the past two years, we have started collaborating with the Macadamia Protection Programme at FABI and the macadamia industry (SAMAC) to support molecular breeding of macadamia in South Africa as we expand our DNA marker service offering through the FMG Precision Tree Breeding Platform.

HIGHLIGHTS OF THE RESEARCH

20 Years of Forest Molecular Genetics!

The FMG Programme celebrated its 20th year in November 2022. The Programme started in 2003 as a joint venture of Sappi, Mondi and the University of Pretoria. Since its inception York Timbers, SAFCOL and NCT Forestry joined as FMG Consortium members and the programme has grown to include a community of more than 100 people including students, contract staff, researchers, breeders and other industry participants in South Africa.

Genomic technologies for precision tree breeding

Over the past two years we have developed (Jackson et al. 2022) and implemented new single nucleotide polymorphism (SNP) DNA marker arrays for eucalypt and topical pine tree species cultivated in South Africa. These genomic resources have wide application in population genomics, genetic dissection of complex traits in pines and eucalypts and in genomic breeding efforts in these species (ongoing research with industry partners).

Reference, pangenome and population genome sequencing of eucalypts

A highlight of 2022 was the funding of our proposal to the US-Dept of Energy (US-DOE) Joint Genome Institute (JGI) for large-scale sequencing of eucalypt tree

genomes aimed at uncovering genetic diversity for woody biomass production and carbon drawdown. This project, led by Prof. Myburg, together with co-leads Prof. Justin Borevitz from the Australian National University and Prof. Jill Wegrzyn from the University of Connecticut, will produce 10 new reference genomes, 48 pan-genomes and over 2000 population genomes, more than half of which had been completed by early 2023.

Haplogenome sequencing and haplotype-based DNA markers for eucalypts

Over the past two years we completed the first phased, haplogenome assemblies for *E. grandis* x *E. urophylla* F1 hybrids providing the first insights into genome sequence and structural variation in these hybrid genomes. We also developed a new haplotype-based marker technology for *Eucalyptus* targeting 5,000 genes prioritised for growth, wood properties and environmental interactions.

Genomic resources for Pine tree breeding

The FMG team has completed SNP genotyping of an interspecific mapping pedigree in tropical pines and generated the first genetic linkage maps for *P. patula* and *P. tecunumanii*. These linkage maps will serve as a scaffold for genome sequencing and the development of gene-based molecular breeding tools for tropical pines.

First Wattle genome assembly

To support new DNA marker development for wattle (*Acacia*), MSc student Mr Mondli Xaba completed Oxford Nanopore sequencing and genome assembly of Black wattle (*Acacia mearnsii*).

Eucalyptus plant tissue culture

He mined the genome sequence for microsatellite sequences that are currently being used to develop a new marker panel for DNA fingerprinting, parentage and hybrid identification in wattle breeding.

Precision tree breeding platform

Over the past two years the FMG Programme received a large capex grant to establish a robotics equipment platform for high-throughput DNA isolation and analysis of plant genomes for molecular breeding application. The Precision Tree Breeding Platform offers DNA marker and genomics research services to the SA forestry industry and has expanded its offering to include small-scale growers who cultivate Wattle (*Acacia*). The platform has also developed new microsatellite DNA marker panels for the Macadamia industry based on three new Macadamia genome sequences completed by PhD student, Ms. Mary Ranketse.

Transcriptional regulation and bioengineering of wood development

Deciphering the molecular mechanisms by which regulatory genes known as transcription factors regulate the hundreds of genes involved in wood development is a challenging task. We have used cutting-edge molecular techniques such as DNA Affinity Purification Sequencing to map the many thousands of places that MYB domain transcription factors can bind in the *Eucalyptus* genome to regulate wood formation. Coupled to machine learning and information about gene expression patterns and the dynamic packaging of the genome, we have over the past two years improved the way in which we predict the target genes of these transcription factors, allowing us to reconstruct the regulatory networks underlying wood formation. We have also demonstrated that some novel *Eucalyptus* transcription factors associated with wood formation can modify wood property traits in transgenic poplar trees.

RGE-FABI TREE HEALTH PROGRAMME

Research leader: **Prof. Mike Wingfield**

Research team:
Based at FABI
Prof. Irene Barnes
Prof. Bernard Slippers
Dr Fahimeh Jami (until 2021)
Dr Ariska van der Nest (from 2022)

Based in Indonesia
Dr Samuel Alves Dos Santos
Dr Alvaro Durán
Dr SriKumar Koda Kkadan
Dr Jupiter Mauro Abad
Dr Leonardo Oliveira
Mr Marthin Tarigan

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 plantation 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*. It is in this domain that RGE and FABI 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 for example biological control, requires global partnerships and strategies that stretch beyond country borders. As with other FABI-industry partnerships, the focus of the RGE-FABI THP is on fundamental research and education, which seeks to empower in-house research and development that can be applied at the operations level. In this way the RGE-FABI 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 recent global partnerships to focus on tree health. It closely links the significant research programmes of RGE and FABI. It also funds postgraduate students and postdoctoral fellows from different parts of the world to study priority disease and pest problems across international boundaries. It has placed RGE's forestry divisions at the forefront of managing pest and disease problems affecting particularly *Eucalyptus* and *Acacia*. In doing so, it has also expanded 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 belonging 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.

- Education and capacity building for the RGE Group.
- Provision of support for the RGE research team, particularly pertaining to diagnoses of pest and disease problems.

HIGHLIGHTS OF THE RESEARCH

- Various new pests and pathogens affecting *Acacia* and *Eucalyptus* have been discovered and are currently being studied.
- One of the most important disease problems being tackled by the RGE-FABI THP team is Eucalyptus scab and shoot malformation. Very substantial effort has been expended on this project, that has led to the discovery of the cause of the disease. This is a fungal pathogen, unknown elsewhere, that the team formally described as the new species *Elsinoe necatrix*. Various studies, including questions such as the origin of the pathogen and management strategies, are ongoing.
- The emergence of Ganoderma root rot has become an increasingly important problem in *Eucalyptus* plantations in Sumatra in the last three years. The RGE-FABI THP team is currently investigating the mode of spread of what is now confirmed to be *G. philippii* in these plantations. This, together with other ongoing investigations will build a better understanding on how to manage this disease in plantation forestry.
- Investigations into Ceratocystis wilt disease on *Eucalyptus* caused by *Ceratocystis manginecans* by the RGE-FABI THP team have yielded several advances in the detection and distribution of this important pathogen.
- A qPCR diagnostic tool has been developed in the program to detect *Ceratocystis* species in the *Ceratocystis* Latin American Clade and validation of the tool is ongoing. Additionally, the global distribution of Ceratocystis wilt in *Eucalyptus* plantations on a global scale is being actively pursued.
- The project has also led to the identification of new diseases and insects damaging *Acacia crassicarpa* in Indonesia, including several new *Fusarium* species vectored by bark beetles.

Acacia karoo
Julia Kreiss

TREE PROTECTION CO-OPERATIVE PROGRAMME (TPCP)

Research leader: **Prof. Bernard Slippers**

Research team:
Prof. Irene Barnes
Prof. Martin Coetzee
Prof. Almuth Hammerbacher
Prof. Brett Hurley
Prof. Sanushka Naidoo
Prof. Emma Steenkamp
Prof. Noëlani van den Berg
Prof. Albé van der Merwe
Prof. Fanus Venter
Prof. Cobus Visagie
Prof. Brenda Wingfield
Prof. Mike Wingfield
Dr Lieschen de Vos
Dr Gudrun Dittrich-Schröder
Dr Tuan Duong
Dr Gerda Fourie
Dr Thabiso Motaung
Dr Trudy Paap
Dr Quentin Santana (ARC)
Dr Michelle Schröder
Dr Neriman Yilmaz
Dr Wilma Nel

BACKGROUND

The Tree Protection Co-operative Programme (TPCP) celebrated its 35th year of operation in 2023. Over this period the TPCP has become an institution in 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 African 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 the 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 accelerating rate at which pests and pathogens are moving around the world. This rate has increased at least four-fold over the past two decades, and simply cannot be dealt with efficiently solely at a local scale. 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 and control.

The successes of the TPCP is the result of the 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, government partners, as well as forestry researchers and managers in other parts of the world. 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 has, over the past 35 years, stretched well beyond dealing with forest pests and diseases. The programme provided the anchor for the establishment of the Forestry and Agricultural Biotechnology Institute (FABI) in 1998, which today houses a number of internationally-recognised forest and agricultural biotechnology research programmes as listed in this report. Through this influence, the TPCP has made a major contribution to the development of research in this field in South Africa and globally.

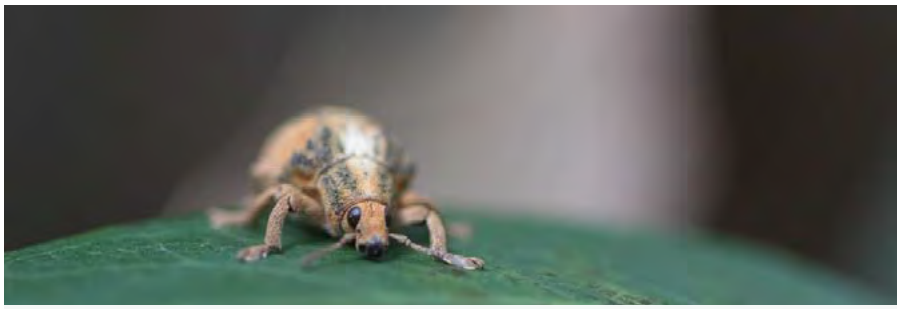
OBJECTIVES OF THE RESEARCH PROGRAMME

- Maintain a comprehensive programme that addresses the forestry pest and disease needs of the country and beyond, including knowledge generation, training of specialists, and 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 global pests and pathogens, developing frontier technologies to understand the biology, epidemiology and community ecology of these organisms, and developing and supporting biological control, surveillance and other management tools.
- Provides a platform to engage with various other research programmes in forestry and agricultural biotechnology globally to share knowledge, facilities and capacities.
- Ensuring that the industry can efficiently access the knowledge and pest management services required to ensure long-term sustainability of plantation forestry in South Africa.

HIGHLIGHTS OF THE RESEARCH

- The TPCP is a leader in Precision Pest Management (PPM) of plantation pests, a concept that considers the variation and diversity in pest systems. This includes both inherent (genetic and phenotypic) variation and differences in the expression of these systems in a landscape, due to variance in both abiotic and biotic interactions.
- In line with a move to PPM, the TPCP is also leading developments in terms of digitisation and remote sensing. In this regard, the group has developed a cloud-based data system, called the Information Hub, to digitise both the capturing, management and sharing of information related to pests and diseases. This includes field extension, diagnostic services, and general research data. It also integrates data across institutions, from UP, to the Institute for Commercial Forestry Research (ICFR), companies and private service providers. The Information Hub also allows the integration of sensor data to study microclimates that affect pest and pathogen populations.
- The TPCP is rapidly developing capacity for precision phenotyping and remote sensing. These efforts included the establishment of a Satellite Lab in Remote Sensing of Plant Health, reported on elsewhere, leading developments in remote sensing of *Gonipterus* sp. n. 2, *Tetatosphaeria destructuns* and with an eye on other pests and pathogens in future.



Gonipterus sp. n. 2 adult (photo: Matthew Harris)

- Other projects include AI-driven tools for early detection of *Phytophthora* root rot using hyperspectral sensor data of leaves.
- The TPCP played a leading role in the implementation of a very effective management program that has brought the *Sirex noctilio* outbreaks in the country under control. This included world-class basic research on the biology of the system, and translation of this information for implementation of the management practices (in particular biological control). Recent work has led to the discovery of a cryptic lineage in Australia that holds promise to improve management of this pest worldwide. The program has also made leading contributions to understanding global invasion patterns, key traits that influence the woodwasp's ecology and biological control, including its mating system, visual and chemical ecology. Ongoing work is translating our strong fundamental understanding of the system to genetics, genomics and gene editing.
- Several invasive insect pests affect the health of *Eucalyptus* trees around the world. The TPCP has significantly contributed to revealing the importance of cryptic lineages, which matter for its management. For example, the team has tracked the invasion of two cryptic lineages of the Eucalyptus gall wasp, *Leptocybe invasa*, around the world, as well as its interaction with its host and various parasitoids (including *Selitrichodes neseri*, *Quadrastichus mendeli* and *Megastigmus zebrinus*). Similarly, the team has characterised cryptic and population-level diversity in populations of *Gonipterus* and its natural enemies in native and invasive regions.
- The TPCP has become one of the leading programs globally studying chemical communication systems in forest plantation pests, including work on both pheromones and kairomones. Identification and use of pheromones for mass trapping of pests has been one of the long-term goals of the TPCP.

Larva of Pine brown tail moth *(Euproctis terminalis)*

Systems for which this has been characterised include *Coryphodema tristis*, *Gonipterus* sp. n. 2, *Naudirillea* sp., *S. noctilio* and *Euproctis terminalis*. Outcomes of this work are already being applied in surveillance and mass trapping programs, and is now leading to research on mating disruption and the potential for reverse chemical ecology from genomics.

- The TPCP has made a significant contribution to the identification and characterisation of biological control agents, as well as the development of methods to use them against plantation pests. Apart from the nematode biological control program on the devastating Sirex woodwasp, the team also discovered and described known and previously unknown 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 *Gonipterus*, *Anaphes inexpectatus*, *Centrodora damoni* and *Anagonia* cf. *lasiophthalma*, were sourced, reared and their biology studied. A new biotype of *Anaphes nitens*, better adapted to subtropic conditions, was studied and released.
- The TPCP contributed extensive knowledge on the diversity, genetics, genomics and evolution of fungal symbionts of bark and ambrosia beetles, especially those associated with invasive species. The group is also playing a leading role in research, legislation and management of the Polyphagous Shot Hole Borer,

Euwallacea fornicatus, in South Africa, including leading the development of biological control for it. This beetle poses a major threat to a large number of tree species in urban, agricultural and native environments.

- The TPCP represents a global centre of excellence for the study of the pitch canker fungus, *Fusarium circinatum*, which is one of the most serious diseases of Pine globally. The work included gaining deep insights into the genome of *F. circinatum* and genes harboured by its genome linked to virulence/ pathogenicity, mating and other factors associated with evolutionary fitness, and with relevance to management. Work also focusses 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 their roots.
- The TPCP often works on emerging global pests and pathogens years before they are introduced into South Africa, and in the process, provides both national and international biosecurity resources and support. One such example is the rust pathogen *Austropuccinia psidii*, which poses a significant threat to Myrtaceae in South Africa and other regions of the world. The TPCP is deeply involved in both basic and applied work to understand the diversity, genetics, epidemiology and host association of the pathogen, across its global distribution.
- The TPCP continues to support the industry with timely and specialist knowledge on new emerging pest and pathogens, often pre-emergence as pathogens emerge elsewhere in the world. One of the most significant such cases is the discovery of *Elsinöe masingae,* which is closely related to *Elsinöe necatrix* that the group has been working on in Indonesia. Other pathogens include *Phytophthora insolita*, a *Parvosmorbus*-like Cryphonectriaceae species. Several new insect pests have been discovered in recent years, including the shell lerp psyllid *Spondyliaspis brimblecombei*, the pine aphids *Cinara pinivora* and *Essigella californica,* that were reported in 2021 for the first time. Similarly, a number of well-known pests and pathogens in the country, re-emerge over time to cause more significant damage and require renewed attention.

Pine emperor moth *(Nudaurelia clarki)* larva feeding on pine

- Soilborne diseases, and in particular those caused by *Phytophthora* diseases, remain some of the most serious locally and globally. The TPCP has, over the past 35 years, advanced the understanding of the introduced and native diversity of these organisms in natural and plantation forests of South Africa. We have also studied their pathogenicity on various hosts. We are now increasingly characterising the total microbiome in forestry soils, with an understanding of other factors influencing these pathogens, as well as the health of soils and the plants that it sustains in general.
- Endophytic fungi in plants are important elements to study in the biology of plants as they can contribute significantly to the health and response of a plant to its environment, both biotic and abiotic. These endophytes can also harbour pathogens that are then easily spread around the world. In this regard the *Botryosphaeriales* have been a model system for us. We have characterised diversity, from orders to populations, for these fungi at a global level, and characterized its interaction with its host. The group is building on this work through whole microbiome studies to understand its interaction with the endophytic community.

- Canker diseases of trees can cause major damage, especially in clonal forestry. Such pathogens in the *Cryphonectriaceae* and *Teratosphaeriaceae* can be credited with the establishment of the TPCP in the first place. Research in the group has contributed to the understanding of global distribution, mating systems, origins and spill-over from native environments to commercial species and threats for future emergence of new disease outbreaks. The TPCP also contributed significantly to the understanding of genomes of all the key species infecting *Eucalyptus* and is leading work that explores the intersection between this information and our basic understanding of biology in the group.
- Wilt and canker diseases caused by *Ceratocystis* species are amongst the most serious global threats to trees in forestry and agricultural industries, and have already resulted in severe losses of *Eucalyptus* spp. in South America and *Acacia mangium* in Asia. The TPCP is one of the leading groups internationally contributing 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. We have the largest collections of these fungi from around the world and have used this to contribute substantially to the global genomics resources for this group of pathogens. The TPCP is also the leading producer of genome sequences and an understanding of evolution and speciation in this group.

Eucalyptus infected with *Ceratocystis* sp. (photo: Kira Lynn)

- Leaf diseases of *Eucalyptus* caused by the *Teratosphaeriaceae* and *Mycosphaerellaceae* are amongst the most serious, and have caused devastation and forced changes of species in many parts of the world. Work from the TPCP has, however, also shown that this group of fungi is amongst the most common amongst endophytic fungal communities in *Eucalyptus*. The TPCP has long-standing work on various species in these groups, but in particular focus on understanding the global diversity, spread, genomics, mating strategy and infection biology of *T. destructans*. Ongoing work seeks linkages between the infection process, resistance and plant genetic markers.
- Pine needle pathogens are receiving increased attention globally as a number of new disease outbreaks are being reported, both in native and non-native pine growing regions. The group has done ground-breaking work on pathogens such as *Phytophthora pinifolia*, *Dothistroma* species and *Lecanosticta* species. The work includes global distribution of diversity, new species discoveries, genomics, mating biology and hybridization patterns, and infection biology. Sentinel trials with South African Pine material, have been planted in other parts of the world in order to determine the effects of this pathogen on our hybrid species.

- The research group has contributed to global studies on bacterial diseases that affect plantation forestry. These bacterial pathogens include *Pantoea ananatis*, *Ralstonia pseudosolanacearum* and *Xanthomonas* species. Work in the group includes genomics, epidemiology and community ecology. While these pathogens typically do not cause major damage in South Africa, they are known to do so in other parts of the world. The TPCP therefore maintains capacity and monitors these pathogens.
- *Acacia* species only make up a small percentage of the total forestry estate in South Africa, but are nevertheless a valuable and important species. The TPCP has contributed to understanding pest and disease diversity on this host in South Africa, and how this spills over from and to native species. The group has also contributed to understanding basic biology of important emerging diseases such as the rust (and periodically galls) caused by *Uromycladium acacia*, and is now exploring the chemical ecology of important pests such as the wattle bagworm.
- The research group maintains a very active diagnostic clinic that screens hundreds of samples annually for members of the programme. These diagnostic services not only provide members with valuable information for management, but helps the program to stay in touch with new diseases, or disease outbreaks around the country. The group also supports the industry via extension services, both through expert technicians and via student and staff visits; typically including more than 80 trips a year to all parts of the country. In the period covered by this report, the TPCP was also gearing up for the implementation of a National Pest and Disease Surveillance Program, funded by DFFE via FSA, and in collaboration with ICFR and Cropwatch Africa.
- Forestry in Africa is a priority to monitor for pest and disease emergence, given how rapidly we know they spread across the continent. In this regard the involvement of the TPCP in a tree health project in Ethiopia focused on *Acacia mearnsii* pest and diseases, with funding from ACIAR (Australian Centre for International Agricultural Research), is important.

Wattle bagworm *(Kotochalia junodi)* bags made of plant material and silk hanging from the tree branches (photo: Shawn Fell)

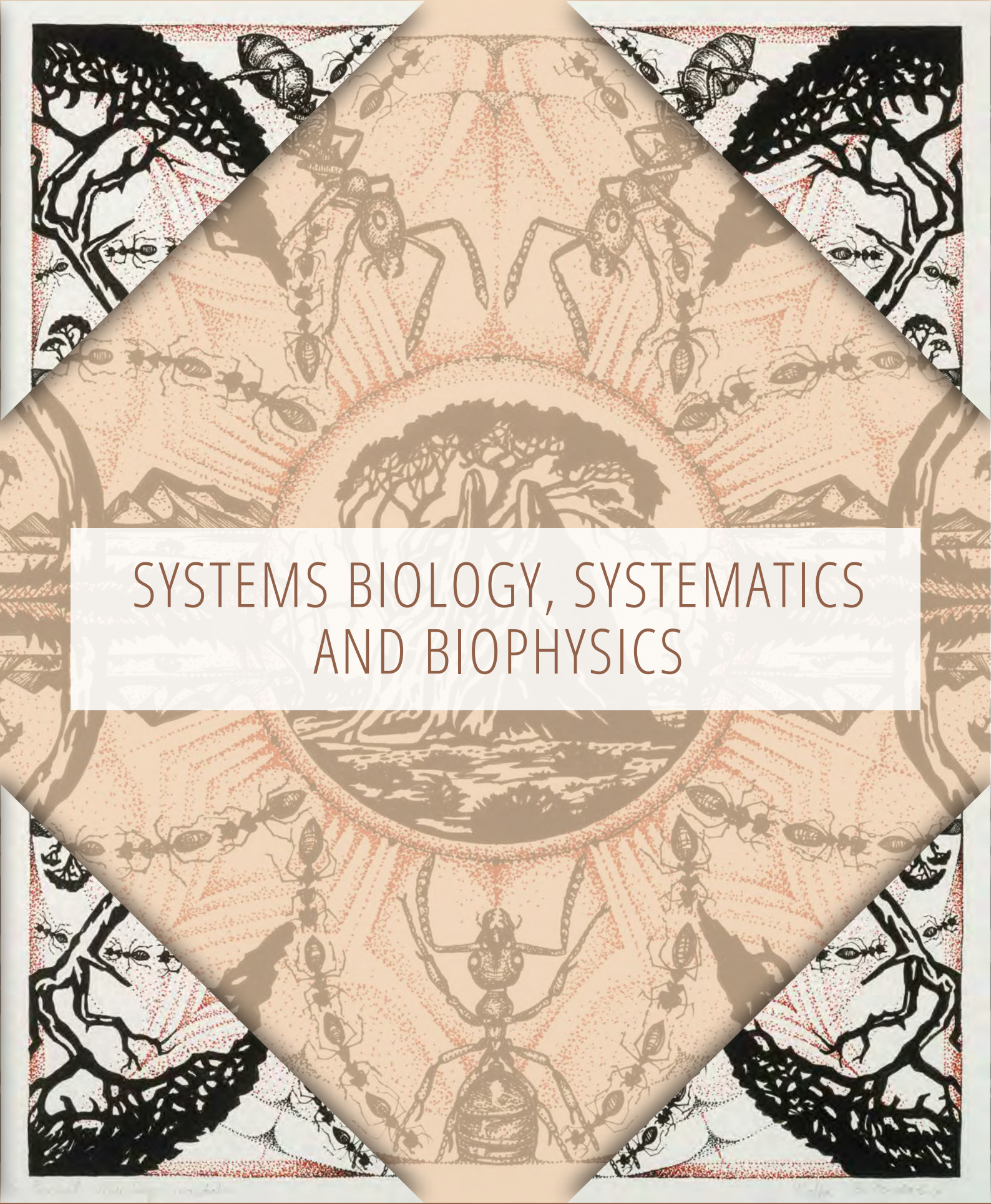
Death of *Eucalyptus* trees due to the fungal pathogen *Teratosphaeria destructans*

This involvement has led to the potential for the TPCP to be involved in larger projects in Ethiopia that include tree health of *A. mearnsii*, *Eucalyptus* spp., and native hosts. Involvement in this and other projects and programmes across the continent contributes to a better understanding of the forest pests and pathogens in the region, many of which are of current or potential future importance to forestry in South Africa.

- A significant new facility development was the upgrading of our insect rearing facilities. These facilities are critical to some of our biological control related work, and especially for our growing work towards gene based management of forest pests through techniques such as CRISPR-Cas9 gene editing. Three high-quality greenhouses dedicated to disease screening and associated research with our industry partners have also been fully operationalised in the past year. The facility already provides important service to our industry partners to screen their plant material for resistance to key pathogens, and offers significant scope to expand further.
- There is significant other work on systems such as *Armillaria*, *Ophiostoma* and insect pests that cannot all be covered here, and for which we suggest the reader visits our website: www.fabinet.up.ac.za/tpcp.

Insect mandala
Retha Buitendach

In this intricate mandala-like masterpiece, the canvas metamorphoses into a terrain where the delicate interactions of insects, from industrious termites to elegant damselflies, converge with the resilience of *Acacia* trees and the silent strength of mushrooms. Their symmetrical beauty mirrors the elaborate systems at play within nature, subtly alluding to the profound connections explored within the realm of biophysics and systematics. As each element finds its place within the symphony of the mandala, a narrative of interdependence unfolds, showcasing the underlying order governing diverse life forms. The artwork becomes a silent testament to the complex interplay of biological systems, where every organism holds a crucial role in the larger harmonious composition.



SYSTEMS BIOLOGY, SYSTEMATICS AND BIOPHYSICS

AFRICAN PLANT SYSTEMS BIOLOGY FOR THE BIOECONOMY (APSB)

Research leader: **Prof. Eshchar Mizrachi**

Research team:
Prof. Tuan Duong
Prof. Almuth Hamerbacher
Prof. Nicky Creux

BACKGROUND

Genomics and synthetic biology will play a key role in determining food security and sustainable crop production on the African continent and globally in the coming decades. Moreover, South Africa is one of 17 megadiverse countries, and contains almost 10% of the world's plant species (around 20-25,000), more than half of which are indigenous and endemic to the region. This includes, famously, the Cape Floral Kingdom in the Western Cape, the only floral kingdom to be contained in a single country (containing about 9,000 species with >65% endemism), as well as our highly-biodiverse grassland biomes, where many ecological functions and species are under threat due to land fragmentation and climate change.

OBJECTIVES OF THE RESEARCH PROGRAMME

- We use 'omics, systems biology, evo-devo approaches, genome engineering and synthetic biology to study important traits in African plants of ecological, cultural and economic importance.
- We are particularly interested in unravelling the molecular networks of development in endemic South African and African plant species, as well as in studying their primary and secondary metabolism.
- We seek to scale and empower new cutting-edge 'omics research in the region and the continent that focuses on indigenous species of our many biodiverse biomes.
- Finally, we engage with multiple stakeholders and partners in the creative industries for societal transformation and transdisciplinary research on ecocultural justice in South Africa, Africa and the Global South.

HIGHLIGHTS OF THE RESEARCH

- In the past two years, we have published the first chromosome-level, high quality genome of a plant native to South Africa – our National flower, the King Protea (*Protea cynaroides*).
  - This genome empowers new research into ecological, developmental and evolutionary questions pertaining to the genus *Protea* and the family Proteaceae, which includes many species in the Global South that are of ecological, horticultural and agricultural relevance.
  - One of the major contributions of the genome has been the insight it provides for the role of whole-genome duplication events (polyploidy) in adaptation to catastrophic environmental upheavals – something of increasing relevance as we seek to understand plant resilience in the climate crisis.
- We have built on this achievement by producing reference genomes, transcriptome and metabolomes of fynbos eudicots and monocots (select members of the Proteaceae, Fabaceae, Cyperaceae and Restionaceae) to model specialised phosphorus-acquisition cluster-, dauciform- and capillaroid- root development.

    - These roots represent specialised (independently evolved) adaptations that are able to mine phosphorus from the soil ordinarily not bioavailable to other species. As such, these are important to understand from an ecological perspective, as they produce locally bioavailable phosphorus in the rhizosphere around them.
    - They are also highly relevant from a biotechnological perspective, as engineering some of these adaptations into important crops can potentially ameliorate the need for intensive fertilization. The first of these new South African plant genomes has been the Cape thatching reed (*Elegia tectorum*).
- In collaboration with VIB and Ghent University, we arranged and held the University of Pretoria Symposium on Plant Genome Evolution and Polyploidy, hosted at UP in February 2023 and featuring some of the world leaders in plant genomics, taxonomy and evolution. The event had around 80 in-person attendees from the region (including SANBI and multiple universities). We intend to host and participate in multiple events such as this one and in the next few years to inform, connect and perform training sessions that would empower researchers in multiple South African universities to perform and lead plant 'omics research focusing on South African indigenous plants.
- We were involved in several engagements exploring the transdisciplinary intersection between ecological, economic and cultural justice in South Africa, relating to biodiversity. For example, we partnered with the South African Creative Industries Incubator (SACII), Alchemy Inspiration and Constitution Hill and commissioned 30 artists to create awareness of and debate around engaging a broader SA public in understanding, engaging with and benefitting from our national biodiversity. Several additional projects are underway involving other African and Global South countries, as well as multiple government, societal and industry stakeholders that utilise, benefit from, or wish to conserve South African biodiversity. Some of the outputs can be found at www.amandlawecell.org.za.

Photo by Danie Smit

BIOPHYSICS

Research leader: Prof. Tjaart Krüger

BACKGROUND

When plants experience stress due to factors such as excessive or fluctuating light illumination, drought, non-optimal temperatures, and various diseases, they switch into a photoprotective mode during which a substantial amount of the light energy absorbed by the plant is safely dissipated as heat. The light emitted during the first steps of the photosynthetic process can be used as a sensitive probe to study the molecular mechanisms of photoprotection.

OBJECTIVES OF THE RESEARCH PROGRAMME

- Develop a detailed understanding of the fast molecular mechanisms of photoprotection.
- Conduct non-invasive, *in situ* fluorometric monitoring of stress responses in plants.
- Theoretical modelling of photosynthetic light harvesting.
- Development of experimental methods to study individual, isolated light-harvesting complexes in physiologically realistic environments.

HIGHLIGHTS OF THE RESEARCH

- We discovered a new component of photoprotection in plants at the level of the light-harvesting antennas. This photoprotective mechanism is immediately activated when the plant experiences stress.

Prof. Tjaart Krüger and Dr Michal Gwizdala measuring the photosynthetic activity of Welwitschia plants in the Namib Desert

- The state-of-the-art, highly sensitive, homebuilt experimental facility has been further developed and allows us to perform spectroscopy on single, freely diffusing light-harvesting proteins. This is an important step towards our ultimate goal of performing spectroscopy with single-protein sensitivity in live cells. In addition to the experimental implementation of real-time single-protein tracking, we have also developed a theoretical basis that gives the user guidance on the most suitable single-particle tracking method for a particular application.
- An open-source data analysis suite for single-molecule spectroscopy data has been completed. This data is available for download at www.github.com/BioPhysicsUP/Full_SMS.
- We developed a method to compare the viability of different theoretical modelling approaches of the spectra of photosynthetic light-harvesting complexes.

ENDOPHYTE ECOLOGY

Research leaders: **Prof. Michelle Greve**

Research team:
Prof. Bernard Slippers

BACKGROUND

One of the most fundamental questions in ecology is characterising patterns of diversity, and understanding what drives these. Such an understanding allows us to predict how global change factors, such as climate change and habitat loss will influence communities in future. The factors that drive diversity in macroorganisms (e.g. plants and animals) have been well tested, but much less is known about patterns and drivers of diversity in microbial communities. Therefore, we describe patterns of diversity and envisage to understand what drives such patterns. Our work has focussed primarily on foliar fungal endophytes.

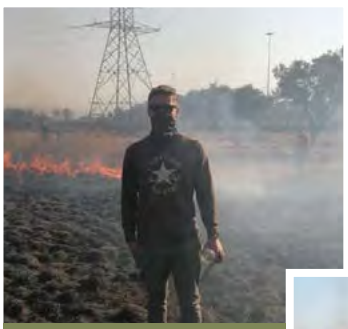
OBJECTIVES OF THE RESEARCH PROGRAMME

- To characterise patterns of microbial diversity.
- To understand what influences or drives such patterns. For example, we test the relative influence of environmental factors such as climate, host characteristics, space and random processes on how microbial communities assemble.

HIGHLIGHTS OF THE RESEARCH

- Ecological succession is the process by which communities assemble after a disturbance or when they are transitioning from a pioneer to a climax community. Woody encroachment, a process by which native tree species densify, is a serious threat to pastures across Africa. We asked, in an area where woody encroachment was happening by succession, whether fungal endophyte communities within three widespread host species also undergo succession. We found little evidence for this. Instead, fungal host communities are primarily determined by the identity of their respective host species. This was published from Mathew Harris' MSc dissertation in Fungal Ecology.

Azorella selago on Marion Island



Mathew Harris sampling endophyte communities from African grass species to assess how fire and herbivory impact endophyte community composition

- PhD student Mathew Harris has been sampling endophyte communities from widespread African grass species to assess how fire and herbivory, major disturbance factors in African savannas and grasslands, impact endophyte community composition.
- PhD student Joshua Tsamba is describing the first foliar fungal endophyte communities from sub-Antarctic Marion Island. He is describing communities from the widespread and versatile keystone plant *Azorella selago*.

SOCIAL INSECTS RESEARCH GROUP (SIRG)

Research leader: **Prof. Christian Pirk & Prof. Abdullahi Yusuf**

Research team:
Prof. Robin Crewe*
Prof. Robin Moritz* (Extraordinary)
Prof. Sue Nicolson†*
Prof. Baldwyn Torto* (Extraordinary)
Dr Ezette du Rand* (Industry funded researcher)
Dr Hannelie Human* (Extraordinary)

**Department of Zoology and Entomology*

BACKGROUND

The Social Insects Research Group (SIRG), also known as the Bee group, focuses its studies, but does not limit itself, to fundamental and applied aspects of sociality in ants, bees, termites and wasps with a particular focus on honey bees. Hence we are teaching and building capacity for bee research, including pollination services and disease control, on the African continent and beyond

OBJECTIVES OF THE RESEARCH PROGRAMME

- One of our main research objectives is to understand the pheromonal communication between colony members, using behavioural observations, analysis of the relatedness of the individuals, bioassays of their responses to pheromonal compounds and gas chromatographic analysis of chemical signals produced. This work allows us to explore the regulation of reproductive conflicts in honey bee colonies and enables us to tease apart social organisation, especially how one individual (the queen) controls thousands of individuals (workers).
- Conserving pollinators and reducing the threats they face amidst changing climate, intensification of agriculture and habitat transformation. We look at the impact of pesticides and how they affect survival, learning and behaviour impairment, foraging and physiology, as well as how bees cope with these challenges.

HIGHLIGHTS OF THE RESEARCH

- On 27 June 2023, the SIRG hosted a German delegation which included the Presidents of two main German funding agencies, the Alexander von Humboldt Foundation and German Academic Exchange Service (DAAD), as well as members of the German Parliament, DG of International Affairs Federal Ministry of Education and Research (BMBF), and Director General for Cultural Affairs of the German Foreign Office. Their visit was to see and access the capacity building and research conducted with German funding over the years at the SIRG.
- In 2022, a pollination services research programme focused on vegetable seed production was established in collaboration with an industry partner. Dr Ezette du Rand was appointed as the senior researcher for the programme.
- In 2022, Dr Ezette du Rand became part of the collaborative international research team at the Centre for Integrated Bee Research (CIBER), Department of Entomology, University of California Riverside, USA. CIBER's research focuses on honey bee reproduction, immunity, and ecology. Their goal is to better understand honey bees and to avoid further dramatic losses encountered in the United States and everywhere in the world.
- In 2021, our group published an article in the Journal of Experimental Biology which shows how the small hive beetle, which is a pest of honey bees, tricks its host to feed it with similar food as the queen bee. This explains how mimicry is used in such a system to the benefit of the pest.
- In an article in 2022, we showed how honey bees save energy in honey processing by dehydrating nectar before returning to the hive. The article published in the journal Scientific Reports indicates honey processing begins soon after collecting nectar from plants and not only upon arrival at the hive.
- In 2021, Prof. Pirk and collaborators published an article which shows how the Bee louse, a wingless parasitic fly, attaches itself to the honey bee. They illustrated, using high-speed video imaging analysis, how the Bee louse's body enables it to cling on with a safety factor of 1130 which is the highest ever recorded from an insect.

SYSTEMATICS AND EVOLUTION OF SYMBIOTIC NITROGEN-FIXING BACTERIA

Research leaders: **Prof. Fanus Venter and Prof. Emma Steenkamp**

Research team:
Prof. Martin Coetzee
Dr Chrizelle Beukes (James Hutton Institute)
Dr Esther Muema (Stellenbosch University)
Dr Marike Palmer (University of Nevada, Las Vegas)

BACKGROUND

South Africa is remarkably rich in legumes and their bacterial symbionts, with which they contribute significantly to biological nitrogen-fixation. In the case of non-native agricultural legumes, these symbiotic bacteria (also referred to as rhizobia) are relatively well-studied, but very little is known about those associating with native legumes in the region. In all cases, however, rhizobial associations are crucial for legume establishment and general ecosystem health. From a biodiversity point of view, rhizobia may also facilitate invasion by non-native legumes such as Australian *Acacia* species, and/or encroachment by generalist native species such as *Vachellia karroo*.

OBJECTIVES OF THE RESEARCH

Our overall goals are to characterise and describe the rhizobia associated with both native and non-native legume species and to reconstruct their evolutionary histories. For this purpose, we employ standard microbiological procedures combined with genetics and genomics approaches to study the processes driving rhizobial evolution. In this way, we endeavour to determine how rhizobial identity and genetics relate to legume host, geography and environmental factors, to ultimately shed light on the possible forces shaping the biogeography and ecology of these bacteria.

HIGHLIGHTS OF THE RESEARCH

- We formally described several new rhizobial species including *Paraburkholderia youngii* associated with South American mimosoids as well as *Bradyrhizobium altum*, *B. oropedii* and *B. acacia*, novel species isolated from South Africa.
- We evaluated the nodulation and growth promotion characteristics of various *Mesorhizobium* species obtained from various origins.

Collecting nodules in a wattle plantation

- In a review paper, we assessed the role *Paraburkholderia* species associated with indigenous South African Papilionoideae could play during the domestication of these legumes to serve as forage in low-nutrient soils.
- We highlighted the negative impact of national biodiversity regulations on the description of new bacterial species isolated from South Africa and contributed to the establishment of the SeqCode, which could assist in overcoming these obstacles.
- Overall, our research contributed to establishing a solid knowledge base of the diversity of rhizobia associated with native and other locally-relevant legumes, and the development of the necessary tools for studying the evolution of this assemblage of agriculturally-important bacteria.

SATELLITE LABS

SATELLITE LABS AT FABI

The satellite laboratories at FABI, in partnership with prestigious international institutions, cement the Institute's commitment to excellence in transdisciplinary research that advances plant health and food security. They are critical to building capacity and world-class collaborations for long-term research programmes as they create a link between a host institute and a partner in industry or academia to transfer knowledge and are led by next-generation experts in fields in which the host institute wants to build capacity. In return, the partner can benefit from another field of expertise that might be well developed at the host institute.

Untitled
Christo Coetzee

In this intriguing abstract composition, a dynamic range of intersecting shapes and forms symbolise the intricate connections fostered in the satellite labs and mirror the collaborative spirit of the host institute with industry and academia. One could interpret the splashes of ink to represent bursts of creativity and knowledge transfer while the deliberate geometrical elements mirror the structured approach guided by next-generation experts. Each shape embodies the capacity-building journey facilitated by our satellite labs, where expertise seamlessly flows between institutions. This visual metaphor encapsulates the active exchange of knowledge, precision in expertise transfer and the cooperative ethos defining our satellite labs, illustrating a nexus of innovation and capacity building.

SATELLITE LAB IN APPLIED CHEMICAL ECOLOGY

Research leader: **Prof. Jeremy Allison**

Research team
Prof. Almuth Hammerbacher
Prof. Brett Hurley
Prof. Bernard Slippers
Dr Gerda Fourie
Dr Quentin Guignard

BACKGROUND

The primary focus of research conducted by the Applied Chemical Ecology group is the development of an understanding of the chemical ecology of insect pests of plantation forests and agricultural tree crops. By using pest species as model systems the group is able to simultaneously make discoveries that advance the understanding of the natural world and provide pest management tools to stakeholders. The research is conducted in co-operation with the Great Lakes Forestry Centre of Natural Resources Canada.

Specific ongoing projects include the development and optimisation of survey and detection tools, characterisation of the active space of semiochemical-baited traps and the biotic and abiotic factors that influence it, the impact of chemical ecology on the efficacy of biological control, the chemical ecology of insect pests of plantation and fruit and nut trees, the causes and consequences of variation in insect sex pheromones, and the development of management tactics that exploit our understanding of the chemical ecology of pest species.

OBJECTIVES OF THE RESEARCH PROGRAMME

- The development and optimisation of survey and detection tools.
- Characterisation of the active space of semiochemical-baited traps and the biotic and abiotic factors that influence it.
- Study the impact of chemical ecology on the efficacy of biological control.
- Expand knowledge about the chemical ecology of insect pests of plantation and fruit and nut trees.
- Elucidating the causes and consequences of variation in insect sex pheromones.
- Understand the influence of visual signals in the behaviour and response of insects to chemical signals.

HIGHLIGHTS OF THE RESEARCH

- We established a fully functional chemical ecology lab, able to study all the aspects of the insect systems, from the chemistry itself, to the electrophysiological responses and behaviour.
- New pheromones were discovered, and the pheromone composition of *Sirex noctilio*, *Coryphodema tristis*, *Nudaurelia clarki*, *Euproctis terminalis*, *Gonipterus* sp. n. 2 and *Bathycoelia distincta* was confirmed.
- We developed and tested field-based tools for the monitoring and management of the above mentioned pests. In the case of *Coryphodema tristis*, the pheromone is currently used for mass trapping of this pest for management in *Eucalyptus nitens* plantations.
- As a relatively newly-formed group, we are proud of a number of high-quality research papers, the graduation of a number of PhD and MSc students, hosting of postdoctoral Fellows, national and international research collaborations, and strong industry partnerships. Two of the recent PhD graduates from the program now serve in leadership roles in International Union of Forest Research Organizations (IUFRO) working groups.
- A framework was developed for initiating an African Centre for Chemical Ecology, which will bring together stakeholders from the continent working in the discipline.
- Our group made high-quality contributions to the 2023 IUFRO Division 7 conference in Portugal with five participants. A PhD student linked to the group won the best student presentation from Africa at the conference.

Dream Vision
Bettie Cilliers-Barnard

Is it a home, is it a forest, is it a dream? This otherworldly image represents the culture of collaboration in FABI – where we engage with each other, share ideas and dreams of a better world through our science.

SATELLITE LAB IN ARTIFICIAL INTELLIGENCE IN FARMING

The Satellite Lab in Artificial Intelligence in Farming was officially launched on 7 September 2020. It is led by Prof. Abdoulaye Banire Diallo of the Bioinformatics Laboratory at Université de Québec à Montréal in Canada.

The current explosion in next-generation biological and information technologies is disrupting agriculture globally. It is opening transformative new opportunities for intensification and diversification in a sustainable manner. Africa, rich in agricultural growth potential, is at a crucial juncture to stimulate economic and social development through accelerated agricultural progress.

However, Africa faces significant challenges. It lacks the capacity and data required to fully leverage the potential of digital and precision agriculture. Additionally, the continent's agricultural community is fragmented, requiring cohesive efforts to promote ownership, social development, and resilience. Furthermore, any intensification must be mindful of Africa's invaluable biodiversity and landscapes, which provide vital ecosystem services, and consider the mounting threats from climate change, pests, and disease.

The Artificial Intelligence in Farming Satellite Lab at FABI, in collaboration with Future Africa @UP (a global research hub at the University of Pretoria), is dedicated to addressing these challenges. Through a partnership with Engineering 4 @UP, it aims to transform the Innovation Africa @UP Experimental Farm into a digital research hub. This transformation involves the integration of sensor technology, autonomous vehicles, drone technology, virtual reality, data science, and artificial intelligence with biological sciences.

Innovation Africa @UP serves as an anchor for the development of a network of like-minded agricultural research hubs, collectively transitioning into 'digital and precision agriculture research and training hubs' across the continent. These hubs will enable the sharing of resources, capacity, and data among similar organisations, creating a platform for focused investments in the future of agriculture in Africa.

This network will foster collaboration among businesses, governments, developmental organisations, and research institutions. It represents a promising path toward sustainable agricultural growth and social and economic development across the African continent.

SATELLITE LAB IN REMOTE SENSING OF PLANT HEALTH

The Satellite Lab in Remote Sensing of Plant Health, established on September 7, 2020, under the leadership of Dr René Heim and Prof. Wouter Maes from the UAV Research Centre at Ghent University, is dedicated to the utilisation of remote and close-range sensor data obtained from satellites and unmanned aerial vehicles (UAVs) to monitor the health of crops and forests.

The use of remote and close-range sensor data, obtained from satellites, aircraft, and UAVs, has already demonstrated its significant value, particularly in the detection of pests and diseases within both managed and natural landscapes. The integration of UAVs with optical sensors for crop and forestry monitoring represents a rapidly advancing field that presents unprecedented opportunities for managing plant health with a level of scale and precision never before achievable.

Within the context of its established leadership in addressing global plant disease and pest issues in commercial systems, as well as their impact on native vegetation, FABI serves as a host to world-leading programs. Furthermore, the university boasts substantial expertise in Engineering and Information Sciences, specifically within departments such as Civil, Electrical, Electronic and Computer Engineering, and Computer Science. The University of Pretoria seeks to leverage these capabilities to enhance its proficiency in remote sensing of plant health, thereby aligning with developments in chemical ecology, plant phenotyping, and data science within FABI.

The UAV Research Centre (URC), a recently-founded centre of excellence at Ghent University, consolidates knowledge pertaining to UAV-based remote sensing applications. Under the leadership of Prof. Wouter Maes and Prof. Hiep Luong, the URC is specifically dedicated to sustainable precision agriculture, with specialised competence in the early detection of pests and diseases. Moreover, the application of UAV technology to enhance agricultural practices in developing countries is a key focus area.

The collaboration between the URC and FABI represents a synergistic alignment. It promises to enhance research endeavours through shared projects and augment collective knowledge and experience in the domain of plant health monitoring across diverse geographical regions and for a variety of crops and plants. FABI's expertise in plant health biotechnology seamlessly complements the capabilities of the URC, laying the foundation for a mutually beneficial and enduring partnership.

Remote sensing for planting date assessments

RIFT-FABI TREE PROTECTION PROGRAMME (RFTPP)

Research leader: Dr ShuaiFei Chen (RIFT, China & FABI)

Team members:
Prof. Irene Barnes
Prof. Tuan Duong
Prof. Bernard Slippers
Prof. YaoJian Xie (RIFT, China)
Prof. Mike Wingfield
Dr FeiFei Liu (RIFT, China)
Mr GuoQing Li (RIFT, China)

BACKGROUND

Science and technology innovation cooperation between China and South Africa is an integral part of the comprehensive strategic partnership between the countries. Both South Africa and China have large and important natural forest ecosystems and dynamic forest industries that are threatened by insect pests and pathogens. There is, for this reason, a substantial need to build a strong and mutually beneficial base of research and training to protect these important resources. The cooperation between China and South Africa in forest protection research has a solid foundation through their long-standing relationship between the Research Institute of Fast-growing Trees (RIFT) (formal institution: China Eucalypt Research Centre (CERC), Chinese Academy of Forestry and the Forestry and Agricultural Biotechnology Institute (FABI)). The RIFT-FABI Tree Protection Programme (RFTPP), a formal structure first established in 2006 and revised in 2015 and 2022, is responsible for promoting research collaboration and education in all aspects of tree health in China, and between China and South Africa.

OBJECTIVES OF THE RESEARCH PROGRAMME

- Study the distribution, genetic diversity and biology of pathogens threatening plantation forestry in southern China.
- Understand the interactions between pathogens and their hosts, and provide support towards breeding and selection of disease-tolerant planting stock.
- Provide education for tree-health specialists and facilitate research collaboration between researchers at RIFT and FABI.

HIGHLIGHTS OF THE RESEARCH

- The primary focus of the RFTPP is to understand the distribution, genetic diversity, biology, and pathogenicity of the important pathogens of eucalypt trees. This includes studies on several important eucalypt plantation diseases, including leaf blight and seedling rot caused by species of *Calonectria*, stem canker disease caused by *Botryosphaeriaceae* and *Cryphonectriaceae*, and wilt caused by species of *Ceratocystis*.

The RFTPP team made good progress on the taxonomy of *Calonectria* and *Botryosphaeriaceae*. We also established a set of effective identification systems based on phylogeny, morphology and mating type for *Calonectria* species. The population studies over the past two years help us to understand the distribution and movements of important species of *Calonectria* at a national and global scale.

- The RFTPP continues to screen *Eucalyptus* hybrids for tolerance to important diseases. The genotypes of *Eucalyptus urophylla, E. urophylla* x *E. grandis* were used to test their tolerances to pathogens in Botryosphaeriaceae and *Calonectria* at RIFT. The tolerant genotypes will be further tested in different regions for use in commercial forestry.

PEST AND DISEASE MONITORING AND DIAGNOSTIC SUPPORT

Blister beetle on a rust gall
Julia Kreiss

This visual narrative of a blister beetle on a rust gall captures the essence of FABI's commitment to monitoring and diagnosing pests and diseases, where even the smallest organisms play a critical role in the delicate balance of ecosystems. The artwork serves as a testament to the institute's expertise in unraveling the mysteries of nature and providing vital support in safeguarding crops against potential threats.

TREE HEALTH EXTENSION AND DIAGNOSTIC CLINIC

Responsible persons:
Prof. Irene Barnes (oversight, TPCP/CPHB diagnostics)
Prof. Brett Hurley (oversight, tree health extension and TPCP/CPHB diagnostics)
Prof. Bernard Slippers (FABI Director)
Dr Gabrielle Carstensen (TPCP/CPHB diagnostics, until January 2023)
Dr Lieschen de Vos (FABI Diagnostic Clinic)
Ms Vinolia Danki (TPCP/CPHB diagnostics, from February 2023)
Ms Sandisiwe Jali (TPCP/CPHB extension)

The extension services of the Tree Protection Co-operative Programme (TPCP) and the DSI-NRF Centre of Excellence in Plant Health Biotechnology (CPHB) at FABI form an integral part of the research and services provided by these research programmes. These services include the monitoring and diagnosis of pests and pathogens of native and plantation trees.

Extension services of the TPCP/CPHB involve routine field visits across the country, as well as field visits in response to emerging pest and disease issues, including new detections and outbreaks. Extension activities are also important to create awareness of plant health amongst the general public, foresters, farmers and conservation staff. Thus, extension activities include presentations at field days, reports in magazines and newspapers, radio and TV interviews, and articles posted on the TreeHealthNet list server. The extension services work closely with the FABI diagnostic clinic, submitting samples to the clinic, and visiting sites from where samples were submitted when further investigation is required to confirm the identity or evaluate the impact of a pest or pathogen.

Correct diagnoses are crucial to the monitoring function of the TPCP/CPHB. Samples that are submitted through the extension services and via our stakeholders are processed by the FABI diagnostic clinic, with the manager overseeing the sample processing and reporting, supported by a capable team of postgraduate students and interns.

The clinic is well positioned within the TPCP and CPHB, allowing it access to some of the best laboratories on the continent and to draw on the skills, expertise and research of a world-class tree health programme.

Besides the crucial services the field extension and diagnostic clinic provide to the relevant stakeholders, these services also provide training for postgraduate students and interns, and thus contribute to the development of future capacity in tree health for South Africa.

MONITORING TREE HEALTH AT SENTINEL SITES: BOTANICAL GARDENS AND ARBORETA

Responsible persons:
Prof. Bernard Slippers
Prof. John R Wilson (Centre for Invasion Biology, Department of Botany and Zoology, Stellenbosch University, Stellenbosch & South African National Biodiversity Institute, Kirstenbosch Research Centre, Cape Town)
Prof. Mike Wingfield
Dr Felipe Balocchi
Dr Mesfin Gossa
Dr Trudy Paap

PROJECT RATIONALE

Worldwide, there is a growing number of damaging invasive plant pests, introduced largely by international trade and the movement of plant material. Notably, many of these pests are not problematic in their native range or were unknown to science prior to their arrival in novel environments. It is challenging to respond to such incursions, but improving surveillance, and in particular global cooperation in surveillance, is likely to have significant benefits. Sentinel plantings are being used to identify future threats before widespread invasions occur. Botanical gardens contain diverse plant collections, providing unique opportunities for sentinel research. Moreover, as they are often close to likely points of entry, botanical gardens are often among the first sites of the establishment of new invasive pests.

In 2016, a sentinel project was initiated in South African botanical gardens to improve surveillance and identification of new and emerging pest risks. The project has led to multiple first reports for the country, including the detection of the Polyphagous Shot Hole Borer (PSHB). It has also provided opportunities for training activities with botanical garden staff and supported the development of novel management options for existing pest issues. By raising plant health and biosecurity, best practice awareness and capacity, the intention is to provide increased opportunities for the detection of invasive plant pests in a country with a limited surveillance budget.

COLLABORATION WITH THE SOUTH AFRICAN NATIONAL BIODIVERSITY INSTITUTE'S DIRECTORATE: BIOLOGICAL INVASIONS (SANBI DBI)

The key objectives of the project reside firmly within the South African National Biodiversity Institute's Directorate: Biological Invasions (SANBI DBI). The stated mission of the Institute is to protect biodiversity and ecosystems from the negative impact of invasive species. The central focus of this project is the detection of current and potential pests and pathogens using sentinel plants within botanical gardens. Information gathered about a particular pest or pathogen, including potential host range, can then be used to determine the risk that they pose and potentially aid in the development of appropriate eradication and/or containment programmes. The project also presents the opportunity to work with and train garden staff to increase capacity with regards to the detection and management of plant pests.

PROJECT HIGHLIGHTS

- Assessment of plant health was undertaken in several botanical gardens across South Africa. These included Free State, Harold Porter, Kirstenbosch, KwaZulu-Natal, Lowveld, Pretoria and Walter Sisulu National Botanical Gardens, Pretoria National Zoological Garden, Arderne Gardens and Durban Botanical Gardens. Samples were collected from damaged plants and identified using morphological and molecular techniques.
- An MSc project was initiated under the SANBI sentinel project to assess the efficacy of phosphite treatment in managing *Phytophthora* dieback of Silver trees in Kirstenbosch National Botanical Gardens.
- In collaboration with Durban University of Technology (DUT), a three-day training workshop was held at the institution in April 2021. Horticulture students and eThekwini Municipality horticulturists attended the training. In August 2021, a follow-up training was organised for students, with a focus on sampling and isolation techniques. Following these training workshops, three student projects were developed and linked to the sentinel plant project.
- A PSHB monitoring system was established at the KwaZulu-Natal National Botanical Garden in collaboration with the Garden horticulturists.
- In collaboration with SANBI's Horticultural Enrichment Form, FABI researchers have developed a guide to biosecurity best practices for living plant collections in South Africa. A two-day workshop was held at Kirstenbosch in October 2022 to launch the guidelines, with the SANBI/FABI team joined by Sydney Royal Botanic Garden's Chief Scientist and Director of Research, Prof. Brett Summerell.

Researchers and horticulturists establishing a PSHB monitoring system at the KZN National Botanical Garden

THE POLYPHAGOUS SHOT HOLE BORER (PSHB) RESEARCH NETWORK

Responsible persons:
Prof. Bernard Slippers
Prof. Wilhelm de Beer (retired March 2022)
Dr Wilma Nel
Dr Trudy Paap

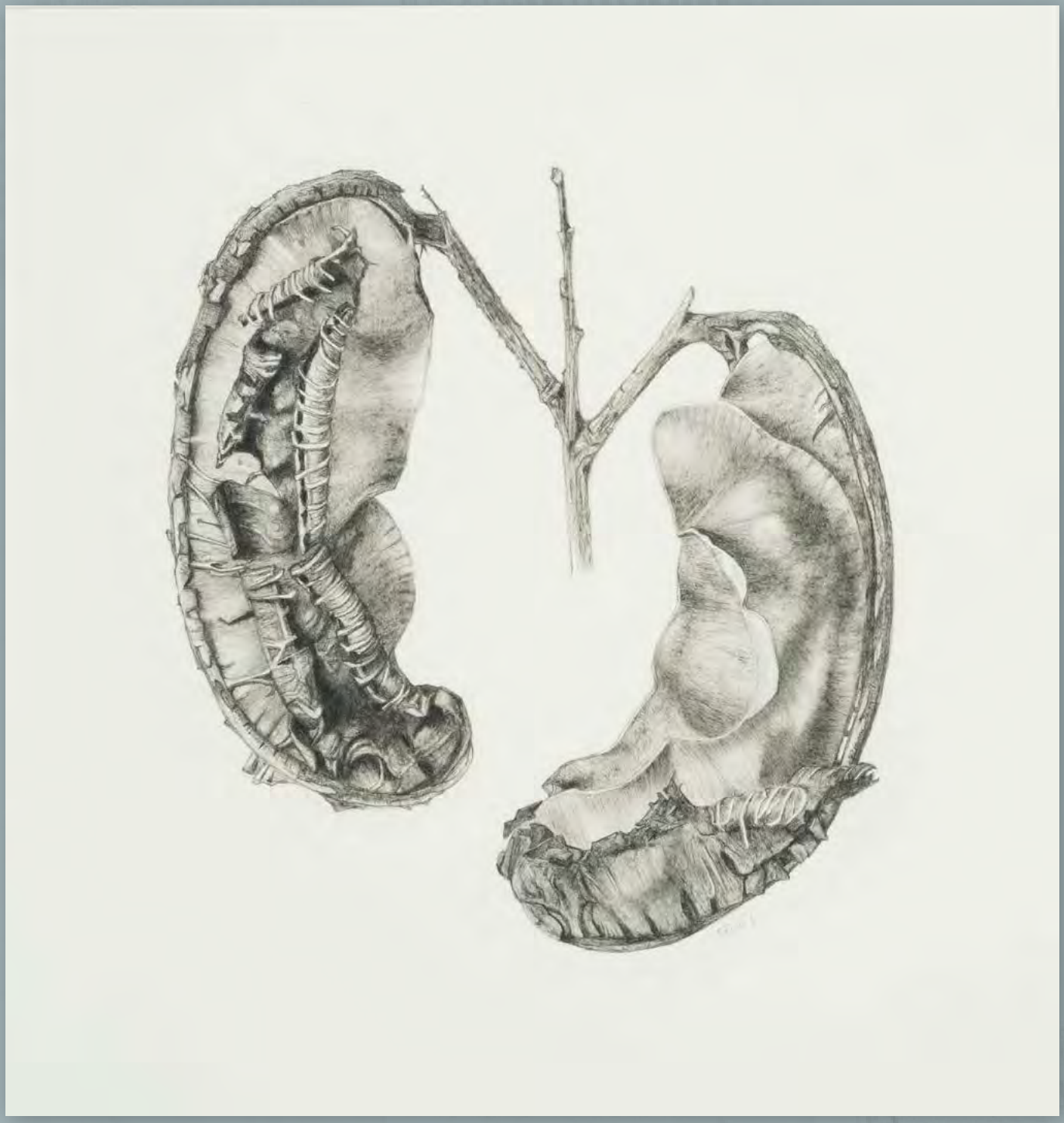
The ongoing invasion of the Polyphagous Shot Hole Borer (PSHB) in South Africa is of major concern to farmers, foresters, landscapers, homeowners and ecologists, as this beetle and its symbiotic fungus can be aggressive tree killers. The beetle is native to Southeast Asia. It was detected in Israel and California in the early 2000s, where it has since caused serious damage to several ornamental tree species, as well as commercial avocado trees.

The presence of PSHB in South Africa was first confirmed in 2017 by the FABI team. Ongoing surveys confirmed that South Africa currently hosts the largest geographical outbreak of this beetle in the world. It is affecting trees in all sectors: the agricultural and commercial forestry sector, urban trees (public spaces, streets, gardens), as well as native trees in natural forests. Prior to the 2000s, almost no research had been conducted on the biology and possible control measures of the beetle and fungus. Although several research papers have been produced during the past 15 years from Israel and the USA, the body of research on the topic remains small and much more work is needed to support proper mitigation measures that can be implemented by all levels of government and other stakeholders in South Africa.

The research team at FABI realised that dealing with the PSHB at a national level needed a multi-disciplinary approach involving experts from across the country. They started collaborating with senior academics from several universities, and from these engagements, a multi-institutional research network evolved.
The PSHB Research Network was established at a meeting of these researchers in May 2019 at FABI. The aims and strategies of the PSHB Research Network are:

- To align and coordinate all research efforts by *bona fide* researchers from academic institutions in South Africa. This is to make sure that expertise and resources are utilised to the maximum in order to answer the most important research questions related to PSHB and its fungal symbionts.
- To provide science- and data-based advice to all stakeholders in government and private sectors.
- To effectively communicate new research findings related to PHSB among network members and to stakeholders and the public.
- To leverage funding by showing that research projects form part of a well-structured, coherent research programme, more funding opportunities should become available.

At present academics, postgraduate students, interns and technical staff from institutes across South Africa are involved in a range of research projects ranging from monitoring the impact of PHSB on trees in orchards and urban and natural forests, to exploring biological control options for the PSHB and its fungal symbiont. Research partners are based at FABI, Rhodes University, Stellenbosch University, University of the Witwatersrand, Durban University of Technology, University of the Free State, UNISA, University of Limpopo and Sol Plaatje University.



Elephantorrhiza elephantina
Trudy Paap

E. elephantina is an underground tree indigenous to several bioregions of southern Africa, with the majority of the plant's biomass existing underground. The seed pods of this species, with their valves separating from the persistent margins when they open, made a fascinating and delightfully intricate topic for Trudy's favored medium, graphite. The image captures the intricate, but often hidden treasures of biodiversity and our role in discovering it.

FABI COMMUNITY

AWARDS AND HONOURS

Ever since its formal inauguration 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 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 Science and Innovation, 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 is 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 for the reporting period were as follows:

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, and support to the maintenance of the structures of the Institute and others. The recipient is chosen by FABI students.

***2021* Nam Pham | *2022* Elisa Pal**

BEST FABI MSc DISSERTATION

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

***2021* Ashleigh Smith | *2022* Shae Swanepoel**

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 chosen based on the ISI impact factor of the paper produced.

***2021* Jane Chepsergon | *2022* Bertus van Heerden**

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.

***2021* Dr Andi Wilson and Dr Neriman Yilmaz**
***2022* Dr Jane Chepsergon**

Untitled
Abraham Jacobus (Appie) van Wyk

In this vibrant artwork, a majestic tree takes centre stage, rooted in a bowl symbolic of the vessel of our community. Surrounding the bowl, a circle of people form a united front, embodying the close-knit FABI community. Some stand within the bowl, fostering growth from its core, while others gather around the tree, intertwining their roots with its branches. The piece comes to life with the warmth of a large orange sun, casting a radiant glow. This visual representation captures the essence of the FABI community - a dynamic ecosystem where individuals, much like the expansive foliage of a tree, contribute to the collective growth and vitality of our community. The tree, a powerful symbol of strength and interconnectedness, stands as a testament to the nurturing environment cultivated within the FABI community, where every individual plays a vital role in fostering a culture of shared knowledge and growth.

FABI AWARD FOR MENTORSHIP

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

2021 **Claudette Dewing, Trystan Nadasen and Elisa Pal**
2022 **Dee Twiddy and Johannes Christoff Joubert**

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.

2021 **Matthew Jackson and Johannes Christoff Joubert**
2022 **FABI Social Media Team: Tania Pogue, Lente van Zyl, Ofentse Mathibela, Samkelisiwe Thango, Vinolia Danki and Willem van der Westhuizen**

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.

2021 **Rina Nieuwenhuis, Rudolf Nieuwenhuis (Cropwatch Africa)**
2022 **Dr Ronald Heath (Forestry South Africa)**

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 who has provided exceptional support to FABI.

2021 **Emily Mokhehle | *2022* Prof. Anton Ströh**

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

2021 **Shawn Fell | *2022* Dr Ariska van der Nest**

Best Photograph Illustrating FABI Research

2021 **Dr Trudy Paap | *2022* Elisa Pal**

FABI AWARD FOR POSTDOC MENTORSHIP/ OUTSTANDING CONTRIBUTIONS

This award goes to a full-time FABI postdoctoral Fellow who has demonstrated outstanding mentorship to other FABIans, or who has significantly contributed towards the goals of FABI, above what is expected.

2021 **Dr Quentin Guignard and Dr Raphael Ployet**
2022 **Dr Dawit Kidanemariam**

FABI AWARD FOR OUTSTANDING RESEARCH FELLOW CONTRIBUTIONS

This award goes to a full-time FABI Research Fellow who has demonstrated outstanding mentorship to other FABIans, or who has significantly contributed towards the goals of FABI, above what is expected.

2021 **Dr Trudy Paap**

CREATIVE ART SUBMISSION

This award is made for the best creative art piece made by a FABIan and submitted based on the theme 'Biodiversity in art'. Any creative item that has a link with biodiversity/nature in any way can be submitted. This includes visual arts or crafts (paintings, drawings, sculptures, woodwork, needlework, jewellery, etc), word art, music or other forms of art.

2021 **Nam Pham**
2022 **Shivan Bezuidenhout and Claudette Dewing**

UNIVERSITY OF PRETORIA AWARDS

CHANCELLOR'S AWARD FOR RESEARCH

2021 **Prof. Brenda Wingfield**

EXCEPTIONAL ACHIEVERS AWARDS

2023–2025 **Prof. Teresa Coutinho**
2022 **Prof. Christian Pirk**

EXCEPTIONAL YOUNG ACHIEVERS AWARD

2021 **Dr Tuan Duong**

SOUTHERN AFRICAN SOCIETY OF PLANT PATHOLOGISTS (SASPP) AWARDS 2022

Prof. Bernard Slippers: Received the prestigious Christiaan Hendrik Persoon Medal, at an awards ceremony of the Southern African Society for Plant Pathologists (SASPP), which took place on the campus of the University of Pretoria on 3 August 2022.

Prof. Brenda Wingfield: Honorary Membership of the SASSP (in recognition of a lifetime of outstanding accomplishments in plant pathology as well as support for and service to the SASPP society and to plant pathology in southern Africa).

Prof. Dave Berger: Fellow of the SASSP (in recognition for outstanding accomplishments in plant pathology as well as support for and service to the SASPP society and to plant pathology in southern Africa).

Dr Minette Havenga: John and Petakin Mildenhall Best PhD Award

Angel Maduke: Pannar Award for Best Poster Presentation by a Student

Alida van Dijk: Runner-up: Poster Presentation by a Student

Lihan Esterhuizen: Pannar Floating Trophy for Best Oral Presentation by a Student

OTHER AWARDS TO FABI MEMBERS

Prof. Dave Berger: Awarded Fellow of the Royal Society of South Africa.

Prof. Dave Berger and Prof. Mike Wingfield: Featured in the British Society for Plant Pathology's (BSPP) "Forty Faces of Plant Pathology" that formed part of the Society's 40th anniversary celebrations (2022).

Prof. Tjaart Krüger: Served on the Executive Committee of the South African Young Academy of Science (SAYAS).

Prof. Tjaart Krüger: Joined the editorial board of the Journal of Physical Chemistry Letters as a Senior Editor

Prof. Zander Myburg: Awarded a United States Department of Energy grant in October 2021 to fund his "Eucalypt genomic resources for woody biomass production and carbon drawdown" project.

Prof. Christian Pirk: Successfully applied for another new EU COST action - BEekeeping products valorisation and biomonitoring for the SAFEty of BEEs and HONEY (BeSafeBeeHoney).

Prof. Christian Pirk: Appointed to the Policy Advice Development and Programme Committee of the Inter Academy Partnership (IAP) of The World Academy of Sciences (TWAS) August 2022 for a period of three years. More than 140 global member academies work together under the IAP to support the advancement of science in developing countries and to seek evidence-based solutions to global problems.

Prof. Jacquie van der Waals: Received the prestigious *Solanum tuberosum* award by Potatoes South Africa. The award was presented to Prof. van der Waals on 20 July 2022 at the gala dinner of the Potatoes South Africa (PSA) annual research symposium, held from 19-21 July 2022 in Langebaan, SA. The award winner is an individual who has served the South African potato industry with dedication and enthusiasm, and thereby promoted and furthered the interests, vision and mission of PSA and the South African potato industry.

Prof. Cobus Visagie: Invited to become a member of the International Commission on the Taxonomy of Fungi (ICTF) in July 2022.

Prof. Cobus Visagie: Won joint third place in the Zeiss Microscopy Image Contest 2021 for his entry of 'Synnemata of a new *Talaromyces* species'.

Prof. Brenda Wingfield and Prof. Mike Wingfield: Received the outstanding Hartig-Patterson Award at the IUFRO Division 7 Forest Health Meeting in Portugal Lisbon, 2022. They were the first recipients of this award. The award was established to specifically recognise global contributions made to Forest Pathology. The name of the award recognises Robert Hartig, who was a German forestry scientist and mycologist, and is considered to be the 'Father of Forest Pathology' for his foundational research into the etiology of tree diseases. Flora W. Patterson was an American mycologist and plant pathologist. She was the first female hired for these roles and is considered the 'Mother of Forest Biosecurity' for her pioneering work in plant quarantine.

Prof. Brenda Wingfield: Received the John F.W. Herschel Medal in 2023. This is the senior medal of the Royal Society of South Africa. The medal is named after Sir John Frederick William Herschel (1791-1871), who lived in Cape Town as an astronomer from 1834 to 1838 and whose grave lies close to Isaac Newton's in Westminster Abbey. The medal is awarded to those who are outstanding in either a field of research that straddles disciplines or in more than one unrelated field.

Prof. Mike Wingfield: Received the prestigious Harry Oppenheimer Fellowship Award for 2021 at a ceremony held on 12 July, 2022 at the Brenthurst Library. This is the flagship award by the Oppenheimer Memorial Trust.

Prof. Mike Wingfield: Included in the Clarivate Web of Science Highly Cited Researchers 2021/2022 list and again in the 2022/2023 list, for the sixth consecutive year.

Prof. Mike Wingfield: Honorary DSc degree from the University of the Free State (UFS). (May 2022)

Prof. Abdullahi Yusuf and Prof. Christian Pirk: Joined the new EU COST action European Network In CHEmical Ecology: translating the language of life into sustainability (E-NICHE) and management committee members. The objective of E-NICHE is to address major societal issues for environmental and sustainable development goals by describing chemodiversity, evolutionary forces, and global changes that will impact biodiversity and ecological interactions.

Prof. Abdullahi Yusuf: Appointed as the Alexander von Humboldt Ambassador Scientist to South Africa in November 2021 for a period of three years. Humboldt Ambassador Scientists support the Alexander von Humboldt Foundation by disseminating information on the Foundation's sponsorship programmes whilst also acting in an advisory capacity. Ambassador Scientists use their research networks to disseminate information about Germany as a research location and advise the Humboldt Foundation and other German funding organisations on local programme promotion and networking. In addition, they are points of contact for Humboldt alumni and Humboldt associations. Currently, 36 Ambassador Scientists in 27 countries support the Alexander von Humboldt Foundation.

Dr Tanay Bose: Appointed as a section editor for the peer-reviewed scientific journal Mycological Progress.

Dr Nicky Creux: The Oil and Protein Seeds Development Trust and the Oilseeds Advisory Committee awarded the best publication award to Dr Nicky Creux for her work on the New Phytologist paper "Flower orientation influences floral temperature, pollinator visits and plant fitness"

Dr Nicky Creux: Elected to the International Sunflower Association Board in June 2022.

Dr Ezette du Rand: Received the prestigious L'Oréal-UNESCO for Women in Science Young Talents Award 2021 for post-doctoral fellows. The programme supports young female scientists and rewards scientific excellence.

Dr Ezette du Rand: Received an award for Excellence in Research and Education during the Charlotte Mannya-Maxeke Institute's 6th Annual BRING HER UP: Women of Firsts Awards 2022.

Dr Steven Hussey: Received the Hofmeyr - van Schaik Silver Medal by the South African Genetics Society for outstanding achievements in Genetics by an emerging researcher.

Dr Agil Katumanyane: Received the L'Oréal-UNESCO For Women in Science Award for Sub-Saharan Africa Young Talents. (November 2021).

Dr Agil Katumanyane: Received the 2022 Chris J. Lomer Memorial Award, which recognises and supports attendance to the Society for Invertebrate Pathology (SIP) annual meeting for excellent scientists in invertebrate pathology and microbial control from lower to middle income countries at the 2022 International Congress on Invertebrate Pathology and Microbial Control.

Dr Neriman Yilmaz: Won the Inqaba "Africa Genome Challenge 2021" Award

Caitlin Gevers: PhD candidate in FABI won the South African Institute of Forestry Merit Award 2021.

Privilege Makunde: PhD candidate in FABI won the South African Institute of Forestry Writing Award 2021.

Innocent Rakubu: MSc student in FABI was awarded the Student Travel Award for the nematode division at the 2022 International Congress on Invertebrate Pathology and Microbial Control.

Rudolph Strydom: MSc student in Plant Pathology and part of the Potato Pathology Programme @UP, was awarded the best student presentation at the Potatoes SA annual research symposium held at Mykonos, Langebaan, in July 2022. The title of his presentation was "Host status of various cover crop species to the soilborne pathogen, *Spongospora subterranea* f. sp. *subterranea*, in South Africa".

Bertus van Heerden: PhD candidate in FABI received a Fulbright Scholarship.

Sumari Venter: MSc student in FABI won the Best Student Oral Presentation in the nematode division at the 2022 International Congress on Invertebrate Pathology and Microbial Control.

25 Years of FABI-lous Minds
Elmarie van der Merwe

Sirex noctilio has oviposited complex questions in the minds of many FABIans over the past 25 years. Each question has hatched a research project, tunneling through the unknown and forming galleries of curiosities. Considering the swarm of disciplines it takes to understand a little insect, one cannot help but be in awe of nature's intricate design and be humbled by the reality of how small we actually are. This piece pays tribute to all the seemingly 'little' projects in FABI that have poured knowledge into a strong foundation for the next 25 years of questions to build upon.

FABI PEOPLE

Academic Staff and Research leaders

Prof. Bernard Slippers
Prof. Fanus Venter
Prof. Yusuf Abdullahi Ahmed
Prof. Irene Barnes
Prof. Dave Berger
Prof. Martin Coetzee
Prof. Teresa Coutinho
Prof. Wilhelm de Beer (retired 2022)
Prof. Tuan Duong
Prof. Michelle Greve
Prof. Almuth Hammerbacher
Prof. Brett Hurley
Prof. Tjaart Krüger
Prof. Kerstin Krüger
Prof. Eshchar Mizrachi
Prof. Lucy Moleleki
Prof. Zander Myburg
Prof. Sanushka Naidoo
Prof. Christian Pirk
Prof. Catherine Sole
Prof. Emma Steenkamp
Prof. Noëlani van den Berg
Prof. Albe van der Merwe
Prof. Jacquie van der Waals
Prof. Cobus Visagie
Prof. Juan Vorster
Prof. Chris Weldon
Prof. Brenda Wingfield
Prof. Mike Wingfield
Dr Khumbuzile Bophela
Dr Nicky Creux
Dr Gerda Fourie
Dr David Nsibo
Dr Honest Machekano
Dr Robert Mangani
Dr Thabiso Motaung Motaung
Dr Velushka Swart
Dr Markus Wilken

Professional Support Staff

Dr Robert Backer
Mr Morné Booij-Liewes
Ms. Samantha Bush
Dr Gabrielle Carstensen (till 2023)
Dr Nanette Christie
Ms. Amy Collop
Ms. Phozisa Dlokweni
Ms. Helen Doman
Dr Zelda du Toit-Boshoff
Mr Shawn Fell (till 2022)
Ms. Heidi Fysh
Ms. Sandisiwe Jali
Mr Joseph Khadile
Ms. Tebogo Khantsi
Ms. Pritty Khumalo
Ms. Ncobile Kunene
Mr Josias Letaoana
Ms. Grieta Mahlangu
Dr Ronishree Mangwanda
Dr Seonju Marincowitz
Mr Lawrence Mataha
Ms. Zandile Mngadi
Ms. Tersia Moabelo
Mr Katlego Moatshe
Ms. Patience Motaung
Ms. Sindiso Mtshubungu
Ms. Eva Muller
Ms. Kelly Kimberly Naidoo
Ms. Aysha Ndou
Dr Wilma Nel
Ms. Makhosazana Ngema
Ms. Thandeka Ngondo
Mr Celani Nkosi
Ms. Sophie Nyoni
Dr Nicky Olivier
Ms. Alisa Postma
Ms. Melissa Reynolds
Ms. Nicole Rudolph
Ms. Doleen Sehlabane
Ms. Nasiphi Siguca
Ms. Lydia Twala
Dr Magriet van der Nest
Ms. Madelein van Heerden
Ms. Adri Veale
Ms. Renate Zipfel
Dr Avhashoni Zwane

Research Fellows

Dr Janneke Aylward
Dr Tanay Bose
Dr Lieschen de Vos
Dr Gudrun Dittrich-Schröder
Dr Fahimeh Jami (till 2021)
Dr Esther Muema
Dr Trudy Paap
Dr David Read
Dr Michelle Schröder
Dr Neriman Yilmaz

Postdoctoral Fellows

Dr Felipe Balocchi
Dr Chrizelle Beukes
Dr Jane Chepsergon
Dr Katrin Fitza
Dr Tanweer Goolam Mahomed
Dr Mesfin Gossa
Dr Quentin Guignard
Dr Michal Gwizdala
Dr Agil Katumanyane
Dr Godfrey Kgatle
Dr Dawit Kidanemariam
Dr Privilege Makunde
Dr Molly Malefo
Dr Rosali Moffat
Dr Nthabiseng Mokoena
Dr Jan Nagel
Dr Sylvans Ochola
Dr Olabimpe Orubuloye
Dr Raphael Ployet
Dr Ashok Prabu
Dr Josephine Queffelec
Dr Hiroyuki Suzuki
Dr Ariska van der Nest
Dr Erik Visser
Dr Andi Wilson

PhD Candidates

Ms. Omotayo Adegeye
Mr Ayaovi Agbessenou
Ms. Juanita Avontuur
Mr Harm Barten
Ms. Mamokete Bokhale
Mr Sikelela Buthelezi
Ms. Julia Candotti
Ms. Annie Chan
Mr Johannes Christoff Joubert
Ms. Claudette Dewing
Mr Philani Dlamini
Mr Sanele D. Dlamini
Ms. Firehiwot Eshetu
Ms. Alicia Fick
Ms. Caitlin Gevers
Ms. Ginna Granados
Ms. Sasha-Lee Gush

Mr Mathew Harris
Mr Darryl Herron
Ms. Vaylen Hlaka
Ms. Nkosikhona Hlatshwayo
Ms. Carlynn Jacobs
Ms. Melissa Joubert
Ms. Tsholofelo Kibido
Mr Maxwell Kibor
Ms. Rosa Knoppersen
Ms. Katlego Kopotsa
Ms. Sithembile Kunene
Ms. Frances Lane
Mr GuoQing Li
Ms. WenWen Li
Ms. QianLi Liu
Mr Johan Liversage
Ms. Anneri Lötter
Ms. Kira Lynn
Ms. Teresia Macharia
Ms. Angel Maduke
Mr Phinda Magagula
Ms. Dineo Mailula
Ms. Phrasia Mapfumo
Mr Mkhululi Maphosa
Mr Sicelo Masuku
Ms. Ofentse Mathibela
Mr Lazarus Mavima
Ms. Pfano Mbedzi
Ms. Tsakani Miyambo
Ms. Rachel Mkandawire
Ms. Sphumelele Mkhize
Ms. Fanele Mnguni
Ms. Mateka Modiba
Mr Sizwe Mthembu
Mr Jufter Musedeli
Mr Knowledge Mushonga
Mr Trystan Nadasen
Mr Nganea Nangammbi
Ms. Debora Narh Mensah
Mr Nkosinathi Ndaba
Mr Ndamulelo Nengovhela
Ms. Phophi Nethononda
Ms. Alandie Nieuwoudt
Ms. Celiwe Nxumalo
Mr Phumlani Nzuza
Ms. Elisa Pal
Ms. Vongai Paradza
Mr Nam Pham
Ms. Jenna-Lee Price
Mr Innocent Rakubu
Ms. Jane Baile Ramaswe
Ms. Ipeleng Randome
Ms. Mary Ranketse
Ms. Manchela Ratsoma
Ms. Brenda Salasini
Ms. Luki-Marie Scheepers
Ms. Cassandra Schoeman
Ms. Nomfundo Shinga
Mr Mandla Sibiya
Ms. Ashleigh Smith
Ms. Myriam Solis
Mr Byron Sonnekus
Ms. Benedicta Swalarsk-Parry
Ms. Shae Swanepoel
Mr Lazarus Takawira
Mr Marthin Tarigan
Mr Demissew Teshome
Ms. Samkelisiwe Thango
Ms. Cheyenne Theron
Mr Renaan Thompson
Mr Garyn Townsend
Mr Joshua Tsamba
Mr Bertus van Heerden
Ms. Nicole van Vuuren
Ms. Lente van Zyl
Ms. Alicia Vermeulen
Mr Edwin Wanjofu
Ms. Tanya Welgemoed
Ms. Raven Wienk
Ms. Nomakula Zim

MSc Students

Ms. Susanna Anbu
Ms. Lina Del Mar Angel Salazar
Ms. Jade Ashmore
Ms. Katelyn Baird
Mr Vasili Balios
Ms. Janine Bisschoff
Mr Ryan Bosch
Mr Gerhard Botha
Ms. Erika Botha
Ms. Iné Botha
Ms. Carla Buitendag
Mr Callin Ceriani
Mr Johan Cilliers
Mr Ricu Claassens
Ms. Gabriélla Clara
Ms. Vinolia Danki
Ms. Cerista de Muelenaere
Ms. Angelique de Wet
Ms. Nokwanda Dlamini
Ms. Deanné du Plessis
Ms. Ruby May Ebbeling
Mr Lihan Esterhuizen
Mr Taygen Fuchs
Mr Johan Griesel
Ms. Adri Grobler
Mr Christiaan Grobler
Mr Aaron Harvey
Ms. Bianca Hattingh
Ms. Alecia Heyns
Mr Lehlohonolo Hlahane
Ms. Cliriska Hoffman
Ms. Marisca Hough
Ms. Bianca Hough
Mr Sung Hyu Luke Kim
Mr Matthew Jackson
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Ms. Marizanne Jones
Mr Harris Keetse
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Mr Wisely Kola
Mr Nigel Kombora
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Mr Kristiann Labuschagne
Mr Kyle Leeuwendaal
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Ms. Ntombizwodwa Luvhimbi
Ms. Mabodiba Maake
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Ms. Chulumanco Majavu
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Ms. Nomaswazi Maseko
Ms. Ndalama Mashava
Mr Lindokuhle Masimula
Ms. Keamogetswe Maswanganyi
Ms. Langanani Matodzi
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Mr Nhlonipho Ngubane
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Ms. Sinethemba Nkosi
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Ms. Tshiamo Phakalatsane
Ms. Anja Piso
Ms. Tania Pogue
Mr Dylan Pullock
Ms. Nombulelo Qikani
Ms. Jostina Rakoma
Mr Msizi Ramaoka
Ms. Lizzy Ramela
Ms. Boitshoko Rammuki
Ms. Claire Randolph
Ms. Lize Reinecke
Ms. Emeldah Rikhotso
Ms. Vera Röder
Mr Kevin Scheepers
Mr Sean Schultze
Ms. Lebone Sebapu
Mr Alinaswe Selebi
Mr Preston Shaw
Ms. Aviwe Simandla
Mr Michal Slupski
Mr Bernard Smit
Mr Hannes Strydom
Mr Rudolph Strydom
Ms. Taponeswa Tasiya
Ms. Hannah Tate
Mr Eloff Theron
Ms. Chanel Thomas
Ms. Marné van Butzelaar
Ms. Elmarie van der Merwe
Mr Willem van der Westhuizen
Ms. Alida van Dijk
Ms. Alishia van Heerden
Ms. Melandre van Lill
Mr Bertus van Rooy
Ms. Sumari Venter
Ms. Anien Viljoen
Ms. Rodé Visser
Mr Mondli Xaba

Honours

Mr Adam Bazerbachi (2023)
Ms. Simoné Bence (2023)
Mr Matthew Bennett (2023)
Ms. Jessica Berry (2023)
Mr Marcelle Booysen (2023)
Ms. Simoné Bornman (2023)
Ms. Jana Botes (2023)
Ms. Vida Burger (2023)
Ms. Johane Cilliers (2023)
Ms. Sapphire de Zoete (2023)
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Ms. Vicki Hurwitz (2023)
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Ms. Michelle Kretzschmar (2023)
Ms. Anthea le Roux (2023)
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Ms. Phenyo Mokgadi (2023)
Ms. Catherina Ngongni-Kuetezang (2023)
Ms. Ipeleng Pooa (2023)
Ms. Kelebogile Sathekge (2023)
Ms. Bernice Small (2023)
Mr Faan Smit (2023)
Mr James Smith (2023)
Ms. Jemma Smith (2023)
Mr Alexander Sotiralis (2023)
Mr Grant Terblanche (2023)
Ms. Hanneke van Loggerenberg (2023)

Interns

Lerato Dhlamini (2023)
Fanelesibonge Hlabisa (2023-2024)
Mukondeleli Khethani (2023-2024)
Siyabonga Magagula (2023-2024)
Bongani Mahlangu (2023-2024)
Tjitjila Makhura (2023-2024)
Andile Matabata (2023-2024)
Mpho Matsetela (2023-2024)
Khulekani Mbatha (2023-2024)
Tina Mfithi (2023-2024)
Thandekile Ncongwane (2023)
Nicolette Sianyuka (2023-2024)

GRADUATES

PhD

Dr Jane Chepsergon

Thesis: Identification and functional characterization of short linear motifs (SLiMs) of *Phytophthora parasitica* var *nicotianae* "Core" RxLR effector proteins.
Supervisor: LN Moleleki

Dr Juanita Engelbrecht

Thesis: Population genetics and genomics of *Phytophthora cinnamomi*.
Supervisor: N van den Berg

Dr Quentin Guignard

Thesis: Visual and chemical ecology of *Sirex noctilio*.
Supervisor: JD Allison
Co-supervisor: B Slippers

Dr Yosef Hamba Tola

Thesis: Characterization of the honey bee and stingless bee gut microbiota: A hidden diversity and host-specific microbiomes from sub-Saharan-African region.
Supervisor: B Slippers
External co-supervisor: JC Paredes Escobar (International Centre of Insect Physiology and Ecology, Kenya)

Dr Minette Havenga

Thesis: Biology and pathology of the *Eucalyptus* foliar pathogen *Teratosphaeria destructans*.
Supervisor: J Aylward
Co-supervisors: BD Wingfield, MJ Wingfield, LL Dreyer (Stellenbosch University), F Roets (Stellenbosch University)

Dr Agil Katumanyane
Thesis: Entomopathogenic nematodes associated with white grubs from forest and sugarcane plantations and mechanisms of resistance of white grubs to nematode infection.
Supervisor: BP Hurley
Co-supervisors: B Slippers, MW Gossa, AP Malan (Stellenbosch University)

Dr Brigitte Langenhoven
Thesis: Insights into northern leaf blight disease: investigating the *Exserohilum turcicum-Sorghum bicolor* interaction.
Supervisor: BG Crampton
External co-supervisor: SL Murray (Centre for Proteomic and Genomic Research)

Dr Mammoloro Malefo
Thesis: Functional characterization of transgenic *Arabidopsis* plants overexpressing the maize Bowman-Birk serine protease inhibitor gene under biotic and abiotic stress.
Supervisor: BG Crampton
Co-supervisor: BJ Vorster

Dr Lorraine Mhoswa
Thesis: Genome-wide association study in *Eucalyptus grandis* for resistance to *Leptocybe invasa*.
Supervisor: S Naidoo
Co-supervisors: AA Myburg, B Slippers

Dr Vallry Moloto
Thesis: Seedborne bacteria of onion: a study on pathogenicity and diversity.
Supervisor: TA Coutinho
External co-supervisors: LJ du Toit (Washington State University, United States of America), T Goszczynska (Agricultural Research Council)

Dr Marja Mostert O'Neill
Thesis: Genomic consequences of natural and artificial selection in wild and advanced breeding populations of *Eucalyptus grandis*.
Supervisor: AA Myburg
External co-supervisors: JOC Borevitz (Australian National University, Australia), JJ Acosta Jaramillo (North Carolina State University, United States of America)

Dr Mmoledi Mphahlele
Thesis: Genomic breeding for accelerated improvement of growth, wood properties and plant defence in *Eucalyptus grandis*.
Supervisor: AA Myburg
External co-supervisors: GR Hodge (North Carolina State University, United States of America), F Isik (North Carolina State University, United States of America)

Dr Wilma Nel
Thesis: Ophiostomatoid fungi associated with fungus farming insects in South Africa.
Supervisor: TA Duong
Co-supervisors: ZW de Beer, MJ Wingfield

Dr Vongai Paradza
Thesis: Development of effective biopesticides against Greenhouse whitefly, *Trialeurodes vaporariorum* Westwood (Hemiptera: Aleyrodidae) in tomato and French bean.
Supervisor: AA Yusuf
External co-supervisors: KS Akutse (International Centre of Insect Physiology and Ecology, Kenya), FM Khamis (International Centre of Insect Physiology and Ecology, Kenya)

Dr Mmatshepho Phasha
Thesis: Functional characterization of pathogenicity genes in *Fusarium circinatum*.
Supervisor: ET Steenkamp
Co-supervisor: MPA Coetzee, BD Wingfield, MJ Wingfield

Dr Joséphine Queffelec
Thesis: Influence of reproductive biology on the invasion dynamics of *Sirex noctilio*.
Supervisor: B Slippers
Co-supervisors: JM Greeff, JD Allison

Dr Ariska van der Nest
Thesis: Species diversity of *Lecanosticta* and population genetics of *Dothistroma* species: important needle pathogens of *Pinus*.
Supervisor: I Barnes
Co-supervisor: MJ Wingfield

MSc
(with Distinction)*

Desiree Biya
Dissertation: Diversity of fumonisin-producing *Aspergillus* and *Fusarium* species in maize collected in South Africa.
Supervisor: LN Moleleki
External co-supervisors: E Ncube (Agricultural Research Council), M Truter (Agricultural Research Council)

Hamish Craze
Dissertation: The use of deep learning for identification of grey leaf spot in maize with mixed diseases under field conditions.
Supervisor: DK Berger
Co-supervisors: F Joubert, N Pillay

Shawn Fell
Dissertation: The impact of the Polyphagous Shot Hole Borer on Pecan trees in South Africa.
Supervisor: ZW de Beer
Co-supervisor: BP Hurley

Stefan Ferreira
Dissertation: The role of transketolase and transaldolase in carbon partitioning to lignin in *Arabidopsis thaliana*.
Supervisor: E Mizrachi
Co-supervisors: AA Myburg, VJ Maloney

Alicia Fick
Dissertation: Identification and expression analysis of putative NLR genes in avocado, *Persea americana*, during infection by the oomycete, *Phytophthora Cinnamomi*.
Supervisor: N van den Berg
Co-supervisor: V Swart

Juanita Hanneman
Thesis: Analyses of the in vitro effects of phosphite on *Phytophthora cinnamomi* isolates.
Supervisor: N van den Berg
Co-supervisors: SA Prabhu, J Engelbrecht

Stephan Henning
Thesis: Genome-wide diversity assessment for genetic resource management of *Eucalyptus dunnii*, *E. grandis*, *E. nitens* and *E. urophylla*.
Supervisor: AA Myburg
Co-supervisor: NA van der Merwe

Granny Hlongwane*
Dissertation: Identification and population genetic studies on *Ceratocystis* spp. infecting *Eucalyptus* and *Acacia* plantations in South Africa and Indonesia.
Supervisor: I Barnes
Co-supervisors: MJ Wingfield, J Roux (SAPPI)

Robert Jansen van Vuuren*
Dissertation: The role of the kauralexin biosynthetic pathway in maize defences against the fall armyworm, *Spodoptera frugiperda* (J.E. Smith) (Lepidoptera, Noctuidae).
Supervisor: DK Berger
Co-supervisors: K Krüger, NM Creux

Lomile Khoete*
Thesis: Population genetic tools for *Gonipterus* sp. 2 and its egg parasitoid *Anaphes nitens*.
Supervisor: MPA Coetzee
Co-supervisors: I Barnes, BP Hurley, B Slippers, ML Schröder

Leandri Klynsmith*
Dissertation: Functional characterisation of *Sirex noctilio* chemosensation genes.
Supervisor: B Slippers
Co-supervisors: JD Allison, TA Duong, A Postma Smidt

Rosa Knoppersen
Dissertation: The bacterial diversity associated with the gut of *Gonipterus* sp.n.2 fed on two different *Eucalyptus* hosts.
Supervisor: A Hammerbacher
Co-supervisor: TA Coutinho

Christopher Liakos*
Dissertation: Bacterial microbiome of healthy and diseased storage onion bulbs from Washington State, USA.
Supervisors: TA Coutinho
Co-supervisors: JE van der Waals, PH Bixirao Neto Marinho Lebre

Anneri Lotter*
Dissertation: Haplotype-resolved genome assembly of an F1 hybrid of *Eucalyptus urophylla* x *E. grandis*.
Supervisor: AA Myburg
Co-supervisors: E Mizrachi, TA Duong, JL Wegrzyn (University of Connecticut, United States of America)

Mabodiba Maake*
Dissertation: Diversity of *Bradyrhizobium* and *Mesorhizobium* strains associated with root nodules of indigenous South African legumes.
Supervisor: SN Venter
Co-supervisor: ET Steenkamp

Pozisa Majaja
Thesis: *Fusarium* species diversity from maize and teff in the northern Free State.
Supervisor: NA van der Merwe
Co-supervisor: N Yilmaz

Sophie Makua
Dissertation: The immune response of *Sirex noctilio* to pathogen infection.
Supervisor: B Slippers
Co-supervisors: MPA Coetzee, A Postma Smidt

Modjadji Makwela
Dissertation: The diversity of fungi associated with endemic and endangered orchids of Southern Africa.
Supervisor: A Hammerbacher
Co-supervisors: MPA Coetzee, BD Wingfield, T Bose

Aaron Maringa*
Dissertation: Investigating the adhesion of encysted zoospores of the oomycete *Phytophthora cinnamomi* during the early infection of avocado.
Supervisor: N van den Berg
Co-supervisor: V Swart

Trystan Nadasen*
Dissertation: Transient expression of two *Cercospora zeina* fungal effectors in *Nicotiana benthamiana*.
Supervisor: DK Berger
Co-supervisor: I Hein

Nganea Nangammbi
Dissertation: Functional testing of xylan-associated genes in *Arabidopsis* and application of CRISPR/Cas9 gene editing in hybrid poplar trees.
Supervisor: VJ Maloney
Co-supervisors: E Mizrachi, AA Myburg

Celiwe Nxumalo
Dissertation: Functional characterization of *Phytophthora parasitica* PpRxLR1 and PpRxLR6 effectors in *Nicotiana benthamiana*.
Supervisor: LN Moleleki

Siphephelo Phungula
Dissertation: Environmental determinants of the abundance of the fall armyworm, *Spodoptera frugiperda* (J.E. Smith) (Lepidoptera: Noctuidae).
Supervisor: CW Weldon
Co-supervisor: K Krüger

Cindy Ramokgano
Dissertation: Diversity of endophytic fungi associated with branches of *Berchemia discolor* in the Limpopo province of South Africa.
Supervisor: MPA Coetzee
Co-supervisor: ET Steenkamp

Doreen Raseala*
Dissertation: Abandoned homestead gardens as a source of plant invasions in rural South Africa.
Supervisor: M Greve
Co-supervisor: PC le Roux

Emeldah Rikhotso
Dissertation: Leaf pathogens of *Eucalyptus* in South Africa with particular reference to *Teratosphaeria destructans*.
Supervisor: J Roux
Co-supervisors: A Hammerbacher, SD Fraser, I Greyling

Cassandra Schoeman*
Dissertation: The *Encephalartos natalensis*-cyanobacterial coralloid root partnership for nitrogen acquisition.
Supervisor: E Mizrachi
Co-supervisors: TP Makhalanyane, D Roodt

Nhlanhla Shabangu
Dissertation: Effect of long-term inorganic fertilizer combinations on weed abundance and diversity in maize.
Supervisor: D Marais
Co-supervisor: BJ Vorster

Byron Sonnekus
Dissertation: Diversity of stink bugs (Pentatomidae) and associated egg parasitoids in Macadamia orchards in South Africa.
Supervisor: G Fourie
Co-supervisors: BP Hurley, B Slippers, E Joubert (Levubu Centre for Excellence)

Medha Sood*
Dissertation: Structure-function relationship between plastid morphology and carbon partitioning during secondary cell wall synthesis in *Arabidopsis thaliana*.
Supervisor: E Mizrachi
Co-supervisors: V van Staden, VJ Maloney, DS Pinard

Shae Swanepoel*
Dissertation: The molecular dialogue between *Eucalyptus grandis* and the myrtle rust pathogen, *Austropuccinia psidii*.
Supervisor: S Naidoo
External co-supervisor: LS Shuey (Department of Agriculture and Fisheries, Australia)

Dr Zorada Swart*
Dissertation: Characterisation of *Deladenus siricidicola* genes potentially involved in parasitism and host immunomodulation.
Supervisor: B Slippers
Co-supervisors: BD Wingfield, TA Duong, A Postma Smidt

Garyn Townsend
Thesis: Initial assessment of the Polyphagous Shot Hole Borer (PSHB) in indigenous afrotemperate forests.
Supervisor: ZW de Beer
External co-supervisors: MP Hill (Rhodes University), F Roets (Stellenbosch University)

Lenteli van Zyl*
Dissertation: Production of defensive metabolites by *Pinus patula* x *Pinus tecunumanii* hybrids in response to *Fusarium circinatum* infection.
Supervisor: A Hammerbacher
Co-supervisors: ET Steenkamp, FF Fru

Raven Wienk*
Dissertation: Genetic structure analysis and the assessment of susceptibility to *Fusarium euwallaceae* of popular avocado cultivars.
Supervisor: N van den Berg
Co-supervisor: MM Mostert
External co-supervisor: NS Abeysekara (Dominican University of California, United States of America)

Shannon Wilson
Thesis: Systemic defence responses induced by *Chrysoporthe austroafricana* in *Eucalyptus grandis*.
Supervisor: S Naidoo
External co-supervisor: LS Shuey (Department of Agriculture and Fisheries, Australia)

HONOURS

Ms. Susanna Anbu (2022)
Ms. Michaela Badenhhorst (2022)
Ms. Michelle Bekker (2022)
Mr Yuvaan Bhimsan (2022)
Ms Carien Carpenter (2022)
Mr Johan Cilliers (2022)
Ms. Cerista de Meulenaere
Mr Taygen Fuchs (2022)
Ms. Sarina Gouden (2022)
Mr Christiaan Grobler (2022)
Mr Aaron Harvey (2022)
Mr Joshua Joffee (2022)
Mr Jason McNeil (2022)
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Ms. Chrizanne Smit (2021)
Ms. Chanel Thomas (2021)
Ms. Alida van Dijk (2021)
Ms. Kerr-Anne van Gaalen (2021)
Ms. Melandre van Lil (2021)

INTERNS

Ms. Shonese Bloy (2022-2023)
Mr Siyabonga Magagula (2022-2023)
Ms. Khukhwane Malatji (2022-2023)
Ms. Kholosa Maqolo (2022-2023)
Mr Lawrence Mathaha (2022-2023)
Ms. Kholiwe Mbanyane (2022-2023)
Ms. Sphumelele Mkhize (2022-2023)
Ms. Sithabile Mtungwa (2022-2023)
Ms. Makhosazana Ngema (2022-2023)
Mr Refiloe Sekalo (2022-2023)
Ms. Amy Collop (2021-2022)
Ms. Phozisa Dlokweni (2021-2022)
Mr Harris Keetse (2021-2022)
Ms. Jabulile Mahlangu (2021-2022)
Mr Kgetise Malele (2021-2022)
Mr Welapie Maluleki (2021-2022)
Ms. Thembeka Mkize (2021-2022)
Ms. Sindiso Mtshubungu (2021-2022
Ms. Anza Muthabi (2021-2022)
Mr Kekgotswe Nakana (2021-2022)
Mr Lungani Nkosi (2021-2022)

VISITORS AND SEMINARS

FABI VISITORS

Prof. Jolanda Roux, Sappi
May 2021

Jonathan Trussler, Interim Director SA Kiwi Growers Association
Frans Louw, SA Kiwi Growers Association
Ross Lowe, SA Kiwi Growers Association
Bruce Cook, SA Kiwi Growers Association
Mike Hulley, SA Kiwi Growers Association
June 2021

Nine delegates from the Lesotho Department of Agricultural Research
October 2021

Dr Carol Nonkwelo, Senior Director: Research, Innovation & Postgraduate Education, Department of Research and Innovation, University of Pretoria
January 2022

Adêla Čmoková, Czech Academy of Sciences
Sona Kajzrova, Czech Academy of Sciences
Michaela Švarcová, Czech Academy of Sciences
Karel Švec, Czech Academy of Sciences
March 2022

Mr Rudolf Nieuwenhuis, Cropwatch Africa
March 2022

Prof. James Nsoso, Acting Vice Chancellor, Botswana University of Agriculture and Natural Resources (BUAN)
Prof. Samodimo Ngwako, Dean: Faculty of Research and Graduate Studies, Botswana University of Agriculture and Natural Resources (BUAN)
April 2022

Kherina Narotam, Chairperson, Up&Out, University of Pretoria
Saturn Palavar, Secretary, Up&Out, University of Pretoria
Rayne Boardman, Up&Out, University of Pretoria
Kate Montieth, Up&Out, University of Pretoria
Cameron Rodrigues, Up&Out, University of Pretoria
April 2022

Flora Asibe, IITA, Nigeria
April 2022

Dr Agena Tanga, Ethiopian Environment and Forestry Research Institute (EEFRI)
Kumela Regasa, Ethiopian Environment and Forestry Research Institute (EEFRI)
Weldesenbet Beze, Ethiopian Environment and Forestry Research Institute (EEFRI)
May 2022

Dr Carlos Rodas, Smurfit-Kappa, Colombia
May 2022

Mr Danny Knoesen, General Manager, NCT Forestry Co-operative Ltd., South Africa
May 2022

Prof. Caterina Villari, Warnell School of Forestry & Natural Resources, University of Georgia, USA
May 2022

Prof. Wouter Maes, University of Ghent, Belgium
May 2022

Dr Yu Pang, Embassy of the People's Republic of China, South Africa
June 2022

Duke Seloane Nkadimeng, Deputy Director: Bilateral Relations, Department of Science and Innovation, South Africa
June 2022

Prof. Sophien Kamoun, The Sainsbury Laboratory, University of Est Anglia, United Kingdom
August 2022

Prof. Paul Birch, James Hutton Institute, United Kingdom
August 2022

Prof. Naresh Magan, Cranfield University, United Kingdom
August 2022

Prof. Eva Stukenbrock, Max Planck Institute for Evolutionary Biology, Germany
August 2022

Prof. Pedro Crous, Westerdijk Fungal Biodiveristy Institute, the Netherlands
Marjan Vermaas, Westerdijk Fungal Biodiveristy Institute, the Netherlands
Hazal Kandemir, Westerdijk Fungal Biodiveristy Institute, the Netherlands
Marileide Moreira Costa, Westerdijk Fungal Biodiveristy Institute, the Netherlands
Lin Zhao, Westerdijk Fungal Biodiveristy Institute, the Netherlands
Duong Vu, Westerdijk Fungal Biodiveristy Institute, the Netherlands
August 2022

Dr Brett Summerell, Chief Scientist and Director of Research at the Royal Botanic Garden Sydney, Australia
October 2022

Prof. Diana Six, Department of Ecosystem and Conservation Sciences, University of Montana
November 2022

Ivan Appel, Arauco, Chile
Dr Claudio Balocchi, Arauco, Chile
José Ordoñez, Arauco, Chile
November 2022

USA NATIONAL SCIENCE FOUNDATION (NSF) WORKSHOP VISITORS (NOVEMBER 2022)

Prof. Steve Brewer, University of Mississippi, USA
Prof. Jason Hoeksema, University of Mississippi, USA
Prof. Rytas Vilgalys, Duke University, USA
Dr Milton Drott, United States Department of Agriculture, USA
Dr Martin Nuñez, University of Houston, USA
Dr Natalia Vargas, Estupiñan Los Andes University, Colombia
Dr YenWen Wang, Yale University, USA
Brooke Allen, University of Mississippi, USA
Christopher Bivins, Univercity of California, Merced, USA
Corbin Bryan, University of Wisconsin-Madison, USA
Jahiya Clark, University of Massachusetts, Amherst, USA
Lauren Corby, Jackson State University, USA
Savanna Fuqua, University of Arizona, USA
Grant Nickles, University of Wisconsin-Madison, USA
Cecilia Stokes, University of Wisconsin-Madison, USA
Jasmine Wallace, Mississippi Valley State University, USA
Taylor Zallek, University of Pittsburgh, USA

OTHER VISITS

Dr Malte Ebinghaus, CIEFAP - Centro de Investigación y Extensión Forestal Andino Patagónico, Argentina
January – research visit
April 2023

Miriam Schalamun, Austrian Institute of Technology, Austria – research visit
February-March 2023

Dr Srikumar Koda Kkadan, Asia Pacific Resources International Holdings Ltd., Indonesia
Ms. Nike Sinulingga, Asia Pacific Resources International Holdings Ltd., Indonesia
April 2023

Dr Dan Jacobson, Chief Scientist for Computational Systems Biology at the Oak Ridge National Laboratory, USA
March 2023

Prof. Anne Pringle, University of Wisconsin-Madison, USA – sabbatical visit
May 2022–May 2023

David Johnson, University of Wisconsin-Madison, USA– sabbatical visit
May 2022–May 2023

Murilo Fonseca Ribeiro, PhD candidate from São Paolo State University, Brazil – study visit
September 2021–August 2022

FABI SPECIAL SEMINARS

Prof. Mike Wingfield
Title: The biology and beauty of unusual arthropod-associated fungi inhabiting ancient flowers at the tip of Africa – World Fungi Day/United Kingdom Arboricultural Association.
October 2021

Prof. Wouter Maes
Title: Thermal remote sensing for plant-water relations and stress detection in agriculture and ecology.
Dr René Heim
Title: Estimating leaf area index and chlorophyll using multi-angular UAV observations and radiative transfer modelling.
December 2021

Dr Brett Summerell
Title: An integrated approach to protecting and conserving plants against the impact of invasive diseases in Australia.
October 2022

Hannelie Coetzee, Tracy Megan and Tarryn Millar
Title: The intersections between science and art.
October 2022

Dr Dan Jacobs
Title: Crises abound: Health, climate, energy, food, pandemics.... How supercomputing, AI, and large scale systems biology can help address the major challenges we are facing.
March 2023

Prof. Diana Six
Title: SciArt: what, why, and how?
November 2022

FABI INTERNATIONAL SEMINAR SERIES

Prof. Jonathan Gershenzon, Max Planck Institute for Chemical Ecology, Germany
Title: Tree texts: How Poplars communicate with friends and foes using volatile organic compounds.
May 2021

Prof. David Hibbett, Clark University, USA
Title: Phylogenomics of *Lentinula* and the origin of cultivated shiitake mushrooms.
July 2021

Prof. Anne Pringle, University of Wisconsin-Madison, USA
Title: The problem of invasive mycorrhizal fungi.
July 2021

Prof. Arunaloke Chakrabarti, Institute of Medical Education and Research, Chandigarh, India
Title: Mucormycosis in India.
August 2021

Dr Damon L. Smith, University of Wisconsin-Madison, USA (in partnership with Grain SA)
Title: Using research-based solutions for managing Sclerotinia stem rot of Soybean.
September 2021

Dr Charissa de Bekker, University of Central Florida, USA
Title: "What makes a zombie ant tick?
October 2021

Dr Nicolas Langlade, INRAE (National Research Institute for Agriculture, Food and Environment), France
Title: Multi-scale modelling to predict and understand sunflower tolerance to abiotic stresses and uses of high-throughput phenotyping.
November 2021

Dr Alistair McTaggart, University of Queensland, Australia
Title: Rust, sex, magic.
February 2023

Dr Jonàs Oliva, University of Lleida, Spain
Title: Functional ecology of forest disease.
March 2022

Dr Svetlana Y. Folimonova, University of Florida, USA
Title: Understanding cross-protection by *Citrus tristeza virus*: our quest for the answer to a century-old question.
April 2022

Dr Claudia Coleine, University of Tuscia, Italy
Title: Microbiomes from extreme environments: challenges to thrive in the most prohibitive conditions.
May 2022

Prof. Keith Seifert, Carleton University, USA
Title: In the right place at the right time: Three "microfungi" that changed the world.
June 2022

Dr Malia Gehan, Donald Danforth Plant Science Centre, USA
Title: Open Challenges in Plant Phenotyping with PlantCV.
July 2022

Dr Stephen Taerum, Connecticut Agricultural Experiment Station, USA
Title: Exploring protist diversity and interactions in the phytobiome.
August 2022

Dr Melvin Bolton, United States Department of Agriculture
Title: Shedding light on a sugar beet pathogen's dark secrets – the role of secondary metabolite effectors and CbNip1 in *Cercosporabeticola* pathology.
September 2022

Dr Eleonora Egidi, Western Sydney University, Australia
Title: Exploring the Australian microbiome: from diversity to functions.
October 2022

Dr Cyril Zipfel, University of Zurich, Switzerland
Title: Identification and use of plant cell-surface immune receptors to improve broad-spectrum disease resistance in crops.
November 2022

Dr João Araújo, New York Botanical Garden, USA
Title: The biology behind the "Zombie-Ant Fungus" phenomenon.
March 2023

SOUTHERN AFRICAN SOCIETY FOR SYSTEMATIC BIOLOGY (SASSB) WEBINAR SERIES (IN PARTNERSHIP WITH FABI)

June 2021
Dr Seraina Klopfstein, University of Bern, Switzerland
Title: Calibrating molecular trees with fossils/ Hymenopteran phylogenetics.
Prof. Martin Coetzee, University of Pretoria (FABI)
Title: Molecular dating through secondary calibration as a tool to infer the dispersal mechanisms responsible for the biogeography of extant fungi.
Terry Reynolds Berry, Iziko Museums of South Africa
Title: A phylogenetic assessment of parasitoid wasps (Ichneumonidae; Banchinae) in the Afrotropical region using total evidence.

July 2021
Joint session with FABI International Seminar Series
Dr David Hibbett, Clark University, USA
Title: Phylogenomics of *Lentinula* and the origin of cultivated shiitake mushrooms.
Dr Wilma Nel, University of Pretoria (FABI)
Title: Phylogenomic analyses resolve taxonomic ambiguity for two genera in the Ophiostomatales.
Aiden Visagie, University of Stellenbosch
Title: Isolation and identification of *Penicillium* from wheat growing agricultural soils.

August 2021
Dr Sandra Knapp, Natural History Museum, London, United Kingdom
Title: Solanaceae – more than potatoes and tomatoes
Bianca Ferreira, University of the Witwatersrand
Title: Morphometric and molecular analysis of the *Senecio achilleifolius* complex (Senecioneae, Asteraceae) in South Africa.
Frederik Becker, Stellenbosch University
Title: The Gigas Effect: A reliable predictor of ploidy? Case studies in *Oxalis*.

September 2021
Dr Isabel Sanmartin, Madrid Botanical Gardens, Spain
Title: The Rand Flora revisited: New approaches for bridging the micro and macro-evolutionary levels in biogeography and evolution.
Joanne Bentley, African Climate Development Initiative (ACDI), University of Cape Town
Title: Lineage origin, historical migration patterns, and the contributions of geographic proximity and ecological filtering to dispersal in an African-centred paper daisy lineage.
Seth Musker, University of Bayreuth, Germany
Title: The genomics of dynamic diversification on a continental archipelago: the case of *Erica abietina* from the Cape Floristic Region: Or 'What to call the things that I'm calling things'.

October 2021
Dr Donat Agosti, Plazi, Bern, Switzerland
Title: Plazi: unlocking the scientific literature related to biodiversity.
Thembile Khoza, Zoological Research, SANBI Foundational Research and Services
Title: Compiling and dissemination of the Animal Checklist for South African species
Ronell Klopper, Botanical Research, SANBI Foundational Research and Services
Title: The South African National Plant Checklist and e-Flora of South Africa projects.

November 2021
Dr Philippe Lemey, Rega Institute at KU Leuven, Belgium
Title: Evolutionary origins of SARS-CoV-2 and tracking its spread using phylodynamic data integration.

April 2022
Prof. Jonah Choiniere, Evolutionary Studies Institute, University of the Witwatersrand
Title: Dinosaurs of darkness: how owl-like senses independently evolved in the ancestors of birds.
Dr Viktor J. Radermacher, University of the Witwatersrand
Title: A new *Heterodontosaurus* specimen elucidates the unique ventilatory macroevolution of ornithischian dinosaurs.

May 2022
Dr Luis M. Rodriguez-R, Department of Microbiology and Digital Science Center (DiSC) University of Innsbruck, Austria
Title: Indexing the genomic diversity of Archaea and Bacteria with MiGA, the Microbial Genomes Atlas.
Catherine Brink, University of Pretoria
Title: Genetic structure and diversity of a *Salinibacter ruber* population.
Diego Castillo, University of Pretoria
Title: Genome resolved metagenomics reveals widespread microbial chemolithoautotrophic potential in the Southern Ocean.

June 2022
Prof. Vinita Gowda, Tropical Ecology and Evolution Lab (TrEE lab), Indian Institute of Science Education and Research (IISER), India
Title: Understanding generation, evolution and maintenance of plant biodiversity in India.

November 2022
Dr Marike Palmer, School of Life Sciences, University of Nevada Las Vegas, Las Vegas, NV, USA
Title: SeqCode: Empowering prokaryotic taxonomists to use resources that are appropriate for naming the organisms they study.

Baobab of dream
Nam Pham

Baobab of dream
nurtured by the soil of
imagination
and underground flows of
inspiration
Resilient, strong, and tall
Standing proud
Overcoming challenges
Embracing life.

The Baobab tree is regarded as a symbol of resilience and longevity. This art piece was made of 100% biodegradable/ recyclable materials.

COMMUNITY INITIATIVES AND ENGAGEMENT

Translating Plant Health Information into South African Languages

In October 2021, FABI staff and student members, Ms. Thembeka Mkhize (intern), Ms. Jane Ramaswe (PhD candidate), Ms. Nombulelo Qikani (MSc student) and Ms Amy Collop (Technical Assistant: Biological Control) took part in translating plant health information into South African languages. This initiative aimed to make information about the 'Importance of plant health', 'Understanding the cause of a plants sickness' and 'How to send a sample to the FABI diagnostic clinic' accessible to smallholder grain farmers in South Africa in their own languages. The project also formed part of a greater effort to bring 4IR plant health management technologies to smallholder grain farmers to help increase productivity and competitiveness of a farming community that is poised to play a crucial role in food security. The information translation project, and other projects, were powered by an alliance with various partners of FABI and Innovation Africa @UP, including Grain SA, Cropwatch Africa, Social Coding SA and funding from the Department of Science and Innovation, UNICEF and Future Africa. The translation initiative was initiated in acknowledgement that (promotional) communication materials are needed in languages that will engage the smallholder grain farmers, and that will connect them with the FABI Diagnostic clinic via the Innovation Africa @UP digital platform. The material was initially being translated in isiZulu, sePedi, isiXhosa and Afrikaans.

Celebrating Mandela Day with Community Service

In celebration of Mandela Day in 2022, a large group of FABIans used their 67 minutes of community service to collect litter around the perimeter of the University of Pretoria's Hatfield campus. Another example of a Mandela Day activity was where FABI PhD candidate Vaylen Hlaka spent her 67 minutes at the Blessing Day Care Centre to volunteer and donate second hand children's clothes to this centre for low income families located in Sunnyside in Pretoria.

"There can be no greater gift than that of giving one's time and energy to helping others without expecting anything in return." – Nelson Mandela.

Seed Packing for the National Maize Cultivar Evaluation Trials

FABIans are now actively involved in doing the season's seed packing as part of the annual National Maize Cultivar Evaluation Trials that is organised by SANSOR and Grain SA. This trial provides maize seeds from various seed companies to be distributed to diverse agro-ecological regions within South Africa. The National Maize Cultivar Evaluation Trials takes place in eight regions and about 90 agro-ecological localities across the country. The goal of the trial is to evaluate the performance and adaptability of different maize cultivars for comparison against cultivars currently on the market. FABI has completed this task for the past three seasons, and although it usually takes a week to complete, the excellent teamwork and dedication from all involved enabled them to complete the task in far less time.

PSHB App training with Johannesburg City Parks and Zoo (JCPZ)

One of the greatest costs of Polyphagous Shot Hole Borer (PSHB) invasion is the loss of trees in the urban environment. There is particular concern about the impact that PSHB will have on Johannesburg's urban forest. Johannesburg City Parks and Zoo (JCPZ) have engaged FABI in a project to generate and provide scientific data on the PHSB outbreak in the City. In June 2022, FABI Research Fellow Dr Trudy Paap and Extension Officer, Shawn Fell joined JCPZ staff at the Johannesburg Botanical Gardens to conduct a training session on PSHB monitoring. Cropwatch Africa has developed a PSHB monitoring project on the Biosecurity Africa mobile application platform. JCPZ staff will now be able to use the app to track the spread and impact of PSHB in the City.

The app ensures consistency in data collection, and is already being used to monitor PSHB outbreaks in Pretoria and the Western Cape. Having all the data in a centralised platform provides a powerful tool, enabling data to be analysed for research or shared with key stakeholders.

FABI partners with Durban University of Technology to Enhance PSHB Monitoring

It has now been over five years since the Polyphagous Shot Hole Borer (PSHB), and its fungal symbiont were first detected in the KwaZulu-Natal National Botanical Garden (KZN NBG) through the South African National Biodiversity Institute (SANBI)-funded Sentinel Plant Project. As part of the Sentinel Plant Project, Dr Mesfin Gossa, in collaboration with Mpho Mathalauga, a horticulturist at the KZN NBG set up a PSHB monitoring system for the London plane trees. The level of PSHB infestation will be quantified on randomly selected trees and the status of tree health, particularly of the crown, will be monitored over time. Data obtained from the monitoring system aids in understanding the long-term effects of PSHB infestation on London plane trees and in the planning of successional planting. Dr Gossa, along with Dr Trudy Paap have subsequently established a collaboration partnership with the Department of Horticulture at Durban University of Technology (DUT) to train students through the SANBI Sentinel Plant Project. In May 2021, they hosted a three-day training workshop on plant health in collaboration with Ms. Indrani Govender and Dr Mark Maistry from DUT. Following the workshop, three student projects, with a focus on monitoring PSHB infestation in Durban Botanic Gardens (DBG), Zimbali Coastal Estate and Amanzimnyama Garden (a private garden in Tongaat) were identified. The students are supervised by Ms. Govender, a lecturer at DUT and technically supported by Drs Gossa and Paap.

FABI Hosts Inaugural Biosecurity Hub Steering Committee Meeting

On 22 July 2022, the inaugural meeting of the Biosecurity Hub Steering Committee hosted by the University of Pretoria's Innovation Africa @UP was held at the Future Africa Campus. Members from the Department of Science and Innovation (DSI), Department of Agriculture, Land Reform and Rural Development (DALRRD) and the Agricultural Research Council (ARC) were among those in attendance. The National Biosecurity Hub is a platform established between DALRRD, the Department of Science and Innovation (DSI) and Innovation Africa @ University of Pretoria. The Hub is part of revitalising the agricultural sector through research, development and innovation, a key requirement of both the White Paper on Science Technology and Innovation (2019/2020) and the STI Decadal Plan 2021-2031. The steering committee's role is to collectively shape and form the face of the Biosecurity Hub towards synergistic and joint efforts on both plant and animal health biosecurity.

Univen Student Visit to FABI

FABI hosted a visit by a group of 23 final-year BSc in Agriculture (Plant Production and Horticulture) students from the University of Venda on 4 October 2022. The group was led by the Head of the Department Plant and Soil Sciences, Prof. Godwin Mchau, along with Dr Odeshnee Naicker (Senior lecturer - Plant pathology), Ms. Terry Leboho (Laboratory technician – Plant production), and Ms. Mashudu Makhado (Horticultural science). FABI, through the DSI-NRF Centre of Excellence in Plant Health Biotechnology (CPHB), has had a long association with the University of Venda through joint research projects and student exchanges. The group were welcomed by the Director of the CPHB, Prof. Emma Steenkamp and Program Manager, Prof. Martin Coetzee. Ms. Benedicta Swalarsk-Parry, a PhD student linked to the CPHB, gave an inspiring talk during which she shared her views on being a postgraduate student and how to be successful in life. The group was then taken on a tour of the Institute's labs and facilities, including the culture collection lab, diagnostic clinic, as well as the sequencing facility. As a final stop at FABI, Dr Thabiso Motaung discussed his research on biofilms with the group and demonstrated some of the methods he used in the laboratory for his research. The group spent the morning at FABI before moving to the Future Africa campus on the University of Pretoria's Innovation Africa @UP campus, where Dr Osmond Mlonyeni spoke to the group about his personal journey from being a young first-year university student to completing his PhD degree in FABI to becoming a Project Manager at Innovation Africa @UP. His talk demonstrated how success was not achieved without hard work and dedication. The student's visit concluded with a visit to the FABI Biocontrol Centre where they were informed about how research conducted in FABI is being applied in biocontrol projects in the forestry and agricultural industries.

Biosecurity Best Practice Workshop

FABI researchers, Dr Trudy Paap and Dr Felipe Balocchi, joined members of SANBI's Horticultural Enrichment Forum (HEF) to host a Biosecurity Best Practice workshop at Kirstenbosch National Botanical Garden (NBG). Since 2016, FABI researchers have been engaging with SANBI NBGs through the Sentinel Plant Project to improve knowledge of plant health threats. The team have worked together to develop a guide to biosecurity best practice for living plant collections in South Africa, to assist in protecting the country's plants from the introduction and spread of harmful organisms. The Royal Botanic Garden Sydney's Chief Scientist and Director of Research, Dr Brett Summerell, joined the team for the two-day workshop (25-26 October 2022), attended by staff from seven SANBI NBGs. Participants included garden managers, estate managers, horticulturists, interpretation officers, interns and scholars. The group received an overview of pest and pathogen issues detected in the SANBI NBGs, as well as a series of presentations detailing aspects of biosecurity including pathways of pest introduction and spread, garden and nursery cultural best practices, quarantine procedures and integrated pest management. Throughout the workshop, garden and nursery walkthroughs encouraged further engagement and discussion among the participants. The workshop was the first in a series of activities to promote the uptake of the biosecurity best practice among SANBI NBG staff.

The FABI Tree House

On 20 October 2021, FABI launched a new project called the TREE House (Trust, Respect, Equality, Engagement). This initiative aims to create a safe space for all FABIans to discuss social issues and to make FABI a more inclusive place. The TREE House meets monthly and welcomes all FABIans in any capacity, from students and research fellows to staff and research leaders. Dr Joséphine Queffelec moderated the sessions with the help of Social Club leader, Leandri Klynsmith. The first meeting of the TREE House focused on creating a social agreement for the group to guarantee that all participants feel safe and heard. Topics dealt with since it establishment included Neurodivergence and neurodiversity in the workplace, pronouns, and a visit by members of the University of Pretoria's Up&Out group was hosted.

PROFESSIONAL DEVELOPMENT AND TRAINING

Population Genomics Workshop

Professor Eva Stukenbrock from the Max Planck Institute for Evolutionary Biology, Plön, and the Christian-Albrechts University of Kiel, Germany presented a workshop on Population Genomics at FABI prior to the 52nd Congress of the Southern African Society for Plant Pathology (SASPP) - SASPP2022 in August 2022. Prof. Stukenbrock illustrated key advances in the field using examples from her ground-breaking work on the *Zymoseptoria* complex of fungi which causes major yield losses to wheat. More than 30 participants attended the workshop which was co-ordinated by Prof. Dave Berger of the MPPI research group. Attendees included SASPP congress delegates, members of FABI, three Departments at the University of Pretoria, the University of KwaZulu-Natal, and the University of the Free State. Each participant had an opportunity to present their research questions and experimental design of their projects, which covered populations of diverse organisms – crops, trees, insects, parasites, fungi, oomycetes, and bacteria. Prof. Stukenbrock gave insights into each project, and during the workshop covered the latest trends in population genetics and genomics studies; how to pose a good research question in the field; experimental design; tracing the evolution of organisms using genome data; and common pitfalls in the field.

Photoshop Course

A group 20 FABIans attended a two-day Photoshop workshop from 16-17 August 2022. The course was organised by Prof. Cobus Visagie and presented by Marjan Vermaas of the Westerdijk Fungal Biodiversity Institute (WI). Her visit formed part of the MSCA-Research and Innovation Staff Exchange project. The course focused on

professionally preparing photo plates for publication in journals and provided an introduction to optimally using this complex software. The course included several hands-on practical exercises that allowed participants to apply what they learned from Marjan's coursework.

FABI Hosts NSF-Sponsored "Research Experience for Students" Symposium

After two years of delay due to the SARS CoViD-2 pandemic, FABI welcomed a large group of USA graduate students and academics to participate in a USA National Science Foundation (NSF)-funded symposium, focused on fungal biological invasions. The symposium, as part of the NSF IRES (International Research Experience for Students) programme, ran for 20 days and included 10 USA graduate students paired with 10 FABI graduate students, together with 14 faculty instructors from various countries and institutions, including FABI. The extensive (and intensive) programme, running from 1-20 November 2022, commenced with two days of lectures on invasion biology at Berg-en-Dal in the Kruger National Park. This was followed by two days of visits to plantations, hosted by York Timber Company in the Sabie area, providing opportunities to collect mycorrhizal samples and to gain exposure to the South African forestry industry. The programme for the symposium, planned over a period of more than a year, was formulated to expose students to a broad range of tools and experiences relating to the study of invasive fungi and biological invasions in general. On their return to the University of Pretoria they underwent training in microscopy techniques for visualising morphology of ectomycorrhizal and arbuscular mycorrhizal structures in plant roots. The students learned to recognise and describe ectomycorrhizal morphotypes under stereo microscope, to section and stain roots for visualising defining characteristics of ectomycorrhiza, to sample ectomycorrhizal root tips for PCR and Sanger sequencing, and to clear and stain roots for visualising arbuscular mycorrhizal fungi. The students used these techniques to compare mycorrhizal fungi among pine roots sampled from multiple contexts, including seedlings regenerating in plantations and donated from York Timbers, as well as roots of eucalypts and *Acacia* sampled in the field. The microscopy course was followed by training in methods used to investigate biological and evolutionary questions based on whole genome sequence data. This part of their training involved hands-on experience using bioinformatic tools to assemble and annotate fungal genomes, conducting phylogenomic studies and characterising genes involved in secondary metabolite production. As a final part of the symposium, the students, with the aid of faculty instructors, prepared their results for a joint publication in a scientific journal.

Mentorship Programme Resumes

Twelve undergraduate students are gaining hands-on experience in research laboratories as mentees in the CPHB Mentorship programme for 2023. The DSI-NRF Centre of Excellence in Plant Health Biotechnology (CPHB) has run the Mentorship programme since 2005 with a focus on preparing undergraduate students to pursue postgraduate studies while also exposing these students to Plant Health. This is the first year since the COVID-19 pandemic that the programme has welcomed new mentees. The new mentees are: Freddie Botha, Celia Coetzee, Matthew Cosser, Levern Cronje, Natalie Kapsosideris, Bianke Marx, JJ Nelson, Annabel Norval, Michané Reutener, Tolu Soogun, Lizaan Taljaard and Kiara van Eck.

Biosecurity App Training by CropWatch Africa

On 24 March 2022, postgraduate students, postdoctoral Fellows and staff from FABI, and an undergraduate class that focus on the management of pests, diseases and weeds, had the opportunity to gain from the experience of Roedolf Nieuwenhuis of Cropwatch Africa. In the morning Roedolf demonstrated the use of the Biosecurity Africa app and online platform for pest and disease surveillance. This platform is used by Cropwatch Africa for its pest and disease surveillance for government, industries and research in agriculture and forestry. FABI students and staff are also increasingly using the platform for extension, field work and research data capturing – from PSHB work in cities, to forestry field work, maize disease image capturing to Macadamias – and much more. Apart from the powerful visualisation of the data on the Biosecurity Africa app, the information also streams directly to the Information Hub where it can be combined with other data, analysed for research or shared with key stakeholders. The National Maize Lepidoptera Surveillance Program, which runs over six provinces throughout the season, exemplifies the use

of the technology, with data captured on Biosecurity Africa app, and streamed to the Information Hub, from where it is updated on a website daily. In the afternoon, Roedolf gave a lecture to 62 second-year BSc students. His lecture aimed to give the students insights into the practical applications of the theory they had learned about integrated pest management in the PLG 251 course presented by Prof. Almuth Hammerbacher. Roedolf showed the students the importance of pest and disease monitoring for governments, farmers and international certification bodies.

Microsatellite Workshops

Introductory microsatellite workshops developed for students with little to no experience in this technology were presented during the reporting period. The microsatellite 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 were presented during the workshop. The first workshop was presented over two days and was held in March 2012. The workshop is co-ordinated by Ms Renate Zipfel (DNA sequencing centre at UP) and facilitated by research staff from UP and FABI.

SOCIAL EVENTS

Valentine's Day Fun

FABI celebrates Valentine's Day with a fun photo competition where FABIans are encouraged to enter photos depicting Love. In 2022, the competition theme was "We/I Love..." and FABIans were encouraged to submit photos or illustrations depicting what they love about their surroundings, research or science. The entries were shown at the Monday Morning Meeting on 14 February and the winner was selected based on the results of an online poll by the meeting participants. Ginna Granados' "Rust love" photo showing a heart shaped *Austropuccinia psidii* rust growing on *Eugenia capensis* taken in Richards Bay, KZN won the first prize of a box of heart-shaped cookies. Those attending the movie night later that evening were treated to snacks, popcorn and drinks to enjoy while watching a selection of romantic comedies.

SPOOF

The annual meeting of the Epsilon Chapter of the Society for the Presentation of Outrageous Findings (SPOOF) is a highlight of the FABI social calendar when students and staff dress up and enjoy an evening of outrageous science findings. In 2021 the Covid-19 pandemic again, as in 2020, prevented an in-person celebration but FABIans enthusiastically dressed up and celebrated with family and friends at home during a virtual meeting. Witches, wizards, elves, pixies, muggles, mudbloods and all other manner of magical folk and creatures joined in the evening's fun at the Harry Potter-themed FABwarts School of Sci-craft and Wizardry. FABIans signed in from as far afield as China, Indonesia and New Zealand, making 2021's SPOOF a truly international occasion.
Returning to an in-person event once again in 2022, FABIans stepped through the magnifying glass to find themselves in the Alice's (weird and wonderful) Wonderland. It was a wonder-filled evening that became curiouser and curiouser as the clock ticked on...

Jackie Robinson Day Celebrated at FABI

An enthusiastic group of FABIans gathered at the LC de Villiers sports campus on Friday 14 April 2023 to celebrate Jackie Robinson Day. This fun social event was organised by the avid baseball fanatic, David Johnson who was visiting FABI along with his wife, Fulbright Scholar Prof. Anne Pringle. Jackie Robinson Day is a traditional event celebrated annually on April 15 in Major League Baseball (MLB) in the USA, commemorating and honouring the day Jackie Robinson made his major league debut. On that one day, all players, coaches, and managers of both teams, and the umpires at all MLB ballparks, wear Robinson's uniform number, 42. April 15 was Opening Day in 1947,

Robinson's first season in the major leagues. Initiated in 2004, the day celebrates Robinson's memorable career. He is best known for becoming the first black major league baseball player of the modern era in 1947. This was when his debut with the Brooklyn Dodgers ended approximately 80 years of baseball segregation. Robinson was inducted into the Baseball Hall of Fame in 1962. FABIans experienced some typical American culture, being treated to boxes of Cracker Jack, a traditional baseball snack (that David had sent from the USA especially for this event), along with Budweiser beer and with boerewors rolls replacing the traditional hotdogs. David led the group in a sing-along of the baseball anthem, "Take Me Back to the Ballgame", before playing an informal game of baseball. There was also a screening at Future Africa the following day of the movie '42', a biographical film about Robinson's life. David had earlier in the year presented a seminar at the FABI Monday Morning Meeting about Jackie Robinson's career after seeing the number 42 on a "cube" right outside his office in FABI 2 – this being Jackie Robinson's uniform number.

Book Fun at FABI

As the December holiday season draws closer each year, FABIans look forward to taking time off from their research activities to recharge their batteries before the new year. Reading is a popular pastime of many, and the Monday Morning Meeting 'Book Fun' at the last Monday Morning Meeting of the year has become a tradition in the Institute. FABIans can then share with their peers the books they enjoyed reading or those that impacted them and perhaps inspire others to read these books. This annual list of 'recommended reads', is a varied selection that will definitely cater for all tastes.

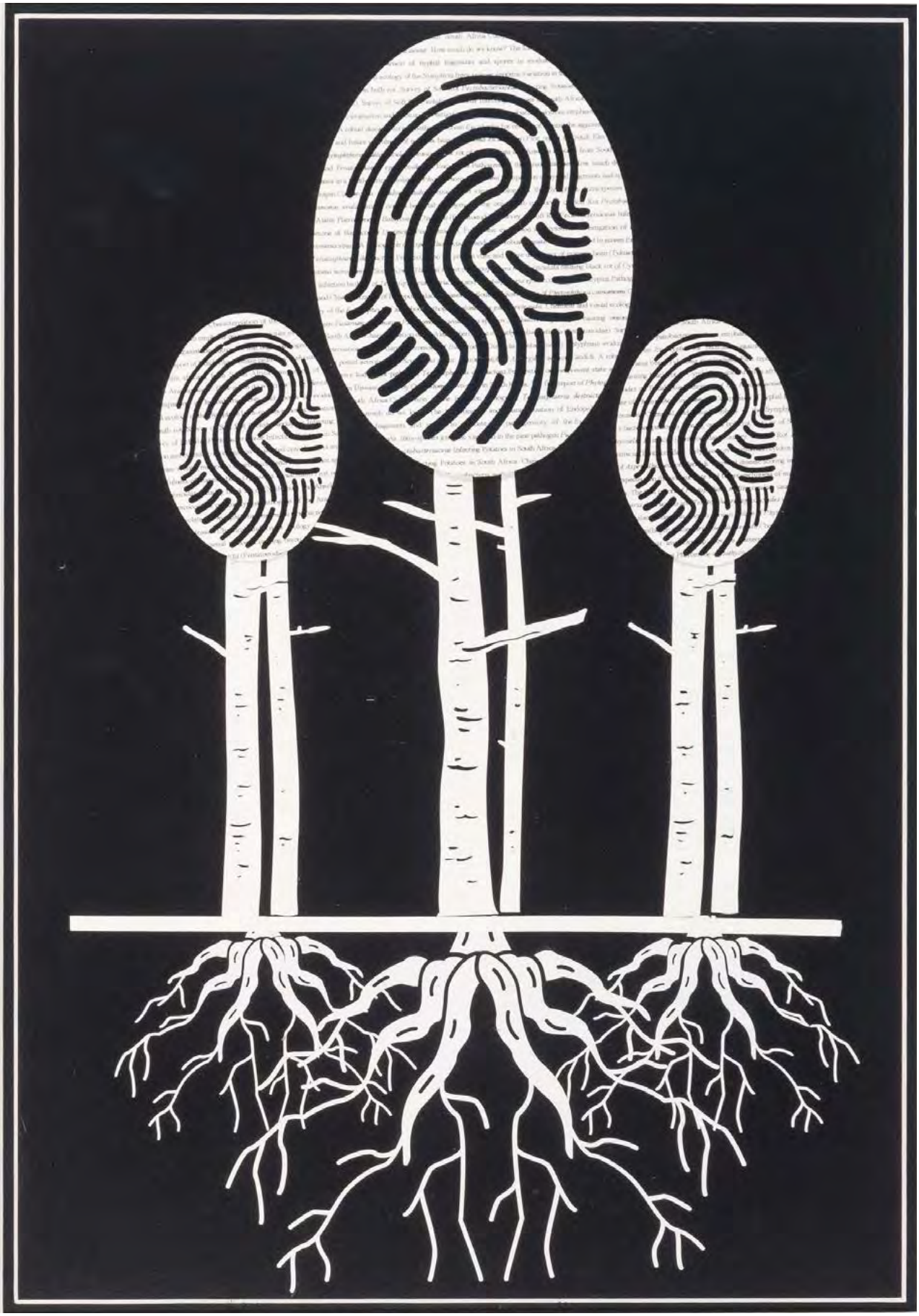
OTHER

FABI Museum Inaugurated

The FABI Museum was inaugurated at an informal gathering on 19 July 2022 where Prof. Mike Wingfield, founding director of FABI also unveiled cabinets displaying many of the artefacts and items, mostly relating to fungi or tree pathogens, which he collected and stored in his office over 20 years during his tenure as Director of FABI. A group of 30 FABIans gathered to hear Mike regale a few stories relating to some of the 50 exhibits. Each item in the museum has a story associated with it, and this information accompanies the displays. Mike made the point that some items were gifts from friends from around the globe that visited FABI; others date back to earlier times in his career. Many of these are eclectic and some are linked to stories, either true or apocryphal, of people or places encountered in various parts of the world. He encouraged FABIans to spend some time looking at the displays and enjoy reading some of the stories associated with them and thus be inspired to collect new items to be included in the museum in the future.

The Art and Trees Artists Visit FABI

Three artists, Hannelie Coetzee, Tracy Megan and Tarryn Millar attended the FABI Monday Morning Meeting on 17 October 2022, specifically to engage with the FABI community regarding their deep interest in the intersections between science and art. The background to this visit emerged from their ephemeral art project 'A Still Life'. This recently concluded project was part of the (Un)Infecting the City 2021 arts festival, a virtual festival organised by the city of Cape Town aimed at making art "a shared, public, open-access encounter". They explained how this was designed to draw attention to six dead or dying trees in Cape Town and presented an alternative experience of mourning loss and death through the lens of a tree. They explained that viewing a city through the lens of dying trees could offer us an alternative experience; one that places our human existence within a greater natural context. Art that responds sensitively to the stories of the trees provides the viewer with an opportunity to consider a moment of stillness and beauty in the cyclical nature of life. Following their success with 'A Still Life' project, they were awarded a Social Impact Prize by the Rupert Museum, which includes funding for a similar project in Johannesburg. For this project, they have drawn on the research being conducted by FABI on the impact of the Polyphagous Shot Hole Borer (PSHB) on existing tree populations in Johannesburg. They explained how they recently met with FABIans Dr Tudy Paap and Felipe Balocchi at the Johannesburg Botanical Gardens in Emmarentia where they were shown first-hand the damage this invasive borer has wrought on the city's trees.



OBITUARIES

Valentina Nkosi

FABI was deeply saddened at the passing of Valentina Nkosi on 23 July 2021. Valentina formed an integral part of the Institute's culture collection (CMW) where she was employed as a senior laboratory technician. Valentina joined the culture collection in 2002, working under the leadership of Sonja de Beer. The current curator of the CMW Culture Collection, Dr Seonju Marincowitz and colleague Lydia Twala described Valentina as a hard worker and dear colleague. In their words "Valentina was an early bird who would always adhere to the rules and complete any task given to her; the quality of her work could always be trusted. She was always friendly towards students and always maintained good relationships with them". FABIans will remember Valentina's ready smile and laughter, and she could always be seen in the FABI courtyard during lunchtime with her close friend Lydia. Valentina was an unassuming person, always shying away from attention or praise for her hard work.

Neville Denison

Neville Denison will be remembered as one of the three visionary directors of research for the three major private forestry companies (Mondi, Sappi and H.L.&H) that initiated the establishment of the Tree Protection Co-operative Programme (TPCP) in 1990. He served on the Board of the TPCP until his retirement, playing a key role in leading the programme. This included the complex and sensitive process of moving the TPCP to the University of Pretoria in 1998 and thus the establishment of FABI, which grew out of the TPCP. Throughout the better part of his career as a forest geneticist and research leader for Mondi, Neville supported and promoted the TPCP and its team. He was responsible for bringing many new ideas and directions to the programme, including the integration of entomology research in 2003. He was also directly responsible for initiating the process with Tony Trahar (then Chairman of Mondi), which led to the establishment of the Mondi Chair in Forest Pathology. This Mondi Chair contribution to Forest Pathology had a 25-year duration, and enabled many young South Africans to obtain postgraduate degrees in Science. The impact that Neville had on forestry and forest research in South Africa can be found in virtually every nook and cranny of the industry today. A "great tree has fallen".

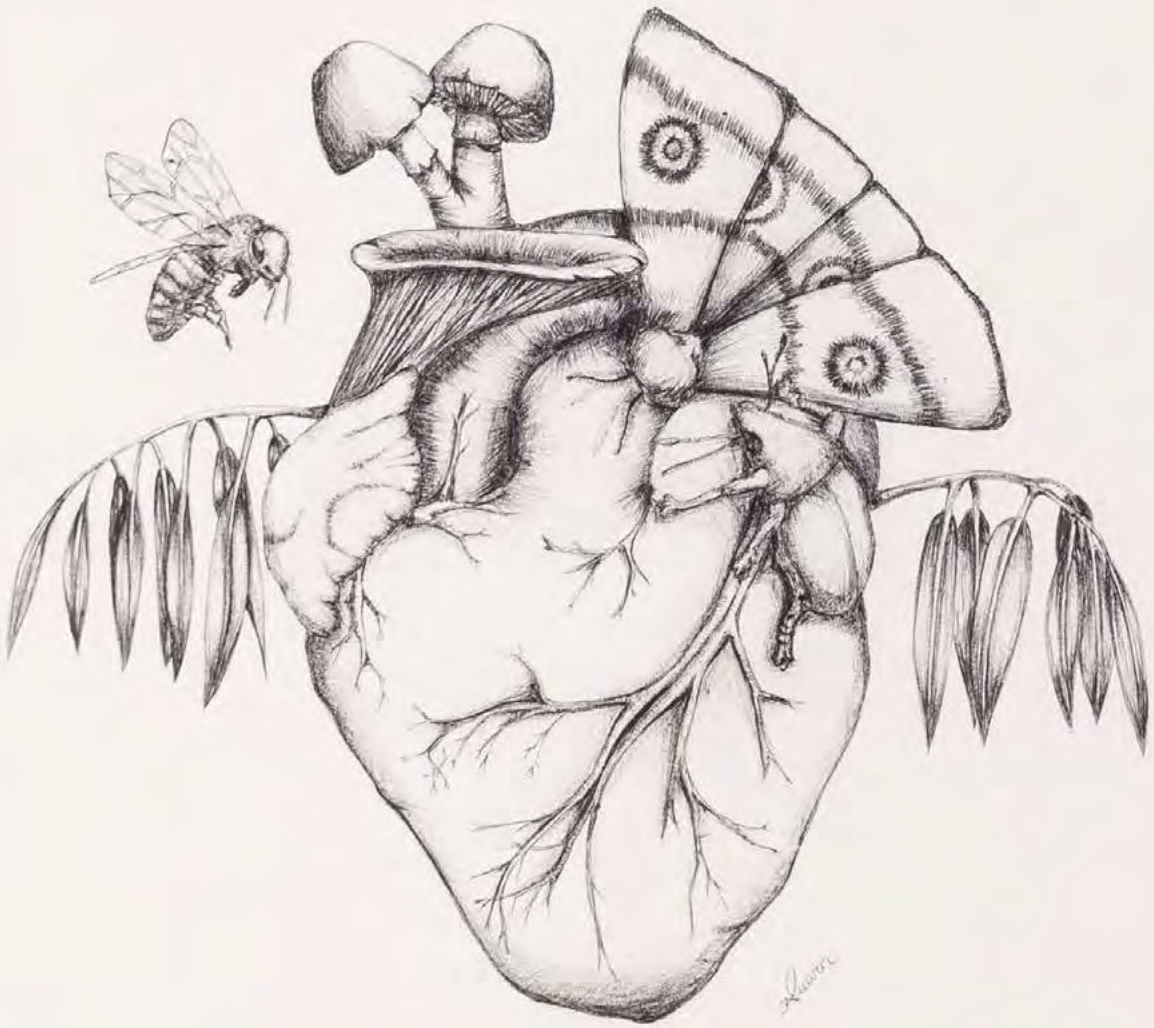
Piet van Zyl

York Timbers CEO, Pieter "Piet" van Zyl, passed away on 17 July 2021, Piet was appointed the CEO of the company, the largest solid wood processor in South Africa, in 2009 to "steer York through the changing economic environment". He led York through significant challenges with insight, decisiveness and courage. Piet was a strong supporter of FABI and the TPCP, and he believed that the future of wood is in engineered wood-building materials. This led to the establishment in 2020 of a multi-disciplinary Chair at the University of Pretoria that is data-driven and focused on wood structural engineering for a sustainable build environment and African bio-economy. He also supported the long-term goal of addressing climate change by deploying site-species matching that entailed planting appropriate species and matching it with suitable temperatures and soil conditions. He also understood the importance of tree breeding, genetics, and genome selection to improve the quality of future plantations and supported this with York joining the Forest Molecular Genetics platform at the University of Pretoria. Piet was an inspirational leader who is missed by many in the industry and FABI.

Our print
Shivan Bezuidenhout and Claudette Dewing

As humans, we have always felt the need to leave our mark on Earth. A legacy is what will succeed us. What began as rudimentary clay prints on cave walls evolved into digital art of the 21st century. This art is a visual representation of the impact we make as scientists. Titles published by FABIans are embedded between the ridges of each fingerprint. All three fingerprint trees are bound together by a strong and interwoven root system. We are the root system, the strength supporting different fields and sharing the beauty of knowledge. That is our mark as scientists. That is the legacy we choose to leave behind.

RESEARCH SUPPORT FACILITIES



The heart of research
Nicole Azevedo

This piece illustrates some of the research FABIans do. The piece also embodies how our research grows close to our hearts and becomes part of us. Mushrooms represent the discipline of mycology, whilst the insects, the bee, *Gonipterus* beetle, and the Pine emperor moth represent the entomology discipline. The heart is also flanked by *Eucalyptus* branches and covered in tree-like veins, representing the forestry industry. This heartfelt representation encapsulated FABI's commitment to research that enriches academic pursuits and contributes to mycology, entomology and forestry. Nicole Azevedo's drawing serves as a visual testament to the dedication of FABIans, where each element within the heart tells a story of passion, knowledge and the relationship between researchers and their chosen disciplines.

BIOLOGICAL CONTROL AND INSECT REARING FACILITY AT FABI

Academic members overseeing the facility: **Prof. Brett Hurley and Prof. Bernard Slippers**

The FABI Biocontrol and Insect Rearing Facility, based on the Innovation Africa @UP campus of the University of Pretoria, provides state-of-the-art facilities for CPHB/TPCP research projects. There are several laboratories equipped with walk-in fridges, autoclaves, incubators and microscopes. These are used for the rearing of, and experimentation on insect pests relevant to forestry and agriculture, and the biological control agents of these pests, including parasitic wasps, and entomopathogenic and parasitic nematodes. The facility contains specialised equipment such as a liquid nitrogen system for cryopreservation of nematodes and a newly-built insect diet room to produce an artificial diet for insect rearing. External facilities include greenhouse tunnels where large-scale inoculation trials are conducted, and seedlings are grown over winter, specialised climate-controlled tunnels for pathogen screening under different climate scenarios 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 where plants are grown for various research projects. In addition, access-controlled Government-certified insect quarantine laboratories and quarantine glasshouse allow for screening and research on potential biological control agents, to use against insect pests of forestry and agricultural crops, before applying to the Government for permission for release. Research at the FABI Biocontrol and Insect Rearing Facility is undertaken by postgraduate students and highly-qualified and experienced staff. There are annual undergraduate practicals and frequent tours showcasing the facilities to both international and national guests.

CHEMICAL ECOLOGY AT FABI

Academic member overseeing the facility: **Prof. Almuth Hammerbacher**

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 an insect species is a sex pheromone which is produced to attract a mating partner.

Chemical signals between species are often 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 therefore available at FABI to strengthen chemical ecology at the Institute and to expand research relating to tree health. These instruments include 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, as well as an Agilent liquid chromatograph coupled to a UV diode-array detector and a small Bruker ion trap mass spectrometer, are available for non-targeted metabolomics.

Facilities are also available to study insect behaviour. These include a wind tunnel as well as assay arenas equipped with light sources and cameras to study insect orientation towards volatile organic compounds.

DNA SANGER SEQUENCING FACILITY

Custodians:
Prof. Sanushka Naidoo
Prof. Wolf-Dieter Schubert

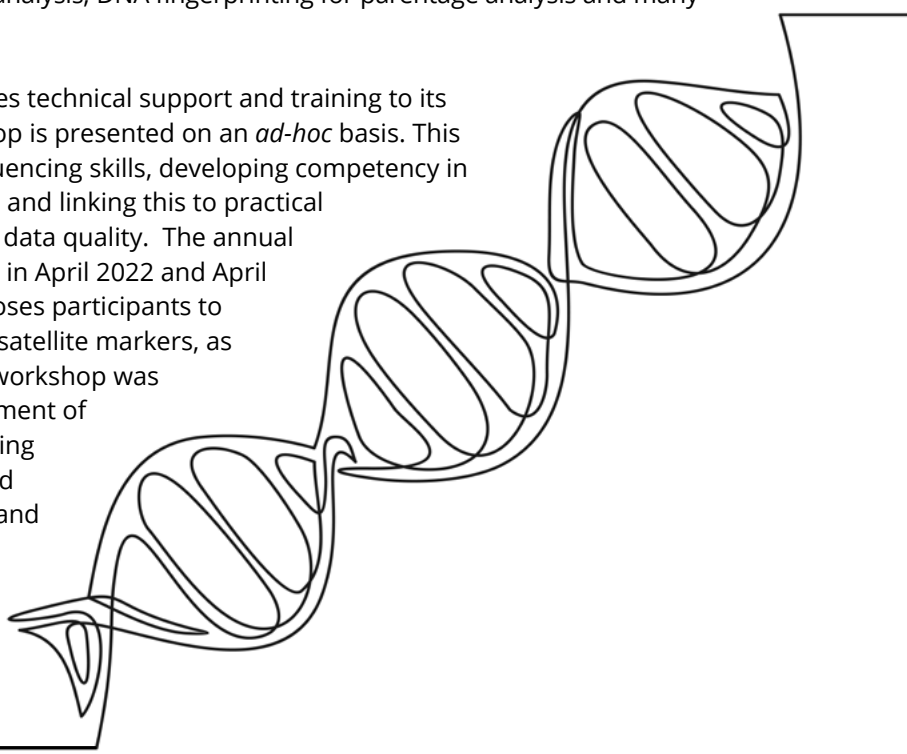
Staff:
Ms. Renate Zipfel (Part time)
Ms. Gladys Shabangu (Full time)
Ms. Onkgopotse Seabi (Student technical support)

The DNA Sanger Sequencing Facility - in the Faculty of Natural and Agricultural Sciences (NAS) is well established and has provided a DNA Sanger sequencing and fragment analysis service to researchers at the University of Pretoria for almost 24 years. The laboratory is situated on the third floor of the FABI Square and Bioinformatics building and hosts two ABI3500xl genetic analyser instruments. The samples are prepared by the researchers and students themselves before submitting them to the facility for processing on the instruments, which are operated by the DNA Sanger sequencing staff.

The facility also hosts a Qubit Fluorometer. This instrument is available for general use to check DNA concentrations, primarily for DNA samples that will be submitted for Next Generation (NGS) DNA sequencing on various platforms.

More than 56 different research projects at the University of Pretoria currently submit samples to the DNA Sanger sequencing and genescan facility. From FABI, 28 researchers, seven research Fellows and the students under their supervision use the services of the facility. In the period 1 June 2021 to 31 May 2023, the facility processed more than 110,000 DNA Sanger sequencing and Genescan samples in total. 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 its clients. A short DNA Sanger sequencing workshop is presented on an *ad-hoc* basis. This workshop focuses on practical DNA Sanger sequencing skills, developing competency in troubleshooting DNA Sanger sequencing results and linking this to practical optimisation in the laboratory to obtain optimal data quality. The annual Introductory Microsatellite workshop took place in April 2022 and April 2023. This week-long, interactive workshop exposes participants to the basic concepts relevant to developing microsatellite markers, as well as generating and analysing the data. This workshop was presented by seven facilitators from the Department of Biochemistry, Genetics and Microbiology, including Prof. Irene Barnes, Associate Professor at UP and research leader in the CPHB-TPCP programme, and FABI students Mr Nam Pham supported by Ms. Claire Randolph and Mr Harman Barten in 2022 and 2023, respectively.



FABI CULTURE COLLECTIONS

Curator: **Dr Seonju Marincowitz**
Technical staff: **Ms. Lydia Twala, Ms. Boitshoko Rammuki and Ms. Anien Viljoen**
Academic member overseeing the collection: **Prof. Cobus Visagie**

The CMW culture collection was founded in 1989 as part of the Tree Protection Co-operative Programme (TPCP) and has since grown to become a crucial collection of fungi in Africa. FABI researchers and collaborators from around the globe contributed to this collection through various projects. Recently, FABI established and registered CMW-IA with the World Federation of Culture Collections (WFCC). CMW-IA is an open culture collection that stores essential reference strains for forestry and agricultural research, such as plant pathogens, ex-type reference strains, and strains with sequenced genomes.

The culture collection currently houses 60,646 fungal strains belonging to 667 genera and over 3,000 species, while CMW-IA houses 4,321 fungal strains belonging to 253 genera and over 690 species. Between May 2021 and March 2023, 3,773 and 4,321 cultures were deposited in CMW and CMW-IA, respectively. During this period, 1,604 strains were requested for research projects and removed from long-term storage.

Complete genome sequences are a crucial component of biological research. To prepare this data, which will become increasingly valuable in the future, FABI has entered into a collaboration with Hexagon Bio (CA, USA) to sequence the genomes of more than 3,500 CMW/CMW- IA strains per year from January 2022. In 2022, a total of 3,745 strains were submitted to Hexagon Bio, representing 245 genera and more than 600 species. The strains submitted mainly include *Botryosphaeria* (n=312), *Ceratocystis* (n=340), *Colletogloeopsis* (n=214), *Coniothyrium* (n=122), *Cryphonectria* (n=175), *Cylindrocladium* (n=261), *Fusarium* (n=267), *Mycosphaerella* (n=191) and *Ophiostoma* (n=200). The aim of the project is to sequence the diversity recorded in CMW and make the genomes available to the FABI research community. We are also using this opportunity to update the species names and other metadata associated with the CMW cultures.

The main collection is housed in three walk-in cold rooms in the FABI building, while certain groups of fungi are lyophilised or stored in special -80°C freezers. In addition to caring for the cultures, collection staff also oversee the microscope room with several state-of-the-art microscopes, a cryo-microtome that can section a sample at -20°C, and a freeze-dryer that is available to all FABI researchers. Four PhD students assist the collection staff for a limited number of hours per week with some tasks in the collection.

FOREST MOLECULAR GENETICS (FMG) PROGRAMME – PRECISION TREE BREEDING PLATFORM

Custodians: Ms. Melissa Reynolds and Prof. Zander Myburg

The Precision Tree Breeding Platform of the Forest Molecular Genetics (FMG) programme provides a high-throughput research service to the forestry industry in South Africa. Through the Platform, breeders, researchers and farmers throughout South Africa can access relevant DNA marker technologies and make use of the expertise of skilled analysts to assist in implementing the outcomes. DNA markers can be used for quality control within breeding programmes by identifying human errors, such as mislabelling throughout the crossing and propagation process. It can also be used to confirm pedigrees, evaluate pollination techniques, confirm pure species trees and identify hybrids. Furthermore, users of the Platform have access to two SNP genotyping arrays at competitive pricing for more complex molecular breeding applications such as genomic selection. The platform has profiled over 95,000 trees for the South African industry over the past decade. In the past year, the Platform extended its service offering to the Macadamia industry with a new microsatellite marker panel for DNA fingerprinting and parentage analysis supported by SAMAC.

In addition to providing a research service to these two industries, the Platform is closely associated with research conducted by students in the FMG programme, providing training and support to those in the Population genomics team and providing a research service to the Eucalyptus and Pine Pathogen Interaction (EPPI) group, and other research collaborators outside of FMG. The close relationship between the Platform and student research projects allows technology transfer from research outcomes to application tools which have a direct impact on the industries. For example, the development of new microsatellite markers for *Acacia* and *Macadamia*.

HIGH-THROUGHPUT DNA EXTRACTION FACILITY

Custodians: **Ms. Melissa Reynolds and Prof. Zander Myburg**

In 2020, the Technology Innovation Agency (TIA) provided funding to establish a high-throughput DNA extraction facility embedded within the Precision Tree Breeding Platform. This facility houses two high-throughput instruments, the GenoGrinder™ and the oKtopure™ DNA extraction robot. Both of these instruments have increased the capacity of the Platform to be able to meet the increasing demands placed on the Platform with the development of new technologies. The GenoGrinder™ can be used for sample preparation, by homogenising up to 576 samples within two minutes prior to DNA extraction. The oKtopure™ DNA extraction robot allows for DNA extraction from up to 768 samples in a morning, increasing the daily capacity of the Platform four-fold.

The DNA extraction protocols, originally developed for DNA isolation from eucalypt leaf tissue and Pine needle tissue, have been successfully applied (with modifications) to isolate DNA from tissue types of many different organisms, such as *Macadamia*, *Acacia*, *Aloe*, Cycad, *Greyia* and even parasitic wasps. The Platform has made use of the increased capacity to serve not only the forestry and Macadamia industries, but also academic collaborators within the University of Pretoria who are either working on large sample numbers or difficult tissue types. The Platform allowed these researchers to tap into the wealth of experience gained by technicians in the Platform over many years. Over the last two years, the annual capacity of the Platform has doubled to 12,000 samples per year, with the potential for an increase in the future.

The TIA funding grant also included the purchase of a cryogenic DNA BioBank, housed within the DNA extraction facility, which provides the capacity for long-term storage of important tissue and DNA samples.

INDUSTRY DISEASE RESISTANCE SCREENING FACILITY AT FABI

Academic member overseeing the facility: **Prof. Almuth Hammerbacher**

Due to the impact of climate change and human activities, South African foresters are faced with unprecedented yield losses due to high levels of pests and diseases in planted forests. Screening tree varieties that are being developed in South African forestry tree breeding programs for resistance or tolerance against pests and diseases is thus imperative to sustain healthy future forests. FABI (in collaboration with Forestry South Africa and the Department of Science and Innovation) has therefore started to develop a state-of-the-art pest and disease screening facility with three fully-automated greenhouse units. Screening methods for *Fusarium circinatum* on Pine and *Teratosphaeria destructans*, *Elsinoe masingae, Phytophthora* spp. and *Gonipterus* sp. n. 2 on *Eucalyptus* have been developed for industry screening trials.

FABI also acquired a high-resolution radiospectrometer. Methods are currently under development to use this instrument for accurate assessment of damage caused by pests and pathogens in screening trials using hyperspectral data. The screening program now employs a postdoctoral Fellow and an intern on a full-time basis to assist with the screening trials and development of screening procedures for other pests and diseases. With this project, FABI and the TPCP aims to fulfil an important need of the South African forestry industry, as well as pushing the technical boundaries of conducting large-scale, accurate assessments of pest and disease damage using novel technologies for even greater precision in our pest management programs.

PLANT TISSUE CULTURE PLATFORM AT FABI

Custodians: **Prof. Zander Myburg, Prof. Sanushka Naidoo, Ms. Adri Veale**

The Forest Molecular Genetics (FMG) Programme manages the Plant Tissue Culture Facility in FABI. The Facility consists of sterile laboratory space, plant tissue culture rooms and plant growth rooms used by the FMG Programme and other research groups in FABI. The Facility is managed by three skilled technicians providing support to postgraduate students. Over the past two years, the Facility hosted several postgraduate student projects focused on the development of genetic transformation technology for *Eucalyptus* trees. These projects, part of a collaboration with Oregon State University, aim to overcome the recalcitrance of *Eucalyptus* genotypes to genetic transformation and regeneration. Besides *Eucalyptus* transformation, the Facility hosted functional genetics projects in *Arabidopsis*, tobacco and poplar, three well-established models for transgenic research in herbaceous and woody plants. These projects included transgenic overexpression and CRISPR gene editing experiments targeting wood (cell wall) chemistry traits, initiation of flowering and pest and disease resistance.


FOREST MOLECULAR GENETICS PROGRAMME

FABI INDUSTRY PARTNERS AND FUNDING

Crowd
Walter Meyer

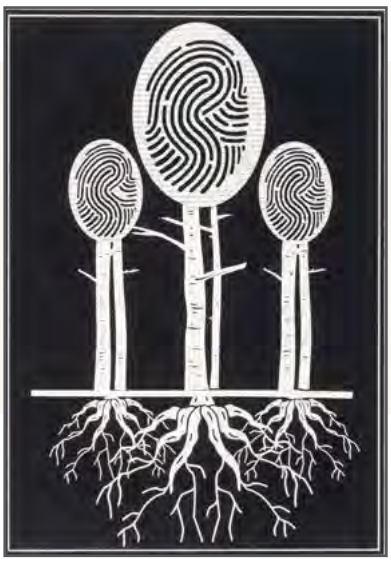
In this lively and colourful painting, abstract forms and shapes converge, resembling a vibrant assembly of people. The energetic strokes and rich tones capture the essence of FABI's collaborations and partnerships. Each figure symbolises a unique entity, representing our diverse stakeholders with whom we have forged close connections. The intertwining shapes reflect our interconnected relationships, driving successful partnerships and visually celebrating the collaborative spirit fueling our research initiatives. Various entities have come together, contributing their own unique colours to create a radiant canvas of innovation and shared goals.

Alexander von Humboldt Foundation
Amathole Forestry Company (Pty) Ltd
April Group - Indonesia
Arauco Forestal Chile
ASICS Biodiversa funding (from DSI)
Bayer
British Society for Plant Pathology
Camcore Breeding and Conservation Cooperative
Cape Pine (Pty) Ltd
Citrus Research International (CRI)
Corteva Agriscience
Department of Agriculture, Land Reform and Rural Development (DALRRD)
Department of Forestry, Fisheries & the Environment (DFFE)
Department of Higher Education
Department of Science and Innovation (DSI)
Deutsche Botschaft Pretoria (German embassy Pretoria)
Deutscher Akademischer Austauschdienst (German exchange Service)
DSI-NRF Centre of Excellence Programme
Forestry South Africa (FSA)
Future Leaders-African Independent Research (FLAIR) Fellowship
Global Challenges Research Fund (GCRF)
Grain SA
Hans Merensky Foundation
Hortgro
Institute for Commercial Forestry Research (ICFR)
Klein Karoo Seed Production Ltd. Pty
Macadamias South Africa NPC (SAMAC)
Maize Trust
Marie Skłodowska-Curie Actions - Research and Innovation Staff Exchange (RISE)
Merensky Timber LTD
Milk SA
Mondi Ltd
MTO Forestry
NCT Forestry Cooperative
NRF Competitive funding for unrated scientists
NRF Competitive Programme for Rated Scientists
NRF ERA-NET co-funding on Food Systems and Climate (FOSC)
NRF Poland/SA Bilateral Grant
NRF SANAP funding
NRF SARChI Research Chair
NRF Swiss/SA Bilateral
NRF-Thuthuka
Oil and Protein Seed Development Trust
PG Bison (Pty) Ltd
Potatoes South Africa
SABIO - South African Bee Industry Organization
Safcol/Komatiland Forests (Pty) Ltd
SANParks
Sappi Southern Africa (Pty) Ltd
SCRI (Speciality Crop Research Initiative)/USDA (United States Department of Agriculture): "Stop the rot: Combating onion bacterial diseases with pathogenomics tools and enhanced management strategies"
South African Grain Lab
South African Kiwi Growers Association
South African National Seed Organisation (SANSOR)
South African Pecan Nut Producers Association (SAPPA)
Southern African Avocado Growers Association (SAAGA)
Stop the Rot USDA NIFA SCRI Onion Bacterial Project (2019-51181-30)
Syngenta South Africa
Technology Innovation Agency (TIA)
The Forestry Sector Innovation Fund (FSIF)
The National Research Foundation (NRF)
The University of Pretoria
TWK Agriculture Ltd
Ukhanyo Farmer Development Programme
US Department of Energy Joint Genome Institute
Westfalia Technological Services
York Timbers (Pty) Ltd

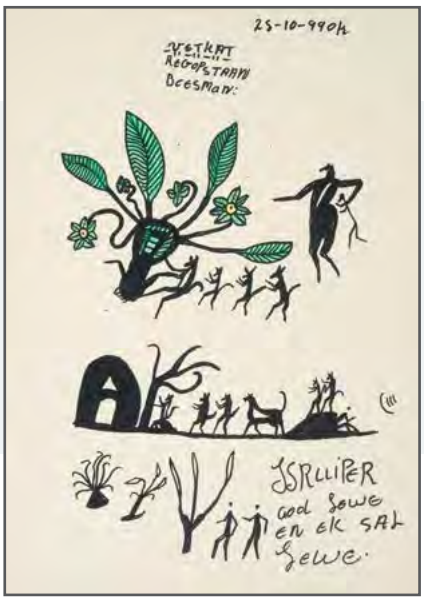
ARTWORK INDEX

"The pieces featured in this report represent the larger collection of artworks hosted at FABI. This collection is curated from professional artists, as well as FABI staff and students. The pieces represent the work done by our researchers and the significant impact that it makes on our natural world. With this collection, FABI emphasises the fusion of art and science – viewing the intersection of creative arts and science as valuable. Scientific art, or Sci-art, serves as a powerful tool for communication, bridging intellectual pursuits with emotions and reaching communities and individuals we might not otherwise connect with. It also provides inspiration and enjoyment for both viewers and artists. To experience these artworks in person, roam the halls of FABI's headquarters on your next visit.

The heart of research
Nicole Azevedo



Our print
Shivan Bezuidenhout and Claudette Dewing



Elements of a selection af art from **Vetkat Kruiper Regopstaan Boesman**. The artist was a member of the Khomani San tribe who lived in the now Kgalagadi Transfrontier Park. His father was a healer and crafter in his community, and clearly had a huge impact on Vetkat's knowledge and understanding of San culture and customs. He is one of very few San artists who sustained the 'lost' (according to some) tradition of San rock art, but with ink on paper as medium. The animality, spirituality and symbolism in Vetkat's works has been the topic of several academic studies.

Insect mandala set
Retha Buitendach

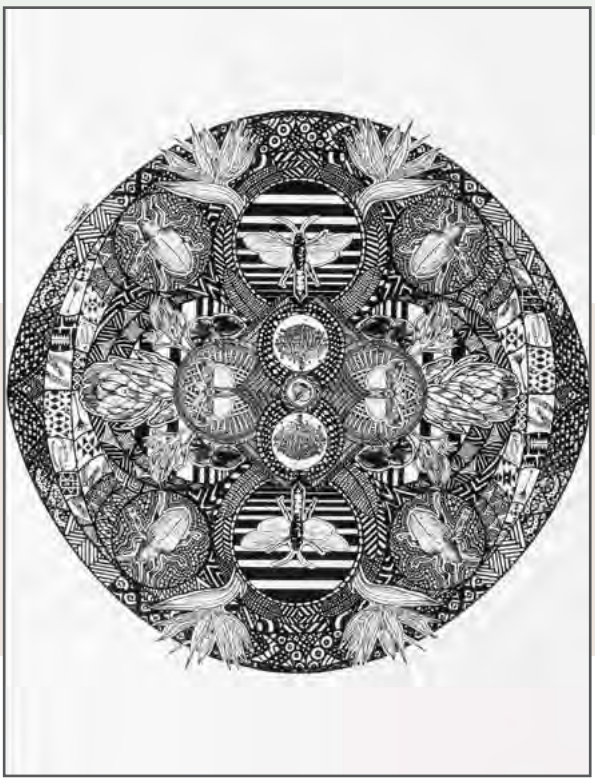
Untitled mixed media
Retha Buitendach

Dream Vision
Bettie Cilliers-Barnard

Ganoderma
Rosa Emelia

Untitled
Christo Coetzee

Untitled
Greta Grunow Guzek

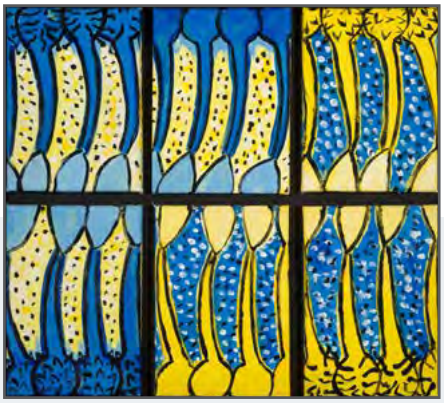


Our world, our wonder
Matt Jackson

Blister beetle on a rust gall
Julia Kreiss

King Protea
Julia Kreiss

Acacia karoo
Julia Kreiss



Ceratocystis is my mistress
Abstract *Ceratocystis, Endoconidiophora* and *Huntiella*
Alistair McTaggart

Abstract rust teliospores
Teliospores of *Sphaerophragmium, Puccinia* and *Uromycladium* inspired by species from South Africa
Alistair McTaggart

Oh oh oh Oomycete
Abstract *Phytophthora, Pythium* and *Plasmopara*
Alistair McTaggart

Untitled
Erich Meyer

Crowd
Walter Meyer

Elephantorrhiza elephantina
Trudy Paap

Baobab of dream
Nam Pham

Birth of a Symbiologist
Diana Six

25 Years of FABI-lous Minds
Elmarie van der Merwe

Untitled
Helen Timm

Anonymous artist

Untitled
Abraham Jacobus (Appie) van Wyk